City of Snohomish

Endangered Species Act Response Planning

Prepared for:

City of Snohomish

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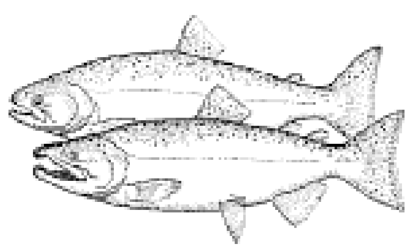

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The Endangered Species Act Strategy for the City of Snohomish identifies and prioritizes actions that the City can take to preserve and enhance its streams, wetlands and riverfront, while promoting rational development and other City goals. The Strategy's recommendations, based primarily on the needs of salmon, provide an integrated approach to City activities to assure compliance not only with the Endangered Species Act but also with other federal and state environmental laws, including the Clean Water Act, the Growth Management Act and the Shoreline Management Act. The recommendations are based on data best available science, including data collected specifically for this purpose, and have been developed in coordination with staff from the National Marine Fisheries Service. Thus, they can be used to guide the City's future activities and protect fish and wildlife habitat within its Urban Growth Area.

City of Snohomish officials, at their discretion, can use the Strategy to update critical area regulations and the city's shoreline management plan, establish a stormwater management program for its NPDES Phase II municipal permit, and develop best management practices for maintenance of public works, parks and riverfront property. The Strategy also identifies and prioritizes habitat restoration projects, which could be implemented through grants and other partnerships, mitigation requirements for public and private projects, and a variety of City programs meant to further conservation goals.

One of the original goals of the ESA Strategy in 2001-02 was to provide the City the potential basis for an exemption from "take" prohibitions for Puget Sound chinook salmon, which was listed as a threatened "Evolutionarily Significant Unit" under the ESA in March 1999 (64 FR 14308). Municipalities such as Snohomish face the risk of federal agency enforcement and citizen lawsuits when listed species are adversely affected by their actions or inactions. To reduce its liability, the City intended to seek approval for certain activities subsumed under one or more "limits" or exceptions to take prohibitions specified under Section 4(d) of the ESA. A 4(d) rule limit provides qualifying governments or individuals with a safe harbor from federal enforcement under the ESA, and greatly reduces the threat of litigation.

As originally conceived, the Snohomish ESA Strategy was to be patterned after a similar effort then underway at the regional level. The "Tri-County" Salmon Conservation Coalition, which represented public and private interests across Snohomish, King and Pierce Counties, was seeking 4(d) rule exemptions for several county programs, including public water systems, road construction and maintenance, and stormwater management. By applying lessons learned in the Tri-County experience to the City of Snohomish's specific needs, the ESA Strategy sought to provide protection for chinook salmon sufficient for NMFS approval, at a reduced cost to the City and its citizens.

The Tri-County coalition ultimately decided not to pursue 4(d) rule exemptions and, for now, it appears prudent for the City to do the same. The legal risks of liability for take appear relatively small due to the difficulty of proving that a program or suite of actions causes the take of individual fish. Moreover, as one of the first municipalities granted an exemption, Snohomish might find itself in the midst of unwanted controversy. Finally, the cost and uncertainties involved in gaining the National Marine Fisheries Service's formal approval of the City's proposal could be substantial, including an Environmental Impact Statement process estimated to require at least 18 months to complete.

If the balance of benefits and costs should change in the future, the City can use the ESA Strategy to pursue one or more 4(d) rule exemptions. In the meantime, the Strategy if implemented will provide substantial protection against agency enforcement action or citizen suits alleging a violation of the take prohibition. It should also streamline the process and reduce uncertainty surrounding federally funded or permitted actions involving the City that require Section 7 consultation with the federal service agencies. Implementation of the Strategy should also ensure that the City is doing its part to support salmon recovery in the Snohomish River basin and Puget Sound as a whole, consistent with regional, state and federal recovery planning guidelines.

Issues Covered

The most important issues addressed by the ESA Strategy are:

- Buffers and other protective measures for streams and wetlands;
- Stormwater standards for development;
- Habitat improvement projects; and
- Maintenance of riverfront property.

Other issues covered in the ESA Strategy include:

- Surface water management programs (capital projects, inspections, maintenance, education, etc.);
- Pilchuck Dam operations and capital improvements;
- Best Management Practices for maintaining City parks, roads and utilities; and
- Promotion of community-based stewardship.

Recommendations

Of the streams and rivers draining the City of Snohomish's Urban Growth Area, conditions within the Pilchuck and Snohomish Rivers are by far the most important to the health of Puget Sound chinook salmon. To ensure adequate protection for chinook salmon and their habitat within sections of the Snohomish and Pilchuck Rivers that border the City, the ESA Strategy recommends that a 100-foot wide "restoration zone" be established along both rivers. The zone would recognize the multiple goals of the state's Shoreline Management Act, the priority of habitat restoration in these rivers, and the degree to which their shorelines are already developed. No further encroachment in the first 50 feet above the ordinary high water mark would be permitted except to enhance public access. In the next 50 feet, no further encroachment would be allowed except for water-related businesses. Voluntary removal of human-placed material and restoration of natural vegetation and shoreline features within the restoration zone would be encouraged. Mitigation, primarily in the form of revegetation, removal of obsolete structures, and salmon rearing habitat improvements, would be required for all new development and redevelopment. To facilitate appropriate mitigation and restoration, the Strategy identifies and prioritizes several potential projects on City-owned land. The Strategy also recommends new ways for the City to maintain riverfront property that will enhance streambank stability and habitat complexity, while reducing long-term maintenance costs.

The City's existing buffer requirements for other streams and wetlands are generally adequate, except that protections for fish-bearing streams should be extended above correctable blockages (identified in Chapter 2). The Strategy provides updated classifications for these critical areas and has field-checked their locations. The Strategy supports allowing reductions in stream and wetland buffers for new development in return for riparian and in-stream restoration, preferably in areas where existing buffers and stream conditions are severely degraded.

The most significant long-term threat to the City's creek systems is stormwater from new development, which could dramatically alter the hydrology and water quality of Cemetery and Bunk Foss Creeks and Blackman's Lake. The ESA Strategy generally recommends using the Department of Ecology's 2001 stormwater standards to address this issue, with some exceptions and alternatives. In the Cemetery Creek basin, the low stream gradient, numerous wetlands and substantial permeable soils provide excellent opportunities for low-impact development as an alternative to strict application of the standards. In the Bunk Foss Creek basin, the recommended alternative to the standards would be substantial forest retention. Below Blackman's Lake and in areas that drain directly to the Snohomish and Pilchuck Rivers, Ecology's 2001 standards are not cost-effective. Ecological benefits are much less, while costs to apply the standards could be much greater, with the latter creating disincentives to develop where growth management goals generally encourage infill development and redevelopment.

Ultimately, the residents and businesses of the City will largely determine the success of efforts to improve habitat and protect natural resources. Restoration is voluntary for the overwhelming majority of properties that do not require development permits in any given year. Even where restoration is regulated, voluntary compliance is far less costly and more assured of long-term success than enforcement, though enforcement will remain necessary in some cases. People living in or doing business in the city should be encouraged to adopt environmentally benign practices, modify their activities to minimize adverse environmental impacts, and voluntarily participate in effort to restore degraded areas to health. Citizen volunteers can stretch limited City funds to accomplish more restoration, and can help spread improved land management practices to their neighbors by example. For the ESA Strategy to succeed, the City must encourage individual accountability and community-based stewardship.

Successful implementation of the Strategy should ensure that salmon continue to return to the City's streams, expanding their distribution to new habitats after the removal of blockages. Once vegetation matures, the abundance and diversity of birds and other wildlife should increase. Over the long-term, property values adjacent to streams and wetlands should also increase, reflecting the amenity value of protected and restored natural areas. Ultimately, implementation of the ESA Strategy should make the City of Snohomish a more attractive place to live for humans as well as fish and wildlife.

1 INTRODUCTION

In March 2002, the City of Snohomish contracted with Steward and Associates to develop a comprehensive Endangered Species Act (ESA) Strategy that would recommend and prioritize City actions to achieve multiple goals:

- Guide the City's compliance with multiple federal and state environmental regulations – including the ESA, the Clean Water Act, the Growth Management Act, and the Shoreline Management Act – in one integrated strategy;
- Protect and restore the City's streams, wetlands and riverfront to maximize their habitat value, while recognizing the constraints of an already developed urban area, competing growth management mandates, and other City goals;
- Provide property owners with greater regulatory certainty and options for environmental mitigation for potential developments; and
- Provide the City the option to pursue an exemption from the ESA's prohibition against "take", which is available under special regulations that the National Marine Fisheries Service (NMFS) issued for listed Puget Sound chinook salmon.

In addressing these goals, the ESA Strategy reviews seven categories of City activities, discussed in detail in Chapter 4 in the following general priority order:

- Development regulations: buffers, stormwater standards and other issues
- Habitat acquisition and restoration
- Maintenance of park and riverfront property
- Stormwater management programs and projects
- Pilchuck Dam operations and improvements
- Technical assistance for community-based stewardship
- Road and other public works maintenance

Priority is assigned based on the extent to which the specified activity impacts, or could potentially impact, salmon and associated habitat.

Chapter 2 of the Strategy provides the technical foundation for the review of City activities, summarizing current conditions in each of five study areas: the Snohomish River within the City's Urban Growth Area (UGA); the Pilchuck River within the UGA; the Cemetery Creek basin; the Bunk Foss Creek basin; and the Blackman's Lake/Swifty Creek basin. Appendix G provides detailed quantitative and qualitative habitat inventories for individual stream segments for Cemetery Creek and Bunk Foss Creek. Chapter 3 identifies and prioritizes recommendations for each study area, focusing on projects to restore or enhance habitat and fish passage, and on programmatic or regulatory recommendations that differ between the study areas.

Chapter 5 considers key implementation issues for the Strategy, including overall priorities and interdependencies. It also discusses monitoring and adaptive management requirements and recommends ways to address funding needs. Lastly, Chapter 6 describes the benefits the City and its citizens can expect from implementing the Strategy.

1.1 Why an "Endangered Species Act" Strategy?

The City and Steward and Associates began work on this Strategy anticipating that the City might seek an exemption from prohibitions against "take" – death or injury – of Puget Sound chinook salmon, which NMFS listed under the ESA in May 1999 (NMFS 1999). At the time, there were widespread fears that local governments would be sued for the unauthorized taking of a listed species as a result of conducting or enabling acts that significantly modify or degrade chinook salmon habitat. Litigation, regardless of the outcome, would likely disrupt ongoing services, halt major developments and seriously damage the regional economy.

One of the responses to the threat of litigation was the formation of a "Tri-County" Salmon Conservation Coalition comprising representatives from the region's largest cities, Indian tribes and business and environmental groups. The Tri-County process identified government actions that could conceivably result in the take of listed fish and wildlife, and attempted to develop a standardized set of regulations and programs that local governments across the region could adopt and implement to avoid or minimize take.

The City of Snohomish's ESA Strategy was originally conceived as a way for the City to get the same legal protections sought by the Tri-County Coalition through actions tailored to the City's unique circumstances, with the goal of achieving long-term environmental protection at reduced cost.

Both the Tri-County process and the Snohomish ESA Strategy were guided by special regulations issued for Puget Sound chinook salmon under Section 4(d) of the ESA. The 4(d) rule identifies 13 exceptions to the general prohibition against take (NMFS 2000). The Fish and Wildlife Service issued a more abbreviated rule for bull trout, which it listed as threatened in 1999, but the regional focus has been on chinook (FWS 1999). Each of the rule's exceptions allows some activity that may take chinook (e.g., scientific research, hatchery production, forestry practices and harvest) to proceed under certain conditions. Two of these exceptions were of particular interest to the Tri-County Coalition and the City of Snohomish: routine maintenance of public works in the road right-of-way (including utility lines and stormwater facilities as well as roads, bridges and related facilities) and regulations and policies governing "municipal, residential, commercial and industrial development" (known as the "MRCI exception").

The Tri-County Coalition developed a regional maintenance program for public works (RRMTWG 2002), which was formally approved under the 4(d) rule in 2003. The Tri-County Coalition also crafted a package of standardized development regulations, which it anticipated submitting for a MRCI exception. Though the Coalition's proposed regulations for urban areas were much more stringent than those in place (then and now) across the region, NMFS found they were inadequate for approval under the 4(d) rule.

Both the U.S. Fish and Wildlife Service and Parametrix, a consulting firm hired by the Tri-County Coalition to provide an independent review of the proposal, concurred in this judgment. All three found that site-scale regulations alone could not address the cumulative impacts of new urban development on natural processes (Parametrix 2002). They concluded that mitigating these impacts requires a substantial commitment to strategically targeted habitat acquisition and restoration, beyond what the region is currently making.

The Tri-County Coalition developed a general proposal to fund habitat projects, but it never developed the details the federal services would have required to ensure the desired outcomes. The Coalition had come together in significant part out of fear of lawsuits under the ESA. But as of February 2004, no lawsuits have been filed in the region against local developments or development regulations, largely because it has proven difficult to meet the legal standards for the ESA's definition of "take" when applied to the indirect effects development generally has on salmon habitat. In other words, it is difficult to demonstrate that fish die or are injured as a result of governmental policies and regulations as they apply to development. With no legal pressure, the momentum behind the Tri-County process faded.

NMFS remained supportive of the City's ESA Strategy, which the City continued to develop even after the Tri-County proposal was effectively withdrawn. NMFS believed that the criticisms it had made of the Tri-County proposal were more easily addressed at the level of a relatively small local government. The City believed formal NMFS approval of its Strategy could provide multiple benefits, going beyond reduced legal liability under the ESA. However, the City and NMFS ultimately determined that NMFS' formal review and approval of the City's Strategy under the 4(d) rule would probably require an Environmental Impact Statement, a process that could take 18 months or longer, during which time environmental groups and others might raise issues leading to NMFS' asking for more from the City. Though the 4(d) rule covers other listed salmon on the Pacific Coast, not one local government has yet sought approval of its development regulations under the rule. The first government that does could face widespread scrutiny for setting a precedent. Since no lawsuits have been filed under the ESA to stop development in the region, the City could potentially face a greater likelihood of an ESA lawsuit if it pursued the 4(d) exemption than if it did not.

For these reasons, the City has decided not to pursue formal NMFS approval of the Strategy under the 4(d) rule at this time. If the risk of an ESA lawsuit should increase in the future, especially if the time, expense and risks associated with seeking NMFS' approval under the 4(d) rule also decrease in the future, the City may still choose to use the ESA Strategy for that purpose.

The City and Steward and Associates were always aware that the City might decide against seeking NMFS' approval. The analysis behind the ESA Strategy remains directly relevant to the first two goals listed above – providing integrated compliance with a range of federal and state environmental laws, and creating a vision and ecological framework for conserving the City's streams, wetlands and riverfront. The 4(d) rule has been a useful guide to identify key issues for the Strategy to consider. Implementation of the ESA Strategy will ensure that the City's policies and efforts to recover salmon and protect the environment are fully integrated with regional, state and federal efforts.

Although the ESA Strategy comprises recommendations designed to yield broad ecological benefits, the ESA Strategy is primarily concerned with salmon and their habitat. Salmon are a keystone species that, by virtue of their complex life histories and ecological requirements, naturally integrate many different environmental variables affected by the City's activities. The Strategy explicitly addresses factors affecting chinook salmon, but also considers the needs of other salmon species affected by City activities – particularly coho salmon, which spawn and rear in both Cemetery and Bunk Foss Creeks. The presence of robust populations of salmon in its rivers, streams and lakes are both an important part of the City's vision for its aquatic habitats and an indicator of the City's success with other aspects of its vision.

1.1.1 Providing Compliance with Multiple Environmental Laws

1.1.1.1 Endangered Species Act

Though the City is not pursuing approval of the ESA Strategy under the 4(d) rule, the Strategy should still help the City with two other aspects of the ESA. First, all federal agencies are required to "consult" with NMFS and the Fish and Wildlife Service concerning actions they may take – including making grants or loans or issuing permits – that may adversely affect listed species. Actions that are consistent with the ESA Strategy should be approved under this process more quickly than they would have been without the Strategy, which should benefit multiple City projects over time. Second, the ESA Strategy has been developed in coordination with the Snohomish Basin Salmon Recovery Forum and the "Shared Strategy for Puget Sound", two regional initiatives that are developing ESA-mandated recovery plans for listed salmon for the Snohomish River basin and Puget Sound, respectively. By implementing the ESA Strategy, not only can the City be confident it is doing "its part" for regional salmon recovery, but over time it may be eligible for regional funding to assist with high priority projects.

1.1.1.2 Clean Water Act

Under the Clean Water Act, in the near future the City's stormwater program will be issued a Phase II National Pollution Discharge Elimination System permit, which will establish a number of requirements for the City. Though the general terms of this permit in Western Washington are currently being negotiated with the Washington Department of Ecology, the ESA Strategy recommends a program that should assure the City's compliance. The Strategy's recommended stormwater standards for new development may require negotiation with Ecology, since they depart from Ecology's 2001 Stormwater Management Manual, but the Strategy provides technical reasons for that departure that should meet with Ecology's approval. Relative to stormwater provisions, the Strategy's recommendations should significantly reduce the cost of development in many areas of the City at little, if any, cost to the environment.

1.1.1.3 Growth Management Act

The Growth Management Act (GMA) requires that counties and cities "include the best available science" in designating critical areas (which include fish and wildlife habitat conservation areas and wetlands) and in developing policies and regulations to protect the "functions and values" of those areas. While doing this, cities and counties must also "give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries." The GMA sets deadlines for cities and counties to update their critical area designations and protections consistent with these requirements. The City of Snohomish is in a group with a deadline of December 1, 2004.

The ESA Strategy directly addresses these GMA requirements, providing the best available science concerning the City's streams, wetlands and riverfront. In addition to recommending protective policies and regulations, the Strategy includes field surveys and classifications of all streams and wetlands within the City's Urban Growth Area, whose locations were established with a Global Positioning System. Related maps and data have been transmitted to the City.

1.1.1.4 Shoreline Management Act

In 2003, the Washington Department of Ecology updated its rules governing local shoreline master programs and the state legislature established a set of deadlines for different local governments to update their programs consistent with the new rules. The City of Snohomish is in a group with a deadline of December 1, 2011. However, the City has modeled much of its shoreline program on that of Snohomish County and may continue to do so. Snohomish County is in a group with a deadline of December 1, 2005.

Consistent with the new rules, the City's updated shoreline program will establish policies and regulations, including a restoration program, for the shorelines of the Snohomish and Pilchuck Rivers within the City's Urban Growth Area. Components of the ESA Strategy that will be directly applicable to the updated program include development regulations, habitat projects and maintenance of riverfront property.

1.1.2 Meeting the City's Vision

Lastly, the City asked Steward and Associates to assess the potential for restoring the habitat values of the City's streams, wetlands and riverfront, while recognizing constraints due to existing and anticipated development, GMA mandates for growth and other City goals (for economic development, fair treatment of property owners, meeting other demands on City funds, etc.). The City asked that the ESA Strategy help define a vision for these habitats as well as a practical set of steps the City could begin taking to move toward that vision.

After listing recommended actions, Chapter 3 provides a "Vision for Future Conditions" for each study area – the Snohomish and Pilchuck Rivers, Cemetery Creek, Bunk Foss Creek and Blackman's Lake/Swifty Creek. The ESA Strategy recognizes that all urban development comes at some environmental cost. The actions recommended in Chapters 3 and 4 are intended to minimize the impacts of future development while addressing the many significant opportunities for restoration across all five areas. Chapter 5 recommends practical steps for implementing these recommendations and Chapter 6 reviews expected results across the City's Urban Growth Area. If the stormwater and buffer protections for new development recommended in the ESA Strategy are implemented, recommended restoration should more than make up for the ongoing impacts of urbanization.

2 CURRENT CONDITIONS

This chapter summarizes current conditions in each of the five study areas for the ESA Strategy, taken in general order of their priority for salmon: the Snohomish River; the Pilchuck River; Cemetery Creek; Bunk Foss Creek; Blackman's Lake/Swifty Creek. Each summary begins with an overview of the study area, including details on land use and land cover, followed by summaries of its fish and wildlife, wetlands, water quality and habitat quality. These summaries, with their accompanying maps, provide the technical foundation for recommendations in Chapters 3 and 4.

2.1 Snohomish River

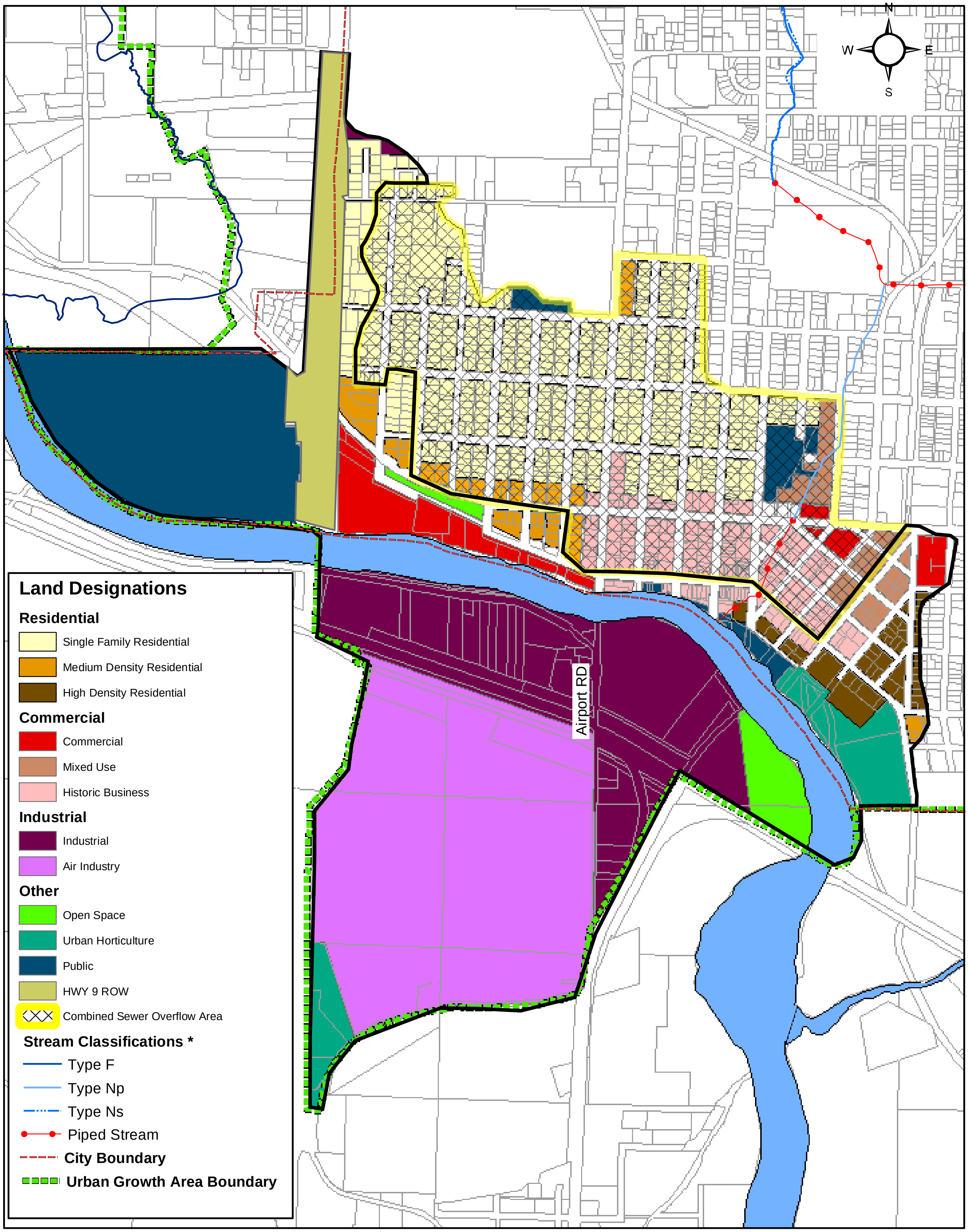
The Snohomish River, a Class 1 stream per Snohomish Municipal Code (SMC 14.51.70; see Appendix C), drains approximately 4,610 km^2 to Puget Sound (Pentec and NW GIS 1999; WSCC 2002). The Snohomish River watershed is the second largest river basin draining to the Sound, with elevations ranging from sea level to 8,000 ft. The mainstem Snohomish River is formed by the confluence of the Skykomish and Snoqualmie rivers approximately 20 miles upstream of Puget Sound near the City of Monroe.

The City of Snohomish is located at approximately RM 12.6 on the right bank of the Snohomish River, just downstream from the mouth of the Pilchuck River. The Snohomish Valley is wide (up to 3.0 miles in some locations) and flat, and was historically associated with the main channel through occasional flood events. The clearing, draining, ditching, and diking of the Snohomish Valley in the mid-19th century (Haas and Collins 2001) led to river channelization and increased development. Land uses in the river basin include forestry; urban, industrial and rural residential; mining; and agriculture (Pentec and NW GIS 1999; SBSRTC 1999). The channelized Snohomish River along the City's southern boundary flows as a long, deep, slow-moving glide (Williams et al. 1975), with daily tidal fluctuations up to 11 feet. The river-bottom substrate near the City is dominated by sand, with very few stretches containing gravel, cobble, or rubble.

For purposes of the ESA Strategy, the Snohomish River study area includes 3.5 km of river, from the mouth of the Pilchuck River to the mouth of Cemetery Creek, as well as land within the UGA that drains directly to this reach (excluding the area served by combined storm and sanitary sewers as well as the Pilchuck River, Swifty Creek and Cemetery Creek basins). Current land use within the study area includes 3.6% single family residential, 1.9% medium density residential, 3.0% high density residential, 6.8% commercial, 58.9% industrial, 17.5% public, 3.0% open space, and 5.3% urban horticulture (see Figure II-1).

Total impervious surface in the Snohomish River study area represents 45% of the existing land cover inside the UGA (methods derived from Hill et al. 2000). Road densities in the study area include paved roads (5.0 km/km^2), gravel roads (2.7 km/km^2), dirt roads (0.81 km/km^2), and paved driveways (1.01 km/km^2).

Snohomish River Study Area: Designated Land Uses



* Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

Feet

0 295 590 1,180 1,770 2,360

Projection: Washington State Plane North (Feet)
Datum: NAD 1983

Figure II-1

2.1.1 Fish and Wildlife

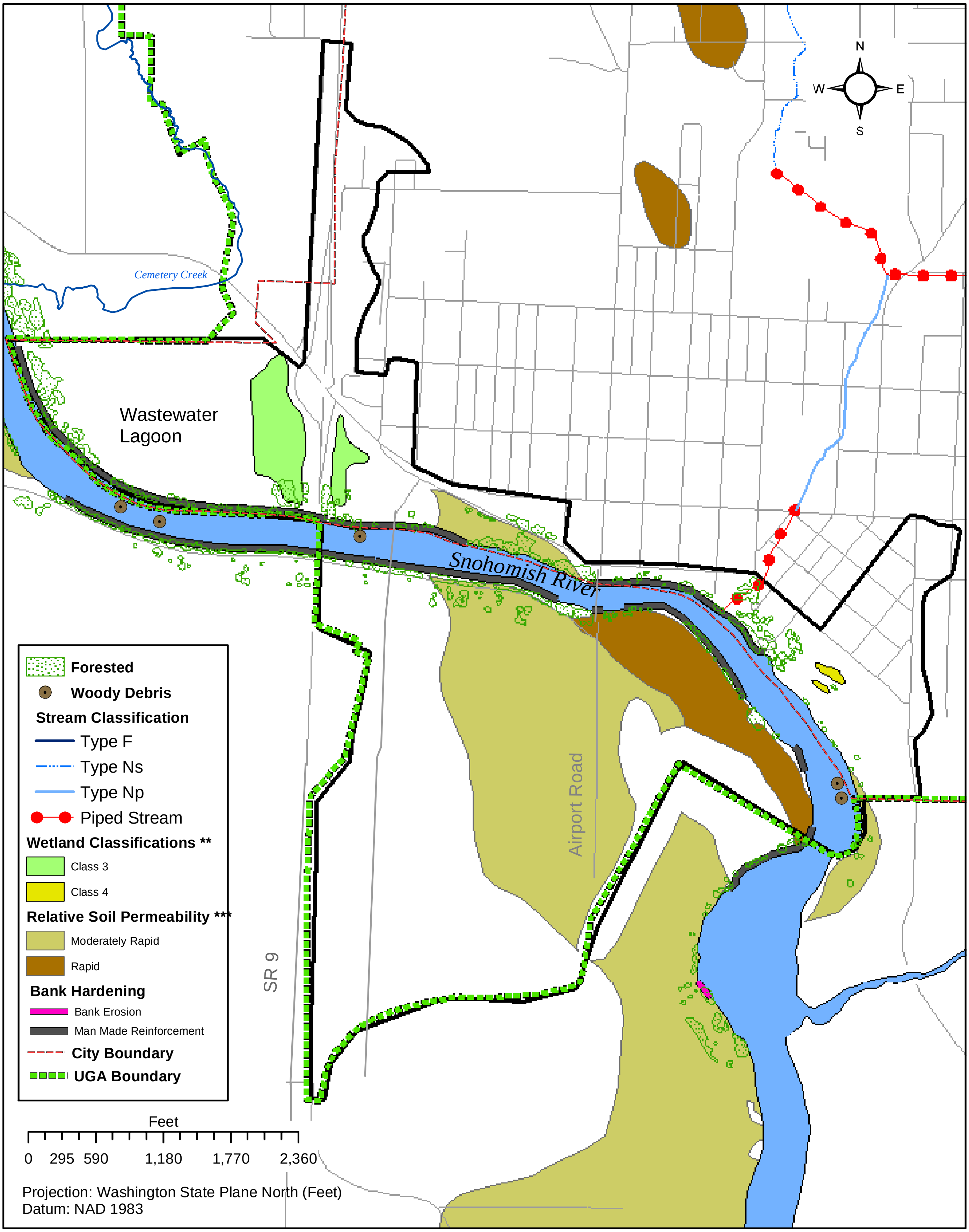
The Snohomish River supports significant anadromous salmonid populations, including chinook, coho, chum, and pink salmon, steelhead trout, bull trout/dolly varden, and sea-run cutthroat trout (WSCC 2002). Other fish found in the basin include resident cutthroat and rainbow trout, mountain whitefish, and other non-salmonid species. Puget Sound chinook salmon and bull trout were listed as threatened under the ESA in 1999 (NMFS 1999; FWS 1999). Disconnection of the river from the floodplain has eliminated approximately 95% of the lower river's historic chinook salmon rearing capacity and coho salmon smolt production capacity in the floodplain (Haas and Collins 2001). Main channel losses in chinook and coho productivity in the Snohomish watershed have largely been attributed to LWD reductions and limited LWD recruitment resulting from riparian loss and disconnection. The SBSRTC (1999) further identified nine factors in the Snohomish basin contributing to the degradation of habitat and subsequent decline in salmonid productivity:

1. Loss of channel area and complexity due to bank protection and diking of the river and major tributaries, cutting off the channel from its floodplain;
2. Dearth of in-channel large woody debris;
3. Flood flows that scour redds at high frequencies;
4. Increased sediment input to streams as a result of slope failures;
5. Poor quality riparian forests;
6. Loss of wetlands due to draining for land conversion that eliminates habitat and reduces water retention;
7. Redd mortality due to siltation or water quality contamination;
8. Urbanization (road construction, commercial and residential construction, additional bank hardening) that further reduces chinook salmon viability in the basin; and
9. Artificial barriers (dams, tide gates, diversions, culverts, pump stations) that prevent juveniles from reaching rearing habitat.

2.1.2 Wetlands

Steward and Associates' surveys indicate the presence of four wetlands inside the study area (see Figure II-2), including two Class 4 isolated wetlands and two Class 3 wetlands (classifications based on SMC 14.51.70; see Appendix C). The latter are disconnected from the river by levees in the vicinity of SR9 and the City's wastewater treatment plant. Historically, floodplain wetlands were common riparian occurrences in the Snohomish River study area (Haas and Collins 2001). However, as discussed above, diking and bank armoring have disconnected the river from historical off-channel wetlands in the floodplain. Historical floodplain wetlands have been converted to agricultural, industrial, and residential lands, thus eliminating floodplain wetland function in the Snohomish watershed. Eliminated floodplain wetland functions include flood peak reduction, sediment and contaminant filtration, groundwater recharge, and fish and wildlife breeding and rearing areas.

Snohomish River Study Area: Key Natural Resources



* Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

** Wetland classifications per SMC 14.51.070 (see Appendix C)

*** Relative soil permabilities were derived from the Soil Survey of Snohomish County Area, Washington USDA/ NRCS 1983 (rapid and moderately rapid permeable soils were the only soils considered)

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Figure II-2

2.1.3 Water Quality

Water quality in the Snohomish River basin has been altered by agriculture and stormwater runoff, industrial and sewage treatment discharge, and riparian degradation (Pentec and NW GIS 1999). Significant water quality problems in the watershed include high water temperatures, bacteria, nutrients, and metals, as well as low dissolved oxygen (Snohomish County 2001). Washington Department of Ecology monitoring data indicate fecal coliform bacteria levels in the lower Snohomish River violated water quality standards each year from 1988 to 1998 (Snohomish County 2000). Likely causes of high bacteria levels include livestock access to the river, inadequate pasture management, and failing on-site sewage disposal systems (WDOE 2003).

Water quality problems that affect fish the most in the basin are reduced dissolved oxygen concentrations and elevated summer water temperatures (Pentec and NW GIS 1999). Daily water temperature in the Snohomish River study area, collected by Steward and Associates between May 16, 2003 and December 8, 2003, at approximately mid-depth in an area with well-mixed water near the SR9 crossing, reached a maximum of 23.2^{o}C on July 31. The study area violated the Washington state standard of 17.5^{o}C for salmon and trout spawning, non-core rearing, and migration in July and August 2003. Washington Department of Ecology monitoring data indicate that up to 50% of the July and August temperature levels since 1990 have exceeded the water quality standard (Snohomish County 2000). Steward and Associates did not collect dissolved oxygen readings, but they have an inverse relationship with water temperature, so the elevated temperatures presumably reduced dissolved oxygen concentrations in the study area.

2.1.4 Habitat Quality

Habitat in the 3.5 km study reach (mouth of Pilchuck River to mouth of Cemetery Creek) was qualitatively assessed during September low flow conditions. Substrate throughout this reach is dominated by fine material, including sand, silt, and clay. Sediment processing functions within the basin have been dramatically altered by channelization. Historically, connected floodplains offered low energy zones for sediment deposition during overbank flood events. Rip-rapping, diking, and dredging in the Snohomish Valley virtually eliminates overbank flows (SBSRTC 1999), causing sediment from the Snohomish watershed to remain in the mainstem and deposit in the quiescent lower river reaches and estuary.

Current riparian vegetation in the entire study area is dominated by sparse deciduous overstory (e.g., cottonwood, maple, alder) and non-native blackberry understory. This composition is dramatically different from the historic basin-wide floodplain riparian forest. Haas and Collins (2001) report that one-fifth of the trees in the Snohomish River basin's historic floodplain riparian forest were coniferous; these trees were often enormous – up to 4 meters in diameter – and collectively made up a majority of the total basal area of trees in the floodplain. Currently, floodplain riparian forests in the overall river basin are estimated to contain 2% conifer species, at early to mid-seral stages. Early seral deciduous trees, primarily comprised of cottonwood, dominate the basin's remaining riparian forest. This loss in overall riparian forest and conifer composition has resulted in severe reductions in LWD recruitment to the main channel, which limits its ability to provide cover and influence sediment transport and channel morphology. The mainstem Snohomish River contains an average of 18 pieces of LWD per channel width, whereas a relatively undisturbed reach of the Nisqually River contains an average of 140 pieces per channel width (Haas and Collins 2001).

There is almost no habitat complexity in the Snohomish River as it flows past the City of Snohomish. The river consists of a single, deep, slow-moving glide, presumably resulting from the diking and bank armoring that has eliminated channel movement.

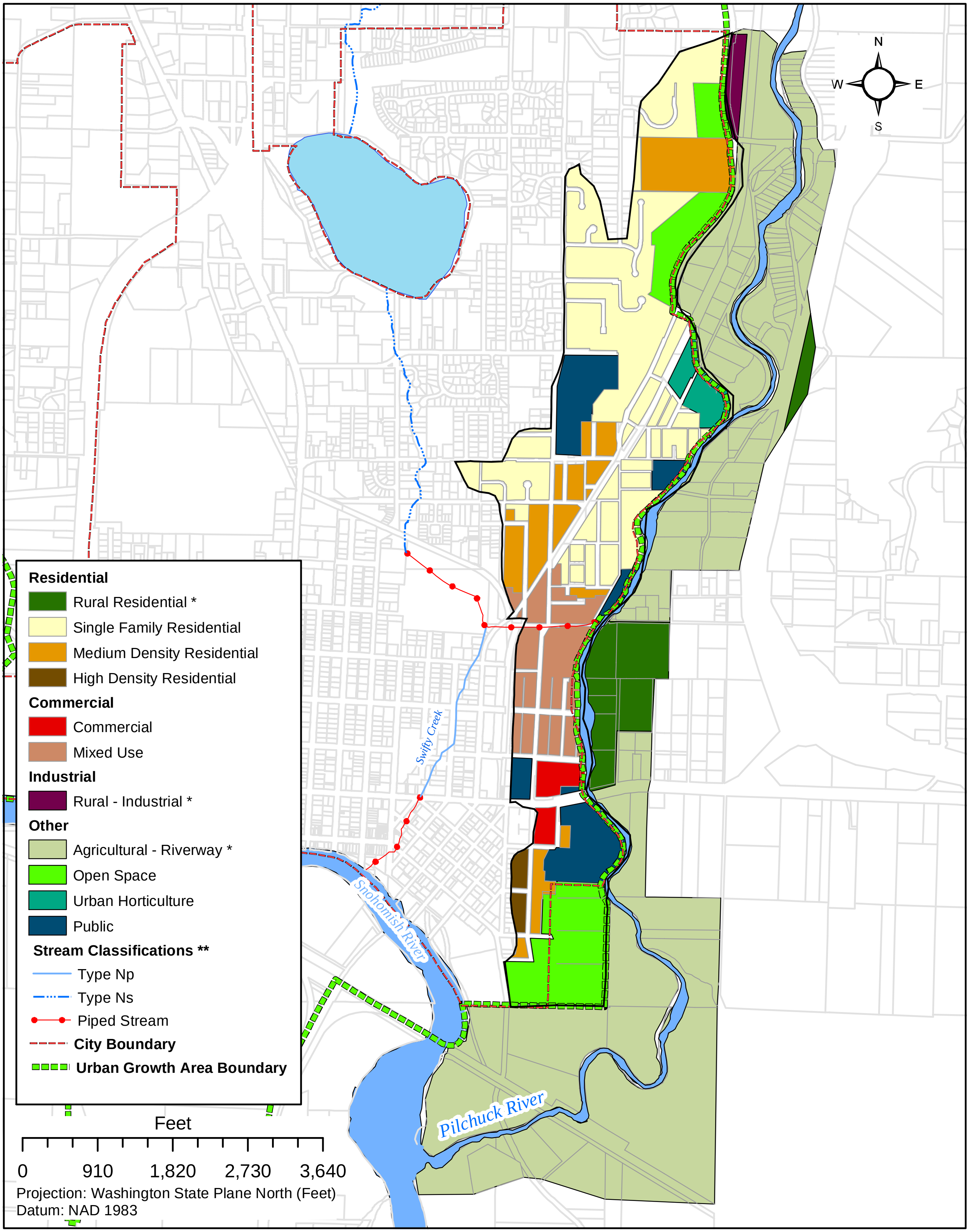
2.2 Pilchuck River

The Pilchuck River, a Class 1 stream per Snohomish Municipal Code (SMC 14.51.70; see Appendix C), drains approximately 341.9 km^2 into the Snohomish River at RM 13.4 (WSCC 2002). The 40-mile river ranges in elevation from over 3000 feet at its headwaters to just above sea level at its mouth (Savery and Hook 2003). Fisheries managers often separate the Pilchuck River into 3 reaches: a lower (RM 0.0-12.0), middle (RM 12.0-26.4), and upper (RM 26.4-40.0) reach (Savery and Hook 2003).

Historically, sand and gravel mining operations occurred in the stream channel and adjacent floodplain of the lower reach between RM 5.9-6.6. The lower Pilchuck basin is mostly zoned rural residential (both ≤ 5 acre and 10 acre agricultural lots); the middle basin is mostly zoned rural residential (≤ 5 acre lots) and forestry; the upper basin is zoned forestry. Land uses throughout the basin have altered the river's hydrology, increased sedimentation and erosion and, particularly in the lower basin, dramatically restricted the river's interaction with its floodplain. Peak flows typically occur in the Pilchuck River near the City of Snohomish between December and February, with 2, 10, and 100-year flows of approximately 5,045, 7,760, and 10,778 cfs respectively (Savery and Hook 2003).

The City of Snohomish is located near the mouth of the river. For purposes of the City's ESA Strategy, the Pilchuck River study area includes 3.85 miles of river, from the mouth of Bunk Foss Creek to the confluence with the Snohomish River, as well as parts of the City's UGA that drain directly to this reach (excluding the Bunk Foss basin); this includes an estimated 456 acres currently within the City of Snohomish. Relatively impermeable glacial till soils underlie the majority of the study area; however, permeable outwash soils occur from the mouth of Bunk Foss Creek to Three Lakes Road (R.W. Beck 2001). Current land use includes 42% single family residential, 18% protected open space, 15% medium density residential, 13.3% public, 3.5 mixed use, 3.5% urban horticulture, 2.7% commercial and 1.8% high density residential (see Figure III-3). Total impervious surface in this area is approximately 42.8% of the existing land cover (methods derived from Hill et al. 2000). Road densities include County/City maintained roads (8.32 km/km^2), paved driveways (4.91 km/km^2), dirt driveways (.50 km/km^2), gravel roads (1.54 km/km^2) and dirt roads (.81 km/km^2).

Pilchuck River Study Area: Designated Land Uses



* As designated by Snohomish County

Steward and Associates 2004

** Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

Figure II-3

2.2.1 Fish and Wildlife

Steward and Associates' surveys in 2003 documented the presence of chinook, coho, chum and pink salmon, rainbow and cutthroat trout, steelhead, and whitefish in the study area. Salmon utilize the lower Pilchuck River for spawning, rearing, and as a transportation corridor to and from habitat in the upper watershed (Snohomish County 2002). Snohomish County bull trout distribution maps indicate the presence of bull trout in the lower Pilchuck River (Snohomish County 2002).

Benthic macroinvertebrates (insects and other visible invertebrates in and on the streambed) are a good indicator of the biological health of Pacific Northwest streams, using the 10-metric Benthic Index of Biotic Integrity (B-IBI; see Karr 1998). Steward and Associates biologists collected samples for B-IBI analyses from the Pilchuck River just downstream of the 6^{th} Street bridge in September, 2003. Samples had a B-IBI score of 32 on a scale of 10-50, indicating fair physical and chemical habitat quality. The metric score with the lowest rank was intolerant taxa richness, indicating likely problems with flashy flows, substrate embeddedness, and chemical water quality.

2.2.2 Wetlands

Steward and Associates' surveys indicate that there are no wetlands within the UGA in the study area. Historically, floodplain wetlands were common riparian occurrences in the study area (Collins et al 2003). The construction of flood control levees and subsequent draining of wetlands has eliminated riparian and floodplain wetlands and their associated functions, including flood peak reduction, sediment and contaminant filtration, groundwater recharge, and fish and wildlife breeding and rearing areas.

2.2.3 Water Quality

Snohomish County water quality monitoring in the Pilchuck River since 1998 shows that the lower Pilchuck River meets Class A standards for dissolved oxygen, turbidity, and pH (Snohomish County Public Works 2000, as cited in WSCC 2002). Average 7-day water temperature data collected in 1999 (per Snohomish County temperature logger data) in the lower Pilchuck River indicate degraded conditions (>15.5 ^{o}C) in spawning areas, and moderately degraded conditions (13.9-17.8 ^{o}C) in rearing areas (Snohomish County Public Works 2000, as cited in WSCC 2002). Daily water temperature in the lower Pilchuck River study area, collected between January 29, 2003 and June 11, 2003 near the mouth of Bunk Foss Creek, reached a maximum of 21.7^{o}C on June 7, violating the state standard of 17.5^{o}C for "non core" areas for salmon rearing. Daily water temperatures were not collected through the remainder of 2003 because of equipment damage, but would likely have exceeded state standards in July, August, and September. Pool water temperatures, collected in the study reach September 16-18, 2003, reached a maximum of 16^{o}C in a pool between the 2^{nd} Street bridge and the downstream soccer fields.

Fecal coliform bacteria levels violated standards from July through September, but usually met the standards during the remainder of the year (WSCC 2002). The Washington Department of Ecology (2003) has identified likely causes as livestock access to the river, inadequate pasture management, and failing on-site sewage disposal systems upstream of the City of Snohomish.

2.2.4 Habitat Quality

The 3.85-mile study reach (mouth of Bunk Foss Creek to the Snohomish River confluence) was divided into two segments (see Figures II-4 and II-5) and qualitatively assessed during September low flow conditions. Segment delineations were based on changes in land use and channel characteristics, as well as obvious landmark locations (e.g. bridges).

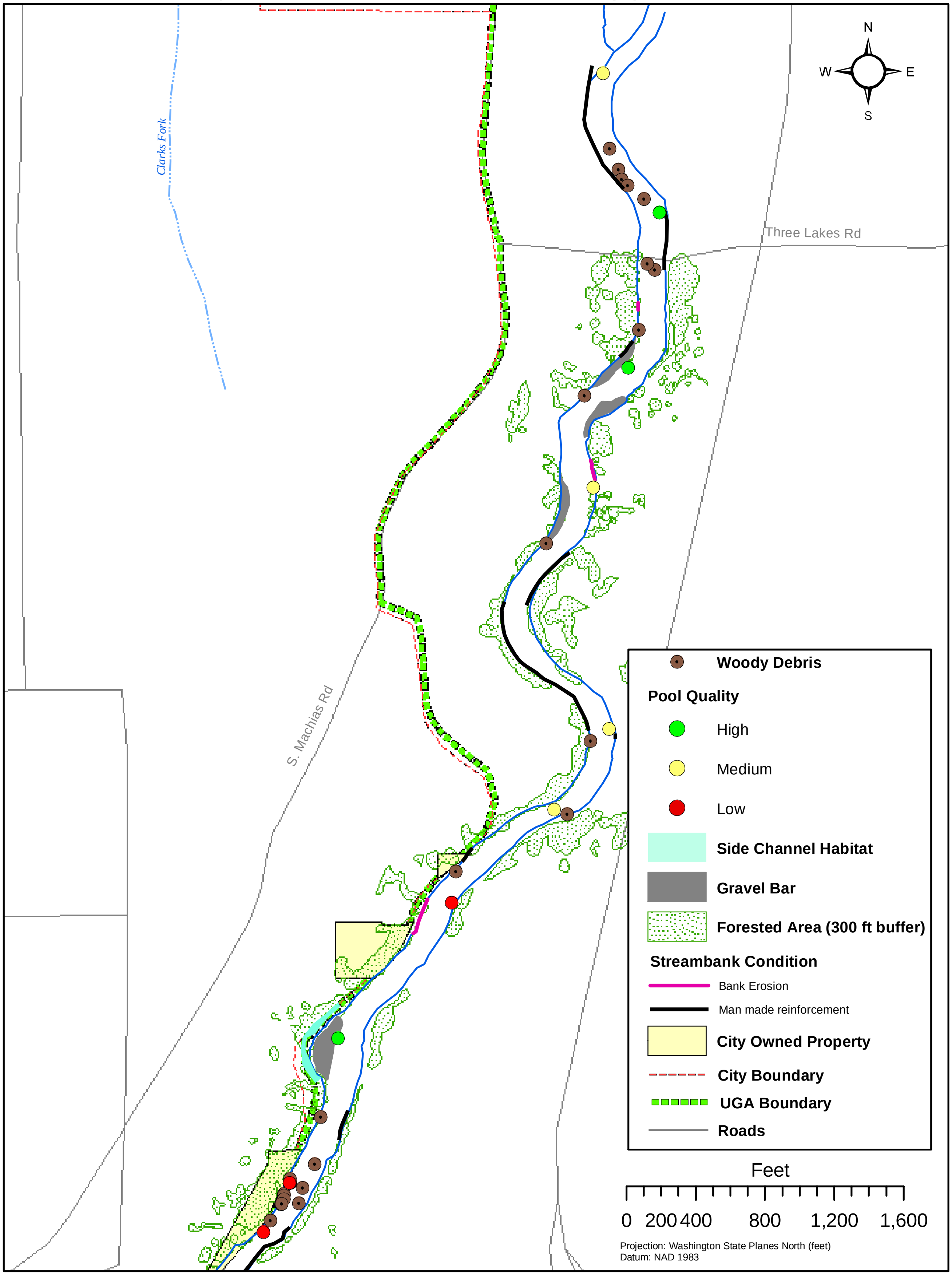
Dominant substrate size decreases from gravel and small cobble in the upstream segment to fines in the downstream segment. Sediment inputs to the river are mostly from the upper and middle basins and have increased significantly since pre-Euro-American settlement, especially because of sand and gravel mining and bank erosion (WSCC 2002). Compounding this problem for the study area, the lower Pilchuck River has lost much of its natural ability to process these sediments because its channel has been simplified and cut off from the floodplain. Increased channel complexity (e.g. sinuosity, woody debris jams) allows a river to deposit sediment in zones of low velocity (e.g. pools, inside bend) while keeping sediment in suspension in zones of increased velocity (e.g. riffles, outside bend). Increased connection with the floodplain allows sediment to be deposited in the low-velocity, off-channel floodplain habitat. Stream bank hardening and channelization in the lower reaches has led to a homogenous channel without lateral exchanges between the river and floodplain. Consequently, the lower Pilchuck study area is unable to process fine sediments as well as to provide off-channel habitat to rearing salmonids and organic matter to aquatic invertebrates.

Riparian areas are in poor condition throughout the study area. An estimated 98% of the stream miles in the 12.0-mile lower Pilchuck River are either cleared or in early seral stage (WSCC 2002). Snohomish County land cover data (as cited in WSCC 2002) indicates that vegetation within 300 feet of the lower Pilchuck River is dominated by crops, grasses, and marshland vegetation. The land cover data also suggests that mature evergreen forests are nonexistent in the riparian areas of the study reach. Due to the prevalence of early seral stage vegetation and dominance of shrub/scrub and invasive species, woody debris recruitment potential is very low throughout the study reach. This exacerbates the degraded condition in the study area, which is already deficient in woody debris.

Pool frequency decreases from upstream to downstream in the study reach, reflecting the transition from pool-riffle complexes to channelized glides. Lower Pilchuck River pools in the study area provide minimal salmonid habitat due to the high proportion of fine sediments and embedded substrates, and the relative lack of woody debris.

Pilchuck River Study Area*: Key Natural Resources

(Bunk Foss Confluence to 6th St. Bridge)



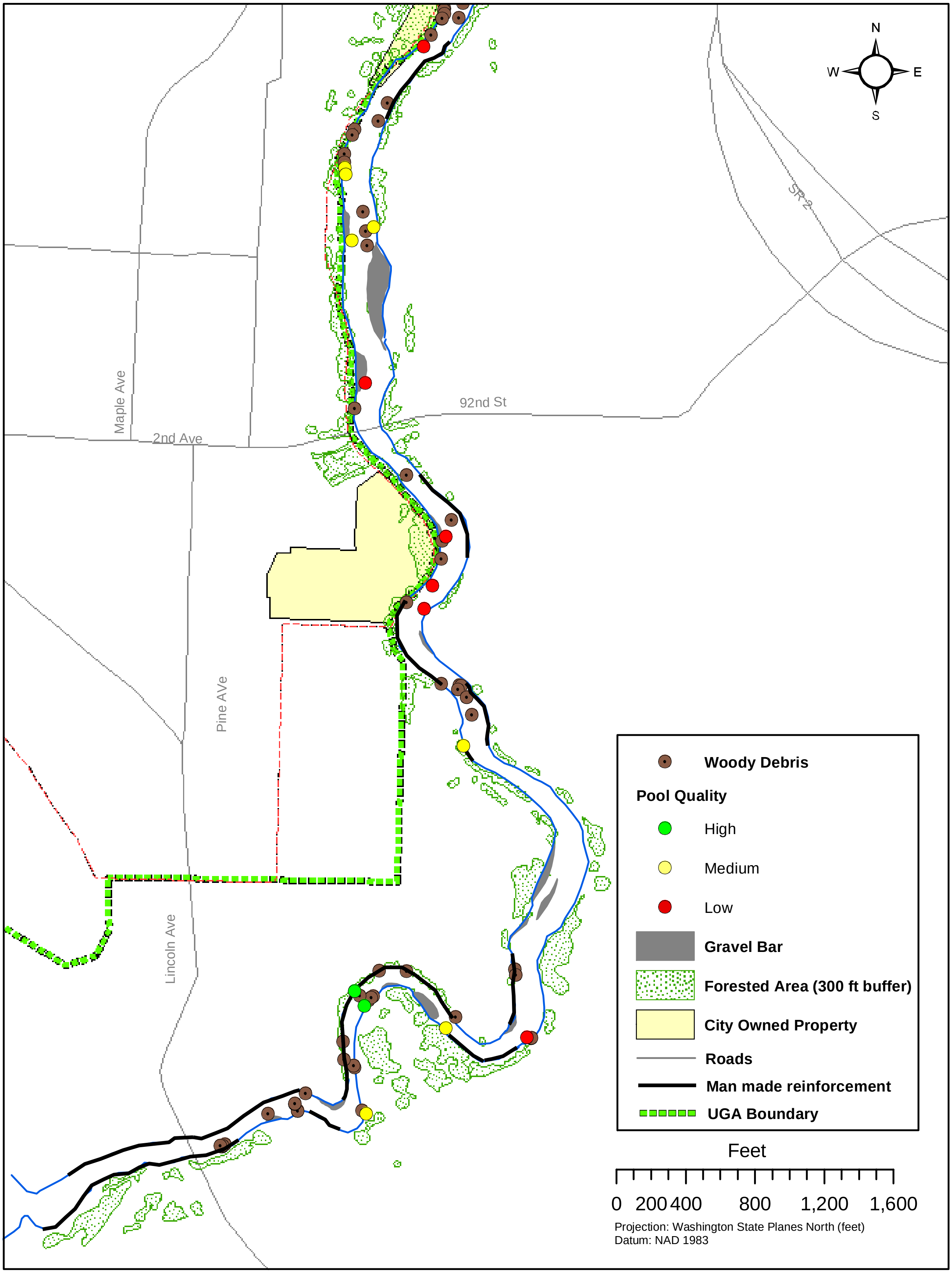
* River width not to scale

Steward and Associates 2004

Figure II-4

Pilchuck River Study Area *: Key Natural Resources

(6th St. Bridge to Mouth)



* River width not to scale

Steward and Associates 2004

Figure II-5

2.3 Cemetery Creek

Cemetery Creek is a second order stream that drains approximately 1,570 acres of flat to moderately sloped land within and adjacent to the western portion of the City of Snohomish. A Class 2 stream per Snohomish Municipal Code (SMC 14.51.70; see Appendix C), it begins at 380 feet in elevation just north of US2 and flows approximately 9.7 miles to the Snohomish River, gaining flow from three major tributaries: Anderson Fork, Myricks Fork, and Harkins Fork.

Land development and related human activities have significantly altered the vegetative cover and hydrology of the Cemetery Creek basin. Current land use within the basin includes 48% rural residential, 21% single family residential, 16% business park, 8% industrial, 3% medium density residential, 2% commercial, 2% public, and less than 1% low density residential and protected open space (see Figure II-6). Future land use will include a substantial conversion of forest and pasture to impervious surface and grass, with expansion of urban densities to the boundary of the City's Urban Growth Area (UGA). Including Harkins Fork, 54% of the basin is in the UGA; excluding Harkins Fork, 70% of the basin is in the UGA. While relatively impermeable glacial till soils underlie much of the Cemetery Creek basin, there are large areas above the Harkins Fork confluence, between Myrick Fork and SR9 and between the mainstem of Cemetery Creek and Bickford Avenue where soils have rapid or moderately rapid permeability (see Figure II-7).

Total impervious surface represents a substantial 31% of the existing land cover in the Cemetery Creek drainage (methods derived from Hill et al. 2000). Snohomish County (2002) estimated 17% of the basin as <u>effective</u> impervious area. The lower number reflects the fact that much of the existing impervious surface directs water into forested and wetland areas, which allows significant amounts of surface flow to infiltrate into the ground before it reaches the creek. Since effective impervious surface is a critical determinant of the health of stream systems, this underlines the importance of protecting these forested and wetland areas as much as possible as the basin develops. Road densities in the basin include County/City maintained roads (5.67 km/km^2), paved driveways (2.39 km/km^2), dirt driveways (1.58 km/km^2), gravel roads (0.69 km/km^2) and dirt roads (0.4 km/km^2).

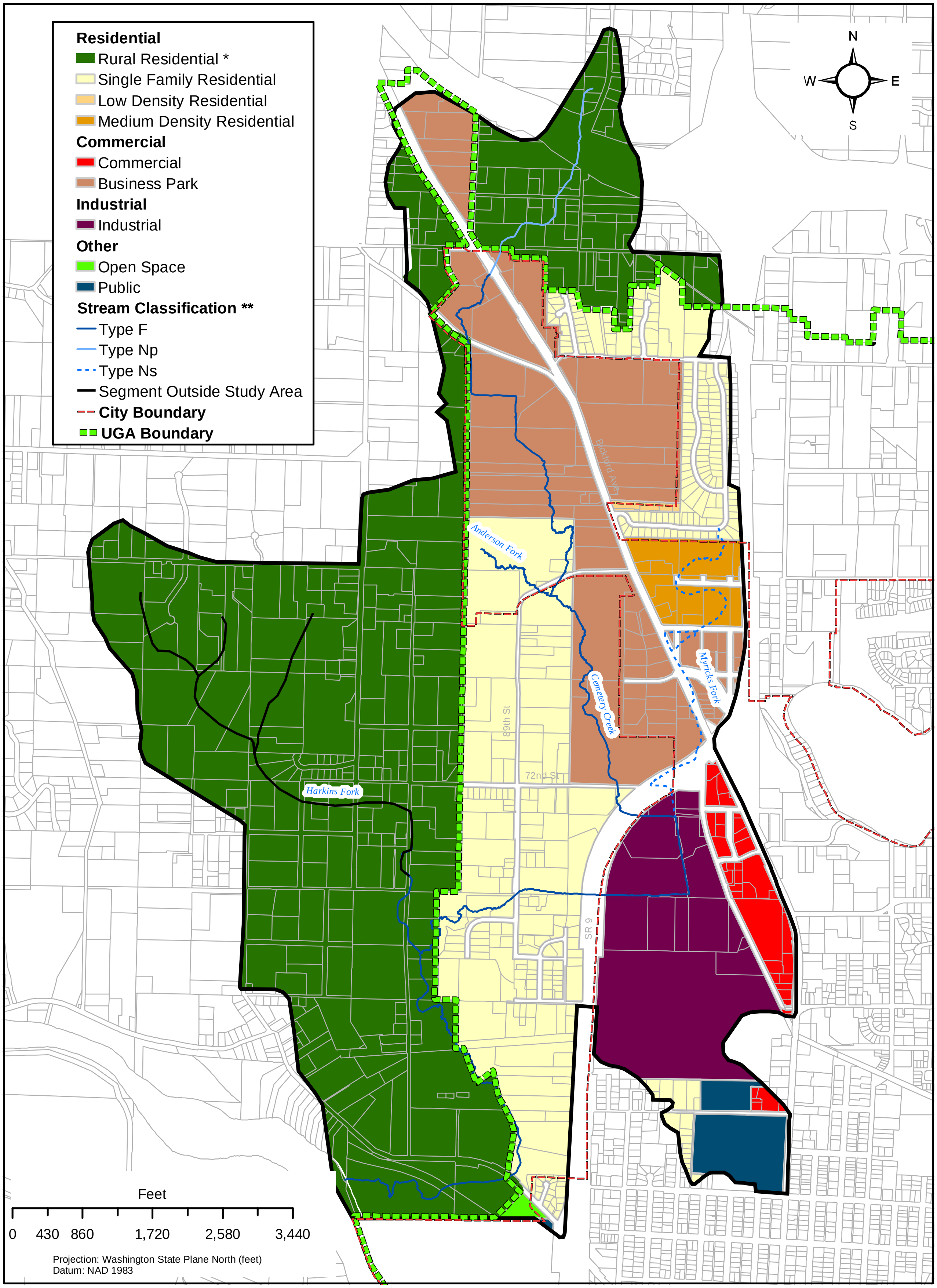
2.3.1 Fish and wildlife

The Cemetery Creek basin supports many fish species. Steward and Associates' surveys in 2003 documented the presence of cutthroat trout, rainbow trout, coho salmon, and Pacific lamprey in Cemetery Creek. With normal rainfall, in recent years coho have spawned and reared up to SR9 in the mainstem and a few hundred meters up Harkins Fork. Juvenile chinook salmon likely use the mouth of Cemetery Creek for rearing and refuge purposes. Bull trout from the Snohomish River also may potentially rear or forage at the mouth of the creek.

Priority wildlife species supported by the Cemetery Creek basin include bald eagle and great blue heron. A bald eagle nest and heron rookery was observed in the large wetland near the mouth of the creek. Crayfish and freshwater mussels were observed during fish surveys up to the confluence of Cemetery Creek and Harkins Fork.

Steward and Associates collected samples of benthic macroinvertebrates for B-IBI analyses from Cemetery Creek adjacent to the GAR Cemetery (in the upper part of segment CC01; see Figure II-7) in September 2003. Samples had a B-IBI score of 26 on a scale of 10-50, indicating poor physical and chemical habitat quality. Metric scores with the lowest rank were mayfly richness, caddis fly richness, intolerant taxa richness, and clinger richness. These results indicate likely problems with high flows and fine sediments, chemical water quality, poor channel complexity, and reduced food sources from native vegetation.

Cemetery Creek Basin: Designated Land Uses



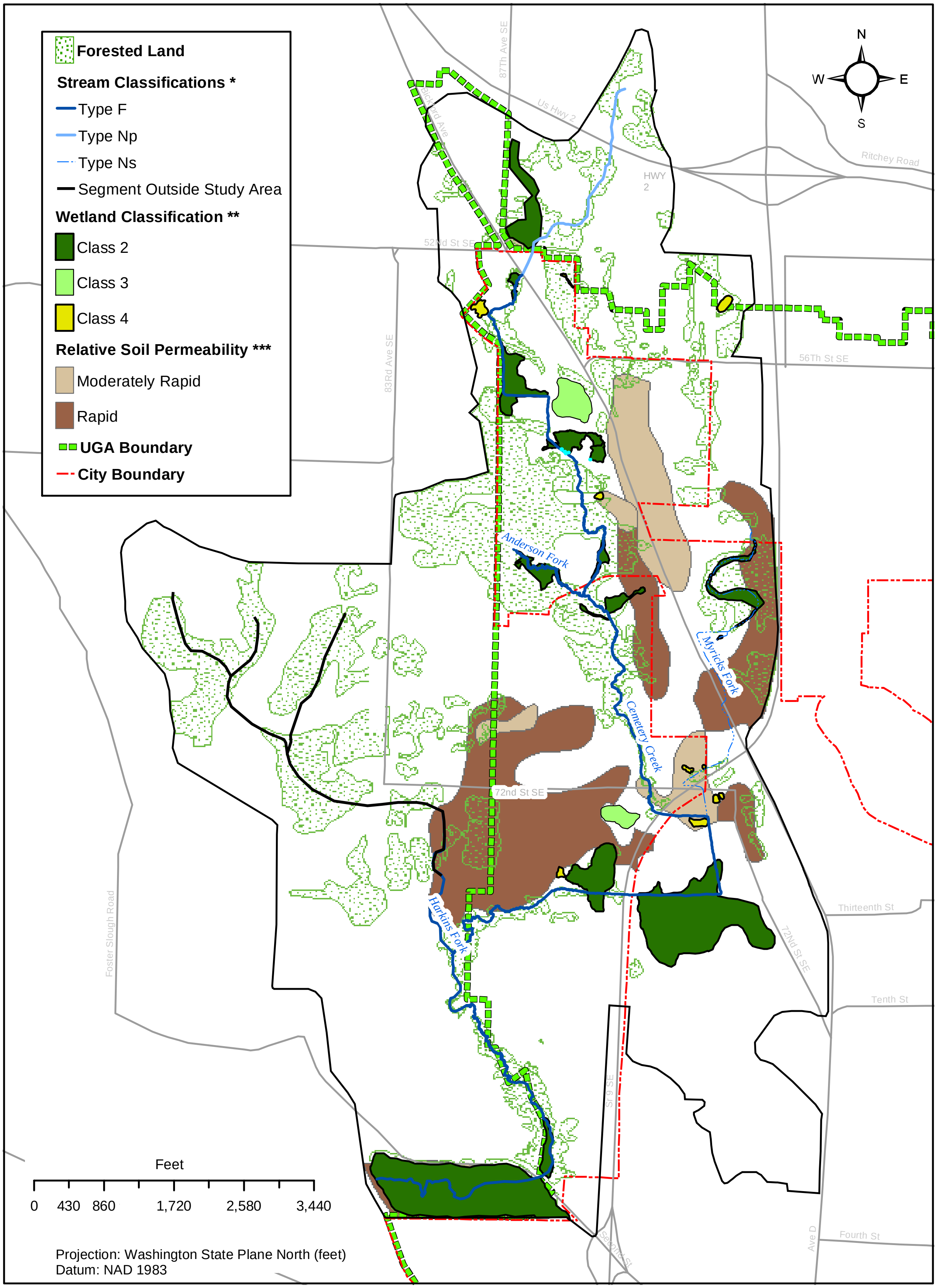
* As designated by Snohomish County

** Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

Steward and Associates 2004

Figure II-6

Cemetery Creek Basin: Key Natural Resources



Steward and Associates 2004

* Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

** Wetland classifications per SMC 14.51.070 (see Appendix C)

*** Relative soil permabilities were derived from the Soil Survey of Snohomish County Area, Washington USDA/ NRCS 1983 (rapid and moderately rapid permeable soils were the only soils considered)

Figure II-7

2.3.2 Wetlands

Steward and Associates' surveys indicate the presence of 38 wetlands inside the UGA within the Cemetery Creek basin (see Figure II-8). Of these, 14 are physically connected to the creek or its tributaries and are therefore Class 2 wetlands, while 24 are isolated wetlands, with 13 that are greater than one acre and therefore Class 3 and 11 that are Class 4 (classifications based on SMC 14.51.70; see Appendix C).

The ability of Cemetery Creek wetlands to store water and recharge groundwater is critical for alleviating flashy flows from storm events and for maintaining base flows during periods of limited rainfall. The drought conditions of 2002-03 resulted in lower than normal flows throughout the Cemetery Creek drainage, with the stream drying up completely upstream of SR9. Based on observations of local residents and stream gauge results in 2001, during years with normal rainfall Cemetery Creek is unlikely to go dry within the UGA (Snohomish County 2003a).

2.3.3 Water Quality

The quality of water within the Cemetery Creek basin varies both seasonally and spatially (see Figure II-7 for sites of water quality problems; see Appendix E for sampling methods and city-wide map of all sampling sites). Temperatures exceeded water quality criteria in CC03, downstream of the Plant Mulch Company. Dissolved oxygen concentrations were below water quality criteria just downstream of CC01 in the summer and throughout the year in CC03 and immediately upstream, in the vicinity of the Plant Mulch Company and the large wetland adjacent to the BPA substation. The low dissolved oxygen concentrations downstream of CC01 are likely a result of high biological oxygen demand in the wetland and the lack of turbulence-induced aeration of the stream. Oxygen levels in CC03 and points upstream were low enough to be lethal to fish from early May to late September. Tests found high phosphorus in CC03 downstream of the Plant Mulch Company, but even higher phosphorus levels (and lower dissolved oxygen levels) in the BPA Wetland at some distance from the stream (see Figure II-9; also see Appendix F for details). High phosphorus concentrations are often related to low dissolved oxygen concentrations in surface waters, since they can lead to excessive growths of aquatic vegetation (i.e. algae, macrophytes), which in turn will deplete dissolved oxygen concentrations as they decompose. The high phosphorus levels and low dissolved oxygen levels in the wetland indicate that the low dissolved oxygen in this reach of the stream is probably mostly due to influence from the wetland, rather than the Plant Mulch Company.

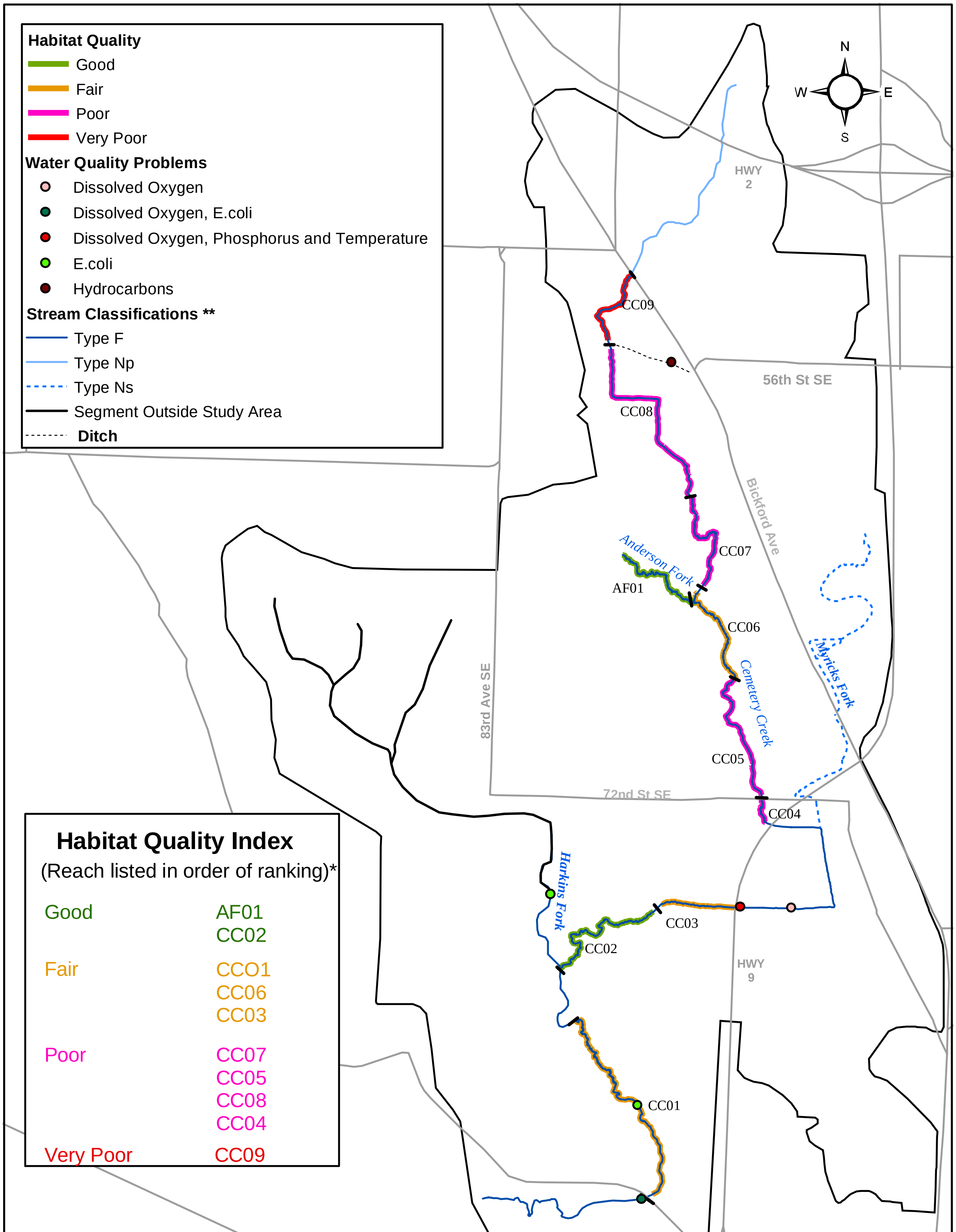
Hydrocarbons (e.g., diesel fuel, motor oil) were high in ditch runoff near Bickford Motors along Fobes Road. Under normal conditions, water from this ditch does not flow directly into Cemetery Creek, but flows into a natural bioswale that infiltrates into the groundwater directly adjacent to the creek. During periods of high runoff, water from the ditch near Bickford Motors likely flows along Fobes Road and into Cemetery Creek.

Hydrocarbon concentrations in Cemetery Creek were not measured near the Bickford Motors ditch due to the lack of water in the creek when samples were taken in July.

Bacterial concentrations of *E. coli* were measured in samples taken from surface waters throughout Cemetery Creek from January through September 2003. Concentrations were greater than Washington State criteria for primary contact recreation (e.g. swimming) at the mouth in April, adjacent to the GAR cemetery in April and June, and in the lower reaches of Harkins Fork in February and June-September. Sources likely include hobby farms (particularly in the vicinity of Harkins Fork), pet wastes, and possibly failing septic systems. This form of bacterial pollution does not pose a threat to salmon, but parallels water quality violations in other tributaries to the lower Snohomish River (WDOE 2003).

Surface waters throughout Cemetery Creek were tested for cadmium, copper, lead and zinc concentrations in April (during high flows) and July (during low flows) 2003. Metal concentrations were very low at all sites from both sampling events. Concentrations of pesticides and herbicides (sampled in April and July, 2003) and hydrocarbons (sampled in July, 2003) in Cemetery Creek surface water were also very low at all sites and sampling events.

Cemetery Creek Basin: Habitat and Water Quality



* The Habitat Quality Index integrates key indicators for stream and riparian functioning, generally using criteria used by NOAA Fisheries to evaluate whether or not salmon habitat is "properly functioning." See Appendix G for details. Index ratings of "good", "fair", etc., are intended for use in setting priorities for protection and restoration.

** Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

Projection: Washington State Plane North (feet)
Datum: NAD 1983

Steward and Associates 2004

Portions of Cemetery Creek were not assessed because these sections did not represent a true stream channel or access to the stream was denied. Stream sections not considered to be a true stream channel included portions of the stream that flowed through associated wetlands, tidally influenced areas, or areas affected by beaver activity. Harkins Fork and Cemetery Creek above Bickford Avenue were not assessed since they are located outside the UGA.

Figure II-8

Cemetery Creek Basin: BPA Wetland Chemical And Nutrient Barriers

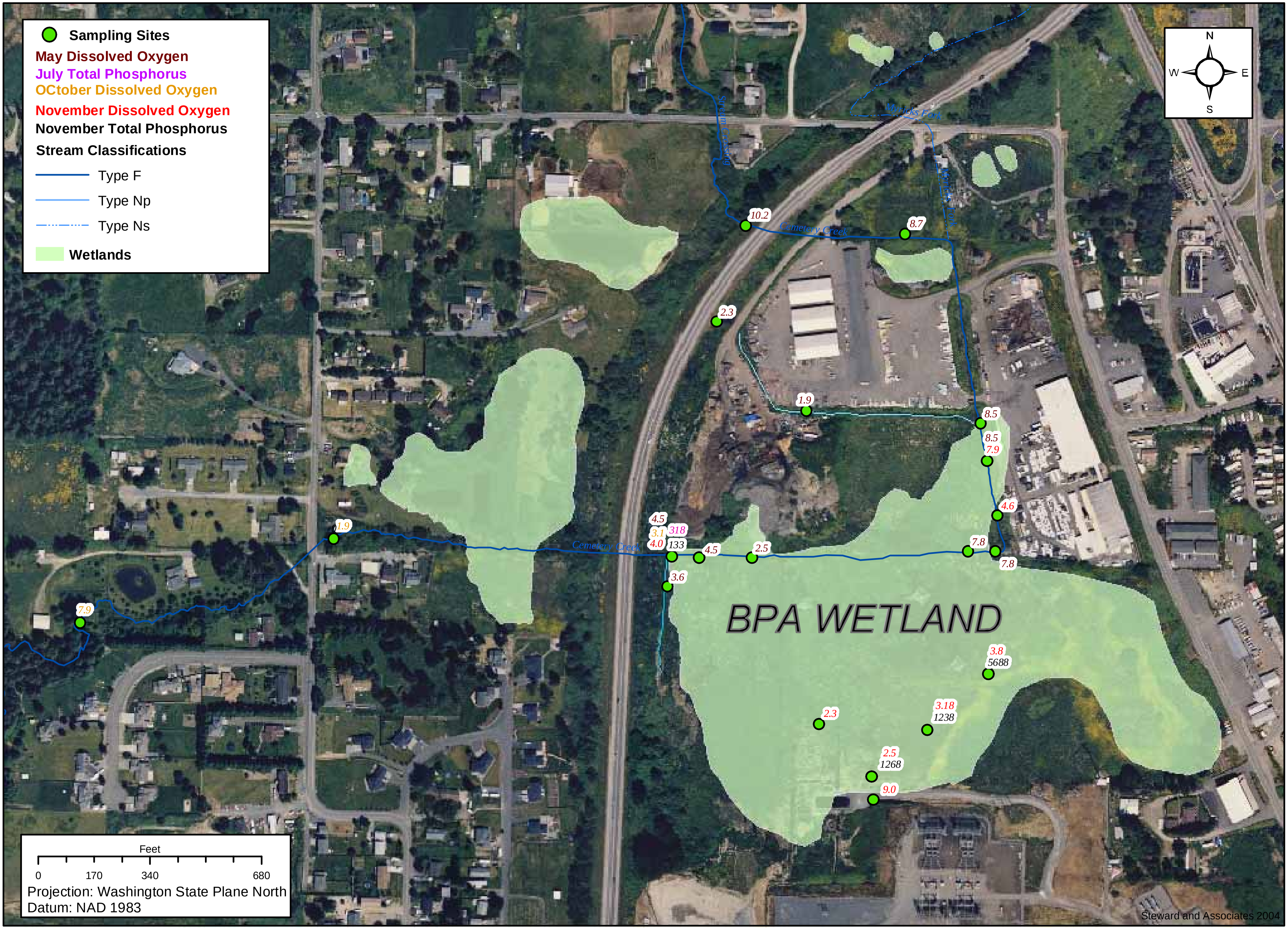


Figure II-9

2.3.4 Habitat Quality

The quality of fish habitat, as indexed by several field-measured parameters, varies considerably throughout the Cemetery Creek watershed (see Figure II-7; for details on the Habitat Quality Index, see Appendix G). The best habitat in the basin is found in Anderson Fork above Weaver Road (AF01) and in the mainstem downstream of 89th Street (CC02). These stream segments are characterized by the presence of gravel and cobble substrates, stable channels and wide riparian areas with mature coniferous vegetation and low amounts of invasive vegetation. The most degraded habitat in the Cemetery Creek system occurs in mainstem reaches between SR9 and 72nd Street (CC04) and above Fobes Road (CC09), as well as in the segment of the creek to the east of SR9 (which was not assessed quantitatively due to its general lack of a well-defined channel.) Degraded stream segments were characterized by high levels of fine substrates and invasive vegetation, unstable stream banks and few conifers or wetlands in riparian areas.

Basin-wide, past channel modifications and removal of woody debris and riparian vegetation have reduced and simplified instream habitat. Except for segments CC02 and AF01, riparian quality throughout the basin is inadequate for the functions of shade, erosion control, woody debris recruitment, wildlife habitat, and the filtration of pollutants and nutrients. Increased runoff because of development has exacerbated erosion and streambed scour. Excessive levels of fine sediments were noted throughout the basin, degrading pools and spawning habitat and filling interstitial spaces that are crucial to benthic macroinvertebrate diversity and salmonid egg and alevin development.

Fish passage constrictions and barriers occur throughout the Cemetery Creek basin (locations identified as F1-F8 in Figure III-4, next chapter). Fish passage constrictions allow fish to pass only under certain flows; fish passage barriers eliminate all fish passage under all conditions.

2.3.5 Confluence Wetland

Cemetery Creek flows through a substantial wetland immediately before its confluence with the Snohomish River. Andy Haas, a habitat biologist with Snohomish County, indicated that this wetland and the confluence area in general were part of a historical meander of the Snohomish River (Haas). When the river was channelized, it was cut off from the meander, allowing the backwater effects of the tide to create wetland habitat where the creek now flows. When the tide is in, large off-channel pools are formed, having the potential to provide good salmonid juvenile rearing and adult holding habitat. Many salmonids, including chinook and bull trout, could utilize this habitat for refuge, rearing, and forage because of its close proximity to the Snohomish River.

2.3.6 Harkins Fork

Harkins Fork, a first order tributary of Cemetery Creek, is located outside the UGA and therefore was not included in Steward and Associates' quantitative habitat assessment.

Its lower reaches, however, were qualitatively assessed. Harkins Fork is a spring-fed perennial stream, which flows from a relatively unaltered drainage and through a rural residential area before its confluence with the mainstem. The spring-fed waters consistently remain below 16°C, even in the warmest part of the year (indicating "Properly Functioning Conditions"; NMFS 2003). The lower reaches of Harkins Fork are comprised mainly of sand and gravel substrates. Stream banks are stable, but riparian vegetation is sparse, including small stands of cedar, big-leaf maple and alder, as well as an understory comprised of Himalayan blackberry, cattails, grasses, and herbaceous plants. One concern in the Harkins Fork subwatershed is the potential impact on water quality of hobby farms located in the lower reaches of the creek. These farms typically raise small numbers of domestic animals, such as goats, chickens, and horses, which are frequently not fenced out of the stream or are allowed to approach within 10 feet of it. This contributes to the lack of riparian vegetation and high fecal coliform levels. There are also several culverts located below streets and driveways that are undersized and may be at least partial barriers to fish passage during portions of the year.

2.3.7 Myricks Fork

Myricks Fork is a first order tributary of Cemetery Creek that is located entirely within the City of Snohomish, flowing into Cemetery Creek below where SR9 crosses over 72nd Street. Myricks Fork historically held populations of resident cutthroat trout, according to local resident Bob Heirman. The stream has intermittent flow, drying up during the late summer months. Because the lowermost reaches of Myricks Fork have been significantly altered (e.g., piped underground for great distances, undersized culverts, etc.), few, if any, fish could move from Cemetery Creek upstream into Myricks Fork when flows pick up again in the fall, even if other migration barriers were removed. Much of Myricks Fork between 62nd Street and Bickford Avenue bisects a Class 2 wetland, which offers wildlife habitat throughout the year.

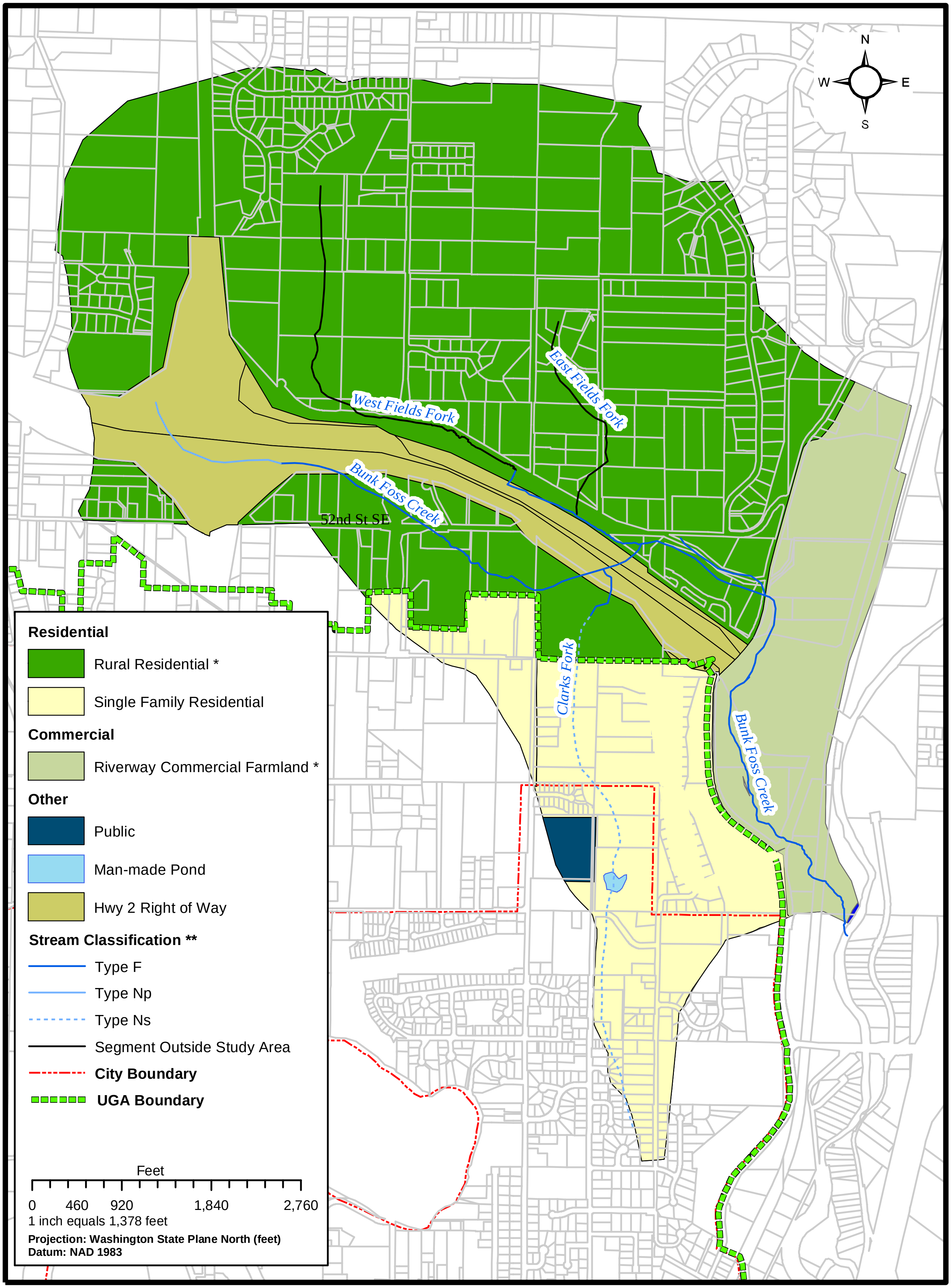
2.4 Bunk Foss Creek

Bunk Foss Creek is a right bank tributary of the Pilchuck River that drains approximately 530 hectares (1300 acres) through 11.4 km (7.1 miles) of stream (Williams et al. 1975; WSCC 2002). Beginning at 122 meters (400 feet) in elevation at its headwaters, this Class 2 stream (SMC 14.51.70; see Appendix C) gains flow from Clarks Fork, Fields Fork, and an unnamed tributary before draining into the Pilchuck River at an elevation of 18 meters (60 feet) (Snohomish County 2002).

Current land use within the basin includes 61.5% rural residential, 16.4% single family residential, 10.9% river-way commercial farmland, 10.7% highway right-of-way, and less than 1% public (see Figure II-10). Approximately 13% of the Bunk Foss drainage area is inside the UGA. At the City's request, Steward and Associates focused its assessment south of US2, including areas currently outside of the UGA that may potentially be added to it in the future.

Total impervious surface represents 24% of the existing land cover in the Bunk Foss drainage (methods derived from Hill et al. 2000). Road densities in the basin include paved roads (3.91 km/km^2), gravel roads (0.32 km/km^2), dirt roads (0.32 km/km^2), paved driveways (1.94 km/km^2) and dirt driveways (1.4 km/km^2).

Bunk Foss Creek : Designated Land Uses



* As designated by Snohomish County

** Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

Steward and Associates 2004

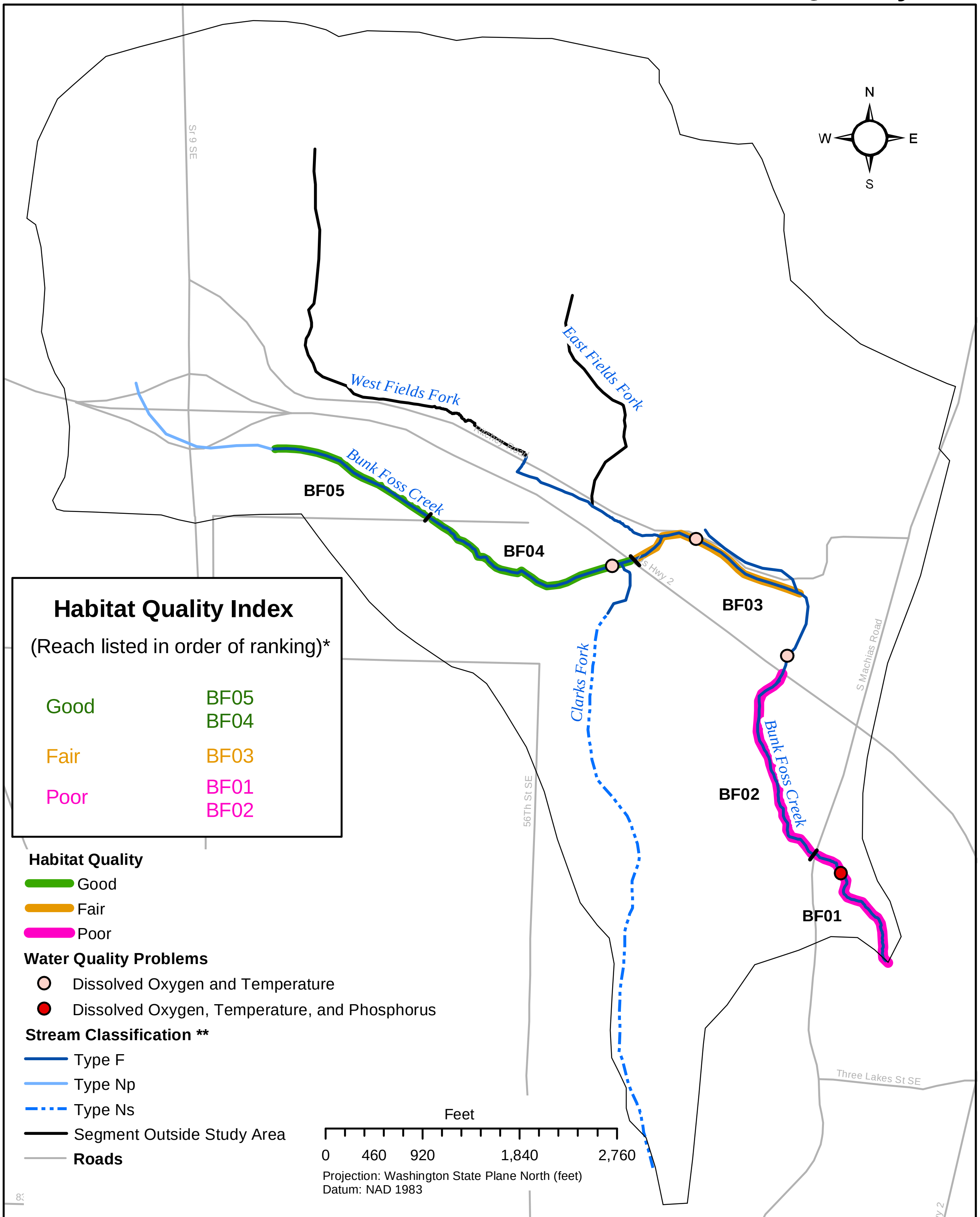
Figure II-10

2.4.1 Fish and wildlife

The Bunk Foss Creek basin supports many fish species including coho, chum and chinook salmon, as well as resident and sea-run cutthroat trout. Steward and Associates documented the presence of coho salmon and cutthroat trout throughout the basin and chinook salmon juveniles just inside the mouth of the creek. Adult coho salmon spawn in the mainstem of Bunk Foss Creek up to the 52nd Street culvert blockage, in Clarks Fork up to an old access road culvert blockage, and throughout the unnamed tributary. Fish passage has been eliminated from Fields Fork due to a perched culvert. While Steward and Associates did not see chum salmon using the creek, sources suggest they use the lower reaches of the creek (Williams et al. 1975).Crayfish and beaver were observed in the Bunk Foss watershed. Beaver dams are prevalent in the wetland just south of the upstream US2 crossing. A summer beaver dam was also constructed in Bunk Foss Creek in the Sheriff's Posse land north of the downstream US2 crossing.

Steward and Associates collected samples of benthic macroinvertebrates for B-IBI analyses from Bunk Foss Creek along the New Bunk Foss Road (in segment BF03; see Figure II-11) in September 2003. Samples had a B-IBI score of 26 on a scale of 10-50, indicating poor physical and chemical habitat quality. Metric scores with the lowest rank were caddis fly richness, intolerant taxa richness, and clinger richness. These results indicate likely problems with high flows and fine sediments, chemical water quality, poor channel complexity, and reduced food sources from native vegetation.

Bunk Foss Creek Basin: Habitat and Water Quality



* The Habitat Quality Index integrates key indicators for stream and riparian functioning, generally using criteria used by NOAA Fisheries to evaluate whether or not salmon habitat is "properly functioning." See Appendix XX for details. Index ratings of "good", "fair", etc., are intended for use in setting priorities for protection and restoration.

** Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

Steward and Associates 2004

Portions of Bunk Foss Creek were not assessed because these sections did not represent a true stream channel, access to the stream was denied, or the segment was located outside the study area. The segment between BF02 and BF03 was influenced by beaver activity and did not represent a true stream channel. Access was denied in lower Collins Creek. Upper Collins Creek was associated with a wetland and did not represent a true stream channel. The tributaries of Bunk Foss, north of Highway 2, were considered outside the study area.

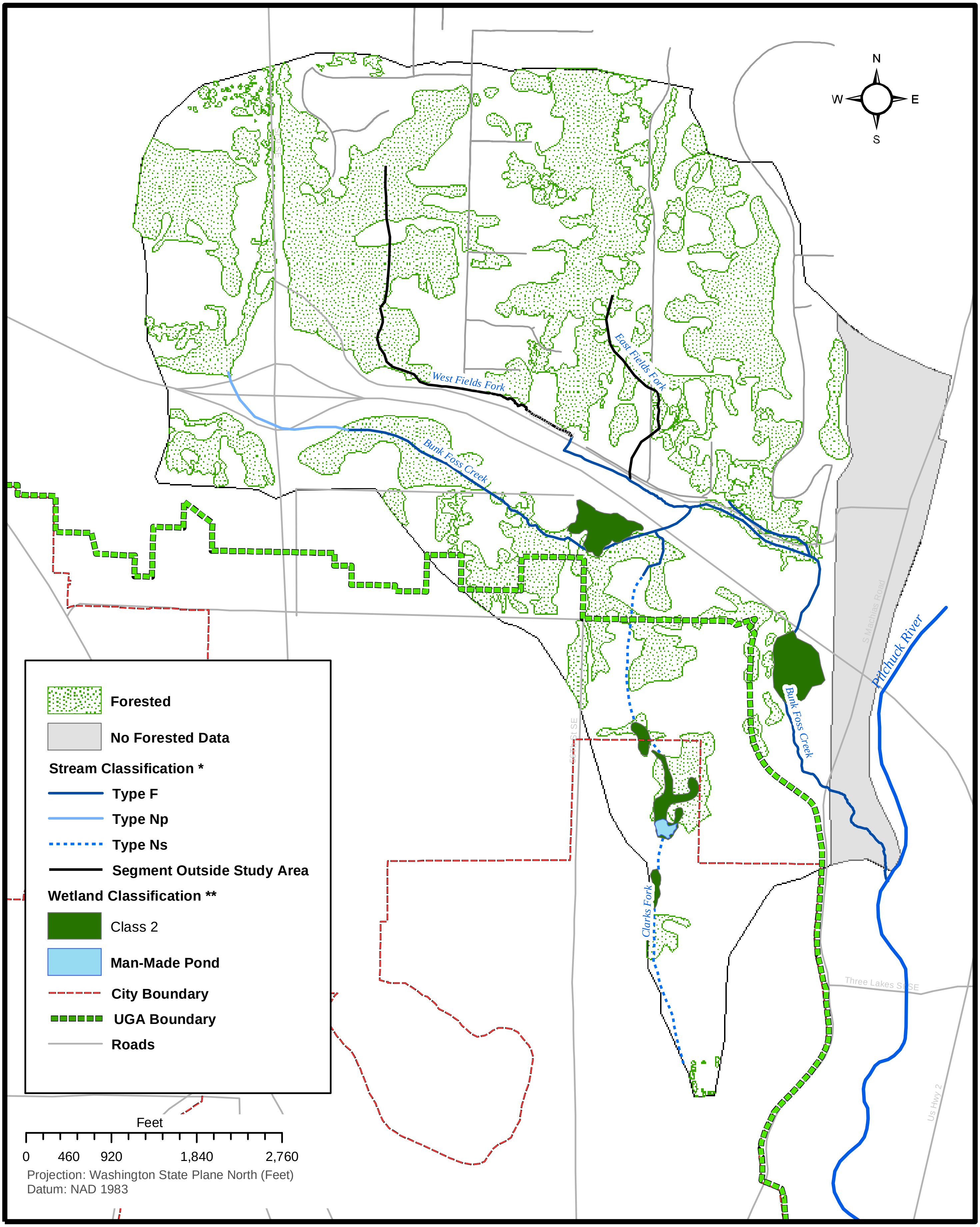
Figure II-11

2.4.2 Wetlands

Steward and Associates' surveys indicate the presence of three wetlands inside the UGA within the Bunk Foss Creek basin (see Figure II-12). These wetlands are Class 2 because of their connection to Clarks Fork (classifications based on SMC 14.51.70; see Appendix C). There are two other wetlands in the Bunk Foss Creek basin that fall outside the UGA but are south of US2, which are also Class 2 because of their association with the mainstem of the creek. Steward and Associates did not survey for wetlands north of US2.

The ability of Bunk Foss Creek wetlands to store water and recharge groundwater is critical in alleviating flashy flows from storm events and in maintaining baseflows during periods of limited rainfall. Even with the drought conditions of 2002-03, the Bunk Foss Creek mainstem, Fields Fork, and the unnamed tributary flowed year round. This is likely due to the storage properties of the large wetland just south of the upstream US2 crossing and the relatively undeveloped status of the drainage. Clarks Fork of Bunk Foss Creek, which falls mostly within the City UGA boundary, is an intermittent stream, even in years of normal rainfall.

Bunk Foss Creek Basin : Key Natural Resources



* *Stream classifications per WAC 222-16-030 (see Appendix xx). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach*

** *Wetland classifications per SMC 14.51.070 (see Appendix xx)*

Steward and Associates 2004

Figure II-12

2.4.3 Water Quality

The quality of water within the Bunk Foss Creek basin varies both seasonally and spatially (see Figure II-11 for sites of water quality problems; see Appendix E for sampling methods and city-wide map of all sampling sites). Temperature and dissolved oxygen water quality criteria were violated at all four water quality sites in the summer low flow period. Oxygen levels at the four water quality sampling sites were low enough to be lethal to fish in July and August 2003. During these periods, fish either move to other areas within the creek with higher oxygen levels or may move to the Pilchuck River, where some pools may provide refuge. Total Phosphorus levels were high at the mouth of Bunk Foss Creek in July 2003. Metals, hydrocarbons, pesticides, and herbicides were measured at the mouth of Bunk Foss Creek in April and July 2003. Although all levels were considered normal (see Appendix F for details), the proximity of Bunk Foss Creek to many roadways leaves it susceptible to contamination by road runoff.

Bacterial concentrations of *E. coli* were measured in samples taken from surface waters throughout Bunk Foss Creek from January through September 2003. Concentrations were greater than Washington State criteria for primary contact recreation (e.g. swimming) at the mouth of Bunk Foss Creek in July. High *E. coli* concentrations at this location are likely due to unrestricted livestock access to the creek both upstream and downstream of South Machias Road. This form of bacterial pollution does not pose a threat to salmon, but parallels water quality violations in other tributaries to the lower Snohomish River (WDOE 2003)

2.4.4 Habitat Quality

The quality of fish habitat, as indexed by several field-measured parameters, varies considerably throughout the Bunk Foss Creek watershed (see Figure II-11; for details on the Habitat Quality Index, see Appendix G). The best habitat in the mainstem of Bunk Foss Creek is upstream of the large wetland south of the upstream US2 crossing (BF04 and BF05). Good habitat in Bunk Foss Creek is characterized by the presence of gravel and cobble substrates, stable channels and wide riparian areas with mature coniferous vegetation and low amounts of invasive vegetation. The most degraded habitat in the Bunk Foss system occurs in mainstem reaches between the mouth and South Machias Road (BF01) and between South Machias Road and the downstream US2 crossing (BF02). High levels of fine substrates, unstable stream banks, and the lack of overstory riparian vegetation characterized these stream segments. Excessive levels of fine sediments degrade pools and spawning habitat by filling interstitial spaces that are crucial to benthic macroinvertebrate diversity and salmonid egg and alevin development. The lack of riparian vegetation in the two downstream most segments increases stream temperatures and allows higher quantities of sediment, nutrients, and toxicants to enter the stream.

Steward and Associates identified three fish passage barriers, in the form of impassable culverts, in the Bunk Foss basin south of US2 (identified as F1-F3 in Figure III-5, next chapter).

2.4.5 Fields Fork

Fields Fork, a tributary of Bunk Foss Creek, is located outside the UGA and therefore was not included in our quantitative habitat assessment. Its lower reaches were qualitatively assessed. Fields Fork is a spring-fed perennial stream, with a West and East Fork. The West Fork flows between US2 and Bunk Foss Road, primarily consisting of runoff flows from both. The East Fork, which flows from a relatively unaltered rural residential area before its confluence with the mainstem, contains most of the flow from the Fields Fork drainage. There is a thin strip of riparian vegetation along the West Fork comprised of coniferous and deciduous trees. East Fork substrates are dominated by gravel and cobble with a smaller percentage of fines. There is a perched culvert on the East Fork, located on the downstream side of Bunk Foss Road, which blocks adult migration of coho salmon. Local residents have indicated that populations of resident cutthroat trout exist in the East Fork.

2.4.6 Clarks Fork

The majority of Clarks Fork, a tributary of Bunk Foss Creek, is located within the City of Snohomish. The stream flows through single family residential lots before emptying into the mainstem just above the upstream US2 crossing. Clarks Fork is an intermittent stream, usually running dry by June each year. Fish use in Clarks Fork is limited to approximately the first 150 meters of stream, due to the presence of a perched culvert beneath an unused private access road. This small, 150-m stretch of stream was filled with spawning coho salmon in November and December of 2002 and 2003.

Clarks Pond is a man-made pond located approximately halfway between the headwaters of Clarks Fork and its confluence with the mainstem of Bunk Foss Creek. Upstream of the pond, the channel has been ditched through a degraded wetland. In this chapter of the stream, riparian vegetation is sparse and substrate consists of fine and organic material. Downstream of Clarks Pond, Clarks Fork has almost no definable channel as it spreads out into a wetland. Riparian forests, comprised of coniferous and deciduous trees, are more apparent downstream of the pond, as well as woody shrubs and wetland herbaceous plants. The creek once again enters a defined channel as it leaves another wetland immediately downstream and flows approximately 600 meters to the perched culvert that is considered the upstream barrier to fish passage. For approximately 150 meters downstream of this barrier, Clarks Fork consists of good spawning substrate with a fair riparian corridor before emptying into the mainstem.

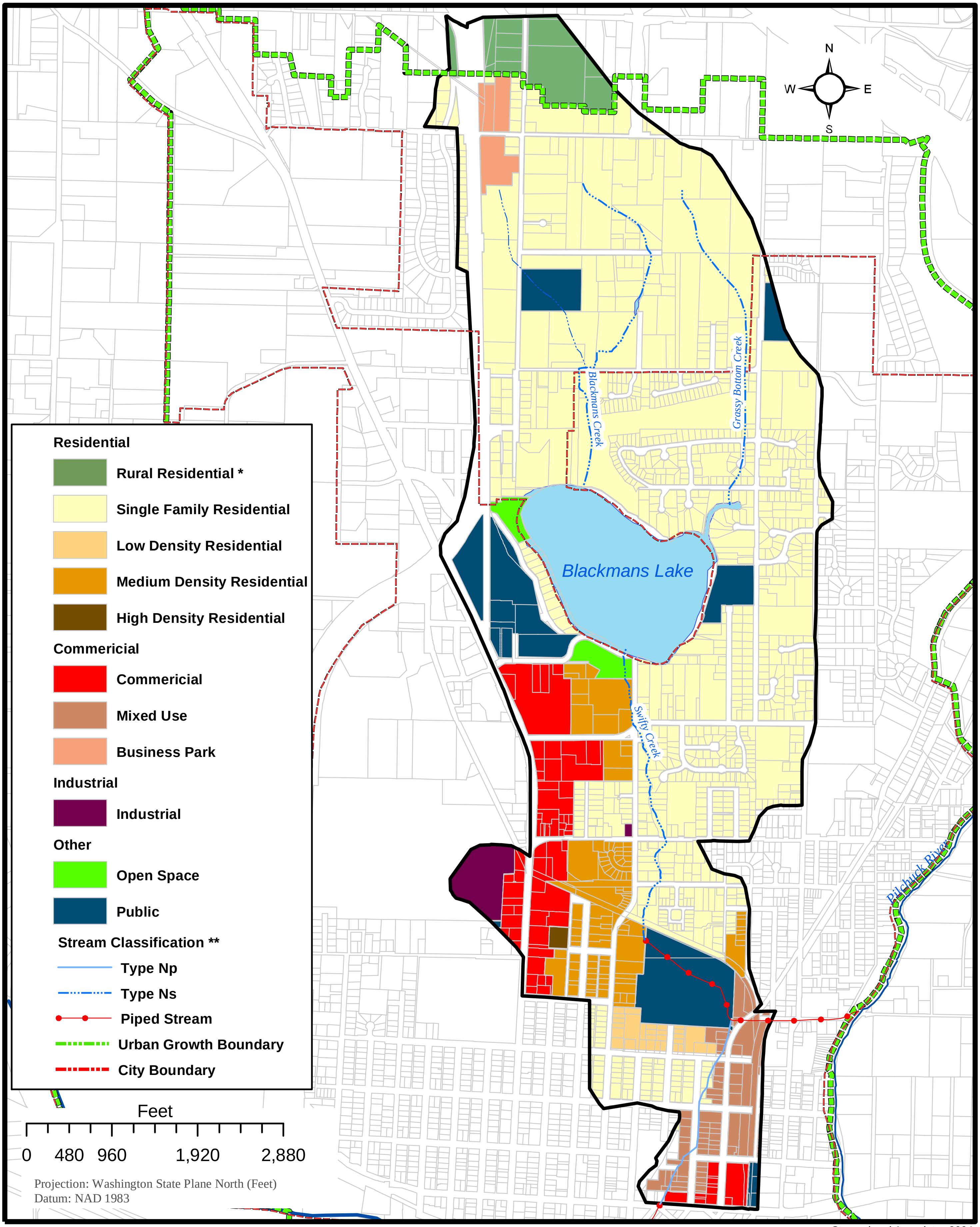
2.5 Blackman's Lake/Swifty Creek

Swifty Creek, the outlet stream of Blackman's Lake, was historically a right bank tributary to the Snohomish River at RM 20.8. Although a portion of the creek still flows beneath downtown Snohomish through an underground pipe to the Snohomish River, the majority of the flow leaving Blackman's Lake is now piped to the Pilchuck River just upstream from the 6th Street bridge. The entire Swifty Creek basin, draining approximately 326 hectares (805 acres), falls within the City UGA boundary and is categorized as a Class 3 stream according to the Snohomish Municipal Code (SMC 14.51.70; see Appendix C).

Significant development has occurred throughout the Swifty Creek basin, dramatically altering habitat conditions and hydrologic characteristics of the watershed. Current land use within the basin includes 66.5% single family residential, 12.5% commercial, 9.0% public, 4.6% medium density residential, 3.5% rural residential, 1.4% industrial, 1.2% low density residential, 1.1% open space, and less than 1.0% high density residential (see Figure II-13).

Total impervious surface represents 43% of the existing land cover in the entire Swifty Creek drainage (methods derived from Hill et al. 2000). Total impervious surface represents 34% and 53% of the existing land cover in the watershed above and below Blackman's Lake, respectively. Road densities in the basin include paved roads (7.34 km/km^2), gravel roads (0.28 km/km^2), dirt roads (0.34 km/km^2), paved driveways (5.21 km/km^2), and dirt driveways (1.41 km/km^2).

Swifty Creek Subbasin: Designated Land Uses



* As designated by Snohomish County

** Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

Figure II-13

2.5.1 Fish and Wildlife

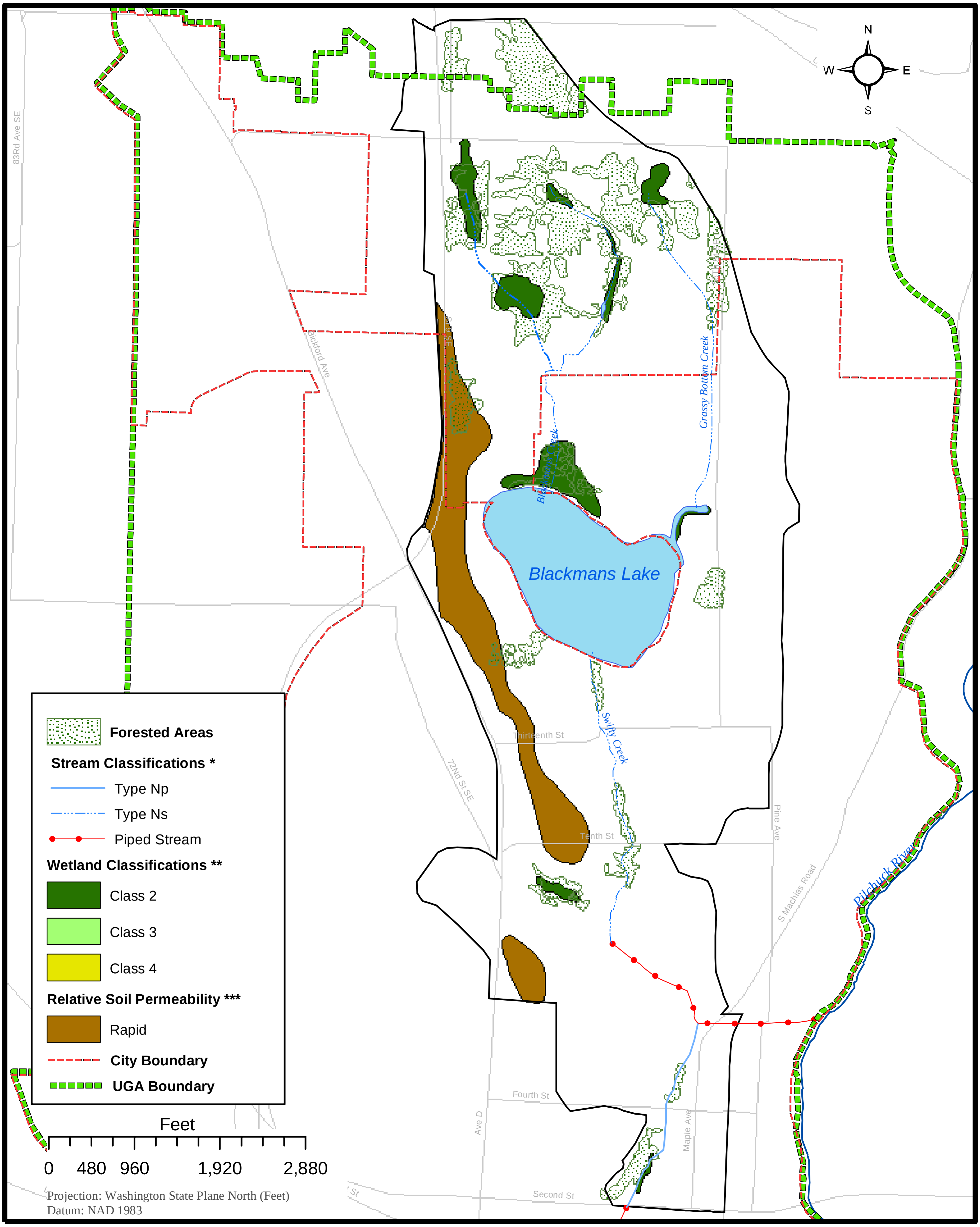
According to local resident Bob Heirman, Swifty Creek and Blackman's Lake historically supported populations of salmon and trout. Currently, fish passage barriers in the Swifty Creek basin have eliminated salmonid migration from the Snohomish and Pilchuck rivers. The combination of perched river-outfall culverts and long piping systems have made it impossible for fish to make their way to the surface water portion of the drainage. The Washington Department of Fish and Wildlife (WDFW) annually stock Blackman's Lake with catchable trout. WDFW personnel have documented that many of the stocked fish hold over in the lake for several years before being caught, suggesting adequate lake conditions for salmonid survival. In 2003, 6,750 catchable trout were planted in Blackman's Lake (WDFW 2003).

Wildlife populations in the Swifty Creek watershed are limited due to the extensive development that has occurred within the basin. Significant waterfowl populations occur in the watershed, primarily associated with Blackman's Lake. Crayfish were found in Swifty Creek downstream of the lake during 2003 Steward and Associates surveys.

2.5.2 Wetlands

Steward and Associates' surveys indicate the presence of 10 wetlands within the Swifty Creek basin (see Figure II-14). This includes one isolated wetland that is Class 2 because it has immature forest and is greater than one acre and nine wetlands that are Class 2 because of their connections to Blackman's Lake, its tributaries or Swifty Creek (classifications based on SMC 14.51.70; see Appendix C).

Swifty Creek Subbasin: Key Natural Resources



* Stream classifications per WAC 222-16-030 (see Appendix xx). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

** Wetland classifications per SMC 14.51.070 (see Appendix xx)

*** Relative soil permabilities were derived from the Soil Survey of Snohomish County Area, Washington USDA/ NRCS 1983 (rapid and moderately rapid permeable soils were the only soils considered)

Steward and Associates 2004

Figure II-14

2.5.3 Water Quality

The water quality of Blackman's Lake has been monitored closely since the early 1990s, first for a lake restoration study (KCM 1994) and more recently by citizen volunteers and Snohomish County (Snohomish County 2003c). The lake is on the 303(d) list as impaired for both fecal coliform and phosphorus. Primary sources of fecal coliform are the abundant waterfowl using the lake and livestock in pastures upstream of the lake. The KCM study found that the lake was mesotrophic (moderately productive), with phosphorus inputs causing "symptoms of accelerated eutrophication (increased nutrients or loading)." Eutrophication would increase blue-green algal blooms, which create odor and aesthetic problems and which increase demands on oxygen when they decompose and sink to the lake bottom. Oxygen levels are already very low in the hypolimnion (below the warm surface layer of the lake in summer and early fall), which reduces habitat for stocked salmonids by forcing them into a narrow band of water between the warm surface layer and the oxygen-starved lower layer. Low oxygen levels in the hypolimnion also have the chemical effect of causing phosphorus in lake sediments to be released back into the water, exacerbating the problems of eutrophication. Without protection of forests, riparian areas and wetlands above the lake, these problems will likely worsen as the area develops, increasing stormflows and erosion.

Steward and Associates measured stream water quality at a single site upstream and two sites downstream of Blackman's Lake from April through December 2003 (see Appendix E for sampling methods, results and city-wide map of all sampling sites). Due to drought conditions in 2003, the upstream portion of the creek ran dry from the end of June to the beginning of October. Water temperature reached a maximum of 20.7^{o}C on June 23rd just downstream of Blackman Lake. Dissolved oxygen levels reached a minimum of 2.1 mg/L on July 21 just downstream of Blackman's Lake and remained below 5.0 mg/L through October at this site. A 1998-2001 monitoring study by the Friends of Blackman's Lake (2001) indicate that temperatures reached a maximum of 22.1^{o}C in July 1999 and dissolved oxygen reached a minimum of 2.4 mg/L in June 2000. High temperatures and low dissolved oxygen levels in lower Swifty Creek would make it difficult for salmonid populations to survive, even if fish passage issues were addressed.

Bacterial concentrations of *E. coli* were measured in samples taken from surface waters throughout Swifty Creek from January through September 2003. Concentrations were greater than Washington State criteria for primary contact recreation (e.g. swimming) downstream of Blackman's Lake in January, February, July, August, and September 2003. This form of bacterial pollution does not pose a threat to salmon, but parallels water quality violations in other tributaries to the lower Snohomish River (WDOE 2003).

2.5.4 Habitat Quality

Since non-stocked fish populations are absent from the Swifty Creek drainage, quantitative assessments of the creek were deemed unnecessary and replaced by qualitative observations.

Blackman's Creek and Grassy Bottom Creek, the primary tributaries to Blackman's Lake, begin in forestlands and wetlands in the unincorporated area north of 64th Street (see Figure II-14). By the time they reach the City limits, riparian vegetation and large woody debris are nearly nonexistent. Grassy Bottom Creek has been channelized along Park Avenue, where it enters a drainage pond south of 22nd Street, from which it continues on Park Avenue before entering a channel dug through a wetland to the lake. Blackman's Creek has been channelized along 64th Street, after which it flows through open BPA right-of-way and a large wetland before reaching the lake. Fine substrates dominate the open field and wetland region, with artificial gravel and rubble substrates in the stream section flowing along 64th Street.

Steward and Associates qualitatively assessed Swifty Creek downstream of Blackman's Lake, including the channel between the lake and the Snohomish High School Freshman Campus, as well as the "old" channel running south of the campus and along Cedar Avenue. Swifty Creek is nearly devoid of LWD and has a very limited recruitment potential due to the sparse nature of the existing riparian area. Swifty Creek flows out of Blackman's Lake and through a small grove of alder trees for 250 meters as a low gradient, soft-bottom stream. Picking up gradient, the stream makes its way through single family residential properties south of 13th Street for 415 meters to 10th Street. In this reach the riparian area is narrow and consists of mature cedar, fir, maple, and salmonberry; the substrate is dominated by gravel. Between 10th Street and 9th Street, the Swifty creek riparian area consists of salmonberry, blackberry, alder, and maple with dominant substrates of cobble and gravel. Downstream of 9th Street, the stream is completely devoid of riparian vegetation as it approaches the Snohomish High School Freshman Campus; the substrate consists of cobble and gravel. From the Freshman Campus, the stream enters an underground pipe, where most of the flow is diverted to the Pilchuck River.

South of the freshman campus, the historic Swifty Creek channel continues to convey small amounts of flow year-round from local springs. The historic channel carves through a small glen south of 5th Street, with riparian vegetation dominated by blackberry and substrates consisting of sand and small gravel. Just north of 2nd Street, the creek enters an underground pipe that flows beneath downtown Snohomish to the Snohomish River near Cady Park.

3 RECOMMENDED ACTIONS BY STUDY AREA

Using the last chapter as a technical foundation, this chapter of the ESA Strategy reviews recommended actions for each study area, focusing on projects to restore habitat and fish access and on programmatic or regulatory recommendations that differ between the study areas (see Figure III-1). Projects are listed in priority order for each study area; projects for the Snohomish and Pilchuck Rivers focused on City-owned property, to ease implementation. At the end of the discussion for each study area, this chapter describes a "Vision for Future Conditions" that would result from implementing recommendations.

Chapter 4 will review recommendations by City activity, including priorities across the Urban Growth Area. Chapter 4 will also provide more detail on programmatic and protection recommendations discussed in this chapter, including buffers, stormwater standards and maintenance of riverbanks.

3.1 Programmatic Recommendations across Study Areas

Stream Typing- The City should adopt a modified version of the State of Washington's stream typing system (WAC 222-16-030; see Appendix D), which distinguishes between shorelines of the state ("Type S"), other streams with fish ("Type F"), perennial streams without fish ("Type Np") and seasonal streams without fish ("Type Ns"). These distinctions are clearer and more relevant to the City's environmental goals than existing definitions in SMC 14.51.070 (see Appendix C). "Fish" for these purposes should be defined as "salmonids". "Type F" streams should include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach by natural migration. Steward and Associates has identified these points on the maps in this chapter and in Chapter 2.

Riparian Restoration- Himalayan blackberry and other invasive, non-native plants dominate much of the vegetation along the City's streams, choking out native species. Riparian restoration projects would remove these plants, and replace them with native species. Native plantings should include trees and shrubs indicated in the lists below. Initial species may need to be tolerant of sun, to be followed in later years by plants preferring shade.

Tree Common Name	Shrub Common Name
Western hemlock	Chokecherry
Douglas fir	Ocean spray
Black cottonwood	Indian plum
Western red cedar	Oregon grape
	Salal
	Snowberry

Snohomish ESA Strategy Recommendations

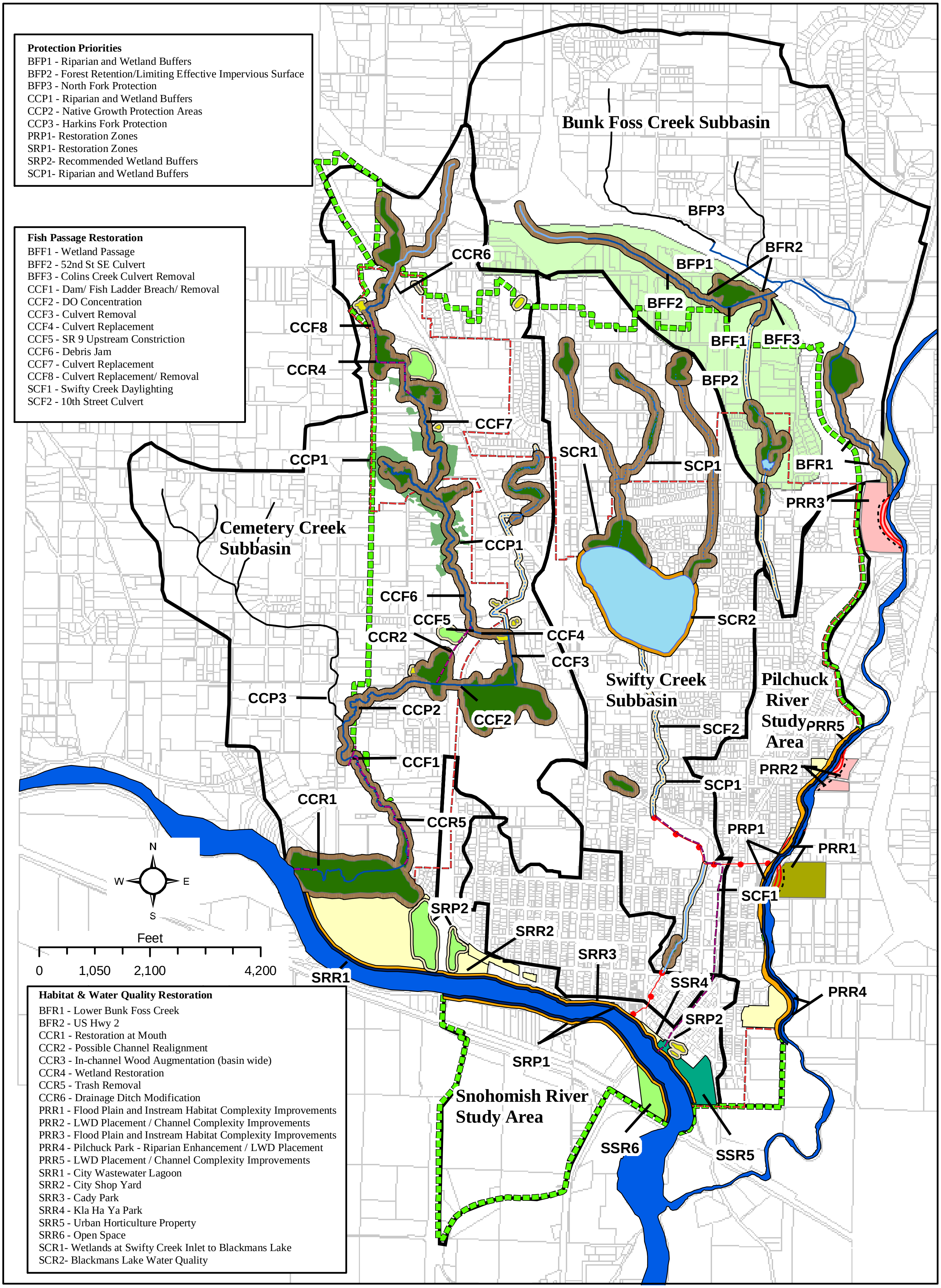


Figure III-1

3.2 Snohomish River

The Snohomish Basin Salmon Recovery Forum (SBSRF) has identified the Lower Snohomish River, including the study area, as a "Mainstem Primary Restoration" sub-basin. Along with the estuary and nearshore environments, these sub-basins have "the highest potential gains with restoration and highest potential losses if further degradation occurs" for salmon recovery across the entire Snohomish River basin (SBSRF 2003; see Appendix H for details). The SBSRF found that "the loss of rearing habitat quantity and quality is the primary factor affecting population performance" in these areas. "First Priority" actions recommended by the SBSRF applicable to the study area include restoring shoreline conditions (removing rip-rap, incorporating LWD into armored banks) and enhancing riparian areas. "Second Priority" actions include addressing water quality impacts and installing engineered log jams and other structural instream habitat. The SBSRF believes that major improvements in habitat conditions in Mainstem Primary Restoration sub-basins will be necessary for the Snohomish River basin to meet targets for abundance and productivity of listed salmon.

3.2.1 Programmatic Recommendations

Streambank Stabilization- Streambanks of the Snohomish River adjacent to the City of Snohomish have been heavily reinforced for flood control. Dikes across the river have increased the force of high flows against the City's banks, particularly below the downtown area. The City should stabilize its riverbanks following techniques in the Washington State Aquatic Habitat Guidelines Program's "Integrated Streambank Protection Guidelines" (2002). Vegetation will generally enhance bank stability, even when combined with riprap. Woody debris and angular rock can also enhance habitat values while promoting bank stability.

Stormwater Detention- The City should eliminate stormwater detention (not water quality) requirements for development and redevelopment in the Snohomish River study area. This should actually reduce the City's contribution to high flows in the rivers, which are delayed by originating much further upstream. It also avoids creating disincentives for development and redevelopment in some of the most heavily urbanized parts of the City, where growth management goals generally seek to concentrate development and where meeting the Department of Ecology's 2001 detention requirements are generally more expensive than in less developed areas.

3.2.2 Protection Priorities

Protection priorities are described in Figure III-2.

P1: River "Restoration Zone"- The City should make the first 100 feet from the ordinary high water mark or floodway a "restoration zone." As discussed in more detail in Chapter 4, the following conditions should apply in the restoration zone:

- No further encroachment by buildings and impervious surfaces beyond existing conditions should be allowed in the first 50 feet, except to provide or enhance public access to the rivers;
- No further encroachment by buildings and impervious surfaces beyond existing conditions should be allowed in the next 50 feet, except for water-related or water-dependent businesses;
- All development and redevelopment within the restoration zone, even if it does not increase encroachment on the rivers, should contribute toward revegetation of the zone and its associated riverbank, with greatest emphasis on revegetation near the river;
- In addition, any development or redevelopment that increases encroachment within the restoration zone should contribute toward projects to enhance salmonid rearing habitat in the rivers, such as R2, R3 or R4 below.

The ecological goals for restoring riparian areas are to provide shade, cover and food sources (insects and litter fall) for salmon rearing areas and habitat along the river's edge. Restored riparian areas also will provide bird and other wildlife habitat, will be less prone to bank failure and erosion of fine sediments into the river, and over time will contribute woody debris to the river, enhancing salmon rearing habitat. Mitigation for encroachment or for other development in the restoration zone should relate to the amount of ecological function that is lost, including the loss of future restoration opportunities.

P2: Wetland Buffers- Existing 50-foot buffers for Class 3 and Class 4 wetlands in the study area are adequate for their functions of water quality protection and wildlife habitat, recognizing their disconnection from the river. New encroachment should, however, be minimized between these wetlands and the river.

3.2.3 Habitat and Water Quality Restoration

Habitat and Water Quality Restoration priorities are described in Figure III-2.

R1: City Wastewater Lagoon- The levee protecting the City's wastewater treatment plant (which is required by the Washington Department of Ecology, to protect water quality in the river) should be enhanced with vegetation, replacing non-native species with native species from the Programmatic Riparian Restoration lists above. The treatment plant is currently not using one of its lagoons, which has been proposed for temporary use in collecting flows from the City's combined storm and sanitary sewer system until the two systems are separated. There is also potential for use of the lagoon for future expansion of the wastewater treatment plant. If portions of the lagoon are not used, they should be reconnected to the wetland at the mouth of Cemetery Creek by removing the levee between them. Lagoon soils should be tested prior to wetland reconnection to avoid wetland contamination.

Restoration work at the mouth of Cemetery Creek could mitigate for wastewater treatment plant expansion. Planting native wetland plants would hasten the restoration process. The transformation of the lagoon to a wetland would increase valuable fish and wildlife habitat at the mouth of Cemetery Creek, including the bald eagle and heron populations that are already present, as well as salmonid rearing habitat.

R2: City Shop Yard- This property is adjacent to the Snohomish River and contains a Class 3 wetland. Non-native vegetation dominates the riverbank and surrounds the wetland. Non-natives should be removed and replaced with natives from the Programmatic Riparian Restoration list above. Old pilings in the river adjacent to the City shop yard could be used for securing a LWD (large woody debris) jam that would provide significant refugia and rearing habitat for juvenile and out-migrating salmonids. As an example of debris jam function, Steward and Associates documented the presence of over 1000 juvenile salmonids using the habitat provided by a small debris jam in the right bank eddy just downstream of the railroad bridge in the study area.

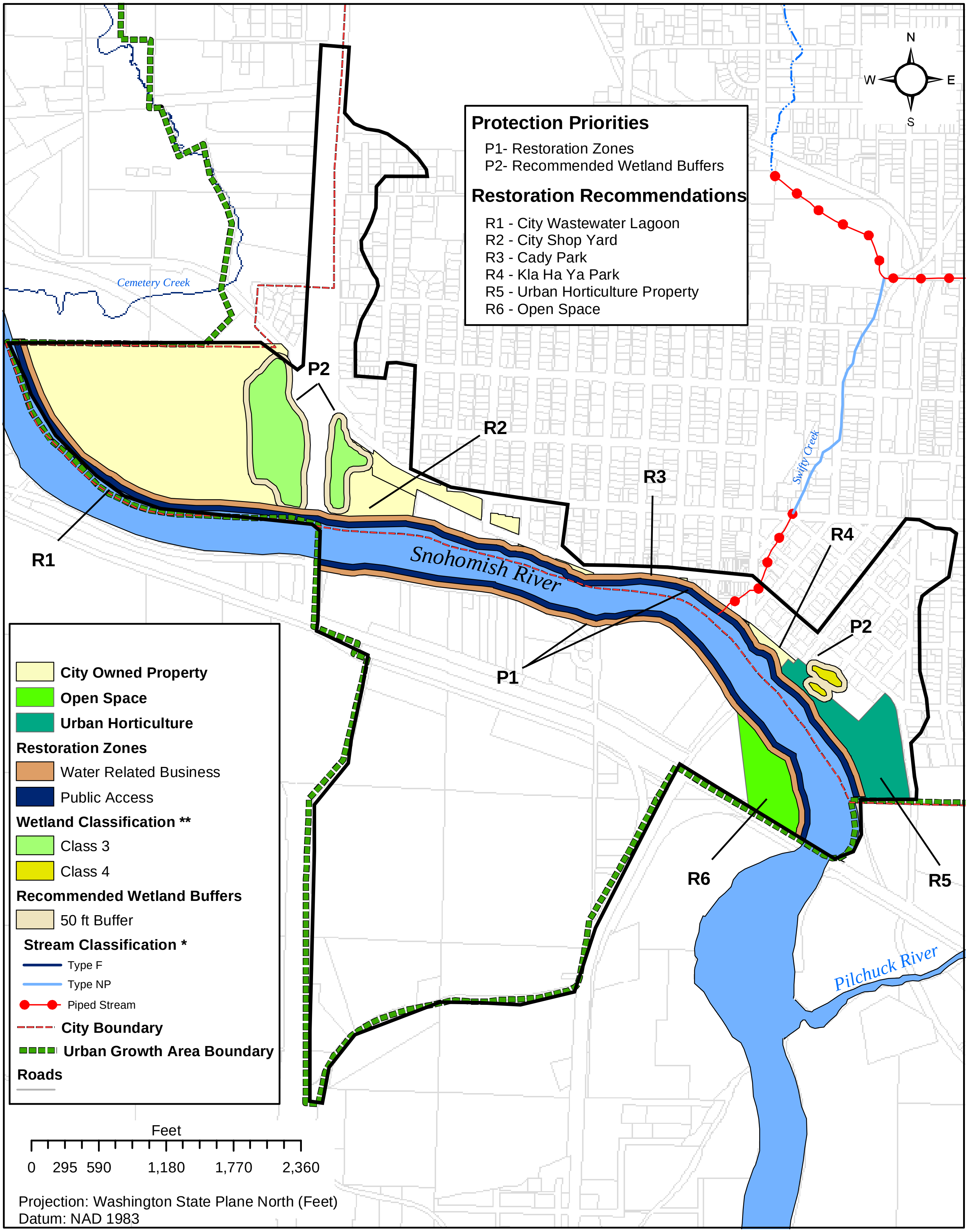
R3: Cady Park- This city park offers an excellent opportunity for enhancement. Non-native plants dominate riparian areas along the river on the park property. Stream bank revegetation, including plantings of willow and other native plants, would help stabilize trampled, eroding banks. Efforts to control public access to the river, thus reducing streambank trampling, should involve limiting the number of access points along the riverbank. Opportunities for LWD placement exist along the lower edges of the right bank due to the presence of a backwater eddy and old pilings, which would provide cover, complexity and food resources to salmonids in the basin. The old pilings could offer the initial framework for the LWD jam. Natural debris jams located in this reach of the river, as indicated in R2, provide essential refugia and rearing habitat for juvenile salmonids.

R4: Kla Ha Ya Park- This is a small riverside city park that offers opportunities for vegetative enhancement. Non-native vegetation dominates the riverbank and could be removed and replaced by native vegetation. Included species could be selected from the Programmatic Riparian Restoration list above.

R5: Urban Horticulture Property- The property designated as urban horticulture, located just inside the eastern edge of the city limits adjacent to the north bank of the Snohomish River, might offer opportunities for replacement of non-native vegetation with native vegetation. Restoration options should be explored with the landowner.

R6: Open Space Property- The property designated as open space, located on the south bank and across the river from the urban horticulture property mentioned above, should also be explored for potential vegetative enhancement or restoration. Options should be discussed with landowner.

Snohomish River Study Area: Recommendations



* Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

** Wetland classifications per SMC 14.51.070 (see Appendix C)

Steward and Associates 2004

Figure III-2

3.2.4 Vision for Future Conditions

Implementing these recommendations would increase and improve rearing habitat for salmon in the lower Snohomish River, which is among the highest priority actions in the entire Snohomish River basin set by the Snohomish Basin Salmon Recovery Forum. Riparian restoration and improved streambank maintenance practices should also provide cover and food sources for salmon and improved habitat for eagles, herons and other birds and wildlife that use the river, while increasing streambank stability and the protection of public and private property from flood damage. The restoration zone should promote these same habitat improvements as well as public access to the river, which the recommendations would make safer and better controlled to protect the environment. Water-related businesses should benefit both by their preferential use of the restoration zone and by the improved amenity value of restored natural areas along the river, which should also benefit City residents and visitors more generally.

3.3 Pilchuck River

The Snohomish Basin (WRIA 7) Salmon Recovery Forum has identified the Pilchuck River as a "Mainstem Secondary Restoration" sub-basin. These areas contain "satellite chinook spawning and rearing areas, as well as spawning and rearing habitat for other salmonids and presumed foraging habitat for bull trout." (SBSRF 2003; see Appendix H for details). Secondary Restoration sub-basins are less important than "Primary" sub-basins (such as the lower Snohomish River) for chinook abundance and productivity, but the Forum believes they are probably necessary for meeting ESA recovery goals within the Snohomish River basin, particularly for geographic distribution and genetic diversity. Actions recommended by the Forum for Secondary Restoration sub-basins include restoring riparian forests and floodplain connectivity, correcting fish passage barriers and reducing the impacts of urbanization.

3.3.1 Programmatic Recommendations

Streambank Stabilization- Pilchuck River streambanks along the City of Snohomish are eroding and unstable in many locations, due in part to constraining dikes on the opposite side of the river. The City should stabilize these banks following techniques in the Washington State Aquatic Habitat Guidelines Program's "Integrated Streambank Protection Guidelines" (2002). Vegetation will generally enhance bank stability, even when combined with riprap. Woody debris and angular rock can also enhance habitat values while promoting bank stability.

Stormwater Detention- The City should eliminate stormwater detention (not water quality) requirements for development and redevelopment in the Pilchuck River study area. This should actually reduce the City's contribution to high flows in the rivers, which are delayed by originating much further upstream. It also avoids creating disincentives for development and redevelopment in some of the most heavily urbanized parts of the City, where growth management goals generally seek to concentrate development and where meeting the Department of Ecology's 2001 detention requirements are generally more expensive than in less developed areas.

3.3.2 Protection Priorities

Protection recommendations are described in Figure III-3.

P1: River "Restoration Zone"- The City should make the first 100 feet from the ordinary high water mark or floodway a "restoration zone." As discussed in more detail in Chapter 4, the following conditions should apply in the restoration zone:

- No further encroachment by buildings and impervious surfaces beyond existing conditions should be allowed in the first 50 feet, except to provide or enhance public access to the rivers;
- No further encroachment by buildings and impervious surfaces beyond existing conditions should be allowed in the next 50 feet, except for water-related or water-dependent businesses;
- All development and redevelopment within the restoration zone, even if it does not increase encroachment on the rivers, should contribute toward revegetation of the zone and its associated riverbank, with greatest emphasis on revegetation near the river;
- In addition, any development or redevelopment that increases encroachment within the restoration zone should contribute toward projects to enhance salmonid rearing habitat in the rivers, such as R1, R2, R3 or R4 below.

The ecological goals for restoring riparian areas are to provide shade, cover and food sources (insects and litter fall) for salmon rearing areas and habitat along the river's edge. Restored riparian areas also will provide bird and other wildlife habitat, will be less prone to bank failure and erosion of fine sediments into the river, and over time will contribute woody debris to the river, enhancing salmon rearing habitat. Mitigation for encroachment or for other development in the restoration zone should relate to the amount of ecological function that is lost, including the loss of future restoration opportunities.

3.3.3 Habitat and Water Quality Restoration

Habitat and water quality recommendations are described in Figure III-3.

R1: Pilchuck Park- Non-native plants dominate riparian areas along the river on the park property. Stream bank revegetation, including plantings of willow and other native plants, would help stabilize eroding levees. Efforts to control public access to the river, thus reducing streambank trampling, should involve limiting the number of access points along the levee. Opportunities for LWD placement exist along the lower edges of the right bank levees, which would provide cover, complexity and food resources to salmonids in the basin. Implementation of this recommendation will require cooperation from the French Creek Diking District.

R2: City Open Space- This property offers excellent opportunities for improving floodplain and instream habitat complexity. Non-native plants should be replaced with natives. LWD can be strategically placed to enhance the existing side channel just upstream of the open space and increase the complexity of the main channel. Conifers should be planted upland of the side channel; willows may be more appropriate on the gravel bar between the main channel and side channel. This project could potentially link to a levee setback project immediately downstream and across the main channel on the property designated for a future Snohomish County park, effectively creating a significant node of quality habitat.

R3: Morgantown Park- This city park has the highest quality existing riparian area on the Pilchuck River downstream of Bunk Foss Creek. The riparian area has a limited width but is composed of a significant number of mature conifers, which should be protected. This park is also a high priority location for LWD placement to add channel complexity to the long homogenous glide adjacent to the park. The pasture land on the opposite bank could potentially allow significant levee setbacks with riparian restoration, possibly through the Conservation Reserve Enhancement Program.

R4: Old Pump House Property- This city-owned property offers an excellent opportunity for LWD placement to increase channel complexity at the upper end of the glide mentioned in R3 above. Non-native vegetation should be replaced with natives, including understory herbs and shrubs, as well as cottonwoods, willows, and conifers. Opportunities for levee setback may also occur on the opposite bank in this location.

R5: Mouth of Bunk Foss Creek- Though this area is outside of the UGA and is not owned by the City, it offers prime opportunities for habitat improvement, given public ownership/easements on both sides of the river (through BPA and City of Everett), significant use by salmonids (especially coho salmon), and the ecological importance of confluence areas. Improvements would primarily consist of riparian plantings and placement of LWD to increase channel complexity and provide cover. The American Legion RV park property downstream of the Bunk Foss confluence is potentially another candidate for levee setback.

Pilchuck River Study Area: Recommendations

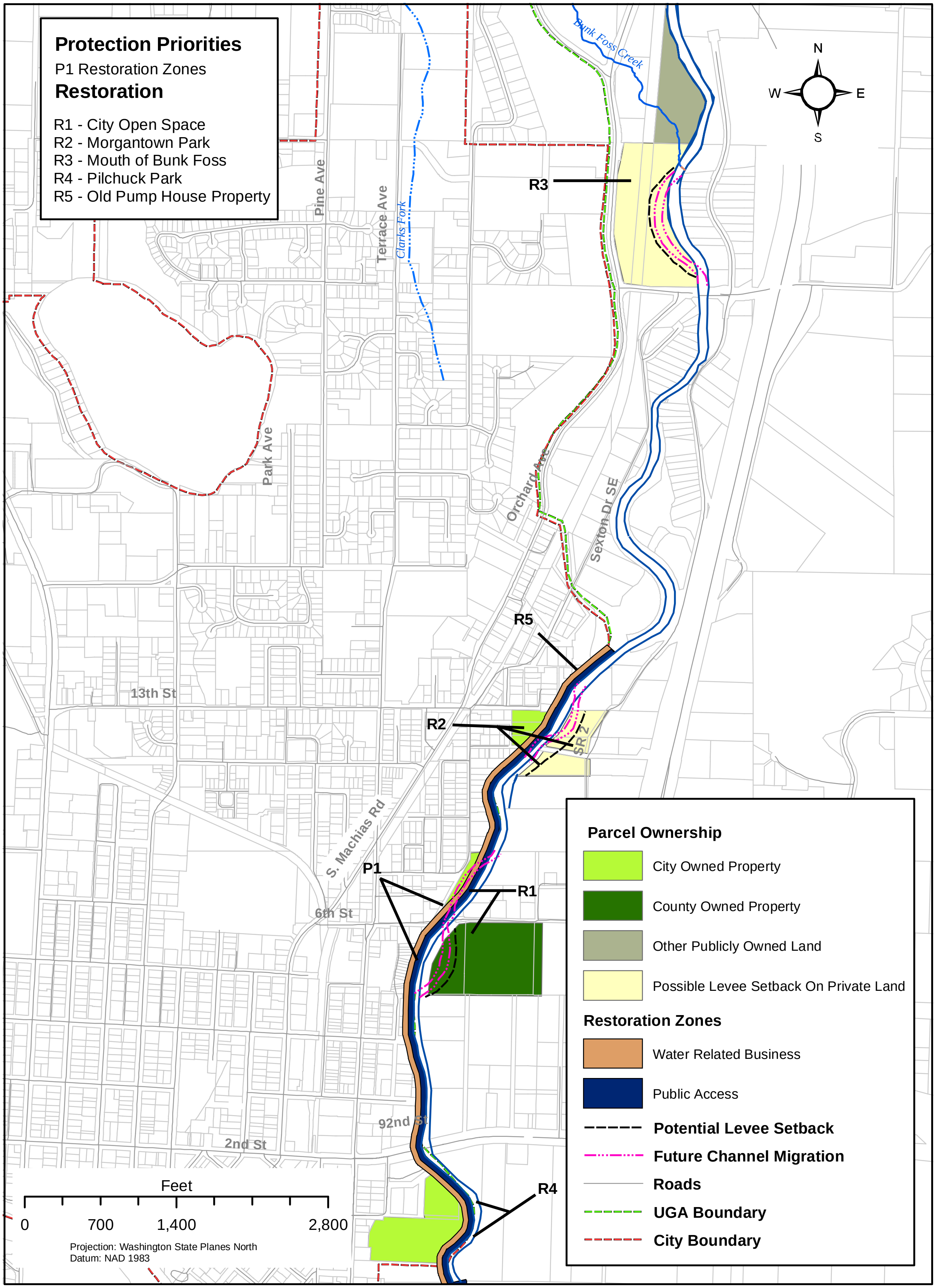


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Figure III-3

3.3.4 Vision for Future Conditions

Implementing these recommendations would increase and improve fish and wildlife habitat in the study area, especially if combined with levee setbacks and riparian restoration on the opposite bank of the river. City parks and open space along the river would become more attractive and valuable to residents and visitors. Strategic additions of woody debris would increase the number and quality of pools in the river, improving important habitat for juvenile chinook and coho and pre-spawning adult salmon of all species. Pools are especially important as holding areas for adult chinook, which return when water temperatures in the river are typically high. Riparian restoration and improved streambank maintenance practices should also add cover and food sources for fish and increase shade and the natural recruitment of woody debris to the river. By benefiting salmon from the entire Pilchuck River basin, these improvements are important for the geographic distribution and potentially the genetic diversity of multiple salmon species in the Snohomish River basin, making them a significant contribution to regional salmon recovery. Improvements to riparian areas would also benefit eagles, herons and other birds and wildlife that use the river.

3.4 Cemetery Creek

3.4.1 Programmatic

Stormwater Standards and Low-Impact Alternatives – Though the City should apply Ecology's 2001 stormwater standards for development in the Cemetery Creek basin, the City should provide incentives for low-impact development as an alternative to the general standards. The Cemetery Creek basin generally provides the best opportunities for this approach of any area in the City, largely for two reasons: no other basin has as much underdeveloped land within the Urban Growth Area; and much of this land overlies soils with rapid or moderately rapid permeability, providing good onsite drainage capacity (see Figure II-8, last chapter). Low-impact development uses natural features of a site (topography, soils and vegetation) to reduce the need for engineered stormwater facilities such as detention ponds. Low-impact developments on permeable soils can achieve high levels of infiltration, which could help maintain summer baseflows, a key objective for Cemetery Creek. Low-impact approaches also can reduce the overall cost of stormwater management for new development.

Riparian Restoration Priorities- Priority stream segments for riparian restoration projects are CC01, where they would provide the greatest benefit to salmonids, and CC03, 04, 08 and 09, where current riparian conditions are poorest in the basin (see Figure II-7, last chapter).

3.4.2 Protection Priorities

Protection recommendations are described in Figure III-4

P1: Riparian and Wetland Buffers – All Type F waters and Class 2 wetlands in the Cemetery Creek basin should have buffers of 100 feet, supplemented by connected upland forest where possible (see Recommendation P4 below). Buffers of at least this size are recommended in the scientific literature to remove pollutants, control fine sediments and protect water temperatures (May, 2000). An adequate buffer is especially critical to the long-term health of upper Cemetery Creek, since much of this area is zoned for business park development (Map 2). This area currently contains a large amount of mature, intact forest in riparian areas and uplands (Map 1), which is unusual for UGAs in western Washington. The lower reaches of Cemetery Creek (i.e., segments CC01, 02 and 03) also already have substantial existing forested riparian areas, which should be protected. Areas with severely degraded existing buffers, such as the area east of SR9, are particularly good candidates for reductions in buffer width in return for significant buffer restoration.

SIDEBAR:
BICKFORD SUBAREA PLAN

Between May and September 2003, the City's Economic Development Commission worked with a consultant team and property owners in recently annexed areas along Bickford Avenue (see map) to develop a "Subarea Plan Concept." Most of the Bickford Subarea is zoned "business park", but much of it is currently undeveloped or in rural residential use. Cemetery Creek runs through the heart of the Subarea to the west of Bickford Avenue. This creates potentially serious constraints on development, especially since many land parcels are narrowly oriented east-west and are bisected by the creek.

The goal of the planning effort was to reach general agreement on a conceptual approach for developing the Subarea that could maximize its economic potential while protecting and enhancing its natural values, at a minimum of public and private cost. The conceptual plan addressed the general locations for:

New roads;
Different types of development (commercial, residential, mixed, etc.);
Stormwater facilities; and
Open space, including habitat corridors.

Assessments for the ESA Strategy helped guide recommendations for stormwater, open space and habitat.

Though the Subarea Plan Concept envisions a number of new roads to serve development, it does not propose any new stream crossings. This is a very important environmental advantage of the Plan Concept, especially when compared with the potential for many stream crossings if the east-west parcels are developed separately, without an overall plan. ESA Strategy Recommendations P1 (buffers), P2 (low-impact development) and P4 (possible enhanced riparian areas) were incorporated into the Plan Concept, while recommendations R3 (in-stream restoration), R4 (wetland and channel restoration) and R6 (drainage ditch modification) were all discussed as restoration priorities that could potentially be funded through mitigation for new development.

The City is currently pursuing grant funding to develop a Programmatic Environmental Impact Statement (PEIS) for the Subarea. This would add more detail to the Plan Concept and evaluate its impacts compared to alternatives. A PEIS would reduce or eliminate the need for future Environmental Impact Statements for individual developments if they are consistent with the Subarea Plan, thus reducing costs and increasing certainty for new development.

P2: Native Growth Protection Areas – In unincorporated Snohomish County, stream and wetland buffers that have been established through development permits are protected as "Native Growth Protection Areas" (NGPAs; Snohomish County 2003b). Within the Cemetery Creek basin, NGPAs play a particularly important role in protecting Segment CC02 downstream of 89th Street, which has the highest quality riparian buffers on the mainstem. The City should continue these protections when NGPAs are incorporated within the City. However, the county's current restrictions against any clearing of NGPAs should be modified to allow removal of non-native vegetation, if replaced by natives.

P3: Harkins Fork Protection – Harkins Fork provides a year-round flow of high quality water to Cemetery Creek. Although Harkins Fork is entirely outside the City's UGA, its headwaters remain relatively intact and should be protected as a major contributor of good quality water to Cemetery Creek. Riparian protections should be at least as strict for Harkins Fork as for the rest of Cemetery Creek. To the greatest extent possible, forest cover should be retained and expanded throughout the area draining to Harkins Fork.

P4: Enhanced Riparian Areas – Where existing forested buffers extend beyond 100 feet in the upper Cemetery Creek basin (see Figure III-4), landowners should be allowed to sell buffer enhancements to other property owners in the Business Park zone of the basin (see Figure II-6, last chapter), who should be allowed to meet their open space requirements off-site through these purchases. These transactions would be voluntary but could significantly increase the ecological value of protected buffers along the creek, especially as wildlife habitat.

3.4.3 Habitat and Water Quality Restoration

Habitat and water quality recommendations are illustrated in Figure III-4.

R1: Restoration of Confluence – The functions of the mouth of Cemetery Creek and its associated wetland should be enhanced to provide improved fish and wildlife habitat as well as water filtration and storage. Chinook and bull trout could use this habitat for refuge, rearing, and forage because of its close proximity to the Snohomish River. Resident cutthroat and rainbow trout, and juvenile and adult coho salmon were observed in this area during snorkel and foot surveys and would also benefit from restored habitat.

The sewage lagoon adjacent to the wetland at the mouth of Cemetery Creek is currently not in use, though it has been proposed for temporary use in collecting flows from the City's combined storm and sanitary sewer system, until the two systems are separated. There is also potential for use of the lagoon for future expansion of the wastewater treatment plant. If portions of the lagoon are not used, they should be reconnected to the wetland at the mouth of Cemetery Creek by removing the levee between them. Lagoon soils should be tested prior to wetland reconnection to avoid wetland contamination.

Restoration work at the mouth of Cemetery Creek could mitigate for potential wastewater treatment plant expansion into the unused sewer lagoon. In addition to possibly connecting the unused lagoon, restoration should include the following:

- Maintain a well-defined channel in the lower reach of the creek with hydraulic characteristics that facilitate fish passage, juvenile rearing and adult holding;
- Foster the restoration and maintenance of the historic wetland by establishing a riparian buffer, constructing drainage control structures, and minimizing further impacts on site or from upstream;

- Plant clusters of native shrubs and trees to provide shade and nutrient inputs to the wetland/creek system;
- Enhance salmonid access to the creek and wetland by removing or restoring the two culverts under the levee. Restoration of the culverts would either involve removing the one-way caps so fish and water can move in both directions or removing the culverts altogether (essentially carving out another opening in the levee); and
- Placement of woody debris that would enhance habitat for both juvenile and adult salmonids seeking refuge in Cemetery Creek and the associated wetland complex.

R2: Channel Realignment and Restoration of BPA Wetland – Realigning Cemetery Creek west of SR9 would have multiple benefits. It would:

- Restore salmonid access to 1.8 miles of spawning habitat, which is proposed for substantial protection and restoration as part of this ESA Strategy and the City's Bickford Subarea Plan Concept;
- Replace the most degraded habitat in the Cemetery Creek system, including an area with consistently low to very low dissolved oxygen levels, with a connection through wetland and forested areas with good restoration potential; and
- Avoid the need to fix three physical obstructions to passage, including a potentially expensive project under SR9, as well as a functional blockage due to the low dissolved oxygen levels, which appear to be at least partly related to the "BPA wetland" adjacent to the stream (see Chapter 2, pp.II-8 and II-9).

OTAK Inc. has developed a preliminary scope and cost-estimate for this project for Snohomish County (OTAK 2002). The realigned stream would be in what is currently an unincorporated area, though it is within the City's Urban Growth Area (see Figure III-4). The estimated cost is between $975,000 and $1.72 million, which OTAK found was less than the likely cost to fix the blockage under SR9 and restore the existing channel. Since the Washington Department of Transportation would be responsible for fixing the blockage when it widens SR9 in this area, it could be a key partner in implementing the alternative realignment project.

R3: In-Channel Wood Augmentation – Basin-wide placement of in-channel woody debris would augment natural wood recruitment, thereby improving fish and benthic macroinvertebrate habitat and channel complexity. The reintroduction of woody debris would create pools, trap sediment, and provide concealment cover for juvenile fish. "Key" pieces of wood, which help form larger concentrations, should be longer than one-half of the creek's bank-full width or greater than one-half meter in diameter (May 1997). The National Marine Fisheries Service defines "Properly Functioning Conditions" for lowland streams to have more than two pieces per bank-full width (NMFS 2003). Not all of this wood must be the size of "key" pieces, so long as in combination it can form relatively stable jams. Wood should be placed in CC01 and CC02 first, as these stream segments are currently utilized by coho salmon, cutthroat trout and rainbow trout and are most accessible to chinook salmon and bull trout.

R4: Wetland and Channel Restoration, CC08 – Restoration of segment CC08 would involve reconstructing a meandering stream channel with complex habitat as Cemetery Creek flows through the 4.3-acre wetland just south of Fobes Road. Restoring channel sinuosity and native vegetation would improve instream habitat and restore connectivity between the stream and its floodplain, increasing the ability of the wetland to store and cleanse stormflows. A meandering channel would also promote stream channel stability and thus minimize further sediment loading from eroding stream banks.

R5: Trash Removal – There are large quantities of trash and refuse thrown over the embankment into Cemetery Creek and its riparian area in CC01, adjacent to the GAR Cemetery (e.g., metal tank, tires, garden hoses, lumber, barbed wire, etc.). This trash could easily be removed. Continued dumping should be actively discouraged in the future.

R6: Drainage Ditch Modification – Drainage ditches along commercially developed sections of Bickford Avenue should be modified to function as vegetated bioswales. Currently, many of the ditches serve the single purpose of stormwater conveyance and do not filter out pollutants.

3.4.4 Fish Passage Restoration

Fish passage restoration recommendations are described in Figure III-4.

F1: Dam/Fish Ladder Breach/Removal- The dam and fish ladder located in CC01 should be removed, breached or modified to allow water and fish to be passed at all flows. The dam and fish ladder appear to be a constriction to adult and juvenile salmon migration (primarily affecting coho). The bottom of the dam is boarded shut, allowing migration only through the fish ladder, which is not passable during low flows. This constriction is very significant since it limits access to the best habitat in the basin, just upstream in segment CC02. Since the dam currently serves no apparent function, it should be removed. Short of that, removing the boards at its bottom would allow fish to pass up and down through the dam rather than the ladder.

F2: Dissolved Oxygen Blockage – Dissolved oxygen concentrations in and around the BPA wetland and Mulch Plant are low enough to block fish migration. Coho salmon generally require dissolved oxygen concentrations above 7 mg/L (Bell, 1973). Concentrations were less than 5 mg/L just downstream of the BPA wetland and Plant Mulch Company throughout the 2003 sampling year (April-October). An option for restoring fish runs above the BPA wetland is the realignment of Cemetery Creek west of SR9 (see R2, which would also obviate the need for addressing F3-F5).

F3: Mill Yard Culvert Removal- There is an old culvert beneath the mill yard near Dunbar Doors that is partially collapsed at one end, constricting fish passage. The stream crossing is not being used as an access road, but instead simply holds several large trash/debris bins. The culvert should be replaced or the entire crossing should be removed. Habitat restoration in the BPA wetland would need to occur in conjunction with this to address low dissolved oxygen concentrations and eliminate Himalayan blackberry growth.

F4: Access Road Culvert Replacement- The culvert beneath Plant Mulch Company access road is a total fish barrier and should be replaced if R2 is not implemented. Habitat restoration in the BPA wetland would need to occur in conjunction with this to address low dissolved oxygen concentrations and eliminate Himalayan blackberry growth.

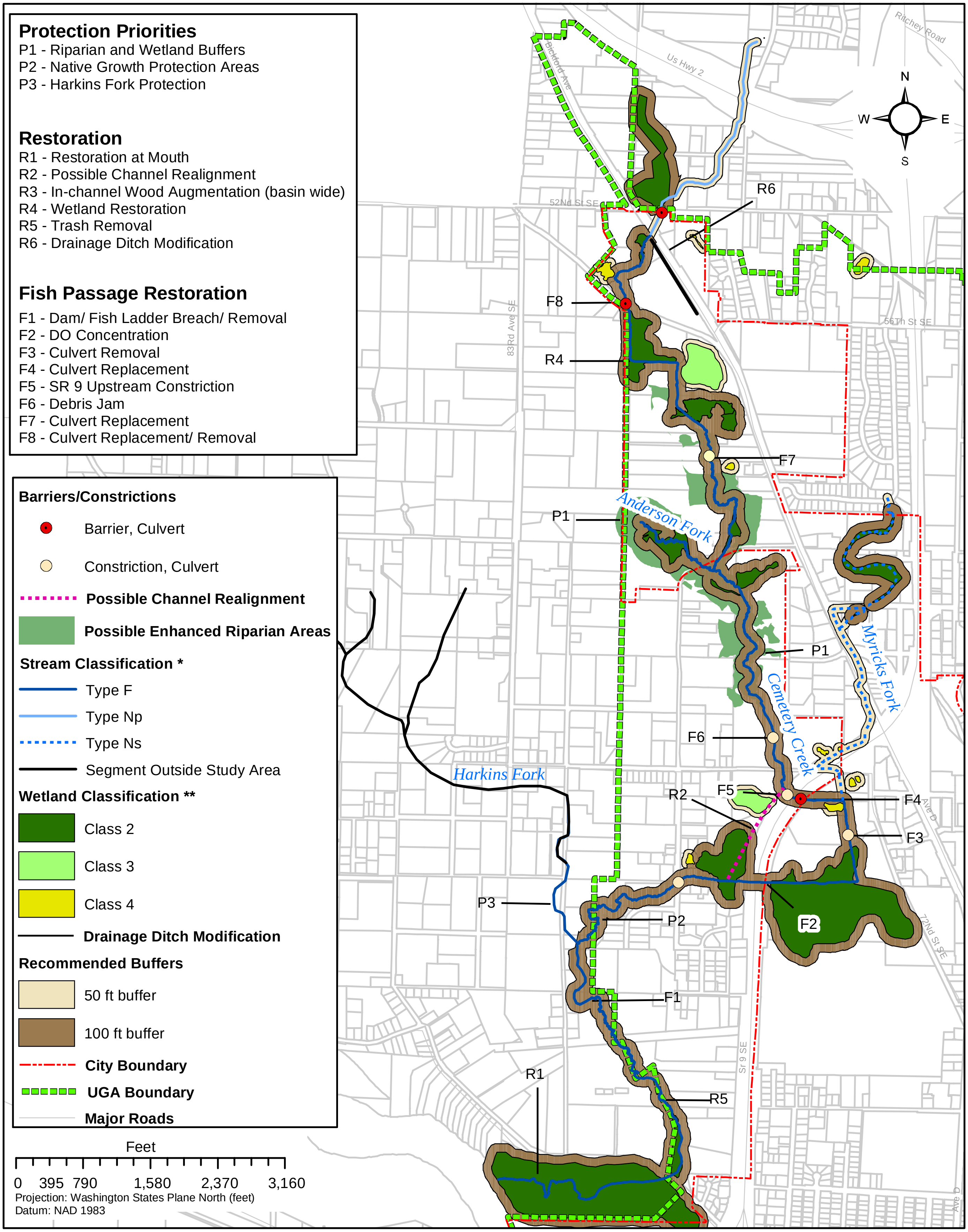
F5: SR9 Upstream Constriction- The upper SR9 crossing of Cemetery Creek is a fish passage constriction. There is either a kink in the culvert halfway through or a large piece of debris that is an impediment to fish passage.

F6: Debris Jam- There is a large debris jam in CC05 at a crossing that connects horse stables east of the creek to pastures west of the creek. The debris is a fish passage constriction and could easily be removed.

F7: Farm Culvert Replacement – Culvert removal or replacement at an old farm crossing in CC08 would facilitate fish passage. The culvert is undersized and the crossing does not appear to be in use anymore.

F8: Fobes Culvert Replacement/Removal- The culvert at the Fobes Road crossing that connects CC08 and CC09 appears to have caved in and is a total barrier to fish passage. However, this project would be a significant expense for limited potential benefits: fish could only reach it if all downstream barriers have been addressed; even with barriers removed, it is already near the likely uppermost extent of fish usage; the amount of useable habitat upstream is small and currently very degraded; and the stream can go dry in this area for much of the year. For these reasons, fixing this barrier is a low priority, and the ESA Strategy defines "Type F" stream as ending at this location.

Cemetery Creek Basin: Recommendations



* Stream classifications per WAC 222-16-030 (see Appendix D). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

** Wetland classifications per SMC 14.51.070 (see Appendix C)

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Figure III-4

3.4.5 Vision for Future Conditions

Implementing the above recommendations would lead to significant improvements in the quality and quantity of Cemetery Creek's habitat for fish and wildlife, even as most of the basin develops to urban densities. Cemetery Creek would provide a valuable natural area for the people of the City and particularly for adjacent property owners, who would see their property values increase accordingly. Low-impact approaches to stormwater management, protection and restoration of the creek's riparian areas, and wetland restoration should mitigate most of the impacts of future development on water quality and flows, while restoration projects should improve the quality of habitat to both fish and wildlife. Barrier removals should make substantially more fish habitat available. As riparian plantings mature, they should provide increased shade and erosion control for the stream and should ultimately contribute woody debris to the channel, increasing habitat complexity and secondary productivity. The biological health of the stream, as measured by B-IBI, should increase. Habitat conditions for chinook and bull trout at the mouth of the stream should improve, due both to direct restoration and improvements to water quality and biological health upstream.

3.5 Bunk Foss Creek

Note: All restoration and fish passage recommendations for Bunk Foss Creek are located outside of the current Urban Growth Area. Unless these areas are annexed into the City in the future, these recommendations will likely have to be undertaken by parties other than the City.

3.5.1 Programmatic

Stormwater Standards. The City should apply Ecology's 2001 stormwater standards for development in the Bunk Foss Creek basin, but should allow reduced requirements as incentives for forest retention, as discussed in P2 below.

3.5.2 Protection Priorities

Protection recommendations are described in Figure III-5.

P1: Riparian and Wetland Buffers – Most property along Bunk Foss Creek is developed at rural densities, if at all. This provides a good opportunity to protect or establish a buffer for the creek and adjacent wetlands that is largely unbroken, maximizing the buffer's ecological value and providing significant protection against the effects of land clearing and development as the surrounding area urbanizes. To the greatest extent possible, new development should not be allowed within 100 feet of the creek and adjacent wetlands, except for that part of Clarks Fork that is seasonal and will not used by fish even with removal of obstructions to passage, where a 50-foot buffer should be adequate. The 100-foot buffers on wetlands, combined with more general forest retention requirements (see P2 below), should ensure that the smaller buffer on parts of Collins Creek is adequate to protect downstream fish habitat.

P2: Forest Retention/Limiting Effective Impervious Surface – The low level of existing development also results in the Bunk Foss watershed having a relatively high level of forest cover overall (approximately 40%). This moderates high and low flows in the stream, which is crucial to sustaining its runs of coho salmon and also benefits chum salmon and juvenile chinook that use the lower reaches of Bunk Foss. If these forested areas are largely cleared with urbanization, all of these benefits would be at risk, especially if the City's UGA is extended to US2. Forest retention is particularly important in this basin because Bunk Foss is considerably steeper than Cemetery Creek and the basin has few wetlands and is almost entirely on glacial till soils; all three factors increase the hydrologic impact of forest clearing. As new areas develop, the City should encourage clustered development to retain up to 65% forest cover in protected tracts where possible, located where it would provide maximum stormwater benefits (e.g., localized depressions, stream and wetland buffers, etc.). This would apply to areas draining to the mainstem above its confluence with Clarks Fork as well as to most of Clarks Fork itself, as shown in Figure III-5. Forest retention requirements would be much less valuable for areas draining directly to the lower creek and in upper Collins Creek, which has little existing forest cover and where flows are moderated by two wetlands. The City should also advocate for as much forest retention as possible in rural areas outside of its jurisdiction. Mitigation for any future expansions of US2 and SR9 should maximize forest retention wherever feasible and provide funding for reforestation efforts.

P3: North Fork Protection – Coho salmon spawn and rear in lower reaches of Fields Fork of Bunk Foss Creek and other stream segments north of US2. Coho that spawn and rear south of US2 (in the mainstem or Clarks Fork) obviously also migrate through the mainstem north of the highway. Though the area north of US2 is not likely to be included in the City's UGA in the foreseeable future, this is an important area to protect for the health of the entire basin. The City should encourage Snohomish County to implement development regulations in this rural area that are at least as protective as those the City applies in its part of the basin.

3.5.3 Habitat and Water Quality Restoration

Habitat and water quality recommendations are described in Figure III-5.

R1: Lower Bunk Foss Creek – Properties near the mouth of Bunk Foss Creek present substantial opportunities for improvements in stream and riparian habitat. Below Old Machias Road, the creek has incised a deep and simplified channel and eroded streambanks have little to no riparian vegetation. Aside from one small horse farm, adjoining land in this area is all publicly owned (the Snohomish County Sheriff's Department, Snohomish County Parks, Snohomish County PUD and the Bonneville Power Administration). Collaborative restoration projects, potentially with volunteer labor, could significantly improve habitat in this area at a relatively low cost. Willows would grow well through much of this area and could provide shade and cover for the creek relatively quickly. The Snohomish Conservation District could potentially assist the horse farm with fencing to limit livestock access to the creek and with subsequent planting of riparian vegetation.

R2: In-Channel Wood Augmentation – Basin-wide placement of in-channel woody debris would augment natural wood recruitment, thereby improving fish and benthic macroinvertebrate habitat and channel complexity. The reintroduction of woody debris would create pools, trap sediment, and provide concealment cover for juvenile fish. "Key" pieces of wood, which help form larger concentrations, should be longer than one-half of the creek's bank-full width or greater than one-half meter in diameter (May 1997). NOAA Fisheries defines "Properly Functioning Conditions" for lowland streams to have more than two pieces per bank-full width (NMFS 2003). Not all of this wood must be the size of "key" pieces, so long as in combination it can form relatively stable jams. South of US2, where recommendations in the ESA Strategy are focused, the highest priority location for placing woody debris is in BF04, where coho salmon spawn and rear in the largest numbers.

3.5.4 Fish Passage Restoration

Passage recommendations are described in Figure III-5.

F1: Wetland Passage – Bunk Foss Creek flows through a Class 2 wetland just south of US2 before flowing under the highway. The culvert blocks wood and debris from upstream, which are used by beavers to construct dams in the wetland that block passage of salmon to most of the upper watershed. Unlike other beaver dams in the Snohomish area, high fall flows typically do not dislodge these dams, which are protected by the wetland. Neighboring residents have sometimes cleared a path through the dams for the salmon to use. The Washington Department of Fish and Wildlife would support permits for this purpose, using small hand-tools to breach these dams in late October or early November, so beavers would be unlikely to rebuild them before coho spawners arrive. Groups like the Snohomish County Sportsmen's Association could sponsor such maintenance.

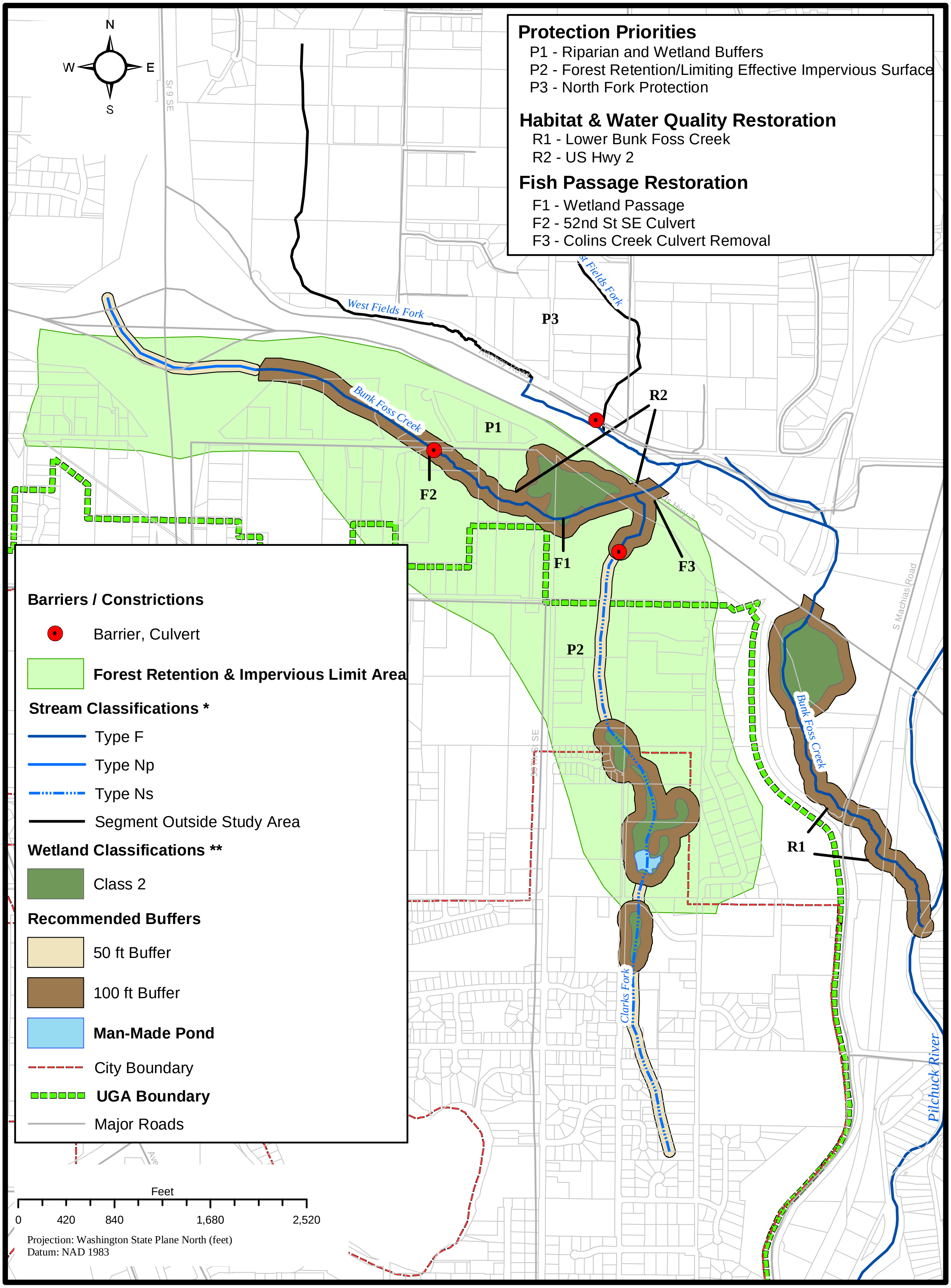
F2: 52nd Street SE Culvert – A culvert beneath 52nd Street SE blocks fish passage to the best spawning habitat in Bunk Foss Creek. The culvert is perched and discharges almost directly into an eroding streambank. A large boulder from the hillslope above the downstream end of the culvert has relocated directly into the culvert opening so as to create an obstacle for fish that attempt to leap into the culvert. Ideally, the culvert should be replaced with a passage-friendly design that requires less artificial reinforcement of the stream bank. However, because the culvert is at a substantial depth from the top of the road surface and is in good condition, we recommend less costly measures, including:

- Removing the boulder;
- Protecting the eroding bank with anchored logs and bioengineering techniques per the Washington State Aquatic Habitat Guidelines Program's "Integrated Streambank Protection Guidelines" (2002); and

- Facilitating fish passage through the culvert by stepping up the stream channel to meet the culvert.

F3: Clarks Fork Culvert Removal – Clarks Fork flows north out of the City of Snohomish and enters the mainstem creek at the wetland mentioned in F1, just upstream of the upstream-most US2 culvert. About 100 meters upstream of this confluence there is a perched culvert that is a total barrier to fish passage. The culvert is on private property just north of the UGA; it currently serves no purpose, since the road it passes under is not in use. Steward and Associates staff have witnessed substantial numbers of coho salmon holding below the culvert, incapable of moving further upstream to areas with good rearing habitat. We recommend working with the landowner, either voluntarily or as a condition for future development, to remove the culvert to allow coho to access upstream habitat.

Bunk Foss Creek Basin: Recommendations



Note: Recommendations focus south of US2 exept for P3

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* Stream classifications per WAC 222-16-030 (see Appendix xx). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

** Wetland classifications per SMC 14.51.070 (see Appendix xx)

Figure III-5

3.5.5 Vision for Future Conditions

Implementing the above recommendations would protect currently functioning habitat in the Bunk Foss Creek basin and would make strategic improvements where they would most benefit fish and wildlife, particularly coho salmon and multiple species of birds found in riparian and forested habitats. Passage improvements would allow fish to access high quality habitat, including the best spawning habitat in the basin. Forest and buffer protections and limits on impervious surface would significantly reduce the negative effects of urbanization on stream conditions and water quality; the remaining effects would generally be more than mitigated by recommended habitat improvements. Chinook and chum salmon, which use the lowest reaches of the creek and adjacent areas in the Pilchuck River, would particularly benefit from R1, which would improve water quality in their habitats by reducing pollutants and the erosion of fine sediments, lowering water temperatures, and increasing secondary productivity. Protected forests and buffers would create valuable open space and natural areas for the people of the City and adjacent property owners, increasing property values.

3.6 Swifty Creek/Blackman's Lake

3.6.1 Programmatic

BPA Vegetation Management. Power lines for the Bonneville Power Administration (BPA) include a wide right-of-way through the Swifty Creek/ Blackman's Lake watershed. BPA has adopted a general management program for its rights-of-way to promote low-growing plant communities, to minimize the long-term costs and environmental impacts of controlling vegetation to protect its power lines (BPA 2000). The City should encourage BPA to implement this program in a timely manner, particularly in this watershed. Replacing grass with low-growing vegetation should improve lake water quality, in part by reducing habitat for Canadian geese.

3.6.2 Protection Priorities

Protection recommendations are described in Figure III-6.

P1: Riparian and Wetland Buffers – The Swifty Creek watershed shows a gradient of increasing urbanization from upstream to downstream. Blackman's Creek flows through low-density properties and a wetland before emptying into Blackman's Lake. Residences surround most of Blackman's Lake. Downstream of the lake, the creek flows through residential lots before entering an underground pipe in the Snohomish Freshman Campus downstream of 9th Street. To the greatest extent possible, new development should not be allowed within 100 feet of the creek and adjacent wetlands upstream of the lake. A buffer of this size is generally effective at removing pollutants and controlling fine sediments, the two most important functions to help protect the lake's water quality. Livestock, which currently typically have direct access to the lake and the streams above it, should be fenced out. Downstream of the lake, a 50-foot buffer is adequate, since the creek does not support anadromous salmon and the primary water quality concern is bacterial pollution. (See F2 below for more details on the ability of the creek to support salmon.) Where development already exists within these buffers, redevelopment should not encroach further on the creek. As to buffers around the lake itself, the existing 75-foot buffer should be adequate. Since many private properties around the lake are built-out with lawns extending to the shore (as is also true for park property), the size of the regulatory buffer is less important than restoring vegetation along the lake's edge. Not only would this improve fish and wildlife habitat and the filtration of pollution and fine sediments from upland areas, it would also discourage geese populations. Geese are drawn to open lawns and are a major contributor to water quality problems in the lake, including high levels of fecal coliform and phosphorus.

3.6.3 Habitat and Water Quality Restoration

Habitat and water quality recommendations are illustrated in Figure III-6.

R1: Wetland at Swifty Creek Inlet to Blackman's Lake – The wetland located at the main inlet to Blackman's Lake is critical to removing sediment, nutrients, and toxicants from flows entering the lake, especially from storm events. We recommend further characterization and study of this wetland to determine its restoration needs and potential. At a minimum, restoration would include planting native vegetation, but may also include constructing a more sinuous channel, which likely could improve wetland functions and water quality in the lake.

R2: Blackman's Lake Water Quality – In the early 1990s, a restoration plan was developed for Blackman's Lake, which focused on protecting the lake's water quality (KCM 1994). The primary goal of the plan was to halt the lake's trend toward eutrophication by reducing its phosphorus levels. Though concerns raised in the plan generally remain valid, few of its recommendations have been implemented. Many of its programmatic recommendations – concerning erosion control, stormwater management, road maintenance, public education and technical assistance to landowners – are similar to those in Chapter 4 of this Strategy. The lake restoration plan included alum treatment to reduce the release of phosphorus from lake sediments. This likely would provide immediate benefits to water quality that would decline with time (the plan estimated benefits could be detectable for as long as 20 years). It also would entail risks to aquatic biota, primarily through lowering the pH of the lake. The plan also recommended a variety of capital improvements to reduce erosion and the delivery of fine sediments to the lake. Some of these may still be valuable today. In particular, the conversion of roadside ditches to bioswales is generally a cost-effective means to reduce fine sediments and pollutants in stormwater.

3.6.4 Fish Passage Restoration (Not Recommended, Due to Costs)

F1: Swifty Creek Daylighting- Seattle University students have studied the feasibility of several alternatives for restoring conveyance capacity and passage for anadromous fish in lower Swifty Creek:

Freshman campus alternatives:

- Open natural channel; or
- Upgrading existing storm drain facilities.

Downstream of freshman campus alternatives:

- One storm drain pipe and one channel pipe to Pilchuck River;
- Open concrete box channel to Pilchuck River; or
- Open natural channel to Snohomish River.

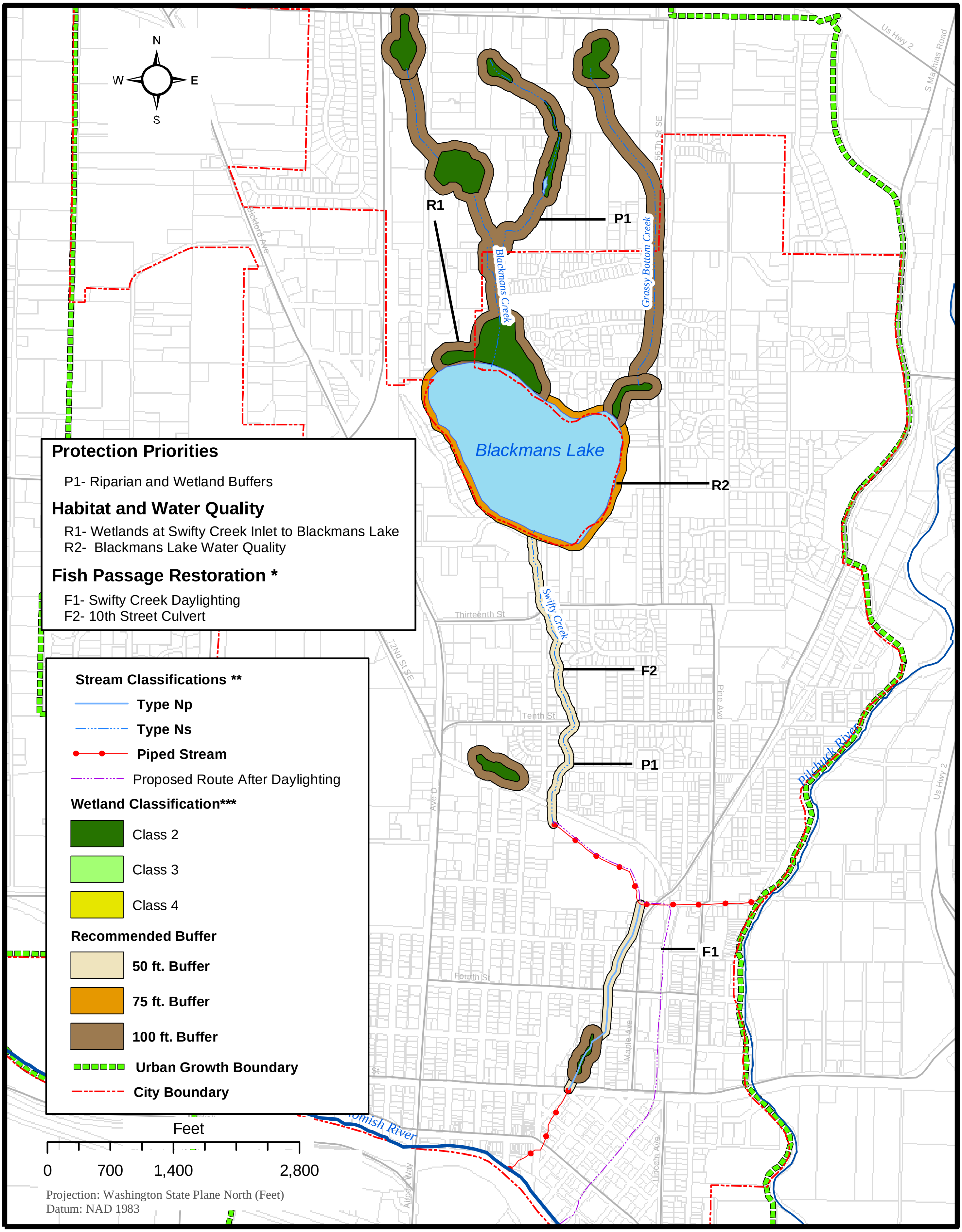
The Seattle University study (2003) recommended constructing an open channel through the freshman campus and along the old railroad grade to the Snohomish River, where a fish ladder would be installed to facilitate upstream passage. This was the most expensive alternative, estimated to cost approximately $2.1 million. This is likely a significant underestimate, because it does not include cost estimates for right-of-way acquisition, utility relocation, and fish ladder construction.

We concur that an open channel design through the freshman campus and along the old railroad grade would provide some usable fish habitat. However, the benefits to fish from this action would be far less than could be achieved through less costly investments in any other stream basin in the UGA by implementing recommendations in this Strategy. Stream habitat is very poor throughout the Swifty Creek basin. Even if physical habitat were restored, however, the creek commonly dries up in the summer below Blackman's Lake and for most of the area above it. During these conditions, the lake provides poor refuge for salmon, since it stratifies during warmer weather into a warm upper layer and a lower layer with very low oxygen levels. Some trout stocked by the Washington Department of Fish and Wildlife have survived recent summers, but the lake system does not appear to support natural production (Pfeifer, 2004). Implementation of the lake restoration plan, including alum treatment, would probably improve oxygen levels in the short-term, but Blackman's Lake would continue to provide very sub-optimal habitat for salmon through the summer. Moreover, the stocked trout as well as resident bass, yellow perch and cutthroat trout would likely prey heavily on juvenile salmon attempting to rear in the lake.

Blackman's Lake can continue to provide a trout fishery, with regular restocking. However, even with restoration of stream conditions and river access, the Swifty/Blackman's system would likely support little, if any, sustainable returns of coho salmon. In fact, salmon drawn into the system to spawn would likely survive in much smaller numbers than they would if they spawned elsewhere.

F2: 10th Street Culvert – The downstream end of the 10th Street culvert is perched approximately 1-2 feet above the stream channel. If anadromous fish passage is restored to the basin, we recommend stepping up the stream channel to match the culvert height, being careful to use substrate sizes large enough to stay in place during high flows.

Swifty Creek Subbasin: Recommendations



*** Not Recommended, Due to Costs**

** Stream classifications per WAC 222-16-030 (see Appendix xx). Type F streams include areas above blockages that the ESA Strategy recommends removing, to the upper-most point fish are expected to reach

*** Wetland classifications per SMC 14.51.070 (see Appendix xx)

Steward and Associates 2004

Figure III-6

3.6.5 Vision for Future Conditions

Implementing the above recommendations would improve water quality in Blackman's Lake, benefiting trout that are stocked there annually. Many species of birds would also benefit from improvements to riparian, wetland and aquatic habitat. Improved water quality would increase the recreational and aesthetic value of the lake for the people of the City and particularly adjacent property owners, who would see their property values increase accordingly. Reductions in bacterial contamination would contribute to efforts being led by the Washington Department of Ecology to reduce such contamination in the Pilchuck River and the lower Snohomish River (WDOE 2003).

4 REVIEW OF CITY ACTIVITIES

Using the recommendations for each stream basin discussed in the previous chapter, this chapter assesses the most important City activities that affect fish and wildlife habitat and prioritizes recommended actions. Priorities are based first on likely benefits to chinook salmon, but more generally on the importance of the action in achieving the "Vision for Future Conditions" discussed for each stream basin in the last chapter.

4.1 City Activities Most Affecting Chinook Salmon

When chinook salmon are in freshwater, they mostly spawn and rear in large rivers; if they enter small creeks at all, it is typically for relatively short periods of juvenile rearing and as refuge habitat, often to escape high river flows. Since all chinook in the Snohomish River basin must migrate through the City's Urban Growth Area using the lower Snohomish River both as adults and juveniles, the Snohomish River study area affects far more chinook than any other part of the UGA. Most of the fish using this area remain in the main channel and so are relatively unaffected by activities the City can control. Some attempt to rear in habitats along the river's edge, however, and more would almost certainly do so with an increase in the quantity and quality of rearing habitat in this stream segment. Improving rearing conditions in the lower Snohomish River is among the highest priorities in the draft WRIA 7 salmon recovery plan for the Snohomish River basin, as discussed in Chapter 2. City activities most important to addressing this issue are:

- Permit conditions on development along the Snohomish River;
- Mitigation for the City's own activities near the river;
- Maintenance practices for riverbanks the City owns; and
- Habitat restoration projects the City may undertake in partnership with others.

Less important City activities include stormwater and wastewater practices, which affect the quality of rearing habitats in the Snohomish River study area through their effects on water quality. (This assumes that the City is already in compliance with the Clean Water Act's prohibition against toxic discharges.)

After the Snohomish River, the other four basins within the City's UGA rank in the following order for their importance to chinook: the Pilchuck River; Cemetery Creek; Bunk Foss Creek; Blackman's Lake/Swifty Creek. In general, recommendations for City activities affecting the Pilchuck River are similar to those for the Snohomish River. The lower Pilchuck River is a "Second Tier" area for restoration in the WRIA 7 plan, which means it is a lower priority than "First Tier" areas like the Snohomish River but is still considered probably necessary to meet recovery goals for chinook, particularly for spatial distribution and genetic diversity. The City operates a dam at River Mile 26.4 on the Pilchuck River, where the City receives most of its water supply. The ESA Strategy includes unique recommendations there concerning fish passage and low flows. Based on field surveys and the general habitat preferences of chinook, some juvenile chinook use the lowest portions of Cemetery and Bunk Foss Creeks as rearing and refuge habitat;

they probably also disproportionately use areas in the Snohomish and Pilchuck Rivers near the mouths of both creeks, in part because the creeks contribute nutrients, insects, and other inputs to the main channels. Chinook do not use Swifty Creek and probably do not disproportionately use the area in the Pilchuck River near its mouth, since its outlet is a pipe perched well above the river under most flows.

Though at the WRIA scale Cemetery and Bunk Foss Creeks are less important to chinook than the rivers, they are also areas where the City's actions have a much greater proportional affect on conditions – particularly in Cemetery Creek, where more than half of the drainage basin is within the City's UGA. Though restoration and protection of in-stream and riparian habitat could help improve rearing conditions for chinook in the lower reaches of both creeks, only part of lower Cemetery Creek is within the City's UGA, while none of lower Bunk Foss Creek is. The City can improve conditions in lower Cemetery Creek through permit conditions on development, mitigation for its own activities (e.g., expansion of its wastewater treatment plant), and habitat restoration projects it may undertake in partnership with others. To improve physical rearing conditions in lower Bunk Foss Creek, the City is largely limited to advocating that others take action. For both creeks, however, City activities can significantly affect upstream conditions, which affect the lower reaches as well as confluence areas with the rivers. Most importantly, this would involve permit conditions on development, including stream and wetland buffers, stormwater management and forest retention requirements. Providing education and technical assistance to landowners who wish to make these improvements voluntarily would augment regulations and increase the likelihood that improved habitat is maintained and connected in larger systems. Maintenance of City stormwater facilities and roads also can significantly affect the amount of pollutants and fine sediments entering streams and ultimately reaching waters used by chinook.

4.2 Priority Activities Based on Criteria Other than Benefits to Chinook

For the Snohomish and Pilchuck Rivers, priority actions to benefit chinook salmon would address most other aspects of the City's vision for future conditions, since these actions would benefit many other fish and wildlife species (including multiple species of salmon) and would make city parks and open space along both rivers more attractive and valuable to residents and visitors. However, many potential improvements could be made to Cemetery, Bunk Foss and Swifty Creeks and Blackman's Lake that would create better fish and wildlife habitat, as well as more attractive and valuable natural areas for residents and visitors, without greatly affecting conditions for chinook salmon. The most obvious of these improvements are stream and wetland restoration projects in areas not used by chinook, including removal of blockages to fish migration. Even actions that provide benefits to chinook downstream provide substantially greater benefits to fish and wildlife species in their immediate vicinity. This includes permit conditions on development, education and technical assistance, and improved City maintenance practices. Coho salmon, which spawn and rear in small streams before migrating to sea, will generally be the fish benefiting the most from City actions to improve habitat in Cemetery and Bunk Foss Creeks. Many species of birds and some mammals will also benefit from these actions, as will freshwater mussels and crayfish found in lower

Cemetery Creek. Birds and some small mammals would benefit from improvements to Swifty Creek and Blackman's Lake, as would rainbow trout that are stocked in the lake in the spring.

Based on the above reasoning, the following City activities are critical components of the ESA Strategy, listed in the approximate order of their importance:

- Development Regulations: Buffers, Stormwater Standards, Other Issues
- Habitat Acquisition and Restoration
- Maintenance of Riverfront and Park Property
- Stormwater Management Programs and Projects
- Pilchuck Dam Operations and Improvements
- Technical Assistance for Community-Based Stewardship
- Road and Other Public Works Maintenance

The remainder of this chapter reviews these activities in more detail.

4.3 Detailed Review of City Activities

4.3.1. Development Regulations: Buffers, Stormwater Standards, Other Issues

Most land within the City's UGA on the Pilchuck River, the south bank of the Snohomish River and the three creeks is privately owned. Development or redevelopment of these parcels is therefore subject to the City's regulations, or will become so upon annexation. Though most of the land along the rivers is built out, the large majority along the creeks and in the areas that drain to them is either undeveloped or underdeveloped. City regulations – particularly for buffers, stormwater management and forest retention – will therefore have an enormous effect on the future health of these systems. Even along the rivers, over time regulated redevelopment should provide opportunities to improve the ecological functions of riverbanks within the UGA significantly.

4.3.1.1 Buffers and Shoreline Regulations

As discussed in the individual basin reviews, the City should establish buffers of 100 feet, measured from the top of the streambank or wetland edge, on either side of:

- The mainstems of Cemetery and Bunk Foss Creeks;
- All other parts of these creek systems used by salmonids;
- All wetlands within stream riparian areas or that meet other criteria for Class 2 wetlands, per SMC 14.51.080 (we did not identify any Class 1 wetlands within the UGA); and
- Swifty Creek above Blackman's Lake (to help protect lake water quality).

This recommendation is based on research concerning the multiple ecological functions riparian areas play, which include shade, erosion control, filtration of pollutants from upland areas, recruitment of woody debris into stream channels, creation of cooler microclimates, and wildlife habitat (May 2000). One hundred-foot buffers with mature native vegetation (typically mostly conifers, outside of channel migration areas and some wetlands) are generally sufficient to provide the maximum shade expected under natural conditions for streams and wetlands (CH2M Hill 2000). They generally also provide maximum or near-maximum levels of streambank stabilization and associated erosion control (Knutson and Naef 1997). They are estimated to provide approximately 80% of the maximum capacity of riparian areas to filter pollutants and fine sediments from upland areas. They provide approximately 93% of the maximum woody debris recruited to stream channels (CH2M Hill 2000). They are not as effective at creating cooler microclimates and providing optimal wildlife habitat, both of which require substantially larger areas.

The larger a stream channel is, the less impact a riparian zone of a given width will have on conditions within it. For example, mature riparian zones can provide near-total shade for small streams, while they may shade only a small part of a big river. More generally, the proportion of water, sediment, wood and nutrients from upstream rather than adjacent areas is much greater in big rivers than in small streams. A 100-foot buffer would therefore have a substantially greater impact on Cemetery Creek than on the Snohomish River. This is not to say that a 100-foot buffer would be of little value for the Snohomish River, or that an even wider buffer would not provide greater value. But the influence of shoreline vegetation on the physical, chemical and biological characteristics of the adjacent channel attenuates as one gets farther from a water body, and the rate of attenuation increases with stream size.

Two additional facts provide further important context for considering how best to regulate development along the Snohomish River, in particular: 1) the banks along both sides of the Snohomish River within the City's UGA are heavily reinforced; and 2) the City owns most of the land immediately adjacent to the river's right bank through this reach. As stated previously, based on the WRIA 7 plan, the most important ecological goal for both rivers within the UGA is to increase the quantity and quality of juvenile salmonid rearing habitat. The City should regulate development along the rivers to help meet this goal over time under the guidelines discussed below, using the update of the City's Shoreline Management Plan as an opportunity to clarify mechanisms for accomplishing that.

Under Washington State's Shoreline Management Act, any development in the UGA within 200 feet of either river with a market value of greater than $5,000 (adjusted for inflation after July 1, 2007) requires a "substantial development permit" (RCW 90.58.030(3)(e)). In administering these permits, the City should make the first 100 feet from the ordinary high water mark or floodway a "restoration zone", where the following conditions generally apply:

- No further encroachment by buildings and impervious surfaces beyond existing conditions should be allowed in the first 50 feet, except to provide or enhance public access to the rivers;

- No further encroachment by buildings and impervious surfaces beyond existing conditions should be allowed in the next 50 feet, except for water-related or water-dependent businesses;
- All development and redevelopment within the restoration zone, even if it does not increase encroachment on the rivers, should contribute toward revegetation of the zone and its associated riverbank, with greatest emphasis on revegetation near the river (where riverbanks have been artificially reinforced, this work should follow Washington State's "Integrated Streambank Protection Guidelines", as discussed in more detail later in this chapter, under "Maintenance of Park and Riverfront Property");
- In addition, any development or redevelopment that increases encroachment within the restoration zone should contribute toward projects to enhance salmonid rearing habitat in the rivers, as identified in Chapter 3.

The ecological goals for restoring riparian areas are to provide shade, cover and food sources (insects and litter fall) for rearing areas and habitat along the river's edge. Restored riparian areas also will provide bird and other wildlife habitat, will be less prone to bank failure and the erosion of fine sediments into the river, and over time will contribute woody debris to the river, enhancing salmon rearing habitat. Mitigation for encroachment or for other development in the restoration zone should relate to the amount of ecological function that is lost, including the loss of future restoration opportunities.

Public access to the rivers should be regulated by designating and improving a limited number of locations where access is allowed or encouraged, such as the trail along the Snohomish River below the downtown area. As recognized under the Shoreline Management Act, rivers serve multiple purposes, including human recreation and water-dependent businesses, in addition to ecological functions. It is unrealistic to prohibit all human access to rivers and their riparian areas, particularly within cities. The City can, however, use signs, plantings and other means (including fencing, where necessary) to restrict human access to the ecologically most sensitive areas. To be effective in areas frequently used by the public, including city parks, these actions should be accompanied by constructing improvements that make access to other locations easier, including trails, viewing areas and steps on steep slopes.

We are not recommending buffers greater than 100 feet in Cemetery and Bunk Foss Creeks primarily for these reasons:

- For chinook, the most important ecological functions that creek riparian areas provide are shade, erosion control and filtration of pollutants and fine sediments. One hundred feet should be sufficient for these functions, if supplemented with other actions to protect water quality.
- Since the first 100 feet of riparian areas provides the large majority of woody debris to streams, this should also be sufficient to provide significant improvements to habitat complexity and other factors benefiting coho salmon, which spawn and rear in the mainstems of Cemetery and Bunk Foss Creeks

(though significant barriers to migration must be removed in Cemetery Creek before they can take advantage of areas upstream of SR9). This is particularly true if in-channel wood is directly augmented, as recommended for both creeks.

- While 100-foot riparian areas are sub-optimal for microclimate benefits and wildlife habitat, the latter is more heavily affected by the continuity of buffers than their width and both of these functions can generally be improved substantially over current conditions with restoration within 100-foot buffers. The city must balance multiple goals in its land use regulations.

To protect water quality in Blackman's Lake, a 100-foot buffer would be valuable on Swifty Creek above the lake to provide erosion control and filtration of pollutants and fine sediment. The existing 75-foot buffer for the lake itself should be adequate. The size of this buffer is less important than restoring vegetation along the lake's edge, since many private properties around the lake are built-out with lawns extending to the shore (as is also true for park property). Restored vegetation would not only improve fish and wildlife habitat and the filtration of pollution and fine sediments from upland areas, it would also discourage geese populations. Geese are a major contributor to water quality problems in the lake, including high levels of fecal coliform and phosphorus.

Fifty-foot buffers are adequate for Swifty Creek below Blackman's Lake, Myricks Fork in the Cemetery Creek basin, Collins Creek in the Bunk Foss Creek basin (upstream of salmon spawning and rearing areas) and isolated wetlands. The smaller buffer recognizes the lower ecological value of these water bodies, the degree to which existing development already generally encroaches on them, and the City's need to balance multiple goals in its land use regulations. Restoration of riparian areas for these water bodies would still be of significant value, however, both as habitat for birds and other wildlife and for benefits downstream. Buffers are not necessary for the portions of Swifty Creek that are piped, given how unlikely it is that these areas will be "daylighted".

Exceptions to all these buffers may be necessary to ensure landowners can make some reasonable use of their property, to accommodate linear public projects (such as roads and utility lines) that have no reasonable alternative but to encroach on buffers or sensitive areas, or to meet other compelling City priorities. However, exceptions should be kept to a minimum and should be appropriately mitigated.

4.3.1.2 Stormwater Standards

The City's current stormwater standards are based on the Washington Department of Ecology's 1992 stormwater management manual. These standards were written to help implement the 1991 Puget Sound Water Quality Management Plan; they were not written to meet requirements of the Clean Water Act or to support recovery of salmon listed under the Endangered Species Act. To address these issues, the Department of Ecology issued an updated stormwater manual in 2001 (WDOE 2001). Standards for stormwater detention in the updated manual are designed to reduce erosion and protect salmon habitat by limiting the duration of flows that tend to cause erosion in typical Western

Washington streams. Appendix I provides further details on key requirements in the updated manual, as well as some of the major criticisms that have been made of them.

The updated manual serves as a guideline for stormwater requirements in state and local development permits; compliance with the manual is not legally required. However, terms for NPDES permits for "Phase II" municipal stormwater programs (for urban jurisdictions with populations below 100,000, such as the City of Snohomish) are currently being negotiated. Final permits will include minimum standards for stormwater requirements for new development and redevelopment, which may require compliance with the 2001 manual or its equivalent. Even if the standards provide more flexibility, they will most likely be stricter than Ecology's 1992 manual. Jurisdictions will probably have the full five-year terms of their permits to comply with the new standards.

Perhaps the most fundamental criticism made of the 2001 manual, raised by the state's Independent Science Panel (ISP), is that its "one size fits all" approach does not take into account the actual costs and benefits of its standard requirements, which can differ dramatically in different areas (ISP 2003). The ISP found that Ecology's manual provides the best available generic standards to protect salmon habitat, but recommended using watershed analyses to tailor more expensive requirements to where they will provide the greatest benefits. This is particularly relevant to redevelopment in already urbanized areas, which generally would face the greatest expense meeting Ecology's standards. This could create disincentives to redevelop already urbanized areas even though growth management and watershed goals favor concentrating growth there.

Full compliance with Ecology's new standards across entire stream basins is not possible, since smaller developments are exempt, and would take generations to approach, given the pace of redevelopment. Even with maximum compliance under ideal conditions, the ISP stressed that Ecology's standards would still not address two major hydrologic impacts of growth – reduced baseflows and increased total storm volumes, because developed land generally cannot match the infiltration and evapotranspiration rates of forests. Ecology acknowledges these criticisms in the manual. It encourages basin plans to propose alternative requirements to the manual and encourages forest retention in site plans and permit requirements to increase infiltration and evapotranspiration rates.

The City should adopt Ecology's 2001 stormwater manual, with some exceptions or clarifications as follows. For the management of stormwater quantity, the City should:

- Require maximum infiltration of stormwater wherever feasible, except where the City determines it may cause soil instabilities or drainage problems downstream (this is consistent with the 2001 manual, but we would specify that the City should require studies to determine the feasibility and likely consequences of infiltration in areas identified as having soils with rapid or moderately rapid permeability).
- Eliminate detention (not water quality) requirements for development and redevelopment in the Snohomish and Pilchuck River study areas, because this should actually reduce the City's contribution to high flows in the rivers, which

are delayed by originating much further upstream. This also avoids creating disincentives for development and redevelopment in some of the most heavily urbanized parts of the City, where meeting the 2001 detention requirements are generally more expensive than in less developed areas.

- Require that development and redevelopment in the Swifty Creek basin below Blackman's Lake not increase peak stormwater discharges from existing levels, rather than meet the 2001 manual's standard of matching the duration of erosive discharges from pre-Euro-American conditions (100% forested, in most cases). The 2001 manual standard is designed to minimize impacts to salmonid spawning areas, and Swifty Creek does not support naturally spawning salmon. The proposed standard helps minimize flooding along Swifty Creek while avoiding disincentives for development and redevelopment in some of the most heavily urbanized parts of the City.
- Apply Ecology's 2001 detention standards to new development in the Cemetery Creek basin, but offer incentives for "low impact" approaches to development (such as permeable pavement, green roofs, reduced road widths and site designs that use natural topography and vegetation to manage stormwater). Incentives should provide a credit against detention requirements for increased infiltration and reductions in stormwater volumes. Redevelopment in the Cemetery Creek basin should be allowed to pay a fee in lieu of constructing stormwater facilities, which the City can put toward regional facilities serving multiple properties.
- Apply Ecology's 2001 detention standards to new development in the Bunk Foss Creek basin upstream of US2, but offer incentives for retaining and replanting forest cover and minimizing impervious surface. Incentives should again provide a credit against detention requirements based on increases in infiltration and reductions in stormwater volumes. If 65% or more of a site can be dedicated to forest cover, in a location where it will reduce effective impervious surface, no additional detention should be required.
- Applying Ecology's 2001 detention standards for new development in the Blackman's Lake basin, but offering reduced requirements in return for contributions toward implementing the Blackman Lake Restoration Plan (KCM 1994). Since Ecology's standards are focused on reducing erosion, which is a major source of phosphorus loading to the lake, they would contribute toward meeting the restoration plan's goal of reducing phosphorus levels in the lake. Implementing other recommendations in the plan could help attain those goals faster and for a longer term.

For the management of stormwater quality, the City should use Ecology's 2001 manual as a general guide for requirements to be placed on new development and redevelopment. However, the ISP noted that tests to establish acute and chronic levels of toxicity for pesticides, metals, hydrocarbons from road runoff and other toxicants have generally evaluated the direct and indirect effects of single chemicals, using test species that are not necessarily the most relevant for Northwest ecosystems. The tests have generally not evaluated the combined effects of multiple chemicals and many potential toxicants have not been evaluated at all. Moreover, a treatment standard that is based on annual runoff, such as Ecology's, will not necessarily address water quality problems when they are probably most acute, which is after storms in the late summer, when flows are low and high temperatures are already stressing fish. For these reasons, Ecology's manual should not be the only guide for the stormwater quality treatment required for new developments and redevelopments. Another source of useful guidance that the City can suggest to developers is Stormwater Treatment: Biological, Chemical and Engineering Principles (Minton 2002).

The City should use a functional standard for evaluating water quality treatment proposals, aimed at addressing the pollutants of greatest concern. For salmon, these are generally the following:

- Hydrocarbons from road and parking lot runoff;
- Metals, particularly copper, cadmium, lead and zinc, each of which has tested above water quality standards in City streams in the past (RW Beck 2001), though Steward and Associates found no violations in 2003 (see Appendix F);
- Pesticides and herbicides; and
- Fine sediments, which can interfere with respiration and suffocate incubating salmon eggs.

More information on chemicals of greatest concern for salmon may soon be available from studies being led by NOAA Fisheries that are exploring reasons for pre-spawning mortalities of coho salmon in lowland Puget Sound streams.

In addition, two other pollutants are of particular concern for the City:

- Phosphorus, particularly in the Cemetery Creek and Blackman's Lake basins. High levels of phosphorus contribute to low dissolved oxygen levels in key locations in the Cemetery Creek basin (see Chapter 2, Figure II-7). The Blackman's Lake Restoration Plan is focused on reducing phosphorus inputs to avoid premature eutrophication of the lake (KCM 1994)
- Fecal coliform, for which all of the City's streams at least occasionally violate state water quality standards. This is not unusual for streams in an urban area, but it raises health concerns where potentially faulty septic systems are located either upstream of human activity centers, such as Blackman's Lake, or in areas with relatively permeable soils, as is true for much of lower Cemetery Creek.

The Department of Ecology is developing a plan to address violations of fecal coliform standards in the lower Snohomish River and its major tributaries, including the Pilchuck River (WDOE 2003). Though fecal coliform from the City's stormwater is a relatively minor contributor to the regional problem, which Ecology believes is mostly due to livestock and faulty septic systems in rural areas, the City is responsible for addressing its share of the problem.

4.3.1.3 Other Issues

Other important issues for development regulations, as identified in the 4(d) rule governing Puget Sound chinook salmon, include the following:

Sensitive Areas: In addition to streams, wetlands and other areas of high habitat value for fish and wildlife, a jurisdiction's regulations must protect other sensitive areas, such as unstable slopes, frequently flooded areas and areas with high potential restoration value. Examples of the last category are identified in the basin studies in Chapters 2; they should be adequately protected through the recommendations discussed above and in Chapter 3. Unstable slopes should be protected through the City's critical area protections for geologically hazardous areas. Snohomish County is currently working with the Federal Emergency Management Agency to update maps of frequently flooded and geologically hazardous areas (including unstable slopes) throughout the county. Though the City should update its protections for these areas when new information is available, the recommendations in this chapter should adequately protect their habitat values.

Channel Migration Zones: The City should protect the ability of stream channels to meander naturally across their floodplains, which promotes gravel recruitment, geomorphic diversity, and habitat development. As noted in Chapter 2, both the Snohomish and Pilchuck Rivers have essentially no ability to migrate through the UGA, due to artificially and naturally hardened banks. The most promising opportunities for setting back existing levees are on the Pilchuck River just outside of the UGA, as shown on Figure III-3. Recommendations in this chapter under "Maintenance of Park and Riverfront Property" below describe actions the City can take to improve habitat values related to riverbanks within the UGA, but opportunities to increase geomorphic diversity are very limited. While Cemetery and Bunk Foss Creeks are not likely to migrate significantly, the buffers recommended in the ESA Strategy would protect their ability to do so.

Stream Crossings: New stream crossings for roads or utilities should be minimized and avoided, where possible. The City has successfully avoided any new road crossings of Cemetery Creek in its conceptual plan for development of the Bickford area. The other location in the UGA where new stream crossings may be considered in the foreseeable future is along Clarks Fork in the Bunk Foss basin, as development occurs between Pine Avenue and North Ridge Drive. As the City updates its transportation plan, it should commit to keeping new stream crossings there to a minimum.

Preserving Hydrologic Capacity: The City should maintain the ability of both perennial and seasonal streams to pass peak flows. This is partly a corollary to avoiding new stream crossings, which typically involve placement of fill in the floodway. The City should also prohibit fill anywhere in the floodway; necessary exceptions (for utilities, etc.) should ensure no net loss of floodway capacity through mitigation.

Natural Landscaping: The City should specify native vegetation for all landscaping or revegetation it requires and should discourage use of pesticides and herbicides. This is consistent with recommendations in the ESA Strategy for buffer protections, forest retention and riparian restoration projects. The City's stormwater program and other public education activities (discussed below) should also help address these issues.

Erosion and Sediment Control: In addition to the stormwater management recommendations above, the City should ensure that construction sites minimize discharges of sediment and pollutants. This can be accomplished by seasonal work limits, clearing land in phases, protecting native topsoil and other strategies identified in Volume II of Ecology's Stormwater Manual, which is focused specifically on controlling stormwater from construction sites. The City should include recommended strategies in an update of its erosion control ordinance.

Water Supply: The City should ensure that its demand for water will not affect flows needed by salmon. These issues are addressed below in the discussion of the City's dam on the Pilchuck River.

Monitoring, Enforcement and Reporting: The City should monitor its implementation of the ESA Strategy, as discussed in more detail in Chapter 6 on monitoring and adaptive management. The City should also commit adequate resources to reviewing development proposals and inspecting developments during and after construction to ensure compliance with regulations, including stormwater requirements. Developments could pay a deposit to fund these inspections, with unused funds returned to the developer.

Compliance with Other Federal and State Environmental Laws: The ESA Strategy is designed to ensure the City is also in compliance with the Clean Water Act, the Growth Management Act, the Shoreline Management Act and other applicable environmental laws.

4.3.2 Habitat Acquisition and Restoration

The City should use grants, stormwater fees, park funds or other funding sources to acquire and restore habitat. Habitat acquisition and restoration may also be accomplished in conjunction with other programs, such as mitigation for development, mitigation for the City's own capital projects, enhancement of stormwater projects, maintenance of riverfront property and technical assistance for community-based stewardship.

Chapter 3 identifies and prioritizes habitat and water quality restoration projects and fish passage projects for each basin study area. The recommended projects are shown across the UGA on Figure III-1 in Chapter 3, with restoration and fish passage projects shown in priority order for each basin, based on best professional judgment. We have weighed likely costs and benefits in our judgments of priorities, but only qualitatively, in part because the expected costs for projects differ widely (some would probably cost more than $1 million, while others might cost little more than a few days of staff or volunteer time). In many cases, rather than follow a priority order, projects are more likely to be implemented as opportunities arise, based on mitigation requirements for public or private projects, the availability of grant funds for particular purposes and other contingencies.

Based on the reasoning at the beginning of this chapter, we would suggest the following priorities across the five basins in the UGA:

- Projects on the Snohomish River
- Projects on the Pilchuck River
- C1 – Restoration at the Mouth of Cemetery Creek
- B1 – Restoration on Lower Bunk Foss Creek
- CF1 – Removal of Passage Constriction at Dam on Cemetery Creek
- BF2 – Removal of Passage Barrier at 52nd St. on Bunk Foss Creek (BF1 is not listed because it is a small maintenance project, which will probably need to be performed multiple times)
- BF3 – Removal of Passage Barrier at Clarks Fork Culvert on Bunk Foss Creek
- C2 – Realignment of Cemetery Creek and Restoration of BPA Wetland
- C3 – In-Channel Wood Augmentation in Cemetery Creek
- B2 – In-Channel Wood Augmentation in Bunk Foss Creek
- Remaining Cemetery Creek restoration and passage projects
- Swifty Creek/Blackman's Lake projects

It is important to note that priorities 3 to 7 are all outside of the UGA, so the City may be unable to perform them itself. Priority 8, discussed at some length on page III-11, is also far too expensive for the City to construct without partners.

The top priority projects, on the Snohomish and Pilchuck Rivers, probably cannot be funded with stormwater fees. Creek habitat projects can be considered mitigation for the effects of stormwater, but the City's stormwater has little affect on the conditions that river restoration projects are intended to address. Moreover, river projects tend to be expensive, partly due to permitting and design costs (land costs are essentially zero for recommended projects on the rivers, which were all chosen in part because they are located on land the City already owns). River restoration projects, therefore, will probably require funding from grants or mitigation. Mitigation funds would likely come from projects along the river shorelines, though it is possible that projects from further away could contribute funds toward restoring rivers downstream, since the impacts and mitigation would be in the same river basin. In general, though, the City should discourage mitigation at a significant distance and substantially different in kind from impacts where they occur, given the degree of restoration and protection needs across the UGA.

The above list does not include programmatic recommendations to restore riparian vegetation and improve riverbank stabilization practices. Riparian restoration for the City's creeks is considerably less expensive than nearly all other recommended restoration projects. Volunteers and property owners can implement smaller-scale projects, as discussed under "Technical Assistance for Community-Based Stewardship" below. Riparian restoration also can be incorporated into development permits and mitigation for capital projects. Priorities for where restoration should be targeted are discussed for each creek basin in Chapter 3.

4.3.3 Maintenance of Riverfront and Park Property

The City owns a substantial amount of property directly on the Snohomish and Pilchuck Rivers, including Cady, Kla Ha Ya, Pilchuck and Morgantown Parks, much of the historic downtown riverfront, the City's wastewater treatment plant and shop yard, and undeveloped land on the Pilchuck River. Since the rivers are where chinook salmon are found in by far the greatest numbers within the UGA, the City's maintenance of these properties is one of the most important activities covered in the ESA Strategy. As used here, "maintenance" does not include projects constructed solely to benefit habitat (part of Section 2 above). Instead, it includes capital projects and ongoing activities, such as management of vegetation, intended to maintain or enhance the ability of artificially reinforced riverbanks to protect property, infrastructure or public safety. Some riverfront maintenance issues relate to more general aspects of park maintenance, so this section will also cover other park maintenance issues important to salmon, including pesticide use.

In general, the edges of rivers, including their immediate riparian areas, contain the most productive fish and wildlife habitat found in river systems. This is partly because river edges are very dynamic in natural systems, most notably when high flows interact with adjacent land to recruit trees or sediment into a river or change a river's location within the floodplain. This dynamism has been almost entirely eliminated on the Snohomish and Pilchuck Rivers as they pass through the City's UGA, where artificial reinforcements essentially lock the rivers in place. The majority of these reinforced banks are not owned or maintained by the City. However, the City has important interests in how all of them are maintained, since reinforced banks it does not own often direct flows against the City's banks with even greater energy.

Though as a general strategy, levees should be set back or removed where feasible, the three best locations for doing so within the study reaches are all outside of the UGA. As discussed in more detail in Chapter 3, all three are on the Pilchuck River: on the right bank below the confluence with Bunk Foss Creek; on the left bank across from Morgantown Park; and on the left bank on Snohomish County park land downstream of the Sixth Street bridge.

Given such limited opportunities to remove or set back levees, the primary goals for the City's maintenance program should be to enhance habitat values in conjunction with maintaining or enhancing the structural stability of the reinforced banks the City owns . What specific actions should be taken at particular places depends on existing levels of structural stability and the reasons for areas of instability. In areas that are generally stable, the City should plant native vegetation, such as willows, alder, cottonwoods and cedar, along and above the riverbank. Non-native invasive plants such as Himalayan blackberry should be removed, using planting fabric to cover bare soils to minimize erosion while new plants establish themselves. After a few growing seasons, the new plants should enhance bank stability, reduce erosion and begin to provide habitat benefits such as cover and insects for fish and wildlife. The City should consider adding anchored "roughness trees" between the high and low water marks in these locations to enhance river habitat, as discussed in the State of Washington's "Integrated Streambank Protection Guidelines" (WSAHGP 2002). Depending on the susceptibility of the locations to scour, the City may be able to remove existing rip rap from them.

In areas of bank instability, the City should first identify the mechanism of potential bank failure (generally either scour or toe erosion) and the likely cause (either site-based, such as a lack of vegetation on the bank, or reach-based, such as a levee on the opposite bank that directs flows into the City's bank, or both). In considering appropriate action, the City should evaluate the habitat potential of the site (e.g., Would the addition of woody debris cause river hydraulics to create pools? Could the slope of the bank be modified to create more shallow edge habitat?). The City must also consider the risks of bank failure (e.g., How likely is it to occur? What would be the consequences of failure to property, infrastructure and public safety?). All of these issues should be considered to identify the best solution.

Where levee toes are unstable, they can be reinforced while improving river habitat with large woody debris, angular rock or both. Where banks can be reshaped, flood "benches" can be dug that increase the hydraulic capacity of a river reach while creating shallow edge habitat during lower flows. Flood benches can include anchored woody debris to add cover and habitat complexity. Portions of benches that are normally above water can be planted with live-stake cuttings of willows, cottonwood, red osier dogwood and other species. The effect of tides on river elevations in the UGA may require some experimentation to determine which species are best-suited to which bank elevations.

The most significant challenge – and opportunity – for the City's riverbank maintenance is just below the downtown area, where the City has the greatest assets to protect and the levee on the opposite bank directs high flows with particular force. If the opposite levee can be modified to reduce the force of these flows, the City should advocate this change to the property owner, diking district and Corps of Engineers. Even with some modification of this levee, rip rap will almost certainly continue to be necessary to protect the City's bank, especially given the serious consequences of bank failure. However, "joint plantings" of willows or other live stakes into rip rap can increase its stability while providing significant habitat benefits. This technique, discussed at some length in the state's guidelines, involves using a backhoe or other heavy equipment to pound a steel rod through breaks in the rip rap to create a pilot hole into underlying soil for the staked plants. Ideally, as much as four-fifths of the stake should be buried in the hole; no more than half should be exposed, to prevent desication and increase the plant's stability during higher flows while it establishes itself. Over time, root systems from the stakes will bind or reinforce soil and prevent the washout of fines between and below the rock. This stabilizes the rip rap, while the upper plant will dissipate some hydraulic energy during high flows and provide cover and insect food sources for fish as well as habitat for birds and other wildlife during low flows. Stakes should be planted in the spring. They will provide limited benefits in their first growing season, but with good survival they will begin to provide substantial benefits by the following fall.

Willow and other stakes are also useful in areas with little or no rip rap that experience some scour during high flows. According to a study cited in the state guidelines, within three to four years of planting, densely planted willows alone can provide erosion protection approximately equal to riprap comprised of "large quarry stone." Staked plants can hold planting fabric in place, giving roots some time to establish themselves. Plants should not be used alone, however, on banks experiencing toe erosion or high levels of scour.

Above the high water mark, restoration of riparian areas should follow the programmatic recommendations in Chapter 3. Restoration of native plant communities in upland areas will also provide habitat for native birds and other wildlife.

Consistent with the City's draft "Integrated Vegetation and Pest Management" policy, the City should generally avoid pesticides when removing non-native invasive species, especially along streams. The City should avoid all use of products containing 2,4-D, carbaryl, diazinon, diuron, malathion, triclopyr BEE, and trifluralin, which are known hazards to salmon in urban stormwater runoff. Within 20-yards of streams or wetlands, the City should avoid using all chemicals that are identified as unauthorized for use in Washington Toxics Coalition et al v. Environmental Protection Agency (W.WA Dist., Seattle, Case No.C01-0132C), consistent with the January 22, 2004, court order.

4.3.4 Stormwater Management

In addition to the stormwater standards to be applied to development discussed in Section 1 above, a variety of other issues relating to stormwater management are important to protect salmon, involving City programs and capital projects. Many of these same issues will need to be addressed in the final National Pollution Discharge Elimination System (NPDES) Phase II permit the City's stormwater program is required to have under the Clean Water Act. Terms for that permit have yet to be determined, as discussed in Chapter 1. However, the issues it must address are listed in Table IV-1, which also shows where they are included in the ESA Strategy. Implementation of the Strategy should ensure compliance with final terms for the City's NPDES permit.

Table IV-1 Addressed NPDES Issues

Issue in NPDES Permit	**Where Addressed in ESA Strategy**
Illicit discharge detection and elimination	This section
Construction site stormwater runoff control	This section
City responsibilities under plans for Total Maximum Daily Loads (TMDLs, which address violations of state water quality standards)	This section
Pollution prevention/good housekeeping	Maintenance of Stormwater Facilities, this section; Maintenance of Park and Riverfront Property, Chapter 3, this chapter; Road and Other Public Works Maintenance, Chapter 7, this chapter
Post-construction stormwater management	Stormwater Standards for Development, Chapter 1, this chapter
Public education and outreach	Technical Assistance for Community-Based Stewardship, Chapter 6, this chapter
Public involvement/participation	Technical Assistance for Community-Based Stewardship, Chapter 6, this chapter
Evaluation of program compliance	Monitoring and Adaptive Management, Chapter 5

Protection of salmon also relates to the following additional issues, the first four of which are also discussed in this section:

- Control of sources of stormwater pollution
- Maintenance of stormwater infrastructure
- Stormwater capital projects
- Intergovernmental coordination for stormwater management
- Inspection and enforcement of stormwater standards (covered in Chapter 1, this chapter)

Issues to be addressed in this section of the ESA Strategy will be reviewed in the order above, starting with the NPDES issues.

4.3.4.1 Detection and Elimination of Discharged Pollutants

The City should identify and map all of its stormwater outfalls, to the extent it has not done so already. It should adopt an ordinance prohibiting non-stormwater discharges into the stormwater system. Except in cases of flagrant and willful violations, or when sanitary sewers discharge into the stormwater system, it should initially address violations through education and technical assistance programs. Source control inspections should confirm that private sanitary sewer lines are properly connected to the public sanitary sewer system. Reports of illicit discharges should be investigated promptly.

4.3.4.2 Construction Site Stormwater Runoff Control

Stormwater runoff from construction sites can contain large quantities of fine sediments in addition to petroleum products, paints and other pollutants. Under NOAA Fisheries standards, most segments of Cemetery and Bunk Foss Creeks within the UGA are currently "Not Properly Functioning" because of high levels of fine sediments (see Appendix G). Substrates for both rivers also include high levels of fine sediment through most of the UGA. In general, the City's existing erosion and sedimentation control standards are good. Volume II of Ecology's 2001 stormwater manual offers many additional Best Management Practices that the City should incorporate by reference. The most important new requirement the City should place on development is to clear land in phases, with tighter restrictions on the length of time soils can remain exposed but not worked from October through April, the period of greatest rainfall. To the extent possible, the City should discourage land clearing during these months. Cleared land not being used should be covered with straw or other erosion protection. Construction sites should be inspected to ensure compliance with their erosion control plan. Complaints concerning turbid runoff from construction sites should be inspected as quickly as possible. Where necessary, stop work orders or other enforcement actions should be taken promptly to bring sites back into compliance.

4.3.4.3 City Responsibilities Under TMDLs

The Department of Ecology has developed a "Detailed Implementation Plan" to address fecal coliform bacterial pollution in the Pilchuck River and other tributaries of the lower Snohomish River. Ecology has identified the primary sources of bacterial pollution in the Pilchuck River to be "livestock access to the stream, inadequate pasture management, and failing on-site sewage disposal systems." The City's implementation of the ESA Strategy should meet its responsibilities under Ecology's plan.

There are no other TMDLs with implementation plans that assign responsibilities to the City. There are, however, other water bodies within the UGA on the 303(d) list for water quality violations. Blackman's Lake is listed for fecal coliform and phosphorus. Ecology would use the Blackman's Lake Restoration Plan as the basis for any TMDL that might be developed for the lake in the future. The ESA Strategy is consistent with this plan and supports lake restoration. The Snohomish River is listed for violating pH standards in the reach below downtown Snohomish. This is likely not an issue that the City would have a primary responsibility to address, but the ESA Strategy should minimize any contributions the City may make to the problem.

4.3.4.4 Source Control

The City should compile a list of existing commercial, industrial, multi-family and government sites that may be significant sources of stormwater pollutants. It should prioritize them based on their potential contribution of the pollutants of greatest concern for salmon, as discussed in Chapter 1 above: hydrocarbons, metals, pesticides, herbicides and fine sediments. Sources within the Cemetery Creek basin should be the highest priority, since that basin has the greatest concentration of potential pollutant sources, it contains juvenile coho salmon year round, and juvenile chinook use the mouth of the creek as rearing and refuge habitat, where they potentially may be found from February through July. For the same reasons, the Cemetery Creek basin should be the highest priority for the City's storm drain stenciling program.

4.3.4.5 Maintenance of Stormwater Infrastructure

The City should adopt maintenance standards for its stormwater facilities, setting thresholds and indicators for when the facilities should be cleaned or repaired. The standards developed by the Tri-County Salmon Conservation Coalition, shown in Appendix J, are a useful starting point for these standards, but can be costly to implement. The City should set it highest standards for facilities that provide detention or water quality treatment, including control of fine sediments, in the Cemetery Creek and Bunk Foss basins. Both basins contain juvenile coho salmon year round, while juvenile chinook use the creek mouths as rearing and refuge habitat. The next highest priority should be on facilities providing water quality treatment for direct discharges to the Snohomish and Pilchuck Rivers. These are not as high a priority as the creeks because the City's stormwater discharge to the rivers is such a small percentage of their total flow, and because salmon in the rivers are generally not concentrated near the City's outfalls. The City should establish inspection schedules for its facilities consistent with these priorities. A sample of catch basins can be inspected to identify areas where further inspection may be necessary. Sampling should include catch basins immediately upstream of any stormwater outfall.

4.3.4.6 Stormwater Capital Projects

For the foreseeable future, by far the largest stormwater-related capital project that the City expects to undertake is the separation of its storm and sanitary sewers where they are currently combined (Figure II-1 in Chapter 2 identifies this area). The separation project is required under a consent decree concerning violations of the City's NPDES permit for its wastewater treatment plant. The decree recognizes that the City cannot fund actual construction of the sewer separation project without outside assistance, the timing of which is uncertain.

If this project was evaluated strictly on the environmental criteria set out at the beginning of this chapter, it would be a lower priority than many of the habitat and water quality projects recommended in this Strategy. Treatment of low-to-moderate volumes of stormwater that do not cause overflows at the wastewater treatment plant almost certainly leads to removing more pollutants from stormwater than is typically accomplished by much of the City's separated stormwater system. Combined sewer overflows, caused by high volumes of stormwater that overwhelm the treatment plant's capacity, will tend to occur when flows are higher than normal in the Snohomish River, thus diluting pollutants that are discharged. (However, the river generally rises slower than the City's creeks because it is drawing from a much larger area, where the greatest precipitation falls many miles upstream, taking time to reach the City.)

Nevertheless, implementation of the sewer separation project creates some valuable opportunities to experiment with low-impact approaches to stormwater management, which could take advantage of the wide City right-of-way in much of the area with combined sewers. The City should review Seattle's experience, in particular, in implementing low-impact and "natural drainage system" approaches to stormwater management, as demonstrated in its SEAStreet, High Point and Broadview projects. Even when located on till soils, these approaches have almost eliminated stormwater runoff from storms up to 2-Year events (which cumulatively cause the greatest harm to salmon). However, stormwater from most, if not all, of the combined sewer area would naturally drain directly to the Snohomish River, where this affect on flow volumes would provide minimal benefit. Nevertheless, the projects benefit water quality, reduce local drainage problems and can be less expensive than stormwater pipes and vaults. They also provide benefits for neighborhood aesthetics and can even help reduce traffic speeds (where they modify otherwise linear streets). Lastly, lessons from experiments with low-impact designs in the combined sewer area could also be applied in the Cemetery Creek and Bunk Foss basins, where managing stormwater volumes will be critical as undeveloped land is urbanized.

Aside from the sewer separation project, the City should build habitat features into its other stormwater capital projects, including the use of low-impact approaches that take advantage of natural features in the landscape, as discussed in the Puget Sound Action Team's "Natural Approaches to Stormwater Management: Low-Impact Development in Puget Sound" (PSAT 2003). Woody debris, bioengineering and native vegetation should be used in all streambank stabilization projects. These techniques are discussed in more detail in Washington State's "Integrated Streambank Protection Guidelines" (WSAHGP 2002). Existing detention facilities should have water quality treatment added to them, where feasible, targeting the Cemetery Creek basin first, for reasons discussed under "Source Control" and "Maintenance of Stormwater Infrastructure" above. Where feasible, unvegetated drainage ditches in high traffic areas should be converted to bioswales, as discussed in the Cemetery Creek recommendations.

4.3.4.7 Intergovernmental Coordination for Stormwater Management

The City should coordinate with Snohomish County on a variety of issues discussed in Chapter 3 for the Cemetery Creek and Bunk Foss Creek basins. Many of the most important habitat improvements that can be made in these systems are outside of the UGA. The long-term health of these basins depends in significant part on how land is developed in their rural areas. The City cannot succeed in improving the productivity and biological health of Cemetery and Bunk Foss creeks without the active cooperation of Snohomish County.

More broadly, since the City is a small part of the Snohomish River basin, the success of its efforts at salmon recovery depend on the broader success of the Snohomish Basin Salmon Recovery Forum and, at an even larger scale, the Puget Sound Shared Salmon Strategy (with which the Forum is working). The ESA Strategy is fully consistent with the efforts of these groups. The City should maintain regular communication with the Forum to ensure continued consistency and to increase the likelihood it will receive regional funding and other support to help implement the ESA Strategy.

4.3.5 Pilchuck Dam Operations and Capital Improvements

The City of Snohomish operates a “run of the river” dam at River Mile 26.4 on the Pilchuck River, where the City gets the majority of its water supply. The remainder of the City’s water is from the City of Everett, which stores water from the Sultan River in Lake Chaplain. Snohomish’s water withdrawal from the Pilchuck raises two issues:

Whether the amount of water the City withdraws has a significant effect on low flows and associated habitat conditions harmful to fish in the river, such as high temperatures; and
Whether the City’s dam is a significant obstacle to fish migrating to the upper river.

4.3.5.1 Recommended Conditional Limit on Withdrawals

In 2002 and 2003, the City’s withdrawals were generally in the range of 800 gallons per minute for most of the year, rising into the low to mid-900s for most of the period from mid-August to mid-October 2002 and in late July 2003, with a peak of 1,100 gpm on August 14 and 17, 2002. This translates to a typical withdrawal of about 1.8 cubic feet per second (the typical measure used for stream flow), with peaks up to about 2.5 cfs. The City has a water claim on the river of 2.5 cfs and a certificated right to withdraw an additional 5 cfs. The city’s claim dates to before Washington’s system of water rights began and is therefore senior to all rights established afterward, though a final determination of seniority requires a formal adjudication. (An adjudication might find that tribal water rights supporting treaty fisheries date to the 1850s, when the treaties were signed, or possibly to “time immemorial”.)

There is no flow gauge on the Pilchuck River in the vicinity of the City's dam. The most relevant available flow information is from a gauge operated by the U.S. Geological Survey near Granite Falls from 1943 to 1957, which was generally a period of low precipitation in the region. It is possible that summer low flows are actually lower at this site than at the dam, since there are no major tributaries between the two and the river may lose some flow to groundwater in that reach. The lowest flow recorded by the USGS was 28 cfs in August 1951; the lowest flows in more typical summers were approximately 40 cfs. If these flows approximate current low flows at the dam (probably a conservative assumption), the City's maximum withdrawals would range between 5 and 10 percent of the river's lowest flows. This is less than half the estimate of 10 to 20 percent of normal low flows in the Limiting Factors Analysis for WRIA 7 (WSCC 2002).

Withdrawals this size may have a minor effect on conditions for salmon downstream. High water temperatures in the Pilchuck River are a sporadic problem above Granite Falls; they become a more serious problem downstream, where they are probably due mostly to the lack of riparian shade and reduced groundwater connections, the latter resulting from constraints on the channel's interaction with its floodplain. Still, the City's impact could increase significantly in the future, given its rights to withdraw significantly more water and likely increases in demand from growth targeted for the City under the Growth Management Act. If the City increases its withdrawals significantly, it should install a staff gauge at the dam to measure river flows. Funding may be available for this from the U.S. Geological Survey or the Washington Department of Ecology. To minimize the City's contribution to downstream problems for fish, it should limit its withdrawals to no more than 10% of the river's low flows. This should not be a major burden on the City, since its connection with Everett's system allows it to switch to a less sensitive water source with relative ease, when conditions warrant. This should ensure that the City's withdrawals do not affect flows needed by chinook salmon, and should also benefit juvenile coho and steelhead and resident trout in the river.

4.3.5.2 Recommended Passage Improvements

The fish ladder at the City's dam is located on the inside of a meander bend, where high flows regularly deposit gravel and other debris. Relative to flow over the dam, the ladder provides a small attraction flow. This commonly causes salmon and steelhead to make repeated attempts to jump over the concrete dam before finding their way to the ladder. Fish cannot pass over the dam due to its height (approximately 10 feet) and the apron at its base, which protects its structural integrity but does not allow fish to start their jump from deep water adjacent to the dam. The City has made numerous efforts to improve this situation. In 1994, the City installed a debris trap above the ladder and modified the lowermost weir to improve attraction flow. In 2003, the City placed a flashboard in an opening to the debris trap to improve its effectiveness. It also constructed but has not yet installed a grate that could be placed over the entire ladder, to reduce vandalism and poaching and screen out larger debris. The City cleans the ladder of all debris annually in August, before chinook are migrating to the upper river, and cleans it on an as-needed basis after high flows. The City monitored the ladder for fish passage more closely in 2003, which included taking video footage of salmon above and below the dam.

Given these actions by the City, the dam probably is a minor obstacle to the migration of adult chinook, which are few in number and likely reach the ladder not long after it has been cleaned, typically before floods deposit much new debris. The dam is probably a greater obstacle to coho migration, which extends well into the flood season, after substantial new debris has entered the ladder. It may especially be an obstacle for steelhead, which migrate in small numbers over much of the flood season, when it may be difficult to keep the ladder consistently clean and operational.

The dam is also an obstacle for juvenile salmon. There is no fish screen on the intake for the City's water withdrawal, only a sediment screen. The number of fish this affects appears to be small, but it is a correctable problem and a requirement under RCW 77.55. Funding may be available from the Fisheries Restoration and Irrigation Mitigation Program, administered by WDFW. Perhaps more importantly, in the late spring and summer it is likely that the large majority of juvenile salmon in the vicinity of the dam seek to migrate upstream, partly in search of cooler temperatures. Age 0+ juveniles are probably not able to pass upstream through the ladder.

In the long-term, assuming that the City will continue to exercise its water right on the Pilchuck River, ideally it should construct a series of step-pools in the river channel, so that fish can migrate naturally in both directions past the dam. Another alternative that would address the passage problem fundamentally would be for the City to move to a groundwater withdrawal and remove the dam. A less radical but probably less costly solution would be to move the fish ladder to the opposite side of the dam, where it would be less prone to vandalism and to filling with sediment and where it would be easier to establish a strong attraction flow. These are all expensive solutions, however, and not within the City's means at this time. If grant funds become available, they would be worth exploring.

Meanwhile, in addition to installing a fish screen on the intake, the City should install the grate it has constructed for the fish ladder and modify the weirs in the ladder to align their notches and ensure no weir has a drop larger than 12", as recommended by WDFW. (Upstream passage for juveniles probably requires even smaller drops, but this is not possible without major modifications to the ladder.) The City should continue its commitment to regular maintenance of the ladder, including regular removal of excess debris deposited by high flows as soon as it is safe to do so. The City should install an electronic monitoring device at the base of the fish ladder that is capable of detecting both upstream and downstream passage of adult fish. More expensive devices could identify fish to species and potentially monitor juvenile as well as adult fish, but this is not absolutely necessary. The timing of adult migrations, combined with training of City staff to visually distinguish between salmon species, should be sufficient to be confident of correctly identifying the large majority of adults passing through the ladder. Electronic monitoring provides the simplest and most reliable means of determining the actual degree the fish ladder may be blocking migration throughout the year. This may assist in further modifications to the fish ladder, or in grant applications for more fundamental improvements.

4.3.6 Technical Assistance for Community-Based Stewardship

Ultimately, it is not so much City government as the residents and businesses of the City who will determine the success of the ESA Strategy in improving habitat and the City's natural resources. Relatively few properties are developed each year, triggering permit requirements under City regulations. Even when the City has a regulatory role, it is closely involved with individual private properties only for a limited time. This is, of course, a critical time, especially when viewed cumulatively over many years. The City's regulatory role has an enormous effect on the environment, which is why this activity is listed as the most important in the ESA Strategy. Nevertheless, property owners largely determine the state of their land over the long term. City enforcement actions are difficult, time consuming and, after construction is completed, rare. Voluntary compliance is always preferred, both to save public resources and because it is least likely to require further intervention. Furthermore, voluntary action is essentially the only way that habitat will be improved on the large majority of properties in the City that do not require development permits in any given year.

For these reasons, programs that provide education, technical assistance and other support to property owners for voluntary habitat improvements on their land have proven very effective and popular in other jurisdictions. Many property owners are more than willing to make at least the easier habitat improvements identified in Chapter 2, particularly the programmatic restoration of riparian areas. They may need little more than help identifying how the recommendations relate specifically to their property – e.g., which plants to remove, which to plant, etc. For more extensive projects, they may need help obtaining permits, which can be a relatively simple process for an experienced professional but daunting to a citizen volunteer. Property owners who have made habitat improvements are the most effective communicators to recruit neighbors to do the same. They also are likely to become active in helping the City ensure that new developments comply with permits, since they see the connection between the success of their efforts and land uses elsewhere in their watersheds. By talking with neighbors about the reasons for permit conditions and the benefits to property values from habitat protection and restoration, citizen volunteers may help the City avoid some enforcement actions.

Ideally, the same City staff person with overall responsibility to coordinate implementation of the ESA Strategy should provide technical assistance for this community-based stewardship. This "community steward" can bring a holistic understanding of how community actions relate to City and other actions that implement the Strategy. Though the steward must work with enforcement staff, experience elsewhere indicates he or she should not be directly responsible for code enforcement, since the steward must win the trust of property owners who may be suspicious of the City and other government agencies. The steward will be most effective if he or she is seen as an advocate for the resource, working with the community to accomplish restoration and protection. In this role, the steward can also help explain City actions to the community, as part of a two-way dialog.

4.3.7 Road and Other Public Works Maintenance

NOAA Fisheries has approved a 4(d) exemption for the "Regional Road Maintenance ESA Program Guidelines" (RRMTWG 2002), which the Tri-County Salmon Conservation Coalition developed in cooperation with the Washington State Department of Transportation (WDOT) and individual local governments. Individual local governments that commit to follow the Regional Guidelines are eligible for this exemption, which NOAA Fisheries has granted to WDOT and 23 local jurisdictions in the Puget Sound area, including Snohomish County and the City of Everett. Most cities that have received the exemption are considerably larger than Snohomish or contract with a county government for their road maintenance. The Regional Guidelines provide a form and a process for additional local governments to apply for the exemption. If resources allow, the City should considering seeking this exemption, but full implementation of the Regional Guidelines is a lower priority than the other activities listed above.

The Regional Guidelines cover more than just "road" maintenance. They include all public works in the right of way, such as water, sewer and other utility lines, stormwater facilities, drainage ditches and bridges. For purposes of the regional program's 4(d) exemption, "maintenance" includes all activities taken to prevent these facilities from losing the ability to perform their intended function. This can include completely replacing a facility when necessary to meet current engineering or environmental standards, but cannot include expanding a facility or changing its intended function. The 4(d) exemption does not waive normal permit requirements, but ensures that NOAA Fisheries will defend approved programs against any lawsuit alleging that they "take" listed salmon. Following the Regional Guidelines also ensures that a jurisdiction's maintenance activities contribute toward regional salmon recovery and are consistent with Clean Water Act requirements.

The heart of the Regional Guidelines is its compilation of 53 Best Management Practices (BMPs), which range from "Aqua Barriers" (a water-filled, portable vinyl tube used to contain or divert water at a work site) to "Washed Rock" (sediment-free gravel used in ditches or other watercourses). The document describes each BMP, explains the reasons for it and lists guidelines for applying it, typically with pictures of examples. All BMPs are designed to achieve one or more desired outcomes, such as keeping water from work areas or reducing the potential for soil or contaminants to enter streams or wetlands. Programs to train staff in the BMPs have been established through WDOT and the University of Washington. The Regional Guidelines use simple checklists to help staff track the use of BMPs for both routine operations and for special circumstances, such as work in sensitive areas, in water or when fish are present. A "Regional Forum", which includes all participating jurisdictions, meets regularly to share experiences with the BMPs, including research, monitoring and adaptive management.

By themselves, most BMPs in the Regional Program are not costly. The expense of the program depends on the frequency of maintenance activities, the cost of staff training and, to a lesser extent, program administration and coordination with the Regional

Forum. Though implementation of the full program is a lower priority than the five other activity categories listed above for limited discretionary funds, the City should follow BMPs to minimize erosion and fine sediments entering watercourses (identified in the "BMP Outcome Category Matrix") to the greatest extent possible. These BMPs would be especially valuable in the Cemetery Creek basin, where there is a high concentration of major roads and high levels of fine sediments are a limiting factor for juvenile coho, which are found in the creek year-round, and potentially for juvenile chinook, which use the creek mouth as rearing and refuge habitat during their migration to the Sound.

5 RECOMMENDED ACTION PLAN

To implement the ESA Strategy, the City must set priorities for its limited resources. It must also explore ways to augment those resources – including partnerships with other organizations as well as citizen volunteers – and must develop new ways of doing business, which may not be more costly but which nevertheless will require conscious decisions and follow-through to put into practice.

The ESA Strategy makes predictions regarding the benefits of its recommendations to salmon and the City's natural resources, but actual results may differ. It may not always be possible to implement recommendations exactly as they are conceived in this Strategy. The natural world is complex and may also not respond as predicted, especially given the complex socio-economic world to which it is connected. Floods may modify stream channels, ocean conditions may affect salmon survival, urban development may occur faster or in different places than expected. It is therefore important to monitor actual conditions in response to implementation of this Strategy, because of the certainty that some aspects of the Strategy will need to change in response to new conditions.

5.1 Overall Priorities

City activities in this Strategy can largely be grouped into two categories, based on whether their primary goal is protection or restoration of habitat conditions. Both categories are necessary to fulfill the goals of the Strategy. However, to the extent the City must allocate resources between them, habitat protection will generally be a higher priority. Protecting habitat that is already functioning is typically both far less expensive and far more certain of a successful outcome than attempting to restore it after it has been degraded. Restoration actions may also fail if the larger systems they are a part of are not protected. Lastly, there is simply the matter of timing. Delaying a restoration project generally comes with little cost; the City can come back to it later. If protection actions are not taken when habitat is at risk, however, they may be meaningless later.

5.1.1 Highest Priorities for Protection

Minimizing Changes to the Hydrology of Streams and Wetlands from Urbanization – Low-impact development in the Cemetery Creek basin and forest retention in the Bunk Foss Creek basin will be crucial to maintaining their ability to support coho salmon. Clearing forest for human development increases the size and frequency of peak flows, increases the total volume of water reaching streams and wetlands and decreases baseflows. Wherever this has happened in the Puget Sound area, coho populations have dropped. No amount of in-stream restoration can fully mitigate for these hydrologic changes. Retaining forest cover and natural soils where they can help manage stormwater are the most effective ways to minimize hydrologic changes from development.

Protecting Intact Riparian Areas – Wide, forested, continuous buffers are the most important factor that can at least partially compensate for the impacts of urbanization on the hydrology and biology of streams and wetlands. Since trees take from decades to centuries to reach maturity, riparian buffers with mature forest are invaluable City assets.

Protecting Water Quality – This goal is particularly important for Blackman's Lake, since high inputs of phosphorus will degrade its water quality in both the short and long term (the latter because of continued recycling from lake sediments). Future development upstream of the lake will accelerate this problem without protective actions by the City. Cemetery Creek is the next highest priority for water quality, because it supports salmon and has multiple potential sources of pollution, which will increase as its basin urbanizes.

5.1.2 Highest Priorities for Restoration

Restoring River Shorelines, Particularly Along the Snohomish River – These areas affect by far the greatest number of salmon found within the City's Urban Growth Area. In addition to creating in-river rearing habitat (the most important action to contribute to regional salmon recovery), the City should revegetate riverbanks it maintains, which should enhance bank stability long with habitat and aesthetic values. The City can also promote river restoration through permit conditions on development within the "Restoration Zone" recommended for both rivers.

Removing Passage Barriers – In general, the simplest and most effective way to improve habitat conditions for salmon is to remove barriers that keep them from functioning habitat. There are significant barriers to migration below the best spawning and rearing habitat in both Cemetery and Bunk Foss creeks. The City must work with landowners, Snohomish County and others to address these barriers, since many of them are located outside of the UGA or (in the case of barriers associated with State Route 9 for Cemetery Creek) removing them would cost far more than the City can afford by itself.

Replanting of Buffers and Augmentation of In-Stream Woody Debris – The Strategy identifies priority areas for this goal, but the City can also restore riparian areas and in-stream habitat on an opportunistic basis, where public or private developments require mitigation or citizens volunteer to assist restoration. Degradation of these areas occurred over more than 100 years; restoration will not be a short-term project. Developments should be provided incentives of reduced buffer widths (increasing the area they can develop) in return for restoring areas closer to streams and wetlands, on the condition that restored buffers are legally protected for the long-term. Restoring the quality and continuity of buffers that are seriously degraded is generally more important than protecting the full widths recommended in this Strategy.

5.2 Strategies to Address Funding Constraints

Looking ahead, the City can expect continued pressures on its general fund as well as its utility revenues, given voter-approved limitations on taxes, increasing demands for City services (especially as population grows), and increasing regulatory requirements (such as the separation of storm and sanitary sewers and conditions in the City's NPDES Phase II stormwater permit). Implementing the ESA Strategy under these conditions will require a combination of strategies, including:

Creative Adaptation of Existing Programs – The City has already begun to explore such opportunities as saving trees cut down in maintenance operations for potential use in habitat projects. Another example is the systematic incorporation of vegetation in maintenance of riverbanks. This can potentially save costs by reducing the need for repeated maintenance, while enhancing habitat values.

Prioritizing Resources – Where the City has discretion to use funds for environmental purposes, it should follow the above priorities for protection and restoration.

Exploring Partnerships – Snohomish County is probably the most important Potential partner with the City on multiple projects, especially along the rivers but also in creek areas that are currently unincorporated but within the UGA. Increased participation in the Snohomish River Basin (WRIA 7) salmon recovery planning process would likely enhance the City's ability to partner with the County and other participants in that process. Citizen volunteers can be excellent partners, especially for maintenance of publicly owned natural areas and collecting uncomplicated data over an extended time. The Stilly-Snohomish Fisheries Enhancement Task Force can provide a low-cost means of constructing habitat projects, for which it may also be able to attract grants. Some data of interest to the City may be of sufficient interest to others that they would share the cost of collecting it. The United States Geological Survey or the Washington Department of Ecology, for example, might be prepared to share the cost of a flow gauge at the Pilchuck Dam.

Exploring Grant Opportunities – The Fisheries Restoration and Irrigation Mitigation Program, funded by the U.S. Fish and Wildlife Service and administered by the Washington Department of Fish and Wildlife, is a potential source for funding passage improvements for both juvenile and adult salmon at the Pilchuck Dam. The Centennial Clean Water Fund, administered by the Washington Department of Ecology, could potentially fund many of the recommendations in the ESA Strategy, including both programs and capital projects. The state's Salmon Recovery Funding Board could potentially fund up to 85% of the cost for major restoration projects on the Snohomish River. The City could count the value of property it already owns and in-kind contributions of labor toward its share. There are many other funding opportunities the City might explore.

Prioritizing Mitigation Requirements – In coming years, the City will undertake numerous major capital projects that will require mitigation for impacts to streams and wetlands. Examples include the City's portion of a regional trail system, the sewer trunk line in the Cemetery Creek basin, the sewer separation project and possible expansion of the City's wastewater treatment plant. The City also will issue permits for developments throughout the UGA that will require mitigation. Wherever possible, mitigation requirements should follow priorities in the ESA Strategy. By restoring and protecting the most important habitats in return for impacts to less important areas, this could provide a significant net gain in habitat values.

Utility Fees – The City is likely to establish a stormwater utility fee, in part to fund requirements of its NPDES Phase II permit. Since stormwater is a major cause of habitat degradation, stormwater fees can be used to fund habitat protection and restoration projects, which can serve as mitigation for effects of the overall stormwater system. Habitat features can also be incorporated into stormwater capital projects, such as erosion control projects that use woody debris and native vegetation. Water utility fees can help fund improvements at the Pilchuck Dam, which can be charged to ratepayers as a cost of exercising the City's water rights in an environmentally responsible way. Sewer utility fees can potentially fund aspects of the sewer separation project that would benefit stormwater quantity and quality, such as "natural drainage systems" that can be less expensive than traditionally engineered stormwater systems.

Community Stewardship – Investments in technical assistance, education and organization to support citizen volunteers can leverage City resources. Beyond taking advantage of donated labor, citizen volunteers provide the only means to improve habitat on the large majority of land in the UGA that is not publicly owned or proposed for development and requiring City permits. In addition, voluntary habitat restoration on one property can spread to others as neighbors learn from each other.

5.3 Monitoring To Evaluate the ESA Strategy

There are three types of monitoring important for the ESA Strategy:

Implementation Monitoring – The simplest form of monitoring, through which the City keeps track of whether and to what degree it is implementing recommendations in the Strategy. This could be in the form of a checklist, to be reviewed periodically by the City Manager and Council.

Effectiveness Monitoring – This considers whether the specific actions recommended in the Strategy are having their intended effects. The Strategy is primarily focused on salmon, but effectiveness monitoring should generally not emphasize changes in the number of salmon. Natural factors alone – including floods, ocean conditions, predator numbers and food availability – can lead salmon population numbers to fluctuate by factors of 10 or more. Monitoring of projects can indicate whether salmon use restored habitats, but increased numbers can be due to these natural or other independent causes or may result from a re-distribution of salmon without an increase in their absolute number.

This is not to say that monitoring whether salmon use restored habitat is of no value. When the City removes blockages to salmon migration, it should monitor for juvenile and adult use of newly opened habitat. When the City restores habitat, it should monitor whether salmon use it, ideally with at least one year of data before construction of the project and periodic monitoring over at least five years afterward. But interpretation of this data is best made in the context of regional research and monitoring, which the City can access through WRIA 7.

In addition to data on salmon, the City can compare habitat indicators for individual stream reaches in Cemetery and Bunk Foss Creeks with those from 2003 in the Habitat Inventory and Assessment tables in Appendix G. With implementation of the ESA Strategy, the habitat quality indices for individual reaches should improve over time. The City should also monitor the Benthic Index of Biotic Integrity in the same general locations identified in Appendix F at least every five years. This, too, should improve over time and is probably the best single indicator of the quality of salmon habitat, since it integrates the effects of many different factors.

Validation Monitoring – This concerns whether the overall ESA Strategy is achieving its vision. Absolute numbers of salmon returning to City streams may be a misleading indicator, but the City should monitor to ensure that salmon not only continue to use its streams but expand their distribution beyond their current locations in response to restoration efforts. Surveys for birds should also, over time, indicate the continued presence of species currently found in the UGA, their expansion into restored habitats (this will generally require sufficient time for newly planted vegetation to mature), and increases in numbers of birds that are less tolerant of human impacts and are rare or absent in the UGA today. The Audubon Society and other groups or individual citizens knowledgeable about birds may be the best sources for monitoring this information, both because of their expertise and because accurate counts may require a large number of observers.

Some properties will lose economic value because of development restrictions in the ESA Strategy, but over time properties adjacent to restored streams and wetlands should increase in value relative to properties elsewhere in the City, since these natural areas will serve as amenities unique to these properties. Other important socio-economic indicators of success include the number of citizens volunteering for maintenance or restoration activities and stream miles or acreage of private property with restored habitat. A City employee assigned to assist volunteer efforts can maintain these statistics.

5.4 Coordination and Adaptive Management

The City should assign one employee the responsibility of coordinating implementation of the ESA Strategy. No single activity can ensure the Strategy's success; instead, the Strategy depends on the interrelated effects of multiple actions, which are best shaped and prioritized by someone who understands how they should fit together. At the same time, the ESA Strategy covers so many different activities, no single person or City program could implement it all. The City should build a team that includes leaders from all relevant programs – Public Works, Planning and Development, Parks, Engineering Services and potentially others – to implement the Strategy. The implementation team should work with the City Manager and City Council to determine specific measures of success for the Strategy at appropriate intervals. On at least an annual basis, the team should discuss the significance of monitoring results relative to these goals with citizen volunteers. Based on these discussions, the team should develop recommendations for the City Manager to modify the Strategy over time. At least once a year, the City Manager should review monitoring results and recommended modifications of the Strategy with the Council.

6 EXPECTED RESULTS FROM ESA STRATEGY

Chapter 3 describes a "Vision for Future Conditions" for each of the five study areas, after listing that area's recommendations. Those visions are joined and summarized here across the City's UGA for salmon, other wildlife and people.

6.1 Benefits to Salmon

All species of salmonids in the Snohomish River basin – chinook, coho, chum and pink salmon, cutthroat and bull trout, whitefish and steelhead – would benefit from improved rearing conditions in the Snohomish River within the UGA. Chinook and coho would particularly benefit because they are the species most likely to use these habitats. Since the Snohomish River is one of the most important sources of wild chinook and coho in the entire Puget Sound area, these benefits would be of regional significance for salmon recovery.

All of these salmonid species would also benefit from habitat improvements in the Pilchuck River within the UGA, which they will use not only for juvenile rearing but for adult holding and, in some cases, for spawning. Since the Pilchuck River is important for the geographic distribution and probably the genetic diversity of these species in the Snohomish River basin, habitat improvements there are also of regional significance, though less so than improvements in the Snohomish River simply because of the smaller number of fish benefiting. More and better pools in the Pilchuck River should particularly benefit adult chinook, which will seek them out as refuges from warm temperatures during their spawning migration, and juvenile coho, which will rear in them throughout the year and during their migration to saltwater.

Coho salmon would be the primary beneficiaries of improvements to Cemetery and Bunk Foss Creeks, though chinook and chum salmon and possibly bull trout would benefit from improved conditions at the creek mouths. Coho should extend their distribution up both creeks as blockages are removed. Their eggs should survive at higher rates as sedimentation is reduced. Juvenile coho, which rear in the creeks for a year or more, should benefit from stream, wetland and riparian restoration projects that increase habitat complexity, cover and food sources. However, all benefits to coho depend on protecting water quality and minimizing stormwater impacts from new development through implementation of low-impact approaches in the Cemetery Creek basin and forest retention in the Bunk Foss Creek basin.

6.2 Benefits to Wildlife

Improvements to riparian habitats, while important to salmon, will probably benefit birds and other wildlife even more. The Washington Department of Fish and Wildlife estimates that 85% of the state's terrestrial vertebrate species use riparian habitat "for essential life activities" (Knutson and Naef 1997). Protection and restoration of buffers around wetlands are particularly important. Even away from riparian areas, protection of mature trees, especially conifers, is also important to birds and wildlife.

Species benefiting from protection and restoration of these habitats include the bald eagle, great blue heron, pileated and other woodpeckers, flycatchers, kingfisher, Swainson's thrush and numerous other birds. Native salamanders, frogs, river otters and other small mammals would also benefit from protection and restoration of streams, wetlands and riparian corridors. Improvements to in-stream conditions would be most easily and reliably detected by increases in the number and diversity of aquatic insects that are included in the Benthic Index of Biotic Integrity, particularly those species least tolerant of habitat and water quality degradation.

6.3 Benefits to Humans

Residents of the City should benefit from implementation of the ESA Strategy, which will improve the natural beauty of their surroundings and increase their opportunities to enjoy native fish and wildlife near home, even as the City grows and urbanizes. Though in some cases property owners near streams and wetlands will lose economic value from development restrictions, as a class their property values should increase from protected and restored natural areas that serve as amenities for their properties. Developers will have greater clarity as to environmental requirements for their projects, better options for mitigation that provides net gains to the environment, and more certainty that appeals, enforcement actions and court challenges will not disrupt their projects. Businesses in general should benefit from the City becoming an even more attractive destination for visitors and shoppers through improvements to the City's physical attractiveness. Recreational, tribal and commercial fishermen will benefit from salmon recovery though many other parties will, of course, need to take action to achieve that.

6.4 Benefits to City Government

City government should benefit from an integrated environmental strategy that helps it comply with multiple federal and state regulations. The ESA Strategy should reduce the time and expense required for the City to update its critical area regulations and shoreline management plan. The Strategy should ensure that those and other activities use the City's limited resources most effectively to benefit the natural environment, consistent with other City goals and responsibilities. It should reduce the number of successful citizen appeals of City policies, regulations and permit decisions. Lastly, it should ensure that the City is doing its part toward ultimately recovering Puget Sound salmon, thus reducing legal restrictions on the region and helping preserve a central part of our shared natural heritage.

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1. PROJECT MANAGEMENT/ADMINISTRATION

Task 1.1. Ongoing Project Management. The Consultant's Project Manager (PM) will be Cleve Steward. The PM will be responsible for all financial, technical, and managerial aspects of the project. Project management will include project tracking, document control, and coordination efforts necessary for project execution. These efforts will include the continuous tracking of schedules, budgets, and products; coordination with sub-consultants relating to work in progress; and coordination with the City.

Task 1.2. Project Management Plan. In Sections 2-6 of this Scope of Work, the Consultant has identified all major work elements, including tasks and subtasks, budgets, schedules, and completion dates, necessary to complete the goals of this project. This Scope of Work will serve as the initial Project Management Plan (PMP). The PMP will be reviewed and revised, as necessary, at the beginning of each phase of the project, and at any time deemed necessary by the City, to update:

- Project tasks and work elements
- Project schedule, including duration and sequencing of the work elements
- Cost controls for completing the work within budget, and
- Project products and deliverables

The Consultant will submit an electronic draft Project Management Plan to the City for a 5 working day review and comment period, upon which the plan will be returned to the Consultant for revision, to become the final Project Management Plan.

Task 1.3. Monthly Progress Reports and Billings. The Consultant will prepare Monthly Progress Reports, in a form approved by the City, that outline the various elements of the work, and the order of performance, in sufficient detail so that the progress of the work can be easily evaluated. These reports will:

- Highlight project milestones,
- Target potential problem areas needing special attention or coordination,
- Outline activities planned for the next period, and
- Compare actual work progress with contractual obligations.

Billings will be prepared by the Consultant in a form and detail as approved by the City, and submitted on a monthly basis. Invoices will be supported by detailed record keeping to closely track the project budget and expenditures.

Task 1.4. Coordinate/Contract with Sub-consultants. The Consultant will coordinate with any sub-consultants regarding contracting procedures, will prepare and execute contracts with individual sub-consultants, and will address contract-related issues with the sub-consultants as they arise during the project.

The Consultant will provide the City with information regarding key personnel, subcontractors, and others who will work on this project. The Consultant will obtain approval from the City for any work to be performed by sub-consultants.

Task 1.5. Draft Documents Reviews. The Consultant will submit one hardcopy and electronic copies of all products and deliverables in draft form for review by the City. The intent is to perform reviews concurrent to work in progress, minimizing delay of the final report and completion of the project.

Task 1 Products:

- Project Management Plan (revised)
- Monthly progress reports
- Monthly billings

2. PROJECT MEETINGS AND AGENCY COORDINATION

Task 2.1. Monthly progress meetings. The Consultant will conduct monthly Progress Meetings with the City. Project activities will be discussed, unresolved problems will be identified, and required actions presented during the meetings. A minimum of 20 monthly Progress Meetings will be held, each lasting no more than 2 hours. It is assumed that the monthly Progress Meetings will include at least one staff each from the Consultant and the City.

The City may elect to convene a Project Advisory Committee (PAC) comprising citizen representatives from the City of Snohomish that would be invited to attend a portion or all of the progress meetings. All meetings will be held at Snohomish City Hall or at an alternate workspace arranged by the City.

Progress Meeting notes will include:

- Meeting agenda and announcement
- Brief meeting purpose statement
- Brief list of meeting discussions
- List of action items

Task 2.2. Federal Agency Coordination Meetings. The Consultant will consider the authorities and requirements of the federal service agencies with respect to the ESA and their respective roles in the development of ESA Strategy for the City. Project activities and products will be coordinated and reviewed with NMFS and, if applicable, USFWS personnel, and their recommendations given due consideration in the development of the ESA Strategy.

The Consultant will coordinate all contacts and discussions involving the agencies and the City.

A minimum of 6 coordination meetings will be held with the NMFS over the course of the project to discuss technical and procedural issues, project options and progress, and ESA requirements. The meetings, which at the City's discretion may include representatives of other federal and state agencies, will be organized by the Consultant and attended by at least one staff from the Consultant.

Agency coordination meeting notes will include:

- Meeting agenda
- Brief meeting purpose statement
- Overview of discussions
- List of action items

Task 2.3. City Council meetings. Consultant will meet with the City Council or its designees on 6 occasions over the course of the project to present and discuss project-related information. The meetings will be organized by the City and attended by at least one staff from the Consultant. The City will be responsible for compiling meeting agendas and minutes. The Consultant will be prepared to present project-related material and lead discussions at the meeting.

Task 2.4. Public meetings. Consultant will stage four meetings with the general public to present project information and obtain feedback. The meetings will be organized by the City and attended by at least one staff from the Consultant. The City will be responsible for compiling meeting agendas and minutes. The Consultant will be prepared to present project-related material and lead discussions at the meeting.

Task 2 Products:

- Monthly progress meeting notes
- Meeting notes for each agency coordination meeting
- City Council meeting materials and exhibits
- Public meeting materials and exhibits

3. ASSESSMENT OF EXISTING CONDITIONS

Overview. We will focus on assessing stream and watershed conditions that are critical for salmon recovery and habitat restoration within the City of Snohomish. While there is a broad spectrum of factors that influence watershed health, there is a smaller subset of factors that are of primary importance in determining salmon production and distribution within the City's drainages. These primary factors, or indicators, can be measured and used to evaluate conditions within the streams. An example of indicators related to large woody debris, considered an important component of salmon habitat, is included as Attachment #1.

Baseline sampling will focus on indicators of stream, watershed, and salmon population health. "Health" is defined by reference to environmental processes and components that occur in undisturbed watersheds; associated with each indicator is a performance standard that describes healthy or "properly functioning" conditions. Evaluation considerations have been described for each 4(d) Rule Limit and will be used to identify appropriate resource indicators and objectives.

Habitat restoration and other conservation measures will address the causes of degradation, with the goal of bringing existing conditions closer to "properly functioning" levels, consistent with Limit requirements.

Task 3.1. Watershed Assessment: Contact key individuals, assemble relevant literature, and compile descriptive information relating to salmonid populations and habitat conditions at the drainage scale; i.e., Snohomish River, Pilchuck River, Cemetery Creek, Swifty Creek, Bunk Foss Creek, and Blackmans Lake drainages. Complete Watershed Assessment Tables (WATs; Attachment #1).

Task 3.2. Reach Classification: Identify and apply geomorphic, hydrologic and other discriminative criteria to define discrete reaches of rivers and streams within the City's limits and associated watersheds. This step will ensure more efficient allocation of effort and facilitate comparisons across reaches.

Subtask 3.2.1. Classify reaches on a preliminary basis using information collected in Task 3.1. [1]

Subtask 3.2.2. Refine reach designations based on information obtained in Task 3.3.

Task 3.3 Describe existing environmental conditions within each reach using key habitat indicators and Properly Functioning Conditions as reference points. Select

[1] The classification system we propose to use is consistent with the one used by the State of Washington and Snohomish County.

and measure a set of environmental indicators that are directly related to salmon life history requirements and the primary factors affecting them. Construct Habitat Indicators Assessment Tables (HIATs; Attachment #2) and use them to evaluate conditions within each reach.

Subtask 3.3.1. HIAT Template: Construct a Habitat Indicators Assessment Table template for each Limit and Species. Identify specific environmental indicators, performance measures, and standards associated with each Limit and Species. Each HIAT template will be applied to all reaches.

- Identify priority information needs based on a review of the literature and 4(d) Rule Limit requirements/guidance. Habitat inventories will focus on stream hydrology, water quality, structural habitat, channel conditions (including fish passage) wetlands, and riparian zones. Biological inventories will focus on the presence/absence, composition, and distribution of salmonid populations.

Subtask 3.3.2. Indicator Data collection: Design and implement a field sampling program that measures environmental indicators/conditions within reaches using accepted field, laboratory, and analytical procedures.

- Define desired data attributes and methodologies for data collection and analysis, define timetable and staff requirements, and implement a sampling and database management program to obtain the requisite information. Indicator data will be quantifiable, statistically valid, cost efficient, and coordinated with other resource entities (e.g., Snohomish County SWM).

- Integrate field data into City's AutoCAD 2000 database and mapping system.[2]

Subtask 3.3.3. Indicator Data integration: Integrate data across indicators, reaches and drainages to determine the overall status of salmon populations and habitat within the City area.

- Reach status: Integrate data across indicators within each reach. Describe existing conditions on a reach-by-reach basis.
- Drainage status: Combine data across reaches within each drainage. Describe existing conditions on a drainage-by-drainage basis and rank drainages according to their ability to support salmon.
- Citywide status: Combine data across drainages within the City. Describe existing conditions for the City as a whole.

[2] The City will be responsible for incorporating GPS data provided by Steward and Associates in .DXF format into AutoCAD, and producing maps at reach, drainage, and Citywide scales.

Subtask 3.3.4. Reach HIATs: Using the HIAT template developed in Subtask 3.3.1 and the data obtained in Subtask 3.3.2, complete a HIAT for each reach. For each indicator:

- Determine its functional value
- Describe Properly Functioning Conditions
- Describe Current Conditions
- Identify Limiting Factors

Task 3.4 Critical Areas: Identify and quantify critical/sensitive areas within the City's Urban Growth Boundary

Subtask 3.4.1. Identify from aerial photos, maps, and field surveys significant features that are critical to the ecological health of streams and associated salmonid populations. Classify and delineate on maps the following:

- Water withdrawals
- Fish passage barriers
- Impoundments
- Hydromodifications[3]
- Off-channel habitat
- Areas of significant erosion and instability
- Riparian areas
- Wetlands
- Potential habitat restoration sites

Note that the extent of wetlands and riparian areas to be delineated, measured, and mapped will depend on sampling criteria developed with NMFS, in conjunction with funding availability.

Task 3.5 Reach and Drainage Model: Develop a conceptual model that shows the spatial and functional relationships among reaches.

Task 3.6 Reach and Drainage Prioritization: Define the relative importance of each drainage, and of reaches within each drainage, in terms of their contribution, or potential contribution, to salmon recovery and watershed conservation. This information will be used in Task 3 to develop a prioritized list of actions for the City to implement.

[3] Direct changes to stream banks and channels such as riprap, dikes, ditching, stream-adjacent roads, and gravel removal.

<u>Task 3 Products</u>: The following products will either be provided separately or incorporated into the project document entitled "Endangered Species Act Compliance and Conservation Strategy for the City of Snohomish."

1. Completed Watershed Assessment: WATs and narrative description of baseline conditions for each drainage
2. Draft assessment based on existing data
3. Refined assessment based on existing and supplemental data
4. Reaches classified and delineated
5. Resource objectives, indicators, and performance standards, supported by literature review and best available science
6. Habitat Indicators Assessment Table templates (Limit, species)
7. Resource Inventories – description of existing conditions on a reach, drainage, and Citywide basis
8. Completed Habitat Indicators Assessment Table (existing conditions) for each reach
9. Map of existing critical/sensitive areas (i.e., wetlands, stream channels, impoundments, riparian areas, unstable slopes, fish passage barriers, areas of significant degradation, and potential habitat restoration sites) within the City's Urban Growth Boundary
10. Spatial and functional model of reaches and drainages
11. Preliminary prioritization of reaches and drainages for salmon protection and restoration

4. ANALYSIS OF THE EFFECTS OF CITY'S ACTIVITIES

Task 4.1 <u>Regulatory Analysis</u>: Summarize purpose, issues of concern, evaluation considerations, and applicability of relevant 4(d) Rule Limits (i.e., #8 – Habitat Restoration, #10 – Routine Road Maintenance, and #12 – MRCI). For each Limit, identify specific evaluation considerations. As an example, Attachment #4 lists evaluation considerations identified by the National Marine Fisheries Service for Limit #12: Municipal, Residential, Commercial, and Industrial (MRCI).

Subtask 4.1.1. Review 4(d) rule requirements associated with each Limit and evaluate their applicability.

Subtask 4.1.2. Identify "Best Available Science" sources and standards in 4(d) rule and specified references.

Subtask 4.1.3. Review and evaluate efforts to achieve 4(d) rule compliance currently underway at regional, state, and local government levels.

Task 4.2 Activity Scoping: Compile a list of City ordinances, plans, and practices (referred to collectively as "City Activities") and non-City Activities that could conceivably be addressed under each Limit. Activities will minimally include:

- City water withdrawal and treatment
- Pilchuck River diversion dam
- City water rights
- Wastewater treatment and discharge
- Stormwater conveyance, detention and discharge
- Combined Sewer Overflow
- Surface Water Management
- Shoreline Management Plan
- Riverfront protection, alteration, or development
- Riparian buffers
- Wetland protection, alteration, or development
- Road and bridge construction and maintenance
- Erosion and sediment control
- Planning, zoning, and development
- NPDES permitting
- Pesticide, herbicide, fertilizer, and other chemical use
- Habitat acquisition and restoration

Subtask 4.2.1. List any City Activities that could conceivably be addressed under each Limit.

- Include major activities such as water withdrawals, surface water management, wastewater treatment, and critical area ordinances, as well as "mundane" activities, such as street cleaning and pest control practices.
- Divide each Activity into logical components, as needed, and discriminate between purpose and implementation, where applicable.

Subtask 4.2.2. List any non-City Activities that may affect salmon or their habitat within the City, or that otherwise may affect the success of the City's recovery/restoration efforts. See Subtask 4.2.1.

Subtask 4.2.3. Describe the relationship between different Activities (i.e., ordinances, plans, and practices).[4] Do the same for non-City Activities.

Subtask 4.2.4. Construct a conceptual model of City/non-City Activity relationships.

Task 4.3 Activity Screen: Identify the effects of each Activity on HIAT indicators at the reach scale under existing and projected future conditions. Determine which Activities are or will likely be "critical" to the health of the reach; i.e., have a comparatively greater effect on conditions within the reach than do other Activities.

Subtask 4.3.1. Identify the magnitude and direction (positive, negative) of effect of each Activity on environmental indicators within each reach. Verify temporal overlap with species in question.

Subtask 4.3.2. Assess the effect of other Activities or external factors that may amplify or reduce the effect of the Activity on the reach.

Subtask 4.3.3. Evaluate the Activity's contribution to the observed "gap" between the Current Condition and Properly Functioning Condition for each indicator. Calculate a "priority" score for each Activity-Indicator pair that reflects the strength or sensitivity of the relationship. Activities that have a pronounced effect and/or are responsible for significant gaps between existing conditions and (desired) Properly Functioning Conditions are considered critical.

Subtask 4.3.4. Consider reasonably foreseeable changes in the Activity or the reach over the next 50 years and predict the effects of the Activity on different indicators. See Subtasks 2.3.1 - 2.3.3.

Task 4.4 Activity Effects Analysis. Integrate the effects of each Activity across indicators, reaches, and drainages to determine the overall impact of each Activity on streams, watersheds, and salmon populations within the City area. Determine combined effects of each Activity under existing and future conditions.

[4] Relationships may include dependence (e.g., Activities that are directly dependent on each other, such as the implementation of a specific policy), association (e.g., Activities that pertain to similar or overlapping issues), conflict (e.g., purpose of one Activity is directly at odds with the purpose of another), etc.

<u>Subtask 4.4.1.</u> Reach scale effects: Integrate Activity effects across indicators within each reach based on functional value and Activity-Indicator relationships.

<u>Subtask 4.4.2.</u> Drainage scale effects: Integrate Activity effects across reaches within each drainage. Consider reach relationships and Activity interactions.

<u>Subtask 4.4.3.</u> Citywide effects: Integrate Activity effects across drainages within the City. Rank Activities according to their overall impact on salmon and habitat within the City.

<u>Subtask 4.4.4.</u> Determine the effects of Activities under assumed future conditions. See Subtasks 4.4.1 - 4.4.3.

Task 4.5 <u>Combined Effects</u>. Describe the combined effects of all Activities by reach, drainage, and Citywide.

Task 4.6 <u>Limit Test</u>. Determine whether each Activity, when evaluated at the reach, drainage, and Citywide scale, and in conjunction with other Activities, meets the requirements for the Limit in question.

<u>Subtask 4.6.1.</u> Describe the relationship between Activity and 4(d) Rule Limit considerations, with reference to the type and magnitude of effect on different habitat indicators and population variables.

<u>Subtask 4.6.2.</u> Determine whether Activity needs to be revised to comply with Limit requirements.

<u>Task 4 Products</u>: The following products will either be provided separately or incorporated into the project document entitled "Endangered Species Act Compliance and Conservation Strategy for the City of Snohomish."

1. Summary of NMFS 4(d) rule authorization process and practical considerations
2. Summary of 4(d) Rule Limits evaluation considerations, indicators, and PFCs (desired conditions).
3. List of City and non-City Activities.
4. Conceptual model of City/non-City Activity relationships.
5. Description of the individual and combined effects of Activities on (indicators of) listed species and habitat within each reach (existing and probable future conditions) and drainage, and in the City as a whole.
6. Ranking of Activities according to severity of impact on listed species and habitat.
7. Recommendation of whether or not to revise Activities to comply with Limit requirements.

5. DEVELOPMENT OF ESA STRATEGY

Task 5.1 Identify and recommend changes in City Activities to positively influence listed species and habitat. Specify separately for 4(d) Rule Limits #10 and #12.

Subtask 5.1.1. Meet with City officials and NMFS to review results of Activity Scoping and Effects Analysis.

Subtask 5.1.2. Review and evaluate efforts by other entities to achieve 4(d) rule compliance.

Subtask 5.1.3. Identify and recommend changes in City Activities to conform to the requirements of Limits #10 and #12. Recommendations should anticipate likely changes in environmental conditions.

- Evaluate and recommend changes to City ordinances and regulations
- Recommend revisions to City plans (e.g., Shoreline Management Plan)
- Identify and recommend changes in specific City practices (e.g., street cleaning)
- Ensure compliance with other applicable state and federal environmental regulations, such as the Clean Water Act, 401 & 404 Permits, NPDES, HPAs, Shorelines, et al., as well as other ESA sections.

Task 5.2 Recommend conservation, protection and restoration actions (Limit #8).

Subtask 5.2.1. Review and evaluate watershed conservation and habitat restoration efforts undertaken by other entities in the Pacific Northwest, with emphasis on WRIA 7 (Snohomish Basin).

Subtask 5.2.2. Identify and prioritize conservation, protection and restoration actions to address limiting factors (i.e., "gaps" in the HIAT tables) and positively affect listed species and habitat at reach, drainage, and Citywide scales. Recommendations should anticipate likely changes in environmental conditions.

Task 5.3 Specify procedures and timetable for proposed remedies (i.e., revised Activities and recommended conservation actions) for 4(d) Rule Limits #8, #10 and #12. Ensure consistency and effectiveness of implementation of the proposed remedies.

Task 5.4 Reanalyze the effects of revised City Activities and recommended conservation actions using the Effects Analysis procedures in Task 2, Tasks 2.1 - 2.5, assuming full implementation.

<u>Subtask 5.3.1.</u> For each recommended measure, run through Task 2 to evaluate potential benefits on salmon populations and habitat in the City area.

Task 5.5 For each Limit, develop appropriate methods, timelines, and resources for monitoring, evaluating, and reporting on the Program's implementation and effectiveness.

Task 5.6 For each Limit, identify procedures, responsibilities, and resources for implementation and adaptive management.

<u>Subtask 5.6.1.</u> Develop guidelines for City staff to follow when implementing Activities (e.g., ordinances in response to development applications).

<u>Subtask 5.6.2.</u> Develop procedures for reassessing conditions and effects, modifying Activities, and revising the ESA Strategy to comply with Limit requirements and achieve conservation goals.

Task 5.7 Meet with City representatives, stakeholders, and NMFS to review and revise recommendations and implementation procedures. Repeat Tasks 5.1-5.6 as necessary.

<u>Subtask 5.7.1.</u> Estimate budget requirements for ESA Strategy implementation.

<u>Subtask 5.7.2.</u> Secure assurances from the City that the relevant portions of the ESA Strategy will be implemented and funded if NMFS approves them.[5]

Task 5.8 Finalize recommendations and incorporate into ESA Strategy document.

<u>Subtask 5.8.1.</u> Submit draft ESA Strategy to City representatives, stakeholders, and NMFS for review and comment.

<u>Task 5 Products</u>: The following products will either be provided separately or incorporated into the project document entitled "Endangered Species Act Compliance and Conservation Strategy for the City of Snohomish."

1. Recommended changes in City Activities to conform with the requirements of Limits #10 and #12, to include modifications to City ordinances, regulations, plans, and practices;
2. List of recommended conservation, protection and restoration actions, including timetable and general cost, to be addressed under Limit #8;
3. Map showing desired (restored) alignment, configuration and condition of streams in the Snohomish Urban Growth Area;

[5] In a letter to Mayor Thorndike dated October 30, 2001 (Attachment #7), NMFS indicated its support for the City's approach to developing an ESA Strategy. NMFS also indicated that it will assist the City and its Consultant in evaluating Activities addressed by the 4(d) rule.

Scope of Work

DEVELOPMENT OF AN ENDANGERED SPECIES ACT COMPLIANCE AND SALMON CONSERVATION STRATEGY FOR THE CITY OF SNOHOMISH

INTRODUCTION

Steward and Associates (Consultant) will assist the City of Snohomish (City) in developing an *Endangered Species Act Compliance and Conservation Strategy* ("Strategy") that would enable the City to comply with ESA and other environmental protection laws, to coordinate with other entities, and to develop and implement appropriate salmonid conservation measures to facilitate the recovery of salmon populations and habitat within the City's urban growth area boundaries. A science-based, ESA-compliant Strategy is needed to provide citizens and City officials with the certainty that their ordinances and activities are legally permissible and have a high probability of recovering ESA listed salmonids.

SCOPE OF SERVICES

The Consultant will work with the City and the National Marine Fisheries Service to develop an ESA Compliance and Conservation Strategy and obtain one or more Limits for its activities under the 4(d) rule for salmon and steelhead. The Consultant will ensure that the information and process used to develop the ESA Strategy and the petitions for exemption from 4(d) take prohibitions are based on "best available science" and guidance from the National Marine Fisheries Service (NMFS).

This Scope of Services comprises the following major work elements:

1. Project Management and Administration
2. Project Meetings and Agency Coordination
3. Assessment of Existing Conditions
4. Analysis of the Effects of City's Activities
5. Development of ESA Strategy
6. Preparation of 4(d) Rule Petitions

Any significant change in the activities, tasks, etc. specified in this scope of work will not be made without advance approval by the City, as specified in Task 1.2 below.

4. Description of the probable impact of proposed remedies and conservation measures on salmon and habitat within reaches and drainages, and the City as a whole;
5. Description of the procedures, responsibilities, and resources for ESA Strategy implementation, monitoring and evaluation, and adaptive management; and
6. Estimated budget for ESA Strategy implementation.

Task 5 Deliverables: The ESA Strategy will integrate the products identified in Tasks 3-5. The Consultant will submit draft copies of the ESA Strategy to the City and NMFS for review. Once reviewed and revised to the City's satisfaction, a final ready-for-reproduction copy of the ESA Strategy will be provided.

1. Report entitled "Endangered Species Act Compliance and Conservation Strategy for the City of Snohomish" and associated appendices.

6. PREPARATION OF 4(D) RULE PETITIONS[6]

Task 6.1 Abstract relevant sections of the ESA Strategy document and prepare petitions for exemption from 4(d) Rule Limits #8, #10 and #12.

Task 6.2 Secure assurances from City that the relevant portions of the ESA Strategy will be implemented as described if NMFS approves them.

Task 6.3 Submit petitions for exemption from 4(d) Rule Limits #8, #10 and #12 to NMFS for review and comment.

Task 6.4 Revise and finalize ESA Strategy document and petitions for exemption from 4(d) Rule Limits #8, #10 and #12. Submit to NMFS for formal authorization.

Task 6.5 Secure NMFS authorization.

Task 6 Products: The following products will be developed from material in the ESA Strategy document and based on discussions with the National Marine Fisheries Service.

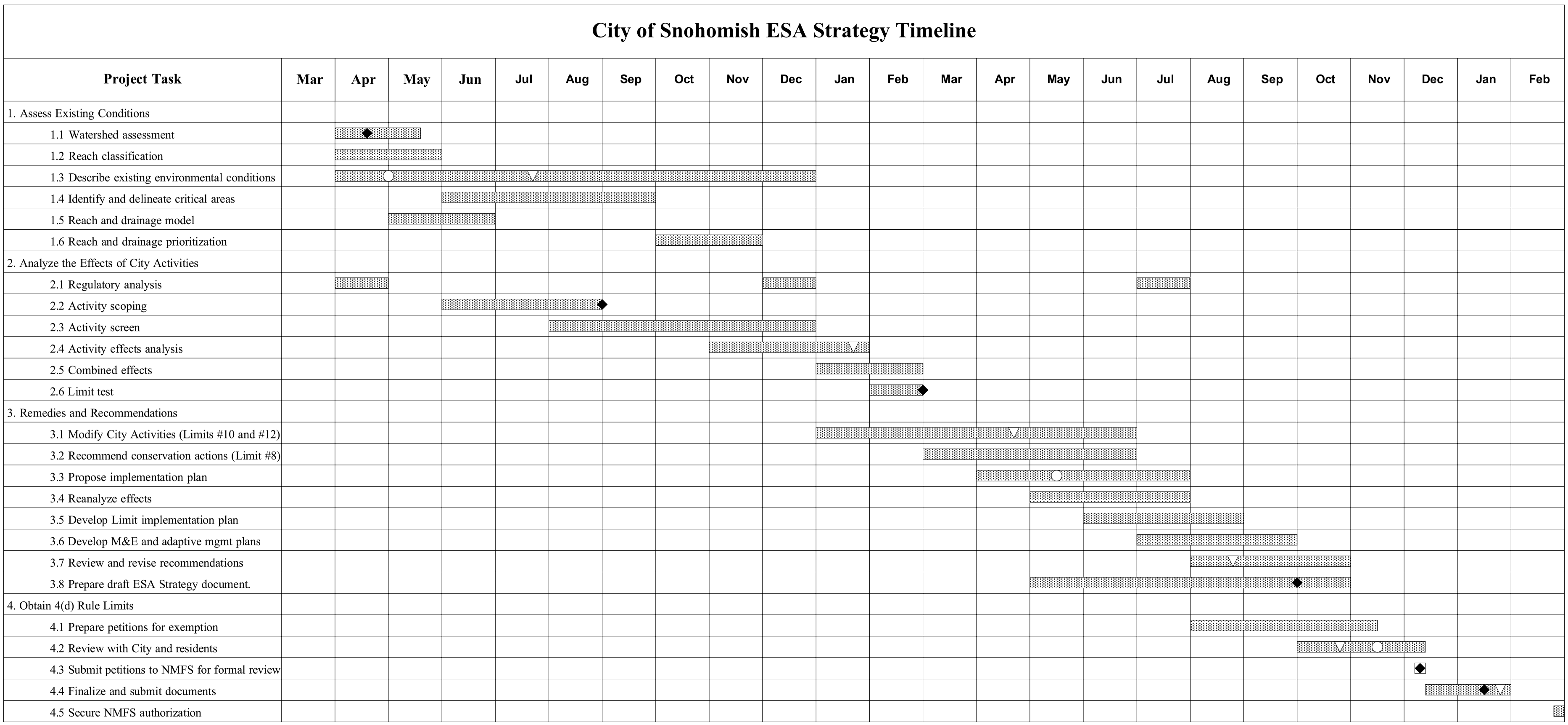
1. Petitions to NMFS for exemption of relevant City Activities from 4(d) Rule Limits #8, #10 and #12

Task 6 Deliverables:[7] The Consultant will submit draft copies of the 4(d) Rule Limit petitions to the City and NMFS for review. Once reviewed and revised to the City's satisfaction, a final ready-for-reproduction copy of the petitions will be provided.

1. Petition by the City of Snohomish for a 4(d) Rule Limit #8 for Puget Sound Chinook Salmon. *Draft August 2003, Final November 2003.*
2. Petition by the City of Snohomish for a 4(d) Rule Limit #10 for Puget Sound Chinook Salmon. *Draft August 2003, Final November 2003.*
3. Petition by the City of Snohomish for a 4(d) Rule Limit #12 for Puget Sound Chinook Salmon. *Draft August 2003, Final November 2003.*

[6] A petition for a 4(d) rule limit for bull trout will not be prepared under the proposed scope of services and budget. However, if the City seeks an exemption and the U.S. Fish and Wildlife Service indicates its willingness to consider a petition, the Consultant will assist the City in the development of a 4(d) rule limit for bull trout for the City of Snohomish.

[7] The timing of these deliverables is dependent on the availability of NMFS staff to meet and review project materials.


City of Snohomish ESA Strategy Timeline
Project Task
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1. Assess Existing Conditions
1.1 Watershed assessment
1.2 Reach classification
1.3 Describe existing environmental conditions
1.4 Identify and delineate critical areas
1.5 Reach and drainage model
1.6 Reach and drainage prioritization
2. Analyze the Effects of City Activities
2.1 Regulatory analysis
2.2 Activity scoping
2.3 Activity screen
2.4 Activity effects analysis
2.5 Combined effects
2.6 Limit test
3. Remedies and Recommendations
3.1 Modify City Activities (Limits #10 and #12)
3.2 Recommend conservation actions (Limit #8)
3.3 Propose implementation plan
3.4 Reanalyze effects
3.5 Develop Limit implementation plan
3.6 Develop M&E and adaptive mgmt plans
3.7 Review and revise recommendations
3.8 Prepare draft ESA Strategy document.
4. Obtain 4(d) Rule Limits
4.1 Prepare petitions for exemption
4.2 Review with City and residents
4.3 Submit petitions to NMFS for formal review
4.4 Finalize and submit documents
4.5 Secure NMFS authorization

APPENDIX C SMC 14.51.070

Existing City of Snohomish Classification System for Streams and Wetlands

<u>14.51.070 Rating System</u>. Streams and wetlands shall be designated according to the criteria in this section. Blackman's Lake will not be categorized and is the only lake which will be within the City of Snohomish jurisdiction.

A. Stream Classifications.

1. Class 1 streams are all streams inventoried as "Shorelines of the State" under RCW Chapter 90.58, and are regulated under the City's Shoreline Management Plan and include only the Snohomish and Pilchuck Rivers.

2. Class 2 streams are smaller than Class 1 streams that flow year-round during years of normal rainfall and are used by salmonids, and intermittent or ephemeral streams that are used by salmonids and serve other important wildlife functions and stormwater control functions.

3. Class 3 streams are Class 2 streams which are not inhabited by salmonids.

B. Wetland Classifications.

1. Class 1 wetlands are those wetlands which meet any of the following criteria:

a. The documented presence of species proposed or listed by the federal government or State of Washington as endangered or threatened.

b. Sites that are documented or qualify as Natural Heritage wetlands sites, or high quality native wetland communities where significant functional values have not been altered (e.g. soils, hydrology, vegetation), and are not predominantly characterized by non-native plant species.

c. Regionally rare wetland communities, i.e. one of five or fewer examples of the wetland type based on plant association.

d. Wetlands with irreplaceable ecological functions, including peat wetlands that have not been subject to significant hydrological modification and mature forested wetlands greater than one acre in size.

e. Wetlands with a total area of ten acres or more that include three or more wetland classes including an open water zone.

f.Documented habitat for listed or candidate sensitive or priority species of plants, fish or wildlife recognized by applicable federal or state agencies.

2. Class 2 wetlands are those wetlands which are not Class 1 wetlands and meet any of the following criteria:

a. Display significant functions and values that may not be adequately replicated through creation or restoration, including peat wetlands with significant hydrologic modification, and forested wetlands that are not mature.

b. Wetlands one acre or greater in size with either 40 percent to 60 percent open water in dispersed patches, or wetlands classified as forested.

c. Wetlands that are associated with other water bodies.

3. Class 3 wetlands are those wetlands which do not meet Class 1 or 2 criteria and are isolated wetlands that are one acre in area or greater and have more than one dominant plant species.

4. Class 4 wetlands are wetlands which do not meet the criteria of Class 1, 2 or 3 wetlands.

Notes:

Under SMC 14.51.040(C.), activities affecting Class IV wetlands smaller than 3,000 square feet in area are exempt from critical area restrictions.

With respect to forested wetlands, Steward and Associates interpreted these classifications as follows:

- Mature forest ≥ 1 acre — Class 1
- Mature forest < 1 acre, ≥ 3,000 sq.ft. — Class 2
- Immature forest, ≥ 1 acre — Class 2
- Immature forest, < 1 acre, ≥ 3,000 sq.ft. — Class 4 (if isolated from other waters)

Steward and Associates used the State of Washington's definition of a mature forested wetland (WDOE 1993):

- Forested wetlands qualify as mature forested wetlands when at least 50% of the forest canopy contains evergreen trees that are more than 80 years old, or deciduous trees that are older than 50 years; **OR**
- 50% of the forest canopy consist of trees taller than 50 ft, and the structural diversity is high as characterized by a multi-layer community of trees > 50 ft tall and trees 20-49 ft tall and shrubs and herbaceous groundcover; **AND** < 25 % of the cover in the herbaceous/ground cover or shrub class are invasive exotic plant species.

APPENDIX D WAC 222-16-030

STATE RECOMMENDED STREAM CLASSIFICATION SYSTEM

WAC 222-16-030 Water typing system. … The department in cooperation with the departments of fish and wildlife, and ecology, and in consultation with affected Indian tribes will classify streams, lakes and ponds. The department will prepare water type maps showing the location of Type S, F, and N (Np and Ns) Waters within the forested areas of the state. The maps will be based on a multiparameter, field-verified geographic information system (GIS) logistic regression model. The multiparameter model will be designed to identify fish habitat by using geomorphic parameters such as basin size, gradient, elevation and other indicators. The modeling process shall be designed to achieve a level of statistical accuracy of 95% in separating fish habitat streams and non fish habitat streams. Furthermore, the demarcation of fish and non fish habitat waters shall be equally likely to over and under estimate the presence of fish habitat. These maps shall be referred to as "fish habitat water typing maps" and shall, when completed, be available for public inspection at region offices of the department.

Fish habitat water type maps will be updated every five years where necessary to better reflect observed, in-field conditions. Except for these periodic revisions of the maps, on-the-ground observations of fish or habitat characteristics will generally not be used to adjust mapped water types. However, if an on-site interdisciplinary team using non lethal methods identifies fish, or finds that habitat is not accessible due to naturally occurring conditions and no fish reside above the blockage, then the water type will be immediately changed to reflect the findings of the interdisciplinary team. The finding will be documented on a water type update form provided by the department and the fish habitat water type map will be updated as soon as practicable. If a dispute arises concerning a water type the department shall make available informal conferences, as established in WAC 222-46-020 which shall include the departments of fish and wildlife, and ecology, and affected Indian tribes and those contesting the adopted water types.

The waters will be classified using the following criteria:

*(1) **"Type S Water"** means all waters, within their bankfull width, as inventoried as "shorelines of the state" under chapter 90.58 RCW and the rules promulgated pursuant to chapter 90.58 RCW including periodically inundated areas of their associated wetlands.

*(2) **"Type F Water"** means segments of natural waters other than Type S Waters, which are within the bankfull widths of defined channels and periodically inundated areas of their associated wetlands, or within lakes, ponds, or impoundments having a surface area of 0.5 acre or greater at seasonal low water and which in any case contain fish habitat or are described by one of the following four categories:

(a) Waters, which are diverted for domestic use by more than 10 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, where such diversion is determined by the department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type F Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50 percent, whichever is less;

(b) Waters, which are diverted for use by federal, state, tribal or private fish hatcheries. Such waters shall be considered Type F Water upstream from the point of diversion for 1,500 feet, including tributaries if highly significant for protection of downstream water quality. The department may allow additional harvest beyond the requirements of Type F Water designation provided the department determines after a landowner-requested on-site assessment by the department of fish and wildlife, department of ecology, the affected tribes and interested parties that:

(i) The management practices proposed by the landowner will adequately protect water quality for the fish hatchery; and

(ii) Such additional harvest meets the requirements of the water type designation that would apply in the absence of the hatchery;

(c) Waters, which are within a federal, state, local, or private campground having more than 10 camping units: Provided, That the water shall not be considered to enter a campground until it reaches the boundary of the park lands available for public use and comes within 100 feet of a camping unit, trail or other park improvement;

(d) Riverine ponds, wall-based channels, and other channel features that are used by fish for off-channel habitat. These areas are critical to the maintenance of optimum survival of fish. This habitat shall be identified based on the following criteria:

(i) The site must be connected to a fish habitat stream and accessible during some period of the year; and

(ii) The off-channel water must be accessible to fish.

(3) **"Type Np Water"** means all segments of natural waters within the bankfull width of defined channels that are perennial non fish habitat streams. Perennial streams are waters that do not go dry any time of a year of normal rainfall. However, for the purpose of water typing, Type Np Waters include the intermittent dry portions of the perennial channel below the uppermost point of perennial flow. If the uppermost point of perennial flow cannot be identified with simple, no technical observations (see board manual, section 23), then

Type Np Waters begin at a point along the channel where the contributing basin area is:

(a) At least 13 acres in the Western Washington coastal zone (which corresponds to the Sitka spruce zone defined in Franklin and Dyrness, 1973);

(b) At least 52 acres in other locations in Western Washington;

(c) At least 300 acres in Eastern Washington.

(4) **"Type Ns Water"** means all segments of natural waters within the bankfull width of the defined channels that are not Type S, F, or Np Waters. These are seasonal, non fish habitat streams in which surface flow is not present for at least some portion of a year of normal rainfall and are not located downstream from any stream reach that is a Type Np Water. Ns Waters must be physically connected by an above-ground channel system to Type S, F, or Np Waters.

*(5) For purposes of this section:

(a) "Residential unit" means a home, apartment, residential condominium unit or mobile home, serving as the principal place of residence.

(b) "Camping unit" means an area intended and used for:

(i) Overnight camping or picnicking by the public containing at least a fireplace, picnic table and access to water and sanitary facilities; or

(ii) A permanent home or condominium unit or mobile home not qualifying as a "residential unit" because of part time occupancy.

(c) "Public accommodation facility" means a business establishment open to and licensed to serve the public, such as a restaurant, tavern, motel or hotel.

(d) "Natural waters" only excludes water conveyance systems which are artificially constructed and actively maintained for irrigation.

(e) "Seasonal low flow" and "seasonal low water" mean the conditions of the 7-day, 2-year low water situation, as measured or estimated by accepted hydrologic techniques recognized by the department.

(f) "Channel width and gradient" means a measurement over a representative section of at least 500 linear feet with at least 10 evenly spaced measurement points along the normal stream channel but excluding unusually wide areas of negligible gradient such as marshy or swampy areas, beaver ponds and impoundments. Channel gradient may be determined utilizing stream profiles plotted from United States geological survey topographic maps (see board manual section 23).

(g) "Intermittent streams" means those segments of streams that normally go dry.

(h) "Fish habitat" means habitat which is used by any fish at any life stage at any time of the year, including potential habitat likely to be used by fish which could be recovered by restoration or management and includes off-channel habitat.

[Statutory Authority: Chapter 34.05 RCW, RCW 76.09.040,[76.09.]050 , [76.09.]370, 76.13.120(9). 01-12-042, § 222-16-030, filed 5/30/01, effective 7/1/01. Statutory Authority: RCW 76.09.040 and chapter 34.05 RCW. 97-24-091, § 222-16-030, filed 12/3/97, effective 1/3/98. Statutory Authority: RCW 76.09.040, 76.09.170 and chapter 34.05 RCW. 94-01-134, § 222-16-030, filed 12/20/93, effective 1/1/94. Statutory Authority: RCW 76.09.040, 76.09.050 and chapter 34.05 RCW. 92-15-011, § 222-16-030, filed 7/2/92, effective 8/2/92. Statutory Authority: RCW 76.09.040. 87-23-036 (Order 535), § 222-16-030, filed 11/16/87, effective 1/1/88; Order 263, § 222-16-030, filed 6/16/76.]

APPENDIX E WATER QUALITY SAMPLING REPORT

1 CEMETERY CREEK

1.1 All Data

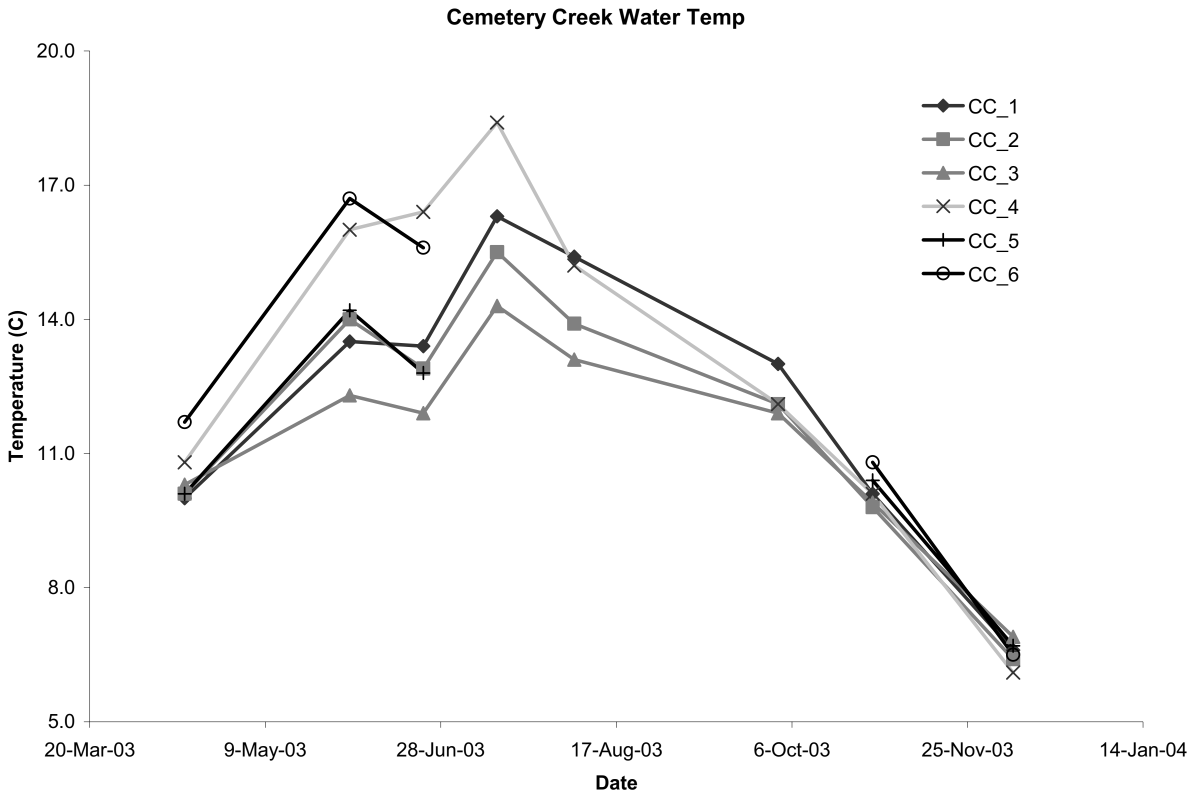
Site	Date	Water Temp (oC)	pH	DO (mg/l)	Turbidity (NTU)	Conductivity (mSiemens)
CC_1	16-Apr-2003	10	7.08	9.3	27	114.6
	2-Jun-2003	13.5	6.98	5.2	16	143.19
	23-Jun-2003	13.4	6.89	4.4	21	160.76
	14-Jul-2003	16.3	6.83	1.4	22	181.86
	5-Aug-2003	15.4	6.84	0.9	24	184.51
	2-Oct-2003	13	6.79	2.5	25	182.98
	29-Oct-2003	10.1	6.91	5.3	18	140.14
	8-Dec-2003	6.6	6.83	5.3	13	102.84
CC_2	16-Apr-2003	10.1	7.31	11.8	19	113.51
	2-Jun-2003	14	7.39	10.8	20	139.5
	23-Jun-2003	12.9	7.45	10.4	23	154.18
	14-Jul-2003	15.5	8.82	9.1	13	164.21
	5-Aug-2003	13.9	7.52	8.6	14	164.13
	2-Oct-2003	12.1	7.74	9.5	14	165.57
	29-Oct-2003	9.8	6.96	10.3	38	137.18
	8-Dec-2003	6.4	7.06	6.8	13	104.77
CC_3	16-Apr-2003	10.3	6.96	11.8	16	132.28
	2-Jun-2003	12.3	7.02	11.2	25	162.61
	23-Jun-2003	11.9	5.97	10.7	39	166.94
	14-Jul-2003	14.3	8.46	10.6	32	176.4
	5-Aug-2003	13.1	8.08	9.2	35	179.77
	2-Oct-2003	11.9	8.04	10.3	37	180.9
	29-Oct-2003	9.9	7.22	10.3	12	150.81
	8-Dec-2003	6.9	7.13	7	6	101

NM = Not Measured (due to low flow)

Site	Date	Water Temp (oC)	pH	DO (mg/l)	Turbidity (NTU)	Conductivity (mSiemens)
CC_4	16-Apr-2003	10.8	6.64	4.5	12	108.06
	2-Jun-2003	16	6.48	4.7	21	121.29
	23-Jun-2003	16.4	6.46	3.8	77	116.08
	14-Jul-2003	18.4	7.14	2.4	15	149.53
	5-Aug-2003	15.2	6.48	5	42	121.85
	2-Oct-2003	12.1	6.52	3.1	63	178.3
	29-Oct-2003	10.1	6.51	4	28	125.06
	8-Dec-2003	6.1	6.73	4.5	17	101.32
CC_5	16-Apr-2003	10.1	7.22	10.2	15	120.97
	2-Jun-2003	14.2	6.84	7.8	18	135.87
	23-Jun-2003	12.8	6.91	8	11	134.05
	14-Jul-2003	NM <-->				
	5-Aug-2003	NM <-->				
	2-Oct-2003	NM <-->				
	29-Oct-2003	10.4	6.8	9.2	16	141.43
	8-Dec-2003	6.7	7.02	7.4	9	114.71
CC_6	16-Apr-2003	11.7	7.04	9.2	12	142.95
	2-Jun-2003	16.7	7.06	7.3	25	185.71
	23-Jun-2003	15.6	6.97	6.9	25	173.68
	14-Jul-2003	NM <-->				
	5-Aug-2003	NM <-->				
	2-Oct-2003	NM <-->				
	29-Oct-2003	10.8	6.75	7.5	21	142.8
	8-Dec-2003	6.5	7.01	6.7	7	132.76

NM = Not Measured (due to low flow)

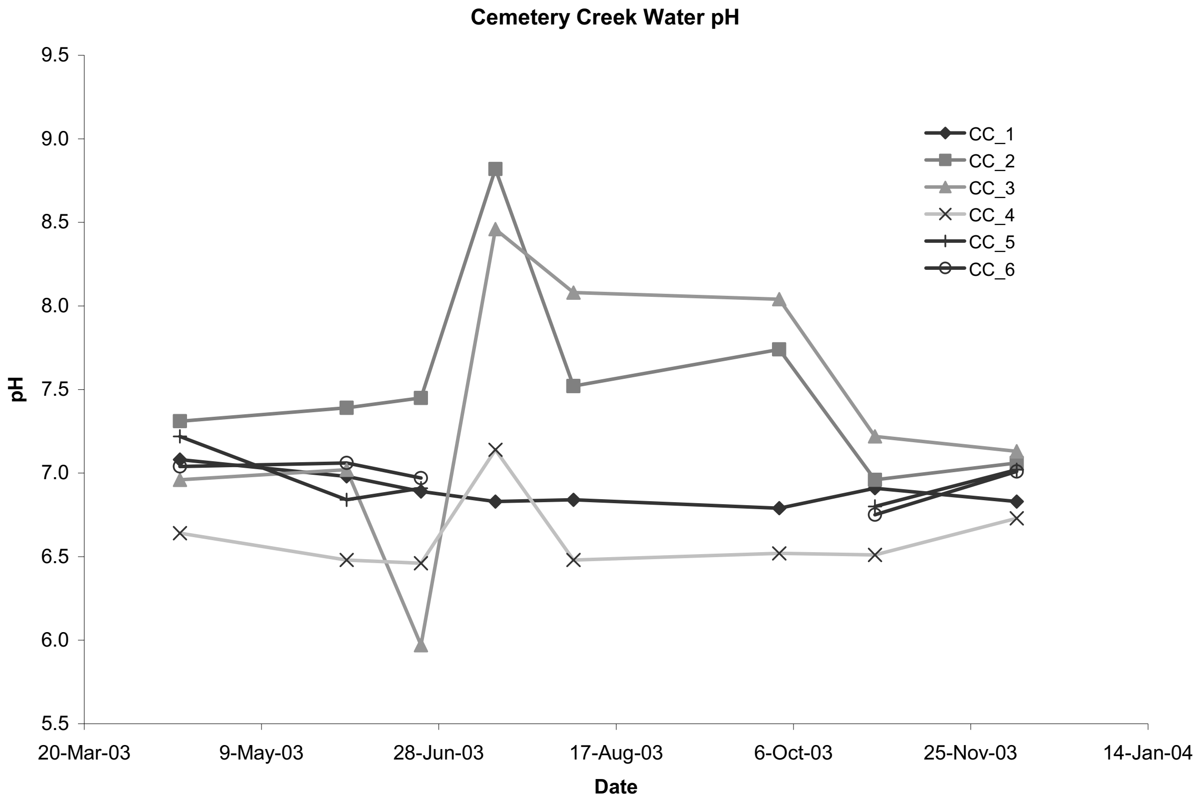
1.2 Water Temperature



Date	Site					
	CC_1	CC_2	CC_3	CC_4	CC_5	CC_6
16-Apr-2003	10	10.1	10.3	10.8	10.1	11.7
2-Jun-2003	13.5	14	12.3	16	14.2	16.7
23-Jun-2003	13.4	12.9	11.9	16.4	12.8	15.6
14-Jul-2003	16.3	15.5	14.3	18.4	NM <--------------------->	
5-Aug-2003	15.4	13.9	13.1	15.2	NM <--------------------->	
2-Oct-2003	13	12.1	11.9	12.1	NM <--------------------->	
29-Oct-2003	10.1	9.8	9.9	10.1	10.4	10.8
8-Dec-2003	6.6	6.4	6.9	6.1	6.7	6.5

NM= Not Measured (due to low flow)

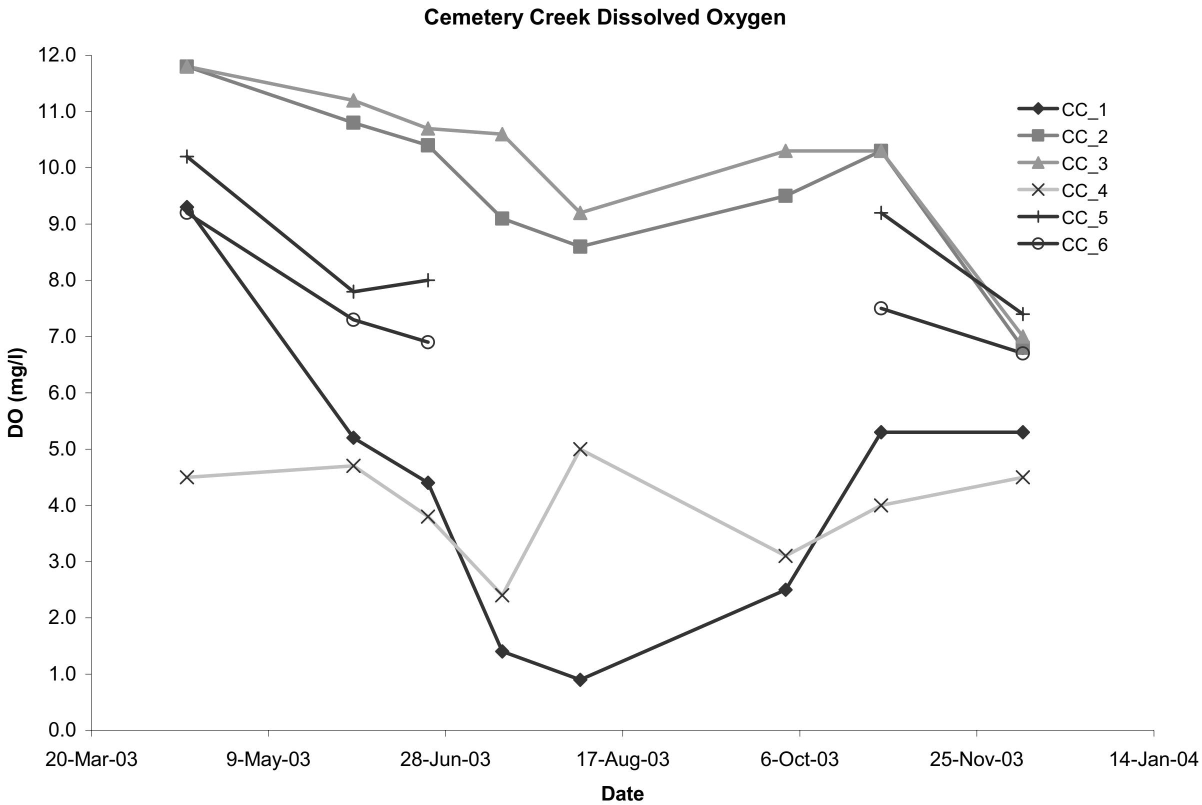
1.3 pH



Date	Site					
	CC_1	CC_2	CC_3	CC_4	CC_5	CC_6
16-Apr-2003	7.08	7.31	6.96	6.64	7.22	7.04
2-Jun-2003	6.98	7.39	7.02	6.48	6.84	7.06
23-Jun-2003	6.89	7.45	5.97	6.46	6.91	6.97
14-Jul-2003	6.83	8.82	8.46	7.14	NM <--------------------->	
5-Aug-2003	6.84	7.52	8.08	6.48	NM <--------------------->	
2-Oct-2003	6.79	7.74	8.04	6.52	NM <--------------------->	
29-Oct-2003	6.91	6.96	7.22	6.51	6.80	6.75
8-Dec-2003	6.83	7.06	7.13	6.73	7.02	7.01

NM= Not Measured (due to low flow)

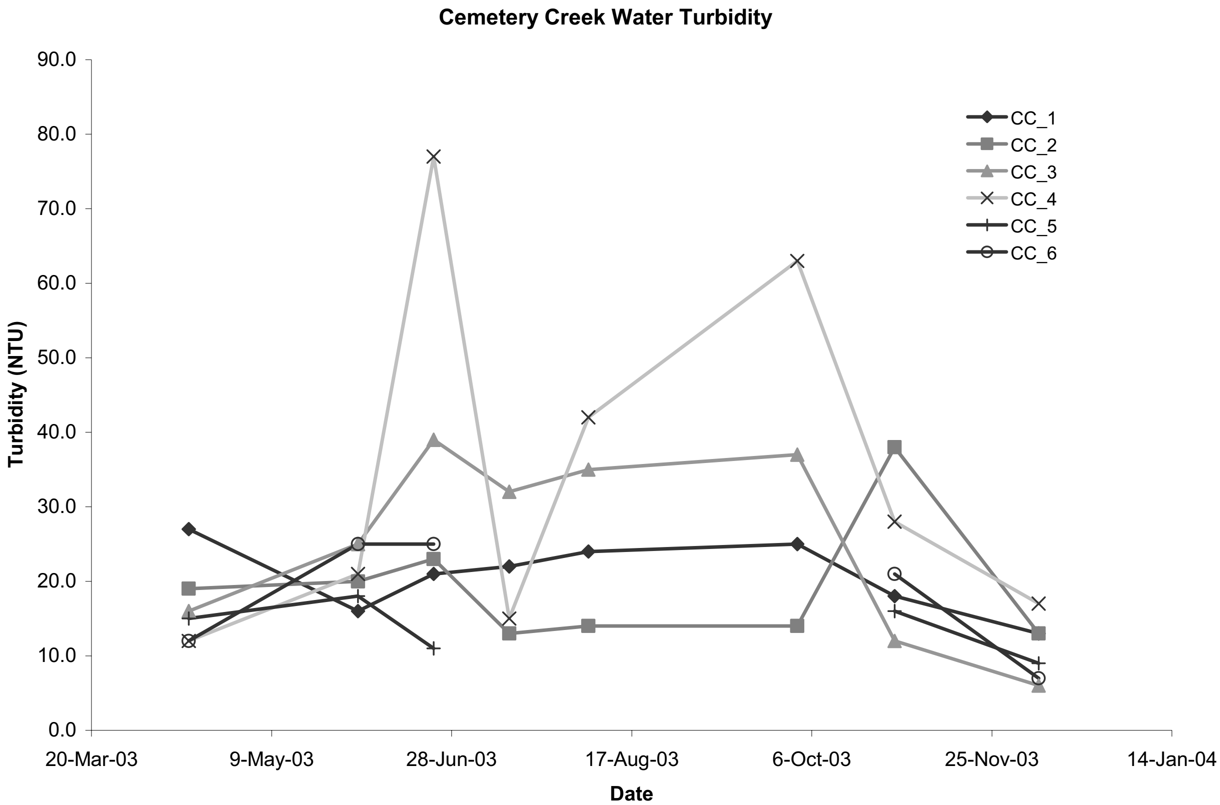
1.4 Dissolved Oxygen



Date	Site					
	CC_1	CC_2	CC_3	CC_4	CC_5	CC_6
16-Apr-2003	9.30	11.80	11.80	4.50	10.20	9.20
2-Jun-2003	5.20	10.80	11.20	4.70	7.80	7.30
23-Jun-2003	4.40	10.40	10.70	3.80	8.00	6.90
14-Jul-2003	1.40	9.10	10.60	2.40	NM <--------------------->	
5-Aug-2003	0.90	8.60	9.20	5.00	NM <--------------------->	
2-Oct-2003	2.50	9.50	10.30	3.10	NM <--------------------->	
29-Oct-2003	5.30	10.30	10.30	4.00	9.20	7.50
8-Dec-2003	5.30	6.80	7.00	4.50	7.40	6.70

NM= Not Measured (due to low flow)

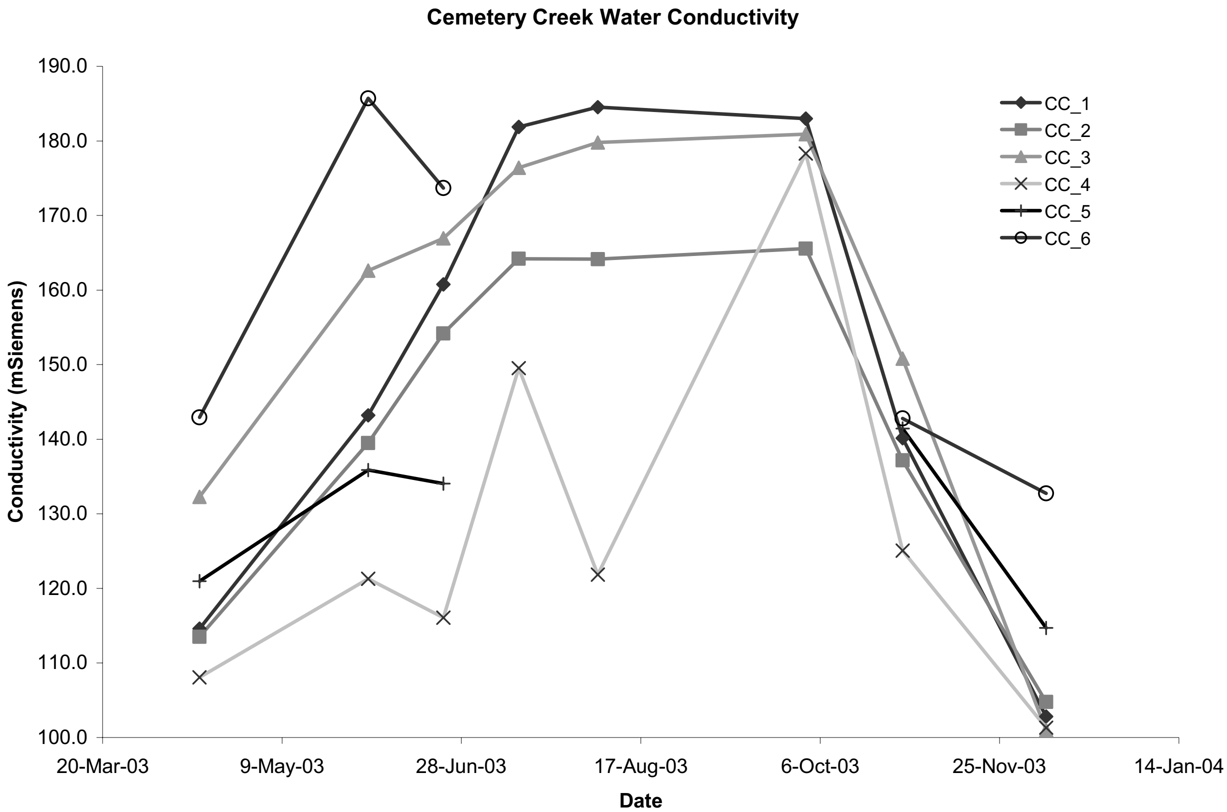
1.5 Turbidity



Date	Site					
	CC_1	CC_2	CC_3	CC_4	CC_5	CC_6
16-Apr-2003	27.00	19.00	16.00	12.00	15.00	12.00
2-Jun-2003	16.00	20.00	25.00	21.00	18.00	25.00
23-Jun-2003	21.00	23.00	39.00	77.00	11.00	25.00
14-Jul-2003	22.00	13.00	32.00	15.00	NM <--------------------->	
5-Aug-2003	24.00	14.00	35.00	42.00	NM <--------------------->	
2-Oct-2003	25	14	37	63	NM <--------------------->	
29-Oct-2003	18	38	12	28	16.00	21.00
8-Dec-2003	13	13	6	17	9.00	7.00

NM= Not Measured (due to low flow)

1.6 Conductivity



Date	Site					
	CC_1	CC_2	CC_3	CC_4	CC_5	CC_6
16-Apr-2003	114.60	113.51	132.28	108.06	120.97	142.95
2-Jun-2003	143.19	139.50	162.61	121.29	135.87	185.71
23-Jun-2003	160.76	154.18	166.94	116.08	134.05	173.68
14-Jul-2003	181.86	164.21	176.40	149.53	NM <--------------------->	
5-Aug-2003	184.51	164.13	179.77	121.85	NM <--------------------->	
2-Oct-2003	182.98	165.57	180.90	178.30	NM <--------------------->	
29-Oct-2003	140.14	137.18	150.81	125.06	141.43	142.80
8-Dec-2003	102.84	104.77	101.00	101.32	114.71	132.76

NM= Not Measured (due to low flow)

1.7 Ecoli

Site	Date	Ecoli (#/100ml)
CC_1	21-Jan-2003	84
	12-Feb-2003	26
	3-Apr-2003	250
	2-Jun-2003	76
	23-Jun-2003	46
	28-Jul-2003	48
	5-Sep-2003	10
	24-Sep-2003	<10
CC_2	21-Jan-2003	92
	12-Feb-2003	78
	3-Apr-2003	100
	2-Jun-2003	140
	23-Jun-2003	
	28-Jul-2003	
	5-Sep-2003	
	24-Sep-2003	
CC_3	21-Jan-2003	82
	12-Feb-2003	170
	3-Apr-2003	88
	2-Jun-2003	
	23-Jun-2003	370
	28-Jul-2003	1300
	5-Sep-2003	530
	24-Sep-2003	680

Site	Date	Ecoli (#/100ml)
CC_4	21-Jan-2003	<2
	12-Feb-2003	4
	3-Apr-2003	10
	2-Jun-2003	
	23-Jun-2003	
	28-Jul-2003	
	5-Sep-2003	
	24-Sep-2003	
CC_5	21-Jan-2003	26
	12-Feb-2003	10
	3-Apr-2003	36
	2-Jun-2003	
	23-Jun-2003	
	28-Jul-2003	
	5-Sep-2003	
	24-Sep-2003	
CC_6	21-Jan-2003	12
	12-Feb-2003	2
	3-Apr-2003	20
	2-Jun-2003	
	23-Jun-2003	
	28-Jul-2003	
	5-Sep-2003	
	24-Sep-2003	

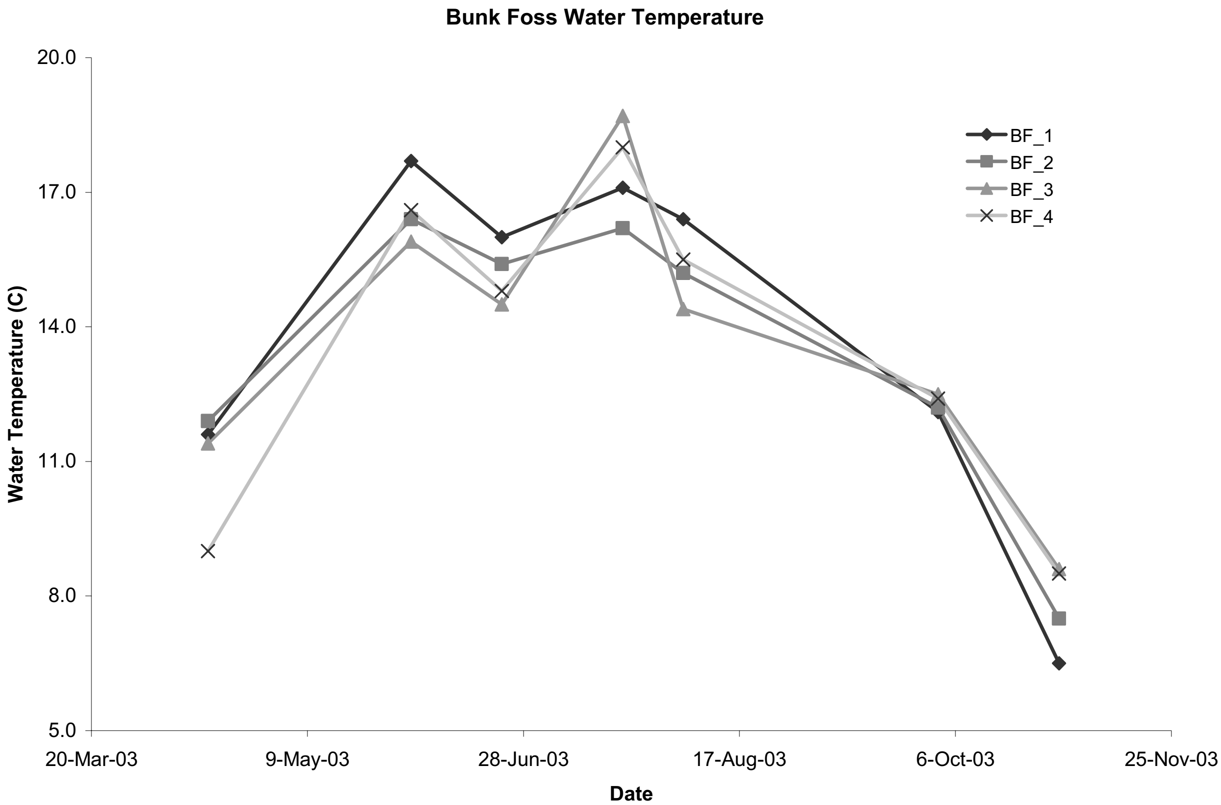
2 BUNK FOSS

2.1 All Data

Site	Date	Water Temp (°C)	pH	DO (mg/l)	Turbidity (NTU)	Conductivity (mSiemens)
BF_1	16-Apr-2003	11.60	7.10	9.20	5.00	119.00
	2-Jun-2003	17.70	6.94	7.50	12.00	174.80
	23-Jun-2003	16.00	6.98	6.70	22.00	177.61
	21-Jul-2003	17.10	6.95	3.90	24.00	303.10
	4-Aug-2003	16.40	6.95	4.40	11.00	293.80
	2-Oct-2003	12.10	6.95	5.70	37.00	219.00
	30-Oct-2003	6.50	6.81	6.10	39.00	138.38
	9-Dec-2003	4.40	6.70	9.60	22.00	100.03
BF_2	16-Apr-2003	11.90	7.20	9.60	9.00	112.31
	2-Jun-2003	16.40	7.17	8.80	7.00	163.09
	23-Jun-2003	15.40	7.02	7.60	18.00	168.3
	21-Jul-2003	16.20	7.18	5.50	8.00	271.00
	4-Aug-2003	15.20	7.12	4.50	16.00	275.20
	2-Oct-2003	12.20	7.12	5.20	31.00	212.40
	30-Oct-2003	7.50	7.04	7.90	17.00	133.49
	9-Dec-2003	4.90	7.20	10.10	13.00	101.72
BF_3	16-Apr-2003	11.40	7.24	10.30	15.00	110.38
	2-Jun-2003	15.90	7.30	10.10	6.00	158.11
	23-Jun-2003	14.50	7.47	9.60	14.00	165.41
	21-Jul-2003	18.70	6.93	1.90	12.00	236.90
	4-Aug-2003	14.40	7.36	6.20	15.00	261.70
	2-Oct-2003	12.50	7.69	8.00	26.00	206.40
	30-Oct-2003	8.60	7.04	7.90	17.00	133.49
	9-Dec-2003	4.90	6.59	9.50	18.00	134.29
BF_4	17-Apr-2003	9.00	7.02	9.90	21.00	117.68
	2-Jun-2003	16.60	7.35	10.10	6.00	161.16
	23-Jun-2003	14.80	7.18	9.00	13.00	165.25
	21-Jul-2003	18.00	7.03	3.40	4.00	275.20
	4-Aug-2003	15.50	7.23	5.10	12.00	266.90
	2-Oct-2003	12.40	7.19	6.70	21.00	209.30
	30-Oct-2003	8.50	6.82	7.70	38.00	136.86
	9-Dec-2003	4.70	7.08	10.20	14.00	106.21

NM = Not Measured (due to low flow)

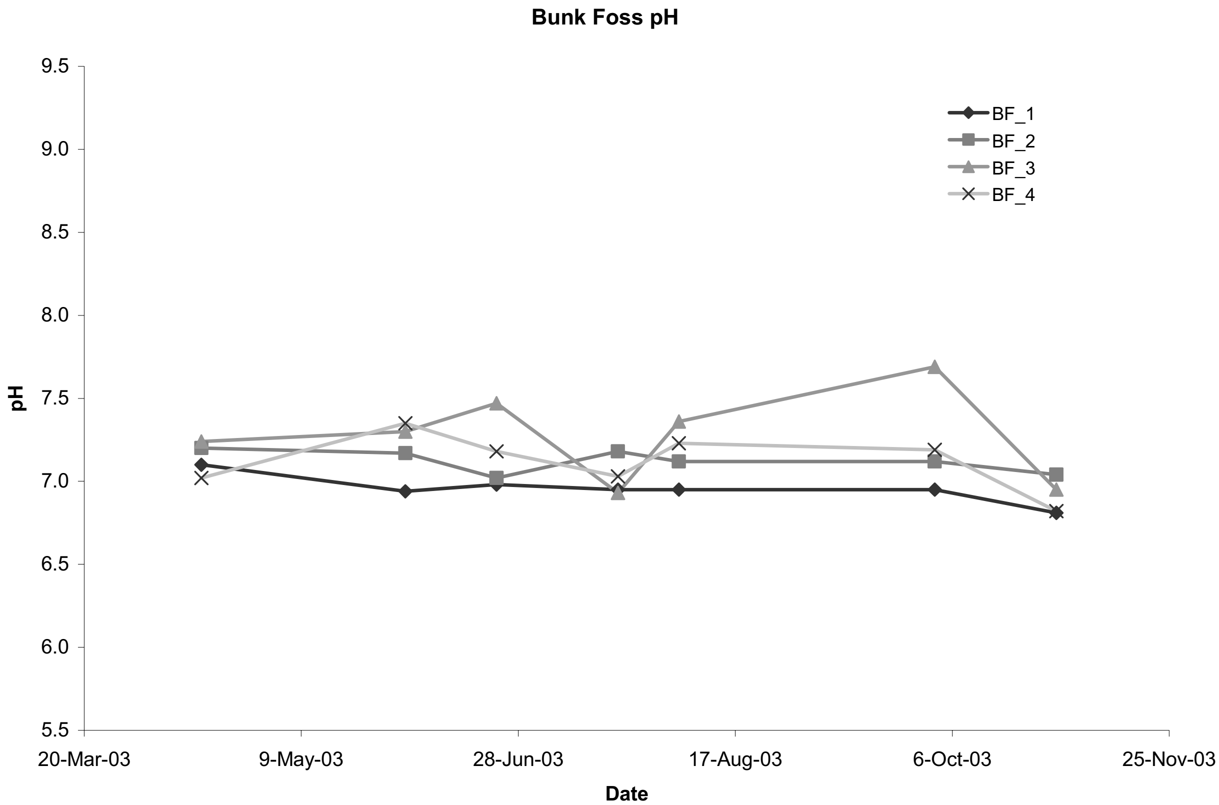
2.2 Water Temperature



Date	Site			
	BF_1	BF_2	BF_3	BF_4
16-Apr-03	11.60	11.90	11.40	9.00
2-Jun-03	17.70	16.40	15.90	16.60
23-Jun-03	16.00	15.40	14.50	14.80
21-Jul-03	17.10	16.20	18.70	18.00
4-Aug-03	16.40	15.20	14.40	15.50
2-Oct-03	12.10	12.20	12.50	12.40
30-Oct-03	6.50	7.50	8.60	8.50
9-Dec-03	4.40	4.90	4.90	4.70

NM = Not Measured (due to low flow)

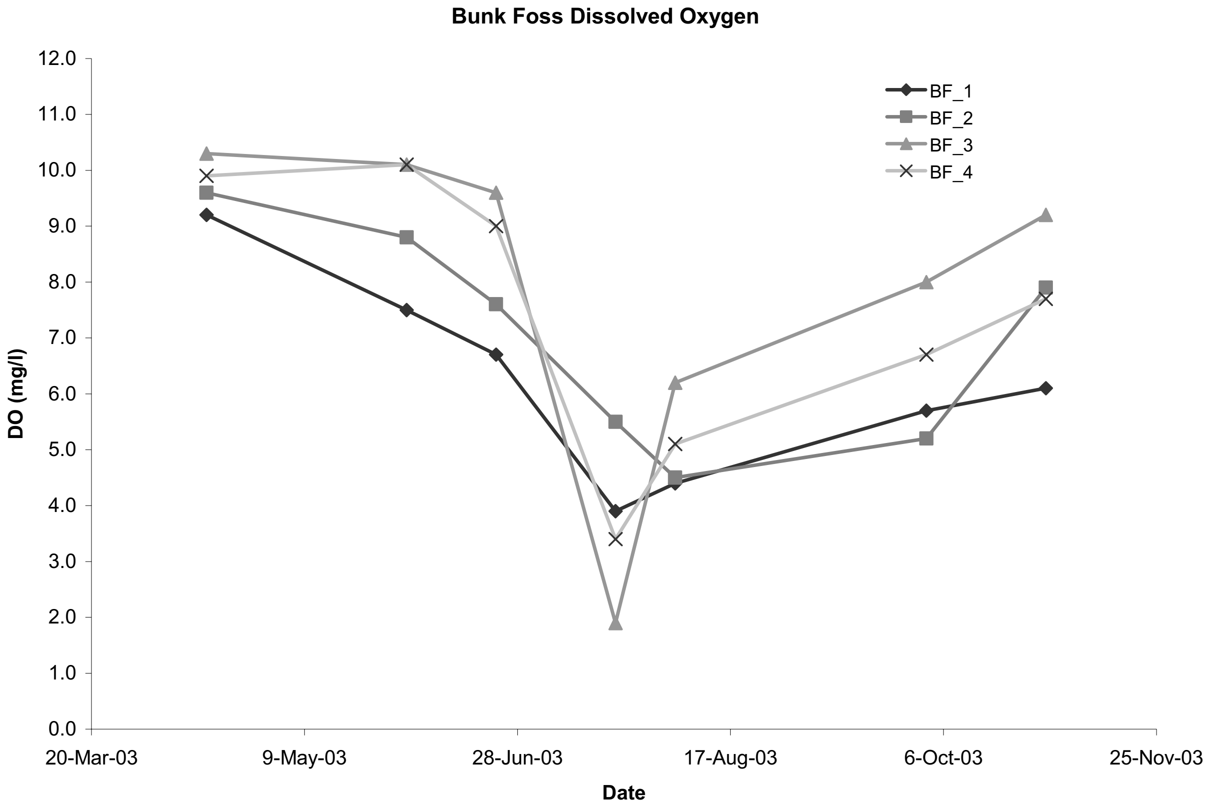
2.3 pH



Date	Site			
	BF_1	BF_2	BF_3	BF_4
16-Apr-03	7.10	7.20	7.24	7.02
2-Jun-03	6.94	7.17	7.30	7.35
23-Jun-03	6.98	7.02	7.47	7.18
21-Jul-03	6.95	7.18	6.93	7.03
4-Aug-03	6.95	7.12	7.36	7.23
2-Oct-03	6.95	7.12	7.69	7.19
30-Oct-03	6.81	7.04	6.95	6.82
9-Dec-03	9.60	7.20	6.59	7.08

NM = Not Measured (due to low flow)

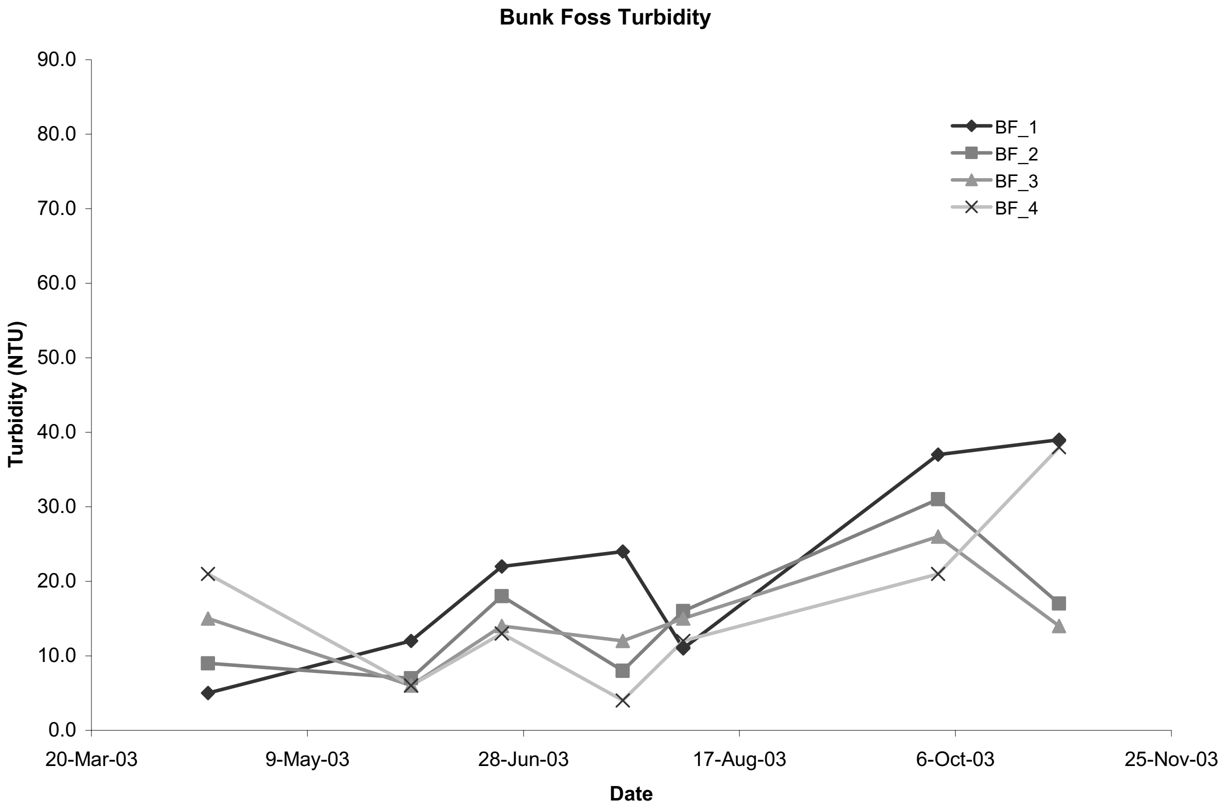
2.4 Dissolved Oxygen



Date	Site			
	BF_1	BF_2	BF_3	BF_4
16-Apr-03	9.20	9.60	10.30	9.90
2-Jun-03	7.50	8.80	10.10	10.10
23-Jun-03	6.70	7.60	9.60	9.00
21-Jul-03	3.90	5.50	1.90	3.40
4-Aug-03	4.40	4.50	6.20	5.10
2-Oct-03	5.70	5.20	8.00	6.70
30-Oct-03	6.10	7.90	9.20	7.70
9-Dec-03	9.60	10.10	9.50	10.20

NM = Not Measured (due to low flow)

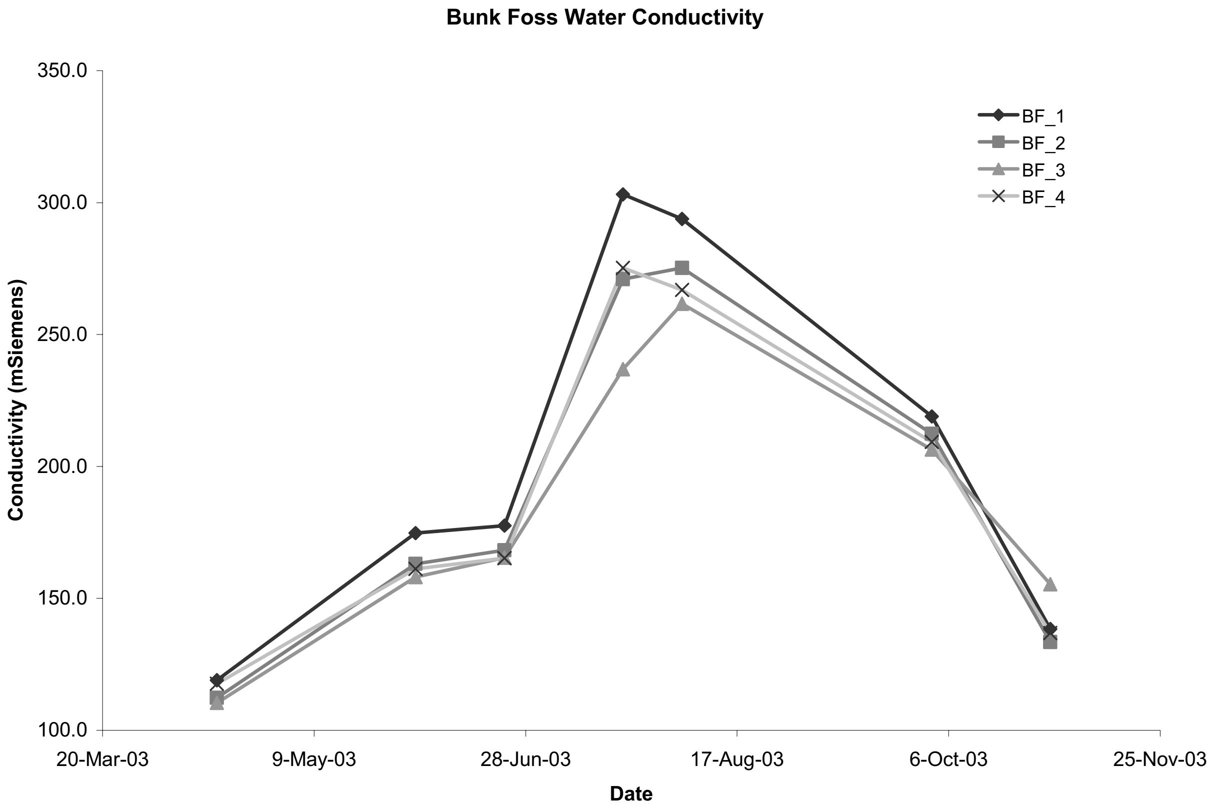
2.5 Turbidity



Date	Site			
	BF_1	BF_2	BF_3	BF_4
16-Apr-03	5.00	9.00	15.00	21.00
2-Jun-03	12.00	7.00	6.00	6.00
23-Jun-03	22.00	18.00	14.00	13.00
21-Jul-03	24.00	8.00	12.00	4.00
4-Aug-03	11.00	16.00	15.00	12.00
2-Oct-03	37.00	31.00	26.00	21.00
30-Oct-03	39.00	17.00	14.00	38.00
9-Dec-03	22.00	13.00	18.00	14.00

NM = Not Measured (due to low flow)

2.6 Conductivity



Date	Site			
	BF_1	BF_2	BF_3	BF_4
16-Apr-03	119.00	112.31	110.38	117.68
2-Jun-03	174.80	163.09	158.11	161.16
23-Jun-03	177.61	168.3	165.41	165.25
21-Jul-03	303.10	271.00	236.90	275.20
4-Aug-03	293.80	275.20	261.70	266.90
2-Oct-03	219.00	212.40	206.40	209.30
30-Oct-03	138.38	133.49	155.39	136.86
9-Dec-03	100.03	101.72	134.29	106.21

NM = Not Measured (due to low flow)

2.7 Ecoli

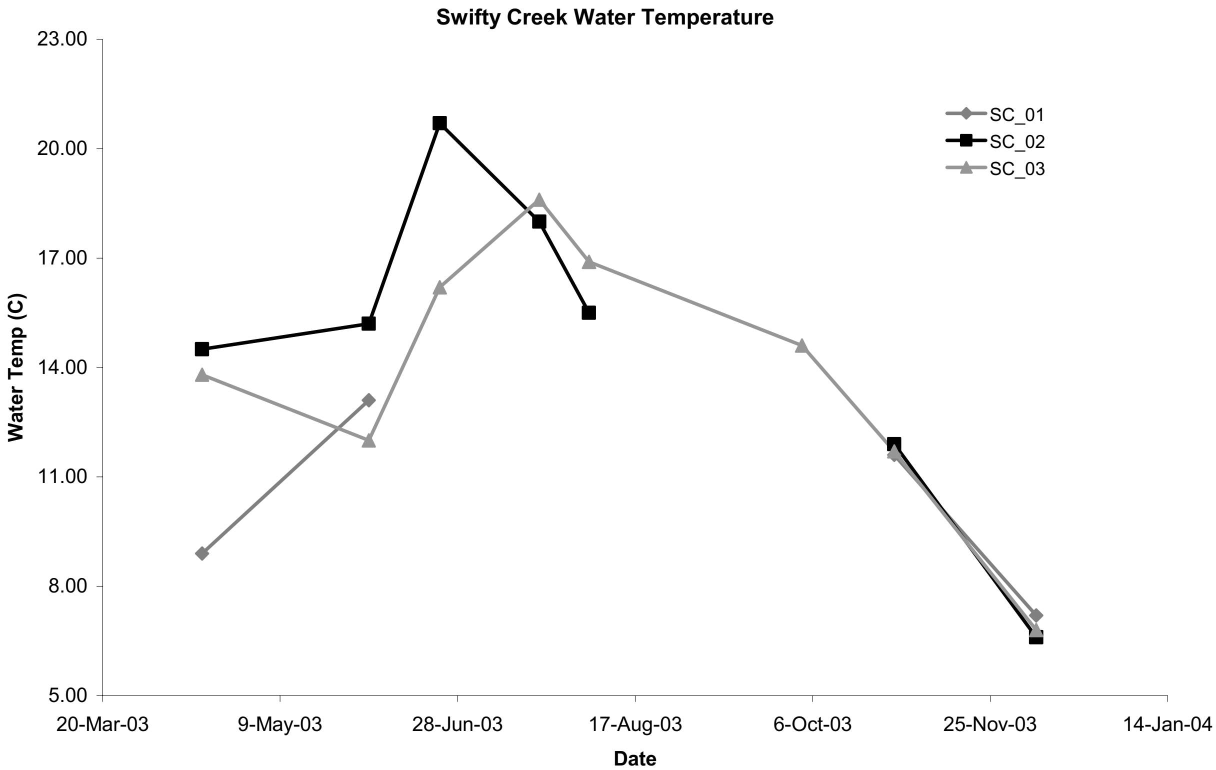
Site	Date	Ecoli (#/100ml)
BF_1	21-Jan-2003	18
	12-Feb-2003	4
	3-Apr-2003	32
	2-Jun-2003	26
	23-Jun-2003	42
	28-Jul-2003	310
	5-Sep-2003	60
	24-Sep-2003	
BF_2	21-Jan-2003	40
	12-Feb-2003	24
	3-Apr-2003	48
	2-Jun-2003	
	23-Jun-2003	
	28-Jul-2003	
	5-Sep-2003	
	24-Sep-2003	
BF_3	21-Jan-2003	34
	12-Feb-2003	24
	3-Apr-2003	62
	2-Jun-2003	
	23-Jun-2003	
	28-Jul-2003	
	5-Sep-2003	
	24-Sep-2003	
BF_4	21-Jan-2003	10
	12-Feb-2003	16
	3-Apr-2003	34
	2-Jun-2003	
	23-Jun-2003	
	28-Jul-2003	
	5-Sep-2003	
	24-Sep-2003	10

3 SWIFTY CREEK
3.1 All Data

Site	Date	Water Temp (°C)	pH	DO (mg/l)	Turbidity (NTU)	Conductivity (mSiemens)
SC_01	17-Apr-2003	8.90	7.01	11.30	25.00	85.19
	3-Jun-2003	13.10	6.14	4.00	17.00	84.47
	23-Jun-2003	NM <------------------------------------->				
	21-Jul-2003	NM <------------------------------------->				
	4-Aug-2003	NM <------------------------------------->				
	2-Oct-2003	NM <------------------------------------->				
	29-Oct-2003	11.60	6.67	8.50	18.00	126.11
	8-Dec-2003	7.20	6.87	7.80	6.00	91.93
SC_02	17-Apr-2003	14.50	7.20	10.40	23.00	86.00
	3-Jun-2003	15.20	6.80	5.30	15.00	87.60
	23-Jun-2003	20.70	7.22	8.60	13.00	88.56
	21-Jul-2003	18.00	6.75	2.80	5.00	93.22
	4-Aug-2003	15.50	6.72	2.10	12.00	93.94
	2-Oct-2003	NM <------------------------------------->				
	29-Oct-2003	11.90	6.22	4.40	41.00	66.58
	8-Dec-2003	6.60	7.04	6.60	9.00	85.76
SC_03	17-Apr-2003	13.80	NM	10.60	50.00	54.63
	3-Jun-2003	12.00	7.32	9.80	18.00	125.87
	23-Jun-2003	16.20	7.90	8.80	18.00	87.52
	21-Jul-2003	18.60	7.08	7.30	14.00	112.55
	4-Aug-2003	16.90	7.38	7.30	10.00	106.77
	3-Oct-2003	14.60	7.40	8.50	13.00	127.71
	29-Oct-2003	11.70	6.72	9.00	25.00	77.05
	8-Dec-2003	6.80	7.12	8.20	38.00	88.22

NM = Not Measured (due to low flow)

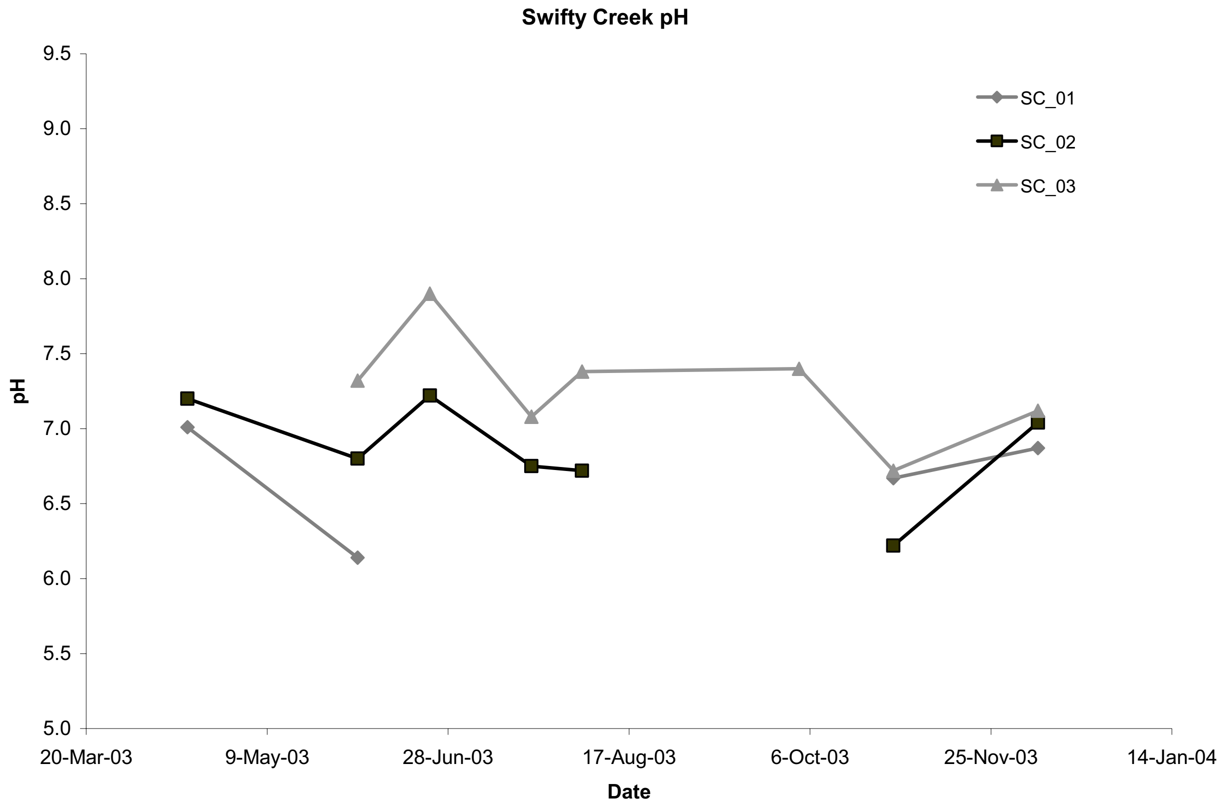
3.2 Water Temperature



Date		Site	
	SC_1	SC_2	SC_3
17-Apr-03	8.90	14.50	13.80
03-Jun-03	13.10	15.20	12.00
23-Jun-03	NM	20.70	16.20
21-Jul-03	NM	18.00	18.60
04-Aug-03	NM	15.50	16.90
02-Oct-03	NM <------------------>		14.60
29-Oct-03	11.60	11.90	11.70
08-Dec-03	7.20	6.60	6.80

NM = Not Measured (due to low flow)

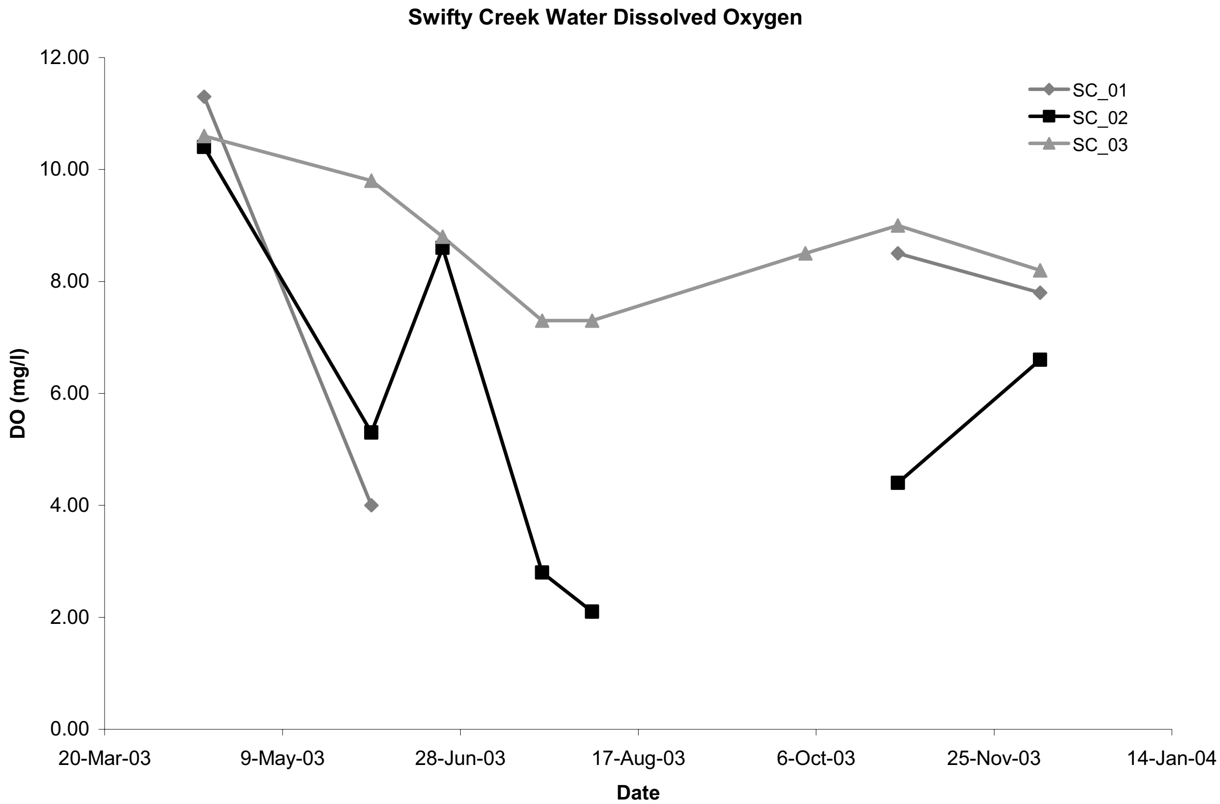
3.3 pH



Date	Site		
	SC_1	SC_2	SC_3
17-Apr-03	6.00	7.20	NM
03-Jun-03	6.14	6.80	7.32
23-Jun-03	NM	7.22	7.90
21-Jul-03	NM	6.75	7.08
04-Aug-03	NM	6.72	7.38
02-Oct-03	NM <------------------>		7.40
29-Oct-03	6.67	6.22	6.72
08-Dec-03	6.87	7.04	7.12

NM = Not Measured (due to low flow)

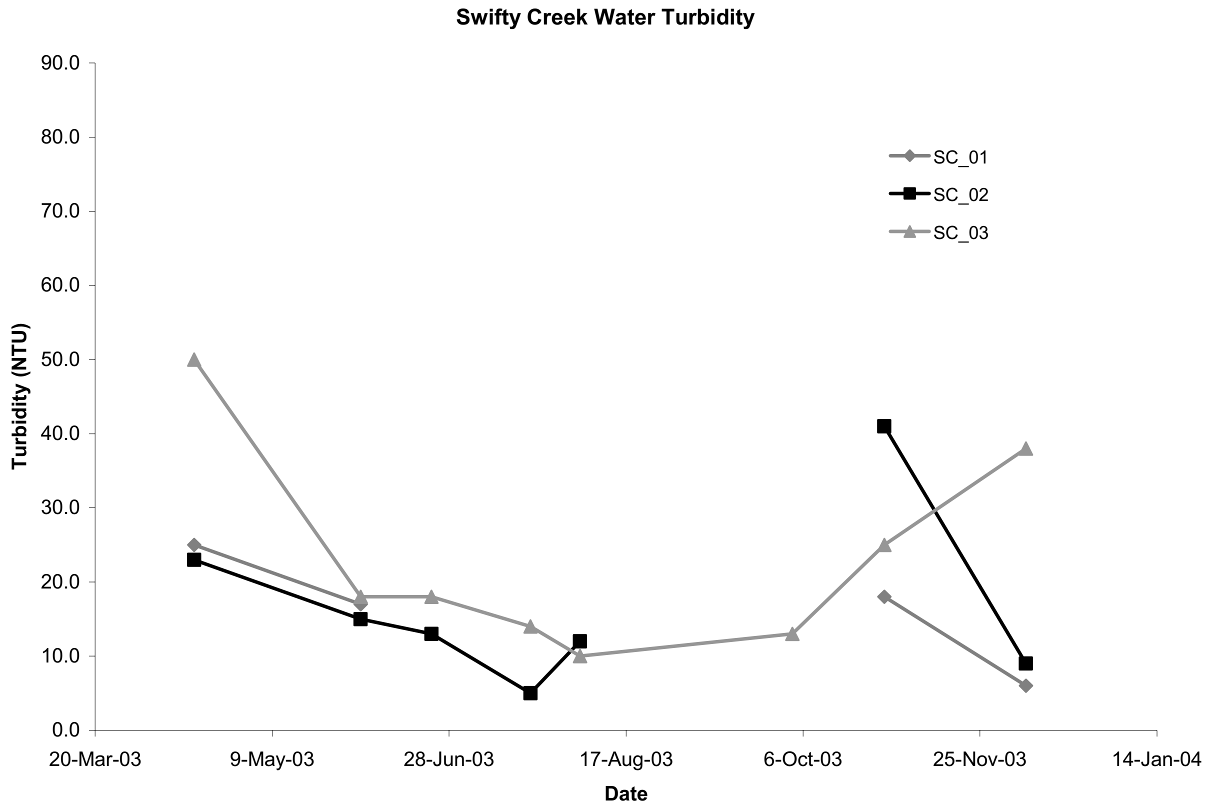
3.4 Dissolved Oxygen



Date	Site		
	SC_1	SC_2	SC_3
17-Apr-03	11.30	10.40	10.60
03-Jun-03	4.00	5.30	9.80
23-Jun-03	NM	8.60	8.80
21-Jul-03	NM	2.80	7.30
04-Aug-03	NM	2.10	7.30
02-Oct-03	NM <------------------>		8.50
29-Oct-03	8.50	4.40	9.00
08-Dec-03	7.80	6.60	8.20

NM = Not Measured (due to low flow)

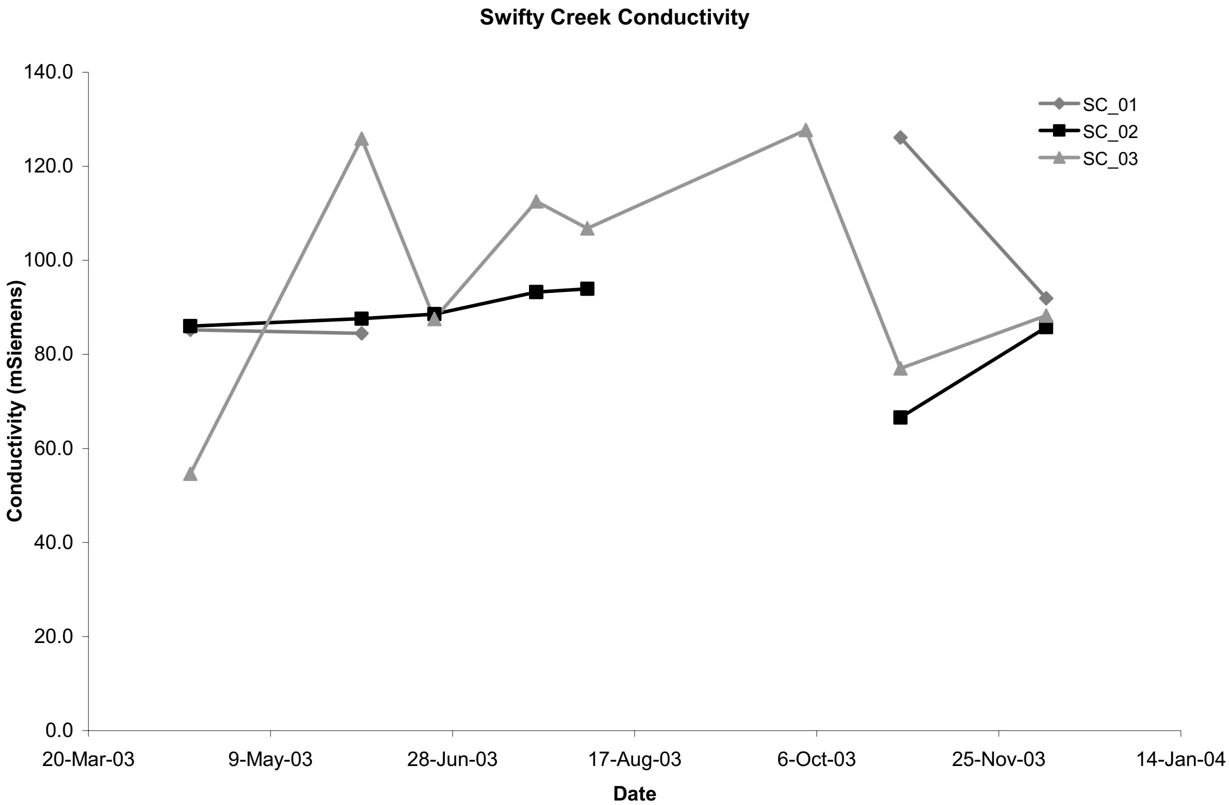
3.5 Water Turbidity



Date	Site		
	SC_1	SC_2	SC_3
17-Apr-03	25.00	23.00	50.00
03-Jun-03	17.00	15.00	18.00
23-Jun-03	NM	13.00	18.00
21-Jul-03	NM	5.00	14.00
04-Aug-03	NM	12.00	10.00
02-Oct-03	NM <------------------>		13.00
29-Oct-03	18.00	41.00	25.00
08-Dec-03	6.00	9.00	38.00

NM = Not Measured (due to low flow)

3.6 Conductivity



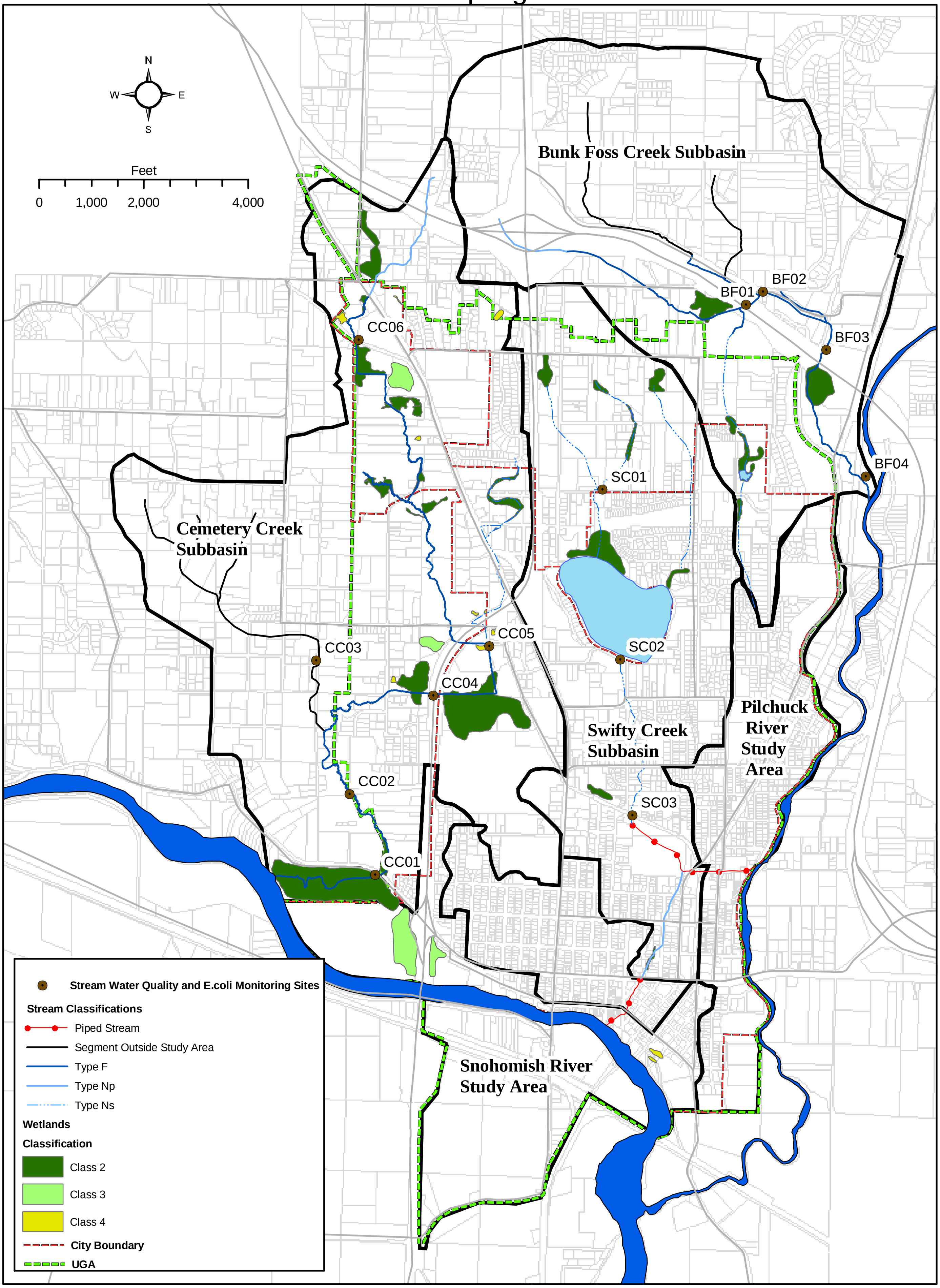
Date	Site		
	SC_1	SC_2	SC_3
17-Apr-03	85.19	86.00	54.63
03-Jun-03	84.47	87.60	125.87
23-Jun-03	NM	88.56	87.52
21-Jul-03	NM	93.22	112.55
04-Aug-03	NM	93.94	106.77
02-Oct-03	NM <------------------>		127.71
29-Oct-03	126.11	66.58	77.05
08-Dec-03	91.93	85.76	88.22

NM = Not Measured (due to low flow)

3.7 Ecoli

Site	Date	Ecoli (#/100ml)
SC_1	21-Jan-2003	12
	12-Feb-2003	2
	3-Apr-2003	52
	2-Jun-2003	1000
	23-Jun-2003	290
	28-Jul-2003	
	5-Sep-2003	
	24-Sep-2003	
SC_2	21-Jan-2003	8
	12-Feb-2003	200
	3-Apr-2003	18
	2-Jun-2003	
	23-Jun-2003	
	28-Jul-2003	44
	5-Sep-2003	380
	24-Sep-2003	130
SC_3	21-Jan-2003	300
	12-Feb-2003	110
	3-Apr-2003	90
	2-Jun-2003	
	23-Jun-2003	
	28-Jul-2003	1400
	5-Sep-2003	2900
	24-Sep-2003	870

Snohomish ESA Monthly Water Quallity Monitoring and E.coli Sampling Locations.



State Freshwater Standards (WDOE 2003)

5.1 Temperature

Category	Highest 7-DADMax
Char	12°C (53.6°F)
Salmon and Trout Spawning, **Core** Rearing, and Migration	16°C (60.8°F)
Salmon and Trout Spawning, **Non core** Rearing, and Migration	17.5°C (63.5°F)
Salmon and Trout Rearing and Migration **Only**	17.5°C (63.5°F)
Non-anadromous Interior Redland Trout	18°C (64.4°F)
Indigenous Warm Water Species	20°C (68°F)

5.2 Dissolved Oxygen

Category	Lowest 1-Day Minimum
Char	9.5 mg/L
Salmon and Trout Spawning, **Core** Rearing, and Migration	9.5 mg/L
Salmon and Trout Spawning, **Non core** Rearing, and Migration	8.0 mg/L
Salmon and Trout Rearing and Migration **Only**	6.5 mg/L
Non-anadromous Interior Redband Trout	8.0 mg/L
Indigenous Warm Water Species	6.5 mg/L

5.3 Turbidity

Category	NTUs
Char	Turbidity shall not exceed: • 5 NTU over background when the background is 50 NTU or less; or • A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Salmon and Trout Spawning, **Core** Rearing, and Migration	Same as above
Salmon and Trout Spawning, **Non core** Rearing, and Migration	Same as above.
Salmon and Trout Rearing and Migration **Only**	Turbidity shall not exceed: • 10 NTU over background when the background is 50 NTU or less; or • A 20 percent increase in turbidity when the background turbidity is more than 50 NTU.
Non-anadromous Interior Redband Trout	Turbidity shall not exceed: • 5 NTU over background when the background is 50 NTU or less; or • A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Indigenous Warm Water Species	Turbidity shall not exceed: • 10 NTU over background when the background is 50 NTU or less; or • A 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

5.4 Dissolved Oxygen

Category	Percent Saturation
Char	Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.
Salmon and Trout Spawning, **Core** Rearing, and Migration	Same as above
Salmon and Trout Spawning, **Non core** Rearing, and Migration	Same as above
Salmon and Trout Rearing and Migration **Only**	Same as above
Non-anadromous Interior Redband Trout	Same as above.
Indigenous Warm Water Species	Same as above.

5.5 pH

Category	pH Units
Char	pH shall be within the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.2 units.
Salmon and Trout Spawning, **Core** Rearing, and Migration	Same as above.
Salmon and Trout Spawning, **Non core** Rearing, and Migration	pH shall be within the range of 6.5 to 8.5 with a human-caused variation within the above range of less than 0.5 units.
Salmon and Trout Rearing and Migration **Only**	Same as above.
Non-anadromous Interior Redband Trout	Same as above.
Indigenous Warm Water Species	Same as above.

6 REFERENCES

Washington Department of Ecology (WDOE). 2003. Water Quality Standards for Surface Waters of the State of Washington. July 1, 2003. Chapter 173-201A WAC.

APPENDIX F REPORT TO PUGET SOUNDKEEPER ALLIANCE
Macroinvertebrate, Contaminant and Nutrient Loading Monitoring in the City of Snohomish Urban Growth Area (UGA)

As part of the settlement of a lawsuit between the Puget Soundkeeper Alliance and the City of Snohomish, which alleged that effluent from the City's wastewater treatment plant violated its National Pollution Discharge Elimination System permit, the City contracted with the Sustainable Fisheries Foundation to test City streams for water quality parameters and indicators of biological health that were not included in the original scope of the ESA Strategy. The Sustainable Fisheries Foundation in turn contracted with Steward and Associates to perform this work, allowing the results to be incorporated into the Strategy.

1 BACKGROUND

1.1 Contaminant and Nutrient Loading Monitoring

Loading sampling within the City of Snohomish Urban Growth Area (UGA) was designed to establish baseline water quality data and to test current conditions in Cemetery and Bunk Foss creeks. Measured parameters include total phosphorus (TP), total kjeldahl nitrogen (TKN), biological oxygen demand (BOD), pesticides, herbicides, hydrocarbons, and metals (cadmium, copper, lead, and zinc).

1.2 Benthic Macroinvertebrates

Benthic macroinvertebrate (BMI) sampling was designed to test the biological implications of current water quality conditions and land uses within the City of Snohomish UGA. Specifically, BMI communities were sampled to determine the abundance and composition of organisms within local creeks and rivers.

There are many advantages associated with the use of BMI as indicators of ecosystem health and stability. Barbour et al. suggest the following advantages in their 1999 U.S. Environmental Protection Agency (USEPA) report:

- Macroinvertebrate assemblages are good indicators of localized conditions. Because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life, they are particularly well suited for assessing site-specific impacts (upstream-downstream studies).
- Macroinvertebrates integrate the effects of short-term environmental variations. Most species have a complex life cycle of approximately one year or more. Sensitive life stages will respond quickly to stress; the overall community will respond more slowly.
- An experienced biologist with only a cursory examination of the benthic macroinvertebrate assemblage can often detect degraded conditions. Macro-invertebrates are relatively easy to identify to family; many "intolerant" taxa can be identified to lower taxonomic levels with ease.

- Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects.
- Sampling is relatively easy, requires few people and inexpensive gear and has minimal detrimental effect on the resident biota.
- Benthic macroinvertebrates serve as a primary food source for fish, including many recreationally and commercially important species.
- Benthic macroinvertebrates are abundant in most streams. Many small streams (1st and 2nd order), which naturally support a diverse macroinvertebrate fauna, only support a limited fish fauna.
- Most state water quality agencies that routinely collect biosurvey data focus on macroinvertebrates (Southerland and Stribling 1995). Many states already have background macroinvertebrate data. Most state water quality agencies have more expertise with invertebrates than fish.

2 METHODS

2.1 Contaminant and Nutrient Loading

Water quality grab samples were collected both April 29 and July 28 of 2003 in Cemetery Creek (CC1, CC6, CCPM), Harkins Fork of Cemetery Creek (CCHF), and Bunk Foss Creek (BF1) (see Map 1 for site locations). April samples included pesticides, herbicides, and metals (Cd, Cu, Pb, Zn); July samples included pesticides, herbicides, metals (Cd, Cu, Pb, Zn), total phosphorus (TP), total kjeldahl nitrogen (TKN), biological oxygen demand (BOD), and hydrocarbons. Samples were immediately delivered to and processed at the Everett Environmental Laboratory in Everett, Washington.

2.2 Benthic Macroinvertebrates

Benthic macroinvertebrates (BMI) were samples were collected in Cemetery Creek, Bunk Foss Creek, and the Pilchuck River September 8, 2003 (see Map 1 for site locations). Samples were collected from Cemetery Creek adjacent to the Grand Army Republic Cemetery; from Bunk Foss Creek near the intersection of Old Machias Road and Bunk Foss Road; and from the Pilchuck River just downstream of the 6th Street bridge. A surber sampler was used to sample BMI in riffle habitat of the sampled streams. Selected riffles were long enough to accommodate three replicate samples. Sampling began in the downstream portion of the riffle and proceeded upstream for the three replicates. At each replicate sampling location the following protocol were used:

- Place Surber sampler on the selected spot with the opening of the nylon net facing upstream. Brace the frame and hold it firmly on the creek bottom.

- Lift the larger rocks resting within the frame and brush off crawling or attached loosely organisms so that they drift into the net. After 'cleaning' the rocks, place them in a bucket.

- Once the larger rocks are removed, disturb the substrate vigorously with a trowel or large spike for 60 seconds. This disturbance should extend to a depth of about 10 cm to loosen organisms in the interstitial spaces, washing them into the net.

- Lift Surber out of the water. Tilt the net up and out of the water while keeping the open end upstream. This helps to wash the organisms into the receptacle.

- On the creek bank, empty contents of Surber into large bucket. Rinse Surber and empty into bucket until all animals are removed. Great care should be taken in this step to collect and preserve all organisms from the Surber sampler as well as from the rocks and water in the bucket. Use of a magnifying glass and tweezers is essential. Rinse bucket through sieve to remove water from sample. Pick out large debris (sticks and leaves) after carefully removing any invertebrates.

- Use spatula to move sample from sieve into a plastic vial. Fill vial to the top with isopropyl alcohol. Put label on inside of vial with name of sampler, date, location, and replicate number. Write location and date on top of vial lid. Place vial in a Ziploc bag labeled with the same information.

- Return to the location of the first sample, walk upstream and collect another sample of invertebrates. Repeat this process once more for a total of three replicate samples from each site location. Each replicate should be labeled (e.g., #1, #2, #3) and archived separately.

Samples were shipped to Rhithron Associates in Missoula, Montana for identification and processing. Rhithron Associates incorporated the results of the BMI processing into a Benthic Index of Biotic Integrity (B-IBI). The B-IBI is a quantitative assessment of invertebrate condition based on several measures of community condition (biometrics). Dr. James R. Karr (University of Washington) and his colleagues, Dr. Billie Kerans and Leska Fore, have developed this tool for use in Pacific Northwest (PNW) streams. Biometric descriptions from the B-IBI are shown below (www.salmonweb.org). Each of the above biometrics is assigned a score (1, 3, or 5) based on the criteria outlined in Table 1. The quantitative result of the B-IBI is the sum of the scores from Table 1. The health of the sampled stream is based on the interpretation of this score. Table 2 outlines the qualitative stream health interpretation of the resultant quantitative score.

Total Taxa Richness
The total number of unique taxa is identified in each replicate. The numbers from the three replicates are then averaged for this metric.

Ephemeroptera Taxa Richness
The total number of unique mayfly (Ephemeroptera) taxa is identified in each replicate. The numbers from the three replicates are then averaged for this metric.

Plecoptera Taxa Richness
The total number of unique stonefly (Plecoptera) taxa is identified in each replicate. The numbers from the three replicates are then averaged for this metric.

Trichoptera Taxa Richness
The total number of unique caddisfly (Tricoptera) taxa is identified in each replicate. The numbers from the three replicates are then averaged for this metric.

Number of Intolerant Taxa
The cumulative number of unique intolerant taxa identified across all three replicates.

Number of Clinger Taxa
The total number of unique clinger taxa is identified in each replicate. The numbers from the three replicates are then averaged for this metric.

Number of Long-Lived Taxa
The cumulative number of unique long-lived taxa identified across all three replicates.

Percent Tolerant Individuals
The total number of tolerant individuals counted in each replicate, divided by the total number of individuals in that replicate, *multiplied by 100.* The percentages from the three replicates are then averaged for this metric.

Percent Predator Individuals
The total number of predator individuals counted in each replicate, divided by the total number of individuals in that replicate, *multiplied by 100.* The percentages from the three replicates are then averaged for this metric.

Percent Dominance
The sums of individuals in the three (3) most abundant taxa in each replicate, divided by the total number of individuals in that replicate, *multiplied by 100.* The percentages from the three replicates are then averaged for this metric.

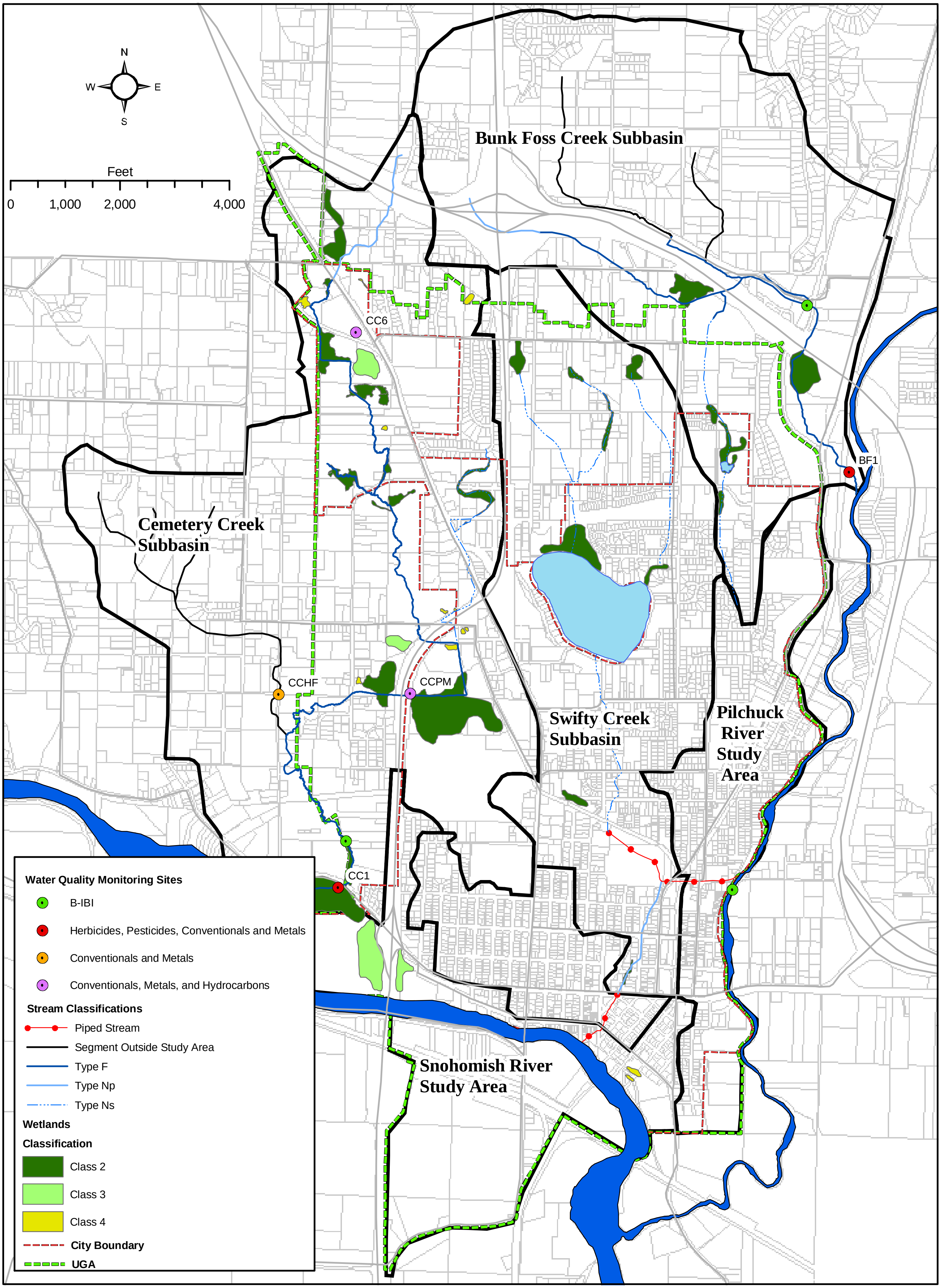
Table 1. **Scoring criteria for B-IBI (Morley 2000).**

	Scoring Criteria		
Metric	**1**	**3**	**5**
Taxa richness and composition			
Total number of taxa	<14	14-28	> 28
Number of Ephemeroptera (mayfly) taxa	<3.5	3.5-7	> 7
Number of Plecoptera (stonefly) taxa	<2.7	2.7-5.3	> 5.3
Number of Trichoptera (caddisfly) taxa	<2.7	2.7-5.3	>5.3
Number of long-lived taxa	<4	4-8	> 8
Tolerance			
Number of intolerant taxa	<2	2-4	> 4
% of individuals in tolerant taxa	> 44	27-44	< 27
Feeding ecology			
% of predator individuals	<4.5	4.5-9	> 9
Number of clinger taxa	<8	8-16	> 16
Population attributes			
% dominance (top 3 taxa)	≥ 75	55-74	<55

Table 2. Stream health interpretation based on the quantitative score from the B-IBI (Morley 2000).

B-IBI Score	Stream Condition
46-50	Excellent
38-44	Good
28-36	Fair
18-26	Poor
10-16	Very Poor

Macroinvertebrate, Nutrient and Contaminant Loading Monitoring Sites



3 RESULTS AND IMPLICATIONS

3.1 Contaminant and Nutrient Loading

The quality of water within the Cemetery Creek basin varies both seasonally and spatially (Table 3). Tests found high phosphorus in CCPM downstream of the Plant Mulch Company. High phosphorus concentrations are often related to low dissolved oxygen concentrations in surface waters, since they can lead to excessive growths of aquatic vegetation (i.e. algae, macrophytes), which in turn will deplete dissolved oxygen concentrations as they decompose. The high phosphorus concentrations in this reach of the stream are most likely due to influence from the wetland, rather than the Plant Mulch Company.

Hydrocarbons (e.g., diesel fuel, motor oil) were high in ditch runoff near Bickford Motors along Fobes Road (CC06). Under normal conditions, water from this ditch does not flow directly into Cemetery Creek, but flows into a natural bioswale that infiltrates into the groundwater directly adjacent to the creek. During periods of high runoff, water from the ditch near Bickford Motors likely flows along Fobes Road and into Cemetery Creek. Hydrocarbon concentrations in Cemetery Creek were not measured near the Bickford Motors ditch due to the lack of water in the creek when samples were taken in July.

Surface waters throughout Cemetery Creek were tested for cadmium, copper, lead and zinc concentrations in April (during high flows) and July (during low flows) 2003. Metal concentrations were very low at all sites from both sampling events. Concentrations of pesticides and herbicides (sampled in April and July, 2003) and hydrocarbons (sampled in July, 2003) in Cemetery Creek surface water were also very low at all sites and sampling events.

The quality of water within the Bunk Foss Creek basin varies both seasonally and spatially (Table 3). Total Phosphorus levels were high at the mouth of Bunk Foss Creek in July 2003. Metals, hydrocarbons, pesticides, and herbicides were measured at the mouth of Bunk Foss Creek in April and July 2003. Although all levels were considered normal, the proximity of Bunk Foss Creek to many roadways leaves it susceptible to contamination by road runoff.

Table 3. Contaminant and Nutrient Loading Monitoring

		CC_1		CC_HF		CC_PM		CC_6	BF_1	
		29-Apr-03	28-Jul-03	29-Apr-03	28-Jul-03	29-Apr-03	28-Jul-03	28-Jul-03	29-Apr-03	28-Jul-03
Conventionals	Phosphorus (ug/L)		218		115		318			168
	BOD (mg/L)		16		24		25			19
	TKN (mg/L)		1.07		0.687		3.91			1.12
Pesticides	alpha-BHC		<.050*							<.054*
	beta-BHC		<.050*							<.054*
	delta-BHC		<.050*							<.054*
	gamma-BHC	0.5*	<.050*						0.5*	<.054*
	Heptachlor	0.5*	<.050*						0.5*	<.054*
	Aldrin		<.050*							<.054*
	Heptachlor Epoxide	0.5*	<.050*						0.5*	<.054*
	Endosulfan I		<.050*							<.054*
	Dieldrin		<.10*							<.11*
	4,4'-DDE		<.10*							<.11*
	Endrin	1*	<.10*						1*	<.11*
	EndosulfanII		<.10*							<.11*
	4,4'DDD		<.10*							<.11*
	Endosulfan Sulfate		<.10*							<.11*
	4,4'-DDT		<.10*							<.11*
	Methoxychlor	5*	<.50*						5*	<.54*
	Endrin Ketone		<.10*							<.11*
	Endrin Aldehyde		<.10*							<.11*
	gamma Chlordane	0.5*	<.05*						0.5*	<.054*
	alpha Chlordane	0.5*	<.05*						0.5*	<.054*
	Toxaphene	50*	<5.0*						50*	<5.4*
Herbicides	2,4,5-TP	1.2*	<.25*						1.2*	<.25*
	2,4,5-T		<.25*							0.25+
	Dinoseb		<1.0*							<1.0*
	Dicamba		<0.50*							<.50*
	2,4-D	5*	<1.0*						5*	<1.3+
	2,4-DB		<5.0*							<6.4+
	Dalapon		<2.0*							<2.0*
	MCPA		<500*							<500*
	Dichloroprop		<1.0*							<1.0*
Hydrocarbons	Diesel		<.25				<.25	250		<.25
	Motor Oil		<.50				<.50	420		<.50
	HC ID							*		
	o-Terphenyl		105%				97.20%	D		99.00%
Metals	Cd (ug/L)	<.2	<.2	<.2	<.3	<.4	<.2		<.5	<.2
	Cu (ug/L	1.7*	3.3*	2.1*	1.5*	2.4*	3.9*		1.6*	2.2*
	Pb (ug/L)	<1	3*	1*	<1	<1	3*		<1	<1
	Zn (ug/L)	<8	24*	<8	<8	10*	11*		<8	<8

* Below Detection

+ undetectable at raised limit due to background interferance or equiptment

D= the surrogate was diluted out

3.2 Benthic Macroinvertebrates

Cemetery Creek samples averaged a total B-IBI score of 26 on a scale of 10-50, indicating poor physical and chemical habitat quality (Table 4). Metric scores with the lowest rank for Cemetery Creek were mayfly richness, caddis fly richness, intolerant taxa richness, and clinger richness. These results indicate likely problems with high flows and fine sediments, chemical water quality, poor channel complexity, and reduced food sources from native vegetation.

Bunk Foss samples averaged a total B-IBI score of 26 on a scale of 10-50, indicating poor physical and chemical habitat quality (Table 4). Metric scores with the lowest rank were caddis fly richness, intolerant taxa richness, and clinger richness. These results indicate likely problems with high flows and fine sediments, chemical water quality, poor channel complexity, and reduced food sources from native vegetation.

Pilchuck River B-IBI scores averaged 32 on a scale of 10-50, indicating fair physical and chemical habitat quality (Table 4). The biometric score ranking the lowest for the Pilchuck River was intolerant taxa richness, indicating likely problems with flashy flows, substrate embeddedness, and chemical water quality.

Table 4. B-IBI average raw metric and total scores for study sites.

Site	Taxa Richness	Ephem.	Plecop.	Trichop.	Intol.	Clinger	L. Lived	% Tolerant	% Predator	% Dominance	B-IBI
Bunk Foss	27.67	4.33	5.67	3.67	0.33	9.33	2.33	31.49	25.01	60.36	26
Cemetery	30.67	2.67	4.33	4.33	0	6.67	3.33	15.83	25.88	51.18	26
Pilchuck	32	5	5.67	5	2	12	4.33	15.78	11.48	61.75	32

REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Morley, S.A. 2000. Effects of urbanization on the biological integrity of Puget Sound lowland streams: Restoration with a biological focus. Master's thesis. University of Washington. Seattle, WA. 70 pp.

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APPENDIX G HIATS, WITH EXPLANATION OF HABITAT QUALITY INDEX

Habitat Inventory and Assessment Table
Cemetery Creek 01

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (^{o}C)	Min-10.1; Max-15.5	A	H
Dissolved Oxygen (mg/L)	Min-8.6; Max-11.8	N	H
pH	Min-7.31; Max-8.82	P	L
Turbidity (NTU)	Min-13; Max-23	P	L
Conductivity (mSiemens)	Min-113.51; Max-165.57	P	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	0.83	NA	NA
Flow Duration (Perennial, Intermittent)	Perennial	P	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	45.6	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	88.9	N	L
Habitat Elements			
Substrate	sand-50%; gravel-50%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-7; SWD-113	N	H
Channel Width/Depth Ratio	8.71	P	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	27	N	H
Pool Quality (% surface fines)	99.5	N	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Low	N	M
Invasive Vegetation (Low, Medium, High)	Medium	N	M
Stem Density (# woody veg. /100 m^2)	8.09	NA	M
Mean Basal Area / Woody Veg. (cm^2)	500.89	NA	M
Recruitment (i.e. LWD potential)	Medium	A	H
Percent Shade (%)	80	P	M
Riparian Width (ft)	Min-20; Max-242; Avg-136	P	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	68	A	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	98	P	M
Wetlands	1 associated	P	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	0.97	P	M
Fish Passage Constrictions and Barriers	archaic cement fish ladder/dam	A	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Cemetery Creek 02

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	NA	NA	H
Dissolved Oxygen (mg/L)	NA	NA	H
pH	NA	NA	L
Turbidity (NTU)	NA	NA	L
Conductivity (mSiemens)	NA	NA	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	1.66	NA	NA
Flow Duration (Perennial, Intermittent)	Perennial	P	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	45.6	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	88.9	N	L
Habitat Elements			
Substrate	sand-23%; gravel-73%; cobble-4%	A	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-20; SWD-87	N	H
Channel Width/Depth Ratio	7.76	P	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	0	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	High	P	M
Invasive Vegetation (Low, Medium, High)	Low	P	M
Stem Density (# woody veg. /100 m^2)	5.99	NA	M
Mean Basal Area / Woody Veg. (cm^2)	2717.79	NA	M
Recruitment (i.e. LWD potential)	High	P	H
Percent Shade (%)	75	A	M
Riparian Width (ft)	Min-20; Max-179; Avg-90	P	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	67	A	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	92	A	M
Wetlands	None	P	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	3.07	A	M
Fish Passage Constrictions and Barriers	None	P	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Cemetery Creek 03

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (^{o}C)	Min-10.8; Max-18.4	N	H
Dissolved Oxygen (mg/L)	Min-2.4; Max-5.0	N	H
pH	Min-6.46; Max-7.14	A	L
Turbidity (NTU)	Min-12; Max-77	P	L
Conductivity (mSiemens)	Min-108.06; Max-178.3	P	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	25	NA	M
Total Kjeldahl Nitrogen (mg/L)	3.91	NA	M
Total Phosphorus (ug/L)	318	N	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	April-<0.4; July-<0.2	P	L
Copper (ug/L)	April-2.4; July-3.9	P	L
Lead (ug/L)	April-<1; July-3.0	P	L
Zinc (ug/L)	April-10; July-11	P	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	Diesel-<0.25; Motor Oil-<0.50	P	L
Hydrology			
Stream Gradient (%)	0.39	NA	NA
Flow Duration (Perennial, Intermittent)	Perennial	P	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	28.1	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	41.5	N	L
Habitat Elements			
Substrate	silt clay-4%; sand-80%; gravel-15%; cobble-1%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-0; SWD-0	N	H
Channel Width/Depth Ratio	6.55	P	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	0	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Low	N	M
Invasive Vegetation (Low, Medium, High)	Medium	A	M
Stem Density (# woody veg. /100 m^2)	3.65	NA	M
Mean Basal Area / Woody Veg. (cm^2)	787.92	NA	M
Recruitment (i.e. LWD potential)	Low	N	H
Percent Shade (%)	86	P	M
Riparian Width (ft)	Min-7; Max-114; Avg-39	N	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	57	A	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	87	A	M
Wetlands	1 associated; 1 isolated	A	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	6.67	N	M
Fish Passage Constrictions and Barriers	None	P	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Cemetery Creek 04

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	Min-10.1; Max-14.2	P	H
Dissolved Oxygen (mg/L)	Min-7.8; Max-10.2	A	H
pH	Min-6.84; Max-7.22	P	L
Turbidity (NTU)	Min-11; Max-18	P	L
Conductivity (mSiemens)	Min-120.97; Max-135.87	P	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	2.18	NA	NA
Flow Duration (Perennial, Intermittent)	Intermittent; no flow July-September	N	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	27.4	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	38.5	N	L
Habitat Elements			
Substrate	silt/clay-31%; sand-37%; gravel-32%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-7; SWD-93	N	H
Channel Width/Depth Ratio	6.05	P	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	0	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Low	N	M
Invasive Vegetation (Low, Medium, High)	Medium	A	M
Stem Density (# woody veg. /100 m^2)	2.52	NA	M
Mean Basal Area / Woody Veg. (cm^2)	199.42	NA	M
Recruitment (i.e. LWD potential)	Low	N	H
Percent Shade (%)	77	P	M
Riparian Width (ft)	Min-10; Max-168; Avg-60	A	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	41	N	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	87	N	M
Wetlands	None	P	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	20	N	M
Fish Passage Constrictions and Barriers	1 culvert	N	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Cemetery Creek 05

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	NA	NA	H
Dissolved Oxygen (mg/L)	NA	NA	H
pH	NA	NA	L
Turbidity (NTU)	NA	NA	L
Conductivity (mSiemens)	NA	NA	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	1.77	NA	NA
Flow Duration (Perennial, Intermittent)	Intermittent; no flow July-September	N	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	14.8	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	29.0	N	L
Habitat Elements			
Substrate	silt/clay-3%; sand-50%; gravel-42%; cobble-5%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-0; SWD-20	N	H
Channel Width/Depth Ratio	11.07	A	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	>27	N	H
Pool Quality (% surface fines)	76	N	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Low	N	M
Invasive Vegetation (Low, Medium, High)	Medium	A	M
Stem Density (# woody veg. /100 m^2)	0.62	NA	M
Mean Basal Area / Woody Veg. (cm^2)	1057.94	NA	M
Recruitment (i.e. LWD potential)	Low	N	H
Percent Shade (%)	86	P	M
Riparian Width (ft)	Min-9; Max-374; Avg-82	P	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	52	A	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	96	P	M
Wetlands	None	P	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	3.57	A	M
Fish Passage Constrictions and Barriers	1 debris dam at culvert	N	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Cemetery Creek 06

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	NA	NA	H
Dissolved Oxygen (mg/L)	NA	NA	H
pH	NA	NA	L
Turbidity (NTU)	NA	NA	L
Conductivity (mSiemens)	NA	NA	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	1.61	NA	NA
Flow Duration (Perennial, Intermittent)	Intermittent; no flow July-September	N	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	13.1	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	24.0	N	L
Habitat Elements			
Substrate	silt/clay-3%; sand-56%; gravel-41%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-20; SWD-60	N	H
Channel Width/Depth Ratio	4.93	P	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	7	N	H
Pool Quality (% surface fines)	71	N	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Medium	A	M
Invasive Vegetation (Low, Medium, High)	High	N	M
Stem Density (# woody veg. /100 m^2)	6.34	NA	M
Mean Basal Area / Woody Veg. (cm^2)	2008.75	NA	M
Recruitment (i.e. LWD potential)	Medium	A	H
Percent Shade (%)	74	A	M
Riparian Width (ft)	Min-79; Max-408; Avg-230	P	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	87	P	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	100	P	M
Wetlands	None	P	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	2.13	A	M
Fish Passage Constrictions and Barriers	1 culvert	A	H

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2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD ≥ 30cm for 7.6m or 2*BFW; SWD ≥ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Cemetery Creek 07

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	NA	NA	H
Dissolved Oxygen (mg/L)	NA	NA	H
pH	NA	NA	L
Turbidity (NTU)	NA	NA	L
Conductivity (mSiemens)	NA	NA	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	1.62	NA	NA
Flow Duration (Perennial, Intermittent)	Intermittent; no flow July-September	N	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	11.7	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	20.1	N	L
Habitat Elements			
Substrate	silt/clay-3%; sand-48%; gravel-44%; cobble-5%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-0; SWD-120	N	H
Channel Width/Depth Ratio	11.07	A	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	7	N	H
Pool Quality (% surface fines)	8.3	P	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Medium	A	M
Invasive Vegetation (Low, Medium, High)	Medium	A	M
Stem Density (# woody veg. /100 m^2)	11.16	NA	M
Mean Basal Area / Woody Veg. (cm^2)	974.82	NA	M
Recruitment (i.e. LWD potential)	Medium	A	H
Percent Shade (%)	86	P	M
Riparian Width (ft)	Min-0; Max-300; Avg-177	P	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	70	A	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	100	P	M
Wetlands	1 associated; 1 isolated	P	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	5.26	A	M
Fish Passage Constrictions and Barriers	1 culvert	A	H

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2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Cemetery Creek 08

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	NA	NA	H
Dissolved Oxygen (mg/L)	NA	NA	H
pH	NA	NA	L
Turbidity (NTU)	NA	NA	L
Conductivity (mSiemens)	NA	NA	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	0.32	NA	NA
Flow Duration (Perennial, Intermittent)	Intermittent; no flow July-September	N	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	4.9	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	9.0	N	L
Habitat Elements			
Substrate	silt/clay-84%; sand-16%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-0; SWD-53	N	H
Channel Width/Depth Ratio	5.08	P	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	0	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Low	N	M
Invasive Vegetation (Low, Medium, High)	High	N	M
Stem Density (# woody veg. /100 m^2)	1.85	NA	M
Mean Basal Area / Woody Veg. (cm^2)	584.81	NA	M
Recruitment (i.e. LWD potential)	Low	N	H
Percent Shade (%)	62	N	M
Riparian Width (ft)	Min-4; Max-300; Avg-95	P	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	58	A	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	100	P	M
Wetlands	3 associated	N	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	3.9	A	M
Fish Passage Constrictions and Barriers	2 culverts	N	H

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2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Cemetery Creek 09

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (^oC)	Min-6.55; Max-16.7	A	H
Dissolved Oxygen (mg/L)	Min-6.9; Max-9.2	A	H
pH	Min-6.97; Max-7.06	P	L
Turbidity (NTU)	Min-12; Max-25	P	L
Conductivity (mSiemens)	Min-142.95; Max-185.71	P	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	1.00	NA	NA
Flow Duration (Perennial, Intermittent)	Intermittent; no flow July-September	N	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	5.1	N	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	9.2	N	L
Habitat Elements			
Substrate	silt/clay-50%; sand-44%; gravel-4%; cobble-2%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-0; SWD-0	N	H
Channel Width/Depth Ratio	11.51	A	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	0	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Medium	A	M
Invasive Vegetation (Low, Medium, High)	Medium	A	M
Stem Density (# woody veg. /100 m^2)	0.46	NA	M
Mean Basal Area / Woody Veg. (cm^2)	561.03	NA	M
Recruitment (i.e. LWD potential)	Low	N	H
Percent Shade (%)	46	N	M
Riparian Width (ft)	Min-0; Max-187; Avg-28	N	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	38	N	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	74	N	M
Wetlands	1 associated; 1 isolated	A	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	5.88	N	M
Fish Passage Constrictions and Barriers	2 culverts	N	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Anderson Fork of Cemetery Creek 01

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	NA	NA	H
Dissolved Oxygen (mg/L)	NA	NA	H
pH	NA	NA	L
Turbidity (NTU)	NA	NA	L
Conductivity (mSiemens)	NA	NA	L
Nutrients[a] (July 28 readings)			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a] (April 29 and July 28 readings)			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (July 28 only)	NA	NA	L
Hydrology			
Stream Gradient (%)	1.27	NA	NA
Flow Duration (Perennial, Intermittent)	Intermittent; no flow July-September	N	M
2 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	NA	NA	L
100 Year Peak Flow (cfs; per HSPF model, Snohomish County 2002)	NA	NA	L
Habitat Elements			
Substrate	silt/clay-16%; sand-42%; gravel-39%; cobble-2%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	LWD-0; SWD-60	N	H
Channel Width/Depth Ratio	6.05	P	L
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	0	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous-Low, Medium, High)	Medium	A	M
Invasive Vegetation (Low, Medium, High)	Low	P	M
Stem Density (# woody veg. /100 m^2)	19.25	NA	M
Mean Basal Area / Woody Veg. (cm^2)	462.96	NA	M
Recruitment (i.e. LWD potential)	Low	N	H
Percent Shade (%)	94	P	M
Riparian Width (ft)	Min-96; Max-300; Avg-250	P	M
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	88	P	M
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	100	P	M
Wetlands	1 associated	P	L
Flood Plain Connectivity	None	N	M
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	1.96	P	M
Fish Passage Constrictions and Barriers	None	P	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Bunk Foss Creek 01

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	Min-4.7; Max-17.7	A	H
Dissolved Oxygen (mg/L)	Min-3.9; Max-9.6	A	H
pH	Min-6.70; Max-7.10	P	L
Turbidity (NTU)	Min-5; Max-39	P	L
Conductivity (mSiemens)	Min-100.3; Max-300.03	P	L
Nutrients[a] (July 28th readings)			
BOD (mg/L)	19	NA	M
Total Kjeldahl Nitrogen (mg/L)	1.12	NA	M
Total Phosphorus (ug/L)	168	NA	H
Metals and Other Toxics[a] (April 29th and July 28th readings)			
Cadmium (ug/L)	April- < 0.5; July- < 0.2	P	L
Copper (ug/L)	April- 1.6; July- 2.2	P	L
Lead (ug/L)	April- < 1.0; July- < 1.0	P	L
Zinc (ug/L)	April- < 0.5; July- < 0.2	P	L
Herbicide/Pesticide (ug/L)	Below detectable limits	NA	L
Hydrocarbons (mg/L) (July 28th only)	Deisel- < 0.25; Motor Oil- < 0.50	P	L
Hydrology			
Stream Gradient (%)	0.62	NA	NA
Flow Duration (Perennial, Intermittent)	Perennial	P	H
2 Year Peak Flow (cfs)	>29.2	N	M
100 Year Peak Flow (cfs)	>66.4	N	M
Habitat Elements			
Substrate	silt/clay-17%; sand-42%; gravel-39%; cobble-2%	N	H
Woody Debris Frequency[b] (# pieces/km stream)	0	N	H
Channel Width/Depth Ratio	4.28	P	M
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	None	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous - Low, Medium, High)	Low	N	M
Invasive Vegetation (Low, Medium, High)	Medium	A	H
Stem Density (# woody veg. /100 m^2)	1.92	NA	M
Mean Basal Area / Woody Veg. (cm^2)	920	NA	M
Recruitment (i.e. LWD potential)	Low	N	M
Percent Shade (%)	48	N	M
Riparian Width (ft)	Min-0; Max-187; Avg-27.7	N	H
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	38%	N	H
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	48	N	H
Wetlands	None	N	M
Flood Plain Connectivity	Yes	N	H
Hydro Modifiers			
Stream Crossings /km[d] (# crossings/km)	4.75	N	M
Fish Passage Constrictions and Barriers	0	P	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Bunk Foss Creek 02

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a]			
Temperature (°C)	NA	NA	H
Dissolved Oxygen (mg/L)	NA	NA	H
pH	NA	NA	L
Turbidity (NTU)	NA	NA	L
Conductivity (mSiemens)	NA	NA	L
Nutrients[a]			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a]			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (mg/L)	NA	NA	L
Hydrology			
Stream Gradient (%)	0.04	NA	NA
Flow Duration (Perennial, Intermittent)	Perennial	P	H
2 Year Peak Flow (cfs)	>29.2	N	M
100 Year Peak Flow (cfs)	>69.4	N	M
Habitat Elements			
Substrate	silt/clay-45%; sand-55%;	N	H
Woody DebrisFrequency[b] (# pieces/km stream)	0	N	H
Channel Width/Depth Ratio	2.96	P	M
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	None	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous- Low, Medium, High)	Low	N	M
Invasive Vegetation (Low, Medium, High)	Low	P	H
Stem Density (# woody veg. /100 m^2)	NA	NA	M
Mean Basal Area / Woody Veg. (cm^2)	NA	NA	M
Recruitment (i.e. LWD potential)	Low	N	M
Percent Shade (%)	9	N	M
Riparian Width (ft)	Min-0; Max-127; Avg-21.8	N	H
% Forested and/or Associated Wetland (% within 100ft buffer)[c]	4%	N	H
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	100	P	H
Wetland Storage and Alterations	None	N	M
Flood Plain Connectivity	Yes	N	H
Hydro Modifiers			
Stream Crossings[d](# crossings/km)	3.08	A	M
Fish Passage Constrictions and Barriers	0	P	H

1. Generally follows indicators in NOAA Fisheries' "Draft Matrix of Pathways and Indicators for Transitional and Lowland Streams", with added detail on nutrients, toxics and riparian areas
2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
   Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD ≥ 30cm for 7.6m or 2*BFW; SWD ≥ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Bunk Foss Creek 03

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (^oC)	Min-4.9; Max-18.7	A	H
Dissolved Oxygen (mg/L)	Min-1.9; Max-10.3	N	H
pH	Min-6.59; Max-7.69	P	L
Turbidity (NTU)	Min-6; Max-26	P	L
Conductivity (mSiemens)	Min-110.38; Max-261.70	P	L
Nutrients[a]			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a]			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (mg/L)	NA	NA	L
Hydrology			
Stream Gradient (%)	2.15	NA	NA
Flow Duration (Perennial, Intermittent)	Perennial	P	H
2 Year Peak Flow	> 29.2	N	M
100 Year Peak Flow	> 69.4	N	M
Habitat Elements			
Substrate	24% Sand; 62% Gravel; 5% Cobble; 1% Boulder; 8% Bedrock	P	H
Woody Debris Frequency [b] (# pieces/km stream)	LWD -6.07 SWD -33.33	N	H
Channel Width/Depth Ratio	6.07	P	M
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	None	N	H
Pool Quality (% surface fines)	NA	NA	H
Riparian			
Canopy Composition (Coniferous- Low, Medium, High)	Low	N	M
Invasive Vegetation (Low, Medium, High)	Medium	A	H
Stem Density (# woody veg. /100 m^2)	9.89	NA	M
Mean Basal Area / Woody Veg. (cm^2)	702.79	NA	M
Recruitment (i.e. LWD potential)	Medium	A	M
Percent Shade (%)	85%	P	M
Average Riparian Width (ft)	Min-27; Max-300; Avg-159	P	H
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	67%	A	H
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	88	A	H
Wetland	None	P	M
Flood Plain Connectivity	None	N	H
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	5.15	N	M
Fish Passage Constrictions and Barriers	0	P	H

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2. Measured condition of segment, based on field observations (see separate note for details)
3. "P,A,N" refers to NOAA Fisheries' categories of Properly Functioning Conditions, At Risk, and Not Properly Functioning
4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD $\geq$ 30cm for 7.6m or 2*BFW; SWD $\geq$ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Bunk Foss Creek 04

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (^{o}C)	Min-4.7; Max-18	A	H
Dissolved Oxygen (mg/L)	Min-3.4; Max-10.2	N	H
pH	Min-6.82; Max-7.35	P	L
Turbidity (NTU)	Min-4; Max-38	P	L
Conductivity (mSiemens)	Min-106.21; Max-275.20	P	L
Nutrients[a]			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a]			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (mg/L)	NA	NA	L
Hydrology			
Stream Gradient (%)	7.50		
Flow Duration (Perennial, Intermittent)	Perennial	P	H
2 Year Peak Flow (cfs; per HSPF model, City of Snohomish 2001)	29.2	A	M
100 Year Peak Flow (cfs; per HSPF model, City of Snohomish 2001)	66.4	A	M
Habitat Elements			
Substrate	Clay-1%; Sand-18%; Gravel-47%; Cobble-24.5%; Boulder-10%	P	H
Woody Debris Frequency[b] (not including recruitment)	LWD -6.67; SWD -40	N	H
Channel Width/Depth Ratio	5.71	P	M
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	None	N	H
Pool Quality (% surface fines)	NA	N	H
Riparian			
Canopy Composition (Coniferous- Low, Medium, High)	Medium	A	M
Invasive Vegetation (Low, Medium, High)	Medium	A	H
Stem Density (# woody veg. /100 m^2)	3.33	NA	M
Mean Basal Area / Woody Veg. (cm^2)	1260.87	NA	M
Recruitment (i.e. LWD potential)	Low	N	M
Percent Shade (%)	85%	P	M
Average Riparian Width (ft)	Min-27; Max-300; Avg-159	P	H
% Forested and/or Associated Wetland[c] (% within 100ft buffer)	65%	A	H
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	77	A	H
Wetland	1 associated	A	M
Flood Plain Connectivity	Yes	A	H
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	3.04	A	M
Fish Passage Constrictions and Barriers	1	N	H

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4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

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c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

Habitat Inventory and Assessment Table
Bunk Foss Creek 05

Indicators[1]	Condition[2]	Rating (P,A,N)[3]	Relative Importance[4]
Water Quality			
Physical[a] (monthly readings)			
Temperature (°C)	NA	NA	H
Dissolved Oxygen (mg/L)	NA	NA	H
pH	NA	NA	L
Turbidity (NTU)	NA	NA	L
Conductivity (mSiemens)	NA	NA	L
Nutrients[a]			
BOD (mg/L)	NA	NA	M
Total Kjeldahl Nitrogen (mg/L)	NA	NA	M
Total Phosphorus (ug/L)	NA	NA	H
Metals and Other Toxics[a]			
Cadmium (ug/L)	NA	NA	L
Copper (ug/L)	NA	NA	L
Lead (ug/L)	NA	NA	L
Zinc (ug/L)	NA	NA	L
Herbicide/Pesticide (ug/L)	NA	NA	L
Hydrocarbons (mg/L)	NA	NA	L
Hydrology			
Stream Gradient (%)	2.43	NA	NA
Flow Duration (Perennial, Intermittent)	Perennial	P	H
2 Year Peak Flow (cfs; per HSPF model, City of Snohomish 2001)	15.1	A	M
100 Year Peak Flow (cfs; per HSPF model, City of Snohomish 2001)	35.6	A	M
Habitat Elements			
Substrate	silt/clay-10%; sand-36%; gravel-47%; cobble- 6%; boulder- 1%	P	H
Woody Debris Frequency[b] (# pieces / km stream)	LWD -6.67; SWD -33.33	N	H
Channel Width/Depth Ratio	9.69	P	M
Off Channel Habitat	None	N	M
Pool Frequency (# pools/km stream)	None	N	H
Pool Quality (% surface Fines)	NA	NA	H
Riparian			
Canopy Composition (Conifers- Low, Medium, High)	Medium	A	M
Invasive Vegetation (Low, Medium, High)	Low	P	H
Stem Density (# woody veg. /100 m^2)	NA	NA	M
Mean Basal Area / Woody Veg. (cm^2)	NA	NA	M
Recruitment (i.e. LWD potential)	High	P	M
Percent Shade (%)	95	P	M
Riparian Width (ft)	Min-22; Max-300; Avg-152	P	H
% Forested and/or Associated Wetland (% within 100ft buffer)[c]	84%	A	H
Channel Conditions and Dynamics			
Stream Bank Stability (%; reach level)	100	P	H
Wetland	None	P	M
Flood Plain Connectivity	None	N	H
Hydro Modifiers			
Stream Crossings[d] (# crossings/km)	3.34	A	M
Fish Passage Constrictions and Barriers	1	N	H

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4. Importance of addressing the indicator to support salmonids in the stream (high, medium, low), based on best professional judgment

a. Samples were not taken at the segment/reach level.
Sample sites were determined by stream sections that displayed similar habitat characteristics, land use, and potential areas of concern.
b. Snohomish County protocol (LWD ≥ 30cm for 7.6m or 2*BFW; SWD ≥ 0.1m for 2.0m)
c. Estimated in GIS using a combination of aerial photos and spatial analyst
d. Calculated based on unique segment length (1crossings/ 1.03 km)

NA - Not Applicable
LWD - Large Woody Debris
SWD - Small Woody Debris
NW - No water when measured

HABITAT QUALITY INDEX

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	1	4	7
LWD Frequency (# pieces / km stream)	<260	260-380	>380	1	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	3
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	1	2	3
Riparian Index	6-9	10-14	15-18	1	4	7
Stream Bank Stability (%)	<75	75-95	>95	1	4	7
Stream Crossings (# crossings / km)	>4	2-4	<2	1	4	7
Fish Passage Constrictions & Barriers	Total barrier present	Constriction present	No artificial constrictions	1	4	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	3

Substrate (% fines)	Reiser and Bjornn 1979
LWD Frequency (# pieces / km stream)	Martin et al. 2003
Width/Depth Ratio	NMFS 1996
Pool Frequency (# pools / km)	NMFS 2003
Riparian Index	See below
Stream Bank Stability (%)	NMFS 2003
Stream Crossings (# crossings / km)	NMFS 2003
Fish Passage Constrictions & Barriers	NMFS 2003
B-IBI	NMFS 2003

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	2	3
Recruitment (i.e. LWD potential)	low	medium	high	1	2	3
Percent Shade (%)	<65	65-75	>75	1	2	3
Riparian Width (ft)	<50	50-75	>75	1	2	3
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	2	3

Canopy Composition	DNR 1997
Invasive Vegetation (Low, Medium, High)	None
Recruitment (i.e. LWD potential)	DNR 1997
Percent Shade (%)	Snohomish County 2002
Riparian Width (ft)	NMFS 2003
% Forested and/or Associated Wetland (% within 100ft buffer)	NMFS 2003

Habitat Quality Index	
Habitat Quality Score	**Habitat Condition**
43-51	Excellent
34-42	Good
25-33	Fair
17-24	Poor
9-16	Very Poor

Site	Riparian Index Score	Habitat Quality Index Score	Habitat Condition
CC_01	13	31	Fair
CC_02	16	34	Good
CC_03	10	25	Fair
CC_04	10	17	Poor
CC_05	12	22	Poor
CC_06	13	27	Fair
CC_07	14	23	Poor
CC_08	9	21	Poor
CC_09	8	11	Very Poor
AF_01	15	36	Good
BF01	7	19	Poor
BF02	8	19	Poor
BF03	14	28	Fair
BF04	13	34	Good
BF05	16	34	Good

CC_01
Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	**4**	7
Stream Bank Stability (%)	<75	75-95	>95	1	4	**7**
Stream Crossings (# crossings / km)	>4	2-4	<2	1	4	**7**
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	1	**4**	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	**3**
			Total HQI Score	**31**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	**1**	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	**2**	3
Recruitment (i.e. LWD potential)	low	medium	high	1	**2**	3
Percent Shade (%)	<65	65-75	>75	1	2	**3**
Riparian Width (ft)	<50	50-75	>75	1	2	**3**
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	**2**	3
			Total Riparian Index Score	**13**		

CC_02
Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	1	**4**	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	4	**7**
Stream Bank Stability (%)	<75	75-95	>95	1	**4**	7
Stream Crossings (# crossings / km)	>4	2-4	<2	1	**4**	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	1	4	**7**
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	**3**
			Total HQI Score	**34**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	2	**3**
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	2	**3**
Recruitment (i.e. LWD potential)	low	medium	high	1	2	**3**
Percent Shade (%)	<65	65-75	>75	1	**2**	3
Riparian Width (ft)	<50	50-75	>75	1	2	**3**
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	**2**	3
			Total Riparian Index Score	**16**		

CC_03
Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	**4**	7
Stream Bank Stability (%)	<75	75-95	>95	1	**4**	7
Stream Crossings (# crossings / km)	>4	2-4	<2	**1**	4	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	1	4	**7**
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	**3**
			Total HQI Score	**25**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	**1**	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	**2**	3
Recruitment (i.e. LWD potential)	low	medium	high	**1**	2	3
Percent Shade (%)	<65	65-75	>75	1	2	**3**
Riparian Width (ft)	<50	50-75	>75	**1**	2	3
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	**2**	3
			Total Riparian Index Score	**10**		

CC_04
Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	**4**	7
Stream Bank Stability (%)	<75	75-95	>95	1	**4**	7
Stream Crossings (# crossings / km)	>4	2-4	<2	**1**	4	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	**1**	4	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	**1**	2	3
			Total HQI Score	**17**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	**1**	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	**2**	3
Recruitment (i.e. LWD potential)	low	medium	high	**1**	2	3
Percent Shade (%)	<65	65-75	>75	1	2	**3**
Riparian Width (ft)	<50	50-75	>75	1	**2**	3
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	**1**	2	3
			Total Riparian Index Score	**10**		

CC_05

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	**2**	3
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	**4**	7
Stream Bank Stability (%)	<75	75-95	>95	1	4	**7**
Stream Crossings (# crossings / km)	>4	2-4	<2	1	**4**	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	**1**	4	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	**1**	2	3
			Total HQI Score	**22**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	**1**	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	**2**	3
Recruitment (i.e. LWD potential)	low	medium	high	**1**	2	3
Percent Shade (%)	<65	65-75	>75	1	2	**3**
Riparian Width (ft)	<50	50-75	>75	1	2	**3**
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	**2**	3
			Total Riparian Index Score	**12**		

CC_06

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	**4**	7
Stream Bank Stability (%)	<75	75-95	>95	1	4	**7**
Stream Crossings (# crossings / km)	>4	2-4	<2	1	**4**	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	1	**4**	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	**2**	3
			Total HQI Score	**27**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	**2**	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	**1**	2	3
Recruitment (i.e. LWD potential)	low	medium	high	1	**2**	3
Percent Shade (%)	<65	65-75	>75	1	**2**	3
Riparian Width (ft)	<50	50-75	>75	1	2	**3**
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	2	**3**
			Total Riparian Index Score	**13**		

CC_07

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	1	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	1	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	3
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	1	2	3
Riparian Index	6-9	10-14	15-18	1	4	7
Stream Bank Stability (%)	<75	75-95	>95	1	4	7
Stream Crossings (# crossings / km)	>4	2-4	<2	1	4	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	1	4	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	3
			Total HQI Score	**23**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	2	3
Recruitment (i.e. LWD potential)	low	medium	high	1	2	3
Percent Shade (%)	<65	65-75	>75	1	2	3
Riparian Width (ft)	<50	50-75	>75	1	2	3
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	2	3
			Total Riparian Index Score	**14**		

CC-08

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	1	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	1	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	3
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	1	2	3
Riparian Index	6-9	10-14	15-18	1	4	7
Stream Bank Stability (%)	<75	75-95	>95	1	4	7
Stream Crossings (# crossings / km)	>4	2-4	<2	1	4	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	1	4	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	3
			Total HQI Score	**21**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	2	3
Recruitment (i.e. LWD potential)	low	medium	high	1	2	3
Percent Shade (%)	<65	65-75	>75	1	2	3
Riparian Width (ft)	<50	50-75	>75	1	2	3
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	2	3
			Total Riparian Index Score	**9**		

CC_09

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	**2**	3
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	**1**	4	7
Stream Bank Stability (%)	<75	75-95	>95	**1**	4	7
Stream Crossings (# crossings / km)	>4	2-4	<2	**1**	4	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	**1**	4	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	**2**	3
			Total HQI Score	**11**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	**2**	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	**2**	3
Recruitment (i.e. LWD potential)	low	medium	high	**1**	2	3
Percent Shade (%)	<65	65-75	>75	**1**	2	3
Riparian Width (ft)	<50	50-75	>75	**1**	2	3
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	**1**	2	3
			Total Riparian Index Score	**8**		

AF_01

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment medium or low	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	4	**7**
Stream Bank Stability (%)	<75	75-95	>95	1	4	**7**
Stream Crossings (# crossings / km)	>4	2-4	<2	1	4	**7**
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of habitat	no artificial constrictions	1	4	**7**
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	**2**	3
			Total HQI Score	**36**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	**2**	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	2	**3**
Recruitment (i.e. LWD potential)	low	medium	high	**1**	2	3
Percent Shade (%)	<65	65-75	>75	1	2	**3**
Riparian Width (ft)	<50	50-75	>75	1	2	**3**
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	1	2	**3**
			Total Riparian Index Score	**15**		

BF_01

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	**1**	4	7
Stream Bank Stability (%)	<75	75-95	>95	**1**	4	**7**
Stream Crossings (# crossings / km)	>4	2-4	<2	**1**	4	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to >80% of habitat	no artificial constrictions	1	4	**7**
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	**3**
			Total HQI Score	**19**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	**1**	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	**2**	3
Recruitment (i.e. LWD potential)	low	medium	high	**1**	2	3
Percent Shade (%)	<65	65-75	>75	**1**	2	3
Riparian Width (ft)	<50	50-75	>75	**1**	2	3
% Forested and/or Associated Wetland (% within 100ft buffer)	<50	50-85	>85	**1**	2	3
			Total Riparian Index Score	**7**		

BF_02

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	**1**	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	**1**	4	7
Stream Bank Stability (%)	<75	75-95	>95	**1**	4	7
Stream Crossings (# crossings / km)	>4	2-4	<2	1	**4**	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to >80% of habitat	no artificial constrictions	1	**4**	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	**3**
			Total HQI Score	**19**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	**1**	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	2	**3**
Recruitment (i.e. LWD potential)	low	medium	high	**1**	2	3
Percent Shade (%)	<65	65-75	>75	**1**	2	3
Riparian Width (ft)	<50	50-75	>75	**1**	2	3
% Forested and/or Associated Wetland (%	<50	50-85	>85	**1**	2	3
			Total Riparian Index Score	**8**		

BF_03

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	1	4	**7**
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	**4**	7
Stream Bank Stability (%)	<75	75-95	>95	1	**4**	7
Stream Crossings (# crossings / km)	>4	2-4	<2	**1**	4	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of	no artificial constrictions	1	**4**	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	**3**
			Total HQI Score	**28**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	**2**	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	**2**	3
Recruitment (i.e. LWD potential)	low	medium	high	1	**2**	3
Percent Shade (%)	<65	65-75	>75	1	2	**3**
Riparian Width (ft)	<50	50-75	>75	1	2	**3**
% Forested and/or Associated Wetland (%	<50	50-85	>85	1	**2**	3
			Total Riparian Index Score	**14**		

BF_04

Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	1	4	**7**
LWD Frequency (# pieces / km stream)	<400	400-800	>800	**1**	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	**3**
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment	>60 and LWD recruitment high	**1**	2	3
Riparian Index	6-9	10-14	15-18	1	**4**	7
Stream Bank Stability (%)	<75	75-95	>95	1	**4**	7
Stream Crossings (# crossings / km)	>4	2-4	<2	1	**4**	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of	no artificial constrictions	1	4	**7**
Flow duration	no flow at any time between	no flow at any time between July	year-round flow	1	2	**3**
			Total HQI Score	**34**		

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	**2**	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	**2**	3
Recruitment (i.e. LWD potential)	low	medium	high	**1**	2	3
Percent Shade (%)	<65	65-75	>75	1	2	**3**
Riparian Width (ft)	<50	50-75	>75	1	2	**3**
% Forested and/or Associated Wetland (%	<50	50-85	>85	1	**2**	3
			Total Riparian Index Score	**13**		

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Habitat Quality Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Substrate (% fines)	>25	15-25	<15	1	4	7
LWD Frequency (# pieces / km stream)	<400	400-800	>800	1	4	7
Width/Depth Ratio	>12	10-12	<10	1	2	3
Pool Frequency (# pools / km)	<60	>60 but LWD recruitment	>60 and LWD recruitment high	1	2	3
Riparian Index	6-9	10-14	15-18	1	4	7
Stream Bank Stability (%)	<75	75-95	>95	1	4	7
Stream Crossings (# crossings / km)	>4	2-4	<2	1	4	7
Fish Passage Constrictions & Barriers	no access to >20% of habitat	year-round access to ≥80% of	no artificial constrictions	1	4	7
Flow duration	no flow at any time between November and June	no flow at any time between July and October	year-round flow	1	2	3

Total HQI Score 34

Riparian Index

Parameter	Range of Values for Metric Scores			HQI Metric Scores		
	Low	Medium	High	Low	Medium	High
Canopy Composition (% conifer)	<30	30-70	>70	1	2	3
Invasive Vegetation (Low, Medium, High)	high	medium	low	1	2	3
Recruitment (i.e. LWD potential)	low	medium	high	1	2	3
Percent Shade (%)	<65	65-75	>75	1	2	3
Riparian Width (ft)	<50	50-75	>75	1	2	3
% Forested and/or Associated Wetland (%	<50	50-85	>85	1	2	3

Total Riparian Index Score 16

APPENDIX H WRIA 7 SUB-BASIN STRATEGIES FOR LOWER SNOHOMISH RIVER AND LOWER PILCHUCK RIVER

Sub-basin Strategy Group: Mainstem Primary Restoration

- **Geo-spatial classification**: Mainstems**; Sub-basins in this group:** Skykomish River - Lower Mainstem, Skykomish River - Upper Mainstem, Skykomish River - South Fork, Skykomish River - Upper South Fork, Sultan River - Lower, Snoqualmie River - Mid Mainstem, Snoqualmie River - Upper Mainstem, Pilchuck River - Middle, Upper Snohomish/Cathcart, ***Lower Snohomish/Marshland [includes Snohomish River Study Area for ESA Strategy]***, Tolt River - Lower, and Raging River
- **Chinook/bull trout use and potential classification:** High
- **Watershed process condition:** Moderately Degraded or Degraded
- **Coho use:** <u>High</u>: Tolt River-Lower; <u>Moderate</u>: Skykomish River - Upper Mainstem, Snoqualmie River - Upper Mainstem, Pilchuck River – Middle, Raging River; <u>Known presence</u>: Skykomish River - Lower Mainstem, Skykomish River - South Fork, Skykomish River - Upper South Fork, Sultan River - Lower, Snoqualmie River - Mid Mainstem, Upper Snohomish/Cathcart, Lower Snohomish/Marshland
- **Recovery need:** Substantial improvement
- **General strategy:** Habitat/process restoration

Description. The waterbodies in this category are large rivers with floodplains in the mid and lower basin. The rivers flow west/northwest out of the Cascade Mountains through broad alluvial valleys of the Puget Lowland. High monthly flows occur from November through January due to winter rains and increased meltwater from rain-on-snow events, and from May through June due to high elevation snowmelt. Annual low flows occur in August and September. Land use is predominantly agricultural and rural residential with some urban and commercial development in cities along the rivers.

This sub-basin strategy group contains the core Chinook spawning and freshwater rearing in the Snohomish River basin. Bull trout exhibiting fluvial and anadromous life history strategies use mainstems for rearing, overwintering habitat for subadults, and adult foraging. Mainstems are also migratory corridors for all salmonid species (Pentec Environmental and NW GIS 1999, Snohomish Basin Salmon Recovery Forum 2001, Haring 2002).

Dikes, bank armoring, roads, railroads, and bridges confine these mainstem rivers, disconnect off-channel habitat, reduce edge habitat complexity, and increase peak flows downstream. Riparian forests have also been substantially reduced. Other habitat problems in this sub-basin strategy group include excessive erosion of streambanks, dearth of LWD, and degraded water quality, i.e., high temperature, low dissolved oxygen, high fecal coliform counts, and high levels of toxic metals (Snohomish Basin Salmonid Recovery Technical Committee 2002, Solomon and Boles 2002, Haring 2002).

<u>Current Habitat Conditions Highlights</u>

- Riparian forest conditions are intact along 57% of mainstem channel edge.
- Access to 57 miles of habitat in small tributary stream within the sub-basin strategy group is known to be restricted or blocked. An additional 49 miles of known blocked stream habitat is located within ½ miles of focus reaches for Chinook within the sub-basin strategy group.
- 82% (994 acres) of off-channel sloughs and ponds are disconnected.
- Several thousand acres of palustrine wetland has been disconnected or drained.
- 67% of mainstem banks are in natural condition.
- 51% of the sub-basin strategy group has hydrologically mature forest.
- Under 4% of the sub-basin strategy group is impervious surfaces.
- Channels have low levels of LWD and LWD jams.

Recovery Role Hypothesis. Along with the estuary and nearshore environments, preliminary modeling efforts have identified sub-basins within this group as having the highest potential gains with restoration and highest potential losses if further degradation occurs. Current spawning capacity is thought to be adequate for recovery. While spawning habitat quality has been impacted in some locations by altered sediment and flow regimes, the loss of rearing habitat quantity and quality is the primary factor affecting population performance. Setting back and removing armoring, restoring access to isolated habitats, replanting riparian forests, and implementing agricultural best management practices (BMPs) will provide the greatest returns in population performance of any restoration actions in the freshwater environment. Major improvements in habitat conditions within this sub-basin strategy group will be necessary to produce an outcome in terms of abundance and productivity within the Shared Strategy planning range.

Recommended Actions

<u>First Priority</u>

1. Preservation (along focus reaches) – i.e., protect intact riparian forest, protect oxbows, prevent floodplain development or fill, maintain opportunities for rivers to migrate within their channel migration zones.
2. Preservation to support hydrologic and sediment processes – i.e., protect wetland, protect floodplains, and protect forest retention.
3. Remove human-made instream barriers along or adjacent to priority reaches – i.e., fix blocking culverts, wiers, pump-stations, flood-gates and tide-gates to provide access by salmonids.
4. Reconnect off-channel habitats – i.e., set back or remove dikes to allow for channel migration and to reconnect off-channel features such as oxbows and side channels.
5. Restore shoreline conditions – i.e., remove rip-rap, incorporate LWD into armored banks.

6. Restore hydrologic and sediment processes (for peak flow and base flow) – i.e., increase wetland functions and values, reconnect floodplains, reforestation, and remove impervious surfaces.
7. Riparian enhancement.

Second priority

1. Address water quality impacts – i.e., prevent illicit discharges, implement agricultural BMPs and farm plans.
2. Instream structural enhancement – i.e., installation of engineer log jams.

Other Actions (not prioritized)

- Culvert replacement on small streams– i.e., prioritize and replace blocking culverts on coho streams based on available habitat upstream. Coho use has been documented at high and moderate levels on index reaches within the Upper Mainstem Skykomish, Upper Mainstem Snoqualmie, Middle Pilchuck, Lower Tolt, and Raging River sub-basins. Other streams may also have high potential gains for coho that has not yet been documented.

Sub-basin Strategy Group: Mainstem Secondary Restoration

- **Geo-spatial classification**: Mainstems**; Sub-basins**: May Creek/Lower Wallace, Skykomish River - Lower North Fork, Skykomish River - Lower South Fork, Woods Creek - Lower, Snoqualmie River Mouth, Tolt River - South Fork Below Dam, ***Pilchuck River – Lower [includes Pilchuck River Study Area for ESA Strategy]***; Coal Creek - Lower
- **Chinook/bull trout use and potential class**: Moderate
- **Watershed process condition**: Moderately Degraded
- **Coho use**: High: Skykomish River - Lower North Fork, Snoqualmie River Mouth; Moderate: Skykomish River - Lower South Fork, and Known presence: May Creek/Lower Wallace, Woods Creek – Lower, Tolt River - South Fork Below Dam, Pilchuck River – Lower; Coal Creek - Lower
- **Recovery need**: Moderate Improvement
- **General strategy**: Habitat/process restoration

Description. These sub-basins contain small rivers with floodplains and large mainstem river reaches that have lower levels of current Chinook spawning or spawning potential relative to mainstem rivers in the primary group. High monthly flows occur from November through January due to winter rains and increased meltwater from rain-on-snow events, and from May through June due to high elevation snowmelt. Annual low flows occur in August and September. Land use is a mix of rural residential, agriculture and forestry with some urban and commercial development and transportation corridors in cities along the rivers.

Sub-basins in this strategy group contain satellite Chinook spawning and rearing areas, as well as spawning and rearing habitat for other salmonids and presumed foraging habitat for bull trout (Pentec Environmental and NW GIS 1999, Snohomish Basin Salmon Recovery Forum 2001, Haring 2002). Habitat problems include decreased fish passage due to human-made barriers such as culverts (primarily affecting coho); loss of floodplain connectivity due to dikes, bank hardening, roads, railroads, and bridges; excessive erosion of streambanks; and loss of riparian vegetation. A paucity of LWD and degraded water quality due to high temperature, nutrient levels, and fecal coliform counts are problems in some of these waterbodies (Snohomish Basin Salmonid Recovery Technical Committee 2002, Haring 2002).

Current Habitat Conditions Highlights

- Riparian forest conditions are intact along 69% of mainstem channel edge.
- 85% (588 acres) of off-channel sloughs and ponds are disconnected.
- 82% of mainstem banks are in natural condition.
- The sub-basin strategy group contains 53% mature forest cover.
- Total impervious area is 2.6%.

- Channels have low levels of LWD and LWD jams.
- Water quality is degraded due to high temperature, nutrient levels, and fecal coliform counts in some areas.

Recovery Role Hypothesis. Sub-basins in the mainstem – secondary restoration strategy group have similar habitat issues to the previous group. Although actions within this groups are not likely to achieve as great of a response in terms of Chinook abundance and productivity, restoring riparian forests and floodplain connectivity, correcting fish passage barriers, and reducing the negative impacts of urbanization and forest clearing within these areas will provide significant benefits in terms of Chinook salmon viability, particularly for spatial structure and diversity. It should also be noted that low flows are thought to limit production in the Lower – Pilchuck sub-basin, and may also be a problem in other small rivers. Actions within these sub-basins provide direct and downstream benefits for all salmonid species. Many core Chinook spawning reaches occur directly downstream. Without recovery actions in this group, it will be unlikely that population performance will recover to the target levels identified by Shared Strategy.

Recommended Actions

First Priority

1. Preservation to support hydrologic and sediment processes – i.e., large-scale actions to retain wetlands, floodplains, and forest cover.
2. Restore hydrologic and sediment processes (for peak flow and base flow) – i.e., increase wetland functions and values, reconnect floodplains, reforestation, remove impervious surfaces.

Second Priority

1. Preservation (along focus reaches) – i.e., protect intact riparian forest, protect oxbows, prevent floodplain development or fill, maintain opportunities for rivers to migrate within their channel migration zones.
2. Remove human-made instream barriers along or adjacent to priority reaches – i.e., fix blocking culverts, wiers, pump-stations and flood-gates to provide access by salmonids.
3. Restore shoreline conditions – i.e., remove rip-rap, incorporate LWD into armored banks.
4. Riparian enhancement.

Third Priority

1. Address water quality impacts – i.e., prevent illicit discharges, implement agricultural BMPs and farm plans.
2. Instream structural enhancement – i.e., install engineered log jams.

<u>Other Actions (not prioritized)</u>

- Culvert replacement on small streams– i.e., prioritize and replace blocking culverts on coho streams based on available habitat upstream. Skykomish River – Lower North Fork, Skykomish River – Lower South Fork, Snoqualmie River – Mouth sub-basins contain index reaches that have high and moderate coho use. Other streams may also have high potential for coho that has not been documented.

Sub-basin Strategy Group: Urban Streams – restoration

- **Geo-spatial Classification:** Lowland tributaries; **Sub-basins:** Lake Stevens Drainages, Everett Coastal Drainages, ***Fobes Hill [includes Cemetery and Blackmans Lake/Swifty Creek Basins in ESA Strategy]***, Quilceda Creek, Allen Creek, Sunnyside Drainages
- **Chinook/bull trout use and potential classification**: Low
- **Watershed process condition**: Degraded
- **Coho use**: Moderate: Quilceda Creek; Known presence: Lake Stevens Drainages, Everett Coastal Drainages, Fobes Hill, Allen Creek, Sunnyside Drainages
- **Recovery need**: Maintain current habitat level and functions
- **General strategy**: Habitat restoration

Description. These Puget lowland sub-basins flank the Snohomish River estuary and have highest levels of land development and development pressure in the basin. Land use is predominantly urban and rural residential development. There is little to no Chinook spawning in the waterbodies, but the lower reaches provide rearing habitat for Chinook. Coho salmon and cutthroat trout use these waterbodies as well (Pentec Environmental and NW GIS 1999).

Habitat problems in this group include decreased fish passage due to human-made barriers such as culverts; increased bank erosion and deposition/embeddedness of fine sediments in spawning gravel; increased peak flows due to high percentage effective impervious area; degraded water quality due to high temperature, low dissolved oxygen, high nutrient levels, high lead levels (Everett Coastal Drainages only), and high fecal coliform counts that do not meet State of Washington water quality standards; loss of riparian vegetation and floodplain wetlands; paucity of LWD; and loss of floodplain connectivity due to dikes, bank armoring and stream channelization/ditching (Snohomish Basin Salmonid Recovery Technical Committee 2002, Haring 2002).

Current Habitat Conditions Highlights

- Riparian forest conditions are intact along 20% of mainstem channel edge.
- Access to 38 miles of habitat in small tributary stream within the sub-basin strategy group is known to be restricted or blocked, particularly within Quilceda Creeks. Access is known to be restricted to an additional 2.6 miles of habitat within ½ mile of Chinook focus reaches (Quilceda Creek).
- The sub-basin strategy group contains 13% mature forest cover.
- Impervious surfaces are over 22%.
- Channels contain low levels of LWD loading and LWD recruitment potential.
- DOE's 303d list identifies multiple water quality problems.

Recovery Role Hypothesis. Watershed processes have been substantially altered within this sub-basin strategy group. Managing these sub-basins to prevent downstream impacts will be adequate for a basinwide Chinook strategy if substantial restoration efforts are undertaken in other areas. Particular care should be taken to protect habitat quality (i.e., water quality, temperature, sediment transport) and diversity where creeks enter the estuary and nearshore environment. Maintaining and restoring riparian forests and fixing culverts within this group may allow these waterbodies to continue to support small populations of resident trout, coho, and occasionally Chinook salmon. Quilceda Creek and Lake Stevens drainages, exceptions within this group due to abundant wetlands, still support significant coho production. With additional protective measures to retain remaining wetlands, riparian forests, and forest cover, these two sub-basins can support healthy coho runs in perpetuity.

Recommended Actions

First Priority

None listed

Second Priority

None listed

Third Priority

1. Preservation (along focus reaches) – i.e., protect intact riparian forest, floodplains and inner gorges, and maintain opportunities for rivers to migrate within their channel migration zones.
2. Remove human-made instream barriers along or adjacent to priority reaches – i.e., fix blocking culverts.
3. Restore shoreline conditions – i.e., remove rip-rap, incorporate LWD into armored banks.
4. Riparian enhancement.
5. Address water quality impacts – i.e., prevent illicit discharges, bio-filter surface water runoff from impervious surfaces.

Fourth Priority

1. Instream structural enhancement – i.e., install LWD.

Other Actions (not prioritized)

- Culvert replacement on small streams – i.e., prioritize and replace blocking culverts on coho streams based on available habitat upstream. Quilceda Creek and Lake Stevens sub-basins are the big coho producers within this sub-basin strategy group.

APPENDIX I TRI-COUNTY STORMWATER MAINTENANCE STANDARDS

From: Attachment M, Stormwater Management Checklist, Draft Tri-County 4(d) Stormwater Proposal (see http://www.salmoninfo.org/tricounty/stormToC.htm).

FACILITY-SPECIFIC MAINTENANCE STANDARDS

The facility-specific maintenance standards contained in this attachment are intended to serve as thresholds to determine whether (and if so, when) maintenance actions are required as identified through inspection. They are not intended to describe a facility's required condition at all times between inspections. In other words, failure to satisfy these thresholds or measures between inspections, prior to scheduled maintenance, or both does not constitute a violation of these standards. These standards are violated only when an inspection reveals that required maintenance action has not been scheduled before the next regular inspection, or reveals that scheduled maintenance has not been completed in a timely and satisfactory manner. A violation may be cured by scheduling required or remedial maintenance actions and completing those actions in a timely and satisfactory manner.

Note: the asterisks in the "defect" column of the following matrices denote those maintenance components for which inspections records will be used to develop inspection schedules, as described in the Stormwater Management Checklist.

NO. 1 – DETENTION PONDS

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris*	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Noxious Weeds	Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No Contaminants or Pollutants Present
	Rodent Holes*	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department)

NO. 1 – DETENTION PONDS

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Beaver Dams*	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion*	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment*	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements*	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping*	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.

NO. 1 – DETENTION PONDS

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Emergency Overflow/Spillway and Berms over 4 feet in height.	Tree Growth	Tree growth on emergency spillways create blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping*	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/Spillway	Emergency Overflow/Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion*	See “Side slopes of Pond”	

NO. 2 – INFILTRATION

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris*	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Noxious Weeds	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes *	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1)
Storage Area	Sediment*	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris*	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion*	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping*	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion*	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris*	6" or designed sediment trap depth of sediment, whichever is greater.	Sediment is removed.

NO. 3 – CLOSED DETENTION SYSTEMS (TANKS/VAULTS)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris & Sediment*	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound.	Vault replaced or repaired to design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See “Catch Basins” (No. 5)*	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).

NO. 4 – CONTROL STRUCTURE/FLOW RESTRICTOR

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash & Debris (Includes Sediment)*	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions*	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions*	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See “Closed Detention Systems” (No. 3)	See “Closed Detention Systems” (No. 3).	See “Closed Detention Systems” (No. 3).
Catch Basin	See “Catch Basins” (No. 5)*	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).

NO. 5 – CATCH BASINS

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris at Catch Basin Opening	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
	Trash & Debris in Catch Basin Bottom*	Trash or debris (in the basin) that exceeds 1/3 the depth. Measured from the bottom of basin to invert of the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
	Trash & Debris at Inlet/Outlet Pipe*	Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
	Dead Animals in Catch Basin	Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment*	Sediment (in the basin) that exceeds 1/3 the sump depth. Measured from the bottom of basin to invert of the lowest pipe into or out of the basin.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.

NO. 5 – CATCH BASINS

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

NO. 6 – DEBRIS BARRIERS (E.G., TRASH RACKS)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash & Debris*	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

NO. 7 – ENERGY DISSIPATERS

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment*	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a “sheet flow” of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged*	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of “Distributor” Catch Basin*	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole or Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects*	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).

NO. 8 – CONVEYANCE SYSTEMS (PIPES & DITCHES)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & Debris*	Accumulated sediment that exceeds 20% of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
	Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipes.
	Damaged	Protective coating is damaged; rust is causing more than 50% deterioration to any part of pipe.	Pipe repaired or replaced.
		Any dent that decreases the cross section area of pipe by more than 20% or puncture that impacts performance.	Pipe repaired or replaced.
Open Ditches	Trash & Debris*	See "Detention Ponds" (No. 1).	Trash and debris cleared from ditches.
	Sediment*	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion Damage to Slopes and channel bottom*	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rock Lining Out of Place or Missing (If Applicable).	Maintenance person can see native soil beneath the rock lining.	Rock lining replaced to design standards.
Catch Basins	See “Catch Basins" (No. 5)*	See “Catch Basins (No. 5).	See “Catch Basins” (No. 5).
Debris Barriers (e.g., Trash Rack)	See “Debris Barriers” (No. 6)*	See “Debris Barriers” (No. 6).	See “Debris Barriers” (No. 6).

NO. 9 – TYPICAL BIOFILTRATION SWALE

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass*	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader*	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage*	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation*	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs, remove brushy vegetation on adjacent slopes.
	Inlet/Outlet*	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash & Debris Accumulation*	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring*	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

NO. 10 – WET BIOFILTRATION SWALE

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation*	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation*	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet *	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash & Debris Accumulation*	See "Detention Ponds" (No. 1).	Remove trash and debris from wet swale.
	Erosion/Scouring*	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

NO. 11 – FILTER STRIPS

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass*	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
	Vegetation*	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
	Trash & Debris Accumulation*	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring*	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded For smaller bare areas, overseed when bare spots are evident.
	Flow spreader*	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

NO. 12 – WETPONDS

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash & Debris*	Accumulation that exceeds 1 CF per 1000-SF of pond area.	Trash and debris removed from pond.
	Inlet/Outlet Pipe*	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom*	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion*	Erosion of the pond's side slopes and/or scouring of the pond bottom, which exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm*	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

NO. 13 – WETVAULTS

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash & Debris Accumulation*	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault*	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

NO. 14 – SAND FILTERS (ABOVE GROUND/OPEN)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Above Ground (open sand filter)	Sediment Accumulation on top layer*	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
	Trash & Debris Accumulation*	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
	Sediment/Debris in Clean-Outs *	When the clean-outs become full or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
	Sand Filter Media*	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow through the overflow pipes occurs frequently.	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
	Short Circuiting	When flows become concentrated over one section of the sand filter rather than dispersed.	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.
	Erosion Damage to Slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.
	Flow Spreader*	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

NO. 15 –SAND FILTERS (BELOW GROUND/ENCLOSED)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault.	Sediment Accumulation on Sand Media Section*	Sediment depth exceeds 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault*	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash & Debris Accumulation*	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts*	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	Ventilation	Ventilation area blocked or plugged	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles/Internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

NO. 16 – STORMFILTER™ (LEAF COMPOST FILTER)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault	Sediment Accumulation on Media*.	Sediment depth exceeds 0.25-inches.	No sediment deposits which would impede permeability of the compost media.
	Sediment Accumulation in Vault*	Sediment depth exceeds 6-inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash & Debris Accumulation*	Trash and debris accumulated on compost filter bed.	Trash and debris removed from the compost filter bed.
	Sediment in Drain Pipes/Clean-Outs*	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed, damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Compost Media*	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

NO. 17 – BAFFLE OIL/WATER SEPARATORS (API TYPE)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accumulation*	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
	Trash & Debris Accumulation*	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation*	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	See “Catch Basins” (No. 5)	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

NO. 18 – COALESCING PLATE OIL/WATER SEPARATORS

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.
	Sediment Accumulation*	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash & Debris Accumulation*	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation*	Oil accumulation that exceeds 1-inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

NO. 19 – CATCH BASIN INSERTS

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation*	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash & Debris Accumulation*	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil*	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated*	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated*	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Normal Product Life*	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.