Whatcom County

Shoreline Master Program Update
Background Information – Volume III

Restoration Plan

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WHATCOM COUNTY PLANNING & DEVELOPMENT NATURAL RESOURCE MANAGEMENT

PLANNING & DEVELOPMENT SERVICES

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ACRONYMS

ALEA	Aquatic Lands Enhancement Account
BMPs	best management practices
CIDMP	comprehensive irrigation district management plan
CREP	Conservation Reserve Enhancement Program
DNR	Department of Natural Resources
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
FWS	U.S. Fish and Wildlife Service
LWD	large woody debris
MF	Middle Fork
MRC	Whatcom County Marine Resources Committee
NF	North Fork
NNR	Nooksack Natural Resources Department
NRCS	Natural Resources Conservation Service
NRT	Nooksack Recovery Team
NSEA	Nooksack Salmon Enhancement Association
OHWM	Ordinary High Water Mark
PSAT	Puget Sound Action Team
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
PUD	Public Utility District
SF	South Fork
SMA	Washington State Shoreline Management Act
SMP	Whatcom County's Shoreline Master Program
SRP	Salmonid Recovery Plan
SWS	Society of Wetland Scientists
TAC	Technical Advisory Committee
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
WAC	Washington Administrative Code
WCC	Whatcom County Code
WCD	Whatcom Conservation District
WDFW	Washington Department of Fish and Wildlife
WID	watershed improvement district
WMU	Watershed management Unit
WRIA	Water Resource Inventory Area
WSU	Washington State University

1. INTRODUCTION AND ACKNOWLEDGEMENTS

This report supports Whatcom County's Shoreline Master Program (SMP){ TC "SMP Whatcom County's Shoreline Master Program" \f A \l "9" } update. The SMP, which is also known as Title 23 of the Whatcom County Code (WCC){ TC "WCC Whatcom County Code" \f A \l "9" }, is being updated to comply with the Washington State Shoreline Management Act (SMA or the Act) requirements (RCW 90.58) and the state's SMP guidelines (Washington Administrative Code [WAC] 173-26, Part III), which were adopted in 2003.

The SMP guidelines specify that local governments must include within their master programs a "real and meaningful" strategy to address shoreline restoration. The guidelines further require that the policies in a shoreline master program promote restoration of impaired shoreline ecological functions where such functions are found to be impaired based on a detailed inventory and characterization of the shoreline ecosystem. Local governments are further encouraged to contribute to restoration by planning for and fostering restoration through the SMP and other regulatory and non-regulatory programs.

The Whatcom County Planning Department staff and a team of qualified consultants prepared this report in cooperation with a Technical Advisory Committee (TAC){ TC "TAC Technical Advisory Committee" \f A \l "9" }, whose diligent and thoughtful participation throughout the course of this project is greatly appreciated. The TAC consisted of scientific experts and regional restoration planning leaders from the following agencies: Lummi Nation, Nooksack Tribe, Washington departments of Ecology, Fish and Wildlife, and Natural Resources, Whatcom County Water Resources Department, Whatcom Conservation District, Whatcom County Public Works, Puget Sound Action Team, Whatcom County Aquaculture Association, Port of Bellingham, and the Small Cities Caucus (see Appendix A for members names).

1.1 PURPOSE AND SCOPE OF PLAN

This document has been prepared to comply with the state's SMP guidelines for restoration planning (WAC 173-26-201(2)(f)). The guidelines recommend that restoration plans:

- Identify degraded areas, impaired ecological functions, and sites with potential for restoration;
- Establish overall goals and priorities for restoration of degraded areas and impaired ecological functions;
- Identify existing and ongoing projects and programs that are currently being implemented, or are reasonably assured of being implemented (based on an evaluation of funding likely in the foreseeable future), which are designed to contribute to local restoration goals;
- Identify additional projects and programs needed to achieve local restoration goals, and implementation strategies, including identifying prospective funding sources for those projects and programs;
- Identify timelines and benchmarks for implementing restoration projects and programs and achieving local restoration goals; and
- Provide mechanisms or strategies to ensure that restoration projects and programs will be implemented according to plans and to appropriately review the effectiveness of the projects and programs in meeting the overall restoration goals.

The guidelines acknowledge that the approach to restoration planning may vary among local jurisdictions, depending on:

- The size of the jurisdiction;
- The extent and condition of shorelines in the jurisdiction;
- The availability of grants, volunteer programs, or other tools for restoration; and,
- The nature of the ecological functions to be addressed by restoration planning.

Whatcom County has hundreds of miles of shoreline and over two-thousand five-hundred square miles of land that influence shoreline conditions. Preparing a detailed plan for restoring these areas is a monumental undertaking. This report is intended to highlight general restoration goals and priorities, and potential restoration opportunities, and create a framework for future implementation. It represents only one step in the shoreline planning process. All of the restoration opportunities mentioned herein will require further investigation and analysis to assess feasibility and determine actual benefits and costs. Considerable additional study will be required before detailed implementation plans, budgets, schedules, and monitoring programs can be developed for any individual project.

This work was funded in part through a grant from the Washington State Department of Ecology (Grant #G0400127). The Whatcom County Marine Resources Committee (MRC){ TC "MRC	Whatcom County Marine Resources Committee" \f A \l "9" } also provided some funding for analysis of marine shoreline restoration opportunities.

1.2 NO NET LOSS AND RESTORATION

The concept of no net loss of shoreline ecological functions is rooted in the Act and in the goals, policies, and governing principles of the state's shoreline guidelines. The Act states: "permitted uses in the shoreline shall be designed and conducted in a manner that minimizes insofar as practical, any resultant damage to the ecology and environment of the shoreline area." According to the governing principles of the guidelines (WAC 173-26-186), protection of shoreline ecological functions are accomplished through the following:

- Meaningful understanding of current shoreline ecological conditions;
- Regulations and mitigation standards that ensure that permitted developments do not cause net loss of ecological functions;
- Regulations that ensure exempt developments do not result in net loss of ecological functions;
- Goals and policies for restoring ecologically impaired shorelines;
- Regulations and programs that fairly allocate the burden of mitigating cumulative impacts among development opportunities; and
- Incentives and voluntary measures designed to restore and protect ecological functions.

These principles suggest that no net loss is achieved primarily through regulatory approaches and that restoration occurs mainly via goals, policies, and voluntary or incentive-based mechanisms. It is also important to note that more than simply preventing further loss of ecological functions, master programs provisions must also "…achieve overall improvements in shoreline ecological functions over time when compared to the status upon adoption of the master program." The mandate to improve functions over time provides the basis for restoration planning and creates a distinction between mitigation and restoration in the context of the SMA. Under the Act, applicants for shoreline permits must fully mitigate new impacts caused by their proposed development. However, applicants are not required to restore past ecosystem damages as a condition of permit approval. Permit applicants will not be required to implement the restoration measures identified in this plan as mitigation for project impacts, but they may elect to implement elements of this plan as mitigation for shoreline development if appropriate.

The chart below (Figure 1) shows the distinction between mitigation and restoration as it is applied through the Shoreline Master Program process.

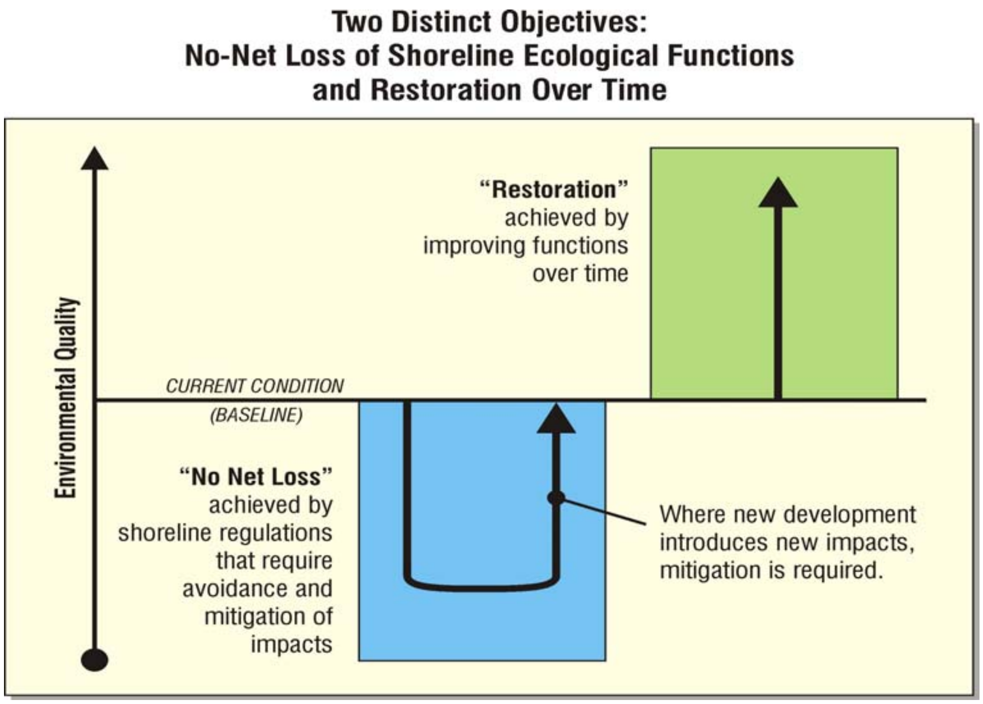

Figure 1. Mitigation Versus Restoration in Shoreline Master Programs
(Source: Department of Ecology)

2. BACKGROUND AND METHODS

Whatcom County's approach to restoring shoreline areas is rooted in the belief that the widespread loss or alteration of nearshore areas, lakes, rivers, streams, and wetlands and their associated ecological functions has serious implications for our quality of life and for overall ecosystem sustainability (National Research Council 1992). Resource managers, community leaders, and government agencies throughout the region and around the world have identified the need for comprehensive restoration strategies to mitigate adverse effects of development and population growth, and to sustain the economic health of natural resource-based industries and businesses (National Research Council 1992; Thom et al. 2005).

2.1 THE RESTORATION PARADIGM

Restoration means the re-establishment of pre-disturbance aquatic functions and related physical, chemical, and biological characteristics (Cairns 1998; Magnuson et al. 1980; and Lewis 1989 in National Research Council 1992). Restoration results in a net increase in the amount, size, and/or functions of an ecosystem or components of an ecosystem (Thom et al. 2005).

Ecology (2005a) defines restoration as "any activity that ensures that the watershed process associated with a key area is reinstated. This can involve restoring the natural condition of the site, but it can also include activities that restore the capacity of the important area to support the process. For instance, an area important for recharge that has already been covered with impervious surfaces could be modified to accommodate recharge or it could be restored to natural conditions."

Inherent in these definitions is the concept of repairing past damage to the resource(s); however, many researchers have cautioned that simply recreating the form or structure of an aquatic habitat without also addressing the controlling processes, habitat structure, and ecological functions will not achieve restoration goals or objectives (Ecology 2005a, Montgomery et al. 2003; Gersib 2001). As an example, the Society of Wetland Scientists (SWS){ TC "SWS Society of Wetland Scientists" \f A \l "9" } Wetland Concerns Committee (2000) reiterates this idea in their position paper on wetland restoration, which identifies five key elements of restoration that are applicable to restoration of wetlands and other aquatic habitats:

1. Restoration is the reinstatement of driving ecological processes.
2. Restoration should be integrated with the surrounding landscape.
3. The goal of restoration is a persistent, resilient system.
4. Restoration should generally result in the historic type of environment, but may not always result in the historic biological community and structure.

Restoration is different from protection. For shorelines, the latter is achieved primarily through policies and regulations that safeguard resources from damage caused by development or human activity. This typically involves designing and operating developments in a way that allows ecosystem processes to continue with minimal impairment. It can also involve open space programs, conservation easements, and similar measures (Ecology 2005a). This plan focuses primarily on restoration using non-regulatory approaches for improving ecological functions and ecosystem conditions. However, protection opportunities are noted where appropriate.

In Whatcom County and throughout the state, several initiatives are underway to restore aquatic habitats, recover threatened fish and wildlife species, and clean up degraded waterways. Advocates of these initiatives have identified programmatic and site-specific restoration goals and objectives using a variety of approaches. Nothing in this plan is intended to override, supplant, or conflict with these established initiatives. The County's intent is to integrate the restoration goals, objectives, and opportunities described herein with other county-wide restoration programs.

2.2 IDENTIFYING POTENTIAL RESTORATION OPPORTUNITIES

Whatcom County identified potential restoration opportunities based on a thorough inventory of shoreline conditions and assessment of ecosystem-wide processes as required by the shoreline guidelines. The *Draft Shoreline Inventory and Characterization Report* (Parametrix et al. 2006) contains important background information on the resources and areas of interest and importance based on detailed assessment of landscape-scale and reach-scale conditions. The report also incorporates findings from numerous other studies conducted throughout Whatcom County.

The County collected, analyzed, and mapped existing information on geology, oceanography, soils, climate, hydrology, sediment transport, water quality/nutrient dynamics, organic matter heat/light inputs, and other data to identify geographic areas that are important for sustaining key processes (these areas are termed "process-intensive" areas or "important" areas). Alterations that have occurred as a result of human action were examined at a coarse-scale for the entire county, including areas outside of shoreline jurisdiction. Actual shoreline conditions (e.g., shoreforms, riparian cover, bank condition, shoreline modification, adjacent land use, fish and wildlife presence, over-water/in-water structures, etc.) were also evaluated at the reach-scale to assess the current level of ecological function and degree of impairment or alteration[1].

While this analysis focuses on identifying opportunities to restore ecosystem processes at the landscape or watershed scale, the County also identified site- and reach-specific restoration opportunities that can improve ecological functions and shoreline conditions in the near-term. These include structural measures such as removing barriers to salmon migration, installing large woody debris jams in streams to promote channel complexity, importing beach sediments to "nourish" eroded nearshore habitats, removing over-water/in-water structures that are adversely affecting habitat, transplanting eelgrass to encourage recolonization, and the like.

In addition, this plan describes actions that can be taken to protect and preserve existing resources. These are over and above compliance with the SMP (and other applicable) regulations and policies and include, but are not limited to:

- Voluntary measures such as establishing conservation easements or acquiring lands for public ownership;
- Implementing education programs with the goal of promoting behaviors that have a positive effect on the environment; and/or
- Developing technologies and best management practices (BMPs){ TC "BMPs best management practices" \f A \l "9" } that reduce pollutants generated through residential and agricultural land use actions.

[1] Methods and results of the assessment are described in detail in the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006).

This plan highlights areas where restoration could or should occur, whether or not those areas are within SMA jurisdiction.

2.3 RATING RESTORATION POTENTIAL

For each Watershed Management Unit (WMU){ TC "WMU Watershed management Unit" \f A \l "9" }, the County evaluated the level of importance (or process-intensity) that individual drainage areas play in terms each process (hydrology, sediment, water quality, organic material, and heat/light) as well as the degree of alteration and assigned ratings of high (↑), moderate (↔) or low (↓) based on best professional judgment (Figure 2).

In this context, important or process-intensive areas are areas within the County that support key ecosystem processes. This is based on the view that each process is governed by a suite of mechanisms associated with specific features on the landscape. Because of their inherent characteristics, areas that are identified as process-intensive have a greater influence on aquatic resource structure and function than other areas and therefore may be more important for protection and/or restoration (Ecology 2005a). However, the designated process-intensive areas are not the only areas where process mechanisms occur.

The potential to restore and/or protect each process in each drainage area is a function of process-intensity and degree of alteration as follows:

Process- intensity	Alteration	Restoration/Protection Potential Rating
↑	↑	**High Restoration**
↔	↑	
↑	↔	**Moderate Restoration**
↔	↔	
↓	↑	
↓	↓	**Low Restoration**
↓	↔	
↑	↓	**High Protection**
↔	↓	

↑ High intensity; High alteration
↓ Low intensity; Low alteration
↔ Moderate intensity; Moderate alteration

Figure 2. Summary of Restoration/Protection Potential Based on "Process-intensity" and Degree of Alteration

Areas that are moderately or highly process-intensive and highly altered are considered to have high potential for restoration. Areas that are moderately process-intensive with moderate alteration and areas with low process intensity and high alteration have moderate restoration potential. By definition, areas with minimal alteration have low restoration potential, but when these areas coincide with areas of moderate or high process-intensity the potential for protection increases.

Restoration potential is a qualitative measure of the relative abundance of opportunities based on the analysis of ecosystem-wide processes and shoreline ecological functions and best professional judgment. Other important considerations must be analyzed concurrently with restoration potential to develop a truly effective restoration plan. Factors such as the relative location of the alterations and the presence of key shoreline functions may also contribute to decision-making regarding implementation of certain restoration actions. As an example, areas that are located between the source of an alteration (e.g., a landslide-prone area that delivers increased sediments) and a high value resource (e.g., a salmon spawning stream) will often be targets for restoration because of their potential to mitigate adverse responses.

In addition, areas with high restoration potential may also contain areas that are relatively intact and warrant protection. Conversely, intact areas that need protection may have some potential for restoration, although the number of opportunities may be fewer than other areas.

While the County is aiming to identify restoration opportunities that provide a comprehensive and holistic solution for addressing altered ecosystem processes (i.e., process-based restoration), site- or species-specific measures and/or structural repairs are also identified where they provide near-term gains in ecological function. As an example, this study identified numerous stream reaches that would benefit from riparian planting to enhance long-term large woody debris (LWD){ TC "LWD large woody debris" \f A \l "9" } recruitment potential. However, an interim measure could involve installing in-channel woody debris to 'jump start' channel formation and provide in-stream habitat complexity.

2.3.1 Additional Assessment of Nearshore Restoration Potential

The Whatcom County MRC provided funding to enhance the County's investigation of nearshore reaches. The results of this work are described in detail in a separate document (Adolfson Associates and Coastal Geologic Services, 2006) and summarized herein. The purpose of the MRC-funded investigation was to supplement existing information and mapping of key nearshore physical and biological characteristics and develop preliminary recommendations for nearshore restoration based on detailed assessment of the physical and biological attributes of each marine reach. The specific objectives of the study were to:

- Classify shore segments based on net shore-drift;
- Identify important sediment input areas;
- Assess degree of connectivity between sediment sources and nearshore reaches;
- Identify key biological resources along each reach;
- Correlate habitat information with shoreform mapping; and
- Rank the habitat value of each reach using models similar to those developed by People for Puget Sound for the Northern Skagit County Bays Blueprint (PPS 2005).

Each marine shore reach was ranked in terms of ability to support forage fish and forage fish spawning, juvenile salmonids, and aquatic vegetation (eelgrass, kelp and algae). Points were assigned to each reach based on positive shore characteristics such as suitable substrate, desirable shoreform and drift patterns, drift cell connectivity, presence of known forage fish spawning/holding areas, abundance of aquatic plant communities, and pocket estuaries. Points were deducted for negative shore attributes including disrupted sediment supply, altered riparian vegetation, shoreline modifications, overwater/in-water structures, disturbed pocket estuaries, and high intensity land use.

To determine the overall restoration potential score, each reach receives a *habitat attribute score* based on the number of positive attribute points and a *habitat impact score* based on the number of negative attributes for each resource, per the following formulae:

> **Forage fish** = (Substrate+Shoreform+Holding and spawning+Eelgrass+Kelp+Algae+Overhanging Riparian)*(Disrupted Sediment Supply +Riparian Alteration + Structures+ Land Use)
>
> **Juvenile salmonids** = (Substrate+Eelgrass+Kelp+Overhanging Riparian+ Pocket Estuary)*(Disrupted Sediment Supply+ Structures+Riparian Alteration+Pocket Estuary+Land Use)
>
> **Aquatic vegetation** = (Eelgrass+Kelp+Algae+Overhanging Riparian)*(Disrupted Sediment Supply +Structures)

Multiplying the habitat attribute score (a positive number) and the habitat impact score (a negative number), and taking the absolute value of the product of the two numbers, yields a range of restoration potential scores from low (sites that have few habitat attributes or few obvious habitat impacts) to high (sites that have both the maximum score in habitat attributes and impacts present). Since this approach is semi-quantitative, the direction of scores (higher being more favorable than lower) is more important than the specific score or precise difference between scores.

3. OVERALL RESTORATION GOALS AND PRIORITIES

3.1 GOALS

The proposed Whatcom County SMP identifies the following overall goal for restoration of shoreline resources (WCC Title 23):

"The goal of restoration is to achieve a net gain in shoreline ecological functions establish at the adoption of the SMP by providing for the timely repair and rehabilitation of impaired shorelines through a combination of public and private programs and actions."

The goal guides implementation of the restoration measures identified in this plan and informs the use, development, and management of shoreline areas throughout Whatcom County. The County seeks to achieve the goal through effective implementation of the SMP policies and regulations, by cooperating with other local, state, and federal agencies, tribes, non-profit organizations, and landowners, and by encouraging and facilitating voluntary actions that will improve shoreline ecological functions over time.

3.2 PRIORITIES

Assigning priority to specific restoration actions is a difficult task that requires balancing the needs and interests of different entities. Fisheries managers have defined recovery of threatened salmonid stocks as top restoration priority. At the same time, residents who rely on drinking water from Lake Whatcom might emphasize restoration measures aimed at improving lake water quality. Other groups may be most interested in restoring nearshore resources such as forage fish spawning beaches or shorebird habitats.

Instead of focusing on a single ecosystem attribute or geographic area, this plan identifies the following general restoration priorities that can be expected to contribute to the goals in Section 3.1 above. These priorities are based primarily on the results of the Draft Shoreline Inventory and Characterization (Parametrix et al. 2006), the WRIA 1 SRP, and other relevant studies. Additional information on watershed- and reach-specific measures/priorities is provided in Chapter 4.

The County will give priority to restoration actions that:

- Create dynamic and sustainable aquatic and terrestrial ecosystems;
- Restore connectivity between stream/river channels, floodplains, and hyporheic zones;
- Restore natural geomorphologic processes that form stream/river channels and nearshore habitats;
- Mitigate peak flows and associated impacts caused by increased stormwater runoff;
- Reduce sediment anthropogenic input to streams and rivers and associated impacts;
- Improve water quality in lakes, rivers/streams, and nearshore areas;
- Restore native vegetation and hydrologic functions of degraded and former wetlands;
- Re-establish native vegetation in riparian areas to improve river/stream and nearshore habitat functions; and

- Are consistent with biological recovery goals for early Chinook salmon, bull trout, and other species for which a recovery plan is available.

3.3 RELATIONSHIP TO SALMONID RECOVERY PLAN (SRP){ TC "SRP SALMONID RECOVERY PLAN" \F A \L "9" }

To attain maximum success, shoreline restoration must be integrated with the Water Resource Inventory Area (WRIA){ TC "WRIA Water Resource Inventory Area" \f A \l "9" } 1 2005 Salmonid Recovery Plan (SRP), the WRIA 1 Watershed Management Plan (WMP), and other planned restoration efforts in Whatcom County. The SRP in particular represents a comprehensive strategy for restoring aquatic resources associated with salmonid habitat in Whatcom County. It outlines goals for recovering Endangered Species Act (ESA){ TC "ESA Endangered Species Act" \f A \l "9" }-listed salmonid populations and provides a framework for implementing recommended actions agreed to by local, state, federal, and tribal governments in WRIA 1. The SRP states:

"The local vision for salmon recovery in WRIA 1 is to recover self-sustaining salmonid runs to harvestable levels through the restoration of healthy rivers and natural stream processes, careful use of hatcheries, and responsible harvest, and with the active participation and support of local landowners, businesses, and the larger community."

Included in the SRP are biological recovery goals for early Chinook salmon and bull trout (see Tables 2.1 and 2.2 in the SRP). Although, salmon-focused by definition, the SRP recognizes the need to restore the landscape processes that form habitats to which wild salmonid stocks are adapted. The SRP states:

"Employing a process-oriented approach to restoration that is based on sound scientific understanding of the biological and physical processes limiting salmonid production, however, will ensure benefit to and facilitate recovery of multiple species, even while benefits to priority species are maximized."

The SRP priorities are generally consistent with, albeit somewhat more specific than, the SMP priorities stated above:

- Focus and prioritize salmon recovery efforts to maximize benefit to North Fork/Middle Fork Nooksack early Chinook and South Fork Nooksack early Chinook salmon.
- Address late-timed Chinook salmon through adaptive management, focusing in the near-term on identifying hatchery versus naturally produced population components.
- Facilitate recovery of WRIA 1 bull trout by implementing actions with mutual benefit to both early Chinook salmon and bull trout and removing fish passage barriers in presumed bull trout spawning and rearing habitats in the upper Nooksack River watershed.
- Address other salmonid populations by protecting and restoring habitats and habitat-forming processes throughout WRIA 1 through regulatory and incentive-based programs, and encouraging and supporting voluntary actions that benefit other WRIA 1 salmonid populations without diverting attention from early Chinook salmon recovery.
- Manage harvest to provide for exercise of treaty-reserved fishing rights while not impeding recovery of early Chinook salmon populations. Protect current harvest levels for late-timed Chinook, sockeye, pink, coho, steelhead and chum salmon.

- Expand harvest of early Chinook salmon to include more meaningful ceremonial and subsistence use and of other stocks (next 11 to 25 years).
- Expand fisheries further to sustainably harvest recovered, self-sustaining salmonid populations (next 25 to 100 years).

In addition, the SRP identifies eight actions to be taken in the next ten years to jump-start recovery:

1. Restore anadromous fish passage at two locations: (1) The City of Bellingham's diversion dam, which will open up 16 miles of formerly accessible Middle Fork habitats and (2) the lower reaches of Canyon Creek (North Fork Nooksack), which will allow unimpeded access to important Chinook salmon tributary habitat and, over time, allow for restoration of habitat functions.
2. Restore properly functioning conditions (wood loading, riparian conditions, water quality, etc.) in the Nooksack forks, main stem, and major early Chinook salmon tributaries.
3. Integrate salmon recovery needs into floodplain management planning so that flood hazard reduction projects are coordinated with recovery projects and provide habitat benefits.
4. Integrate salmon habitat protection into updates to critical areas ordinances and shoreline master programs to ensure that the best available science regarding salmon and salmon recovery is used.
5. Evaluate and, if feasible, establish a South Fork gene bank/supplementation program to preserve the unique genetic characteristics of the South Fork Chinook salmon until river habitat conditions improve.
6. Establish new instream flows in WRIA 1 to ensure adequate flows are available for salmonid spawning, rearing, and migration.
7. Protect and restore estuarine and nearshore areas to provide the quality habitat conditions that will lead to the recovery of Nooksack salmonids (Chinook salmon and other stocks) and stocks originating in other areas that use WRIA 1 marine habitats.
8. Restore riparian and water quality conditions and reconnect isolated habitats in lowland tributaries (mainstem Nooksack) and independent tributaries to the Fraser River and the Strait of Georgia.

These priorities, which are identified for purposes of implementation and allocating salmon recovery funds, are important considerations in the overall shoreline restoration prioritization approach. At the same time, the County's SMP restoration strategy must take into account a broad spectrum of species and habitat needs. So, while this plan includes information from the SRP, it is not a complete replication of that effort. Every attempt has been made to integrate the two plans within the limitations of the SMP scope, yet in some cases information on restoration potential and/or specific restoration opportunities is presented differently in the two plans[2]. These differences notwithstanding, the WRIA 1 SRP is adopted by reference and considered part of this SMP restoration plan; no conflict or inconsistency should be assumed[3].

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[2] As an example, the SRP identifies restoration needs/priorities based on salmonid limiting factors, whereas this plan uses the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006) as a basis. The two plans are mandated by different state laws and have inherent differences as a result.

[3] The reader is directed to the 2005 Salmon Recovery Plan, including Chapter 5 (Strategy and Actions) and Appendix E, the Salmonid Habitat Restoration Strategy, for more information. The plan is available at http://whatcomsalmon.wsu.edu/action-processes-recoveryplan.html

4. DEGRADED AREAS, IMPAIRED FUNCTIONS, AND RESTORATION POTENTIAL

This chapter summarizes information from the *Draft Shoreline Inventory and Characterization Report* (Parametrix et al. 2006) on degraded and impaired areas and areas that have potential to be restored. The focus of this plan is on restoring ecosystem-wide processes, but restoration of site-specific features or habitat attributes is also appropriate in many areas.

Table 1 identifies a general suite of process-based restoration measures that can be applied throughout Whatcom County and their desired ecosystem responses. These sections that follow describe specific process-based and site-scale restoration opportunities in each WMU or group of WMUs that have similar restoration needs and opportunities (Figure 3).

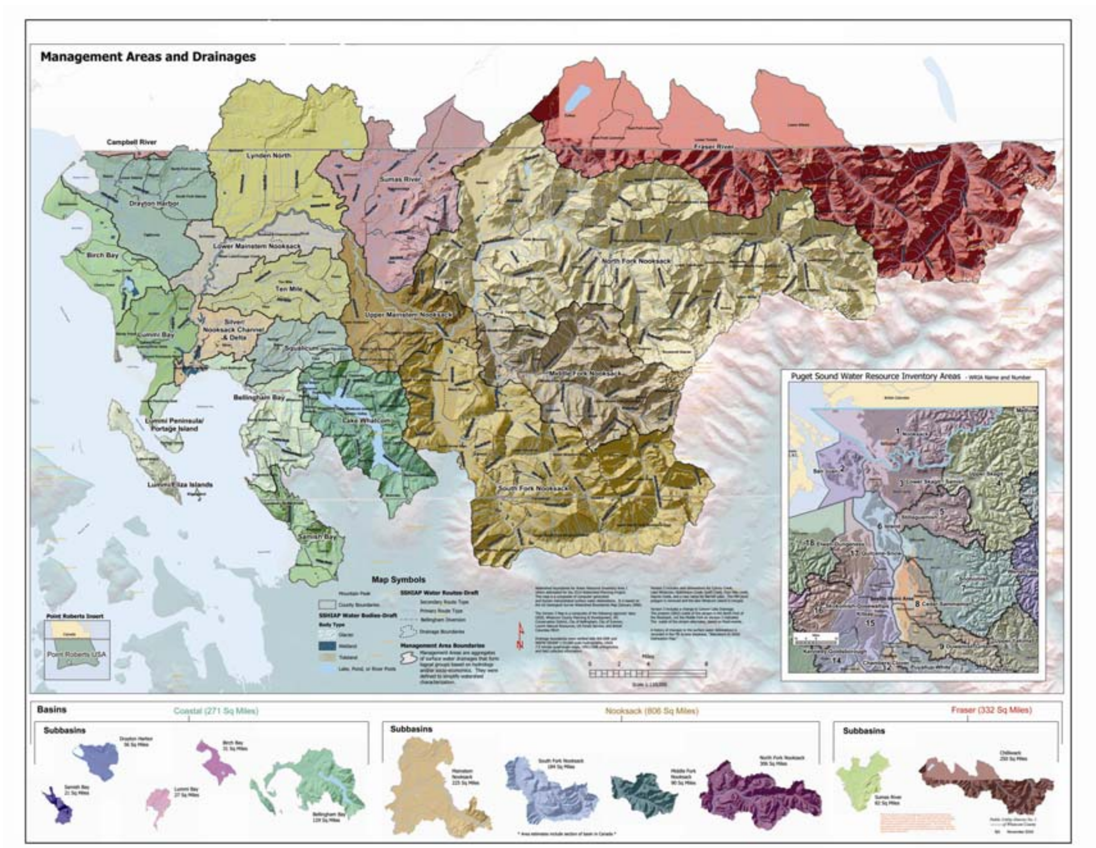

Figure 3. WMU Boundaries in Whatcom County (WRIA 1)

Table 1. Summary of Process-based Restoration Priorities

Process/ Mechanism	Restoration Measure	Desired Ecosystem Response
Freshwater Rivers, Streams and Lakes		
Hydrology		
Infiltration/ Recharge Surface Water Storage Runoff and Peak Flows Groundwater Discharge	Restore forest cover in rain-on-snow zones Plug ditches and remove drain tiles to restore wetland hydrology in lowland areas Remove bank hardening to allow channel migration and increase stream length and sinuousity Disconnect roadside ditches from natural drainage network Retrofit urban development on permeable deposits and along stream valleys to incorporate permeable pavement, infiltration ponds/trenches, etc. Relocate development outside of floodplains Restore depressional wetlands in headwater areas Provide setback levees/dikes to improve floodplain and riverine wetland connectivity Breach/remove dikes to restore and reconnect tidal channels Manage groundwater withdrawals	Improved infiltration and groundwater recharge Adequate instream flows Reduced streambank erosion Reduced scour and stream incision Improved channel morphology and instream habitat Improved habitat for wetland-dependant wetland-associated wildlife species Improved tidal flushing in estuarine habitats Improved access to rearing habitat Improved habitat complexity
Sediment		
Sediment Delivery and Storage	Rehabilitate forest roads where feasible Restore forest cover in landslide hazard areas and erosional areas to minimize erosion Restore wetlands between sediment source and downstream aquatic resources Implement best management practices in agricultural areas and developed areas to minimize erosion Restore stream buffers in agricultural areas and on forest lands to reduce bank erosion	Reduced fine sediment loads, turbidity, and embeddedness Improved channel morphology and instream habitat complexity Reduced egg, fry, and alevin mortality Reduced phosphorus transport Diversification of stream biota

Table 1. Summary of Process-based Restoration Priorities (continued)

Process/ Mechanism	Restoration Measure	Desired Ecosystem Response
Water Quality		
Nitrogen Delivery and Removal	Restore and protect riparian vegetation in groundwater discharge areas Restore and protect riparian vegetation along headwater streams Restore and protect riparian vegetation in areas with shallow alluvium or hydric outwash conditions Restore and enhance depressional wetlands and lakes downstream of urban and agricultural lands Remove or plug ditches to increase residence time Remove dikes and/or install setback levees to restore overbank flow, hydraulic connectivity and hyporheic functions	Denitrification Fewer shellfish closures Reduced algal blooms Improved nutrient cycling Improved invertebrate richness
Phosphorus Delivery and Removal	Restore depressional wetlands on upland terraces and in erosion-prone areas Restore riparian buffers and valley bottom vegetation Re-establish stream meanders in areas of straight line hydrography Encourage reduced fertilization of lawns, especially along lakeshores	Reduced Biological Oxygen Demand (BOD) Increased Dissolved Oxygen (DO) Reduced algal blooms
Pathogen Delivery and Removal	Infiltrate surface runoff Restore depressional wetlands upstream of estuaries Use infiltration trenches with sand filters Reconnect and re-establish/rehabilitate floodplain wetlands to allow sediment removal Remove or plug ditches to increase residence time Restore overbank flooding in important areas above aquatic resource of concern; focus on areas that have riverine depressional wetlands (mineral soils)	Reduced shellfish closures Reduced algal blooms Improved nutrient cycling Improved invertebrate richness
Organic Materials		
LWD Recruitment	Re-establish conifer stands and fast-growing hardwood species adjacent to stream Eliminate structures that minimize channel migration to increase recruitment potential via channel migration or avulsion Restore forest cover on mass wasting risk areas with the potential to deliver wood to streams	Improved channel complexity and habitat diversity Improved channel stability Lower stream temperatures Increased side channel formation Increased detritus inputs Improved bank stability
Heat/Light		
Canopy Cover	Restore canopy cover in riparian and nearshore areas	Lower stream temperatures Increased bank cover

Table 1. Summary of Process-based Restoration Priorities (continued)

Process/ Mechanism	Restoration Measure	Desired Ecosystem Response
Marine/Nearshore		
Circulation	Remove/breach dikes to reconnect tidal channels Remove intertidal fill Remove groins, piers or other impediments to drift patterns	Increased estuarine wetland area Increased salmonid rearing/migration habitat Improved tidal flushing
Sediment Supply	Remove in-water structures and replace shoreline armoring with bioengineered materials Import materials to nourish beaches Remove groins or other impediments to drift patterns Relocate developments/structures/fills that disconnect nearshore areas from upland sediment sources	Improved/increased forage fish spawning habitat
Heat/Light	Plant nearshore riparian areas with native woody species	Improved habitat for forage fish Increased forage fish spawning area Increased nutrient inputs
Nutrient Dynamics/Water Quality	Same as above for Freshwater Replant/transplant eelgrass beds Remove/replace creosote pilings and/or beach logs	Same as for Freshwater Reduced shellfish bed contamination/closures

4.1 NOOKSACK BASIN WATERSHED MANAGEMENT UNITS

The following sections summarize restoration potential and opportunities for WMUs in the Nooksack River Basin. The WRIA 1 SRP identifies a number of restoration priorities for this area as listed in Table 2. Additional opportunities are identified for each WMU within the Nooksack Basin based on the results of the Daft Shoreline Inventory and Characterization Report (Parametrix et al. 2006).

Table 2. Nooksack Basin habitat restoration priorities by watershed area, WRIA 1 Salmonid Recovery Plan (Source: Nooksack Natural Resources et al. 2000

Area	Restoration Priorities
Lower North Fork	Riparian planting of the channel migration area for wood recruitment Riparian planting for shading benefits Construction of stable in-stream wood structures Protection of existing in-stream wood Monitoring of forest practice activities Relocation of stream-adjacent roads and infrastructure

Table 2. Nooksack Basin habitat restoration priorities by watershed area, WRIA 1 Salmonid Recovery Plan (continued)

Area	Restoration Priorities
Upper North Fork	Large-scale LWD placement Riparian restoration to improve wood delivery to the channel Riparian restoration to improve channel shading Set back infrastructure from the channel
North Fork tributaries	Riparian restoration to improve wood delivery to the channel Riparian restoration to improve channel shading Canyon Creek fish passage improvement Canyon Creek habitat restoration
Lower Middle Fork	Upland forest management Riparian restoration on timber managed lands Riparian planting of the channel migration area for wood recruitment Riparian planting for shading benefits
Upper Middle Fork	Restore Passage at Middle Fork Diversion Dam Establish and manage for sufficient instream flow at the Middle Fork Diversion Dam Upland forest management Riparian restoration on timber managed lands
Middle Fork tributaries	Riparian restoration on timber managed lands
Lower South Fork	Upland forest management through Forest and Fish, Northwest Forest Plan, including forest road maintenance and monitoring, riparian management, and avoidance of unstable slopes Protect existing function through regulations (critical areas ordinance and shoreline master program) Acquisition of priority habitats Large-scale LWD placement Restoration of channel migration area Riparian restoration to improve wood delivery Riparian restoration to improve riparian shading Set back infrastructure from the channel Wetland restoration to improve baseflow, temperature maintenance
Upper South Fork	Upland forest management through Forest and Fish, Northwest Forest Plan, including forest road maintenance and monitoring, riparian management, and avoidance of unstable slopes Priority habitat acquisition Large-scale LWD placement Decrease river-adjacent sediment inputs to South Fork Mainstem Riparian restoration to improve channel shading and wood delivery to the channel
South Fork tributaries	Riparian restoration to improve wood delivery to the channel Riparian restoration to improve channel shading

Table 2. Nooksack Basin habitat restoration priorities by watershed area, WRIA 1 Salmonid Recovery Plan (continued)

Area	Restoration Priorities
Upper Mainstem	Riparian and floodplain habitat acquisition Riparian restoration for shading in the Upper Mainstem Area Riparian restoration for wood recruitment in the Upper Mainstem Area Levee setback and removal of bank protection along the Upper Mainstem Nooksack LWD placement
Lower Mainstem	Early action projects that integrate floodplain management with habitat recovery: Bertrand Creek area; Whiskey-Schneider Creek area Implementation of Best Management Practices on urban and agricultural lands Restore mainstem channel complexity Systematically integrate flood planning with habitat recovery
Mainstem tributaries	Restoration of tributary slough habitat to provide flood refuge for fry and overwintering juveniles in the lower mainstem Small-scale riparian restoration through CREP, voluntary stewardship, or community-based programs that do not compete with early Chinook salmon projects Establish and manage for instream flows through Watershed Management Project Implement best management practices to maintain water quality for downstream habitats Restore fish passage using funding sources specifically targeted for fish passage improvements Implement Forest and Fish rules (applies to Smith and Anderson Creek watersheds)
Nooksack Estuary and Bellingham Bay	Restore riverine-tidal blind channel network: Marietta Slough Set back levees on left bank of river between Slater Road and Ferndale Restore channel complexity Prioritize and implement relevant recommendations from the Bellingham Bay Pilot Project

4.1.1 North Fork Nooksack WMU

The North Fork (NF){ TC "NF North Fork" \f A \l "9" } Nooksack WMU encompass approximately 287 square miles of land in northeastern Whatcom County. The North Fork is the main channel of the Nooksack River with headwaters on Mt. Baker. A significant portion of the drainage area is within the Mt. Baker-Snoqualmie National Forest. Areas within the National Forest are generally considered to be low priority for restoration compared to many areas in the lowland parts of the County, although some opportunities may be available on parcels that are privately owned.

The NF mainstem channel and major tributaries are vitally important to salmonid production, especially for early Chinook salmon. The WMU also provides important habitat for bald eagles, Rocky Mountain elk, and numerous other species. Degraded Areas and Impairments

Increased sediment supply and transport to streams is a primary problem affecting shoreline resources throughout the WMU. Timber harvesting and high road densities throughout the watershed, and particularly in areas of high mass wasting and/or erosion potential, have degraded instream, riparian and wetland habitats and reduced salmonid production.

In the NF WMU, nearly all of the drainages are considered moderately to highly impaired with respect to sediment delivery and storage processes. Erosion, debris flows, and landslides in upper and middle tributary drainages have directly affected stream morphology and instream habitat burying redds, widening channels, and increasing the potential for entrenchment. The alterations have contributed to downstream channel instability, turbidity, and reduced survival to emergence. Historically, the lower North Fork was an anastomosing (braided) channel with stable forested islands, but altered sediment processes have created a braided stream with frequent channel shifting, elevated fine sediments in spawning gravels, and channel scour during periods of spawning and egg incubation. The loss of stable forested islands and hydraulic roughness has reduced the quality, availability, and diversity of habitat for fish and other aquatic species. Channel stability has decreased.

Other notable impairments in the NF WMU include: loss of mature forest cover in the lower and middle drainages, especially in rain-on-snow zones in the Maple, Boulder and Coal Creek drainages; loss of wetlands in the floodplain of the mainstem near the base of Slide Mountain and the mouth of Kendall Creek; and high percentages of impervious surface on permeable deposits in the Kendall Creek drainage. The loss of infiltration in that area may be contributing to low summer flows in Kendall Creek and nearby tributaries.

That the NF mainstem and White Salmon, Kendall, Bells, Canyon, Thompson, Gallop, Cornell, Maple, and Racehorse Creeks are all closed to water rights allocation (Ecology 1995b) suggests that surface and/or groundwater withdrawls also have an effect on stream flows and instream habitat. As an example, the Nooksack Falls hydroelectric facility is required to maintain only 30 cfs in the bypass reach on the mainstem (personal communication, Ned Currence, Nooksack Natural Resources).

Development along stream banks and within the channel migration zone and/or on alluvial fans is also a problem in portions of the NF WMU. Areas of concern include the mainstem NF at river mile 40.75 (where the Mosquito Lake Road Bridge constricts channel movement and migration); portions of lower Canyon Creek where flood control structures have been constructed to protect adjacent development; Canyon Lake, and Glacier Creek upstream from Glacier that have been heavily rip-rapped; and portions of Kendall, Maple, Canyon and Glacier Creeks where residential development is encroaching into the riparian zone.

Extensive riparian areas are also identified as being degraded. LWD recruitment potential is considered to be impaired along portions of lower NF mainstem, especially between Canyon Lake Creek and Coal Creek. Debris jam densities are considered low compared to historic conditions—presumably a direct result of the loss of forest cover, altered sediment delivery and floodplain development/modification described above. LWD processes are moderately to highly altered on many NF tributaries including lower Boulder, Canyon, and Cornell Creeks, upper Kendall Creek, and the lower four reaches of Maple Creek. Poor quality riparian habitat impacts stream temperatures, channel complexity, instream sediment storage, and diversity of invertebrate communities.

4.1.1.1 Restoration Potential

Restoration potential is concentrated in lower and middle NF river valley and in drainages with high road densities and mass wasting potential. The extensive floodplain and associated wetlands of the NF Nooksack River provide opportunities to restore multiple ecosystem processes, and could help mitigate the effects of altered sediment processes. The valley bottoms are also subject to increased development pressure and human activity; restoration of these areas would not only benefit the immediate reaches but also contribute to positive functional responses downstream.

Restoration potential is also concentrated in the Kendall, Maple, and Racehorse Creek drainages. However, their influence on conditions on the mainstem is limited relative to the NF valley bottom, therefore restoration of the North Fork valley may produce more tangible results.

The Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006) summarizes restoration potential for portions of the NF WMU as shown in Table 3.

Although the upper NF mainstem and tributaries were not identified as having moderate or high potential to restore processes, these areas would benefit from improved road management and related actions that would reduce the adverse effects of mass wasting.

4.1.1.2 Restoration Opportunities

The following specific restoration opportunities have been identified for the NF WMU:

- Stabilize and/or abandon roads crossing unstable slopes to reduce sediment delivery to the North Fork.
- Restore fish passage to Canyon Creek to allow unimpeded access to important Chinook salmon tributary habitat.
- Enhance riparian cover on the Canyon Creek alluvial fan to increase habitat diversity and provide hydraulic roughness.
- Enhance riparian vegetation in areas of residential and agricultural development to increase shade and detrital inputs, and otherwise buffer adverse effects of adjacent development.
- Reforest managed timberlands, including areas subject to rain-on-snow events to restore natural runoff patterns.
- Create stable islands in appropriate locations by installing log jams to restore lateral and vertical channel stability, increase hydraulic roughness, and promote off-channel habitat development.
- Increase conifer density and cover in hardwood-dominated riparian areas to improve long-term LWD recruitment potential.
- Restore degraded or lost wetlands within the floodplain to mitigate the effects of increased sediment loads and increase water storage capacity.
- Relocate infrastructure away from the channel migration areas and alluvial fans (see specific recommendations in WSDOT reports, GeoEngineers 2001; Gowan 1989).

4.1.2 Middle Fork Nooksack WMU

The Middle Fork (MF){ TC "MF Middle Fork" \f A \l "9" }{ TC "MF Middle Fork" \f A \l "9" } WMU drains 103 square miles in the eastern part of Whatcom County. The mainstem channel and associated tributaries provide important habitat for salmonids including Chinook salmon and bull trout. Bald eagles, marbled murrelets, and Nooksack elk also inhabit the area. Like the NF, much of the upper drainage area is federally owned National Forest.

4.1.2.1 Degraded Areas and Impairments

The MF WMU is generally similar to the NF in terms of topography, geology, climate, and land use. As a result, similar watershed processes are at work in both areas and similar alterations have occurred. As with the NF, altered sediment processes in the MF are responsible for increased lateral migration rates and braiding of the mainstem channel. Channel widening is also evident upstream of river mile 7.2, and some tributaries such as Porter Creek, show signs of aggradation due to increased sediment supply. The MF also has some unique impairments associated with the City of Bellingham's water diversion dam. The dam impedes fish passage and disrupts natural downstream transport of water sediments and organic material.

Degraded riparian areas occur throughout the watershed. Specifically, lower and upper Clearwater Creek and portions of Rocky Creek have low LWD recruitment potential. Streams with areas on the threshold of having impaired LWD recruitment potential include most of Porter Creek, much of the Clearwater drainage, Warm Creek, Rankin Creek, and significant portions of the mainstem (Coe 2001), including most areas downstream of the diversion dam. Porter, Heislers, and Sisters Creeks also have low to moderate canopy cover.

Otherwise conditions in the MF are generally less impaired than the NF WMU:

- Impervious surfaces do not have a significant impact on infiltration processes,
- Floodplain disconnection and channel confinement are not as widespread as in the NF, and
- LWD recruitment processes tend to be more intact than in the NF WMU.

4.1.2.2 Restoration Potential

The lower mainstem MF valley and floodplain have high restoration potential. This area, which coincides with a large surficial aquifer, has high capacity for surface and subsurface water storage. The valley riparian areas also provide areas for nitrogen removal and phosphorous storage/removal, thereby improving water quality.

The lower MF also has the potential to mitigate upstream impacts resulting from accelerated sediment loading in numerous tributaries. This area is also the most susceptible to human alteration and increased development pressure. Restoration potential is also concentrated in tributary drainages with high road densities and landslide frequencies.

Opportunities at Mosquito (Jorgenson) Lake could focus on protecting and restoring depressional wetlands and infiltration of surface waters on permeable deposits to provide area for nutrient storage, transformation, and loss, and pathogen retention and loss. The Draft Shoreline Inventory and Characterization Report summarizes restoration potential for portions of the MF WMU as follows (Table 4):

Table 3. Summary of Process Intensity and Alterations by Drainage Area, North Fork Nooksack WMU[1]

Process	Process Intensity[a]																						Potential for Restoration and Protection
	Hydrology								Sediment						Water Quality				LWD		Heat/LIght		
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion		Storage		Inputs		Storage		LWDRP		Canopy Cover		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	
Lower North Fork	↑	↔	↑	↔	↓	↓	↑	↓	↓	↑	↓	↓	↑	↔	↓	↓	↑	↔	↔	↑	↓	↔	Floodplain and riparian processes have been moderately impaired and likely limited the capacity of the channel to accommodate increased sediment inputs without significant morphological changes.
Lower Tributaries	↓	↓	↓	↓	↑	↔	↓	↓	↓	↑	↔	↔	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔	Improving riparian cover and conifer component and installing LWD are high priorities. Lower relief relatively to the upper WMU limits mass wasting in these tributaries despite high road densities.
Canyon Lake Creek	↔	↓	↓	↓	↑	↓	↓	↓	↔	↑	↓	↔	↓	↓	↓	↓	↓	↓	↑	↔	↑	↑	Canyon Lake moderates sediment inputs from the upper watershed; sediment in the lower watershed is a limiting factor. Poor riparian conditions lead ultimately to high water temperatures, homogenous habitat, and poor instream sediment storage. Improving LWD recruitment potential and possibly installing LWD would improve habitat diversity and instream cover and provide hydraulic roughness.
Racehorse Creek	↓	↓	↓	↓	↑	↔	↓	↓	↑	↑	↓	↔	↓	↓	↓	↓	↓	↓	↑	↔	↑	↔	Significant potential ecological function is limited by sediment impacts and limited riparian function. High restoration potential in this drainage.
Middle North Fork	↔	↓	↑	↔	↓	↓	↑	↓	↔	↔	↓	↓	↑	↔	↓	↓	↑	↔	↔	↔	↓	↔	Similar conditions to lower North Fork, but floodplain/riparian impairments appear to be somewhat more limited. Alterations decrease moving upstream, and are relatively limited above Boulder Creek. Restoration potential is moderately high from Kendall to Boulder Creek, but opportunities to protect intact floodplain areas are also common, particularly upstream of Boulder Creek.
Kendall-Maple	↑	↔	↔	↓	↑	↔	↑	↔	↔	↑	↓	↔	↔	↓	↓	↓	↔	↓	↑	↔	↑	↑	High process-intensity and alterations relative to other tributaries. Build-out should be highly protective of existing process features.
Middle Drainages	↓	↓	↓	↓	↔	↔	↓	↓	↑	↑	↓	↔	↓	↓	↓	↓	↓	↓	↑	↔	↑	↑	Highest priority for sediment management given mix of unstable slopes and less conservative forest practices than in upper watershed, which is National Forest.
Upper North Fork	↓	↓	↔	↓	↑	↓	↓	↓	↑	↔	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↔	↔	Generally low priority because its National Forest land. Opportunities are related to road management to prevent mass wasting, and improving riparian cover and LWD recruitment potential.
Upper Tributaries	↓	↓	↓	↓	↔	↓	↓	↓	↑	↔	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔	

Gold: High potential for protection – process intensive areas with limited alteration

Red: High potential for restoration – areas with moderate to high process-intensity and moderate to severe alteration

Blue: Moderate potential for either protection or restoration – areas with moderate process-intensity and moderate levels of alteration

White: Low potential for either restoration or protection – areas with low process-intensity and low to moderate levels of alteration

[1] Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

Table 4. Summary of restoration and protection potential for key processes by drainage area, Middle Fork Nooksack WMU[1]

	Process Intensity[a]																						
Process	**Hydrology**								**Sediment**						**Water Quality**				**LWD**		**Heat/Light**		
Mechanism	**Infiltration & Recharge**		**Surface Water Storage**		**Snowmelt and Runoff**		**Ground-water**		**Mass Wasting**		**Surface Erosion**		**Storage**		**Inputs**		**Storage**		**LWDRP**		**Canopy Cover**		
Intensity	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Potential for Restoration and Protection**
Lower Middle Fork	↑ (Red)	↔ (Red)	↑ (Red)	↔ (Red)	↓	↓	↑ (Gold)	↓ (Gold)	↑ (Red)	↑ (Red)	↓	↓	↑ (Red)	↔ (Red)	↓	↓	↑ (Red)	↔ (Red)	↓ (Red)	↑ (Red)	↔	↑	The lower Middle Fork River Valley has the highest overall process intensity, and is most susceptible to human alteration, making restoration potential higher in this area than the upper river valley or tributary valleys.
Lower Tributaries	↓	↓	↓	↓	↔ (Red)	↑ (Red)	↓	↓	↑ (Red)	↑ (Red)	↓	↓	↓	↓	↓	↓	↓	↓	↑ (Gold)	↓ (Gold)	↑ (Red)	↔ (Red)	Forest practices in sensitive areas have altered mechanisms common in montane areas.
Porter Creek	↓	↓	↓	↓	↔ (Gold)	↓ (Gold)	↓	↓	↑ (Red)	↑ (Red)	↓ (Blue)	↔ (Blue)	↓	↓	↓	↓	↓	↓	↑ (Red)	↔ (Red)	↑ (Red)	↔ (Red)	Management of sediment inputs from mass wasting and surface erosion are priorities in this area, and loss of riparian function likely exacerbates functional responses to increased sediment supply. This area has a high potential for restoration.
Middle Fork	↔ (Gold)	↓ (Gold)	↓	↓	↓	↓	↔ (Gold)	↓ (Gold)	↑ (Red)	↑ (Red)	↓ (Blue)	↔ (Blue)	↓	↓	↓	↓	↓	↓	↔ (Gold)	↓ (Gold)	↑ (Red)	↔ (Red)	The diversion dam is the highest priority for restoration in this area, where increasing valley confinement begins to limit floodplain function and the dam prevents fish passage.
Jorgenson Lake	↑ (Red)	↔ (Red)	↔ (Gold)	↓ (Gold)	↔ (Blue)	↔ (Blue)	↑ (Gold)	↓ (Gold)	↑ (Red)	↑ (Red)	↓	↓	↔ (Gold)	↓ (Gold)	↓	↓	↔ (Gold)	↓ (Gold)	↑ (Gold)	↓ (Gold)	↑ (Red)	↔ (Red)	This area has glacial outwash deposits (process intensity for infiltration and recharge) resulting in relatively high process-intensity coupled with moderate land use alteration. Restoration potential is high, but the unique character of this area suggests that some level of priority should be placed on the area for protecting existing processes and ecological functions.
Clearwater Creek	↓	↓	↓	↓	↑ (Gold)	↓ (Gold)	↓	↓	↑ (Red)	↑ (Red)	↓ (Blue)	↔ (Blue)	↓	↓	↓	↓	↓	↓	↑ (Red)	↑ (Red)	↑ (Red)	↔ (Red)	Both sediment input mechanism have the potential for restoration in this area, and loss of riparian function likely exacerbates functional responses to increased sediment supply. This area has a high potential for restoration.
Middle Drainages	↓	↓	↓	↓	↔ (Red)	↑ (Red)	↓	↓	↑ (Red)	↑ (Red)	↓ (Blue)	↔ (Blue)	↓	↓	↓	↓	↓	↓	↑ (Gold)	↓ (Gold)	↑	↓	Forest practices have altered hillslope mechanisms common in montane areas.
Upper Middle Fork	↔ (Gold)	↓ (Gold)	↔ (Gold)	↓ (Gold)	↑ (Gold)	↓ (Gold)	↓	↓	↑ (Red)	↑ (Red)	↓	↓	↔ (Gold)	↓ (Gold)	↓	↓	↔ (Gold)	↓ (Gold)	↑ (Red)	↑ (Red)	↑	↓	National Forest – Roads and riparian restoration present most of the opportunity for restoration/management.
Upper Tributaries	↓	↓	↓	↓	↓	↓	↓	↓	↑ (Gold)	↓ (Gold)	↓	↓	↓	↓	↓	↓	↓	↓	↔	↓	↑	↓	

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

[1] Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

The upper MF mainstem has high potential for restoring LWD recruitment processes, but the upper tributaries were not identified as having moderate or high potential to restore processes. Nevertheless, these areas would benefit from improved road management and related actions that would mitigate the adverse effects of mass wasting.

4.1.2.3 Restoration Opportunities

The following specific restoration opportunities have been identified for the MF WMU:

- Restore fish passage upstream of the diversion dam – this is one of the most important restoration opportunities in this WMU.
- Stabilize and/or abandon roads crossing unstable slopes to reduce sediment delivery to the Middle Fork.
- Reforest managed timberlands, including areas subject to rain-on-snow events to restore natural runoff patterns.
- Enhance riparian cover on Porter Creek to mitigate temperature increases.

4.1.3 South Fork Nooksack WMU

The South Fork (SF){ TC "SF South Fork" \f A \l "9" } Nooksack WMU lies in southeastern Whatcom and northeastern Skagit counties, draining a 162-square mile area. This WMU is a mountainous area of high topographic relief and high drainage density. However, the SF differs from the North and Middle forks because it does not have a glacial origin, and channel gradient and valley width are much wider than anywhere else in the forks' watershed. Consequently, gross reach morphology is more similar to portions of the mainstem Nooksack River than to the North or Middle forks (which flow through steeper, narrower valleys). The low gradient SF reaches are depositional zones characterized by fine sediment and wood accumulation and frequent channel movement/migration.

Outwash and alluvial fan deposits adjacent to the SF valley have been identified as potentially important groundwater discharge areas (USGS 2000). These areas may be important for maintaining streamflows during the summer low flow periods.

Extensive wetlands occur along the riparian corridor south to the Samish River and on the outwash deposits along Hutchinson Creek (56 to 86 percent of each reach analyzed); wetlands are more limited on hillslopes outside the river valley and in tributary drainages. The upper watershed contains national forest, wilderness, and parkland, with forest practices as the dominant land use. Private forest holdings are present in the middle and lower watershed.

The SF WMU is identified as one of the top priority areas for salmon recovery. Lands in the southern portion of the drainage to the southern County line are included in the Chuckanut Wildlife Corridor, designated by the County as a habitat of local importance.

4.1.3.1 Degraded and Impaired Areas

Degraded areas include cleared forest lands in the lower and middle WMU, especially along Van Zandt Dike, the area northeast of Lyman Hill. Degraded areas also include the slopes along the west edge of the WMU in the upper basin where timber harvesting has removed hydrologically mature vegetation creating transitional areas that contribute to increased runoff and peak flows, especially in rain-on-snow zones.

Lands in the vicinity of Acme and in the valley downstream (along Highway 9) have high levels of impervious surface, which reduces the potential for infiltration/recharge of the shallow underlying aquifer and can adversely impact stream baseflows.

Other impairments include loss of wetlands in the mainstem valley below Acme (mainly east of Highway 9) and extensive floodplain disconnection caused by bank armoring (riprap, levees, roads, etc.) along the South Fork mainstem. Riprap, levees, and roads along the river reduce the ability of the floodplain to store runoff and attenuate peak flows, especially during rain-on-snow and snowmelt events in early winter and early summer, respectively.

Low flows are a major concern on the South Fork Nooksack River because stream flows are not sustained by snow melt/glacial melt and there is a natural tendency toward low summer flows, which can have significant consequences on habitat availability and water temperature. As a result, the South Fork mainstem, Hutchinson Creek, and Skookum Creek are closed to further water allocations during summer low flows (Ecology 1995).

Streams in the South Fork Nooksack WMU are degraded due to altered sediment processes, and high sediment loads are well documented as a significant problem in the South Fork Nooksack system. The 2005 SRP indicates that fine sediment has a moderate impact on salmonid productivity (especially for spring Chinook salmon) and affects over-wintering/rearing and out-migration.

Channel instability and pool infilling are evident in the lower South Fork mainstem, and increased sediment is likely a contributing factor (Smith 2002). Substrate fining is also a prevalent problem in tributary drainages. Hutchinson Creek has very high levels of substrate fining, almost always exceeding 20 percent[4]. Fine sediment levels are even higher in Skookum Creek, with Cavanaugh Creek having as high as 47 percent subsurface fines, although evidence of pool infilling was limited in both drainages (Smith 2002).

Agriculture and residential development in the SF valley may be increasing pathogen inputs. NWIC (2005) suggests that the South Fork may be a significant contributor to fecal coliform loading downstream, including the Nooksack River estuary.

Riparian habitats are degraded throughout this WMU. Approximately 41 percent of the riparian zone in the lower WMU has low LWD recruitment potential. Black Slough and the upper South Fork Nooksack have predominately low LWD recruitment potential, while the lower and middle sections of the South Fork Nooksack mainstem vary between low and moderate LWD recruitment potential (Coe 2001). Other areas with low LWD include the unnamed tributary just upstream of Jones Creek (through Acme), Hutchinson Creek tributaries, Skookum Creek, Cavanaugh Creek, and lower Wanlick Creek, which has a mixture of low and moderate LWD recruitment potential.

Instream LWD also tends to be low throughout the watershed, even in reaches with high recruitment potential. Smith (2001) characterizes instream LWD conditions as fair to poor in the lower mainstem, Hutchinson Creek, Skookum Creek, and Edfro Creek.

Riparian areas with low canopy cover occur along the South Fork Nooksack downstream of Larsen's bridge (RM 24.7). Most of the tributary riparian areas with low canopy cover are in the Hutchinson, Black Slough, South Acme, Dye, and Lower South Fork drainages, and the Saxon drainage has no riparian areas above target shade levels. As a result, high stream temperatures are a critical problem for the South Fork Nooksack mainstem. The South Fork experiences steep increases in temperature downstream of Bell and Wanlick Creeks, and subsequently cools, but not to the original temperature (Watershed Sciences 2002).

[4] Fine sediment levels exceeding 20 percent are generally considered to be impaired.

Most tributaries provide cooler water to the South Fork than the ambient South Fork temperature. Exceptions include Standard Creek and the RM 11.8 side channel. Other side channels lower in the watershed and Edfro and Wanlick Creeks contribute water at a temperature at or near the ambient South Fork temperature. Howard Creek temperature was below the ambient South Fork temperature, but only by 1 degree Celsius, a much smaller difference than most other tributaries.

4.1.3.2 Restoration Potential

The lower mainstem SF valley and floodplain has the highest intensity of processes and mechanisms. This is the only area in the watershed with a large surficial aquifer and the vast majority of storage areas (for water, sediment, and nutrients). The storage areas provided by the permeable outwash and alluvial fan deposits adjacent to the valley allow subsequent discharge to the SF mainstem. Recharge will take place during the later part of the season at lower flows in some portions of the river, depending on the presence of adjacent permeable deposits. The floodplain and valley have potential to help mitigate functional responses caused by impairments upstream. The lower South Fork also has a high degree of development. Thus, floodplain restoration (via reforestation, removing impervious surface, and reconnecting the river to the floodplain) is of primary importance on the lower SF.

Managing sediment inputs from hillslope processes and restoring riparian areas are also key restoration objectives in this WMU. Skookum Creek in particular has high restoration potential because it is highly altered but sediment inputs are manageable. River left tributaries along the lower SF mainstem also have high restoration potential because of high road densities and high landslide densities. Restoring impaired riparian corridors would not only improve water temperatures but also add sediment storage potential by improving LWD recruitment. The Draft Shoreline Inventory and Characterization Report summarizes restoration potential for portions of the SF WMU as shown in Table 5.

4.1.3.3 Restoration Opportunities

The following specific restoration opportunities have been identified for the SF WMU:

- Install instream LWD at key areas to improve channel stability, habitat diversity (e.g., pool formation, etc.), temperature, and habitat quantity for adult holding and spawning in the lower South Fork. See the Acme-Saxon In-stream Assessment (Maudlin et al. 2002) and the Acme to Confluence Assessment (Nooksack Natural Resources, in prep.), which identifies specific areas for in-stream wood placement.
- Remove or set back infrastructure that is constraining channel migration in the lower South Fork. Examples include pipeline crossings (natural gas pipeline and City of Bellingham water pipeline), a railroad, State Route 9, Mosquito Lake Road, and Saxon Road.
- Enhance riparian areas along stream corridors (mainstem and tributaries) dominated by deciduous trees through planting conifers to improve LWD wood delivery to the channel and mitigate temperature impacts.
- Restore former and/or degraded wetlands on the floodplain (e.g., Rothenbuhler Slough, Foxglove wetland complex near Acme, and the Landingstrip Creek area) and in the vicinity of Black Slough. Also, restore drainage ditches on the floodplain to enhance wetland functioning.
- Manage forest roads to mitigate sediment generated from road failures.

- Acquire lands in the upper South Fork floodplain from timber interests.
- Restore side channels and other off-channel habitat and enhance riparian areas on Hutchinson Creek to aid in long-term sediment storage (through LWD recruitment and pool creation).

4.1.4 Upper Mainstem Nooksack River WMU

The Upper Mainstem Nooksack WMU stretches from the towns of Everson and Nooksack upstream to the confluence of the Middle Fork and North Fork. The contributing area for the upper mainstem includes the watersheds of the three forks.

The upper mainstem floodplain is extensive and includes numerous associated wetlands. Two primary drainages are Smith Creek to the north (right bank) and Anderson Creek to the south (left bank), both of which contain jurisdictional shoreline along a portion of their length. Land use changes from forest practices in the foothills to residential development and agriculture in the Nooksack river valley and lower Anderson Creek.

The upper mainstem and associated off-channel habitat provide important rearing areas for juvenile Chinook salmon and bull trout. High quality riparian habitat (as defined by WDFW PHS data) is found along all of the upper mainstem reaches and these areas provide important habitat for bald eagles (WCDPS 2005).

4.1.4.1 Degraded and Impaired Areas

The lower reaches of the Upper Mainstem channel have been modified, largely for flood control purposes. The downstream portion of the WMU, where the river sometimes overflows to the Sumas drainage, marks the beginning of consistent armoring along both banks of the main channel. Riprap lines most of the right bank for nearly 3 miles upstream of the levee and is intermittent on the left bank. The levees and riprap reduce overbank storage potential and alter hyporheic function. These impacts may be partially offset by the many riparian wetlands along the mainstem that provide water storage capacity when surface water is delivered to them. However, wetland losses have been extensive in tributary drainages, including the lower Smith Creek drainage (within the historic Nooksack floodplain), and in the mid Anderson Creek drainage (vicinity of E Smith Road), and these altered areas may limit overall surface water storage in the watershed.

Instream flows in Smith and Anderson Creeks are impaired and these streams are closed to further water rights allocations during the low flow months (Ecology 1995). Water quality monitoring conducted in 2004-5 showed that Smith Creek dried up during summer months and seepage runs on Anderson and Smith Creeks indicate that some reaches are also losing reaches for at least some part of the summer low flow season (USU 2001).

Road densities in the upper mainstem drainage generally are high enough (3 to 5 mi/mi2) to increase landsliding and sediment transport, even though the percent of watershed area with unstable slopes is much less here (generally less than 16 percent) than in the higher elevation WMUs. The same is true for tributary drainages including Smith Creek and Anderson Creek (North and South Forks).

Table 5. Summary of restoration and protection potential for key processes by drainage area, South Fork Nooksack WMU[1]

	Process Intensity and Degree of Alteration																
Process	**Hydrology**								**Sediment**						**Water Quality**				**LWD**		**Heat/LIght**		
Mechanism	**Infiltration & Recharge**		**Surface Water Storage**		**Snowmelt and Runoff**		**Ground-water**		**Mass Wasting**		**Surface Erosion[a]**		**Storage**		**Inputs[a]**		**Storage**		**LWDRP**		**Canopy Cover**		
Intensity	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	
Lower South Fork (including Black Slough)	↑	↔	↑	↑	↓	↓	↑	↔	↓	↑	↔	↑	↑	↑	↓	↔	↑	↑	↓	↑	↓	↑	The lower Middle Fork River Valley has the highest overall process intensity, and is most accessible to human alteration, making restoration potential higher in this area than the upper river valley or tributary valleys.
Lower Tributaries	↓	↓	↓	↓	↑	↑	↓	↓	↔	↑	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔	The potential for restoration of the predominate sediment and hydrologic mechanisms is high, while limiting further alteration in riparian zones will allow full recovery.
Middle South Fork	↔	↓	↔	↓	↓	↓	↔	↓	↓	↑	↓	↓	↔	↓	↓	↓	↔	↓	↔	↔	↓	↑	Like the lower South Fork, the river valley through with the middle portion of South Fork flows has high process intensity. Conditions, however, are much less altered, and the potential for protection is high.
Hutchinson Creek	↑	↓	↔	↓	↑	↔	↔	↓	↓	↑	↓	↓	↔	↓	↓	↓	↔	↓	↑	↔	↑	↔	Given lower level of mass wasting areas, road maintenance could be more strategic, while riparian protection will allow recovery.
Skookum Creek	↓	↓	↓	↓	↑	↓	↓	↓	↑	↑	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑	↑	↔	Riparian restoration and careful management of ROS zones would improve instream flow, channel stability, and habitat complexity.
Middle Tributaries	↓	↓	↓	↓	↑	↔	↓	↓	↔	↑	↓	↓	↓	↓	↓	↓	↓	↓	↑	↔	↑	↔	Hillslope processes, including ROS zone management and landslide hazard/road management will be dominant management actions in these smaller drainages.
Upper South Fork	↓	↓	↓	↓	↑	↓	↓	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔	Generally low priority because its National Forest land. Opportunities are related to road management to prevent mass wasting, and improving riparian cover and LWD recruitment potential.
Upper Tributaries	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔	

Gold: High protection potential - Moderate to high process intensity with low degree of alteration

Red: High restoration potential - Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential - Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential - Low process intensity with low to moderate degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

[1] Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

Erosion-prone areas near Everson (along the Nooksack River channel) and along the lower Smith Creek channel just upstream of Highway 9 are being affected by high-impact land uses that can increase sediment delivery to downstream resources. The increased sediment inputs have multiple implications for water quality in both the mainstem and lower Anderson Creek because adsorptive pollutants and fecal coliform thrive in sediment rich environments. NWIC (2005) reports that the relative proportion of fecal coliform loading in the Nooksack system that originates in the Upper Mainstem and Forks WMUs is increasing.

The Upper Mainstem Nooksack riparian corridor is highly disturbed at the mouths of its primary tributaries, and there are no areas with high LWD recruitment potential elsewhere on the Upper Mainstem channel. LWD recruitment potential is impaired because mature conifer stands have been replaced by non-forested land and monotypic deciduous stands.

Riparian corridors are relatively intact in the Upper Mainstem tributaries. LWD recruitment potential is high on Smith Creek except near the mouth. Forest practices in the upper Anderson Creek drainage and rural land use in the lower drainage have reduced recruitment potential somewhat, but middle Anderson Creek and approximately half of the headwater tributaries have high LWD recruitment potential. Like Smith Creek, the portion of Anderson Creek on the Nooksack floodplain has a disturbed riparian corridor and low LWD recruitment potential.

LWD densities in the Upper Mainstem are much lower than they were historically (Collins and Sheik 2004a). In addition, the quality of wood is lower and the river lacks the key pieces of large conifers required to produce stable jams (Nooksack Natural Resources et al. 2005). The changing river morphology is also a response to altered wood delivery processes, including the loss of stable jams that catalyze sediment deposition in medial bars and create the patchwork mosaic indicative of naturally functioning anastomosing (braided) streams. Currently, the Upper Mainstem exhibits braided channel morphology with unstable sediment aggradation and transport.

Canopy cover on Anderson Creek and upper Smith Creek is in the range of 40-70 percent, but lower Anderson Creek and lower Smith Creek have a number of reaches with only 20-40 percent canopy cover. The edges of the Nooksack River are almost exclusively 0-20 percent canopy cover, suggesting impaired heat/light conditions (low shading) along the main channel edges. In addition, the transition from an anastomosing to braided channel suggests reduced potential for shading / warm water temperatures in side channels and other off-channel habitats.

4.1.4.2 Restoration Potential

Restoring processes that contribute to mainstem channel stability and allow a return to historic morphology are high priorities for the Upper Mainstem WMU. This would include addressing sediment and wood delivery from the Forks' WMUs, relocating roads and other infrastructure outside the historic channel migration zone, restoring riparian areas to conifer-dominated stands to improve LWD recruitment potential in the long-term, and repairing bank conditions to a more natural state (e.g., removing riprap and removing or relocating levees). These measures would also improve stream shading and water quality. Riparian restoration activities will need to consider flood control, as that is the major purpose of the existing dikes and levees along the Upper Mainstem Nooksack. Until the historic channel morphology is re-established, the potential for restoring off-channel habitat is low (Buffington et al. 2003).

Riparian areas along the Upper Mainstem Nooksack have high restoration potential as these areas support numerous processes and are also highly altered from historic conditions. Efforts should focus on increasing surface water storage and infiltration and recharge, and trapping and storing nutrients and sediments entering the system. Maintaining areas of groundwater seep/discharge along the river channel (right bank) near Everson could improve stream temperatures (USGS 2000).

The Draft Shoreline Inventory and Characterization Report summarizes restoration potential for portions of the Upper Mainstem WMU as shown in Table 6.

4.1.4.3 Restoration Opportunities

The following specific restoration opportunities have been identified for this WMU:

- Protect deltaic character of the Anderson Creek mouth to maintain complex instream and riparian habitats.
- Restore wetlands upstream of the Anderson Creek mouth in Reaches 3, 4, and 5, to provide areas for sediment storage and nutrient cycling.
- Repair armored banks and depauperate riparian zones along the mainstem, especially in the low gradient, unconfined reaches.
- Introduce key pieces of LWD to stabilize what are generally loose aggregates of LWD deposits within the mainstem to jumpstart stabilization/restoration of stream morphology by creating permanent islands, increasing instream sediment storage capacity, and providing habitat complexity.
- Enhance riparian cover in areas of bank instability such as SMP inventory Reach 19 upstream of the Mount Baker Highway crossing and Reach 20 upstream of Deming.
- Reconnect Smith Creek to the Nooksack floodplain and protect existing riparian forest of the Nooksack floodplain near the confluence of Smith Creek.
- Protect groundwater discharge areas on the right bank upstream of Everson to ensure cool water supply to the mainstem.

4.1.5 Lower Mainstem Nooksack River WMU

The Lower Mainstem stretches from the confluence with Tenmile Creek upstream to the towns of Everson and Nooksack. Conditions within the WMU are affected by the area’s contributing basin, which includes the Forks, the Upper Mainstem, and Lynden North WMU, as well as the Tenmile WMU to the south and downstream. Wiser and Fountain Lakes lie to the south of the river. While Wiser Lake drains via Cougar Creek to the Nooksack just above the Tenmile Creek confluence, Fountain Lake drains to Scott Ditch, which runs from Everson to its confluence with the river south of Lynden. Wetland complexes are associated with both lakes and Cougar Creek, but most existing wetlands occur lower in the WMU and are associated with Schneider Creek and/or the Nooksack floodplain.

Agriculture, including dairies, row crops, and till agriculture, dominates the landscape along the lower mainstem. Forest cover is limited and occurs in isolated patches associated with non-agricultural land uses. The towns of Everson and Lynden mark the upper and lower extent of the WMU, and residential land use extends between the two in the southern portion of the WMU, including substantial development surrounding Wiser Lake.

Table 6. Summary of restoration and protection potential for key processes by drainage area, Upper Mainstem Nooksack WMU[1]

Process	Process Intensity[a]																						Potential for Restoration and Protection
	Hydrology								Sediment						Water Quality				LWD		Heat/LIght		
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion		Storage		Inputs		Storage		LWDRP		Canopy Cover		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	
Lower Nooksack Floodplain	↑	↓	↑	↓	↓	↓	↑	↔	↓	↓	↓	↔	↑	↓	↓	↔	↑	↓	↔	↑	↓	↑	This portion of the Nooksack Mainstem has significant, intact riparian wetlands, but armoring and levees likely limit surface, hyporheic, and groundwater interactions between the river and its floodplain. Strategic levee setbacks accompanied by riparian restoration may help restore natural stream morphology and improve habitat.
Smith Creek	↓	↓	↓	↓	↑	↓	↓	↓	↓	↔	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↑	Upper Smith Creek is relatively unimpaired by forest practices. Lower Smith Creek lies on the Nooksack floodplain, and has a hydrologic connection to the larger river system. Restoring /preserving connectivity in the lower drainage may improve functions in both the Nooksack and the creek.
Lower Anderson Creek	↔	↓	↔	↑	↓	↓	↔	↔	↓	↓	↓	↓	↔	↑	↓	↔	↔	↑	↑	↔	↑	↔	Restoring lost wetlands and riparian areas in lower Anderson Creek has the potential to improve water quality, water quantity, and habitat complexity.
Upper Anderson Creek	↓	↓	↓	↓	↑	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔	The upper Anderson Creek is relatively unimpaired by forest practices. Protection of rain-on-snow zones and landslide hazard areas is recommended to prevent increased disturbance regime.
Upper Nooksack Floodplain	↑	↔	↑	↔	↓	↓	↑	↔	↓	↓	↓	↔	↑	↔	↓	↔	↑	↔	↔	↑	↓	↑	Riparian restoration is the key component for re-establishing natural geomorphology. Such restoration will likely succeed only in the context of reduced sediment supply from upstream sources. The area in the vicinity of Smith Creek is highly altered and may provide significant opportunities for restoration projects.
Other Tributaries	↓	↓	↓	↓	↔	↔	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↔	These are typically short, steep tributaries upstream of the major tributaries. Opportunities for restoration may be more limited.

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

[1] Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

The Lower Mainstem WMU provides important habitat for salmonids. Additionally, the WMU includes mapped bald eagle habitat, trumpeter swan habitat, shorebird foraging habitat and concentrations of wintering waterfowl at Wiser Lake, band-tailed pigeon habitat along the upper reaches of an unnamed tributary west of Willeys Lake, and sandhill crane foraging and roosting habitat in the agricultural lands around an unnamed tributary to the north of Lower Mainstem (WCPDS 2005). There is also a sensitive sedge species (bristly sedge) along the shoreline of Wiser Lake west of the Guide Meridian.

4.1.5.1 Degraded and Impaired Areas

Degraded and impaired areas occur throughout the entire WMU. One apparent alteration is the widespread conversion of forest land to agricultural land, which occurred decades ago. Forest cover within the WMU is a fraction of historic conditions. In addition, a large percentage of wetlands have been converted to agricultural use or otherwise altered. The Scott Ditch area, upper Schneider Creek drainage, and areas immediately upstream and downstream of Wiser Lake have experienced the most pronounced wetland losses.

The upper reaches of Cougar Creek and Scott Ditch have been straightened, which alters hyporheic zones and, in combination with agricultural use, urbanization, road crossings, and impervious area, contributes to sediment and nutrient loading within the WMU. This WMU exhibits higher levels of impervious area than most areas in the County, ranging from 3 to 10 percent in the area from Wiser Lake east to Nooksack. Areas of high impervious surface also occur in the southwest corner of the WMU (near the north edge of Ferndale) and in the Schneider Creek drainage near Tatlow and Harksell roads. These impervious areas tend to coincide with permeable deposits indicating increased potential for impaired infiltration/recharge and discharge processes.

Surface and groundwater withdrawals, the interruption of surface and groundwater flows, and loss of surface water storage areas, have affected baseflows within the WMU. Extensive diking along the mainstem of the river has also increased sediment transport and deposition, altering channel morphology compared to historic conditions.

The loss of storage and infiltration/recharge capacity has not only altered peak runoff patterns but also reduced groundwater quantity and limits base flow. Effects on baseflow are also being caused by water consumption. Based on 1997 water rights data, potential consumption of groundwater and surface water in the Lower Mainstem tributary drainages (Scott Ditch, Wiser Lake/Cougar Creek, and Schneider Creek) amounts to approximately 99 cfs, the majority of which is groundwater. This figure is dwarfed by water rights on the Nooksack River, which is estimated at 697 cfs (all water rights converted to cfs for consistency), most of which is surface water. These estimates suggest that consumption is large enough to influence both surface and groundwater hydrology.

Riparian cover is reduced from historic conditions as well, both on the mainstem and the tributaries. Off-channel rearing habitat has been altered and mostly lost. All of these alterations adversely affect water quality and quantity throughout the WMU.

Levees and riprap line the riverbanks to contain peak events with recurrence intervals up to approximately 5 five years. Increased sediment supply from upstream sources has likely increased the rate and amount of sediment deposition along the lower mainstem (Smith 2002). The existing levees/armoring limit the delivery of surface water to potential storage areas and contribute to channel straightening, which increases gradient, decreases flowpath length, and ultimately reduces the potential for peak flow attenuation. The loss of floodplain connectivity and wetland storage also reduces habitat availability and habitat complexity for fish and other aquatic organisms.

The WRIA 1 SRP (Nooksack Natural Resources et al. 2005) reports several responses that can be linked to the hydrology impairments noted above: The length of the lower mainstem channel between RMs 15 and 19 decreased by 35 percent between ~1800 and 1938 due to bank modifications/armoring. Similarly, floodplain area decreased from 33 square miles to 2 square miles below Everson.

Smith (2002) reports reduced baseflow responses to hydrologic alterations. Wiser Lake and most of the tributary drainages along this section of the Nooksack River that are in separate WMUs have partial or full water rights allocation closures. Seepage runs performed by USU (2001) report that on the day sampled, the Nooksack River was a losing reach upstream of the mouth of Kamm Slough.

Increased frequency and duration of peak flows in the Lower Mainstem WMU are predicted based on conditions within the contributing area (which includes the Upper Mainstem and Forks WMUs).

4.1.5.2 Restoration Potential

Much of the land area in the Lower Nooksack Mainstem WMU lies within the Nooksack floodplain, which is an important area for most processes. Restoring drained, degraded, and/or ditched wetlands within the mainstem floodplain including in the Scott Ditch and lower Schneider Creek drainages is one of the key opportunities that should be investigated. Wetland restoration in the Cougar Creek/Wiser Lake corridor and in the Upper Schneider Creek drainage could also help improve water quality and instream flows. Restoration efforts in the area would need to be coordinated with ongoing agricultural uses and existing and planned flood management activities. Overall restoration potential is depicted in Table 7.

4.1.5.3 Restoration Opportunities

The following specific restoration opportunities have been identified for this WMU:

- Enhance riparian cover in areas of high bank instability such as SMP inventory Reach 15 downstream of Everson.
- Integrate floodplain management with habitat recovery, especially in the Schneider Creek area.
- Implement Best Management Practices on urban and agricultural lands to prevent water quality and habitat degradation.
- Restore tributary slough habitat by reconnecting channels to provide flood refuge for fry and overwintering juveniles in the lower mainstem.
- Restore riparian forest cover on the mainstem and tributaries through CREP, voluntary stewardship, or other community-based programs.
- Establish and manage for instream flows through the WRIA 1 Watershed Management Project.

Table 7. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Lower Mainstem Nooksack WMU[1]

	Process Intensity[a]																						
Process	**Hydrology**								**Sediment**						**Water Quality**				**LWD**		**Heat/LIght**		**Potential for Restoration and Protection**
Mechanism	**Infiltration & Recharge**		**Surface Water Storage**		**Snowmelt and Runoff**		**Ground-water**		**Mass Wasting**		**Surface Erosion**		**Storage**		**Inputs**		**Storage**		**LWDRP**		**Canopy Cover**		
Intensity	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	
Upper Nooksack floodplain	↔	↔	↑	↑	↓	↓	↑	↑	↓	↓	↓	↑	↑	↑	↓	↑	↑	↑	↓	↑	↓	↑	
Scott Ditch	↑	↔	↑	↑	↓	↓	↑	↑	↓	↓	↓	↑	↑	↑	↓	↑	↑	↑	↑	↑	↑	↑	
Wiser Lake	↑	↑	↑	↑	↓	↓	↑	↑	↓	↓	↓	↑	↑	↑	↓	↑	↑	↑	↑	↑	↑	↑	
Schneider Creek	↑	↑	↑	↑	↓	↓	↑	↑	↓	↓	↓	↓	↑	↑	↓	↔	↑	↑	↑	↑	↑	↑	
Lower Nooksack floodplain	↔	↑	↑	↔	↓	↓	↑	↑	↓	↓	↓	↓	↑	↔	↓	↔	↑	↔	↓	↑	↓	↑	

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

[1] Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

4.1.6 Lynden North WMU

The Lynden North WMU encompasses the area between the Drayton Harbor and Sumas WMUs and drains to the lower mainstem Nooksack River. Almost half of the watershed lies in Canada. Of the WMU lying within Whatcom County, almost three fourths of that area (40 percent of the watershed) is in agricultural use. Land use in the Canadian portion of the WMU is a mixture of urban and agricultural uses.

The Lynden WMU contains the right bank of the lower mainstem Nooksack River, and the following tributaries: Fishtrap Creek, Bertrand Creek, and Kamm Slough. Judson Lake lies on the Canadian border to the east of Fishtrap Creek. The middle portion of Fishtrap Creek flows through the City of Lynden, where most urban development in the drainage is concentrated. Numerous wetlands are associated with the Bertrand Creek headwaters, and riparian wetlands remain along lower Bertrand Creek and its tributaries. Wetlands are also prevalent in the Kamm Slough headwaters and at the confluence of its two primary headwater tributaries.

Streams in the Lynden North WMU provide important habitat for salmonids. In addition, Bertrand Creek contains a narrow band of high quality riparian habitat (as defined by the WDFW PHS database) just above the confluence with the Nooksack River and in portions of the middle and upper reaches. Fishtrap Creek also contains bald eagle habitat.

Landowners in the Bertrand Creek watershed have established a watershed improvement district (WID){ TC "WID watershed improvement district" \f A \l "9" } and are implementing a comprehensive irrigation district management plan (CIDMP){ TC "CIDMP comprehensive irrigation district management plan" \f A \l "9" } to improve water quantity, water quality, and aquatic habitat conditions throughout the watershed (EES 2004).

4.1.6.1 Degraded Areas and Impairments

Important infiltration/recharge and water storage areas have been altered throughout the Lynden North WMU. The City of Lynden is located directly over an area with high infiltration/recharge potential, and extensive wetlands in the Fishtrap Creek and Kamm Slough drainages have been filled or drained. These hydrologic alterations effectively reapportion precipitation from baseflow to surface runoff. This is particularly true in the area north of Lynden where there are numerous straight-lined channels. Many wetlands are still present in the Bertrand Creek drainage, although large areas of wetland have been drained/ditched or degraded in the upper drainage near the Beaver Ponds.

Within the Nooksack River floodplain, lower Bertrand Creek and nearby Fishtrap Creek are leveed for flood control purposes. The levees disconnect the streams from their floodplains, decreasing surface water storage during peak runoff events, promoting channel incision in the erosion-prone floodplain, and restricting lateral channel migration. Channelization is severe along mainstem tributaries. Such conditions typically limit storage potential both in the channel and in the associated riparian and hyporheic zones, and increase transport by decreasing channel roughness and shortening stream length.

Water withdrawals are also a major issue in the Lynden North WMU and contribute to reduced streamflow during the summer low period. Most water is consumed during summer months for agricultural purposes. EES (2004) estimates that between 8,400 and 10,550 acre-feet of water is consumed annually for agricultural purposes in the Bertrand drainage and could reach as much as 16,800 acre-feet during dry years. Ecology has closed all three major drainages to additional water rights allocations, and both Bertrand and Fishtrap Creeks are currently failing to meet legally established flow minimums (Blake and Peterson 2004). Also, anecdotal evidence cited by Sinclair (2005) contends that Judson Lake currently dries up during the summer months as a result of a low water table.

The backsides of levees bordering the Nooksack River are prone to surface erosion, and lack of forest cover likely contributes to increased sediment supply from these areas. Cultivated lands, which are extensive throughout the WMU, may be another source of increased sediment inputs. High road densities and urbanization near Lynden increase the potential for sediment transport to aquatic resources via ditches and storm sewers. Rapid build-out in the City of Lynden and its UGA may be contributing to increased fine sediment in Fishtrap Creek.

Areas important for nutrient uptake, storage, and cycling have been extensively impaired throughout this WMU. Stream channelization, development adjacent to the Nooksack tributaries, and construction of levees are indicators that hyporheic functions are impaired. Source areas for fecal matter and associated pathogens are also widespread in this WMU. A large number of dairies exist throughout the northern part of the WMU and in Kamm Slough. Septic systems occur in high densities in the lower Bertrand Creek drainage to the west of the City of Lynden.

High fecal coliform levels are a primary concern throughout the Lynden North WMU. Bertrand Creek has an established TMDL for fecal coliform in the lower drainage, and certain reaches are listed as impaired for fecal coliform, dissolved oxygen, and nitrogen (Ecology 2004). Bertrand Creek is also listed as an area of concern for dissolved oxygen and nitrogen (EES 2004; Ecology 2004). Recent TMDL monitoring results show that Bertrand Creek exceeded the TMDL geometric mean and 90th percentile standards for fecal coliform and the standard for dissolved oxygen in 2004-5 (NWIC 2005).

In Fishtrap Creek, water quality impairment occurs mostly upstream of the City of Lynden. Particular sites include Double Ditch (east and west) and the ditches along Benson Road, Bender Road, Depot Road, and Assink Road. This is consistent with water quality data that suggest the largest fecal coliform contributions appear to occur upstream of Pangborn Road and between Bender Road and Lynden's Main Street (USU 2001; NWIC 2005). TMDL monitoring in 2004-5 shows that Fishtrap Creek failed to meet established standards for 90th percentile and median fecal coliform concentrations (NWIC 2005). Fishtrap Creek also violated standards for dissolved oxygen in the most recent monitoring (NWIC 2005).

Kamm Slough also has an established TMDL for fecal coliform and is listed as impaired for dissolved oxygen and pH throughout its entire drainage (Ecology 2004). TMDL monitoring in 2004-5 show that Kamm Creek exceeded 90th percentile and geomean targets for fecal coliform and also violated the dissolved oxygen standard during the winter months.

NWIC (2005) also reports general trends this decade in relative fecal coliform loading in the Nooksack system. The relative contribution from Fishtrap Creek and Kamm Slough is decreasing, while relative fecal coliform loading in Bertrand Creek is increasing. The likely cause of such a trend is improved management in Fishtrap Creek and Kamm Slough.

There is also evidence of groundwater contamination in this WMU. The WRIA 1 groundwater quality study identifies the Lynden North WMU as having some of the highest nitrate concentrations in the County, exceeding EPA limits for annual maximum concentration in every year during the 1990s (USU 2002). USU (2002) identifies the Judson Lake and Bertrand Creek drainages as also having particularly high nitrate concentrations in groundwater.

USU (2002) also identifies pesticide contamination in groundwater. Consequently, USU (2002) identified Bertrand and Fishtrap Creeks as the top priority in WRIA 1 for managing groundwater quality.

The ability of many streams in this WMU to recruit LWD is low because of the lack of intact riparian vegetation and straight line hydrography. Straight-lined channels are evident in the Kamm and Fishtrap Creek drainages, where agricultural land uses typically extend to streambanks leaving very little riparian vegetation. Areas with at least limited LWD recruitment potential occur on the mainstem Fishtrap Creek in and upstream of the City of Lynden, although riparian areas there are somewhat disturbed. The right bank of the Nooksack River has little to no LWD recruitment potential due to the proximity of agricultural fields and lack of channel migration potential. There are significant patches of forest in the Bertrand drainage, and recruitment potential along the mainstem Bertrand Creek remains functional. Many streams in the Lynden North WMU also lack instream habitat complexity. As an example, lower Bertrand Creek, the upper West Branch, and upper McClellan Creek generally lack pool habitats (EES 2004).

Areas lacking adequate canopy cover in the Lynden North WMU are extensive (Coe 2001). Bertrand Creek and its tributaries have only one segment with a greater than 70 percent canopy cover. Canopy cover in Fishtrap Creek is somewhat better; segments on the mainstem near the mouth, in the City of Lynden, and upstream of Lynden have at least 70 percent canopy cover. However, Kamm Creek and Fishtrap Creek tributaries have very low canopy cover. The lack of adequate canopy cover (shade) contributes to increased stream temperatures in lower Bertrand Creek, lower Fishtrap Creek (at Flynn Road), portions of Kamm Slough, and possibly other locations in the watershed.

4.1.6.2 Restoration Potential

The Nooksack River floodplain is a very important area for all key processes. It is also highly impaired and therefore ripe with restoration potential (Table 8). Actions should focus on reconnecting floodplain wetlands to the main channel and enhancing riparian cover. Restoration efforts in this area need to be carefully coordinated with the agricultural community and with the City of Lynden to ensure success and minimize conflicts with existing land uses.

Bertrand Creek is the least degraded of the three major drainages, yet restoring riparian areas and wetlands could contribute significantly to improved ecological function. There is potential to improve water quality and provide additional sediment storage in the upper Bertrand drainage by strategically restoring wetlands and riparian areas downstream of existing sediment and nutrient sources (often dairies). Protecting wetlands in the Boundary Upland and preserving areas of alluvial and outwash deposits along the Nooksack Valley are priorities for baseflow maintenance during summer low flow periods. Exiting high quality riparian buffers should also be protected.

Wetlands could also be restored in the middle Fishtrap drainage where extensive peat deposits have been ditched and drained. Reclaiming these areas as wetland could help to achieve instream flow and water quality goals for this watershed. In addition, directing future development around the City of Lynden toward areas that do not have high infiltration capacity would minimize future alteration of surface and groundwater flows.

The majority of the riparian corridors in this WMU, with the exception of the headwaters of Bertrand Creek and portions of Middle Bertrand Creek and the Beaver Ponds area, would benefit from improved riparian structure and cover.

Restoring aquatic resources and riparian areas in the Lynden North WMU will promote full use of available salmonid spawning and rearing habitat, which is a primary goal for Whatcom County.

4.1.6.3 Restoration Opportunities

The shoreline inventory and the Bertrand Creek WID CIDMP (EES 2004) identify numerous restoration opportunities and needs for portions of the Lynden North WMU. Successful implementation of the CIDMP can improve watershed conditions by leading to higher streamflows during low-flow periods, better prospects for recovery of listed species, and cleaner water, and is therefore a key element of the overall restoration strategy for this WMU. Other restoration opportunities for this WMU include[5]:

- Improving fish passage at specific locations identified by Whatcom County, including the West Branch of Bertrand Creek and McClellan Creek, the tide gate on Duffner Ditch, on Fishtrap Creek in the City of Lynden, and other fish passage-limiting culverts throughout the watershed. Modify exiting conditions on the West Branch and McClellan Creek to enable passage over the full range of streamflows.
- Reconnecting floodplain wetlands in lower Bertrand Creek (SMP inventory reaches 1-4) to the creek and planting with native trees and shrubs to enhance habitat value for terrestrial and aquatic wildlife.
- Restoring drained/ditched wetlands on peat deposits to provide additional water storage capacity.
- Implementing Best Management Practices on urban and agricultural lands to prevent nutrients, pathogens, and sediments from reaching streams and degrading water quality and habitat.
- Programmatically evaluating the costs and benefits of upgrading culverts (to improve fish passage) on agricultural lands on a watershed-wide basis.
- Re-establishing riparian buffers along the natural and artificial watercourses to provide habitat for salmon and other fish and wildlife, improve water quality, control erosion, provide shade, and filter/retain sediment, and nutrients.
- Directing development away from important infiltration areas (permeable deposits) and implement Best Management Practices (including stormwater retrofitting) to prevent future impacts to infiltration/recharge and groundwater discharge processes.
- Restoring riparian cover along Fishtrap Creek in conjunction with floodplain restoration in Reach 1. Restore riparian areas upstream to improve water quality function in areas correlated with increased loading, such as Reaches 7 and 8 and at tributary junctions. Restore channelized sections to a more natural morphology in Reaches 1 and 6.
- Improving canopy cover by planting conifers and fast-growing deciduous species along stream banks, especially in the lower reaches (Reach 1 through 4) of Bertrand Creek.

[5] Some of these are derived directly from the Bertrand Creek CIDMP (EES 2004).

Table 8. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Lynden North WMU[1]

Process	Hydrology								Sediment						Water Quality				LWD		Heat/LIght		
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion[a]		Storage		Inputs[a]		Storage		LWDRP		Canopy Cover		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Potential for Restoration and Protection
Lower Bertrand/ Fishtrap	↑ [Red]	↔ [Red]	↑ [Red]	↑ [Red]	↓ [White]	↓ [White]	↑ [Red]	↑ [Red]	↓ [White]	↓ [White]	↓ [Red]	↑ [Red]	↑ [Red]	↑ [Red]	↓ [Red]	↑ [Red]	↑ [Red]	↑ [Red]	↑ [Red]	↑ [Red]	↔ [Red]	↑ [Red]	This area lies on the Nooksack floodplain and is highly impaired at both the riparian and landscape scales. Restoration could involve reconnection of streams and wetlands and enhancement of riparian wetlands. Preservation of ongoing agricultural land use may limit restoration potential in some areas.
Middle Bertrand	↓ [White]	↔ [White]	↔ [Gold]	↓ [Gold]	↓ [White]	↓ [White]	↑ [Red]	↑ [Red]	↓ [White]	↓ [White]	↔ [Red]	↑ [Red]	↔ [Gold]	↓ [Gold]	↓ [Red]	↑ [Red]	↔ [Gold]	↓ [Gold]	↑ [Red]	↔ [Red]	↑ [Red]	↑ [Red]	Riparian processes in this area are somewhat more intact, particularly on the mainstem. Protection of existing buffers is recommended, and restoration opportunities are available, along tributaries. Non-riparian, process-based restoration potential is more limited, but potential and existing storage areas provide restoration opportunities in the North Fork and McClellan Creek headwaters.
Upper Bertrand	↓ [Blue]	↑[b] [Blue]	↑ [Gold]	↓ [Gold]	↓ [White]	↓ [White]	↔ [Blue]	↔ [Blue]	↓ [White]	↓ [White]	↓ [Blue]	↔ [Blue]	↑ [Gold]	↓ [Gold]	↓ [Blue]	↔ [Blue]	↑ [Gold]	↓ [Gold]	↑ [Gold]	↓ [Gold]	↑ [Red]	↔ [Red]	Potential for protection is high; strategic opportunities for restoring water quality and sediment processes are available.
Middle Fishtrap Creek	↓ [Blue]	↑ [Blue]	↔ [Red]	↑ [Red]	↓ [White]	↓ [White]	↑ [Red]	↑ [Red]	↓ [White]	↓ [White]	↓ [Red]	↑ [Red]	↔ [Red]	↑ [Red]	↓ [Red]	↑ [Red]	↔ [Red]	↑ [Red]	↑ [Red]	↑ [Red]	↑ [Red]	↑ [Red]	Middle Fishtrap includes Lynden and agricultural ditches/tributaries to the north. Restoration of key processes is needed but may be limited due to high degree of alteration. The large organic wetland that has been converted to agricultural use is a potential opportunity for restoring hydrology and water quality processes. Infiltrative areas along the east border of the drainage may provide opportunities for restoring peak flow regime.
Upper Fishtrap Creek	↔ [Blue]	↔[b] [Blue]	↓ [Blue]	↑ [Blue]	↓ [White]	↓ [White]	↑ [Red]	↑ [Red]	↓ [White]	↓ [White]	↓ [Red]	↑ [Red]	↓ [Blue]	↑ [Blue]	↓ [Red]	↑ [Red]	↓ [Blue]	↑ [Blue]	↑ [Red]	↔ [Red]	↑ [Red]	↔ [Red]	Like Middle Fishtrap, upper Fishtrap is highly altered with limited potential for restoring mechanisms that would improve peak runoff patterns, sediment delivery, and water quality. High potential for restoring riparian-scale processes (e.g. LWD and heat light).
Kamm Slough	↑ [Red]	↔ [Red]	↔ [Blue]	↔ [Blue]	↓ [White]	↓ [White]	↓ [Gold]	↑ [Gold]	↓ [White]	↓ [White]	↓ [Blue]	↔ [Blue]	↔ [Blue]	↔ [Blue]	↓ [Red]	↑ [Red]	↔ [Blue]	↔ [Blue]	↑ [Red]	↑ [Red]	↔ [Red]	↑ [Red]	Protection opportunities are numerous in upper Kamm Slough, which contains many depressional wetlands and stable groundwater supply. Lower Kamm Slough has high potential for restoration, but successful restoration will depend on linkages with restoring Nooksack floodplain connectivity. The degree of land use alteration may also limit the potential for full restoration in the Nooksack floodplain.
Judson Lake	↑ [Red]	↔ [Red]	↔ [Gold]	↓ [Gold]	↓ [White]	↓ [White]	↑ [Red]	↑ [Red]	↓ [White]	↓ [White]	↓ [Red]	↑ [Red]	↔ [Gold]	↓ [Gold]	↓ [Gold]	↑ [Gold]	↔ [Gold]	↓ [Gold]	N/A	N/A	N/A	N/A	Judson lake is highly altered and its isolated position in the watershed likely makes it a lower priority restoration. Restoration actions would likely include restoring the lacustrine fringe wetlands and reducing groundwater consumption easements to stabilize summer flux in the lake level.

↑ High Intensity; High alteration
↓ Low Intensity; Low alteration
↔ Moderate intensity; Moderate alteration
Red: High restoration potential: Moderate to high process intensity with high degree of alteration
Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration
White: Low restoration potential: Low process intensity with low to moderate degree of alteration
Gold: High protection potential: Moderate to high process intensity with low degree of alteration
[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.
[b] Areas of high alteration exist in Canada, but process-intensity is unknown. Process-intensive areas within the delineated areas have moderate degrees of alteration (i.e., lack of forest cover but limited impervious area)
[1] Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.
N/A: not applicable

- Moving existing levees on the Nooksack, lower Bertrand, and lower Fishtrap approximately landward of their current location to provide more reliable flood protection for downstream areas and allow for natural meandering through the low gradient floodplain. Levee setback would increase availability and complexity of riffles, pools, and in-channel structure and decrease the potential for levee breaks and harmful flooding.
- Installing large logs with intact rootwads below the ordinary high water mark (OHWM) to create low-velocity zones and cover for juvenile salmonids. Create densely vegetated mid-slope benches to reduce localized erosion and provide low-velocity flood refuge for salmonids over a range of flows.
- Placing slash, logs, and trees on banks and gravel bars and in the stream or river channel for easy recruitment, or key pieces placed in the channel to catch and collect floating debris.
- Continuing to protect water quality by supporting the fecal coliform TMDL clean up plan elements related to dairy waste management, municipal sewage treatment, and rural residential septic waste.

4.1.7 Tenmile Creek WMU

The Tenmile Creek WMU drains 35 square miles in the southern portion of the lower Nooksack basin bordering Ferndale. Shorelines of the state within this WMU include the lower 7.4 miles of Tenmile Creek and Fazon Lake. In addition, the Tenmile WMU includes two major tributaries: Fourmile Creek and Deer Creek, and several small lakes. Barrett Lake is a former artificial impoundment of Tenmile Creek that now consists of a stream/wetland complex. Deer Creek, Tenmile Creek, and their tributaries have associated riparian wetlands along much of their length, and Fazon Lake is surrounded by a large wetland complex. Non-riparian wetlands are also common throughout the WMU, but the Fourmile drainage contains fewer existing wetlands than other areas.

Agriculture is the primary land use in the Tenmile WMU. This includes dairies and associated feed production and crop farms. Pasture and hay fields are distributed throughout the watershed and make up more than 50 percent of land in the WMU (WCD 1986). Less than 25 percent of the WMU remains forested. Most of the remaining forest is second- to later-growth mixed deciduous and conifers located in the southeastern corner of the WMU, in the Deer Creek headwaters.

This WMU provides important habitat for salmonids. Tenmile Creek supports fall run Chinook and coho salmon, and steelhead/rainbow and cutthroat trout, and is primarily used for rearing and migration (including holding). Fazon Lake has been documented as important habitat for waterfowl during the winter, spring, and fall (WDFW 2004).

4.1.7.1 Degraded Areas and Impairments

Existing and historic land uses have altered infiltration and recharge, nutrient storage/uptake, and sediment storage processes in the Tenmile WMU. Sediment and nutrient loading have increased from historic conditions due to loss of forest cover, urban development, road crossings, and till agriculture. The increased sediment loading along with decreased stream flows appears to have created opportunities for extensive colonization by reed canarygrass in stream channels and adjacent riparian zones. Periodic dredging of Tenmile Creek provides temporary relief from streambed aggradation and canarygrass infestation, but dredging disturbs and homogenizes habitat and does not provide a long-term, process-based solution to habitat problems. Reduced groundwater storage has also lowered baseflow in the WMU.

Throughout the WMU, streams have been straightened and ditched, and riparian cover has been reduced. Numerous wetlands have been drained, particularly in the middle Tenmile drainage near the confluence with Fourmile Creek. Historically, streamside wetlands provided important salmonid rearing habitat and backwater habitat for myriad aquatic and terrestrial species, but channelization has limited these functions and reduced habitat heterogeneity.

The impairments to surface water storage, infiltration, and groundwater recharge and the lack of area for sediment storage and nutrient uptake directly affect water quality in the WMU. These impacts are exacerbated by the riparian-scale alterations, which lower hyporheic and riparian wetland function and decrease the stream length along which water quality functions can occur.

Tenmile and Fourmile Creeks are listed as areas of concern for water temperature (Ecology 2004), but Deer Creek is not on the 303(d) list for temperature. Listings were based on Joy (2000) data for Tenmile Creek and unpublished NSEA data on Fourmile Creek. The data show a higher incidence of temperature exceedances below Barrett Lake. Only one temperature sample on both Tenmile and Fourmile Creeks upstream of Barrett Lake exceeded Ecology’s 303(d) temperature criteria.

4.1.7.2 Restoration Potential

In this WMU, restoration potential is concentrated in the lower Deer, middle Tenmile, and Fourmile Creek drainages (Table 9). These areas are important for most processes and are also highly altered. In addition, there are opportunities to improve riparian cover along all streams as canopy cover and LWD recruitment potential are generally below desired levels.

Fourmile Creek is perhaps the most altered drainage within the WMU. The mainstem is almost entirely channelized, and many of the associated wetlands, which contain organic soils important for nutrient storage and uptake, have been drained or filled. Hydrology of wetlands along the stream corridor (particularly upstream of the Guide Meridian) and depressional wetlands outside the riparian corridor could be restored to improve water storage capacity, flood desynchronization, and baseflow support.

The Fourmile Creek drainage also contains extensive areas for infiltration/recharge, water storage, and groundwater discharge, but many of these areas have been altered to support agricultural development and other land uses. Restoring forest cover and re-establishing degraded wetlands on permeable deposits within and outside the riparian corridor could improve baseflow, and water quality, and mitigate sediment delivery to streams. Low-order headwater streams are also important nutrient sinks, and water quality function may be enhanced by restoring riparian vegetation and streamside wetlands in these areas as well.

Because of the level of urbanization in the Fourmile and particularly Deer Creek drainages, there are fewer opportunities for restoring altered processes, but opportunities for site-specific functional improvements may be available.

Table 9. Summary of Process Intensity and Alterations by Drainage Area, Tenmile WMU[1]

Process	Hydrology								Sediment						Water Quality				LWD		Heat/Light		Potential for Restoration and Protection
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion[a]		Storage		Inputs[a]		Storage		LWDRP		Canopy Cover		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	
Lower Tenmile	↓	↑	↑	↔	↓	↓	↑	↑	↓	↓	↓	↑	↑	↔	↓	↔	↑	↔	↔	↑	↔	↑	Riparian restoration on Nooksack floodplain. Ferndale urbanization has limited restoration potential in process-intensive infiltration/recharge and storage areas. Low potential to influence ecological function in the Tenmile WMU because of its spatial position.
Barrett Lake	↔	↑	↔	↓	↓	↓	↑	↑	↓	↓	↓	↑	↔	↓	↓	↑	↑	↓	↔	↔	↔	↑	Riparian-scale process-intensity is high and alteration is moderate. Changing conditions add complexity and increase the difficulty of prioritizing restoration/protection. However, this area warrants close monitoring and adaptive management to prevent near-term degradation.
Lower Deer Creek	↔	↑	↔	↔	↓	↓	↑	↑	↓	↓	↓	↑	↔	↔	↓	↑	↔	↑	↔	↑	↔	↑	Non-shoreline restoration potential limited due to high levels of impairment (wetland loss, urban land use). Potential restoration of storage and transport mechanisms between source inputs and aquatic resources.
Middle Tenmile Creek	↑	↔	↑	↔	↓	↓	↑	↑	↓	↓	↓	↑	↑	↔	↓	↔	↑	↔	↔	↑	↔	↑	The portion of Tenmile Creek between Fourmile Creek and the King Mountain upland has significant process-intensive areas and moderate impairment, particularly of input and storage features. This area has a high potential for restoration.
Fourmile Creek	↑	↔	↑	↑	↓	↓	↑	↑	↓	↓	↓	↑	↑	↑	↓	↑	↑	↑	↔	↑	↑	↑	High levels of alteration may limit efficacy of restoration, but this is the important area for infiltration/recharge, so management could focus on base flow issues such as allocation easements and artificial groundwater expressions such as drainage ditches.
Upper Tenmile Creek	↔	↓	↑	↔	↓	↓	↓	↔	↓	↓	↓	↔	↑	↔	↔	↔	↑	↔	↔	↑	↑	↑	This area has a moderate to high level of process-intensity but is less impacted by land use alterations than other areas lower in the WMU. Protection of existing processes may be more feasible in this area, but restoration opportunities are still likely available.
Upper Deer Creek	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓	↓	↓	↓	↓	↔	↔	↓	↓	↔	↔	↑	↔	Limited process-intensive areas and low levels of impairment. Not a priority for restoration or protection. However, this area does contain much of the last remaining forested areas in the watershed, which may be important for protection regardless of process-intensity.
Fazon Lake	↑	↓	↑	↓	↓	↓	↑	↑	↓	↓	↓	↔	↑	↓	↔	↔	↑	↓	↔	N/A	↓	N/A	Restore sediment and phosphorous processes in areas outside the Fazon Lake shoreline by restoring storage areas and riparian zones, implementing agricultural BMPs, and educating residential land owners.

↑ High Intensity; High alteration
↓ Low Intensity; Low alteration
↔ Moderate intensity; Moderate alteration
Red: High restoration potential: Moderate to high process intensity with high degree of alteration
Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration
White: Low restoration potential: Low process intensity with low to moderate degree of alteration
Gold: High protection potential: Moderate to high process intensity with low degree of alteration
[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.
1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.
N/A: not applicable

4.1.7.3 Restoration Opportunities

Specific restoration opportunities for the Tenmile WMU include:

- Implement measures to control reed canarygrass infestations in Tenmile Creek including Barrett Lake.
- Implement measures to eradicate spotted knapweed (Reach 2) and tansy ragwort (Reaches 2 and 6) along Tenmile Creek.
- Restore former riparian wetlands along Fourmile Creek, including wetlands on organic deposits.
- Protect existing forest cover along the lakeshore of Fazon Lake. The existing buffer width ranges from approximately 150 feet on the south end to more than 1,000 feet on the northwest shoreline.
- Plant conifers and fast-growing hardwoods throughout the riparian zones on lower Tenmile, Deer, and Fourmile creeks, as well as headwater tributaries where cover is lacking, to improve LWD recruitment potential.
- Increase stream sinuousity and floodplain connectivity along Fourmile and Deer Creeks.
- Implement Best Management Practices on urban and agricultural lands to prevent nutrients, pathogens, and sediments from reaching streams and degrading water quality and habitat.
- Protect the alluvial fan near the mouth of Tenmile Creek from encroachment or other disturbance.

4.1.8 Nooksack Delta/Silver Creek WMU

The Nooksack Delta/Silver Creek WMU stretches north from Bellingham Bay upstream to the Tenmile Creek confluence and west to include Tennant and Silver Creek drainages.

The primary aquatic resource in this WMU is the Nooksack estuary. Both Tennant Creek, which drains Tennant Lake, and Silver Creek and its associated tributaries, flow into the Nooksack before draining to Bellingham Bay. The Nooksack floodplain has extensive areas of associated wetlands. Tennant Lake and Tennant Creek lie within the Nooksack delta floodplain and consequently also have large areas of associated wetlands. Silver Creek also has large areas of associated wetlands in the lower drainage that lie in the Nooksack floodplain, but wetlands are also common throughout within this drainage, occurring in larger, contiguous tracts in Bear Creek and upper Silver Creek. Many of these wetlands contain lakes or large areas of open water.

Land use and cover vary widely across the Nooksack Delta/Silver Creek WMU. A significant amount of open space remains in the form of rural residential development and limited agricultural use. The Nooksack delta is mostly undeveloped. The delta, along with the Silver Creek headwaters, encompass the most extensive forested area in the WMU. However, deciduous trees and shrubs dominate most remaining forests. Pockets of more intense development exist around the airport and along major road corridors, including I-5, Northwest Road, Smith Road, and SR 539.

The delta reaches and associated off-channel habitats provide rearing areas for juvenile Chinook salmon and bull trout. Mapped priority habitats include habitat for bald eagle, wintering waterfowl concentrations, wintering peregrine falcon, high quality riparian habitat (as defined by WDFW PHS database) and estuarine habitat (WCPDS 2005).

4.1.8.1 Degraded and Impaired Areas

The Nooksack Delta/Silver creek area is much changed from historic conditions. Until the early 1900s, the Nooksack River commonly avulsed and drained to both Lummi Bay and Bellingham Bay at different times, distributing this sediment to different places. However, settlers permanently diverted the river to Bellingham Bay, substantially altering the characteristics of the estuary. Historically, tidally influenced wetlands extended from the Delta mouth upstream to Tennant Lake. Much of the mainstem of the Nooksack has been diked over the years. In addition, most (56 percent) of the floodplain tributaries to the mainstem have been ditched (Collins and Sheik 2004). Diking and ditching move water more quickly through the system, and reduce the potential for storage and water quality improvement.

An additional consequence of the extensive diking and ditching has been a shift in hydrologic influence from predominantly tidally influenced wetlands to predominantly freshwater wetlands within the Delta and floodplain tributaries.

Because the basin is adjacent to two urban areas (Bellingham and Ferndale) and bisected by several major roadway arterials, including I-5, impervious surfaces are relatively extensive in this WMU. Fortunately, these impervious areas generally do not overlie highly permeable deposits that provide substantial infiltration and recharge capacity.

In the Silver Creek drainage, large wetlands around Larsen Road, the Brennan Lake headwaters, and the Bellingham Airport are no longer intact. The wetlands upslope of Brennan Lake and near Larson Road appear to have been drained by ditches. The wetland upslope of Brennan Lake was also likely filled as part of the I-5 construction, and the highway appears to create a barrier to hydrologic connectivity between wetlands on the upslope and downslope sides.

Groundwater consumption in unincorporated areas (from the Sumas-Blaine surficial aquifer), and surface water consumption for agricultural purposes likely influence streamflow in parts of this WMU. Summer low flows in Silver Creek are below the criteria set by the state and the creek is closed to further water rights allocations for part of the year (WAC 173-501). The criterion is based on the IFIM model for setting minimum flows required for fish habitat.

The majority of water quality contaminants in the Silver/Nooksack Delta WMU are likely delivered from upstream areas in the Lower Mainstem, Tenmile, Lynden North, and Upper Mainstem WMUs. In-basin contaminant sources include dairies in the Silver Creek drainage, on- site septic systems (including concentrations near Marietta and the vicinity of Smith Road/Northwest Drive intersection), and the Bellingham and Ferndale UGAs.

In addition, landscaping practices associated with rural residential areas may contribute to increased levels of nutrients and toxicants in surface and groundwater On-site septic systems in these residential areas are a potentially significant source of water quality impairment due to their density, increasing number associated with a growing rural population, lack of maintenance, and unsuitable soils. Areas bordering the Nooksack floodplain and to the north along Northwest Road will likely continue to be potential sources of fecal matter and nutrient contamination in groundwater. These areas are particularly important because they occur in areas with high aquifer susceptibility.

Urbanized and commercial/industrial areas with the potential for introducing contaminants to aquatic resources include Bellingham International Airport and other sprawl associated with the Cities of Bellingham and Ferndale.

Existing wetlands in this WMU provide areas for water quality improvement, especially in the Tennant Creek and Silver Creek drainages. However, other wetlands have been substantially altered, eliminating opportunity areas for nutrient spiraling /pathogen storage. GIS data show loss of a large wetland at Larson Road and associated channel modifications. Ditches are also apparent on Silver Creek above Marine Drive and on Tennant Creek and tributaries just below Tennant Lake. In the Nooksack delta, one large wetland has been lost along an approximately 2-mile section of the left bank of the Nooksack River above Marine Drive. Although many other floodplain wetlands remain, the river is diked in the upper portion of the delta (RM 2 – RM 6) limiting floodplain connection and hyporheic functions, and reducing the potential for water quality improvement.

Coe (2001) reports that 75 percent of surveyed area in the Nooksack delta has low LWD recruitment potential. No areas of high recruitment potential were found (Coe 2001). Areas near the mouth and on the left bank west of Tennant Lake have moderate recruitment potential. However, the stands in these sections are dominated by cottonwood trees, with very few conifers. The stand width along the river extends up to 100 feet in places, but not beyond.

Coe (2001) also identifies only 13 percent of the stream length in the Silver Creek drainage as having high LWD recruitment potential, while more than 70 percent has low recruitment potential. Hyatt et al. (2004) report that the majority of the mainstem Silver Creek has functioning LWD recruitment potential. Areas in which the two studies are in agreement regarding low LWD recruitment potential include the north fork of Silver Creek near Larson Road and Tennant Creek.

4.1.8.2 Restoration Potential

Despite the change from tidal to freshwater influence, the extensive wetlands that characterize the Delta area offer some of the best opportunities for protection, restoration, and conservation within the County (Table 10). They provide water quality and water storage functions, which could be improved by reconnecting the floodplain within this area. Habitat availability for juvenile salmonids could also be expanded by removing ditches and dikes, though such actions would have to be weighed against the benefits of flood protection and potential effects on existing agricultural uses.

Opportunities for restoration also exist within the Upper Nooksack, though processes are more degraded here than in the lower Delta. However, there is a potentially significant opportunity for improved processes by restoring the floodplain connectivity between the river and the Tennant Lake natural area (in an area of existing open space). The entire floodplain area should be protected from encroaching development resulting from existing urban areas.

4.1.8.3 Restoration Opportunities

Restoration opportunities for the Silver Nooksack Delta area include:

- Restore riverine-tidal blind channel network at Marietta Slough.
- Set back levees on left bank of the river between Slater Road and Ferndale to improve the rearing habitat and passage characteristics of the estuary.
- Restore instream habitat complexity of the mainstem channel.

- Prioritize and implement relevant recommendations from the Bellingham Bay Pilot Project.
- Restore degraded wetlands directly downslope of Ferndale.
- Redesign or remove tide gates to enhance and/or increase the extent of tidal influence and estuarine area. The potential for restoring estuarine and/or tidally influenced areas extends beyond the existing distributary channels into Reach 3 and Reach 4.
- Install LWD to improve channel roughness and habitat heterogeneity.
- Expand public land holdings to include Tennant Lake, the Nooksack River, and the associated floodplain and wetlands in between.

4.2 COASTAL BASIN WATERSHED MANAGEMENT UNITS

The following sections describe restoration opportunities for the coastal basin WMUs in Whatcom County, including areas on the Lummi Indian Reservation[6]. In addition to the WMU-scale assessment of restoration opportunities and potential, section 4.2.10 describes restoration potential of each marine shore reach according to the methods discussed in section 2.3.1.

[6] Lands of the reservation are under the jurisdiction of the Lummi Nation, not Whatcom County. The reservation lands are not subject to the SMP.

Table 10. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Nooksack Delta /Silver WMU[1]

Process	Process Intensity[a]																						
	Hydrology								Sediment						Water Quality				LWD		Heat/LIght		
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion		Storage		Inputs		Storage		LWDRP		Canopy Cover		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Potential for Restoration and Protection
Upper Nooksack delta	↓	↓	↑	↑	↓	↓	↔	↓	↓	↓	↓	↓	↑	↑	↓	↓	↑	↑	↓	↔	↓	↑	Floodplain reconnection and expansion of tidal influence would not only improve process function but also directly increase habitat availability and complexity.
Nooksack distributaries	↓	↓	↑	↑	↓	↓	↔	↓	↓	↓	↓	↓	↑	↑	↓	↓	↑	↑	↓	↔	↓	↑	Connectivity is also the primary restoration objective for the distributaries. Vegetative enhancement should be included for any changing process regimes to catalyze reestablishment of estuarine or tidal areas.
Lower Silver Creek	↓	↑	↑	↔	↓	↓	↓	↓	↓	↓	↓	↑	↑	↔	↓	↔	↑	↔	↑	↓	↑	↑	High potential for restoring storage areas such as floodplains and wetlands. Focus on areas downstream of increased source inputs such as dairies, golf course, and dense residential development.
Upper Silver Creek	↓	↔	↔	↓	↓	↓	↓	↓	↓	↓	↓	↔	↔	↓	↓	↔	↔	↓	↑	↔	↑	↑	Protect existing forest cover and wetlands, enhance riparian zones with planting and reconnecting habitats.

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

4.2.1 Squalicum WMU

The Squalicum WMU includes much of Bellingham and areas north of the City limits. Squalicum Lake provides the source water for Squalicum Creek, which drains to Bellingham Bay. Major tributaries to Squalicum Creek include Toad Lake and McCormick, Baker, and Spring Creeks. Large contiguous tracts of wetlands occur along the lower Squalicum Creek and McCormick Creek and surrounding Squalicum Lake, although wetlands are scattered throughout the WM, except on Squalicum Mountain, where hillslope processes predominate.

Land use within the WMU is partially forested in the upper Squalicum WMU and includes a mix of rural residential, agriculture, forestry, and open space. The second-growth forests are primarily deciduous. Mixed stands with limited pockets of conifer-dominated forest become more dense in the upper Toad Lake and upper Squalicum Lake drainages. Much of the riparian zone is forested in the upper portion of the WMU. The lower WMU (incorporated Bellingham and portions of the reaches on the Lummi Indian Reservation) exhibit intense development and high levels of impervious areas and degraded riparian conditions typical of urbanized development.

Chum salmon and coho salmon spawn and rear in Squalicum Creek. Winter steelhead and sea-run cutthroat trout have been documented in Squalicum Creek. Portions of the lower reaches of Squalicum creek are mapped by the WDFW PHS database as high quality riparian habitat. Large concentrations of wintering waterfowl are found at Toad Lake (WCPDS 2005).

4.2.1.1 Degraded and Impaired Areas

Though nearly half of the Squalicum Creek drainage is forested, the forest is immature and dominated by deciduous vegetation. As a result, surface water storage is much less than it was historically. Significant wetland and water storage areas have been lost, altered, or otherwise affected in the lower drainage. The area of highest wetland loss is located within the Upper Squalicum Creek drainage. Most of the wetlands identified as important for water quality remain intact in lower McCormick Creek and lower Squalicum Creek.

Degradation also includes agricultural encroachment on riparian zones along upper Squalicum Creek and to a lesser extent in the Baker and Spring headwaters. Though the City of Bellingham does not extract water from the Squalicum Creek drainage, the drainage is closed to further water rights allocations, an indication of poor baseflow support. Urbanization is likely the primary source for sedimentation within the WMU. Agriculture is fairly limited within the WMU, but road stream crossings can contribute to surface water sedimentation.

Water quality degradation is concentrated in the urban areas within the City of Bellingham, but there are point sources elsewhere in the WMU associated with agriculture, road crossings, and a dairy in the upper portion of Baker Creek.

4.2.1.2 Restoration Potential

Within this WMU, there is potential to restore water quality storage features within the upper Squalicum Creek drainage (Table 11). Riparian conditions within the Upper Squalicum Creek drainage are also degraded and could be improved through planting. Restoration of these headwater streams would slow nutrient and sediment transport within the system, and alleviate water quality problems downstream. The McCormick Creek drainage has the least amount of alteration, and is therefore a significant area for protection. The Toad Lake area is highly altered as a result of fairly high density residential development and associated septic systems and groundwater withdrawals. The Toad Lake area also contains the most process-intensive area within the WMU for infiltration/recharge. This area should be protected and restored as it is critical to maintaining baseflows.

Restoration Opportunities

Other restoration opportunities in the Squalicum WMU include:

- Restoring former wetlands south and east of Squalicum Lake.
- Improving instream habitat in Squalicum Creek (SMP inventory Reach 3).
- Restoring the historic Squalicum Creek floodplain and replanting riparian vegetation along the stream channel.

The Squalicum Creek estuary is also a high priority for restoration. The estuary and the Squalicum Creek shoreline that is with SMA jurisdiction are in the City of Bellingham and under city jurisdiction. The City of Bellingham identifies the following restoration actions for Squalicum Creek (http://www.cob.org/documents/planning/2006-04-17-appendix-a.pdf):

- Remove creosote pilings, plant native vegetation, and increase salt marsh habitat within the pocket estuary.
- Protect and/or restore estuary habitat, wildlife corridors, and habitat forming processes.
- Minimize bank erosion and downcutting in Squalicum Creek from Meridian Street to the mouth. Increase LWD placement and recruitment opportunities, restore native riparian vegetation, decrease peak flow events, improve stormwater detention, increase use of Low Impact Development techniques in the Squalicum watershed, and implement the 2005 stormwater manual and the Lower Squalicum log jam project.

4.2.2 Lake Whatcom WMU

Lake Whatcom dominates the landscape in the WMU. Hillslope processes drive conditions in this WMU, which is characterized by high drainage density and relatively few wetlands. Some wetlands do occur in outwash deposits in the Agate Bay drainage and to the south in Anderson, Brannian, and Fir Creeks.

Lake Whatcom supplies drinking water to the City of Bellingham and approximately half the residents of the County. As a result, much of the drainage is undeveloped, with nearly 90 percent of the watershed in forestry. Residential development dominates the northwestern corner and shoreline, and in the Austin/Beaver drainage.

Kokanee (*Oncorhynchus nerka*) and resident cutthroat trout are found in Lake Whatcom. Lake Whatcom supports rearing and migration; kokanee spawning occurs primarily in tributary streams. Whatcom Falls, just downstream of Lake Whatcom on Whatcom Creek is an impassable barrier to anadromous fish. The Brannian Creek hatchery on Lake Whatcom is one of the important producers of kokanee eggs and brood stock in the U.S. Portions of Lake Whatcom include areas designated as high quality riparian, and portions of Agate Bay support concentrations of waterfowl. Bald eagle habitat has also been mapped along the shoreline. In addition, a large tract of urban natural open space to the west of the lake on Lookout Mountain extends to the Lake Whatcom shoreline (WCPDS 2005).

Table 11. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Squalicum WMU[1]

	Process Intensity[a, b]																						
Process	**Hydrology**								**Sediment**						**Water Quality**				**LWD**		**Heat/Light**		
Mechanism	**Infiltration & Recharge**		**Surface Water Storage**		**Snowmelt and Runoff**		**Ground-water**		**Mass Wasting**		**Surface Erosion**		**Storage**		**Inputs**		**Storage**		**LWDRP**		**Canopy Cover**		
Intensity	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Potential for Restoration and Protection**
City of Bellingham	No Analysis Performed																						City of Bellingham is conducting its own SMP update independently of Whatcom County.
Spring-Baker Creeks	↓	↓	↑	↔	↓	↓	↓	↑	↓	↓	↓	↔	↑	↔	↓	↑	↑	↔	↑	↑	↑	↑	Significant intact resources, but restoration potential is still high; focus should be on storage areas downslope of sediment and water quality source alterations. Riparian condition appears on pictometry to be generally disturbed, so there is high potential for riparian restoration as well.
Toad Lake	↑	↓	↓	↑	↓	↓	↓	↑	↓	↓	↓	↔	↓	↑	↓	↑	↓	↑	↑	↑	↑	↑	Dense development around lake likely a significant alteration to water quality with limited potential for source restoration. Lake provide sink for nutrients, pathogens, and toxicants that somewhat mitigates downstream impacts, but at the expense of lake health. Riparian protection along lakeshore and restoration/protection in stream riparian corridors is high priority for managing water quality.
McCormick Creek	↔	↓	↔	↓	↓	↓	↔	↑	↓	↓	↓	↔	↔	↓	↓	↔	↔	↓	↑	↔	↑	↔	Intact wetlands indicate relatively few alterations; potential for protection is high along stream with significant riparian-scale processes.
Upper Squalicum	↔	↓	↑	↔	↓	↓	↓	↑	↓	↓	↓	↓	↑	↔	↓	↔	↑	↔	↑	↑	↑	↑	Riparian-scale processes are intensive around lake and the mainstem Squalicum Creek but are more altered than in McCormick Creek, including areas of wetland loss. Restoration potential is high, but existing process-intensive areas should also be protected.

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

a Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration

b Lower Squalicum Creek is within the City of Bellingham and is not included in this analysis.

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

Kokanee and resident cutthroat and rainbow trout use Anderson Creek, Smith Creek, and other non-shoreline streams for spawning. Austin Creek supports all life-history stages of resident cutthroat trout, but not kokanee spawning.

All of the Lake Whatcom jurisdictional tributary streams include WDFW-designated high quality riparian habitat (WCPDS 2005). Mirror Pond has been mapped by the County as a pond/lake and is within the Chuckanut Wildlife Corridor, a habitat of local importance (WCPDS 2005). Anderson Creek is also within the Chuckanut Wildlife Corridor and the riparian habitat along the creek provides habitat for the Pacific Townsend's big-eared bat, a federal species of concern and state candidate species (WCPDS 2005). The shoreline zone of Lake Louise adjoins the Lookout Mountain urban natural open space, a large, forested tract that provides habitat for northern goshawks and tailed frogs (WCPDS 2005).

4.2.2.1 Degraded and Impaired Areas

Over the last century and a half, forest practices have altered the composition and age class of forest cover within the Lake Whatcom WMU. Increased sedimentation and runoff associated with logging and forest road construction have affected water quality and habitat conditions in the Lake and its tributaries. Coniferous forest is present within the eastern portion of the WMU, but forest age class is young and forests are composed mainly of deciduous trees. Areas along the Lake Whatcom shoreline in the City of Bellingham and from Geneva south have very high road densities (>10 mi/mi^2). Stream crossings are numerous on Austin and Beaver Creeks upstream of the lake shoreline, near Bellingham, and in the Anderson Creek drainage.

Shoreline modifications (bulkheads and docks and other over-water structures) along Lake Whatcom are extensive, especially in Reaches 1 through 3, 5 through 7, and 13 to 14 (more than 50 percent of the lots in Reaches 4 and 12 have private docks or piers). Pockets of the lakeshore near Silver Beach, Geneva, and parts of Sudden Valley are characterized by impervious surface areas, which reduce potential for infiltration, recharge, and water quality processes.

Shoreline vegetation has been replaced by residential development along the northern Lake Whatcom shore, which is characterized by an almost complete lack of forest cover. Rural residential zoning along the western shoreline in Reaches 7 through 11 results in varied riparian conditions. Reaches 9 and 11 are urbanized and contain little natural vegetation.

Lake Whatcom is in violation of several water quality parameters. Sections of the lake are listed as impaired (303d category 5) for mercury, ammonia-N, and fecal coliform, dieldrin, total phosphorous, and total PCBs. The lake is a water of concern (303(d) category 2) for pH and dissolved oxygen. Lake Whatcom has a TMDL for dissolved oxygen. Anderson, Smith and Austin Creek also have water quality problems.

Eurasian milfoil, an aggressive, invasive aquatic weed, has been found in Lake Whatcom.

Flow from the Middle Fork Nooksack is diverted to Anderson Creek. The diverted water enters Anderson Creek at the top of Mirror Pond and flows the length of Anderson Creek before entering Lake Whatcom. The influx of water from the diversion has altered the natural hydrologic characteristics of this system.

4.2.2.2 Restoration Potential

Restoration potential varies widely in this WMU (Table 12). Areas such as Agate Bay/North Shore have high potential for restoring surface water storage mechanisms. Austin Creek/ Lake Louise has high potential to restore infiltration and recharge mechanisms.

Because of its importance as a regional drinking water source, the water quality of Lake Whatcom is of primary concern, and there is moderate to high potential to address water quality inputs throughout this WMU. This is a key issue because as urbanization, residential development, and road densities increase, the potential for sediments, phosphorous, and other contaminants to reach the lake increases.

Managing and limiting sources of water quality degradation will be difficult because the causes are difficult to pinpoint. Water quality can be managed to some degree by maintaining and restoring wetlands throughout the watershed, but opportunities are somewhat limited because of the natural geology and topography of this WMU. Well-vegetated stream and wetland buffers will help to mitigate effects of nutrient and sediment loading, and buffers should be maintained and managed to protect existing water quality-related functions. Proper road management and maintenance on forest lands will reduce landslide potential and prevent sediments from reaching aquatic resources.

4.2.2.3 Restoration Opportunities

Specific restoration opportunities include:

- Removing channel-constraining features on the Smith Creek alluvial fan (such actions may require concurrent acquisition of at-risk properties).
- Restoring instream habitat in Anderson Creek if the management of the Middle Fork Diversion changes.
- Restoring wetlands below Mirror Lake and just upstream of the mouth.

The completely channelized section of Austin Creek flowing through Sudden Valley golf course is also a good candidate for restoration. The intact riparian corridor just upstream should be protected.

4.2.3 Bellingham Bay WMU

The City of Bellingham occupies the majority of the WMU; unincorporated areas are generally limited to the upland areas in the vicinity of Galbraith Mountain and areas between Chuckanut Creek and Chuckanut Mountain. All of the Whatcom Creek, Padden Creek, and Lake Padden jurisdictional shorelines are within the City of Bellingham, as is most of the Chuckanut Creek shoreline. However, a short (200-foot long) segment is in County jurisdiction.

This chapter focuses on the areas under Whatcom County jurisdiction, which include the 200-foot reach Chuckanut Creek, and the two reaches of the marine shoreline–Fort Bellingham (north of the city limits) and Chuckanut Bay (south of the city limits).

4.2.3.1 Degraded and Impaired Areas

The Bellingham Bay WMU has more impervious surface than any other WMU in the County and infiltration and runoff patterns are highly altered as a result. In many cases, the impervious surfaces overlie the important infiltration/recharge areas, but permeable deposits in the upper Padden Creek and upper Chuckanut Creek drainages are less altered. Urban development has also reduced the area available for surface water storage.

Table 12. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Lake Whatcom WMU[1]

Process	Process Intensity and Degree of Alteration																						Potential for Restoration and Protection
	Hydrology								Sediment						Water Quality				LWD		Heat/Light		
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion		Storage		Inputs		Storage		LWDRP		Canopy Cover		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	
Basin 1	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓	↑	↓	↓	↑	↑	↑	↑	Urbanization around Basin 1 has contributed to deterioration of water quality in the Lake. The extent of alteration may limit restoration potential. Functional restoration is possible, and riparian zones may hold the most promise.
Basin 2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓	↑	↓	↓	↑	↓	↑	↓	Urbanization is almost as extensive as in Basin 1, and water quality degradation in the lake is proportional to the level of alteration. Process-based restoration is feasible, but a lack of intensive areas will limit restoration efficacy.
Agate Bay/ North Shore	↔	↔	↔	↑	↔	↓	↓	↓	↓	↓	↓	↔	↔	↑	↓	↔	↔	↑	↑	↓	↑	↓	Process-based restoration is likely more feasible in this area due to the relatively high amount of process-intensive storage areas.
Blue Canyon	↓	↓	↓	↓	↑	↔	↓	↓	↑	↔	↔	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↓	Forest practices are a source of alteration in this area. Restoration could focus on improving stream function, such as sediment supply and related disturbance, and riparian conditions.
South Bay	↓	↓	↓	↓	↔	↓	↓	↓	↓	↓	↔	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↓	Alterations are located primarily near the lakeshore, limiting potential for process-based restoration. Protection of important areas seems feasible in this area.
West Lake	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓	↓	↑	↓	↓	↑	↓	↑	↓	This area along the lake shore is mostly built out with limited process-intensive areas and potential for restoration.
Smith Creek	↓	↓	↓	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↓	Limited alteration except near the lake, so limited restoration opportunities.
Anderson Creek	↔	↓	↓	↓	↔	↓	↓	↓	↓	↓	↔	↓	↓	↓	↓	↔	↓	↓	↑	↓	↑	↓	High potential for protection of intact areas. Potential to restore wetlands below Mirror Lake.
Austin Creek/ Lake Louise	↑	↔	↓	↓	↔	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓	↑	↔	↑	↔	Manage/reduce nutrient inputs, and enhance riparian/lakeshore vegetation.

Gold: High priority for protection – process intensive areas with limited alteration
Red: High potential for restoration – process-intensive areas with moderate to severe alteration
Blue: Moderate restoration potential -- areas with moderate process-intensity and moderate levels of alteration
White: Low potential for restoration or protection– areas with low process-intensity and areas that are too altered for process-based restoration to be feasible.

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

There are extensive areas of high intensity residential and commercial development, overall road density is high (generally 10.1 to 30.5 mi/mi^2), and there is a dense drainage network to facilitate transport of sediments to downstream areas and nearshore habitats.

Streams in this WMU are impaired for dissolved oxygen, fecal coliform, and temperature. Toxins include diazinon and chlorothalinol in Padden Creek, pentachlorophenol in Whatcom Creek, and PCBs in Lake Padden.

In the nearshore areas, the industrial piers located along southern Fort Bellingham and other structures along the downtown shoreline have altered circulation patterns. A total of one-hundred fourteen groins and piers (including Squalicum Marina), and twenty-one jetties were mapped in the study area (some in City jurisdiction). Several of these modifications are found within regions of negligible nearshore drift; however, the affects on other nearshore processes can be substantial. At some locations, the dense pilings in the nearshore tend to attenuate waves and currents and increase deposition of fine sediments. Extensive overwater structures along the Fort Bellingham reach also reduce light levels and eelgrass growth, and the density and extent of eelgrass beds.

The Burlington Northern Santa Fe railroad causeway crossing nearshore embayments in southern Bellingham, Mud/Chuckanut Bay, the lagoons on the north and south side of Post Point, and the Padden Creek estuary can greatly reduce tidal flushing within the landward portion of the embayments. The reduction in tidal flushing can lead to accelerated local sedimentation rates, the long-term effects of which can eliminate submerged aquatic habitats or alter the surface water hydrology or temperature.

Sediment inputs to Bellingham Bay have been greatly increased due to the change in location of the Nooksack mouth to Bellingham Bay. The delta is prograding and has extended outward into the bay, increasing the area of salt marsh intertidal flats. Nutrient uptake and cycling capacity of the highly productive tidal flat habitats have likely increased compared to historical conditions. Loss of tidal exchange due to dikes and tide gates has resulted in the loss of estuarine habitat on the landward side of these features. Ecology’s Water Quality Assessment (2004 303(d)) designates the Nooksack River delta and Fort Bellingham reaches as Category 1 (meets tested standards) for fecal coliform and a water of concern (303(d) category 2) for dissolved oxygen.

Bacterial contamination has been documented in parts of Chuckanut Bay. The Bay has been closed to shellfish harvest since 1994 when tests showed high counts of fecal coliform bacteria.

4.2.3.2 Restoration Potential and Opportunities

Restoration opportunities in this WMU are concentrated in the nearshore zone. One potentially significant, yet challenging, opportunity involves relocating the Burlington Northern railway and revetment to open up large beach areas and bay shores and restore the limited sediment transport that occurred pre-revetment. In the absence of railway revetment removal, performing beach nourishment along some portions of the sediment-starved beaches would improve conditions.

Other, more straightforward, opportunities involve removing smaller structures and providing overhanging vegetation to upper shade intertidal habitats. Specific opportunities include:

- Removing concrete rubble and riprap along the base of bluffs and the derelict (creosoted wood) cement plant pier.

- Restoring the Little Squalicum Creek mouth/estuary and the armored shore around portions of the Mount Baker Plywood area would provide habitat improvements.
- Removing abundant wood debris smothering nearshore sediments along the Cliffside community beach in the northwest portion of the reach.
- Removing wood waste/LWD from backshore marshes where it is likely causing disturbance and reducing primary productivity of coastal wetlands.
- Removing abundant invasive species in the marine riparian area.

Feeder bluffs, intact coastal wetlands, and marine riparian vegetation in the Fort Bellingham reach should be protected. In the Chuckanut Bay reach, intact coastal wetlands and remaining limited sediment sources for bay beaches should be preserved.

4.2.4 Lummi Bay WMU

The Lummi Bay WMU encompasses the portion of the marine shoreline from just north of Neptune Beach to Gooseberry Point on the Lummi Peninsula including Lummi Bay and Sandy Point. The WMU has an area of approximately 27 square miles acres, nearly all of which is within the Lummi Indian Reservation and generally under the jurisdiction of the Lummi Nation, not Whatcom County. The WMU contains the Lummi River (Red River) and other smaller drainages that flow directly into the bay[7].

The town of Ferndale, which lies in the northeastern corner of the WMU, accounts for most of the urbanization in the WMU. Ferndale is surrounded by till agriculture and pasture. The Lummi Peninsula remains primarily forested, as does a large tract to the north of Lummi Bay.

Cutthroat, coho, fall Chinook salmon, and chum are all found within the Lummi River system. Distribution maps suggest that spawning likely occurs in Johnson Creek, the lower Lummi River, and possibly upper Lummi River. These species are also known either currently or historically to occur in the Jordan Creek drainage. Salmonids use the Lummi River shoreline mostly for migration and juvenile rearing. Bull trout adults and sub-adults are presumed to enter the shoreline to forage and overwinter. The Lummi Peninsula also provides priority habitats for bald eagle (nesting territory), peregrine falcon winter foraging, and waterfowl concentrations during winter, spring, and fall.

4.2.4.1 Degraded and Impaired Areas

The Lummi River currently has limited (relative to historic conditions) freshwater inputs and functions as a slough dominated by tidal influence. Tide-gates and dikes/levees installed to manage the tidal regime limit access to available habitat and act in concert with the flow diversion to limit habitat potential. The earliest map of this area (c. 1880) shows extensive emergent and scrub-shrub estuary habitats extending well past the Lummi River's major deltaic distributary channels almost to the Red River confluence. Tidally influenced wetlands extended most of the length of the Lummi River. Today, most small remnants of the estuary and tidal habitats remain other than the shallow tide-flats of Lummi Bay. The loss of tidal wetland habitat also extends to Sandy Point, which historically was a productive estuary but today contains no estuarine habitat (Collins and Sheik 2004, Deardorff 1992).

[7] Portions of the WMU border the right bank of the lower Nooksack/Silver Creek WMU. The shoreline of the Nooksack River may be referenced in this Chapter in as much as it influences the Lummi Bay WMU, but discussion of the Nooksack River itself can be found in Chapter 11.

The most significant impairment in this WMU is the permanent diversion of low flow discharge of the Nooksack River to Bellingham Bay. Historically, the Nooksack River flowed to both Lummi and Bellingham Bays, but in 1860 a logjam blocked the Nooksack River near present-day Ferndale and diverted it to a small stream that flowed into Bellingham Bay (USFS 1995a). According to the Lummi Nation Multi Hazard Mitigation Plan (Lummi Nation 2004), a dike/seawall was constructed along the shore of Lummi Bay and a levee was installed along the west side of the Nooksack River. Levees were also constructed along the Lummi River to prevent saltwater from Lummi Bay from flowing onto adjacent farmlands during higher tides. Currently a four-foot culvert (Deardorff 1992) allows flow to the Lummi River only during relatively high-flow conditions (approximately 10,000 cfs).

Other notable impairments include agricultural ditching and draining/loss of wetland areas. Bortleson et al. (1980) estimated that wetlands located landward of the general saltwater shoreline in the lower Lummi River watershed have decreased from approximately 2.0 to 0.1 square miles (approximately 95 percent) over the 1888 to 1973 period.

The loss of estuarine and tidal habitat and the lack of connectivity in existing habitat is the primary habitat impairment. As a result of tidal and river management that includes flow restrictions and dikes/levees, the river and its distributaries have become channelized. What was once a dynamic system with migrating, frequently avulsing distributaries is now predominately a series of relatively static channels that are fixed in place and change little.

Water quality degradation has accompanied these hydrologic and habitat alterations. Data collected by the Lummi Water Resources Division show elevated fecal coliform levels from many streams where they cross Reservation boundaries. A portion of the west side of the Sandy Point Peninsula near a treatment plant outfall is closed to shellfish harvest (DOH 2005). DOH has listed part of Lummi Bay as threatened (DOH 2005).

Physical alterations in the nearshore zone have affected nearshore processes. These include the extensive system of dikes surrounding the Seapond at Lummi Flats, the dredged network of channels in the Sandy Point Basin, the three piers at Gooseberry Point, and sediment impoundment resulting from residential bulkheads.

4.2.4.2 Restoration Potential

There is high potential to restore most processes in this WMU (Table 13). The area with the greatest restoration potential appears to be the lower delta. This area historically supported highly productive estuaries that, although heavily altered, support valuable fish, wildlife, and other cultural resources. The delta area is altered to a greater extent than tributary drainages and those drainages feeding directly to Lummi Bay.

There is also potential to improve water, sediment, and nutrient storage/removal processes by restoring wetlands on coarse-grained soils in the Jordan Creek drainage, but this area has been mostly deforested and opportunities may be limited.

The potential to restore nearshore processes depends on whether structures inhibiting littoral transport can be removed. Where removal is not an option, sediment bypassing or beach nourishment to replenish sediment starved beaches offer potential.

4.2.4.3 Restoration Opportunities

Specific opportunities in this WMU include:

- Remove the sediment accreted north of the Conoco-Phillips pier base and bypass it to the south. This would entail removing sediment from the backshore and leaving the berm intact, thereby creating a new coastal wetland as well. A second bypass option would be at the entrance channel of the Sandy Point basin. Filling this entrance channel will allow net shore-drift to continue south and restore accretion processes at Sandy Point. Bluff sediment sources could be reconnected in other bulkheaded areas in the reach.

- Enhance or create marine riparian vegetation/dune habitat along Neptune Beach and the no- bank portions of the reach.
- Remove unnecessary bulkheads to restore upper beach and backshore habitat in the Sandy Point Basin reach.
- Protect the function of the up-drift feeder bluff segments and the remaining coastal wetland near Neptune Beach.
- Create riparian buffer/dune habitat to provide habitat and flood control benefits.
- Restore marsh habitat by removing fill in undeveloped uplands.
- Remove some of the numerous creosote soldier pile bulkheads and pilings along Lummi Flats and Sandy Point Basin reaches.
- Protect fair-condition nearshore habitat on the north side of the South Cape area.
- Pull back the dike and recreate a more natural upper foreshore on the West Lummi Bay reach.
- In the Lummi Flats reach, remove extensive dikes and tide gates across the river delta to restore tidal inundation and improve fish habitat.
- Prevent further infilling of coastal wetlands and marsh, including preventing the construction of additional impervious surfaces.
- Within the Gooseberry Point reach, restoration opportunities include removing sediment impoundments (bulkheads) and alongshore drift impediments such as the failed concrete and rock bulkhead located approximately 0.7 mile north of Gooseberry Point. Additionally, broken concrete bulkhead sections could be removed from the foreshore, primarily north of Gooseberry Point and near the tip and south shore of the point.
- Protect the feeder bluffs of the Lummi Peninsula.

4.2.5 Birch Bay WMU

The Birch Bay WMU includes the Semiahmoo Peninsula, Birch Point, Birch Bay, and the Cherry Point area between Point Whitehorn and Sandy Point. It extends inland to the west edge of Ferndale and encompasses Lake Terrell.

Land use and land cover in the Birch Bay area are a mix of residential and commercial uses. Upper Terrell Creek and Lake Terrell drainages contain agriculture and rural residential land uses. The Semiahmoo area contains high density residential development, but also retains a fairly large portion of deciduous forest cover. Cherry Point is characterized by water-related industrial uses surrounded by open space, wetlands, and mixed deciduous forest.

Table 13. Summary of restoration and protection potential for key processes by drainage area, Lummi Bay WMU[1]

Process	Process Intensity																						
	Hydrology								Sediment						Water Quality				Organic Matter		Heat/Light		
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion		Storage		Inputs		Storage		LWDRP		Canopy Cover		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	**Potential for Restoration and Protection**
Lummi Distributaries	↓	↓	↑	↑	↓	↓	↑	↑	↓	↓	↓	↔	↑	↑	↔	↔	↑	↑	↓	↓	↓	↓	Restore hydrologic connectivity of estuarine and tidal habitat
Upper Lummi River	↓	↓	↑	↑	↓	↓	↑	↑	↓	↓	↓	↑	↔	↑	↓	↑	↔	↑	↔	↑	↔	↔	Restoring portion of Nooksack flow would increase habitat availability for salmonids and likely increase the amount of estuarine habitat. However, such an action would likely be deleterious to water quality in the river, estuary, and bay.
Red River (Schell)	↓	↔	↔	↑	↓	↓	↓	↔	↓	↓	↓	↑	↔	↑	↓	↑	↔	↑	↑	↑	↑	↑	Alteration associated with Ferndale urban land uses are high, but the area has relatively limited process-intensity. Restoration/protection of riparian corridors, particularly in headwater tributaries, likely has most potential for influencing ecological function of aquatic resources.
Jordan Creek	↔	↔	↑	↑	↓	↓	↓	↔	↓	↓	↓	↔	↑	↑	↓	↔	↑	↑	↑	↑	↑	↑	Jordan Creek appears to have experience extensive wetland loss. Restoration of these areas and protection/restoration of riparian zones is recommended
Sandy Point	↔	↑	↔	↑	↓	↓	↓	↔	↓	↓	↓	↔	↔	↑	↓	↑	↔	↑	↑	↔	↑	↔	Potential for restoration on the Sandy Point Peninsula may be limited. Recommended management focus should be on water quality, with potential for use of infiltrative areas in sandy soils.
Lummi Peninsula	↓	↓	↓	↔	↓	↓	↔	↓	↓	↓	↓	↓	↓	↔	↓	↓	↓	↔	↑	↔	↑	↔	Process-intensive Areas that are present occur near the marine shoreline. Protection/restoration of these areas is recommended.

Gold: High priority for protection – process intensive areas with limited alteration
Red: High potential for restoration – process-intensive areas with moderate to severe alteration
Blue: Moderate restoration potential -- areas with moderate process-intensity and moderate levels of alteration
White: Low potential for restoration or protection– areas with low process-intensity and areas that are too altered for process-based restoration to be feasible.

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

The freshwater and nearshore areas of Birch Bay support a number of important fish and wildlife species, including: a bald eagle breeding territory; waterfowl concentration areas and wintering habitats; Chinook, coho, and chum salmon, sea-run cutthroat and possibly steelhead trout; herring spawning (Semiahmoo Bay and Cherry Point stocks); surf smelt spawning; a harbor seal haul out area (just north of Birch Point); and scattered kelp beds to the north of Birch Point. The bay is used for recreational shellfish harvest (primarily hardshell clams and Dungeness crab). A pocket estuary occurs near the marina but is considered to be Not Properly Functioning (Redman et al. 2005).

Lake Terrell provides important breeding habitat for priority species, including bald eagles, wood ducks, and common loons, and is one of only a few Western Washington common loon breeding sites (Richardson et al. 2000; WDFW 2004). Large numbers of waterfowl are found at Lake Terrell in the winter, spring, and fall.

4.2.5.1 Degraded and Impaired Areas

Portions of the Birch Bay WMU (near Semiahmoo and Birch Bay Village) are fairly heavily developed and some areas (such as Terrell Creek drainage) have relatively high percentages of impervious surface. Development occurring on important infiltrative areas (such as near Drayton Harbor and Birch Bay Village) may be disrupting hydrologic processes including hydrologic support of a wetlands downslope of these areas.

Dense residential development and developing areas are also known to increase nutrient loading and delivery of contaminants to aquatic resources. Roads associated with development accelerate delivery rates of fine sediment to the bay. Increased sediment delivery from developing areas may be correlated to degraded water quality.

Water quality degradation is a growing concern in this WMU. Areas near Birch Bay Village are at risk for pathogen loading because of numerous on-site septic systems. Other potential sources of fecal bacteria are present throughout the WMU and include municipal sewage treatment plants, broken sewage conveyance pipes, waste discharge from boat tanks, runoff from agricultural fields, and wastes from domestic pets and wildlife. Pathogen inputs are threatening shellfish beds in Birch Bay, which is identified as a “threatened” shellfish growing area due to degrading water quality (CH2MHill 2006).

Other impairments include the industrial piers at Cherry Point, the groins within Birch Bay, and nearshore structures (bulkheads) along all of the marine reaches. The industrial piers tend to attenuate currents and wave energy and likely increase deposition of fine sediments (Schwartz 1987). The Birch Bay Village Marina jetties and the solid fill located at the base of the Intalco-Alcoa and Conoco-Philips piers likely have localized effects on circulation, most notably in the upper beach.

4.2.5.2 Restoration Potential

Improving water quality is one of the overarching restoration goals for this WMU. One mechanism to achieving this goal is wetland restoration, including restoring ditched and/or drained wetlands throughout the WMU, especially in the Lake Terrell drainage and Terrell Creek. Focused wetland restoration in and around urbanizing areas can also mitigate some water quality impairments, but may not be sufficient to fully restore water quality processes within those drainages (Table 14).

Riparian areas throughout the WMU also have restoration potential. Riparian zones throughout the WMU tend to be lacking in LWD and have low LWD recruitment potential and canopy cover.

The potential to restore nearshore processes is high. There are numerous actions that can be taken to rectify past problems caused by bulkheads, groins, and other structures. Conservation and protection of remaining resources is also key. This includes conserving mapped feeder bluff segments to prevent further degradation of habitats, conserving beach and backshore near Birch Bay State Park reach, and most importantly, conserving the remaining feeder bluff segments in Cherry Point as these are the primary sediment sources for both Sandy Point and Birch Bay beaches.

4.2.5.3 Restoration Opportunities

Specific restoration opportunities in the Birch Bay WMU include:

- Restoring historic wetlands, particularly in Semiahmoo and Birch Bay, to provide areas for nutrient retention and removal.
- Enhancing existing wetlands through planting to improve habitat conditions for wetland- associated wildlife.
- Protect the off-channel habitat at the upper end Reach 1 of Terrell Creek from future encroachment and channelization.
- Restoring and enhancing riparian wetlands within the Birch Bay and Fingalson Creek drainages.
- Enhance the monotypic plant communities in the wetlands associated with Terrell Creek at Birch Bay State Park.
- Removing bulkheads and other nearshore structures in the Birch Bay and Cherry Point reaches that are known to impede alongshore movement of sediment and negatively affect adjacent beaches.
- Protect sediment sources that supply large accretionary beaches and marshes, such as Semiahmoo Spit, Birch Bay, and the Gulf Road pocket estuary.
- Remove old and failing structures, possibly in conjunction with large-scale beach nourishment in the Birch Bay reach. This would include removing groins and bulkheads along Birch Bay Drive to restore upper beach and backshore habitats.
- Restore historic marsh areas where possible and create a riparian buffer along the Birch Bay shore.
- Remove bulkheads, including unauthorized bulkheads, between Birch Bay State Park and Point Whitehorn.
- Restore littoral processes in the Cherry Point reach by re-introducing impounded sediment on the north side of the pier base fills, and excavating and bypassing the accreted sediment south of the two southern industrial piers at Cherry Point (which could also create coastal wetlands in the backshore). When and if the marina entrance channel at Sandy Point is dredged, sediment could be bypassed to the south.

Table 14. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Birch Bay WMU[1]

	Process Intensity																						
Process	**Hydrology**								**Sediment**						**Water Quality**				**LWD**		**Heat/Light**		
Mechanism	**Infiltration & Recharge**		**Surface Water Storage**		**Snowmelt and Runoff**		**Ground-water**		**Mass Wasting**		**Surface Erosion**		**Storage**		**Inputs**		**Storage**		**LWDRP**		**Canopy Cover**		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	**Potential for Restoration and Protection**
Semiahmoo	↑	↔	↑	↑	↓	↓	↑	↔	↓	↓	↓	↑	↑	↑	↓	↑	↑	↑	↔	↑	↓	↑	High potential for restoration, but potential influence on freshwater aquatic resources is limited. Water quality management is high priority, but potential for process-based restoration may be limited.
Birch Bay	↓	↑	↑	↓	↓	↓	↔	↔	↓	↓	↓	↑	↑	↓	↓	↑	↑	↓	↔	↑	↓	↑	Wetlands are more intact in Birch Bay than in Semiahmoo but may not occur between the resource (Birch Bay) and altered source areas. Focused restoration and protection opportunities are likely available, however.
Terrell Creek	↓	↓	↑	↔	↓	↓	↓	↓	↓	↓	↓	↔	↑	↔	↓	↔	↑	↔	↑	↑	↑	↑	Lower Terrell Creek likely has the most non-marine ecological function in the WMU and existing conditions should be protected. Riparian-scale restoration is limited near the mouth but is possible upstream of there. Process-based restoration in upstream contributing areas could further improve function in the stream.
Lake Terrell	↔	↓	↑	↔	↓	↓	↓	↓	↓	↓	↓	↔	↑	↔	↓	↑	↑	↔	↑	↑	↑	↑	Water quality restoration is the priority in this drainage, starting with wetland and riparian restoration. Each will indirectly improve at least 2 other processes as well.
Fingalson Creek	↓	↓	↔	↔	↓	↓	↓	↓	↓	↓	↓	↔	↔	↔	↓	↔	↔	↔	↑	↑	↑	↑	Water quality restoration is the priority in this drainage, starting with wetland and riparian restoration. Each will indirectly improve at least 2 other processes as well.
Cherry Point	↓	↔	↑	↑	↓	↓	↓	↓	↓	↓	↓	↓	↑	↑	↓	↑	↑	↑	↔	↑	↓	↑	Aquatic resources occur primarily in the form of wetlands in the Cherry Point drainage. Feeder bluffs and accretionary shoreforms along Cherry Point; eelgrass, kelp and forage fish resources present in nearshore areas

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Functional responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

4.2.6 Drayton Harbor WMU

Drayton Harbor is a coastal watershed located in the northwest corner of the County, to the west of the lower mainstem Nooksack River and Bertrand Creek.

In addition to Drayton Harbor's two major tributaries, California and Dakota Creeks, a few small streams drain directly to Drayton Harbor. Other aquatic resources include a large impoundment on the North Fork Dakota Creek and an area referred to as the Beaver Ponds in the headwaters of the North Fork Dakota Creek. Wetlands are present in abundance throughout the WMU and compose 16 percent of total land area or 21 percent of the land cover if mudflats are included (Nelson et al. 1991).

Agriculture (54 percent) is the primary land use in the Drayton Harbor WMU and is particularly dense in the South Fork Dakota Creek and in the middle and upper California Creek drainage. Areas in and around Drayton Harbor are dominated by urban, residential, and commercial land use associated with the City of Blaine and Semiahmoo and development along the I-5 corridor. Drayton Harbor also contains commercial shellfish beds.

Chinook, chum, and coho salmon and cutthroat trout have been documented in Dakota Creek and coho salmon and cutthroat trout are documented in California Creek. Native char are presumed to be present in these streams. The Drayton Harbor WMU supports seabird nesting areas, eelgrass beds, and sandlance, surf smelt and Pacific Herring spawning areas. During migrations, Drayton Harbor is a stopover point for seabirds and waterfowl between the two large major deltas along the migration route: Fraser River delta and Skagit Bay. Black brant forage extensively on the extensive eelgrass beds within the harbor during their migration. Pacific herring spawning areas are also extensive.

4.2.6.1 Degraded and Impaired Areas

A number of studies have highlighted that processes related to hydrology (e.g., surface and ground water storage) and water quality, including nutrient and sediment transport, are degraded within the Drayton Harbor WMU (Ecology 2005). Shellfish contamination is a primary indicator of alterations to water quality processes in Drayton Harbor. Shellfish area closures are very common as a result of fecal coliform contamination and occurred as early as 1952. Currently, Drayton Harbor is listed as impaired on the 2004 303(d) list.

South Fork Dakota Creek is a 303(d) area of concern for fecal coliform based on samples near the upper extent of shoreline jurisdiction. USU (2001) states that both California and Dakota Creeks likely contribute to fecal coliform contamination in Drayton Harbor.

Drayton Harbor indicators of water quality alteration also include 303(d) listings for algal blooms (Frankenstein 2000), indicating increased nutrient inputs. In addition, potentially toxic levels of nitrate were sampled in NF Dakota Creek (Dickes 1992), and fish kills have resulted from water quality contamination in both the NF and SF Dakota Creek (Nelson et al. 1991). USU (2001) indicates that nitrogen and phosphorous loading are heightened beyond acceptable levels in the watershed, but nutrient levels are much higher in California Creek than in Dakota Creek.

Stream channelization and loss of tidal sloughs have affected the lower reaches of both Dakota and California Creeks. For example, Loomis Trail Road runs along the right bank of Reach 2 and appears to present a barrier between the stream and an associated wetland. An opportunity exists here to reconnect the wetland and improve hydrology, storage potential, and habitat access.

4.2.6.2 Restoration Potential

A major restoration goal for the Drayton Harbor WMU is to improve water quality by reducing surface flows, stormwater peak flows, and downstream erosion, and managing the transport of sediment, nutrients, and harmful bacteria and toxins within the WMU.

Areas that are highly altered but also support key processes include the mainstem Dakota Creek, upper California Creek, the lower Haynie, and South Fork drainages of Dakota Creek (Table 15). The California Creek drainage has perhaps the highest restoration potential, and restoring wetland and riparian areas there would likely have a positive influence on water quality in both the stream and Drayton Harbor. The headwaters of the Dakota Creek drainage, including lower Dakota Creek, Haynie Creek, and the North Fork Dakota Creek, have process-intensive areas with low levels of alteration and warrant protection. Infiltration and storage zones in these areas may be particularly important to supporting baseflow in soils with high transmissivity.

Restoration of nearshore areas is related to removing shoreline modifications such as the jetty and industrial fill structure associated with the City of Blaine marina. Restoration of the processes affected by such structures is only possible by physically removing them. Although full restoration is highly unlikely, a number of other restoration opportunities exist with the WMU.

4.2.6.3 Restoration Opportunities

Specific restoration opportunities in the Drayton Harbor WMU include:

- Restore wetlands and riparian areas associated with the California Creek through planting.
- Restore riparian vegetation along California Creek, focusing on Reaches 2, 5 and 8.
- Restore riparian vegetation along Reaches 5 and 7 of Dakota Creek.
- Protect existing forest cover, particularly conifer stands such as those found in Reach 8 of Dakota Creek, to ensure long-term LWD recruitment potential.
- Improve instream habitat conditions in Dakota and California Creeks by creating additional off-channel estuarine and tidal habitat in the lower reaches.
- Investigate and address the potential barrier at Loomis Trail Road between the stream (California Creek) and an associated wetland. Reconnect the wetland to improve hydrology, storage potential, and habitat access.
- Install LWD in both streams to rectify problems of low quality pool and riffle habitat. Reach 5 of California Creek appears to provide the best opportunity for combined channel realignment, off-channel habitat creation, riparian planting, and in-stream structure placement.
- Remove creosote pilings including soldier pile bulkheads at a degraded soldier pile bulkhead (scoured away on landward side) located northwest of Dakota Creek, and at creosote piles located near the Semiahmoo Spit marina (in the City of Blaine).
- Modify the California Creek causeway.
- Restore marine riparian vegetation in areas devoid of overhanging vegetation.
- Removing unnecessary bulkheads, and debris in intertidal areas.

Table 15. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Drayton Harbor WMU[1]

Process	Process Intensity and Degree of Alteration																						
Process	Hydrology								Sediment						Water Quality				LWD		Heat/Light		
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion[a]		Storage		Inputs[a]		Storage		LWDRP		Canopy Cover		
Area	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Potential for Restoration and Protection
Blaine	↔	↔	↔	↑	↓	↓	↓	↔	↓	↓	↓	↑	↔	↑	↓	↑	↔	↑	↔	↔	↓	↓	Alterations near the Drayton Harbor shoreline may limit potential for process-based restoration. Functional improvements may be more achievable in certain instances, such as the management of fecal coliform sources and storage/transport mechanisms. Mapping information identifies important areas to be protected in and around Blaine.
Lower Dakota	↑	↓	↔	↓	↓	↓	↔	↔	↓	↓	↓	↓	↔	↓	↓	↔	↔	↓	↑	↔	↔	↓	Significant amounts of forest cover in lower Dakota Creek indicate potential protection areas. These areas may serve as a buffer between upstream impairments and the harbor.
Haynie	↑	↑	↑	↔	↓	↓	↔	↓	↓	↓	↓	↓	↑	↔	↓	↓	↑	↔	↑	↓	↑	↓	Upper Haynie is mostly intact, while agriculture land uses in the lower watershed indicate potential alteration of sediment and water quality and potentially riparian processes. Numerous opportunities exist for improving the function of storage areas.
Upper Dakota	↔	↔	↔	↓	↓	↓	↑	↑	↓	↓	↓	↓	↔	↓	↓	↑	↔	↓	↑	↑	↑	↔	Riparian wetlands still exist but may have altered vegetative cover. These areas provide important benefits that mitigate inputs in the upstream end of this area and in the South Fork Dakota Creek.
NF Dakota	↓	↔	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓	↑	↓	↑	↔	↑	↓	This is the most intact drainage in the WMU and has high potential for protection that could influence multiple processes, including infiltration/recharge.
SF Dakota	↓	↑	↑	↔	↓	↓	↑	↑	↓	↓	↓	↑	↑	↔	↓	↑	↑	↔	↑	↑	↔	↑	One of the most impaired areas in the watershed and potentially a significant source of fecal contamination. Potential for restoration may be limited due to the extent of alteration, but restoration performed in upper and lower Dakota Creek would mitigate source inputs from South Fork Dakota drainage.
Lower California	↓	↔	↑	↓	↓	↓	↔	↓	↓	↓	↓	↔	↑	↓	↓	↔	↑	↓	↑	↔	↔	↓	Alterations are less intense but occur over a broad area. Intact process-intensive areas likely mitigate land use impacts both in this area and in upper California Creek.
Upper California	↔	↑	↑	↑	↓	↓	↔	↔	↓	↓	↓	↑	↑	↑	↓	↑	↑	↑	↑	↑	↑	↔	Highly altered area, including both source and storage alterations. Riparian condition is poor, and impervious areas are also present. Restoration possible, but riparian restoration in lower California Creek would mitigate alterations to all processes except organic matter.

↑ High Intensity; High alteration
↓ Low Intensity; Low alteration
↔ Moderate intensity; Moderate alteration

Red: High restoration potential: Moderate to high process intensity with high degree of alteration
Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration
White: Low restoration potential: Low process intensity with low to moderate degree of alteration
Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration [a]. Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

[b] Areas of high alteration exist in Canada, but process-intensity is unknown. Process-intensive Areas within the delineated areas have moderate degrees of alteration (i.e., lack of forest cover but limited impervious area)

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

4.2.7 Portage Island and Lummi Peninsula WMU

This WMU includes the southeast side of the Lummi Peninsula and Portage Island, which are entirely within the boundaries of the Lummi Indian Reservation.

4.2.7.1 Degraded and Impaired Areas

The upland portions of this WMU are little altered compared to other WMUs. Most of the notable alterations are in the nearshore zone. Nutrient dynamics in the Lummi Peninsula – Portage Bay marine reaches are dominated by oceanic nutrient inputs from the Georgia Straits, circulation patterns within Bellingham and Portage Bays, terrestrial and fluvial inputs from several small streams and the Nooksack River, and nutrient cycling within the shallow waters of the bay. Because of limited circulation and flushing in Portage Bay, nutrient and/or pathogen inputs from terrestrial or fluvial sources can elevate concentrations, cause eutrophication, and/or deplete nutrients following algal blooms.

Major impediments to net shore-drift in this WMU are limited to the Lummi Shore Road area. However, there are a number of small areas where rockery has been used to curb bluff erosion, thereby reducing the volume of sediment input to the nearshore. Waterward protrusions of the large rock revetment that runs along approximately 2 miles of Lummi Shore Road, locally known as “truck turnarounds”, tend to collect sediment on the up-drift (southwest) end of each protrusion, while erosion occurs along the down-drift (northeast) side of the truck turnarounds

4.2.7.2 Restoration Potential

Because this WMU is relatively unaltered compared to other areas, restoration potentially is generally low. Conservation of sediment sources that supply large accretionary beaches and marshes is a high priority. This includes the extensive beaches, marshes, and spits on Portage Island, The Portage, and the few remaining sediment sources that are not impounded along the Lummi Peninsula. Conservation of remaining marine riparian areas is also recommended.

4.2.7.3 Restoration Opportunities

The major alterations to nearshore processes found in the Lummi Peninsula - Portage Island WMU are mostly along Lummi Shore Road. The most substantial alteration is the nearly 2-mile long riprap revetment that runs along Lummi Shore Road. The greatest impact resulting from this shore modification is sediment impoundment. Moderate interruptions in longshore drift also result from the protruding truck turnarounds. The revetment may also induce beach erosion through wave reflection/scour. Relocating this road, which was considered in the 1990s but rejected due to cost and logistical concerns, and removing the revetment would be the only way to eliminate these impacts to nearshore processes. Continued nourishment of beaches may help to prevent and restore degraded beach habitat resulting from sediment impoundment.

Reach-scale restoration of nearshore areas in the Portage Island reach is not a high priority due to the relatively unaltered condition of the island’s outer shores. No bulkheading or other modifications are present in this area. Conservation of the Portage Island reach would help protect the function of marsh areas and existing feeder bluffs, especially those along the south and west shore of the island, as well as marine riparian areas.

The same is true for Portage Bay reach, which is mostly unaltered. Conservation of the large marshes, particularly in the southern portion of the bay and limited feeder bluffs is a high priority. Also conservation of the healthy marine riparian areas should be a focus.

In the Lummi Shore reach, restoration potential appears limited, unless the recent large revetment can be altered. The ideal nearshore restoration scenario would be to relocate the road further inland and remove all or portions of the riprap revetment. Ensuring that beach nourishment is continued should be a priority. Also, portions of the protruding truck turnarounds could be modified to allow longshore drift to continue and to minimize down-drift erosion, which has been occurring (Johannessen and Chase 2005). Other restoration could be focused on replacing marine riparian vegetation where possible. Removing derelict drift nets, debris, and other foreign material from the Lummi Shore Road beaches would provide a direct benefit. Enhancing the revetment/bank with riparian plantings may provide habitat benefits.

Another opportunity involves repairing a ~500-foot-long portion (called the “Section 14” portion) of the Corps revetment along Lummi Shore Road, which used undersized rock and did not have a deeply buried toe. The upper intertidal beach in this area is now completely exposed, impacting potential forage fish habitat. The revetment rock is repeatedly toppling on to the beach and would be best replaced with larger, more durable rock (not limestone), and relocated landward on the order of 5 to 15 feet.

Conservation potential in the Lummi Shore reach is more limited, and should be focused on maintaining conditions favorable to the abundance of surf smelt spawning habitat.

4.2.8 Lummi/Eliza Island WMU

Lummi and Eliza Islands are located southwest of the Lummi Peninsula. Hale’s Passage separates Lummi Island from the Peninsula. Bellingham Bay is to the east and Georgia Strait is to the west. Lummi Island is on of the largest islands in Puget Sound/Georgia Basin. Lummi Island has no freshwater shorelines but has over 20 miles of marine shoreline. Eliza Island also has no freshwater shorelines and has approximately 3 miles of marine shore.

4.2.8.1 Degraded and Impaired Areas

In the upland portions of Lummi and Eliza Islands, degradation and impairment are minimal. Development is sparse in these areas. The north half of Lummi Island consists of low-density residential development, and the south half of the island is undeveloped forested land. Land cover along the Lummi Island marine reaches is predominantly forest, ranging from 45 percent along north Lummi Island to 83 percent along the south. Wetlands (7 to 32 percent) and grasslands (3 to 17 percent) make up most of the remaining land in the reaches. Areas classified as developed are most concentrated in the Hale Passage reach (6 percent of the reach).

Existing land use on Eliza Island consists primarily of single-family residential or recreational homes on 0.5 to 1-acre lots with approximately 100 feet of waterfront. Land cover on the island is a mix of forest (41 percent), wetlands (34 percent), and grassland (16 percent).

Shoreline modifications and alterations to circulation and sediment transport patterns are minimal along most of the Lummi Island reaches. Exceptions include bulkheads along the Hale Passage reach (18 percent) and North Lummi Island (4 percent), as well as one over-water structure in the Hale Passage reach. These over-water structures and bulkheads occur in the areas most likely to support eelgrass and forage fish spawning and may affect light levels in eelgrass beds and forage fish spawning habitats in those locations.

4.2.8.2 Restoration Potential

The restoration potential in this WMU is more limited compared to other areas. Full restoration of nearshore processes would require removal of bulkheads, which may not be feasible. Alternatives with better potential for success include sediment bypassing or beach nourishment to replenish sediment starved beaches.

Conservation of sediment sources that supply accretionary beaches and marshes should be the goal of protecting nearshore resources. Prevention of further filling of coastal wetlands should also be a conservation goal. Marine riparian vegetation is relatively intact along these reaches and should be protected.

4.2.8.3 Restoration Opportunities

Reach-scale nearshore restoration in Hale Passage should be focused on restoring sediment sources that are "locked up" behind bulkheads when feasible. Due to limited coarse-grained sediment in the banks, conserving remaining feeder bluff sources would contribute to protection of beach habitats. Areas with over-water structures adjacent to the ferry terminal should be investigated for potential mitigation of shading and disturbance due to ferry operations adjacent to forage fish spawning areas.

Restoration in the south Lummi Island reach does not seem necessary since the area does not have appreciable net shore-drift for the most part and habitats are associated with the prevalent rocky shore. Most of this shore is not available for development of housing due to state ownership and very steep slopes. The one exception to this is the rock quarry at Smuggler Cove run by Ace Rock, which is on WDNR property. The shore could be restored through removal of fill and riparian restoration to resemble the rocky shore prior to site development.

The north Lummi Island reach presents more opportunities for conservation and restoration than other reaches in this WMU. The area immediately east of Village Point would benefit from removal of relict structures in backshore/marsh environments with marsh restoration. The road setback in this area is non-existent, as the beach has eroded and a seawall was constructed in a portion of the area by Whatcom County in recent years. Removal of a failed solid fill pier, large rock groin, concrete debris and derelict piles in the western portion of Legoe Bay would benefit the nearshore. Derelict piles (likely creosoted) could also be removed from eastern Legoe Bay. There is significant room for habitat enhancement at Lummi Point on the northeast part of the island. Any bulkheads that are not necessary for protection of houses could be scaled back or moved landward where possible and picnic structures over what would be active beach could be removed, particularly on the east end of the spit. Also riparian planting could be enhanced.

4.2.9 Point Roberts

The Point Roberts peninsula protrudes south from mainland Canada into the open waters of Boundary Bay. This 5-square mile portion of Whatcom County is located roughly 14 miles west of Blaine and is accessible by boat or by car through Canada. Point Roberts has 7.3 miles of marine shoreline and no freshwater shorelines.

4.2.9.1 Degraded and Impaired Areas

Point Roberts is an important area for infiltration/recharge and water storage mechanisms. Approximately three quarters of the peninsula has high infiltration/recharge potential due to the underlying outwash deposits. Development and the associated conversion of pervious surfaces to impervious areas have altered the natural infiltration and recharge processes, especially near Maple Beach, the residential areas north of Lighthouse Point, and around the marina where impervious surface exceed 30 percent.

Many depressional wetlands on the peninsula have been filled or drained. These wetlands would have historically served a sediment storage function as well as water storage functions.

Residential areas are sources of potential nutrient loading and delivery of contaminants. Pathogen loading is a concern considering the density of onsite septic systems.

Major alterations to marine circulation patterns are associated with the two large industrial causeways located north of the US/Canada border. The Tsawwassen ferry causeway extends approximately 2 miles southwest into the Strait of Georgia to the international boundary. The Deltaport facility pier extends over 3 miles into the Strait of Georgia. The causeways shield local shores from waves and currents and also alter the mixing of Georgia Strait-Fraser River estuarine water masses, thereby changing temperature, salinity, and nutrient inputs. With the construction of the Tsawwassen causeway, the west shore of Point Roberts is in the wave shadow of the causeway and southward net shore-drift has ceased. Without sediment transport from the western shore, Lighthouse Park has experienced substantial erosion in recent decades. Erosion rates of 2.0 to 2.6 feet per year have been documented for the southwest point (Johannessen 1998). A beach nourishment project was installed in 1998 in the southeast portion of Lighthouse Park that experienced significant erosion in its first (storm-prone) year and has performed well since (see Ecology 2001 oblique 010524-113416) (Johannessen and Chase 2004).

There are extensive shoreline modifications in all Point Roberts marine reaches except Lily Point and Boundary Bluff, which only have 13 and 7 percent bulkheads respectively. The Maple Beach reach has approximately 79 percent bulkheads. The Lighthouse reach has the most shoreline modifications with 39 percent bulkheads, twenty-six over-water structures (seven per mile), two jetties per mile, and a breakwater at the entrance to the marina.

Other nearshore impairments include loss of estuarine and freshwater tidal wetlands near the marina and lack of marine riparian vegetation along Lighthouse reach. These alterations reduce the capacity for riparian areas to retain nutrients from terrestrial sources.

Over-water structures affecting light levels for benthic algae or eelgrass will affect uptake rates and cycling of nutrients. Over-water structures are relatively limited in Point Roberts, with the exception of the Lighthouse reach (twenty-six structures or 7 per mile).

4.2.9.2 Restoration Potential

The potential to restore nearshore processes on the Point Roberts peninsula is somewhat limited because many of the alterations are large in magnitude, and likely irreversible. However, there is potential for several site-specific measures that could improve local habitat conditions. These are described below.

4.2.9.3 Restoration Opportunities

Opportunities for nearshore restoration in the Maple Beach reach of the Point Roberts peninsula are limited unless portions of the bulkhead are to be removed in the future. The entire reach contains a vertical face bulkhead, the majority of which is in the form of concrete seawall, with an impaired road immediately adjacent to the wall. Small lengths of the seawall footing have been exposed in recent years (Johannessen and Chase 2005) such that removal is unlikely. One opportunity exists in the County seawall area where an outfall crosses the beach near the end of Elm Street. It is not known if the water receives any treatment, and this should be determined to see if the water needs treatment. The outfall structure, short groin, and the old pilings could be at least partially removed to create beach area and remove the foreign material. Conservation opportunities are very limited in this reach due to the above-mentioned degree of bulkheading.

Reach-scale restoration opportunities in the Lily Point reach include site-specific removal of derelict structures and possible acquisition of properties along the toe of the bluff if they become damaged during coastal flooding events. Removal opportunities are present at the large accretion shoreform located just northeast of Lily Point, where an old cannery was located (Bauer 1974). Pilings, slag piles, and various debris such as concrete pieces could be removed from the intertidal and backshore. A row of houses/cabins with revetments is present west of Lily Point that both cover a portion of the beach and cause sediment impoundment. Acquisition of these properties and restoration should be a long-term goal. This area would also benefit from restoration of marine riparian vegetation. Conservation is key in the Lily Point reach, particularly as it pertains to maintaining and protecting high value feeder bluffs (exceptional feeder bluffs, unbulkheaded) that supply all of the sediment for the Maple Beach reach. The same applies to the accretion shoreforms in the reach, particularly in the southern half of the reach.

The Lighthouse reach receives all net shore-drift sediment from sources further east and conservation of the net shore-drift process is essential to maintaining nearshore habitats and property throughout the reach. Efforts should focus on ensuring that sediment bypassing at the Point Roberts Marina is performed according to permit conditions, some of which require that sediment be pushed into the active foreshore. Site-specific restoration opportunities include removal of the old telephone building and associated shore defense structures from the southwest point of the County Park. This includes a soldier pile bulkhead and a boulder and debris revetment. Other derelict structure removal opportunities in the reach include two large sets of abandoned piles north of Lighthouse Park that are in the intertidal (including by the west end of Gulf Road). Efforts could be made to restore filled backshore marshes and restore hydrologic connectivity with the marine environment.

Similar to the Lighthouse reach, the Boundary Bluff reach is dependent on net shore-drift sediment from the Lily Point reach, and preservation and restoration of sediment input is also a priority here. Restoration in the reach should be focused on site-specific removal of rock bulkheads in the southern and central portion of the reach, where erosion does not appear to be substantial. Conservation of healthy marine riparian vegetation, which offers morning shade to the upper intertidal, should be carried out.

4.2.10 Reach–scale Ranking of Nearshore Restoration Priorities

This section describes the relative restoration potential of each individual nearshore reach as depicted in Figure 4[8]. Using the approach outlined in Section 2.3.1, each reach was ranked in terms of the potential to restore:

- Forage fish spawning (Pacific herring, Pacific sand lance, and surf smelt)
- Juvenile salmonids
- Aquatic vegetation (eelgrass, kelp and algae)

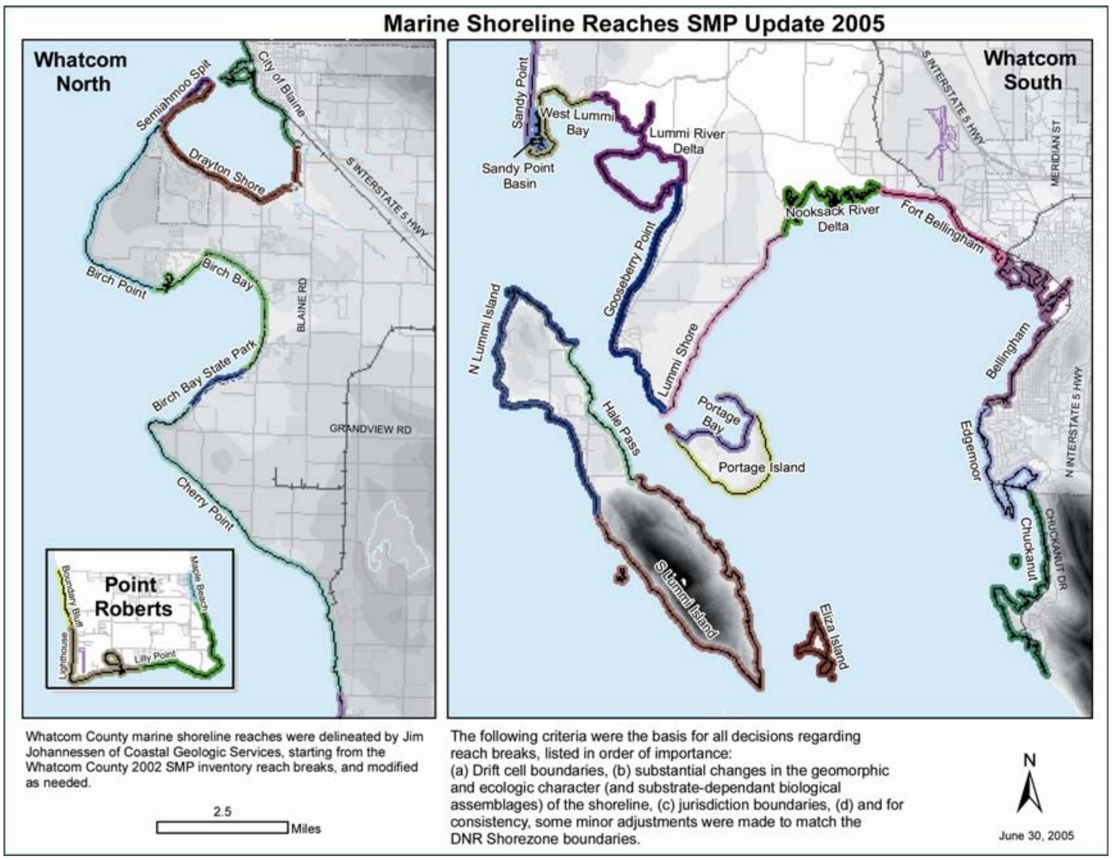

Figure 4. Marine shore reaches of Whatcom County

[8] The Enhanced Nearshore Assessment work is described in detail in a separate report by Adolfson Associates and Coastal Geological Services, August 2006.

Reaches that ranked highest for forage fish restoration potential based on the scoring are Birch Bay State Park, Sandy Point, Gooseberry Point, Lilly Point, Boundary Bluff, and Portage Island. Drayton Shore, Portage Bay, and Hale Pass also ranked relatively highly but these reaches are located in relatively low bank, low energy areas where the up-drift portion of the drift cell has little connectivity between sediment source and the net shore-drift system, which reduces their restoration potential. Other high ranking reaches had many positive attributes such as existing spawning populations of one or more forage fish species, appropriate sediments (sand, mixed fine or mixed coarse), moderate sediment input and connectivity, and proximity to eelgrass and/or kelp beds. At the same time, these reaches are characterized by alterations such as lack of riparian vegetation, intensive upland development, and/or in-water/over-water structures, which if repaired or mitigated could improve overall habitat conditions.

The Sandy Point basin, Birch Bay, Lighthouse, and Fort Bellingham reaches ranked highest for juvenile salmonid restoration potential. The high ranking was primarily because of the presence of pocket estuaries, which are considered to be highly important rearing habitats, and because of the extent of alteration. The pocket estuaries associated with these reaches are considered to be "not properly functioning", suggesting a need for restoration. In contrast, the pocket estuaries associated with the Drayton Shore and Potage Bay reaches are in somewhat better condition (although still considered "at risk"), which resulted in a lower overall restoration potential score. Other reaches such as the Nooksack delta, Drayton Shore and Lummi Bay (which do not have pocket estuaries) may also have important restoration opportunities for juvenile salmonids because of the proximity of these reaches to natal streams.

The Lummi River Delta, Birch Bay and Chuckanut reaches ranked relatively highly for restoration of aquatic vegetation. These reaches support or have the potential to support kelp and eelgrass beds but have extensive in-water or over-water structures or disrupted sediment supply.

4.2.10.1 Nearshore Reach-scale Restoration Opportunities

Specific restoration opportunities are described below for each nearshore reach. These areas are depicted on Figure 5 (attached as a separate document). High priority opportunities are shown in *italics.*

Figure 5. Nearshore Restoration Opportunities (in separate document)

Maple Beach

In the County seawall area, an outfall crosses the beach near the end of Elm Street. It is not known if the water receives treatment of any kind prior to discharge from the outfall, and the need for treatment should be determined. The outfall structure, short groin, and the old pilings could be at least partially removed to free up beach area and remove the foreign material.

Restoration opportunities in the Lilly Point reach include cleanup of derelict structures. Cleanup opportunities are present at the large accretion shoreform located just northeast of Lilly Point, where an old cannery was located (Bauer 1974). Pilings, slag piles, and debris such as concrete could be cleaned up from the intertidal and backshore areas.

Lilly Point

A row of houses/cabins with revetments is present west of Lilly Point. These structures cover portions of the beach and cause bluff sediment impoundment, negatively impacting both *surrounding reaches. Opportunistic acquisition of these properties should be a long-term goal, especially if they become damaged during coastal flooding events. Marine riparian vegetation in this area should be restored.*

Conservation in the Lilly Point reach should include the high value, unbulkheaded, exceptional feeder bluffs that supply all of the sediment for the Maple Beach reach. This is also true for the accretion shoreforms in the reach, particularly in the southern half of the reach, which are undeveloped and offer excellent recreational opportunities (Bauer 1974).

Lighthouse

Site-specific restoration opportunities include removing the old telephone building and associated shore defense structures from the southwest point within the county park. This includes a soldier pile bulkhead and boulder and debris revetment.

Other derelict structures that could be removed in the reach include two large sets of abandoned piles north of Lighthouse Park that are in the intertidal area (including by the west end of Gulf Road).

Other restoration opportunities in this reach include restoring now-filled backshore marshes and hydrologic connectivity with the marine environment, and improving marine water quality at the marina.

Boundary Bluff

Restoration in the reach should be focused on site-specific removal of rock bulkheads in the southern and central portion of the reach, where erosion does not appear to be substantial.

Drayton Shore

Removal of creosote pilings including soldier pile bulkheads would provide a suite of benefits to the nearshore environment. These opportunities exist at a degraded soldier pile bulkhead (scoured away on landward side) located northwest of Dakota Creek, and at creosote piles located near the Semiahmoo marina (in the City of Blaine).

Numerous bulkheads, some of which protrude well into the intertidal, are located between California Creek and Dakota Creek. Most of these structures are composed of rock but some are composed of concrete, including very recent construction located immediately north of the mouth of California Creek. Other structures located south of Dakota Creek zigzag across the upper foreshore. In general, these bulkheads appear unnecessary because of the relatively low wave energy and apparently slow erosion rates, combined with moderate house setbacks.

A large platform and foundation cross the intertidal area immediately east of the mouth of Dakota Creek. This entire structure could be removed to restore the beach and fringing marsh.

Near the intersection of Drayton Harbor Road and Harbor View Road (along the Willamette Meridian), there is a restoration opportunity to remove a dilapidated dock that stretches across the beach of three adjacent properties, as well as miscellaneous building materials from the intertidal area.

Birch Bay

Restoration in the Birch Bay reach should be focused on removing old and failing structures (possibly in conjunction with large-scale beach nourishment currently under consideration). This would include removing groins and bulkheads along Birch Bay Drive to restore upper beach and backshore habitats.

Other restoration goals for this reach would be to restore historic marsh areas where possible and to create a riparian buffer along the Birch Bay shore.

Cherry Point and Sandy Point

The bluffs in the vicinity of Point Whitehorn are the sole sediment source for the miles of accretionary shoreform and valuable habitat in Birch Bay and Birch Bay State Park reaches. Numerous bulkheads (many apparently not permitted) are located near Point Whitehorn, providing a restoration opportunity on the drift cell basis.

A larger opportunity for restoration in the Cherry Point reach includes reintroducing impounded sediment on the north side of the pier base fills. This would be accomplished by excavating and bypassing the accreted sediment located in the backshore on the north side of the Conoco-Phillips pier (the southern of the three industrial piers at Cherry Point). Sediment would be excavated from landward of the berm and bypassed to the south side of the pier fill area in stages. This would also create coastal wetlands in the backshore. A tidal channel should be evaluated and, if feasible, could be excavated after backshore excavation was completed in an attempt to maintain a saltmarsh. However the inlet may not remain open. Investigation into routing fresh water may make it possible to create a pocket estuary.

Sandy Point Basin

Restoration opportunities include removing unnecessary bulkheads and reducing the intertidal slope to restore upper beach and backshore habitat. Reducing impervious surfaces and creating riparian buffer/dune habitat would provide habitat benefits and aid with flood control. Portions of the undeveloped (filled) uplands could be restored to marsh where possible.

Other restoration opportunities include removing some of the numerous creosote soldier pile bulkheads and pilings inside the basin, as well as removing invasive species.

West Lummi Bay

The east shore of Sandy Point could be partially restored through pulling back sections of the long dike and recreating a more natural upper foreshore where biologically advantageous. Another opportunity includes removing creosote piles.

Lummi River Delta

Restoration opportunities include removing extensive dikes and tide gates across the Red River delta to restore tidal inundation and greatly increase fish habitat. Other opportunities include removing creosote piles.

Gooseberry Point

Restoration opportunities include removing sediment impoundments (bulkheads) and alongshore drift impediments such as the failed concrete and rock bulkhead located approximately 0.7 miles north of Gooseberry Point.

Additionally, broken concrete bulkhead sections could be removed from the foreshore, primarily north of Gooseberry Point and near the tip and south shore of the point.

Portage Island

Restoration is not required due to the relatively unaltered condition of the island's outer shores.

Lummi Shore

Restoration potential appears limited, unless the recent large revetment can be altered. The ideal nearshore restoration scenario would be to relocate the road further inland and remove all or portions of the riprap revetment.

A restoration priority should be to ensure the beach nourishment started under the U.S. Army Corps of Engineers constructed revetment continues as needed based on beach monitoring.

Other restoration could be focused on replacing marine riparian vegetation where possible. Enhancing the revetment/ bank with riparian plantings may provide habitat benefits.

Also, removing the fairly abundant derelict drift nets, debris, and other foreign material from the Lummi Shore Road beaches would provide a direct benefit.

Fort Bellingham

Restoration should be focused on removing structures wherever possible. This could include remove concrete rubble and riprap along base of bluffs and the derelict (creosoted wood) cement plant pier.

Restoration of the Little Squalicum Creek mouth/estuary could include removal of debris and exotic species and revegetation with native plants.

Debris removal and restoration of the armored shore around the west side of the Mount Baker Plywood area would provide habitat improvements.

A straightforward opportunity exists in removing abundant wood debris that is smothering nearshore sediments along the Cliffside community beach in the northwest portion of the reach.

Similarly, removal of wood waste/LWD from backshore marshes where it is likely causing disturbance and reducing primary productivity of coastal wetlands should be evaluated.

Removal of the abundant invasive species in the marine riparian area, perhaps starting with an education effort, would improve conditions.

Chuckanut Bay

Restoration opportunities include major and small projects. Removal of the Burlington Northern railway and revetment would uncover large beach areas and allow for major restoration of bay shores and the limited sediment transport that occurred pre-revetment, including uncovering the toe of rocky cliff areas.

Without railway revetment removal, performing beach nourishment along some portion of the sediment-starved beaches would partially mitigate for the railway revetment.

Hale Passage

Reach scale nearshore restoration should be focused on restoring sediment sources “locked up” behind residential bulkheads where feasible.

South Lummi Island

Restoration generally does not seem necessary since the area does not have appreciable net shore-drift for the most part, and habitats are associated with the prevalent rocky shore.

The one exception to this is the rock quarry at Smuggler Cove run by Ace Rock, which is on WDNR property. The shore that is not in use could be restored through removal of fill and riparian restoration to resemble the rocky shore prior to site development.

North Lummi Island

The area immediately east of Village Point would benefit from removal of relict structures in backshore/marsh environments with marsh restoration. The road setback in this area is non-existent, as the beach has eroded and a seawall was constructed in a portion of the area by Whatcom County in recent years.

Removal of a failed solid fill pier, large rock groin, concrete debris and derelict piles in the western portion of Legoe Bay would benefit the nearshore. Derelict piles (likely creosoted) could also be removed from eastern Legoe Bay.

There is significant room for habitat enhancement at Lummi Point on the northeast part of the island. Any bulkheads that are not necessary for protection of houses (such as on the north side of the point) could be scaled back or moved landward as possible. Picnic structures located over what would be active beach could be removed, particularly on the east end of the spit. Riparian planting could be enhanced.

Eliza Island

Few major alterations to nearshore processes are found in this watershed management area. The most substantial alteration appears to be several rows of relict pilings associated with boat ramps along the northern accretion beach, as well as a small cluster at the western point of the island. These piles are likely creosoted and toxic to marine and human life. Additional restoration opportunities include restoring marine riparian vegetation along cleared lots.

Conservation of feeder bluffs is required to assure the permanence of the low-lying accretion shoreforms that connect the headlands. This is especially crucial along bluffs that feed the southern accretionary beach, which is the most exposed to storms and low in width and elevation. Building setbacks should be strictly enforced along bluffs, as “emergency” bulkhead and other erosion control structures typically lead to sediment impoundment. Soft shore protection should be used for erosion control, if feasible and as necessary.

4.3 FRASER RIVER WATERSHED MANAGEMENT UNITS

Areas of the County draining to the Fraser River system are described below.

4.3.1 Sumas River WMU

The Sumas River WMU is part of the Fraser River basin. Although separated from the Nooksack River system by levees, the WMU includes a portion of the historic Nooksack floodplain. During flood events, the Nooksack River sometimes flows north into Canada via the Sumas River. Approximately one third of the total drainage area is in Canada.

Within the WMU there are three distinct geologic areas; the Sumas Mountain area in the west, wherein land use is dominated by forest practices; the Sumas River valley and associated floodplain, and the lowland valley floor to the west, which is dominated by agricultural use, including dairies as well as row crops. Incorporated areas include Nooksack and Sumas.

This WMU includes extensive wetland including wetlands on organic deposits. Pangborn Lake occupies a scoured depression and is representative of a significant land area in the Johnson Creek sub-drainage in which organic wetlands historically formed.

Chinook, chum, and coho salmon, steelhead, bull trout, and sea-run cutthroat trout have been documented in the Sumas River. Sockeye salmon have been observed in the lower reaches. Major tributaries including Saar, Johnson, and Breckenridge Creeks also provide important salmonid habitat. Great blue herons, band-tailed pigeons, bald eagles, vaux's swift, peregrine falcons, and trumpeter swans also occur in this WMU.

4.3.1.1 Degraded and Impaired Areas

The Sumas River valley floor has been altered by agricultural practices including ditching and draining of wetlands and streams, and loss of forest cover. Loss of historic wetlands is particularly evident along Johnson Creek, Sumas River, Bone Creek, and Saar Creek floodplains, and in the Pangborn Lake area.

Forest practices in the Sumas Mountain area have altered sediment transport and hydrologic processes in this area, but the degradation does not appear to be severe. Riparian corridors throughout the WMU are lacking in LWD and cover. Predominant riparian conditions include mowed grasses or shrubs to within 25 – 50 feet of the stream edge. The central portion of the WMU, the transitional foothills area, is not conducive to agriculture, and is characterized by mixed residential use. Ecological processes are relatively intact in this area and should be protected.

Water quality degradation is evident in several areas. The Sumas River has had elevated fecal coliform and low dissolved oxygen. Pangborn Creek, Clearbrook Creek, three reaches of Squaw creek, seven reaches of Johnson Creek, and Saar Creek also have been listed as impaired for fecal coliform levels (Ecology 2004). A TMDL was established in 2000 for fecal coliform and dissolved oxygen in the Johnson Creek drainage. A TMDL was also established in 1996 for chlorine, ammonia-nitrogen, and BOD in the Sumas River drainage. The Sumas River WMU has some of the highest nitrate concentrations in the County, exceeding EPA limits for annual maximum concentration in 8 of 11 years during the 1990s (USU 2002; Mitchell et al. 2005).

4.3.1.2 Restoration Potential

The mainstem Sumas River lies on the lowland outwash plain and processes are severely impaired. Opportunities for restoration are extensive, including enhancing existing riparian wetland habitats that have a high potential for hyporheic function and nutrient cycling (Table 16). The same is true for Johnson Creek, which has good potential for wetland restoration. Protecting existing peat wetlands in Johnson Creek is critical for continued nitrogen transformation mechanisms.

The North Fork Johnson Creek and the headwaters of Saar Creek are two areas where many processes are relatively intact, and there are extant wetlands that support multiple processes. Since ecological functions are less degraded in these areas, they are good candidates for protection and conservation. Upper Johnson Creek also retains some ecological function, but process alteration is still extensive.

The transitional foothill area is an important management area that is not conducive to agriculture but supports residential and other development. This area contains lower-gradient streams that are relatively unaltered. Protection of important areas in this zone would minimize further degradation of the valley.

4.3.1.3 Restoration Opportunities

Opportunities for restoring this WMU include:

- Restoring riparian zones and riverine wetlands along lowlands streams to improve hyporheic function, riparian filtering, and chemical cycling functions.
- Protecting intact Sumas River tributaries in the Sumas Mountain foothills.

4.3.2 Fraser River WMU

Although the Fraser River lies completely in Canada, headwater tributaries such as the Chilliwack River drainage reach south into the United States and Whatcom County north of Mt. Baker and the North Fork Nooksack River WMU. There is only one area in this WMU that is subject to shoreline jurisdiction: it is a short reach of Coultus Creek (also known as Frost Creek) located near the US/Canada border north of Bald Mountain and northeast of Black Mountain. The primary restoration opportunities for this area are: 1) managing existing roads and protecting areas from increased road density to limit downstream impacts, and 2) protecting the 200-foot riparian corridor on Coultus Creek to encourage long-term LWD recruitment.

4.3.3 Campbell River WMU

This WMU consists of a very small area in the northwest corner of the County; most of the watershed is in Canada. There are no freshwater or marine shorelines in this WMU. No specific restoration opportunities are identified.

4.4 SKAGIT RIVER WATERSHED MANAGEMENT UNITS

4.4.1 Samish River WMU

The Samish River WMU drains a small area of south-central Whatcom County between Lake Whatcom and the South Fork Nooksack River. Most of the watershed lies in Skagit County; only the upper reaches of the Samish River mainstem are in Whatcom County's shoreline jurisdiction. The Samish River flows to the Skagit River through a broad valley confined by bedrock outcroppings. The surrounding mountain areas are dominated by forest. The valley floor is dominated by agricultural use and contains extensive wetlands.

The Samish River WMU is within the Chuckanut Wildlife Corridor, a locally important habitat area (WCDPS 2005).

4.4.1.1 Degraded and Impaired Areas

The Samish River Valley is relatively unaltered possibly because extent palustrine wetlands have limited development. The valley is largely intact, though a railroad bed parallels the river along the right bank, which may have some effect on hyporheic functions in that area. Forest practices, which dominate the montane areas, are most intense in the Snub Mountain area, though many areas still support a mix of seral stages of forest cover.

4.4.1.2 Restoration Potential

Restoration potential in this WMU is considered to be low for most processes (Table 17). Exceptions include high potential for restoring LWD recruitment potential and canopy cover in all drainages and high potential to improve runoff processes in the Snub Mountain drainage. In addition, there is moderate potential to restore sediment delivery processes by improving forest practices and road management in areas prone to mass wasting.

4.4.1.3 Restoration Opportunities Samish River

Restoration opportunities within the Whatcom County portion of this WMU are limited but include:

- Restoring riparian vegetation along tributaries and the mainstem Samish River to improve LWD recruitment potential and shade.
- Controlling reed canarygrass and other invasive species to return the Samish River riparian corridor to a more natural state.
- Managing nutrient and fecal bacteria inputs from on-site septic systems associated with the town of Wickersham to improve downstream water quality.

4.4.2 Lake Samish WMU

The Lake Samish WMU is in the southwestern corner of Whatcom County between Lake Whatcom, Bellingham Bay, and Samish Bay. The basin is situated between Chuckanut and Lookout Mountains and drains south to Skagit County. Shorelines of the state in this WMU include Lake Samish, a short segment of Friday Creek, and Cain and Reed Lakes.

This WMU is predominantly mountainous in terrain, with forest practices comprising more than 75 percent of existing land use (Greenberg et al. 2002). The geology of the WMU naturally limits the extent of wetlands, but lacustrine fringe wetlands surround Reed and Cain Lakes. About 10 percent of the Samish Lake WMU has been converted to residential use. Residential development is generally limited to areas along the Samish, Reed, and Cain Lake shorelines. The Interstate 5 corridor also runs along the east shoreline of Lake Samish.

Table 16. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Sumas River WMU[1]

	Process Intensity[a]																						
Process	**Hydrology**								**Sediment**						**Water Quality**				**LWD**		**Heat/Light**		
Mechanism	**Infiltration & Recharge**		**Surface Water Storage**		**Snowmelt and Runoff**		**Ground-water**		**Mass Wasting**		**Surface Erosion**		**Storage**		**Inputs**		**Storage**		**LWDRP**		**Canopy Cover**		
Intensity	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Potential for Restoration and Protection**
Johnson Creek	↑	↔	↑	↑	↓	↓	↑	↑	↓	↓	↑	↑	↑	↑	↓	↑	↑	↑	↑	↑	↑	↑	Water quality considerations are clearly a high priority in all the lowland drainages, including Johnson Creek, the mainstem Sumas River, and Saar Creek. Management actions such as the TMDL Implementation Plans and Farm Plans to address these issues are ongoing. Wetland restoration, particularly peat bogs, and riparian enhancement are key to improving water quality function as well as improving the function of other processes.
Lower Saar Creek	↓	↔	↔	↑	↓	↓	↑	↑	↓	↓	↔	↑	↔	↑	↓	↑	↔	↑	↑	↑	↑	↑	
Lower Sumas River	↑	↔	↔	↑	↓	↓	↑	↑	↓	↓	↓	↑	↔	↑	↓	↑	↔	↑	↑	↑	↑	↑	
Sumas Mountain	↓	↓	↓	↓	↑	↓	↓	↓	↔	↔	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↓	Sumas Mountain is relatively undeveloped, although forest practices are present farther upslope and rural residential development is encroaching into the foothills. Protecting mostly intact riparian zones from disturbance associated with residential development should be a primary goal of SMP implementation, particularly to prevent new sources of water quality impairment in the already impaired lowlands

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

Table 17. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Samish River WMU[1]

Process	Process Intensity[a]																				
	Hydrology								Sediment						Water Quality				LWD		Heat/Light		
Mechanism	Infiltration & Recharge		Surface Water Storage		Snowmelt and Runoff		Ground-water		Mass Wasting		Surface Erosion		Storage		Inputs		Storage		LWDRP		Canopy Cover		
Intensity	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Process	Alteration	Potential for Restoration and Protection
Samish River valley	↑	↓	↔	↓	↓	↓	↑	↓	↓		↓	↓	↔	↓	↓	↔	↔	↓	↑	ND	↑	ND	Protect hydrology; long-term vegetation and short-term instream habitat restoration on Samish River floodplain.
Snub Mountain	↓	↓	↓	↓	↑	↔	↓	↓	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↑	↔	↑	↔	Altered peak flows resulting from forest conversion in ROS zones are likely and present an opportunity for restoration through reforestation. Based on overall land cover, riparian corridors are predicted to have significant non-forested areas, restoration of which would mitigate both sediment and hydrology impacts resulting from forest practices.
Anderson Mountain	↓	↓	↓	↓	↑	↓	↓	↓	↔	ND	↓	↓	↓	↓	↓	↓	↓	↓	↑	↔	↑	↔	Forests are more intact in this area dominated by hillslope processes. Protection of riparian corridors and ROS zones will limit additional alteration of sediment and hydrology, and protect instream habitat. Opportunities for restoration likely already exist, particularly in areas actively managed for forestry.
Lyman Hill	↓	↓	↓	↓	↑	↓	↓	↓	↔	ND	↓	↓	↓	↓	↓	↓	↓	↓	↑	↔	↑	↔	Forests are more intact in this area dominated by hillslope processes. Protection of riparian corridors and ROS zones will limit additional alteration of sediment and hydrology, and protect instream habitat. Opportunities for restoration likely already exist, particularly in areas actively managed for forestry.

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

Sockeye salmon and winter steelhead use Lake Samish (PSFMC 2005) for migration and rearing and tributary reaches for spawning. Coho rearing and migration occurs in Lake Samish and spawning and rearing occurs in Friday Creek. Coho also use certain non-shoreline tributary streams for spawning (Streamnet 2005). Chum spawning and rearing occurs up to Lake Samish outlet (Streamnet 2005). Based on the morphological conditions, most spawning in Friday Creek probably occurs downstream of Whatcom County's jurisdictional shoreline.

Priority species/habitats within the Lake Samish WMU include bald eagle habitat, waterfowl concentration areas, and osprey habitat (WCPDS 2005). This area is also part of the Chuckanut Wildlife Corridor, a County-designated habitat of local importance (WCPDS 2005).

4.4.2.1 Degraded and Impaired Areas

The Whatcom County portion of this WMU is not heavily degraded or impaired compared to other WMUs. Impairments such as docks, piers, and boat launches are present along the shoreline of Lake Samish and Cain and Reed Lakes. Lack of riparian cover along portions of Friday Creek, suggests that LWD recruitment and canopy cover are impaired.

In the Reed Lake headwaters and other headwaters in the Lake Samish watershed, recent cutting and logging could alter peak flow patterns in lake tributaries, which also contribute to peak events downstream in Friday Creek and the lower Samish River.

The Ecology's 303(d) list (2004) designates Lake Samish as impaired (303d category 5) for total PCBs and a waters of concern (303d category 2) for mercury.

4.4.2.2 Restoration Potential

Restoration potential is generally low for most processes (Table 18). Potential to restore LWD recruitment and canopy cover is high in the Friday Creek drainage. There is moderate potential to restore infiltration and recharge processes in the Cain/Reed Lake drainages and in the Lake Samish drainage. The Lake Samish and Friday Creek drainages also have good potential for restoring water quality processes.

4.4.2.3 Restoration Opportunities

The primary restoration opportunities in this WMU appears to be restoring lacustrine wetlands along the Lake Samish shoreline (particularly along the north shore) to improve water quality functions, and restoring riparian cover and instream habitat in Friday Creek.

4.4.3 Samish Bay WMU

The Samish Bay WMU consists of a very small area in the southwest corner of the County; most of the watershed is in Skagit County. There are no freshwater shorelines in the Whatcom County portion of this WMU. The short segment of marine shore that abuts this WMU is covered in the Bellingham Bay section. No specific restoration opportunities are identified.

4.4.4 Skagit River WMU

This WMU in southeastern Whatcom County drains to the Skagit River basin (WRIA 3). Whatcom County's portion of the Skagit watershed is wholly contained within the North Cascades National Park and/or Ross Lake National Recreation Area, which are managed by the federal government. In general, management of resources in this WMU is generally outside of County jurisdiction. Most of the land is protected and process alterations are limited. In the Baker River drainage, there may be opportunities to manage the impact of forest roads on mass wasting and hydrology mechanisms and to improve hydrology by regulating timber harvest in rain-on-snow zones. However, the alterations to these processes appear limited, and restoration actions may be best targeted for other more impaired areas.

Table 18. Summary of Restoration and Protection Potential for Key Processes by Drainage Area, Lake Samish WMU[1]

	Process Intensity[a]																						
Process	**Hydrology**								**Sediment**						**Water Quality**				**LWD**		**Heat/Light**		
Mechanism	**Infiltration & Recharge**		**Surface Water Storage**		**Snowmelt and Runoff**		**Ground-water**		**Mass Wasting**		**Surface Erosion**		**Storage**		**Inputs**		**Storage**		**LWDRP**		**Canopy Cover**		
Intensity	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Process**	**Alteration**	**Potential for Restoration and Protection**
Samish Lakeshore	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓	↔	↓	↓	↓	↔	↓	↔	Water quality considerations along the Lake Samish shoreline are a concern both ecologically and as a drinking water source. Management of source inputs is a priority along the shoreline.
Lookout Mountain	↓	↓	↓	↓	↔	↓	↓	↓	↓	ND	↔	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↓	Forest practices are the dominant land use, but hillslope sediment and hydrology processes are limited. Protection/restoration of these few areas would prevent degradation of tributary streams, but influence on Lake Samish would be limited.
Samish West	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↑	↓	Forest practices are the dominant land use, but hillslope sediment and hydrology processes are limited. Protection/restoration of these few areas would prevent degradation of tributary streams, but influence on Lake Samish would be limited.
Reed/Cain Lakes	↓	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓	↑	↓	↓	↓	↔	↓	↔	Residential development is extensive along both lakes, although process-intensity is limited. Primary concern for restoration is contamination of water quality from OSSs.
Friday Creek	↓	↓	↔	↓	↓	↓	↓	↓	↓	↓	↓	↓	↔	↓	↓	↔	↔	↓	↑	↑	↑	↔	Hydrology of Friday Creek is predicated by Lake Samish, and consumption requires management in the context of minimum flow requirements. Riparian wetlands also important for habitat and water quality maintenance of upstream (i.e., Lake Samish) sources. Opportunities for riparian-scale restoration are abundant.

Red: High restoration potential: Moderate to high process intensity with high degree of alteration

Blue: Moderate restoration potential: -- Moderate to high process intensity with moderate degree of alteration; OR low process intensity with high degree of alteration

White: Low restoration potential: Low process intensity with low to moderate degree of alteration

Gold: High protection potential: Moderate to high process intensity with low degree of alteration

[a] Function responses to alteration of these processes tend to be less dependent on the level of process-intensity, which is historically low in Whatcom County. Therefore, the assessment of restoration potential is based primarily on the degree of alteration.

1 Based on results of the Draft Shoreline Inventory and Characterization Report (Parametrix et al. 2006). If a key process is not listed in the table, the potential to restore or protect the process in that drainage area is considered low. See also Section 2.3 of this report for methods.

5. EXISTING RESTORATION AND PROTECTION PROGRAMS

Existing and planned restoration and protection programs in Whatcom County are summarized below. These programs are being planned, funded, implemented, and monitored by various local, state, federal, and tribal entities working together to achieve shared goals. The restoration efforts described below are integral to shoreline management in Whatcom County and contribute towards meeting the goal of preserving resources and improving shoreline ecological functions over time. This summary, which is not exhaustive, highlights the entities, activities and programs that are most relevant to the shoreline restoration strategy summarized herein. Many of these activities in some way address salmonid habitat restoration.

5.1 WRIA 1 SALMONID RECOVERY PLAN AND SALMONID HABITAT RESTORATION STRATEGY

As noted in Chapter 1, the WRIA 1 SRP outlines actions necessary to recover ESA-listed salmonid populations, with a particular focus on Chinook salmon. The draft SRP includes a Salmonid Habitat Restoration Strategy (Version 2.4, 2004) that identifies and prioritizes specific projects to protect and restore habitats and the ecosystem processes essential to the recovery of threatened Chinook salmon and bull trout, along with other salmonids native to the Nooksack watershed. The SRP was submitted for inclusion in the Shared Strategy for Puget Sound, a regional recovery plan for threatened salmon (see more information on Shared Strategy in Section 5.7 below).

The SRP takes a comprehensive look at the scientific data collected on salmonids and their habitat over the last several decades, explains the factors limiting salmonid populations, and describes strategies and actions needed to recover threatened salmonids. The restoration measures identified in the SRP have the ability to benefit the full range of shoreline processes and can therefore be expected to have a direct benefit on shoreline ecological functions throughout the County.

5.2 WRIA 1 WATERSHED MANAGEMENT PLAN

WRIA plans are developed pursuant to the Washington State Watershed Management Act, which was passed by the Washington State Legislature in 1998 and codified as RCW 90.82. The intent of the Act is to provide a framework for government and non-governmental organizations, to plan for and address issues relating to water quantity, water quality, instream flow and fish habitat within a given geographical area. The Watershed Management Act states:

> "The legislature finds that the local development of watershed plans for managing water resources and for protecting existing water rights is vital to both state and local interests… The development of such plans serves the state's vital interests by ensuring that the state's water resources are used wisely, by protecting existing water rights, by protecting instream flows for fish and by providing for the economic well-being of the state's citizenry and communities."

Watershed management plans must balance competing resource demands. This includes recommending long term strategies to satisfy minimum instream flows and provide water for future out-of-stream needs. Optional elements that may be addressed include water quality and habitat. The Whatcom County WRIA 1 planning process chose to address all elements, including instream flow, water quality, and habitat.

The WRIA 1 planning process began in Whatcom County in October 1998 when Whatcom County, the City of Bellingham, the Lummi Nation, the Nooksack Tribe, and Public Utility District (PUD){ TC "PUD Public Utility District" \f A \l "9" } Number 1 entered into a Memorandum of Agreement on the process. The scope of work included defining project goals, addressing technical elements (specific to water quantity, water quality, instream flows and fish habitat), and defining solutions for implementation including governance structure, funding, long-term monitoring, and adaptive management (Final Draft: *WRIA 1 Watershed Management Plan (WMP) – Phase 1, February 2005*). These activities led to a list of recommended actions for WRIA 1 and a long-term monitoring program to evaluate success of WRIA 1 projects. The WRIA 1 plan is designed to be an iterative, living document that will evolve over time as projects and programs to address water quantity, quality, instream flows, and fish habitat are implemented and monitored over time. These project are expected to have direct benefits on shoreline resources and contribute to meeting the no net loss goals of the SMA and the County SMP.

5.3 TENMILE CREEK WATERSHED VOLUNTEER RIPARIAN RESTORATION PILOT PROGRAM

This WRIA 1 early action program was spearheaded by members of the WRIA 1 Agriculture Caucus and community leaders such as Dorie Belisle. The intent of the pilot program is to provide seed money for a volunteer riparian restoration program involving farmers and other landowners. The specific goals of the program are: 1) to improve water quality in the lowlands of Whatcom County by improving fish habitat while maintaining the ability to farm, and 2) to set the stage for a two-year pilot program and to educate and engage watershed residents in efforts to restore riparian areas on a watershed or sub-watershed basis.

The program operates under the guidance of the Tenmile Advisory Committee, which includes numerous landowners and representatives from the Washington Department of Fish and Wildlife (WDFW){ TC "WDFW Washington Department of Fish and Wildlife" \f A \l "9" }, the Whatcom Conservation District (WCD){ TC "WCD Whatcom Conservation District" \f A \l "9" }, the Nooksack Salmon Enhancement Association (NSEA){ TC "NSEA Nooksack Salmon Enhancement Association" \f A \l "9" }, Washington State University (WSU){ TC "WSU Washington State University" \f A \l "9" }, and the Natural Resources Conservation Service (NRCS){ TC "NRCS Natural Resources Conservation Service" \f A \l "9" }. The program has helped plant over 1,800 trees along rivers and streams in the Tenmile watershed.

The WRIA 1 Watershed Management Project provided preliminary funding for the program. Additional funds have been acquired through grants from the WDFW and Ecology's Centennial Clean Water Fund, in partnership with the NSEA and the WCD. By improving riparian and wetland conditions in the Tenmile watersheds, this program contributes toward meeting the overall restoration goals of this plan.

5.4 CONSERVATION RESERVE ENHANCEMENT PROGRAM (CREP){ TC "CREP CONSERVATION RESERVE ENHANCEMENT PROGRAM" \F A \L "9" }

The Conservation Reserve Enhancement Program (CREP) is a federal-state partnership that focuses on establishing wooded stream buffers on agricultural lands. Participants must agree to remove riparian areas from production and grazing for 10-15 years. The WCD is responsible for implanting this program in Whatcom County. WCD helps landowners plant vegetated stream buffers to improve water quality and habitat where poor riparian conditions are a limiting factor for salmonids, especially Chinook salmon. For land to qualify under CREP it must have the required cropping history, be able to support trees and shrubs, and include an eligible stream. Almost 500 miles of streams and rivers in the lowlands and rural areas of Whatcom County are eligible.

CREP provides incentives to encourage sound riparian stewardship. Landowners receive annual rent payments for the land and a bonus for joining the program. In addition, they have the option to implement the restoration activities themselves, or to allow CREP-funded contractors to do the work. All maintenance costs of the vegetated area are also funded until there is a successful, self-sustained buffer area.

As of January 2005, 137 projects had been implemented across the County, affecting 75 stream miles and 1,274 acres of land. More than 625,000 seedlings have been planted.

5.5 LAKE WHATCOM WATERSHED MANAGEMENT PROGRAM

The Lake Whatcom Management Program is a joint effort of the City of Bellingham, Whatcom County, and Lake Whatcom Water and Sewer District (formerly Water District #10) to protect Lake Whatcom as a source of drinking water. In 1992, a set of 21 goals was adopted by the elected bodies of the three jurisdictions, which set into motion the Lake Whatcom Management Program. Information on the project's web site (http://www.Lakewhatcom.wsu.edu) provides background on the Lake Whatcom Management Program as well as information on specific program activities.

5.6 PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP){ TC "PSNERP PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT" \F A \L "9" }

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a large-scale initiative that affords a unique opportunity to tackle some of the foremost habitat restoration needs in Washington State's Puget Sound basin. This project is similar in scope and scale to the restoration of the Everglades in Florida, or Chesapeake Bay in Maryland. Nearshore Project goals are to identify significant ecosystem problems, evaluate potential solutions, and restore and preserve critical nearshore habitat. The project is a cooperative effort among government organizations, tribes, industries and environmental organizations to preserve and restore the health of the Sound's nearshore. Major funding partners include the U.S. Army Corps of Engineers and the U.S. Geological Survey.

The first phase includes developing plans to do the actual restoration and preservation work. The second phase would be a commitment of billions of dollars to restore and preserve Puget Sound. Eventually, the Puget Sound Nearshore Project could be as significant as the nearly $8 billion authorized for restoring the Everglades in Florida and $5 billion for restoring Chesapeake Bay in Maryland.

The project is currently in its feasibility study phase. The purpose of the feasibility study is to evaluate the factors that are causing the habitat to decline and pollution to occur in the Puget

Sound Basin; to formulate, evaluate, and screen potential solutions to these problems; and to recommend a series of actions and projects. The study will look for projects that have both a federal interest and support from local communities that are willing to provide the necessary investment to address the habitat or pollution problems in their area of the Sound.

The project's steering committee works with local governments, tribes, environmental groups, Salmon Recovery Lead Entities, and Marine Resources Committees to develop a process to identify and set priorities for individual restoration and preservation projects.

The PSNERP Work Plan is available in pdf format (http://www.pugetsoundnearshore.org). It describes three project stages:

1. Program and Tool Development
2. Strategic Needs Assessment
3. Restoration Plan Formulation

The project is currently in Stage 2, anticipated to be complete in June 2006. The Work Plan is intended to be a living document, updated periodically to reflect progress and improved understanding of project tasks. The current version is a June 2004 working draft. More information on PSNERP is available at their website: http://www.pugetsoundnearshore.org.

5.7 SHARED STRATEGY FOR PUGET SOUND

The Shared Strategy is a collaborative effort to protect and restore salmon runs across Puget Sound. Shared Strategy engages local citizens, tribes, technical experts and policy makers to build a practical, cost-effective recovery plan endorsed by the people living and working in the watersheds of Puget Sound. To accomplish this, Shared Strategy partners have designed a work program that calls for draft chapters of recovery plans by June 2004 and for final chapters by June 2005.

Shared Strategy staff support local watershed planning areas in developing policy and technical approaches to recovery planning. These approaches will result in a chapter that contains actions and commitments. Shared Strategy staff support watersheds in obtaining the additional support necessary for them to develop their chapter. Shared Strategy staff also work with the Action Team to support the development of a Puget Sound-wide nearshore chapter. More information on the organization is available at their web-site at: http://www.sharedsalmonstrategy.org.

6. IMPLEMENTATION AND MONITORING

This chapter outlines aspects of plan implementation and monitoring that are necessary to achieve restoration goals.

6.1 PARTNERS

Successful implementation of this plan will require cooperation and coordination with other agencies and entities that are engaged in restoration planning and natural resource management. Some of the key partners are described below.

6.1.1 Lummi Nation

The Lummi Nation is active in most of the ongoing natural resource protection and management efforts in Whatcom County. These efforts encompass a wide range of issues related to salmon recovery, shellfish management, aquaculture, and water quality/quantity. In addition, the Lummi have proposed a number of specific habitat restoration projects in the Nooksack River Estuary (http://www.lummi-nsn.gov/).

The Lummi Nation is also in the process of developing a wetland mitigation bank in cooperation with the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency (USEPA){ TC "USEPA U.S. Environmental Protection Agency" \f A \l "9" }. The proposal entails restoring, enhancing and preserving over a thousand acres of estuarine wetland area at two sites. The first site, located in the Lummi Delta, proposes wetland restoration and enhancement on approximately 395.7 acres. The second site, located in the Nooksack Delta, proposes a combination of wetland enhancement and preservation on approximately 847.7 acres (Gail Terzi, USACOE Wetland Mitigation Banking lead, personal conversation 11/14/05). The proposal is currently in process.

6.1.2 Nooksack Tribe

The Nooksack Tribe is also very active in natural resource protection and management, with a focus on fisheries and shellfish. The Nooksack Natural Resources Department (NNR){ TC "NNR Nooksack Natural Resources Department" \f A \l "9" } works to protect and recover the treaty resources of the Nooksack Tribe by assessing, preserving and restoring salmon habitat, and by managing fish and shellfish resources for the long term in an ecologically sound, sustainable manner. NNR works in cooperation with other jurisdictions to promote responsible resource management. NNR reviews permitting activities, such as forest practices applications, road maintenance plans, Total Maximum Daily Load allocations, and hydropower and flood control proposals. Through providing technical input, the department helps educate others on habitat requirements for the various treaty resources, and how their actions can help promote recovery. NNR also encourages regulatory changes that support habitat recovery. More information on the Nooksack Tribe can be found at their website at: http://www.nooksack-tribe.org.

6.1.3 Nooksack Salmon Enhancement Association (NSEA){ TC "NSEA Nooksack Salmon Enhancement Association" \f A \l "9" }

The NSEA works cooperatively with local, state, and federal agencies and local tribes, including the Whatcom Conservation District, the Nooksack Recovery Team (NRT){ TC "NRT Nooksack Recovery Team" \f A \l "9" }, the WDFW, Department of Natural Resources (DNR){ TC "DNR Department of Natural Resources" \f A \l "9" }, Department of Ecology (Ecology), the U.S. Forest Service (USFS){ TC "USFS U.S. Forest

Service" \f A \l "9" }, the U.S. Fish and Wildlife Service (FWS){ TC "FWS U.S. Fish and Wildlife Service" \f A \l "9" }, the Nooksack Tribe, the Lummi Nation, and the City of Bellingham.

NSEA was formed in 1990 as a non-profit coalition of community members with a common vision of seeing naturally spawning salmon returning to Whatcom County streams. NSEA is one of the 14 regional salmon enhancement groups in the WDFW and Wildlife Regional Fisheries Enhancement Group Program. The NSEA supports numerous community efforts including five diverse watershed steward groups actively involved in adopting and restoring their streams. The program provides the building blocks improving the environment, creating new partnerships, and sustaining healthy wild fish production. Through Stream Steward workshops, regular meetings, and on-the-ground stream restoration projects, participants are gaining the tools and knowledge to work together to protect and restore streams in Whatcom County.

6.1.4 The Nooksack Recovery Team (NRT){ TC "NRT Nooksack Recovery Team" \f A \l "9" }

Established in 1994, the NRT is a nonprofit organization dedicated to restoring fish habitat in the Nooksack watershed. Membership is made up of representatives from Lummi and Nooksack tribes, private industry, government agencies, and nonprofit, agricultural, forestry, and environmental organizations. The NRT contributes to watershed restoration efforts in Whatcom County by contributing money, equipment, time, and technical expertise towards watershed improvement and improved aquatic habitat for salmonids.

6.1.5 Washington Department of Ecology (Ecology){ TC "Ecology Washington Department of Ecology" \f A \l "9" }

Washington Department of Ecology (Ecology) has regulatory authority on waters of the state. Ecology is actively involved in watershed planning, as well as outreach and education efforts to improve water quality throughout Whatcom County.

6.1.6 Washington Department of Fish and Wildlife (WDFW){ TC "WDFW Washington Department of Fish and Wildlife" \f A \l "9" }

The Washington Department of Fish and Wildlife (WDFW) is a state leader in providing technical support staff as well as funds for salmon recovery efforts. A complete list of WDFW's activities is available at their website at http://www.wdfw.wa.gov.

6.1.7 Washington State Department of Natural Resources (WDNR)

The Washington State Department of Natural Resources (WDNR) manages forests, farms, commercial properties and underwater lands under state ownership within Whatcom County. Much of this land is dedicated to supporting public institutions like schools and universities. DNR's aquatic lands are managed to provide access to rivers, lakes, streams and Puget Sound. DNR also works to serve the continuation of navigation and commerce.

Two of DNR's largest responsibilities in resource protection are fire prevention and suppression and regulating forest practices (or timber harvest). With respect to timber harvest, the DNR has recently issued a report on the Lake Whatcom Landscape Management Plan Pilot Project, which details the Department's efforts on timber harvest and watershed management on 15,000 acres of state trust lands in the Lake Whatcom Watershed. More information on this effort, which is an outgrowth of the Lake Whatcom Landscape Management Plan (Nov. 04), is available at the DNR web-site: http://www.wa.gov/dnr.

6.1.8 Marine Resources Committee (MRC){ TC "MRC Marine Resources Committee" \f A \l "9" }

Part of a network of seven committees in the state, the Whatcom County MRC is charged with identifying and solving problems with local marine resources, such as intertidal and estuarine habitat, shellfish beds, and bottomfish. Whatcom County's Water Resources Division is represented on the committee and provides technical and administrative support to the MRC.

The MRC was established by the Northwest Straits Marine Conservation Initiative, which Congress authorized in 1998 in response to concerns over declining marine life and habitat in the Straits of Juan de Fuca and northern Puget Sound. The Initiative established a 13-member Northwest Straits Commission and MRCs in seven western Washington counties. The MRC's main purpose is to guide local communities, using up-to-date information and scientific expertise, to achieve the important goals of resource conservation and habitat protection within the Northwest Straits. The Whatcom County MRC takes a comprehensive approach towards marine issues in Whatcom County. There are numerous groups that focus on specific marine issues or on specific areas of the marine environment. The MRC is designed to take a broad-based approach to marine issues as seen in their Marine Resources of Whatcom County Report, Rapid Shoreline Inventory, the 2001 Marine Summit, and miscellaneous marine educational information.

The MRC provided funding to support development of this restoration plan. The funding enabled a detailed assessment of drift cell data, detailed mapping and classification of feeder bluffs and accretion shoreforms along portions of the marine shore between Neptune Beach and Drayton Harbor, and overall ranking of nearshore restoration priorities as described herein. Additional information on the work funded by the MRC is provided under separate cover.

6.1.9 Northwest Indian College

Students from the Northwest Indian College have participated in various monitoring and restoration projects throughout the County. Specific information on the college can be found at their website: http://www.nwic.edu.

6.1.10 Puget Sound Action Team (PSAT){ TC "PSAT Puget Sound Action Team" \f A \l "9" }

In response to the challenges facing the Sound, the Washington State Legislature created the Puget Sound Action Team (PSAT) in 1996, to protect and restore Puget Sound and its diversity of life now and for future generations. The Partnership organizes its work around three goals:

1. Protect and restore Puget Sound's water quality.
2. Protect and restore habitat for all native species in Puget Sound.
3. Protect the biological resources of Puget Sound and recover species at risk, including orcas, salmon, and groundfish.

To achieve these goals, the Action Team Partnership currently focuses its work on seven core priorities, which cumulatively represent critical threats to the ecosystem:

- Clean up contaminated sites and sediments.
- Reduce continuing toxic contamination and prevent future contamination.
- Reduce the harm from stormwater runoff.
- Prevent nutrient and pathogen pollution caused by human and animal wastes.
- Protect shorelines and other critical areas that provide important ecological functions.
- Restore degraded nearshore and freshwater habitats.
- Conserve and recover orca, salmon, forage fish and groundfish.

Actions of the PSAT are established in and governed by the Puget Sound Water Quality Protection Act RCW 90.71. Whatcom County Council member Dan McShane represents County interests as a member of the Puget Sound Action Team. More information on the PSAT can be found at: http://www.psat.wa.gov.

6.1.11 WSU Cooperative Extension

WSU Cooperative Extension, a non-degree program funded through Washington State University, offers a variety of hands-on public educational materials and programs that support environmental and natural resource management in the community. Courses are available to landowners in the following subject areas: forestry, riparian management, water, wildlife, and watershed and beach masters. WSU Cooperative Extension often works closely with other community organizations such as the Conservation District and Whatcom County in providing public educational services. The Cooperative Extension is also active in supporting agriculture and best management practices throughout Whatcom County in cooperation with the USDA, NRCS, Whatcom Agricultural Advisory Committee, Whatcom Conservation District, and others. More information on the Cooperative Extension, and the services they provide, is available at their web-site: http://www.whatcom.wsu.edu.

6.1.12 Public Utility District # 1

The Whatcom County PUD #1 was formed in 1937 as a publicly owned utility by the vote of Whatcom County citizens. The PUD became an operational utility in 1952, when it provided energy to serve the Cherry Point refinery. During the 1960s, the PUD became actively involved in providing water services, first to industrial users in and around Cherry Point, and subsequently providing raw water to the City of Ferndale. The PUD has the authority to provide water and electric services throughout Whatcom County, with the exception of electricity within the cities of Blaine and Sumas. The PUD is actively involved in watershed planning and in maintaining services to its current service area in the industrial zones at Cherry Point and Grandview. The PUD also encourages environmental awareness, energy and water conservation and re-use. As a member of the Nooksack Recovery Team, the PUD maintains an active role in fish and wildlife habitat recovery efforts. Additional information on the PUD is available at their web-site: http://www.pudwhatcom.org.

6.2 TIMELINES AND BENCHMARKS

Specific timelines and benchmarks for implementing individual elements this plan are difficult to determine without additional information regarding the feasibility and cost of identified restoration measures. Timelines should be developed according to the general priorities described herein and emphasis should be given to areas with the greatest restoration potential.

6.3 FUNDING

Funding sources will need to be identified for specific projects or elements of this plan. It is expected that funding will be derived from a variety of sources. In some cases, applicants for shoreline permits may implement one or more of the restoration projects to fulfill mitigation requirements. Potential public funding sources include: the County general fund, the Salmon Recovery Funding Board, the Aquatic Lands Enhancement Account (ALEA){ TC "ALEA Aquatic Lands Enhancement Account" \f A \l "9" }, and the WRIA 1 program. For example, the County could identify some of the projects in the Capital Facilities Program to ensure that they are considered during the budget process, or develop a specific restoration fund for shoreline projects.

Incentives program could be established to facilitate restoration. These might include preferential tax incentives (such as Open Space Taxation) to encourage private landowners to preserve shoreline resources.

6.4 OBSTACLES AND CHALLENGES

In many cases, the restoration opportunities described herein require acquisition of private land, relocation of public infrastructure, dramatic changes in land use, and restrictions on future development. While most of these actions are technically feasible, they are extremely challenging from a socio-political perspective. One of the key obstacles to be overcome is consensus on what needs to be accomplished and how. This will require extensive cooperation and coordination with citizens, private landowners, and other stakeholders.

6.5 MONITORING STRATEGIES

The County is required to monitor the effectiveness of the SMP, including this restoration plan, over time to assess whether net loss of ecological functions and processes is occurring. This will require tracking shoreline development activities to ensure permit compliance and periodically re-assessing the ecological health and status of shoreline resources. The latter should include identifying which restoration activities have occurred compared to stated goals, objectives and priorities of this plan.

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