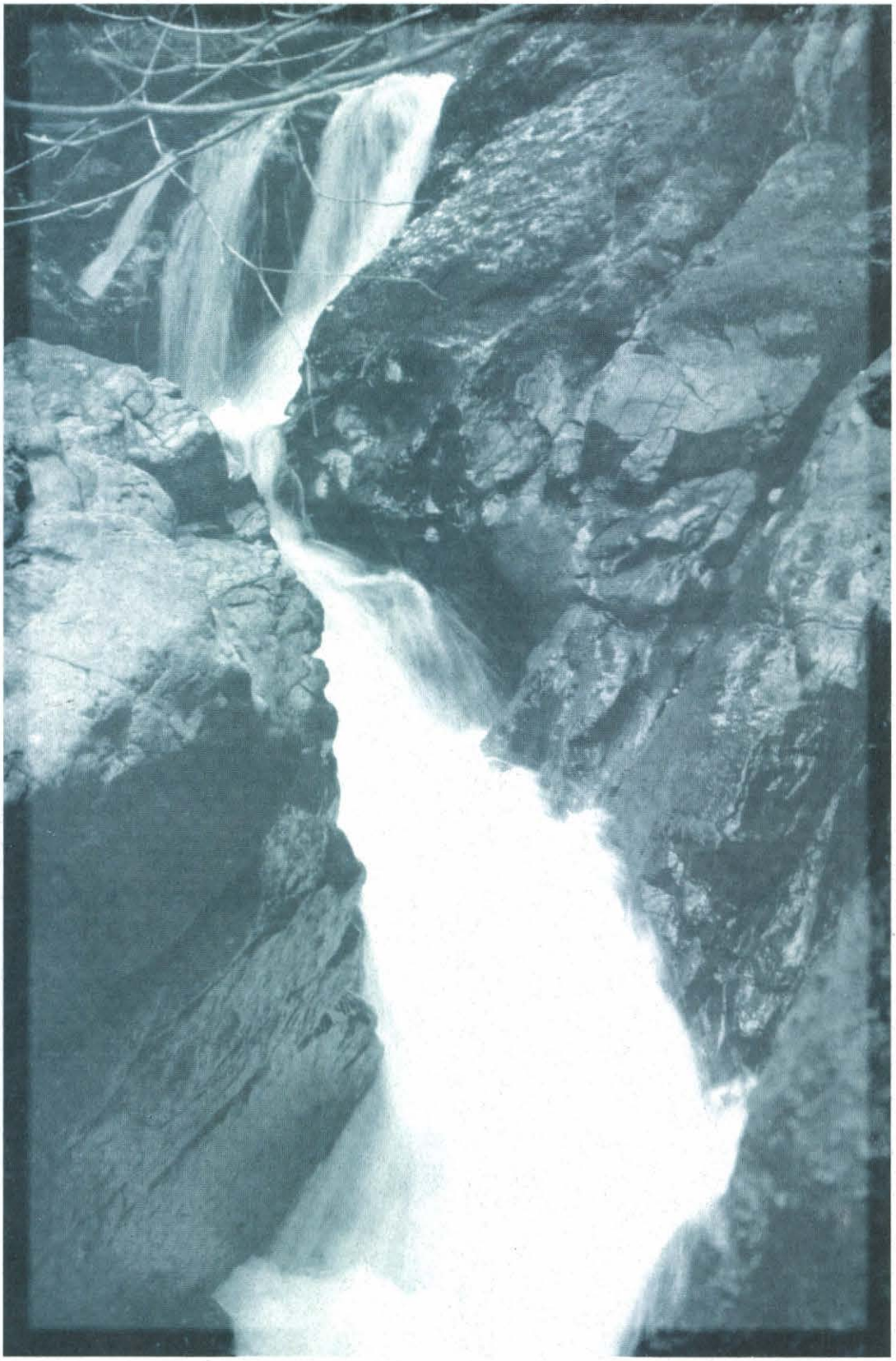

ISSAQUAH CREEK

Watershed Management Committee - Proposed
Basin and Nonpoint Action Plan

King County
Surface Water
Management
Everyone lives downstream

Issaquah Creek
Watershed Management Committee
Proposed Basin and Nonpoint Action Plan

September 1994

King County (Lead Agency)
Department of Public Works
Surface Water Management Division
700 Fifth Avenue
Suite 2200
Seattle, Washington 98104
(206) 296-6519

Issaquah/East Lake Sammamish
Watershed Management Committee
City of Issaquah
King Conservation District
King County
Muckleshoot Indian Tribe
Washington Dept. of Natural Resources

Funded in part by the Washington State Department of Ecology Centennial Clean Water Fund

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Louise Miller, District 3
Larry Phillips, District 4
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Text will be made available in large print, Braille, or audiotape as requested.

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Chapter 1

Introduction

Chapter 1: Introduction

ABOUT THE PLAN

The purpose of the Issaquah Creek Basin and Nonpoint Action Plan is to develop a program of effective actions to prevent and reduce flooding, nonpoint source pollution, habitat degradation, and stream-channel erosion in the basin.

The plan was developed by a technical team staffed by the City of Issaquah and King County Surface Water Management under the direction of an interagency Watershed Management Committee and the Basin Advisory Team, a citizens advisory committee. The project was funded by the City, the County, and the Washington State Department of Ecology. For more information on the planning process and the responsibilities of the agencies and committees, see *Chapter 2: Plan Development.*

The plan that arose from this process is a hybrid, combining a basin plan and a nonpoint action plan. The basin plan is one of a series being completed by King County Surface Water Management (SWM) for basins in the urbanizing areas of King County. The basin plans have traditionally focused on stormwater management and protection of stream and wetland habitats. The nonpoint action plan is one of many being conducted on basins that drain to Puget Sound with financial and technical assistance from the Washington State Department of Ecology. The nonpoint action plans are intended to identify actions to prevent and remedy pollution from nonpoint sources in the basins studied.

The plans were combined in the Issaquah Creek basin because of the interrelationships among water quantity, water quality, and habitat. The land and waters of the Issaquah Creek basin must be evaluated and managed as a whole, integrated system. Erosion cannot be managed without controlling the high flows that cause erosion, water pollution cannot be adequately reduced without controlling the runoff and sediment by which pollutants are transported, and aquatic habitat cannot be managed without considering all of the chemical, physical, and hydrologic elements that define each habitat.

The *Current/Future Conditions and Source Identification Report for the Issaquah Creek Basin,* available from King County SWM preceded the development of the plan. The report documents current water quality, aquatic resources, and surface-water conditions in the basin and examines potential change resulting from future land-use changes.

ISSAQUAH CREEK AND THE BASIN

The Issaquah Creek basin encompasses about 61 square miles of King County and contains both Issaquah Creek and Tibbetts Creek (Figures 1-1 and 1-2). Both

creeks flow from steep headwaters in the southern basin into Lake Sammamish at the northern edge of the basin. The basin contains Issaquah Creek and its major tributaries (Holder, Carey, Fifteenmile, and McDonald creeks, and the North and East Forks of Issaquah Creek) as well as Tibbetts Creek. The basin plan has been divided into eight subbasins for this report: Upper Issaquah, Fifteenmile, Middle Issaquah, McDonald, East Fork, North Fork, Lower Issaquah, and Tibbetts creeks subbasins. Although Tibbetts Creek is not tributary to Issaquah Creek, it shares a common floodplain with the mainstem in large flood events and was therefore incorporated into this basin plan.

The basin is diverse in natural features. Elevations range from more than 3,000 feet at the peak of Tiger Mountain to near sea level at the mouth of Issaquah Creek. More than 80 percent of the basin is forested, with the remainder in wetlands, pastures, and cleared areas. The streams, wetlands, and forests provide habitat for a great variety of fish and wildlife species, including eight species of salmonids, six of which are anadromous. The high quality habitat and abundant populations of fish and wildlife distinguish the Issaquah Creek basin as one of the three most significant basins in the King County Surface Water Management (SWM) Division service area together with Soos Creek and Bear Creek, in terms of natural resources.

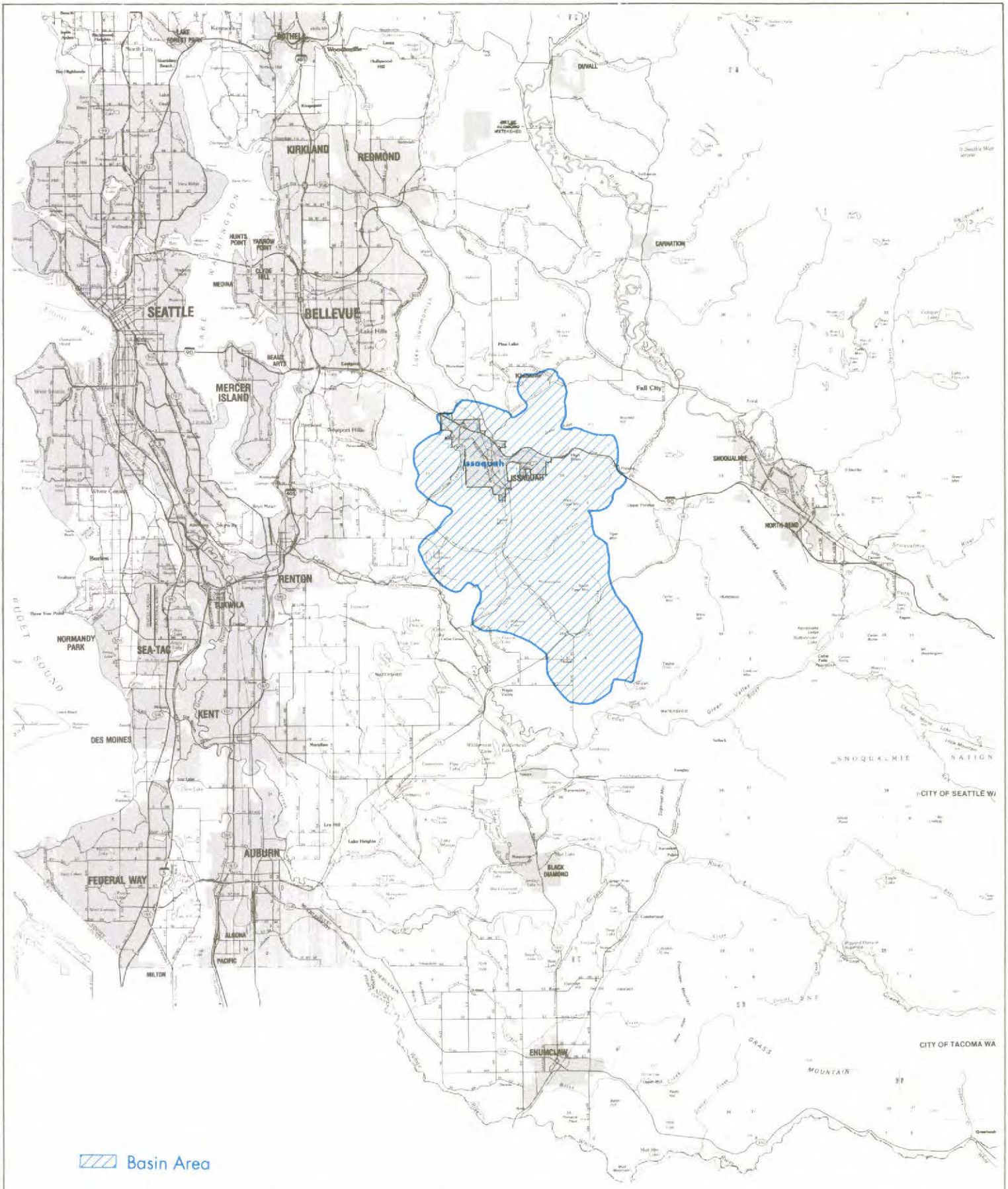
The land uses in the basin are also diverse. Remnants of the historic forestry and agricultural activities in the basin exist in commercial forestry harvesting within the Tiger Mountain State Forest (Figure 1-3), which covers much of the eastern flanks of the basin, and in the few farms that remain along the mainstem of Issaquah Creek. In the upper basin, these uses have been supplanted by dispersed residential development and, in recent years, with several large subdivisions (Figure 1-4). In the lower valley, agriculture has been replaced by the growth of the City of Issaquah, a community of 8,000 people.

SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

The principal outcome of the planning process has been the development of the findings and recommendations that are described in detail in the rest of this report. The following discussion summarizes the plan's major findings and recommendations.

Major Findings

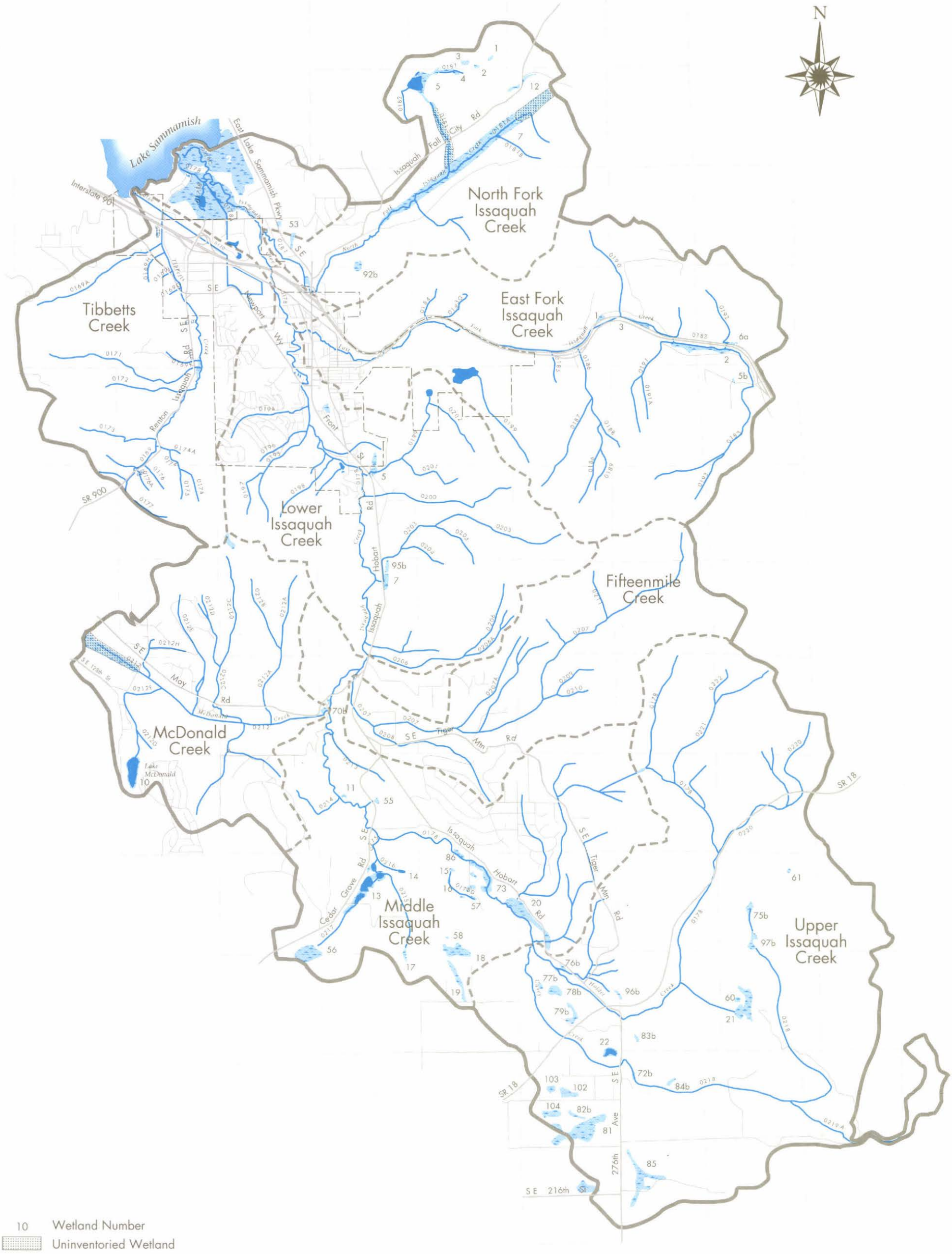
1. The lower portions of Issaquah Creek through the City of Issaquah are subject to widespread flooding that is expected to worsen with future basin development. The lower segments of Issaquah Creek and Tibbetts Creek overflow their banks on a frequent basis, resulting in flooding in hundreds of homes and businesses. According to hydrologic and hydraulic modeling, more than 350 structures, including 212 homes, would be flooded in the 100-year flood event (the flood that occurs, on average, once every 100 years) under current basin conditions. More than 90 percent of these structures are within the City of



ISSAQUAH BASIN VICINITY MAP

Issaquah Creek Basin Planning Area

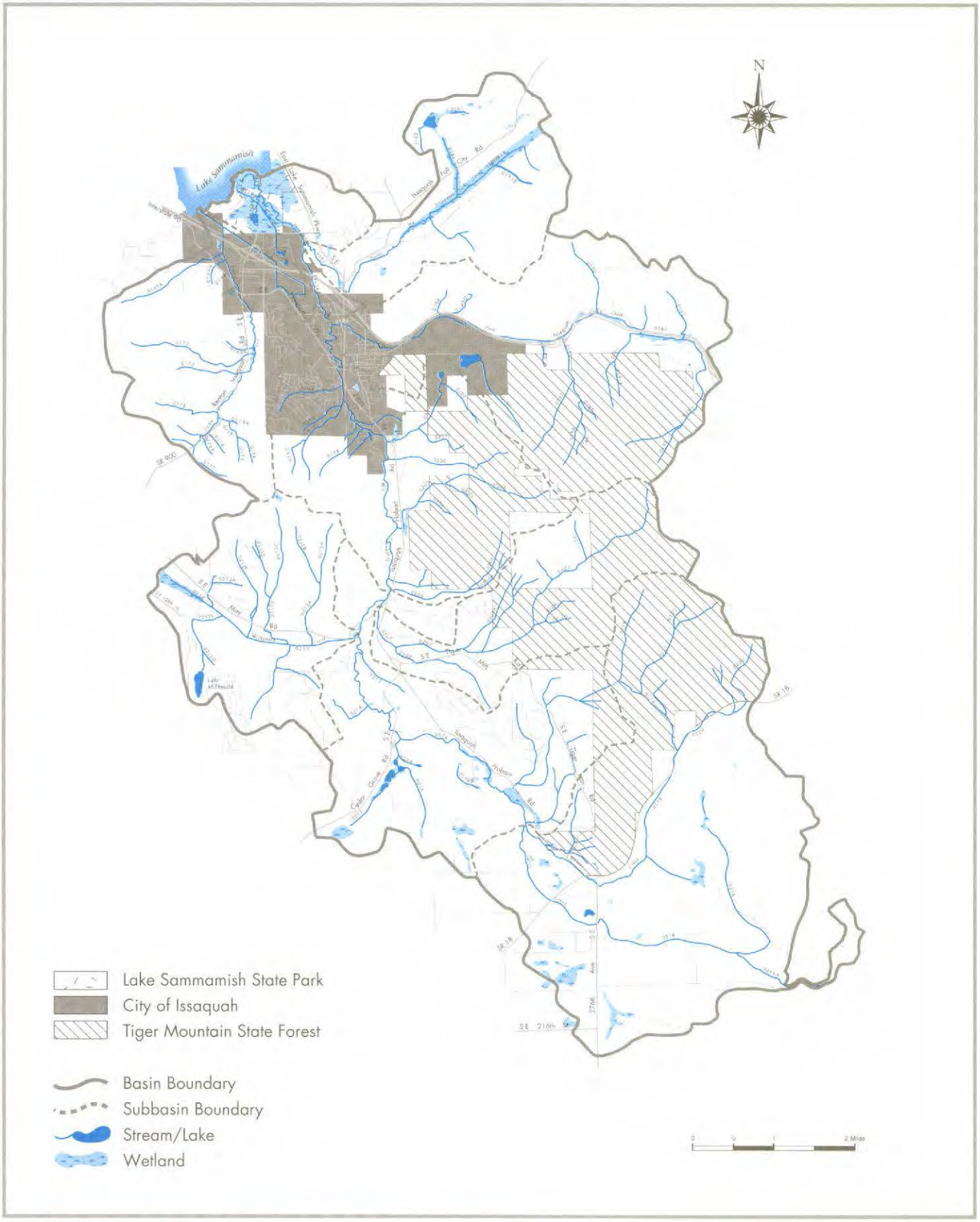
Figure 1-1



WATER FEATURES MAP

Issaquah Creek Basin

Figure 1-2



MAP OF JURISDICTIONAL BOUNDARIES
Issaquah Creek Basin

Figure
1-3

Issaquah. Many of these structures were flooded in 1990, when there were two fairly large floods. While most flooding problems are not severe, causing nothing more than property damage, there are some locations in the basin where flooding results in hazardous conditions.

Flooding problems are largely the result of extensive development in floodplains in the lower basin, rather than increases in flood flows due to upstream development. This is predicted to change in the future, as additional development of the upper basin increases stormwater runoff into the stream system. If the basin develops to the limits of existing zoning with current land-use controls in place (Figure 1-5), the stormwater flows reaching the City of Issaquah will increase by about 20 percent in the mainstem; increases in tributaries could exceed 40 percent. Consequent increases in overbank flow and the expansion of the floodplain will result in a significant increase in the number of homes and businesses that will be subject to flooding. Stated another way, floods comparable to the 1990 events would be expected to recur every 12 to 15 years after basin development, rather than every 30-35 years as is currently the case.

2. Existing water quality in the Issaquah Creek basin, while generally good in current conditions, is predicted to deteriorate markedly with clearing and development in the upper basin. Despite localized pollution from urban sources, roads, and agricultural and forestry activities, the water quality in Issaquah Creek and its tributaries is good, particularly during baseflow conditions. Analyses in the plan indicate that this is likely to change with clearing and development of forest lands in the upper basin, which would result in increases in the amount of nutrients, sediment, and toxic materials such as heavy metals entering the stream system. Without mitigation in excess of current requirements, modeling indicates that lead loading to the stream system would increase by 75 percent, solids by 43 percent, and phosphorus by 92 percent as a result of future clearing and land development. Increases in solids and phosphorus are particularly important because the Issaquah Creek system provides 70 percent of the inflow to Lake Sammamish, which is already subject to eutrophic conditions and is expected to deteriorate markedly in the future unless these pollutants are controlled.

3. Deterioration in habitat within the Issaquah Creek basin has resulted in loss of fish and wildlife populations, and habitat and populations are predicted to decline further with continued basin development. Although more than 80 percent of the basin remains forested, the 20 percent that has been cleared and developed in other land uses includes land along most of the mainstem and several of the larger tributaries of Issaquah Creek. These areas once featured important aquatic and riparian habitat, and the loss of habitat has resulted in a loss of native fish and wildlife populations in the Issaquah Creek system. The protection of existing habitat is critical to the survival of remaining populations, particularly to the eight species of salmonids, six of which are anadromous, that use the stream for spawning and rearing. Without stringent mitigation measures, the hydrologic and water quality impacts of future clearing and land development that have been discussed previously are expected to render areas of the basin unsuitable for salmon and other important fish and wildlife species. Maintaining fish and wildlife

populations in the Issaquah system will also require the restoration of important habitats, such as mainstem spawning and rearing areas.

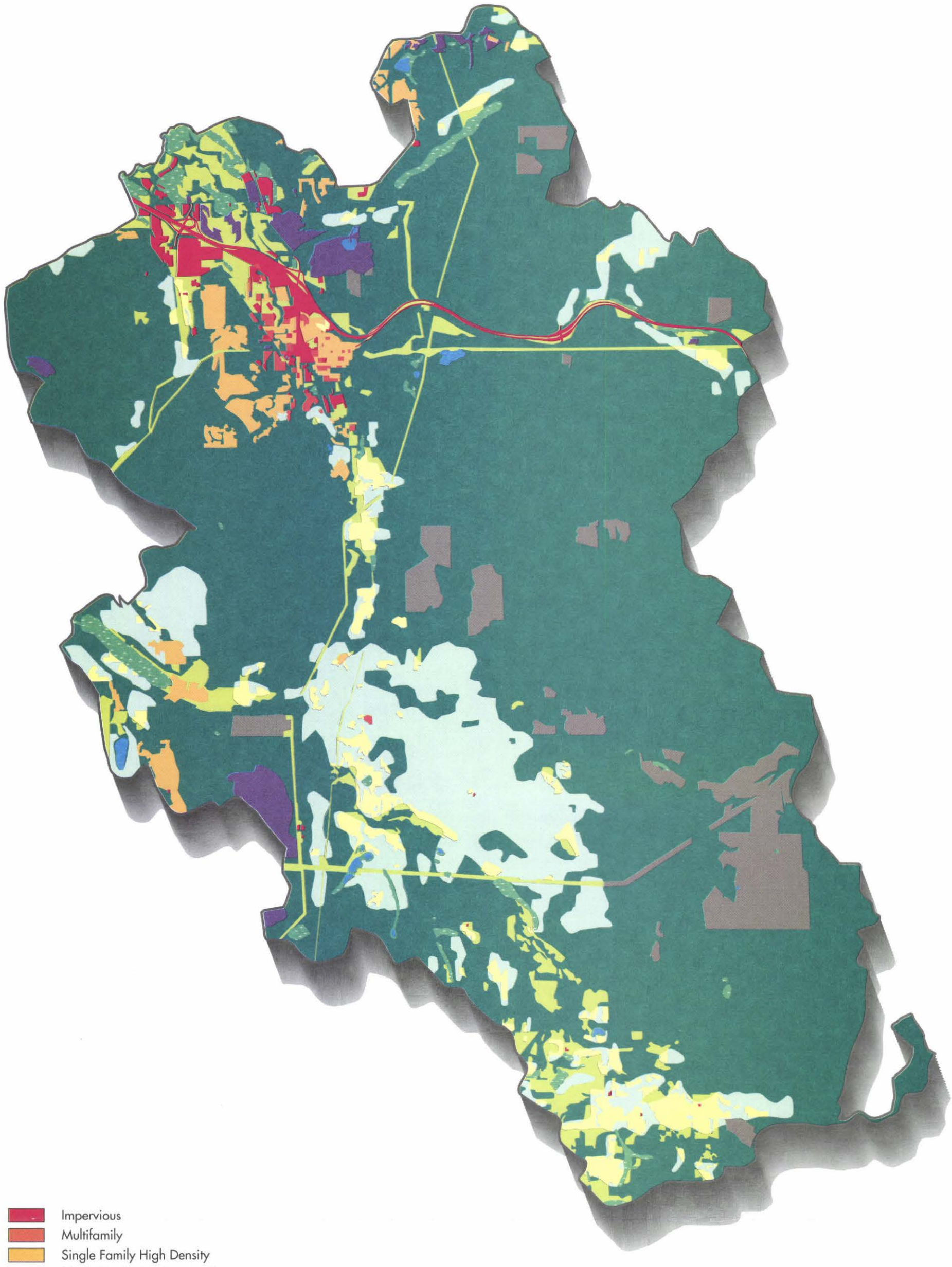
Major Recommendations

1. Reduce flood hazards by removing homes from the stream corridor, acquiring easements on undeveloped property, and restoring channel and floodplain capacity. The natural functions of the stream channel and floodplain to transmit and store flood waters have been compromised by development of the stream corridors in the Issaquah basin. The plan proposes to restore these functions through the selective removal of homes and reconfiguration of the stream channel within the floodplain. Easements would also be purchased to allow reconfiguration of the channel on undeveloped streamfront land. In addition to benefits in flood protection, the purchase of land and easements and reconfiguration of the channel will allow the restoration of degraded fish and wildlife habitat along the mainstem and major tributaries.

The analysis in the plan indicates that the flood protection and habitat benefits of this program would be optimized at a cost of around $15 million. It is assumed that overall costs, financing terms, and administration of the program would be negotiated between King County and the City of Issaquah after basin plan adoption. An analysis of flood protection alternatives conducted in the planning process indicates that this combination of purchase and restoration, when combined with a floodproofing program also recommended in the plan, provides a moderate level of flood protection and excellent environmental benefits at a cost substantially lower than other options.

2. Regulate the location and characteristics of new development to reduce impacts on stormwater runoff, water quality, and fish and wildlife habitat. Flooding, water quality, and habitat problems will be much more severe in the future if all residentially-zoned areas of the basin are developed, even at the rural densities that predominate under current zoning. The plan proposes clearing and subdivision regulations that would dramatically reduce the amount of clearing associated with new construction. Modeling in the basin plan indicates that these measures alone will be highly effective at reducing runoff and the transport of sediment and nutrients into the stream system. In particularly sensitive areas, the plan proposes regulations that would increase the capacity and effectiveness of new stormwater control facilities. In two small areas of the basin, the plan recommends that current zoning be reevaluated through a community plan amendment to determine if the densities proposed are compatible with their environmental sensitivity. The other regulatory recommendations are proposed to be implemented through changes to King County codes.

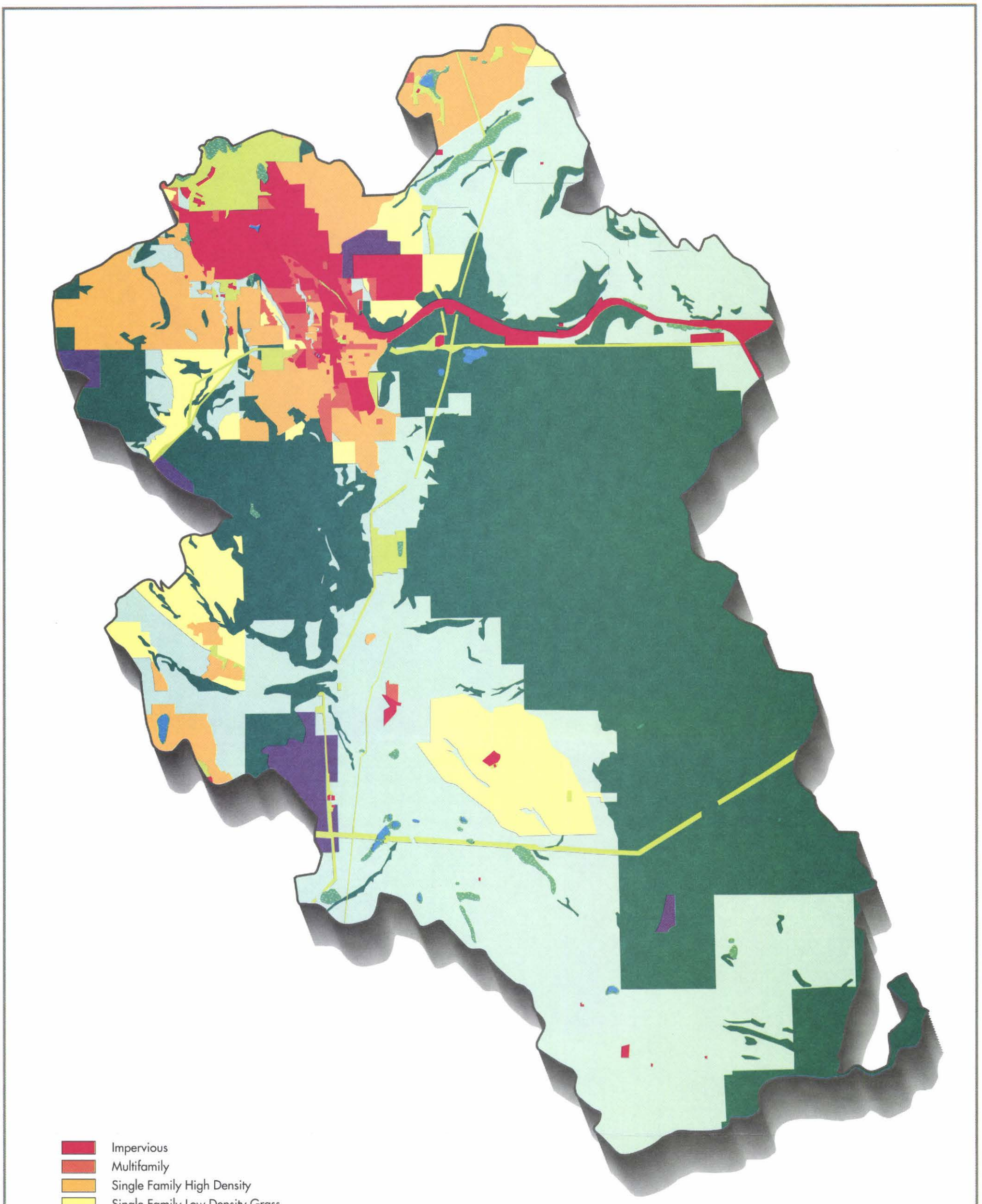
3. Solve discrete drainage problems through capital improvement projects. Many discrete drainage problems were identified in the plan, most of which are associated with inadequate drainage facilities for roads and residential subdivisions in the basin. The plan proposes a capital improvement program that includes 44 projects at a total cost of $7.4 million. More than half of the proposed projects are retrofits of road culverts, stormwater facilities, or other drainage facilities. It is



CURRENT LAND USE/LAND COVER

Issaquah Creek Basin

Figure 1–4



FUTURE LAND USE

Issaquah Creek Basin

Figure 1-5

assumed that funding for the capital improvement program will come from bonding and pay-as-you-go sources financed through surface water management fees.

4. Restore disturbed fish and wildlife habitat through capital improvement projects and public programs. The plan also identified many areas of the basin where land use or road construction has degraded the quality of aquatic and riparian habitat. Restoration of habitat is addressed through projects under the capital improvement program discussed previously and through several public programs recommended in the plan. The plan proposes to increase support for volunteer restoration projects through the efforts of a County-employed basin steward, provide technical assistance to citizens on bioengineering techniques for bank stabilization, and form a Conservation Corps to expedite small, simple restoration projects in the Issaquah Creek basin and elsewhere in the SWM service area. King County's participation in these public programs is expected to be funded on a pay-as-you-go basis financed through surface water management fees or, in the case of the Conservation Corps, through reallocation of funding from the capital improvement program.

5. Reduce pollution from nonpoint sources through capital improvement projects, monitoring, enforcement, and education. The plan proposes a variety of capital improvement, monitoring, and education efforts sponsored by several public agencies and private organizations to address nonpoint pollution from sources other than land development. Among the King County responsibilities are training sessions for land developers, production of educational materials for landowners on septic-system maintenance, and negotiation of an agreement with the Washington State Department of Natural Resources on forest practices within the basin. The plan assumes that these responsibilities will be divided among the basin steward and other SWM staff and staff of DDES and other County agencies. For more significant nonpoint sources, including the active and inactive mine sites in the basin, the plan recommends that these measures be supplemented by more aggressive enforcement of regulations by County and State agencies.

IMPLEMENTATION

The actions recommended in this plan will vary in when and how they will be implemented. Certain actions, such as changes in Issaquah or King County codes and regulations, will be initiated as soon as the plan is adopted by the City and County councils. Most capital improvement projects recommended as high priorities in the plan will be constructed in the three years following adoption (1995-1997), as funding becomes available and design and permitting tasks are completed. Funding for these projects will be contingent on Council review and approval of budgets and financing proposals after the plan is adopted. If approved in plan adoption, the terms of the recommended City/County program to restore the lower floodplain of Issaquah Creek will be subject to negotiations. It is hoped that the negotiations will be completed within a year after plan adoption and that the program will be fully funded and operational within three years. The implementation of other programmatic recommendations, such as proposals for

new educational programs, will occur as staff and budgets allow, with the highest priority programs beginning in the first year after plan adoption.

Implementing Agencies

More than 20 agencies and organizations have a role in implementing the plan. Key tasks for which these agencies will be responsible include development of programs, projects, budgets, and regulations that are consistent with the plan. Implementing agencies include:

King County Agencies:
Department of Development and Environmental Services (DDES)
- Land Use Services
- Building Services Division
- Environmental Division

Department of Public Works
- Roads and Engineering (Roads) Division
- Surface Water Management (SWM) Division
- Solid Waste Division (KCSWD)
- Department of Metropolitan Services (Metro)

City Agencies:
City of Issaquah
Seattle Water Department

Regional Agencies and Special Purpose Districts:
King Conservation District (KCD)
Seattle/King County Department of Public Health (SKCDPH)

Indian Tribes:
Muckleshoot Indian Tribe (MIT)

State Agencies:
Washington State Department of Agriculture (WSDA)
Washington State Department of Ecology (WDOE)
Washington State Department of Fish and Wildlife (WDFW)
Washington State Department of Health (DOH)
Washington State Department of Natural Resources (DNR)
Washington State Department of Transportation (WSDOT)
Washington State Parks and Recreation Commission (WSPRC)

Federal Agencies:
National Marine Fisheries Service (NMFS)
United States Fish and Wildlife Service (USFWS)

Others:
Save Lake Sammamish (SLS)

USING THE PLAN

The substance of the plan is found in three chapters. *Chapter 3: Problems, Goals, and Approaches* provides an overview of what the plan is trying to accomplish, and how, in each of the four major topical areas of the plan: flooding, water quality, stream and wetland habitat, and stream-channel erosion and deposition. Problems are summarized based on the analysis of existing and future conditions in the planning process. Explicit goals for solving these problems are defined. Finally, the approaches to the solutions that have been adopted in the plan are described, with references to the corresponding plan recommendations.

Chapter 4: Basinwide Recommendations, describes the plan recommendations that apply to multiple subbasins or to the entire basin. The description of the recommendation includes information on who will do the action, when, and why.

Chapter 5: Subbasin Recommendations, describes plan recommendations for each of the eight subbasins of the Issaquah Creek basin (Figure 1-2). This chapter gives detailed information on the application of programs, regulations, and capital improvement projects within the subbasin area, and as with *Chapter 4,* it specifies who will do the action and why.

Chapter 2

Plan Development

Chapter 2: Plan Development and Implementation

INTRODUCTION

This chapter focuses on three topics: the development of the plan—including who worked on the project and the process—the implementation process and schedule, and priorities for implementation.

DEVELOPMENT OF THE PLAN

The Planning Team and Advisory Committees

The Issaquah Creek Basin and Nonpoint Action Plan is the work of a planning team, two committees, various public agencies, and the general public. The roles and functions of each will be described in the following summary.

1. The planning team: This plan has been produced by a multidisciplinary team staffed by King County Surface Water Management (SWM) and City of Issaquah employees. Team members are listed under the *City of Issaquah* and *Contributing Staff* on page ii. The team works under the overall direction of the King County SWM Division and City of Issaquah management and the elected councils of both jurisdictions. The role of the planning team has been to conduct all technical analyses and evaluations required in the planning process, develop recommendations, convene and oversee the work of the advisory committees, and produce the draft and final plans. The team also ensures that the process for plan development follows the requirements of the Nonpoint Rule (Chapter 400-12 WAC) and that the plan is consistent with other pertinent regulations, such as Section 319 of the Federal Clean Water Act.

2. The committees: Two committees have been formed to participate in the development of the basin and nonpoint action plan. The Watershed Management Committee (WMC) is composed of representatives of King County SWM, the City of Issaquah, the Washington Department of Natural Resources, the Muckleshoot Indian Tribe, and the King Conservation District. The WMC was established as a steering committee under State of Washington regulations governing the nonpoint action planning process (Chapter 400-12 WAC) and functions as the principal decision-making body for policy issues in the basin and nonpoint action plan. The Basin Advisory Team (BAT) is composed of residents of the Issaquah basin. The BAT functions as the principal advisor to the planning team and WMC on major issues in the planning process and as liaison to other community groups and the general public. Both committees meet monthly. Committee members are listed on page ii of this plan.

3. Other public agencies: In addition to the agencies that are represented on the planning team and committees, many agencies at the city, county, state, and federal level have been involved in the planning process. Staff of these agencies have served as advisors to the planning team and committees and as reviewers of the draft plans. The *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan*, published separately, contains a list of these agencies.

4. The general public: The citizens of the basin and other members of the public have participated in the planning process in several ways. First, the public has been involved in committee meetings and several presentations to the City Council and their advisory committees. All of these forums have been open to the public and allowed public comment. Second, volunteer activities have been conducted in the Issaquah basin since the beginning of the planning process, including storm drain stenciling, stream cleanups, salmon rearing and releases, and corridor revegetation projects. A third opportunity to participate is through review of drafts of this plan, and through public meetings and hearings associated with this process.

Planning Process

The basin and nonpoint action planning process includes the following major tasks:

1. Evaluation of current and future basin conditions: The focus of this task was to define the current surface-water conditions in the basin and predict the future conditions. Current conditions were defined by research on previous studies and plans for the basin, field evaluations, stream gaging and monitoring, and hydrologic and hydraulic modeling (see the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan*, published separately). Future conditions were predicted through simulations, based on future basin land-use options, and additional hydrologic and hydraulic modeling.

This task was conducted for the Issaquah Creek Basin and Nonpoint Action Plan in 1990 and 1991 and culminated in the publication of the *Current/Future Conditions and Source Identification Report* in October, 1991. This report, containing detailed results of the conditions analysis, is available from King County Surface Water Management.

2. Definition of surface-water problems and analysis of possible solutions: The objective of this task was to determine which surface-water problems require action under the plan and to analyze a range of possible actions to solve these problems. This task began with a reevaluation of the findings of the conditions analysis to define those systemic and acute problems that require solutions under the plan. This included a priority-setting process involving the planning team and the advisory committee(s) working on the project. A range of potential capital improvement, programmatic, and/or regulatory solutions were then evaluated for each of the priority problems.

This task was conducted in early 1992. Priority-setting workshops were held with the planning team and both committees during this process. Reports completed

during this task included a *Summary of Conditions* report documenting the key problems identified in the conditions analysis and a *Solutions Notebook* compiled by the planning team. Both are available for review in the King County Surface Water Management offices.

3. Development and refinement of recommendations: The focus of this task was to develop recommended solutions to the problems defined in previous tasks and to incorporate the solutions into drafts of the basin and nonpoint action plan. Recommendations were initially developed by the planning team in consultation with the advisory committee(s) and implementing agencies. Recommendations were refined through a series of reviews of draft plans. For combined basin and nonpoint action plans, a sequence of three draft plans are produced and circulated for comment.

The preliminary draft plan, the first of three review drafts of the plan, was released for review by the advisory committees and implementing agencies in August, 1992. The draft plan, released in December 1992, was the second draft of the plan, and the first available for general public review. This version, the WMC-Proposed plan, is scheduled to be reviewed, revised, and adopted by the Metropolitan King County Council in 1994.

Each version of the plan incorporates recommendations to resolve problems identified in the preceding analysis. Recommendations take three forms. Regulatory recommendations propose actions to create or revise land-use and environmental regulations at the city, county, or state level. Programmatic recommendations propose actions to create or revise public agency programs, such as those that offer technical and financial assistance to the public, or those that focus on public education. Capital improvement recommendations propose actions to restore habitat and construct or modify facilities for drainage or water quality control.

4. Adoption and implementation: The objective of this task is to have all of the implementing agencies and organizations initiate the actions recommended in the plan. For public agencies, this will require adoption of the relevant portions of the plan as policy, revision of ordinances and capital improvement programs as necessary to undertake the recommended actions, and the initiation of projects recommended in the plan. The programmatic and regulatory recommendations are typically implemented in the first two years following plan adoption, and the capital improvement projects should be completed within three years.

This task is expected to begin in 1995.

5. Plan Evaluation: Evaluation measures are necessary to determine whether the basin and nonpoint action plan is meeting its stated goals, whether implementation is proving feasible and affordable, and whether it is necessary to alter the plan to improve the results. To evaluate the success of plan implementation, monitoring actions are specified in basinwide recommendation 30. This recommendation includes hydrologic, water quality, wetland, and stream habitat monitoring to define conditions in the basin, as well as plan monitoring to determine which actions are implemented according to the plan schedule. The basin steward will

complete annual reports to describe the status of the plan, and the schedule for ongoing plan implementation. More detail on this process can be found in basinwide recommendation (BW) 30 in *Chapter 4*.

PRIORITIES FOR IMPLEMENTATION

This plan establishes an ambitious program for reducing and preventing surface-water problems in the Issaquah Creek basin. In all likelihood, it will be difficult to fully fund all programs and capital improvement projects that are recommended in this plan. Priorities were established to define a recommended sequence for carrying out the various projects and programs.

Process for Defining Priority Problems and Recommendations

The priority-setting process for this plan began in early 1992, when a series of three workshops were held with the WMC, the BAT, the project team, and the Issaquah Rivers and Streams Board to discuss their views on high priority problems. Based on these workshops, criteria for defining priority problems and solutions were developed. The workshops focused on ranking the problems identified in the *Current/Future Conditions and Source Identification Report*. The workshops and subsequent team meetings resulted in lists of high and medium priority problems for the overall basin and eight subbasins.

To further refine the priority-setting and ranking process, the planning team developed two sets of criteria for defining priorities: one for capital improvement projects and another for programmatic and regulatory recommendations.

The following tables summarize the results of the ranking process. Capital improvement projects are grouped by "core" (Table 2-1) and "non-core" (Table 2-2) assignments and then sorted by priority. Programmatic recommendations are grouped by the nature of the action (e.g., "flooding" or "water quality") and then sorted in order of their priority (Table 2-3). Table 2-4 shows the estimated cost of each programmatic recommendation and breaks down the costs by implementing agency. For more detail on the criteria and how they were applied to each recommendation, please refer to the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan*, published separately.

Table 2-1 CIP "Core" Recommendations (sorted by priority)

Subbasin	Responsible Agency[1]	Project Number	Project Name	1994 Costs[2]
Upper	DNR	2546	Holder/Pheasant Creek Diversion	$10,000
Upper	WSDOT	2543	Upper Holder Fish Passage	$3,500
Upper	WSDOT	2544	Tributary 0220 Fish Passage I	$30,000
Upper	WSDOT	2545	Tributary 0220 Fish Passage II	$30,000
Lower	SWM	2599H	Tributary 0199 Coop Stream and Riparian Enhancement	$10,000
North Fk	SWM	4613	Habitat Improv for North Fk Wetland 5 (Yellow Lk)	$36,000[3]
Tibbetts	SWM	6718	Large Woody Debris Placement	$100,000
North Fk	SWM	4612	Water Quality Imprv for North Fk Wetland 5 (Yellow Lk)	$60,000[3]
Middle	SWM	2599B	Stream-Corridor Riparian Wetland Revegetation	$120,300[3]
Tibbetts	ISS	6711C	NW Poplar Way Culvert Replacement	$167,000
Middle	SWM/Road	2532	Mirrormont Erosion Control	$305,000[3]
Upper	SWM	2599E	Holder Ck Sed. Management and Hab. Enhancement	$135,000[3]
Upper	SWM	2547	Carey Creek Fish Passage at SE 204th St.	$380,400[3]
Tibbetts	ISS	6711D	SE Newport Way Culvert Replacement	$308,800
Tibbetts	ISS	6712A	Newport Wy Cross. Replace. at Anti-Aircraft (0169A) Ck	$163,500
Upper	SWM	2599F	Stream-Corridor Riparian Wetland Revegetation	$183,700[3]
Lower	SWM/Road	2524	Tributary 0203 Stream-Channel Relocation/Restoration	$491,700[3]
Lower	SWM/Road	2522	Tributary 0199 Fish Passage Enhancement	$297,400
North Fk	SWM	4615	Klahanie Stormwater Facility Improvements	$200,000[3]
Tibbetts	ISS	6711A	NW Sammamish/SE 56th St. Culvert Replacement	$415,800
Upper	SWM	2599G	Holder Creek Stream-Channel Enhancement	$214,200[3]
North Fk	SWM	4614	North Fork Wetland 7 Habitat Improvements	$287,900[3]
Tibbetts	SWM	6717	Bianca Mine Spoils Remediation	$700,000
East Fk	ISS	1411	NE Dogwood St. Br. Hydraulic Constriction Elimination	$250,000
Tibbetts	WSPRC	6713A	Lake Sammamish State Park Channel Reconstruction	to be determined
Tibbetts	WSDOT	6711B	Interstate-90 Culvert Replacement	to be determined
Tibbetts	ISS	6713B	Tibbetts Ck Relocation and Floodplain Restoration	to be determined
Tibbetts	ISS	6713C	Tibbetts Manor Flood Setback Berm/Dredging	to be determined
				Total $4,900,200

[1] DNR = Department of Natural Resources
ISS = City of Issaquah
Road = King County Roads Division
SWM = King County Surface Water Management Division
WSDOT = Washington State Department of Transportation
WSPRC = Washington State Parks and Recreation Commission

[2] Includes surveying, design, project management, and right-of-way costs.

[3] Proposed for 1994 bonding

Table 2-2 CIP "Non-Core" Recommendations (sorted by priority)

Subbasin	Responsible Agency[1]	Project Number	Project Name	1994 Costs[2]
Lower	SWM	2599A	Nudist Park Ck LWD Placement	$4,000
Upper	SWD	2542	Hotel Creek Diversion	$10,000
Tibbetts	WSDOT	6711E	State Route 900 Fish Passage	$14,000
McDonald	KCSWD	2557	Improve Turb. Control from Cedar Hills	$25,000
Middle	SWM	2533	Embankment Stabilization of 231st Place SE	$158,000
East Fork	ISS	1412	Bar Scalping at RM 0.75 and 1.00	$44,200
East Fork	SWM/ISS	1499	Large Woody Debris Placement	$71,100
Middle	SWM	2599D	Four Creeks Ranch Cooperative Bank Stabilization	$240,800
Lower	SWM/Road	2525	Nudist Park Creek Fish Passage	$450,800
East Fork	ISS	1413	Dogwood St. Bank Stabilization	$95,800
Middle	SWM	2599C	Pheasant Ck Cooperative Bank Stabilization	$330,200
Tibbetts	SWM	6716	Kelly's Ranch Riparian Restoration	$100,000
Middle	Road	2534	Embankment Stabiliz. of SE May Valley Rd	$106,600
Tibbetts	WSDOT	6712B	SR 900 Stream Modification at Trib 0171	$393,000
Tibbetts	SWM	6715	Ficker Tributary Revegetation	$88,400
Lower	SWM/Road	2523	Tributary 0200 Sediment Management	$335,000
			Total	$2,466,900

[1] DNR = Department of Natural Resources
ISS = City of Issaquah
Road = King County Roads Division
SWM = King County Surface Water Management Division
WSDOT = Washington State Department of Transportation
WSPRC = Washington State Parks and Recreation Commission

[2] Includes surveying, design, project management, and right-of-way costs.

Table 2-3 Priorities for Programmatic Recommendations, by Category

Category	Rank	Recommendation	Priority[1]
Regulations	1	BW 5: Issaquah CAO	A
	2	BW 2: Erosion Protection R/D Standards	A
	3	BW 4: TESC Program	A
	4	BW 3: Open Space	A
	5	BW 1: Flow Reduction R/D Standards	B
	6	BW 6: Zoning Changes	C
Flooding	1	BW 7: Floodplain Restoration	A
	2	BW 9: Floodplain Mapping	A
	3	BW 10: Flood Warning System	A
	4	BW 12: Culvert Design Criteria	B
	5	BW 8: Floodproofing and Elevation	C
Water Quality	1	BW 19: WQ Treatment Design Strds.	A
	2	BW 16: Forest Practices	A
	3	BW 17: WQ from Road Drainage	B
	4	BW 18: Hazardous Spill Response	B
	5	BW 13: Urban WQ	B
	6	BW 15: Farm WQ	B
	7	BW 14: Septic Systems	C
	8	BW 20: Other WQ	C
Habitat	1	BW 21: Significant Resource Areas	A
	2	BW 22: Habitat Restoration	A
	4	BW 23: Bank Stabilization	B
	5	BW 24: Fish Management Task Force	B
	6	BW 27: Mitigation Banking	B
	7	BW 26 Wetland Inventory	C
Multiobjective	1	BW 29: Basin Steward	A
	2	BW 30: Monitoring	B
	3	BW 31: Enforcement	B
	4	BW 28: Channel Migration	C
	5	BW 34: Transfer of Development Credit	C
	6	BW 33: Guidelines for Site Design	C

[1] Priorities set by points as described in the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan.*

Table 2-4 Programmatic Recommendation Costs by Implementing Agency

Recommendation	Implementing Agency [1]	Priority	Public Agency Costs[2] Year 1 $,000 FTE	Expen.	Total	Ongoing $,000 FTE	Expen.	Total	Notes
BW 1: Flow Reduction Std. for On-Site R/D Facilities	SWM DDES	B	— 0.50		25K				No costs-SWM Training-DDES Other costs covered by existing programs
BW 2: Erosion Protection Std. for On-Site R/D Facilities	SWM DDES	A							Costs covered by existing programs
BW 3: Open Space Retention Requirements	SWM CP DDES MIT	A	0.10 0.10 0.20 0.03		5K 5K 10K 1.5K	0.05 0.20 		2.5K 10K 	
BW 4: Comprehensive TESC Program for Construction Sites	SWM DDES MIT	A	 0.25 0.05		 12.5K 2.5K				SWM costs budgeted and funded on a county-wide basis
BW 5: Issaquah Critical Areas Ordinance	ISS	A							Costs covered by existing programs
BW 6: Zoning Changes in Critical Areas	SWM CP	C							Costs covered by existing programs
BW 7: Channel and Floodplain Restoration	SWM ISS MIT	A	0.50 1.00 0.05		25K 50K 2.5K	0.25 1.25 		12.5K 62.5K 	Admin costs only (capital costs in subbasin recommendations)
BW 8: Floodproofing and Elevation Program	SWM ISS	C							Admin costs included in BW 7 (capital costs in subbasin recommendations)
BW 9: Floodplain Mapping	SWM	A	0.10		5K				
BW 10: Flood Warning System	SWM ISS	A	0.10 0.10		5K 5K	 0.05		 2.5K	
BW 12: Stream Crossing Design Criteria	SWM Roads	B	0.20 0.20		10K 10K				
BW 13: Source Control Practices Within Urban Areas	SWM ISS MIT	B	0.10 0.25 0.03	3K 3K	8K 15.5K 1.5K	0.10 0.25 	2K 3K 	7K 15.5K 	
BW 14: On-Site Septic Systems	SKCDPH	C	0.25	2K	14.5K	0.10		5K	
BW 15: Improvement of Farm Practices	KCD SWM, SWD, SKCDPH	B	1.00 — —	5K — —	55K — —	0.25 — —	2K — —	14.5K — —	SWM, SWD, & SKCDPH costs covered by existing programs
BW 16: Interagency Procedures for Administering Forest Practices	SWM DDES DNR MIT	A	0.10 0.40 — 0.10		5K 20K — 5K	0.10 0.40 — 0.10		5K 20K — 5K	DNR costs covered by existing programs
BW 17: Improvement of Water Quality from Road Drainage Systems	WSDOT Roads SWM ISS SKCDPH	B	0.40 0.20 0.10 0.20 —	15K	35K 10K 5K 10K —	0.20 0.10 0.10 —		10K 5K 5K —	SCKDPH costs covered by existing programs
BW 18: Spill Response Program	SWM WSDOT ISS Roads	B	0.10 0.10 0.10 0.10	5K	10K 5K 5K 5K	0.05 0.05 0.05 0.05		2.5K 2.5K 2.5K 2.5K	
BW 19: Water Quality Treatment Design Standards	SWM	A							Costs covered by existing programs

Table 2-4 Continued

Recommendation	Implementing Agency[1]	Priority	Public Agency Costs[2] Year 1 $,000 FTE	Expen.	Total	Ongoing $,000 FTE	Expen.	Total	Notes
BW 20: Additional Water Quality Recommendations	SWM	C	0.30		15K	0.11		5.5K	
	DDES		0.10	10K	15K				WSDA, Roads, WSPRC,
	ISS		0.20	10K	20K	0.05		2.5K	SKCDPH costs covered
	WSDA, Road		–		–	–		–	by existing programs
	WSPRC		–		–	–		–	
	SKCDPH, SLS		–		–	–		–	SLS volunteer hours
BW 21: Designation and Protection of SRAs	SWM	B							Cost included in
	ISS								basin/subbasin recommendations
BW 22: Habitat Restoration and Enhancement Program	SWM	A	0.50	57.5K	82.5K	0.50	50K	75K	Assumes 25% of county-wide program costs
BW 23: Bank Stabilization Program	SWM	B	0.35	10K	27.5K	0.10		5K	
	ISS		0.10		5K	0.10		5K	
	WDFW		0.20		10K				
	MIT		0.05		2.5K				
BW 24: Issaquah Fishery Management Task Force	SWM, MIT, WDFW, ISS, USFS, NMFS	B	0.60		30K				0.10 FTE/agency
BW 26: Wetland Inventory	DDES	C	0.25	10K	22.5K				
	SWM		0.10		5K				
BW 27: Aquatic Resource Mitigation Banking	SWM	B	0.20		10K				
	DDES, Roads, ISS, Parks		0.40		20K				0.10 FTE/agency
	MIT		0.03		1.5K				
BW 28: Channel Migration Hazard Areas	SWM	C	0.20	2K	12K				
	ISS								
BW 29: Basin Steward	SWM	A	0.50	10K	35K	0.50	10K	35K	
	ISS		0.10		5K	0.10		5K	
	KCD, DNR, SKCDPH, MIT, DDES, WSPRC, WDFW, WDOE, Roads		0.45		22.5K	0.45		22.5K	0.05 FTE/agency
BW 30: Basin Plan Monitoring	SWM	B	0.75	10K	47.5K	0.75	10K	47.5K	
	ISS		0.25	5K	17.5K	0.25	5K	17.5K	
BW 31: Basin Plan Enforcement	DDES	B	0.50		25K	0.50		25K	
	SWM		0.25		12.5K	0.25		12.5K	Metro, DNR WDOE, SKCDPH, KCD costs covered by existing programs
	Metro, DNR WDOE, SKCDPH, KCD								
BW 33: Guidelines and Standards for Site Design	SWM	C	0.40	10K	30K				
TOTAL			13.79	167.5K	857K	7.36	82K	450K	

[1] CP = King County Community Planning
DDES = King County Dept. Development and Env. Serv.
DNR = Department of Natural Resources
ISS = City of Issaquah
KCD = King Conservation District
Metro = Department of Metropolitan Services
MIT = Muckleshoot Indian Tribe
NMFS = National Marine Fisheries Service
Parks = King County Parks Department
Roads = King County Roads Division
SKCDPH = Seattle/King County Dept Public Health
SLS = Save Lake Sammamish
SWD = Seattle Water Department
SWM = King County Surface Water Mngmt Division
USFS = U.S. Forest Service
WDFW = Washington State Department of Fish and Wildlife
WDOE = Washington State Department of Ecology
WSDA = Washington State Department of Agriculture
WSDOT = Washington State Department of Transportation
WSPRC = Washington State Parks and Recreation Commission

2 Expenditures depend on availability of funding and staff

Chapter 3

Problems, Goals, and Approaches

Chapter 3: Problems, Goals, and Approaches

The following is a discussion of problems, goals, and approaches for each of the four major issues addressed in the plan: flooding, water quality, stream and wetland habitat, and stream-channel erosion and deposition. Each section characterizes the problems identified in the conditions analysis, describes goals that will address these problems, and suggests approaches to achieve these goals. The basinwide recommendations corresponding to these solutions are also identified. Some of the goals can be attained immediately through the adoption and initial implementation of the plan; others are long-term targets and may not be completed for decades. The later goals are included to set an overall direction, however distant its achievement.

FLOODING

Flooding Problems

The following problems were identified in the analysis of conditions in the early phases of the plan. For more information on these problems, see the Issaquah Creek *Current/Future Conditions and Source Identification Report.*

Development in Floodplain Areas: The single greatest flooding issue in the Issaquah basin is that many roads, homes, businesses, and public facilities, have been constructed in areas prone to flooding. The impacts of flooding vary considerably due to the siting of the structures within the floodplain. The floodplain is the area inundated by flows of a given frequency; for example, the 100-year floodplain is the area inundated by the "100-year flow," the flow that has a one percent chance of being equalled or exceeded in any given year.

Because the city of Issaquah is situated on a broad, fan-shaped accumulation of stream sediments, there are few topographic barriers to impede flooding in the lowermost part of the basin. As a consequence, a considerable area beyond the immediate stream channel is subject to sheet flow. Sheet flow is shallow and is controlled by the artificial system of road ditches, swales, and the filled areas and excavations associated with development. While sheet flow can result in property damage, it rarely results in hazardous conditions, except on high-speed arterials.

Approximately 362 structures would be flooded by the 100-year flood under current conditions, of which 212 are residences. The total assessed value (1991) of this property is $160 million. More than 90 percent of these structures are within the city of Issaquah, where the corridors of the mainstem, East Fork, and Tibbetts Creek are heavily developed. Three-quarters of these structures are also within the 25-year floodplain; many were flooded as recently as 1990, when two floods occurred in one year.

Many roads and bridges in the lower basin are also flooded fairly frequently. In the 1990 floods, flooding occurred on SE 56th Street, Poplar Way, 19th Avenue NW, Newport Way, Gilman Boulevard, 12th Avenue NW, W Sunset Way, Juniper Street, Dogwood Street, Clark Street, Wildwood Boulevard, Sycamore Drive, Front Street, Interstate 90, and numerous private roads and driveways.

The two floods in 1990, the largest on record for Issaquah Creek, had nearly equivalent peaks and recurrence intervals of about 30 to 40 years. These floods have increased conjecture that flooding in downtown Issaquah is largely the result of upstream changes in land use. This is not borne out by hydrologic modeling, which indicates that the change from forested conditions to current (1989) land use is responsible for only a seven percent increase in the 25-year peak flow. While this change has led to some increase in the magnitude and frequency of flooding in Issaquah, the primary reason for flooding impacts in the city is development in the historical floodplain.

In a few areas in the lower basin, flooding conditions pose a direct hazard to human health and safety. Notable examples of these areas are found within the city of Issaquah south of Interstate 90, where several road crossings and residences are subject to severe flooding during extreme events.

Development within the floodplain is not isolated to the stream segments in the city of Issaquah. Much of the floodplain areas along the upper mainstem of Issaquah Creek, the lower segments of Holder Creek, and McDonald Creek have been in agricultural use for decades. Whereas pasture flooding is a common occurrence, it is neither hazardous nor severe enough to warrant remedial actions under this plan. More recently, however, some of the agricultural land in floodplains has been developed. The most notable example is the Sunset Valley Farms subdivision in the McDonald Creek subbasin, which has several homes within the floodplain of the stream.

Road Flooding in the Upper Basin: A number of roads in the upper basin flood. Unlike road flooding in the lower basin, which is largely due to widespread flooding throughout the valley floor, most of the upper-basin road flooding problems are due to inadequate culverts under roads that cross the lower drainage areas of steep tributaries of Issaquah Creek, McDonald Creek, and Tibbetts Creek. Storms in the upper catchments of these tributaries result in high peak runoff rates and large sediment loads, particularly where the streams flow across erosion-prone outwash soils. The combination of high flows and large sediment loads overwhelm the culverts and other drainage facilities at the road crossings and commonly result in flooding and debris flows over the roadway and, in extreme cases, road washouts.

Examples of this condition occur at several crossings of the Issaquah-Hobart Road with Nudist Park Creek, Pheasant Creek, an unnamed tributary off the Mirrormont subdivision; where May Valley Road crosses tributary 0212A; and also at the Newport Way crossing of Anti-Aircraft Creek (trib. 0169A). Less severe road-related flooding problems are found on roads within the Mirrormont, High Valley, and Summerhill subdivisions.

Flooding from Future Basin Development: Hydrologic modeling for the basin plan indicates that were future development to occur to the extent allowed under existing zoning, without stormwater mitigation, increases in flood flows would result. The conversion of forest lands to impervious and grassed areas in the development process would result in a 40 percent increase in the 25-year flow in some parts of the basin. The 25-year flow in the lower mainstem of Issaquah Creek is projected to increase 21 percent. Existing floods would also occur with greater frequency, with the current 25-year flood expected to recur every 10 years. Flows comparable to those during the 1990 floods would be expected to occur every 12 to 15 years.

These modeling results assume that increases in development-related runoff are unmitigated by on-site or off-site facilities. This may seem odd considering that current drainage regulations require mitigation, but those regulations are triggered only by development at higher densities than those expected for much of the Issaquah Creek basin. Stormwater retention/detention facilities would be required at higher residential densities and for master planned developments, but much of the increase in stormwater in the Issaquah Creek basin would be unmitigated under existing zoning and regulations.

The increase in flows would lead to higher flood stages, increased overbank flooding, and an increase in floodplain size. Particular areas affected include: the lower North Fork; McDonald Creek upstream of 208th SE; and the mainstem of Issaquah Creek from SE 56th Street to Interstate 90, from Juniper Street to Clark Street, upstream of Sycamore Drive, and from Cedar Grove road to 252nd Avenue SE. The number of homes and businesses affected by flooding in the basin would increase significantly.

Flooding Goals and Approaches

Flooding Goal 1: Keep flooding from getting worse with future basin development. Hydrologic modeling indicates that development in the basin to the limits of current zoning, even if regulated under current land-use laws, would result in substantial increases in runoff from the upper basin. If this trend is accompanied by continuing construction in floodprone areas, the severity of flooding in the lower reaches of Issaquah Creek and its tributaries will increase dramatically. The goal of this plan is to have no net increase in flooding problems in the Issaquah Creek basin in the future.

Approaches

Restrict new development in floodprone areas: Development in floodprone areas results primarily in displacing floodwaters to other areas, but in some cases it may also result in immediate threats to public health and safety. It is therefore appropriate to restrict the location and type of structures in these areas using local land-use regulations. *See Basinwide Recommendation (BW) 5 and BW 6.*

Require techniques to reduce stormwater runoff for all new development: All new development in the basin should be subject to regulations that restrict the peaks, volumes, and durations of runoff from the developed site, with the stringency of the regulations driven by the size and potential impact of the development proposal and the sensitivity of the local stream network. *See BW 1, BW 2, BW 3, BW 4, BW 5, and BW 6.*

Acquire property or development rights for floodplain properties that are vested but not built: There are areas in the Issaquah Creek basin where development has been permitted under regulations that predate restrictions on floodplain land but the planned structures have not yet been built. In cases where the planned development would cause substantial flooding problems, the property or development rights should be acquired and the parcel left undeveloped. *See BW 7.*

Flooding Goal 2: Eliminate flooding that is hazardous to human life and health. Flooding and the drainage problems associated with flooding have a variety of impacts within the Issaquah basin: houses and businesses are inundated, roads are overtopped, pastures are flooded. Some impacts are relatively inconsequential, with minimal long-term effects and no direct hazards to people living and working in the basin. Other problems pose a real and significant danger. These include several residential and commercial areas and roads where flooding results in deep, rapidly flowing water outside of stream channels. Other hazards include flooding and debris flows on steep tributary streams in residential areas and flooding over high-speed arterial roads. As the population of the basin continues to grow, the likelihood of a serious flooding-related accident will increase. This plan seeks to eliminate all flooding hazards that threaten human life and health.

Approaches

Conduct a floodplain audit to identify properties that are subject to hazardous flooding: Hydrologic and hydraulic modeling conducted in the basin planning process provides a general view of the extent and severity of flooding along Issaquah Creek, but cannot provide the level of detail necessary to determine exactly which properties are subject to hazardous flooding conditions. This should be determined through a property-by-property audit of flooding conditions for structures along Issaquah Creek and tributaries. *See BW 8.*

Remove homes from hazardous locations in the floodplain: Homes with hazardous flooding problems should be relocated or purchased and removed from floodplains. While structures such as floodwalls may provide temporary relief from flooding, they also pose adverse impacts such as increasing the velocity of water (which increases erosion), they divert water to other properties that would not otherwise be flooded, and they disrupt fisheries habitat. Therefore, only removal of structures from floodprone areas will provide the assured level of protection that is warranted in areas with serious flooding hazards. *See BW 7 and BW 8.*

Warn people about hazardous flooding conditions: Many locations with potentially hazardous conditions are dangerous only if people enter the area unaware of the hazard. The current warning and preparation program should be improved to close access to hazardous areas and notify people of potential flood-related hazards. *See BW 10.*

Improve stream crossings on high-speed arterial roads to reduce flooding: Several of the heavily-traveled arterials in the basin (I 90, SR 900, Issaquah-Hobart Road, May Valley Road) are subject to flooding and debris flows. All are high-speed roads with potential for serious accidents when flooded. Drainage and conveyance problems should be solved to avert accidents. *See BW 12.*

Flooding Goal 3: Reduce nonhazardous flooding where feasible, environmentally beneficial, and economical. Most flooding and drainage problems in the Issaquah Creek basin do not pose an immediate threat to people living or working in the basin. In these cases, the plan seeks to reduce the property damages and other impacts of periodic flooding as much as possible. This must be accomplished through programs and projects that are not only technically feasible, but are economical and protect or enhance the environment of the Issaquah Creek system.

Approaches

Remove homes from floodplains wherever possible: Removal of structures is the most direct and effective solution to flooding problems that have been caused by widespread development of floodprone areas, as is the case in the Issaquah Creek basin. In addition to the technical merits of this solution, the removal of structures provides an excellent opportunity for enhancement of the streamside environment. It is an expensive solution, however, and removal of structures should be pursued selectively, where flooding damages or environmental benefits are exceptionally high or costs are unusually low. This will be defined through the property-by-property audit of floodplain properties recommended in flooding goal 2. *See BW 7 and BW 8.*

Construct setback berms where particularly effective: Setback berms can be used to contain floodwaters in a prescribed corridor along the stream. While a continuous berm is physically and economically impractical along the lower segments of Issaquah Creek and the East Fork, there are small segments where a berm could be particularly effective at preventing flooding of houses, businesses, and roads by sheet flow. Lower Tibbetts Creek is an excellent example of this, due to the low cost of the setback berm and the high value of protected structures.

Purchase streamfront easements wherever possible: Many privately-owned properties along Issaquah Creek and its tributaries remain undeveloped or have homes that have been built some distance from the

stream. To ensure that the stream corridor in these areas will remain undeveloped and available for increased flood conveyance and habitat restoration, the City and County should purchase easements from the owners of these parcels. *See BW 7.*

Provide assistance for floodproofing and elevation of floodplain structures: To provide relief for residents not affected by hazardous flooding conditions, financial and technical assistance for floodproofing should be made available to floodplain property owners. For hazardous flooding conditions, acquisition and removal of structures is the preferred solution. Floodproofing and elevation should be the principal flood relief available to commercial and multifamily residential structures. *See BW 8.*

Improve the local drainage system to reduce the extent and duration of flooding: Once floodwaters overtop the banks of Issaquah Creek, flows must be carried by the constructed drainage network in downtown Issaquah. Because these drainage facilities are not sized for these larger, periodic pulses in flow, floodwater is impounded at various places in the city. This situation, which is particularly pronounced just upstream of Interstate 90, increases the extent and duration of flooding in downtown Issaquah. Flooding due to the impoundment of flows should be reduced by increasing the size of local drainage facilities. *See BW 12 and subbasin recommendations.*

WATER QUALITY

Water Quality Problems

The following problems were identified in the analysis of conditions in the early phases of the plan. For more information on these problems, see *Chapter 6: Nonpoint Water Pollution*, which was excerpted from the *Issaquah Creek Current/Future Conditions and Source Identification Report* and includes a discussion of beneficial uses, nonpoint source characterization, water quality assessment, and source specific goals and objectives that were used to develop the plan recommendations. The problems and goals presented in this section reflect those that most directly affect water quality conditions in the basin.

Nonpoint Sources in the City of Issaquah: The concentration of land uses and activities, coupled with an increase in impervious surfaces, result in a concentration of pollutants in urban areas. In Issaquah, pollutants include those typical of urban areas, such as sediment from construction activities; metals, oil and grease from automobile use; nutrients from fertilizers, soil erosion, and detergents; and bacteria from septic tanks, sewer leaks or failures, and animal wastes. Organic and toxic contaminants from commercial or industrial sources are also common and may lead to severe water quality problems.

Pollutants reach Issaquah and Tibbetts creeks and their tributaries primarily by stormwater runoff. Pollutants collect on impervious areas of the basin, including

rooftops, driveways, sidewalks, parking lots, and roads, and are washed off into storm drains, or directly into streams during heavy rainfalls. One consequence of this method of transport is that pollutants tend to reach stream systems quickly and in high concentrations during typical storms. Peak pollutant concentrations often exceed acute water quality criteria and may impact aquatic life.

Transport of pollutants from the city of Issaquah was believed to be the cause of two fish kills in the North Fork of Issaquah Creek in 1990. Water and tissue samples indicated that metals, ammonia, sulfides, and organic chemicals acted in combination with low hardness to result in the death of juvenile salmonids. Based on bioassays conducted later in 1990, the storm sewer outfall at river mile 0.2 was indicated as the source of the pollutants. This outfall discharges much of the stormwater from downtown Issaquah.

Agricultural and Forestry Sources: Agricultural uses are not extensive in the Issaquah basin, but where these activities occur they tend to create significant problems. Animal keeping practices on small farms, and activities associated with several larger cattle and horse keeping operations contribute to water quality degradation. Problems in the basin include overgrazing of pastures, inadequate manure storage and disposal, and unlimited animal access to streams and wetlands. These activities cause increases in the transport of sediment, nutrients, and bacteria to wetlands and streams. These problems are particularly pronounced along the mainstem of Issaquah Creek above the McDonald Creek confluence, where the largest concentrations of small farms are located. Tibbetts Creek has long suffered water quality impacts from a large horse keeping operation.

Long-term commercial forestry practices in the Issaquah basin are largely confined to the Tiger Mountain State Forest, which comprises much of the eastern portion of the basin and to private forest lands east of SR 18. The current plan for the 15-square-mile State forest establishes a 60-year rotation on timber harvest. There is a projected harvest of 1250 acres of timber in the Issaquah basin in the next decade. These harvests will be concentrated in the Holder Creek subbasin (44%), and the East Fork subbasin (21%), with the remainder equally divided between the Fifteenmile and Issaquah Creek subbasins. Forest harvest impacts may include increases in erosion and sediment transport to streams, increases in stream temperature due to loss of shade from the forest canopy, and mobilization of nutrients from exposed forest soils, tree debris, and logging slash.

The remaining large tracts of forest land may convert to other uses in the next decade. A 1,700-acre parcel owned by Manke Lumber company in the Holder and Carey Creek subbasins has already been vested for a 250-unit housing development. A 1,200-acre parcel adjacent to the Manke land was recently harvested by Weyerhauser and could be proposed for development under current zoning. Impacts of these conversion activities are discussed in the section on future basin development.

Water Pollution from Industrial Sources: There are three major industrial sites in the Issaquah basin that vary considerably in their contribution to nonpoint pollution problems. The first, Lakeside Sand and Gravel, was incorrectly identified

as the source of a contaminated water quality sample in the *Current/Future Conditions and Source Identification Report* for this basin plan. While Lakeside has been a historical source of sediment entering the North Fork of Issaquah Creek, the operators have recently installed a wastewater recycling system to treat, and recirculate the water used for washing gravel. This is expected to reduce the use of settlement ponds on the site for nonstormwater treatment and remedy the discharge of sediment-laden water into the North Fork.

The second industrial site, the Cedar Hills Landfill operated by the King County Solid Waste Division, is located partially in the McDonald Creek subbasin. The water quality treatment facilities on the site are the best available technology for the industry, and monitoring data from sites surrounding the landfill indicate few water quality problems. The most significant problem is the turbidity observed in a tributary of McDonald Creek, which receives stormwater runoff from a landfill stormwater treatment pond. Levels are high enough to occasionally exceed State standards for Class A waters. The likely source of this turbidity is erosion caused by earth-moving and cover activities, rather than leachate from the landfill itself.

The most significant industrial source of water pollution in the Issaquah basin is Sunset Quarry in the upper Tibbetts Creek basin. This rock quarry straddles Tibbetts Creek in its uppermost reaches, and drainage from active and inactive mining areas is discharged directly into the stream as it traverses the site. The entire stream is routed through a two-celled detention pond that is inadequately sized to allow sediment to settle out before water is discharged. Turbid water is therefore discharged directly to downstream reaches. This site has an eight-year history of water quality violations and enforcement actions. The arrival of a new site operator in early 1992 and permitting of a new site-operating plan provide an opportunity to remedy this significant water quality problem.

In addition to these current industrial sources, there are two abandoned mine sites and several mining spoils piles on upper Tibbetts Creek that are significant pollution sources. At one site, a tributary of Tibbetts Creek crosses unvegetated spoil piles and steep cleared slopes. Another is characterized by the erosion of large spoil piles (30 to 40 feet deep) that were deposited within the mainstem stream corridor. These sites are major sediment sources.

Water Pollution from Road Runoff: An interstate highway (I 90), two State roads (SR 900 and SR 18), and a major County road (Issaquah-Hobart Road) cross the basin. In many locations where roads pass along or over the stream system, untreated road runoff is discharged directly to the streams. Contamination of groundwater (used for drinking water by Issaquah and the Sammamish Plateau Sewer and Water District) near Issaquah is also a potential problem. On the 4.5-mile East Fork segment of Interstate 90, there are approximately 50 drainage outfalls that discharge either directly into the stream or into swales that drain to the stream. Road runoff contains oil and grease, heavy metals, and synthetic organics that degrade water quality in these streams. While monitoring data are insufficient to determine the severity of this degradation, preliminary modeling suggests that highway runoff is a significant source. The results of the model examining the impacts of Interstate 90 on the East Fork showed that highway

runoff accounts for almost half the lead loading discharged from the entire subbasin.

Another problem with highways and other major roads is the potential for water pollution from hazardous or toxic material spills. Truck traffic is heavy on the sections of Interstate and SR 18 that parallel the East Fork and Holder Creek. The drainage facilities on these highways are insufficient to contain a spill of hazardous materials, and an accident involving a truck carrying such materials could result in the immediate discharge of pollutants into the streams, and contamination of the City's and district's groundwater production wells.

Increases in Nutrients and Other Pollutants with Future Basin Development: Residential development in the Issaquah basin has the potential to increase substantially in the future. Existing zoning would allow development of more than half of the forest land in the basin. This development will increase impervious areas, increase stormwater runoff, decrease infiltration and interflow, and increase sediment loads to streams. Because stormwater and sediment are the principal means for downstream pollutant transport, the development will likely result in degraded water quality conditions in downstream creeks and in Lake Sammamish. Additionally, the development pattern, primarily low-density single-family residential, will result in little or no drainage control or water quality treatment with existing regulations and zoning.

Modeling conducted in the development of this plan predicted change for three pollutants that would occur if the basin were built out to existing zoning without water quality mitigation. Three pollutants—lead (Pb), total suspended solids (TSS), and total phosphorus (TP)—were selected as indicators of common pollutant classes (heavy metals, sediments, and nutrients) that are likely to increase with basin development. Results indicated several disturbing trends. On a basinwide scale, annual loadings were predicted to increase by 75, 43, and 92 percent for Pb, TSS, and TP, respectively. Some subbasins were significantly higher; for example, North Fork loadings were predicted to increase by 160, 105, and 234 percent for Pb, TSS, and TP, respectively. Under these scenarios, the chemical and biological integrity of the Issaquah Creek system and Lake Sammamish will be at risk.

Lead is toxic to a variety of aquatic organisms, including plants, invertebrates, amphibians, fish, and waterfowl. Like most heavy metals, lead accumulates in organisms. As a result, continuous exposure to chronic lead sources can be more hazardous, and more common than acute exposure. Organisms vary in their susceptibility to lead poisoning, with invertebrates more susceptible than fish, and salmon more susceptible than other fish (Haslam, 1990). Suspended solids abrade plants and animals, clog plant and animal respiratory surfaces, reduce photosynthesis for aquatic plants, eliminate interstitial habitat, and smother spawning gravels, thus preventing the emergence of young fish. Phosphorus acts as a fertilizer in lakes, ponds, and stream pools, increasing the production of aquatic plants and algae. The result is eutrophication, a condition characterized by frequent algal blooms, increases in aquatic plant growth, and low summer dissolved oxygen levels. Eutrophication leads to a decrease in the diversity of

aquatic organisms and a change in the plants, animals, and microorganisms that are dominant. These conditions favor coarse fish such as perch and carp over salmonids. Algal blooms and aquatic plant growth also reduce the aesthetic and recreational benefits of lakes and streams. For Lake Sammamish, the near doubling in phosphorus loading has been predicted to result in decreased water clarity and an approximate doubling of algal growth.

Water Quality Goals and Approaches

Water Quality Goal 1: Reduce water pollution from urban sources.
Most of the problems related to urban runoff quality are due to the prevalence of impervious surfaces and pollutants that accumulate on these surfaces. This includes both atmospheric deposition and human-related activities such as fertilizer and pesticide application, hazardous waste disposal, and dumping of used motor oil. Little, if any, of the urban runoff within the city limits is treated before discharge to surface waters. Poor housekeeping practices (e.g., unmaintained dumpster areas, oil spillage around automotive-related businesses, washing of fats, oil and grease from cooking equipment, improper hazardous material storage) were identified as significant problems in a recent City survey of 50 businesses.

Approaches

Education and involvement: Nonpoint source pollution is produced largely from human activity. Developing information that is both useful and accessible to the specific target audience is an important part of the overall strategy for reducing nonpoint pollution from the urban areas of the basin. Moreover, by working in a cooperative manner and involving those who are directly capable of reducing nonpoint source pollution (business owners and homeowners), a greater sense of community stewardship can be fostered. *See Basinwide Recommendations (BW) 13, BW 20, and BW 29.*

Require Best Management Practices (BMP's) for pollution sources: BMP's are nonstructural and low-structural measures that are determined to be the most effective, practical means of preventing or reducing pollution inputs from nonpoint sources in order to achieve water quality goals. New industrial and municipal National Pollutant Discharge Elimination System (NPDES) regulations require that most commercial and industrial businesses, and other land owners (including homeowners) minimize the pollution originating from their land. Several BMP manuals have been developed (King County's BMP manual is scheduled for completion in mid-1994) to provide guidance on controlling pollutants on individual properties. If source-control BMP's are implemented, it will minimize the need for more costly treatment BMP's. *See BW 13, BW 17, and BW 20.*

Increase monitoring and enforcement of point and nonpoint pollution sources: Water quality monitoring is necessary to assess the effectiveness of public education and involvement programs, and the implementation of BMP's by businesses and homeowners. Monitoring can also be used to

detect previously unidentified problems and to pursue enforcement actions. Enforcement actions can be pursued when business or land owners fail to comply with current regulations that require the control of activities on their properties or stormwater discharges from their land. *See BW 29, BW 30, and BW 31.*

Water Quality Goal 2: Reduce water pollution from agricultural sources. Agricultural activities, primarily animal keeping, were identified as significant sources of sediment, nutrients, and bacteria in the Issaquah basin (Minton and Fitch, 1988). Many problems occur on small farms (typically those less than five acres) where poorly maintained or overstocked pasture areas, animal access to streams, or improper animal waste storage and disposal practices contribute to the degradation of surface waters. Small farms are found throughout the upper watershed, mainstem, and tributary streams to Issaquah Creek.

There are few commercial farming operations in the basin. Problems associated with these operations are similar to those of small farms, but on a larger scale. The effects on water quality from past and present commercial agricultural activities are most evident along Tibbetts Creek and the mainstem of Middle Issaquah Creek. In these areas, direct animal access to streams has occurred and pastures are over-utilized and frequently flooded during winter storm events.

Approaches

Encourage farmers to retain and restore riparian corridors and wetlands: Much of the historical land-use change in the watershed was for agricultural development. Before the importance of the riparian corridors and wetlands was understood, many aquatic functions were impaired or destroyed when land was developed for agriculture. Recognizing the important functions provided by intact wetland and riparian areas (*e.g.*, flow attenuation and storage, water quality treatment, habitat maintenance), it is important to protect and restore these areas of the basin wherever it is feasible. *See BW 15, BW 20, BW 22, and BW 29.*

Educate and involve farmers in the use of pollution control techniques: To achieve resource protection, a greater understanding of impacts related to agricultural land use must be fostered with farmers. It is important that information and access to technical assistance and incentives become part of the ongoing education program to successfully implement BMP's on small and commercial farms. *See BW 15, BW 20, and BW 29.*

Increase monitoring and enforcement of farm pollution sources: As described above for urban stormwater, monitoring provides a tool for evaluating the effectiveness of BMP implementation, educational programs, and restoration of streams and wetlands. Water quality monitoring can be used to identify stream reaches where water quality violations occur, thus providing backup for enforcement actions, when current practices fail to protect water quality. *See BW 29, BW 30, and BW 31.*

Water Quality Goal 3: Reduce water pollution from forestry sources.
In the future, ongoing forest practices will occur primarily in the Tiger Mountain State Forest. Therefore, to minimize water quality degradation from forest practices, recommendations focus on the relationship between the County and DNR, the major forestry property owner and supervisor of the harvest management program. Recommendations are also included to address the conversion of forest lands to residential land uses.

Approaches

Encourage DNR and timber owners to act consistently with King County's Sensitive Areas Ordinance (SAO) in all areas likely to convert: Attaching SAO restrictions to forest practices in areas likely to convert is necessary to achieve consistency in the treatment of all landowners in residentially zoned areas of the basin. With the exception of Tiger Mountain State Forest, there is little commercial timber land in the basin. Therefore, future forestry activity in the basin is likely to be conversion-related. Conversion of forest lands to residential land uses is one of the key problems facing the resources of the watershed. King County regulates development activity and should have a role in regulating conversion-related forest practices. The SAO was developed to protect County resources and it should be applied in addition to Forest Practice Application (FPA) regulations on lands undergoing conversion. *See BW 16.*

Educate and involve timber owners and workers: In order to achieve resource protection, a greater understanding of impacts related to timber/forestry land use must be fostered with timber owners and workers. Education, technical assistance programs, and incentives could all be a part of this process. By working in a cooperative manner with those capable of reducing nonpoint source pollution on forest lands, we can meet the goals of the FPA and protect the resources of the basin. *See BW 16 and BW 29.*

Increase monitoring and enforcement of timber harvest practices: Increased monitoring of timber harvest practices is needed to ensure compliance with FPA requirements. Development of a cooperative agreement between DNR and the County would increase the effectiveness of current programs that oversee and enforce FPA's for timber harvesting. *See BW 16, BW 29, BW 30, and BW 31.*

Water Quality Goal 4: Reduce water pollution from industrial sources.
There are three major industrial operations in the basin—a resource extraction (gravel and quarry rock) operation, a public landfill, and a sand and gravel mine—that have had significant impacts on water quality. The Tibbetts Creek system has had a long history of water quality impacts from both agriculture and resource extraction (including both current and historic coal, clay, and rock mining). The quarry in the headwaters of Tibbetts Creek must be stabilized to reduce current impacts on downstream water quality. A portion of the landfill is located in the McDonald Creek basin. Stormwater runoff from nonactive areas of

the landfill is a source of turbidity problems and fine sediment transport into the McDonald Creek system.

Approaches

Increase monitoring of industrial operations: Monitoring is necessary to assess the effectiveness of source- and treatment-control BMP's implemented on industrial sites. Visual monitoring is required as part of NPDES industrial permits, but water quality monitoring is also necessary. *See BW 30.*

Enforce water quality regulations: Lack of enforcement of water quality regulations and permit conditions is a key problem for mining sites in the Tibbetts Creek basin. King County and State agencies should work more aggressively with land owners to develop site-specific management plans. Follow-up inspections and enforcement are necessary to ensure that such a plan is implemented and that BMP's are maintained. New NPDES and animal regulations (K.C.C. 21A.30) must also be enforced to protect water quality from landfill and agriculture activities in the basin. *See BW 31.*

Educate and involve industrial business owners and workers: In order to achieve resource protection, a greater understanding of impacts related to industrial activities must be fostered with industrial business owners and workers. Education and technical assistance programs should be coordinated with NPDES industrial permitting requirements to achieve a high degree of permit compliance in the basin. *See BW 13, BW 20, and BW 29.*

Water Quality Goal 5: Reduce water pollution from road runoff and the potential for pollutant spills from roads. Many miles of roadway are present in the basin, crossing numerous water features. In most cases, untreated road runoff enters streams directly at these road crossings. Improved maintenance of roadside ditches and facilities, retrofitting of storm drainage systems, and construction of new water quality treatment facilities are necessary to reduce the impact of road runoff on stream water quality. Also, an emergency spill response program should be developed to respond quickly to spills of hazardous materials on roadways.

Approaches

Improve road ditch and stormwater facility maintenance practices: Road ditch maintenance should be improved to minimize vegetation removal during cleaning operations. Catch basins and other stormwater facilities should be regularly maintained to prevent them from becoming pollutant sources. In systems where sediment and decant are collected from catch basins or facilities receiving road runoff, it is necessary to properly dispose of this material. *See BW 17.*

Encourage retrofitting of major roads with source- or treatment-control BMP's: In most of the urbanized areas and along the roads of the basin, much of the collected runoff is discharged untreated to the surrounding surface waters. When road widening or other modifications occur, treatment BMP's such as biofiltration swales or detention ponds should be constructed to treat runoff. In cases where no road modifications are planned, opportunities for retrofitting should be examined to determine the feasibility and effectiveness of a retrofit program. *See BW 17.*

Improve the emergency response program for responding to hazardous material spills: In areas where human activity is concentrated and on major transport roadways, there is an increased risk of hazardous material spills. The East Fork of Issaquah Creek is particularly susceptible to the effects of a hazardous spill, because much of its length borders an interstate freeway. By developing a spill response program for the area, a proactive approach can be taken to minimize the impact of such a spill on the surrounding aquatic resources. *See BW 18 and BW 31.*

Water Quality Goal 6: Reduce water quality degradation associated with future basin development. Future water quality concerns primarily focus on increases in sediment and nutrient (phosphorus) loadings to streams in the basin and to Lake Sammamish. Stream water quality and fish spawning areas are at risk from erosion and sedimentation due to basin development, and instream erosion due to increased flow volumes. Lake Sammamish is at risk of accelerated eutrophication if existing watershed growth occurs without substantial water quality protection efforts. Issaquah Creek currently contributes 70 percent of the water and nutrient budget to the lake. Thus, any land-use change in the watershed is likely to have an effect on lake water quality.

Other pollutants including heavy metals, oil and grease, bacteria, and toxins are also expected to increase in the future. In many cases, the control strategies for these pollutants are linked to sediment and phosphorus control strategies.

Approaches

Restrict development in areas that produce high sediment loading: The physical features of the basin vary dramatically, making certain areas more prone to increased erosion and sediment transport as a result of development. Through zoning changes and site design criteria, future water quality impacts can be reduced by restricting or regulating development in areas with highly erosive soils and steep slopes. The primary approach taken to maintain forest cover is through a package of incentives and regulations that maintain open space and vegetation. The impacts of clearing and grading are minimized through the development of a new temporary erosion and sediment control program. *See BW 2, BW 3, BW 4, BW 5, BW 6, and BW 33.*

Establish new water quality treatment design standards for phosphorus control: With future development at currently projected densities, the water quality in Lake Sammamish is expected to decline because of increased phosphorus loadings. Stormwater treatment of runoff from new development, using current design standards, reduces phosphorus loadings, but there is still a significant increase over pre-development conditions. A program should be developed to evaluate the effectiveness of various facilities built according to existing standards. Those found to be effective at controlling phosphorus should be recommended for use in the basin. As new treatment technologies are developed and current designs are improved, design standards should be updated to reflect the new information. *See BW 19 and BW 33.*

Educate and involve K-12 school children: To improve resource protection now and in the future, a greater understanding of impacts related to human activities must be fostered with the basin residents and workers of the future. Education programs aimed at grades K-12 should be implemented in the Issaquah school district at appropriate grade levels. *See BW 20 and BW 29.*

Increase monitoring and enforcement of development standards: Ongoing basin monitoring should be carried out to evaluate the effectiveness of proposed mitigation (e.g., facility design standards), site development criteria, and zoning changes. As monitoring results are analyzed, strategies can be evaluated and adjusted to meet originally defined goals and objectives. Effective application and enforcement of existing guidelines and regulations are fundamental to the success of this resource protection strategy. *See BW 30 and BW 31.*

Develop site-specific design criteria for developments not covered by current regulations: Much of the development that will occur in the basin under projected future land use falls below most thresholds requiring drainage review and water quality treatment for runoff quantity and quality control. This includes most small-site and single-lot developments. Individually, the impacts from such sites are often insignificant, but collectively they can significantly degrade water quality and natural resources. Minimum design criteria should be developed for such sites as part of King County's new BMP manual and *Surface Water Design Manual* updates. *See BW 19 and BW 33.*

Minimize water quality impacts from on-site sewage treatment facilities: Much of the new development in the basin will be dependent upon on-site sewage treatment systems for human waste disposal. To prevent on-site septic systems from becoming a significant source of pollutants in the basin, it is necessary to properly site and maintain such systems. Educational efforts and minor regulatory changes should be implemented to focus on improved system maintenance. As part of this effort, information should be distributed on siting, designing, installing, operating, and maintaining on-site septic systems. *See BW 14.*

STREAM AND WETLAND HABITAT

Habitat Problems

The following problems associated with stream, wetland, and riparian habitats were identified during the conditions analysis in the early phases of the Issaquah plan. For more detailed information, see the *Issaquah Creek Current/Future Conditions and Source Identification Report.*

Encroachment, Stream Channelization, and Bank Hardening: Streams in the lower portions of the basin have been significantly altered due to construction of railways, of Interstate 90, and urban development in and around the city of Issaquah. This construction has resulted in straightening and confinement of channels, reducing habitat suitability for salmonid species.

The East Fork of Issaquah Creek has been altered at least twice in recent decades by major construction activity. Railroad construction parallel to the streamcourse down the East Fork valley required sections of the channel to be shifted and hardened; construction of Interstate 90 in the 1970's resulted in extensive channel relocation near Preston and major bank protection at interchanges and bridges. Meanders of the channel were lost as a result of this activity, much of the channel was confined between hardened banks, and the gradient of the channel was artificially increased. Near Preston, and downstream near the Sunset Way interchange, fish passage weirs were installed to provide access through these now-steepened reaches. Within the city, development for housing and business near the East Fork has resulted in almost continuous bank hardening.

The mainstem of Issaquah Creek has been confined and hardened as well. Although somewhat less obvious than in the East Fork, side channels have been lost to encroachment and filling throughout the lower mainstem, and banks—especially at curves—have been hardened with rock and concrete in an almost-continuous manner through the city. Above and below the city this activity is reduced. Nevertheless, this activity has caused major changes in local flow patterns above and below the work and has significantly reduced the suitability of habitat for salmonids. In areas such as the Four Creeks Ranch and the lower reaches of Pheasant Creek and McDonald Creek, the streambanks are protected by large rock. This confinement of the channel causes the bed to erode locally downward, shifting deposition patterns, and may cause exacerbated bank erosion upstream and downstream of the hardened banks. Other local channelization/bank hardening occurs at the mouth of Fifteenmile Creek, Holder Creek at the Issaquah-Hobart Road, and in several smaller tributaries such as tributary 0203, which flows in a ditch along the Issaquah-Hobart Road. The confinement on the mainstem and its tributaries, as well as on the East Fork, causes a cumulative reduction in habitat quality and will likely increase as development activity near the stream increases.

Riparian Zone Alteration: Major changes have occurred in the streamside zones of most tributaries in the basin. Vegetation was cleared for agricultural purposes early in the century and more recently for urban development. Streamsides once

dominated by conifers and large hardwoods such as big leaf maple gave way to fields and pastures, and then to homes and yards. The loss of large streamside vegetation has two important consequences. First, the environmental conditions near the stream (particularly the temperature), collectively called the microclimate, are altered as the canopy is changed. The moderating "tunnel" that once protected the stream from extremes of temperature, humidity, and sunlight gives way to a more open canopy, less moderating in extreme conditions. Second, the loss of large trees in the riparian zone means less recruitment of large wood into the channel, large wood upon which the structure of salmonid habitat depends. Without these large structural elements, stream habitats become relatively uniform, dominated by long stretches of riffle with few voluminous pools. Examples of these habitat effects can be found through the city where lawns dominate the streamside, and throughout the valley of the mainstem, lower Tibbetts Creek, lower North Fork, and in Holder and Fifteenmile creeks.

Erosion/Sedimentation of Habitat: Present land uses in certain parts of the basin are causing severe erosion and sedimentation of in-stream habitat. In Tibbetts Creek, pasture use of the streamside in the lower mainstem is causing erosion of banks and is a significant source of fine sediment to the channel. This source pales in comparison, however, to the historic and present quarrying activity farther upstream. Past mining activity on the mainstem of Tibbetts and on three of its tributaries contribute copious amounts of fine sediments to lower Tibbetts; near the headwaters, an active operation (Sunset Quarry) occupies about one-half of the tributary area of the upper basin and is a chronic source of fine sediment. Downstream of these sites, the fine sediment has infiltrated the gravel beds of the creek, rendering them largely incapable of interflow and thereby eliminating successful spawning activity in this system.

Other sediment problems are associated with historic logging activity, road building, or with diversions of streams. Fifteenmile Creek is a major sediment source to mainstem Issaquah Creek but its basin is mainly forested. Its headwater channels show signs of extensive erosion, probably related to past forestry activities. Clearcuts produced increased surface runoff and streams were destabilized by removal of large wood from channels. Sediments previously stored in jams were mobilized and storage areas lost. This effect is apparent in Holder Creek as well. Moreover, in Holder Creek, construction of SR 18 has confined the channel and forced it against the erodible slopes that form its upper ravine. The stream has undercut these hillslopes in places, causing the slopes to fail into the channel. This material has been transported to the lower, flatter reaches of the stream and has buried pools and riffles used by salmonids.

In tributary 0212E to McDonald Creek, gravel deposition has covered a habitat restoration site just upstream of the confluence with McDonald Creek proper. In addition to the habitat damage, the sediment has reduced the capacity of the stream channel and contributes to local flooding in the surrounding subdivision.

In upper Carey Creek, a diversion out of the Cedar River watershed delivered large pulses of sediment to the Carey Creek channel during the most recent 1990

storms. Pools and spawning areas were buried under the load and are just now reforming around sites of woody debris accumulation.

Underutilization of Issaquah Creek by Salmonids: Eight species of salmonids use the Issaquah Creek system for spawning and rearing at various times of the year (See Chapter 8.2.1 of the *Current/Future Conditions & Source Identification Report* for the Issaquah Creek Basin). The Washington Department of Fish and Wildlife hatchery at RM 3.8 intercepts chinook and coho salmon for artificial propagation, passing other species upstream to spawn naturally. Up to 3,000 coho are passed over the capture weir depending on the success of the hatchery's spawning operation in any given year; no chinook are released to spawn naturally though some have escaped during floods. Observations of spawning and rearing fishes by King County Surface Water Management (SWM) Division biologists suggest that the 27 miles of accessible habitat upstream of the hatchery is significantly underutilized by naturally-spawning salmonids. Such a naturally-spawning population would be beneficial for several reasons. Naturally spawning populations can provide a genetic buffer against the in-breeding depression that often occurs in hatchery stocks, maintaining a level of variability that is often reduced in hatchery populations; the population acts as a stock reserve, adapted to the stream conditions, that could be drawn upon to revitalize the hatchery stock; and, as evidence from the Columbia system suggests, when anadromous stocks are eliminated from stream systems, productivity of other salmonids is reduced. This is mainly a result of the nutrient deficiency typical of northwest streams and alleviated by the "free" nutrients supplied by decomposing salmon carcasses.

Migration Barriers: Numerous barriers to upstream passage exist in the Issaquah system. Many are natural, such as the falls or cascades on the North Fork, Carey Creek, and Fifteenmile Creek. Most barriers, however, are the result of poorly placed culverts and stream crossings, or other artificial structures. Lateral tributaries to the mainstems of Issaquah and Tibbetts creeks have been the most vulnerable. Artificial barriers—complete or partial—occur on tributary 0171 to Tibbetts Creek, on the Tibbetts mainstem at about RM 3.3, at the hatchery diversion dam fishway on the mainstem of Issaquah, on Issaquah tributary 0203 at RM 0.5, on Carey Creek at RM 3.8, on Holder Creek at the upper SR 18 crossing at RM 16.4, and on Holder tributary 0220 at RM 0.25 and RM 0.40.

Wetland Encroachment and Filling: Wetlands in the basin have been affected by agriculture, forestry and development activities. Losses have occurred on the deltas of Issaquah and Tibbetts creeks, and in the McDonald valley as wetlands were converted first to agricultural fields, and then to urban uses. Issaquah Wetland 53, adjacent to East Lake Sammamish Parkway SE and south of SE 56th Street, has been completely lost to commercial development.

Many wetlands in the basin have suffered some kind of intrusion. Roadways, pipelines and power lines cross these areas and occasional dwellings can be found abutting or built within some wetlands. Issaquah Wetlands 7, 18, 19, 20, 22, 51, and 56 all have some level of intrusion; Wetlands 19 and 61 have been cut over, leaving no buffer vegetation.

North Fork Wetlands 5 and 7 are being encroached upon by subdivision development. In particular, Wetland 5—Yellow Lake—has had most of its catchment area developed for the construction of the residential development of Klahanie, isolating Yellow Lake and its satellite wetlands from the surrounding landscape. Sedimentation during construction produced a large plume in the lake and trash and debris now accumulate in the wetland. Hydrologic and water quality effects are suspected because more than half of the catchment is now urbanized. Other wetlands may be susceptible to such hydrological effects of urban development as well: Issaquah Wetlands 13, 18, and 22, and North Fork Wetland 7. Wetland 7 lies downstream from Yellow Lake at the northern base of Grand Ridge. Development on the ridge and in other areas surrounding Wetland 7 will almost certainly produce hydrologic changes in the wetland.

Habitat Goals and Approaches

Habitat Goal 1: There should be no net loss of stream, wetland, or riparian habitat structure, function, or area in the Issaquah basin. High-quality stream, wetland, and riparian habitats are critical to the survival of numerous species of fish and wildlife—especially salmon—in the Lake Washington watershed. Much of the long-term decline in salmon populations in the watershed and throughout the Puget Sound basin may be attributed to the loss of high-quality habitat in small stream systems like Issaquah Creek.

The interplay of wetlands, riparian zones, and stream channels produces the conditions that support various species; loss or modification of any component results in a change in these support conditions. Mitigating these changes requires that existing habitat components be protected, all the more critical if restoration or enhancement is intended. To paraphrase Aldo Leopold: "The first rule of intelligent tinkering is to save all the pieces."

Recognition of, and protection for, these critical habitats is accomplished through Significant Resource Area (SRA) designations and their associated requirements. Stream habitats in the basin are evaluated according to criteria (see BW 21 and the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan*, published separately) and may be placed in one of two SRA categories: Regionally Significant Resource Areas (RSRA) or Locally Significant Resource Areas (LSRA).

Approaches

Regulate new development throughout subbasins with critical salmonid habitat: While restrictions on corridor development such as buffer widths and clearing restrictions provide some protection to stream and wetland habitats, many of the basic conditions necessary to support these habitats depend on land use at the subbasin and basin scale. Subbasin conditions are the primary influence on channel size and shape, the frequency and intensity of flows—including floods—in the stream system, and water quality in wetlands, all of which are critical in maintaining a physical and biologic regime that is favorable to salmonids. Protection of the existing hydrologic

regime in all recognized LSRA's and RSRA's should be accomplished through local zoning, drainage, and clearing regulations. *See Basinwide Recommendations (BW) 1, BW 2, BW 3, BW 4, BW 6, and BW 21.*

Acquire fee title or development rights where regulations are insufficient: In certain cases, regulations will not provide adequate protection for LSRA's and RSRA's. These cases include situations where unbuilt projects are vested under standards inconsistent with salmon habitat protection. In these cases, property or development rights should be acquired to ensure that inappropriate development is avoided. *See UI 3.*

Give priority attention to LSRA's and RSRA's in all habitat-related programs under the plan: Given the preeminent importance of maintaining salmon production in the Issaquah basin, projects within the LSRA's and RSRA's should receive priority attention in all habitat-related programs, including habitat restoration, capital improvement, land-use regulatory, and land-acquisition programs. *See BW 21, BW 22, and BW 23.*

Scrutinize, more carefully, any in-stream or riparian activities that occur in salmonid-bearing streams during spawning periods: In concert with the Washington Department of Fish and Wildlife, the Muckleshoot Indian Tribe, and others, develop regulations at the local and state levels with the objective of eliminating all in-stream activity during spawning periods in salmonid-bearing streams and their tributaries. This should be a task of the interagency group established in BW 24. *See BW 24.*

Habitat Goal 2: Stop inappropriate land uses in stream channels and corridors. Many of the problems related to aquatic habitat in the Issaquah Creek basin are due to inappropriate actions associated with development and land use in the stream corridors and wetland buffers of the system. Within the city of Issaquah, activities such as wetland filling, channel encroachment, bank stabilization, and clearing of the riparian corridor are widespread, and they have severely degraded aquatic and riparian habitat. In upstream areas of the basin, the historic agricultural use and modern residential development have contributed to similar conditions in several specific sites, such as Four Creeks Ranch and Sunset Valley Farms, and, to a lesser extent, along the mainstem as a whole. The losses in habitat diversity, food supply, favorable channel morphology, and water quality associated with these land-use activities are detrimental to anadromous and resident fish and other organisms that depend on intact aquatic and riparian habitat. Inappropriate land-use activities must be halted in order to retain the remaining habitat.

Approaches

Restrict new development in stream corridors with local land-use regulations: The laxity in City and County land-use regulations in the past has resulted in widespread development in floodplains, wetlands, and other sensitive habitat areas. Many of these areas have been irretrievably

damaged; others can be restored but only at great cost. Recently, both the City and County have enacted regulations to restrict development in sensitive areas. These ordinances must be enforced vigorously to stop disturbance of sensitive habitat areas and reduce future restoration costs. *See BW 5.*

Reduce inappropriate actions on developed property with enforcement and education: In stream corridor and wetland management areas that have already been developed, the only practical way to reduce illegal filling and clearing activities is through a combination of law enforcement and landowner education. *See BW 20, BW 29, BW 30, and BW 31.*

Habitat Goal 3: Restore and enhance habitat that has been degraded by prior land-use activities. As indicated in the discussion above, prior land-use activities in stream corridors and wetlands throughout the Issaquah basin have resulted in substantial losses of aquatic and riparian habitat. While the impacts of habitat loss have not been quantified, the loss of habitat is inevitably accompanied by a reduction in populations of fish and wildlife that are native to the habitat. A habitat restoration program would begin to compensate for past losses and would help to ensure the long-term prospects of native fish and wildlife.

Approaches

Increase the number of stream restoration projects in the Issaquah Creek basin: Several stream restoration projects have already been done in the basin using County work crews and volunteers. Staffing and funding should be provided to increase these efforts in the basin. *See BW 22.*

Require restoration of disturbed sites as mitigation for new development projects: New road construction and other development projects frequently have significant impacts on local stream and wetland habitat. While the impacts of construction can be minimized, there will almost always be some permanent loss in the functioning of the habitat and its usefulness for fish and wildlife. In these cases, restoration of habitat should be required as mitigation for the development-related loss. *See BW 3, BW 22, and BW 27.*

Provide incentives for landowner revegetation: Most of the disturbed sites that are most suitable for habitat restoration are on private property, and much of the effort to revegetate and restore these areas will need to come from private landowners. Public agencies should offer incentives to encourage landowners to revegetate pasture lands and other disturbed areas. *See BW 22, BW 23, and BW 29.*

Habitat Goal 4: Ensure fish passage to all salmonid spawning and rearing areas. The conditions analysis conducted for the basin plan identified several areas of the Issaquah Creek basin that have high-quality salmon spawning and rearing habitat but that are blocked by culverts, weirs, or other physical barriers. In general, the

goal of this plan is to ensure that all artificial barriers are eliminated or modified to allow free passage of anadromous fish. A special case exists with the Issaquah fish hatchery, where the harvest of salmon for hatchery production has substantially reduced the migration of salmon into the upper basin. The facility should be managed for escapement sufficient to allow the full use of available habitat in the upper basin.

Approaches

Retrofit structures that are barriers to salmon passage: Many of the passage barriers in the Issaquah basin can be retrofitted to allow greater salmon passage. The agency or individual who installed the barrier should bear the financial and regulatory responsibility for retrofitting. *See BW 12 and subbasin recommendations.*

Investigate ways to increase fish passage by the hatchery: Fishery management agencies should work cooperatively to investigate ways to manage the fishery to meet hatchery needs but also to allow greater passage of fish to upstream areas of the basin. The focus of this work should be to increase salmon use in high-quality, but underused habitat areas. *See BW 24.*

STREAM CHANNEL EROSION AND DEPOSITION

Stream Channel Problems

The following problems were identified in the analysis of conditions in the early phases of the plan. For more information on these problems, see the *Issaquah Creek Current/Future Conditions and Source Identification Report.*

Development in Channel-Migration Zones: Issaquah and Tibbetts creeks are migrating streams, and they display the same patterns of channel migration common to all such systems: zones of long-term stability and other zones where channel shifting is a near-annual event. The migration is a natural response to changes in flow, channel gradient, and sediment load, and is not, in itself, a problem. The problems arise when structures are built within the zones of active channel migration and are subsequently threatened by the migrating stream.

This problem is particularly evident within the Four Creeks Ranch subdivision, which is located at the confluence of Issaquah and McDonald creeks. Bank erosion in the migration zone here has substantially reduced the setback between several houses and the stream. While the effect of long-term incremental migration, at rates that are currently estimated at one to two feet per year, is likely to be limited to property damage, abrupt channel changes in high-flow events could pose a significant threat to the residents of the affected houses.

A segment of the mainstem between the Sycamore subdivision and Nudist Park Creek has a similar pattern and rate of migration, but fewer structures lie within the active channel-migration zone. About a dozen houses within this two-mile segment are located within the migration zone. Most are within the floodplain as well, and face the dual risk of inundation due to flooding as well as loss of setbacks due to bank erosion.

The stream channels in the lower segments of Issaquah and Tibbetts creeks and the East Fork once meandered and braided across the alluvial floodplain, which is now occupied by the city of Issaquah. The migration in these segments has been reduced through widespread efforts to reinforce streambanks with riprap and concrete. In solving one problem, these projects have created others. Placement of bank-armoring structures within the stream channel has reduced channel width substantially, resulting in a reduction in the capacity of the channel to carry flood flows. The result is an increase in overbank flow and flooding problems in areas such as the lower East Fork, which features nearly continuous bank armoring. Such projects also disturb aquatic and riparian habitat and the use of this habitat by fish and wildlife. Finally, the armoring of banks tends to distort patterns of channel migration and may result in increased erosion in unarmored segments in the vicinity of the project.

The two most active migration zones along Issaquah Creek remain largely undeveloped. The first is on a segment of the creek just upstream of Lake Sammamish, where the channel-migration zone is up to 300 feet wide. Because it is within the state park, this segment is expected to remain undeveloped. The second is along Issaquah Creek downstream of the Cedar Grove Road, where the channel has shifted as much as 200 feet from 1961 to 1989. Similar conditions have been reported in the reach above Cedar Grove Road but have not been confirmed. The segment below Cedar Grove Road is within a rural residential zone, and existing regulations on development (principally the King County Sensitive Areas Ordinance) do not appear to be sufficient to prevent construction in all of this channel-migration zone.

Sediment Deposition in Stream Channels: A variety of land-use activities in the upland areas of the basin result in increases in sediment entering the steep tributaries of Issaquah Creek. There are two primary sources of erosion and the mobilization of sediment in the Issaquah basin. The first is erosion in headwater areas due to logging, clearing related to mining, and clearing for residential development. The extent of erosion in the headwaters of the basin is highly dependent on slopes and soils, with particularly severe erosion and sediment inputs to the stream system from the steeper hillslopes of Cougar, Squak, and Tiger Mountains and from areas underlain by the highly-erodible Vashon advance outwash deposits. The second major source of sediment is erosion of the channel banks and bed. In natural conditions, a balance exists between the erosivity of the flow and the erosional resistance of the channel banks and bed. When flow rates increase due to changes in upstream land use, this balance is disturbed, the channel erodes more rapidly, and additional sediment enters the stream.

Once eroded, the sediment that is transported by Issaquah Creek and its tributaries remains in motion only as long as the flow is competent to transport it. Although flow competence is a result of several factors, on a basinwide scale it is crudely proportional to both the stream discharge and the channel gradient. Unless stream discharge increases (through the inflow of a tributary, for instance), a reduction in the channel gradient is likely to result in a reduction in competence and the deposition of sediment. Confinement of the stream channel by culverts, bridge crossings, and other structures also reduces flow competence and induces sediment deposition.

Because there are many locations in the Issaquah basin where these natural and constructed conditions occur, zones of sediment deposition are common. The most obvious examples are found in the lower valleys of Issaquah and Tibbetts creeks, where thousands of years of deposition have resulted in the formation of alluvial fans, upon which the city of Issaquah is built. Smaller zones of deposition were identified through an analysis of data from floodplain studies, bridge surveys, and fieldwork conducted during the development of the *Issaquah Creek Current/Future Conditions and Source Identification Report*. The most dramatic of these are in the 1.3-mile reach of Issaquah Creek just downstream of the confluence with Fifteenmile Creek and in the segment of Tibbetts Creek between Tibbetts Manor and Interstate 90. In the Issaquah Creek segment, several feet of sediment were deposited in the channel between 1977 and 1989. The principal sources of this sediment are No Name and Nudist Park creeks (trib. 0206 and 0203A), where timber harvest activities in 1976 and 1983 have resulted in erosion and sediment transport to the lower-gradient mainstem of Issaquah Creek. In the Tibbetts Creek segment, several feet of sediment were deposited in the two 1990 storms alone, the principal sources of which were abandoned mines and development upstream.

Deposition becomes a serious problem when sediment reduces channel capacity in developed areas. This results in an increase in the frequency and duration of overbank flow and flooding of areas adjacent to the stream, particularly where deposition occurs in segments where the channel is already constrained by a bridge, weir, culvert, or other constriction. This is a common problem within the city of Issaquah, where the deposition of sediment associated with channel constrictions aggravates flooding problems at Dogwood Street, Clark Street, and Gilman Boulevard on the mainstem of Issaquah Creek. On Tibbetts Creek, deposition in the undersized channel magnifies flooding problems from Tibbetts Manor to the Interstate 90 crossing.

Sediment transport and deposition is also one of the principal causes of road flooding in the upper Issaquah basin. Virtually all of the road crossings over steep headwater tributaries have been subject to flooding, including the May Valley Road crossings of the tributaries of McDonald Creek, the Newport Way crossing of Anti-Aircraft Creek, and the Issaquah-Hobart road crossings of Pheasant, No Name, and Nudist Park Creeks. In these cases, flooding problems are either directly caused or aggravated by culverts that are inadequately sized to pass sediment as well as stormwater in large floods.

Negative effects of erosion and deposition of sediments on habitat are addressed in the Stream and Wetland Habitat section of this chapter.

Stream Channel Goals and Approaches

Stream Channel Goal 1: Restrict new development in, and remove structures from, active channel-migration zones. The stream channels of the Issaquah Creek basin naturally migrate across their floodplains in response to changes in sediment load and streamflow. The rate of migration varies, with some stream segments being particularly susceptible to lateral migration due to factors such as bed and bank materials or the energy of tributary streams. These segments include reaches of Holder Creek, Carey Creek, and the East Fork and mainstem of Issaquah Creek. The principal problems with channel erosion in the basin are due to development in these zones. Continual migration in developed stream corridors has resulted in threats to the safety and property of local residents. These threats have been addressed through bank-stabilization techniques that degrade habitat and often transfer stability problems downstream. Problems with bank instability should be addressed by preventing additional development in active channel-migration zones and removing structures that have been built in hazardous migration areas.

Approaches

Prohibit new development in active channel-migration zones with City and County regulations: Because development in active channel-migration zones results in immediate threats to public health and safety, it is appropriate to restrict the location and type of structures in these areas with local land-use regulations. *See Basinwide Recommendation (BW) 5 and BW 28.*

Remove homes from areas with hazardous migration conditions: Homes in areas where channel migration and flooding are both serious hazards should either be relocated or purchased and torn down. This should be accomplished through the purchase program identified in flooding goal 2. Hazards should be identified through the property-by-property floodplain audit called for in the flooding goals or through an independent geotechnical analysis. *See BW 7, BW 8, and BW 28.*

Stream Channel Goal 2: Promote environmentally sound techniques for bank stabilization. Many homes and businesses in the Issaquah basin have been located in stream corridors that are naturally subject to channel migration. In order to reduce the loss of property and safety threats inherent with living in these areas, many private landowners have stabilized their streambanks with riprap, revetments, and other structures. In some segments of the East Fork and mainstem of Issaquah Creek, the private bank-stabilization structures are nearly continuous. These structures are destructive to aquatic and riparian habitat and reduce the conveyance of water in the stream channel. Other, more environmentally benign

techniques of bank stabilization have been tested with success, and their use would reduce impacts to habitat and conveyance.

Approaches

Modify and enforce regulatory standards to prevent riprap and other destructive techniques except in extraordinary circumstances: Property owners are required to get an Hydraulic Project Approval (HPA) from the Washington State Department of Fish and Wildlife for all instream work, including bank stabilization. Modification of permit standards to require bioengineering techniques and prohibit riprap and concrete except in tightly constrained circumstances would reduce the use of inappropriate techniques. *See BW 5 and BW 23.*

Establish incentives to encourage property owners to retrofit stabilization projects with bioengineering techniques: Because much of the damage associated with riprap and concrete has already been done, it is important to establish a mechanism to replace these projects with bioengineering techniques. The use of technical support as incentives would encourage property owners to convert to better techniques at a reasonable public expense. *See BW 23.*

Use bioengineering techniques on all public works projects: Use of bioengineering techniques for all City, County, and State public works projects in the Issaquah basin will demonstrate the success of these approaches and increase public acceptance and adoption of new techniques. *See BW 12, BW 17, and BW 23.*

Stream Channel Goal 3: Reduce the need for sediment removal by controlling sediment at its source. The conditions analysis for the basin plan indicates that the deposition of sediment in stream channels is a serious problem at several locations in the Issaquah basin. Sediment deposition covers salmonid spawning gravels, clogs culverts, and reduces channel capacity, resulting in increased overbank flow and flooding during large flow events. These problems are most evident in the lower segments of Tibbetts Creek and the East Fork and mainstem of Issaquah Creek. While dredging of these segments to improve channel conveyance has been proposed, the consequences of a major dredging project on aquatic habitat and water quality could be severe and should be avoided if at all possible. Because many of the sediment deposition problems are due to continued loading from upstream sources, an aggressive uplands sediment control strategy should reduce or eliminate the need for downstream dredging.

Approaches

Reduce development in erosion-prone areas: Certain areas of the Issaquah basin are inherently more prone to erosion and the release of sediment into the stream system than others. Development in these areas will intensify these processes, and will result in higher sediment loading

than development in less erosion-prone areas. Residential densities in these areas should be reduced via local zoning. *See BW 5 and BW 6.*

Minimize sediment production from new development: Various mitigation requirements, imposed at the time of site development, can minimize sediment production from developed areas. Much of the sediment production associated with development occurs during the construction process. Strict enforcement of existing regulations on erosion and sediment control on construction sites should reduce construction-related sediment production. *See BW 3, BW 4, BW 6, BW 30, BW 31, and BW 33.*

Correct conditions at existing upland sediment sources: There are several sites in the Issaquah basin, particularly Sunset Quarry and the abandoned mining sites in the Tibbetts Creek subbasin, where erosion and sediment production are excessive. These sites contribute directly to downstream flooding, water quality degradation, and loss of aquatic habitat. Sediment production from these sources must be controlled in order to alleviate these problems. *See subbasin recommendations.*

Reduce sediment production from channel scouring: Increased flows from urban development typically increase the size of channels by scouring sediment from streambeds and banks. Reducing these flows, or at least their future increases, and repairing those bank failures that have already occurred can significantly reduce the volume of sediment that otherwise can clog downstream segments. *See BW 1, BW 2, and BW 23.*

Dredge only when absolutely necessary, and then with the least destructive techniques: Only time will tell how effective an aggressive source control strategy will be in reducing sediment deposition problems in downstream reaches. Even after upstream sources are controlled, downstream accumulations of sediment will not be flushed from the system until larger floods occur, if they are fully flushed at all. Where deposition-related problems make it necessary to supplement the natural processes of sediment transport, dredging should be conducted using techniques and during seasons that minimize impacts to aquatic habitat.

Chapter 4

Basinwide Recommendations

Chapter 4: Basinwide Recommendations

Note on Costs: Programmatic costs are approximations and will be refined as the programs and projects are further developed. Costs are divided into one-time and annual expenses, with one-time costs covering capital costs (e.g., equipment) for ongoing programs and total costs for programs that are conducted in one discrete task (e.g., special studies). Annual costs are estimated based on full time equivalent (FTE) staffing, with each FTE assumed to cost $50,000 (salary and overhead). Where responsibilities are assumed to be handled by existing agency or organization staff, or through positions created expressly by other recommendations (e.g., the Basin Steward), costs are given as "no change" from current programmed costs.

BW 1: Establishment of Flow Reduction Standard for On-Site Retention/Detention Facilities

Recommendation: In most of the Issaquah basin except for the subbasins listed in BW 2, on-site retention/detention (R/D) facilities, where mandated by the *King County Design Manual* should be designed to control the post-development peak hourly flows to corresponding pre-development levels for all annual peak hourly flows from the 2-year up to the 10-year. Whenever allowed by the *Design Manual,* infiltration should be used to achieve this goal.

At this time, either of three analysis techniques may be used:
The first technique is to use a modification to the Santa Barbara Urban Hydrograph (SBUH) method. A seven-day rainfall distribution based on actual storms in the Puget Sound Lowlands replaces the Soil Conservation Service (SCS) Type 1a distribution in the *Design Manual.* Additionally, the hydrographs for pervious and impervious surfaces are computed separately and added to obtain the total hydrograph for pervious and impervious segments. Travel time and time of concentration computations for pervious land segments are based on the sum of interflow, shallow concentrated flow, and open channel flow. Technical guidance for this modification is included in the reference section of the *Design Manual* as updated in August 1994. The calculated storage volume should be increased by a safety factor of 30 percent.

The second technique uses the method of the 1990 *Design Manual* with modified release requirements as follows:

Post Development Storm Event	Pre-Development Flow Release Target
2-year	one-half of the 2-year
10-year	2-year
100-year	10-year

No safety factor is required for facilities using these release rates.

The third technique involves iterative design using a calibrated continuous flow hydrologic simulation model. The Hydrologic Simulation Program - Fortran (HSPF) model used for the analysis in this basin plan is an example of this type of model. The calculated storage volume should be increased by a safety factor of at least 10 percent.

Other methods for designing detention ponds that meet the stated performance goal may be substituted by the King County Surface Water Management Division in the future. SWM Division staff are investigating design methods that more reliably and efficiently design detention facilities to achieve the stated performance goals in preparation of the revised *Design Manual.*

DDES will administer these retention/detention standards once they are adopted.

Discussion: This standard is intended to keep future development in the Issaquah basin from increasing flooding problems downstream. The conditions analysis indicated that if upstream areas of the basin develop to the limits of existing zoning without mitigation of stormwater runoff, flooding conditions in downstream reaches would get significantly worse, with the number of houses and businesses subject to flooding increasing substantially. Both of the new design standards (BW 1 and BW 2) for stormwater facilities that are proposed will reduce the impacts of upstream development and alleviate this predicted increase in downstream flooding problems. These standards are particularly important in the Issaquah basin, where extraordinary measures are required to keep downstream flooding problems from getting worse in the future.

The modified, 7-day storm, SBUH design method, rather than the method stipulated in the Design Manual, is recommended because analysis has shown that the modified method better achieves the performance goal of controlling peak flows to their pre-development levels. Continuous hydrologic simulation of pond performance, conducted by County staff and by private engineering consultants, has shown that peak flows consistently increase in basins where the Design Manual standard is applied to all developments. In the Issaquah basin, where flooding is already problematic, it is not acceptable to apply a detention standard known to allow flooding increases. The recommended standard, which requires larger detention volumes, is necessary to better protect against flood-flow increases.

Estimated Cost: One-time (0.5 FTE staff training) = $25,000.

BW 2: Establishment of Erosion Protection Standard for On-Site Retention/Detention Facilities in Especially Sensitive Basins

In subbasins where stream stability and habitat are highly sensitive to higher future flows, specifically the Upper Issaquah, Middle Issaquah, and McDonald Creek subbasins, on-site R/D facilities, where mandated by the *King County Design Manual* should be designed to reduce post-development flow durations to their pre-developed levels for all flows greater than 50 percent of the 2-year event and less than the 50-year event. Additionally, the 100-year post-development hourly peak flow should be reduced to the pre-development level. Whenever allowed by the *Design Manual*, infiltration should be used to achieve this goal.

At this time, either of two analysis techniques may be used. It is recommended that a calibrated continuous flow simulation model, such as HSPF, be used for this analysis. The calculated storage volume should be increased by a safety factor of at least 10 percent.

If a continuous model cannot be used, the method of the 1990 *Design Manual* may be used with the 24-hour design event with the following release requirements.

Post-Development Storm Event	Pre-Development Flow Release Target
2-year	one-half of the 2-year
10-year	2-year
100-year	10-year

The calculated storage volume should be increased by a safety factor of 30 percent.

Other methods for designing detention ponds that meet the stated performance goal may be substituted by the King County Surface Water Management Division in the future. SWM Division staff are investigating design methodologies that more reliably and efficiently design detention facilities to achieve the stated performance goals.

DDES will administer these retention/detention standards once they are adopted.

Discussion: This standard is intended to keep future development in the Issaquah basin from increasing both flooding and habitat problems downstream. Design of facilities to this standard will prevent erosion of stream channels and sedimentation of streambeds in areas of exceptional habitat value, as well as provide flood control benefits. Application of this standard is most critical in the uppermost headwaters of the basin where runoff enters the stream system in numerous small streams and rivulets that are very sensitive to changes in flow regime. The conditions analysis indicated that if upstream areas of the basin develop to the limits of existing zoning without mitigation of stormwater runoff, flooding conditions in downstream reaches would get significantly worse, with the number of houses and businesses subject to flooding increasing substantially.

This standard prevents any particular high flow from occurring more often than it does prior to development. Viewed over the whole flow record, the amount of time any particular high flow is exceeded will not change. Both of the new design standards (BW 1 and BW 2) for stormwater facilities that are proposed will reduce the impacts of upstream development and alleviate this predicted increase in downstream flooding problems. These standards are particularly important in the Issaquah basin, where extraordinary measures are required to keep downstream flooding problems from getting worse in the future.

Estimated Cost: Covered by existing programs.

BW 3: Establishment of Open-Space Retention Requirements for Subdivisions and Clearing Restrictions on Existing Lots

Recommendations:

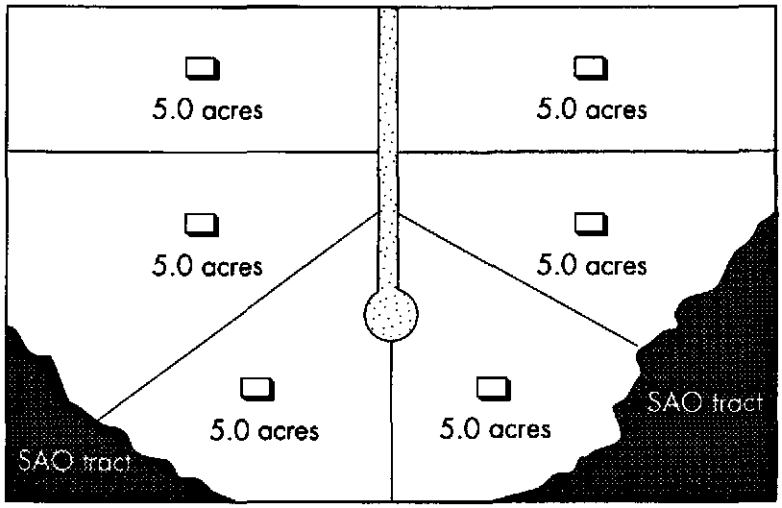
1. Subdivisions, Short Subdivisions, and Segregations

The Metropolitan King County Council should amend the King County Comprehensive Plan and the King County Zoning Code to require that all new subdivisions, short subdivisions, and segregations within rural residential zones in the Issaquah Creek basin retain a substantial portion of the property in one or more contiguous open-space tracts, the relative size of which should depend on whether detention facilities are constructed for the subdivision or short subdivision. For subdivisions and short subdivisions that are exempted from detention requirements and choose not to construct detention systems, all developable lots should be sited on a maximum of 35 percent of the area of the subdivision. These open-space tracts, plus any other tracts recorded and managed separately under the King County Sensitive Areas Ordinance (SAO), should total at least 65 percent of the subdivision or segregation. Subdivisions and short subdivisions that construct detention facilities according to the detention standards prescribed for the Issaquah Creek basin should site all developable lots on no more than 60 percent of the area of the subdivision. In this case, the open-space tracts, plus any other areas recorded and managed separately under the King County SAO, should total at least 40 percent of the subdivision. Wherever possible, open-space tracts created under this basinwide should be contiguous with SAO tracts.

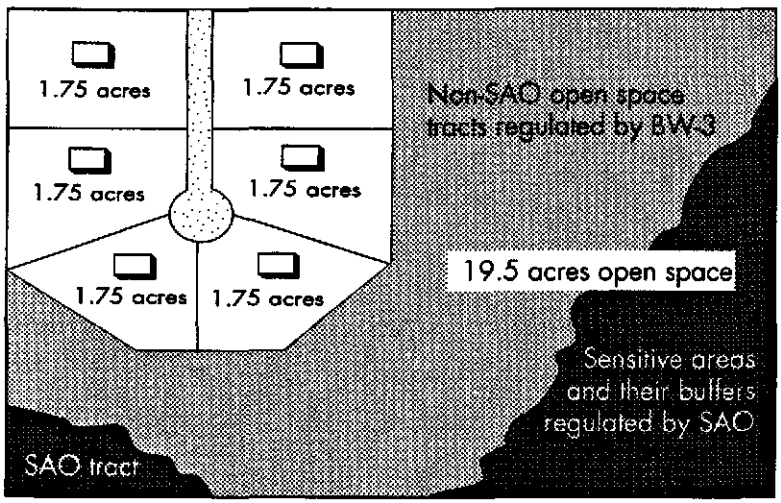
All tracts created under this basinwide should be clearly marked with at least one sign per buildable lot bordering the tract indicating that the tract is permanent, dedicated open space. Tracts should be shown on all property maps, and must be protected by covenants, approved by the County, that restrict their uses to the uses described below. Wherever possible, open-space tracts should adjoin open space or wooded areas on adjacent property. All trees within open-space tracts existing at the time of the subdivision application should be retained, except for clearing related to allowable and conditional uses described below, and except for dangerous and/or diseased trees. Subdivision and segregation applicants, should they decide to reforest pre-existing cleared areas, should follow the replanting requirements in *Chapter 1, Appendix C* of the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan*, published separately.

In addition to this mandatory open-space-retention requirement, the amendments should include a bonusing system that would also apply to all rural residential zones, in which bonus densities up to a 50 percent increase in allowable density would be allowed for subdivisions, short subdivisions, and segregations that retain at least 80 percent of the property in one or more open-space tracts. If necessary, more specific bonusing criteria should be formulated jointly by King County Community Planning, SWM, and the Department of Development and Environmental Services (DDES). A typical rural development scenario and the two open-space-retention alternatives are illustrated in Figure 4-1.

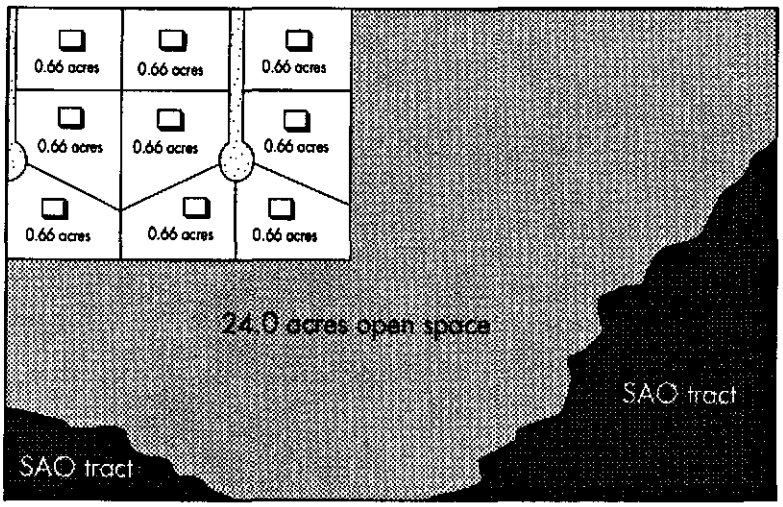
Figure 4-1 Open Space Retention Options



A. TYPICAL RURAL DEVELOPMENT



B. BASIC OPEN SPACE RETENTION OPTION



C. BONUSED OPEN SPACE RETENTION OPTION

Each open-space tract created under this basinwide recommendation should be limited to the following uses and subject to the following requirements:

Uses Permitted Outright:

A. Passive Recreation – This may consist of undisturbed open space, pedestrian and bicycle trails, nature viewing areas, fishing and camping areas, and other similar uses that do not require permanent buildings. Small recreational structures such as playground equipment and picnic tables are permitted. Cleared areas and/or areas of compacted soil containing these recreational uses should comprise no more than eight percent of an open-space tract. Pedestrian and bicycle trails should be permitted, provided that they are designed and located to minimize erosion and other environmental impacts. Equestrian trails should be permitted, provided that horse grazing and stables are not located in the open-space tract.

B. Utilities and utility easements, including surface-water facilities – Wherever possible, surface-water facilities and utility easements should be sited within or adjacent to existing roads or utility easements.

Conditional Use:

A. Timber harvesting – Limited timber harvesting should be allowed only if the homeowners' association of a tract prepares and files with DDES a timber harvest management plan and obtains a clearing permit. The management plan should recognize the underlying objectives of the basin plan in maintaining the hydrologic and water quality functions of these tracts as well as maintain secondary objectives of wildlife habitat, and it must be approved by DDES with review by the Basin Steward (BW 29). Specific criteria to review harvest management plans will be developed jointly by SWM, DDES, the Washington State Department of Natural Resources (DNR), and the Muckleshoot Indian Tribe (MIT). Homeowners' associations allowed to harvest timber under the management plan should be required to replant the harvested portion of the tract. Guidelines for revegetation are found in *Chapter 1, Appendix C* of the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan* (published separately). DDES, with assistance from the Basin Steward, should monitor these tracts to assure compliance with the management plan. DNR can provide assistance by formulating a Stewardship Management Plan for tracts larger than ten acres in size.

Exemptions from Open-Space-Tract Requirements and Clearing Restrictions

The preceding open-space requirements and clearing restrictions may be waived at the discretion of the director of DDES under the following circumstances:

A. For the subdivision, segregation, or development of property for public uses such as schools, fire stations, parks, and roads.

B. For the subdivision or segregation of land that has been previously cleared and used for agricultural purposes (under definitions specified in the implementing ordinance), under one of the following conditions:

a. All lots or parcels created by the subdivision or segregation are 10 acres or larger in size; or

b. One lot smaller than 10 acres is created that includes an existing farm residence, provided that the remaining area is retained in one or more parcels, none of which is smaller than 10 acres in size.

2. Clearing Restrictions on Existing Lots

On all lots larger than 20,000 square feet within rural residential zones created prior to the establishment of the open-space tract requirements above, at least 65 percent of the area of each lot should be retained in native wooded cover in no more than two contiguous areas on each lot. On lots smaller than 20,000 square feet, no more than 7,000 square feet of the lot should be cleared of tree cover. Tree retention areas should include all sensitive areas and their buffers. If a lot contains less than 65 percent tree cover, all existing tree cover should be retained and structures should be sited within cleared portions of the lot, wherever possible. Schools, churches, and other public facilities should be exempted from this requirement.

These code amendments should be prepared by SWM in coordination with Community Planning and DDES. After adoption, the new regulations would be enforced by DDES.

Discussion: The Issaquah Creek basin is already experiencing severe flooding problems in downstream reaches of the stream system and degradation of water quality in the stream and Lake Sammamish, problems that have been aggravated by upstream development. Given that much of the basin could be further developed under existing zoning, it is imperative that additional measures be taken to control the quantity and quality of upstream runoff. Hydrologic modeling conducted by SWM indicates that the quantity of runoff can be decreased substantially by retaining a large portion of a developing parcel in a forested open-space tract. When combined with previous analyses of the water quality benefits of forest retention, these findings indicate that intensive development of a small portion of a subdivision has much less impact on hydrology and water quality than widespread clearing and dispersed development.

A variety of land-use scenarios were modeled on a sample 100-acre parcel with moderate slopes and rainfall-runoff characteristics typical of the Issaquah Creek basin (see *Chapter 1, Appendix G* of the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan*, published separately). All scenarios were modeled without on-site detention because detention usually is not required for rural development. The scenarios included a typical rural development scheme of 5-acre lots with 50 percent of the forest cleared, four scenarios with smaller lots and at least 65

percent of the forest land retained after development, and maintenance of the entire site in forest (as a control). For each of the scenarios, the hydrologic model predicted peak flows from a single point of discharge for storms of various frequencies.

Full results are included in the appendix cited previously. The results support the following conclusions for rural development within the range of the scenarios modeled:

1. The amount of forest land that is retained after development is much more important in controlling peak flows than the number of houses constructed or the gross site density. Even minor increases in forest retention, such as the increase from 76 percent to 80 percent in two scenarios with comparable levels of development, have significant effects in decreasing flows.

2. Rather than reducing environmental problems, the typical rural scenario with 5-acre lots has the poorest hydrologic performance of the scenarios modeled. In this scenario, the flows following the 2-year storm are predicted to be greater than experienced following the 10-year storm in forested conditions, a regime that would be highly destabilizing to stream systems that receive these flows.

While a detention facility could alter these results by decreasing peak discharges, there are a number of other advantages of forest retention as a mitigation measure that are not provided by constructed drainage systems. First, forest retention provides control of runoff volume and duration as well as peaks, performing functions that would be difficult and expensive to provide in a constructed system. Second, forest retention promotes infiltration at a higher rate than can be provided through most constructed systems, ensuring the maintenance of baseflow conditions in streams. Third, forest retention reduces soil erosion and the transport of sediment borne pollutants to streams and wetlands, performing these functions far better than any constructed water quality facilities.

Furthermore, the results indicate that the advantages of forest retention are considerable enough to offer density bonuses to encourage landowners to retain more forest land in their development proposals. In determining the minimum percentages of forested open space needed in each subdivision, SWM modeling showed that, at 65 percent forested open space, the 2-year post-developed flow generally becomes less than the 10-year forested flow. While there would still be some degradation to the stream system at that flow level, it would be significantly less than an unmitigated scenario. To achieve 80 percent forested open space, a 50 density bonus was chosen because that is the minimum bonus needed to allow a 10-acre lot to be able to bonus at least one unit, while any bonus larger than 50 percent would result in lot sizes too small, in some cases, to allow on-site septic systems.

The need to have open-space areas in separate, marked tracts is borne out by recent research. According to a 1990 study by the King Conservation District, "Native Growth Protection Easements: Survival and Effectiveness," 72 percent of surveyed NGPE's not in separate tracts had some sort of alteration (e.g., cutting,

clearing), while only 64 percent of NGPE's in separate open space tracts had been altered. Furthermore, while 73 percent of NGPE's without signs or field markings had been altered, only 50 percent of those with markings had been altered.

Estimated Cost: One-time (staff training) = $21,500; Annual (.25 FTE) = $12,500 plus added enforcement (included in BW 31).

BW 4: Comprehensive TESC Program for Construction Sites

Recommendation: King County is currently operating a comprehensive temporary erosion and sedimentation control (TESC) program on a pilot basis. This county-wide program should be applied in the Issaquah Creek basin to reduce erosion and sediment transport from construction sites. The existing program includes the following elements:

1. Problem Assessment - Assesses the importance of construction sites in terms of contribution to sediment loadings and impacts on fisheries. An assessment of the types and number of construction sites in the Issaquah basin in the 1990's should be a part of this effort.

2. Regulations - SWM updates the Surface Water Design Manual section on construction site controls to reflect current knowledge and conditions in King County development, new construction site BMP's, and information from the problem assessment.

3. Education - Provides educational opportunities for the construction industry and public works about construction site BMP requirements. As part of this program, DDES inspectors will also receive training about BMP's and impacts of sediment on downstream water bodies.

4. Program Coordination - SWM and DDES each provide staff to coordinate and administer this program.

5. Monitoring and Evaluation - Calls for an evaluation report after each wet season. The report recommends changes and improvements as necessary, and is transmitted to the Metropolitan King County Council for review prior to the beginning of the subsequent wet season. The Muckleshoot Indian Tribe, the private sector, and other public agency personnel are involved in the evaluation of the program and preparation of the report. If necessary after the first year program is complete, additional requirements should be considered including targeted seasonal clearing and grading limits, more enforcement, construction phasing, educational efforts, and procedural changes in permitting and enforcement.

6. Enforcement - DDES enforces erosion and sediment control requirements through the use of notice of violations and stop work orders, as necessary, to attain compliance with regulations.

7. Incentives - The program is designed to introduce incentives and disincentives into the process as much as is practicable.

Discussion: Transport of soil into downstream water bodies degrades water quality and impacts fisheries resources. Erosion from construction sites, which results in such transport of soil, has been an ongoing problem in King County since widespread development began in unincorporated areas. Several resource agencies and the Muckleshoot Indian Tribe have identified sediment generated from the erosion of construction sites as a problem for anadromous fish and their habitat, and hatchery operations. Evidence from the problem assessment program will be used to quantify such impacts.

The King Conservation District (KCD) has been trying to improve erosion and sediment control (ESC) efforts in the county since the mid-1970's. Improvements have been made as a result of efforts by the Department of Development and Environmental Services (DDES), KCD, and the 1990 Surface Water Design Manual; however, more effort is needed on the part of the private and public sectors if erosion is to be reduced further. The above recommendation describes a new cooperative effort between the public and private sector and resource agencies to solve an old problem. Evaluation of this program after one year will recommend changes, as needed, for further improvement.

Estimated Cost: = $15,000.

BW 5: Adoption of City of Issaquah Critical Areas Ordinance

Recommendation: The Issaquah City Council should adopt a final Critical Areas Ordinance to replace the interim version now in effect. The intent of this recommendation is to regulate development in floodprone areas, segments with active channel migration, and areas with important aquatic and riparian habitat; these methods will also control sediment mobilization. The final ordinance should include standards that are consistent with, or more stringent than, the King County Sensitive Areas Ordinance (SAO). In particular, the following requirements should be incorporated:

1. Buffer zones should be required to restrict development and clearing along streams and wetlands. The SAO standards of 100-foot buffers for Class 1 streams, Class 2 streams with salmonid use, and Class 1 wetlands and 50-foot buffers for other Class 2 streams and Class 2 wetlands should apply.

2. A zero-rise criteria for the 100-year floodplain should be adopted to restrict development and filling within the floodplain. The ordinance should clearly state that such development is prohibited unless no practicable alternative exists.

3. Restrictions on the location, density, and allowable uses of development and the establishment of buffers around steep slopes and landslide hazard areas should be incorporated in order to control erosion and sediment transport into streams.

4. Increased penalties for code violations should be established and should include requirements to restore areas that are damaged by illegal land-use activities.

5. Funding should be provided to ensure that adequate staffing is available to conduct permitting, monitoring, and enforcement actions under the ordinance.

Discussion: Many of the flooding and habitat problems within the City of Issaquah are due to the construction of homes and businesses too close to streams and the clearing, grading, and bank stabilization work associated with this development. This development creates significant public and private costs due to the flooding of roads and structures and the loss of habitat for fish and wildlife, and it can only be corrected at substantial public and private expense. The regulation of development in these areas is therefore entirely justified in the interests of protecting public health, safety, and general welfare.

Consistency with the King County SAO will make it easier for landowners to understand the regulations and for City and County staff to monitor and enforce compliance throughout the basin.

Estimated Cost: Costs covered by existing programs.

BW 6: Adoption of Zoning Changes in Critical Resource and Sensitive Areas

Recommendation: During the update of the King County Comprehensive Plan, the King County Community Planning Division and the Metropolitan King County Council should consider rezoning areas of the Issaquah basin that meet the following criteria:

1. Where development under the densities or uses allowed in the existing zoning would cause significant adverse impacts to stream and wetland areas that have been designated as regionally significant under provisions of BW 21 in this plan;

OR

2. Where development under the densities or uses allowed in the existing zoning could aggravate severe erosion, flooding, habitat, and/or water quality problems that currently exist within the basin; **AND**

3. Where site development standards and other mitigation measures required by local, state, and federal laws and regulations are judged to be insufficient to ensure the protection of regionally significant streams and wetlands and/or the prevention of more severe hazards; **AND**

4. Where existing patterns of plats and lots and the extent of vesting under previous zoning would allow the rezone to have a significant impact on future development patterns.

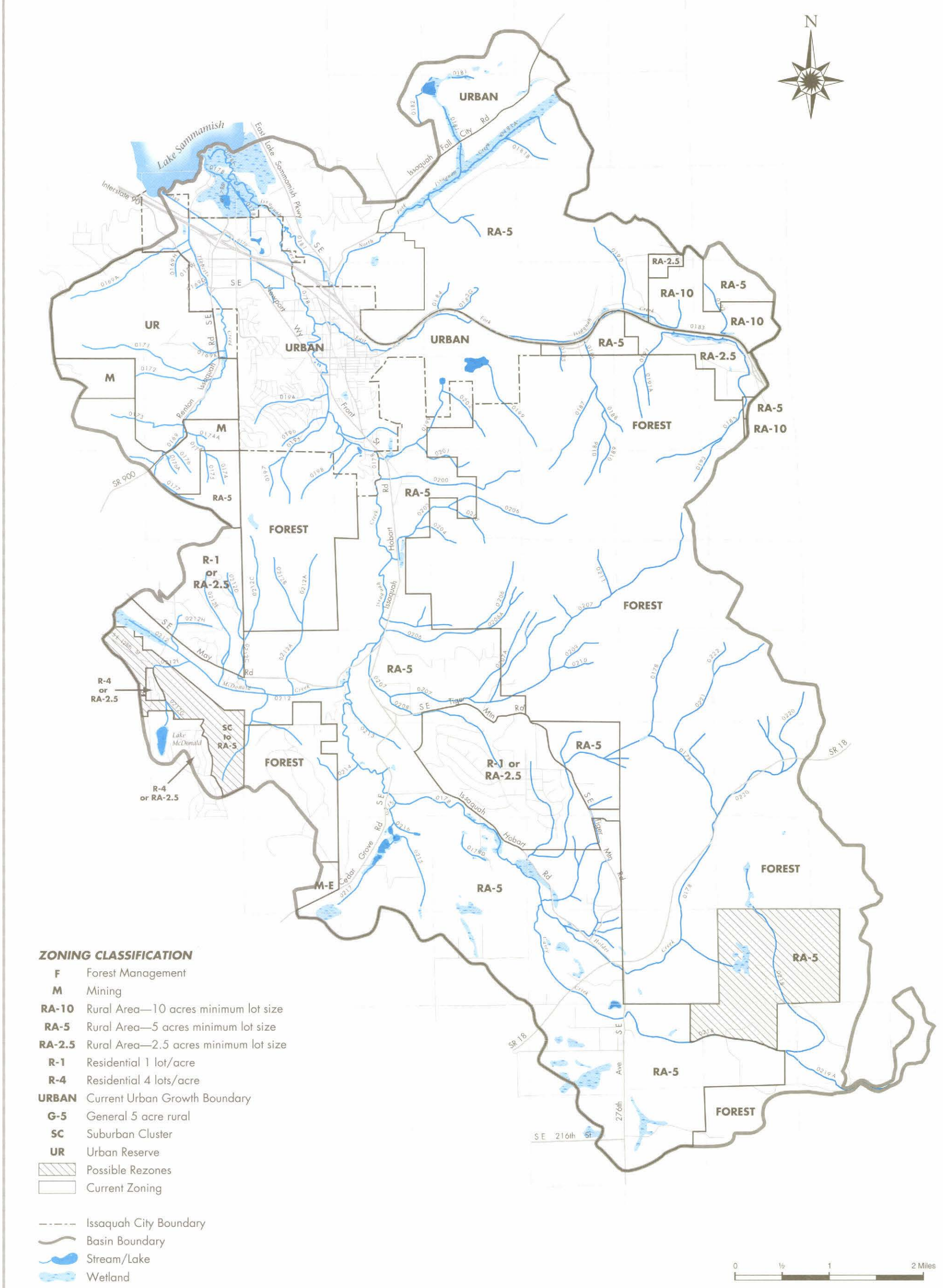
In these circumstances, the zoning designation should be changed to restrict allowable uses or reduce development densities.

There are two areas, one in the McDonald Creek subbasin and one in the Upper Issaquah subbasin (see Figure 4-2), that may meet the criteria after further analysis and the disposition of vested development proposals. These areas should be reevaluated when the relevant County plan is revised or amended.

Discussion: Most of the Issaquah Creek basin upstream of the City of Issaquah is zoned for long-term forestry or low-density residential uses (at a density of one home per five acres). By and large, this zoning is appropriate, providing for a range of uses and densities that are compatible with plan goals to protect fish and wildlife and water quality in the stream and Lake Sammamish and prevent greater downstream flooding problems.

There are a few areas, however, that have zoning that would allow land uses and development densities that may be incompatible with these goals. The case that most clearly meets the criteria established in the recommendation is the referenced area of the McDonald Creek subbasin. While the zoning of the Upper Issaquah area is low-density residential, even this level of development could damage the extremely sensitive streams and wetlands of this subbasin, and this area should also be reevaluated through the County planning process to determine if rezoning is appropriate.

Estimated Cost: Covered by existing programs.



ZONING CLASSIFICATION

F	Forest Management
M	Mining
RA-10	Rural Area—10 acres minimum lot size
RA-5	Rural Area—5 acres minimum lot size
RA-2.5	Rural Area—2.5 acres minimum lot size
R-1	Residential 1 lot/acre
R-4	Residential 4 lots/acre
URBAN	Current Urban Growth Boundary
G-5	General 5 acre rural
SC	Suburban Cluster
UR	Urban Reserve
	Possible Rezones
	Current Zoning
	Issaquah City Boundary
	Basin Boundary
	Stream/Lake
	Wetland

ZONING CHANGES

Issaquah Creek Basin

Figure 4-2

BW 7: Establishment of Channel and Floodplain Restoration Program

Recommendation: The City of Issaquah and King County should restore stream channels and floodplains in areas where homes and businesses have been constructed within the corridors of Issaquah Creek and its major tributaries. The City and County should be responsible for funding the program within their respective jurisdictions. The County should also provide the City with technical assistance and advice. This program should (1) restore the ability of the channel and floodplain to convey and store floodwater, and (2) enhance the fish and wildlife habitat of the corridor. The restoration program will be accomplished in the Lower Issaquah, East Fork, and North Fork subbasins through various combinations of the following tools.

1. Removal of homes from the floodplain – In order to provide a corridor for flood conveyance and habitat restoration, the City and County should initiate a program to remove homes that have been constructed too close to the stream. The program should offer two options to streamfront homeowners: (1) purchase of the home followed by removal, or (2) relocation of the home to a location outside the corridor and above the 100-year floodplain. Participation by landowners in either option should be voluntary, with no condemnation of homes or property. All houses within 25 feet of the creek should be eligible for purchase or relocation. Other houses within 75 feet of the creek **and** in the 100-year floodplain should be eligible for consideration on a case-by-case basis. Using these criteria, approximately 89 houses would be eligible for consideration. While formal criteria for prioritizing houses to be purchased would need to be developed by the City and County after approval of the program, it is recommended that first priority be given to houses threatened by both flooding and channel migration, followed by houses threatened by flooding alone and houses that contribute to flooding problems elsewhere. Other determining factors might be the site's potential for providing flood storage, improving conveyance, or restoring habitat.

To estimate the costs of this program, the only houses included were those within a 125-foot-wide corridor that shifted laterally to include as few houses as possible. It is estimated that there are 47 single-family and 3 multi-family homes within this corridor in the basin. For costing purposes it was assumed that 26 (55%) of the owners of single-family and 1 (33%) of the owners of multi-family homes would sell their property to the City or County in the ten-year life of the purchase program. Preliminary mapping of the corridor and the location of eligible homes is available for review at the offices of the King County Surface Water Management Division and the City of Issaquah Engineering Department.

2. Purchase of easements – Many privately owned properties along Issaquah Creek and its tributaries remain undeveloped or have homes that have been built some distance from the stream. To ensure that the stream corridor in these areas will remain undeveloped and available for increased flood conveyance and habitat restoration, the City and County should purchase easements from the owners of these parcels. The easements should allow channel reconfiguration, habitat restoration, and maintenance; public access should be allowed only by consent of the property owners. Width of the easement could vary, with an average of 50

feet and a minimum of 25 feet for a total corridor width of 100 feet, not including the width of the stream. As with the purchase of homes, the sale of easements should be voluntary and no condemnation should be used. It is estimated that 157 properties would be eligible for this program, and for costing purposes it was assumed that 94 (60%) of the owners would choose to sell easements to the City or County in the ten-year life of this program.

3. Purchase of property or development rights – There are areas in the Issaquah Creek basin where development has been permitted under regulations that predate restrictions on floodplain land but the planned structures have not yet been built. In cases where the planned development would cause substantial flooding problems, the property or development rights should be acquired and the parcel left undeveloped. This will ensure that the stream corridor is available for flood conveyance, habitat restoration, and possibly public access.

4. Removal of fill and bank stabilization structures – In order to increase the capacity of the channel and floodplain to carry floodwater, fill and bank stabilization structures along streambanks should be removed, at public expense, from purchased properties and easements, except where structures are necessary to prevent channel migration onto houses or adjacent properties.

5. Revegetation of the floodplain – The City and County should initiate two programs to revegetate the channel and floodplain on Issaquah Creek and major tributaries. The first effort should be to use agency work crews, conservation corps, and other sources of labor to restore native vegetation on all purchased properties and easements. The second program should be to offer technical assistance, materials, and labor to streamfront landowners who are interested in revegetating their property but have opted not to participate in the purchase programs described above (this program is described in detail in BW 22).

6. Improvements in public access – Additional public access and recreational use of the stream corridor should be considered in areas where the purchase of several adjacent properties would provide a contiguous open-space area. Provided that such uses could be accommodated without reducing the quality of fish and wildlife habitat or disturbing adjacent landowners, improvements such as short trails, tables and benches, and other facilities for walking, bird watching, and picnicking should be provided in these areas. It is estimated that three access sites would be acquired and improved in the ten-year life of this program. The King County SWM Division, the Muckleshoot Indian Tribe, relevant agencies, and neighboring land owners should be consulted in the planning and development of these sites.

If this recommendation is approved in principle through adoption of the plan by the Issaquah City Council and the Metropolitan King County Council, the City and County should negotiate an interlocal agreement to define responsibilities for program administration and establish financing mechanisms for the program. Ideally, the program should be funded through a combination of local, state, and federal sources. Potential sources of the local share of funding include existing surface-water capital improvement funds at the City and County or establishment

of a new fund financed by a surcharge on surface water management fees. The City of Issaquah and King County should be responsible for funding the program within their respective jurisdictions.

Discussion: Flooding problems and potential solutions are discussed in detail in the *Technical Appendix 1: Flood Protection Alternatives for the Issaquah Creek Basin* and *Technical Appendix 2: Floodproofing and Removal of Floodplain Structures in the Issaquah Creek Basin,* published in the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan,* published separately. The key findings of the appendices and the basin planning process are:

Flooding is a natural phenomenon in lower Issaquah Creek. Much of the City of Issaquah is built on areas that have historically been flooded by Issaquah Creek and its tributaries. Given the steep headwaters of the upper basin and the broad alluvial plain on which the City is sited, flooding is a natural and inevitable occurrence in the lower reaches of the Issaquah Creek system.

The principal cause of current flooding problems is widespread development of floodplains. More than 350 homes and businesses have been built in floodplains along Issaquah Creek. Modeling indicates that more than 200 of these structures are in areas that are flooded at least every 25 years. Construction in these areas not only places the individual structure at risk but also displaces floodwaters into places that may not have flooded previously.

Upstream development has not caused major increases in flood flows in lower Issaquah Creek. More than 80 percent of the Issaquah Creek basin remains in forest cover and most of the rest is developed at rural densities. While existing development may cause localized flooding, the low level of disturbance associated with current land use throughout the basin indicates that flood flows in lower Issaquah Creek today are likely to be similar to flood flows in the stream prior to basin development. Hydrologic modeling confirms this, indicating that the range of flood flows under current conditions is approximately seven percent greater than the range in flows that occurred when the basin was entirely forested.

Flooding will be aggravated by upstream development in the future. Unless stringent measures are adopted to control stormwater, additional clearing and development in the upper basin will result in substantial increases in the frequency and extent of flooding. Without intervention, some areas that have not flooded previously are likely to flood and flooding will get more severe in other areas of the floodplain.

Using these findings as the foundation of the analysis, the basin planning team evaluated several alternative solutions to downstream flooding problems using three criteria: feasibility, benefits, and costs. The benefit analysis considered both flood protection and environmental benefits, in keeping with the overall focus of the basin plan to not only solve surface-water problems but to also protect and enhance the streams and wetlands of the basin. The cost analysis considered both economic and environmental costs. The overall goal of the analysis was to find a solution to existing flooding problems, assuming that increases in flood flow from

upstream development could be adequately addressed through controls on new construction.

Five alternatives were considered: bypassing flows around the city in pipes or canals, building upstream reservoirs, dredging the channel, floodproofing floodplain structures, and removing homes from the floodplain. The conclusion of the analysis was that **only two of the alternatives – floodproofing and removal of homes – were feasible and provided flood protection and environmental benefits at a reasonable cost.** The dredging and reservoir options were judged to be infeasible due to technical and regulatory constraints and the bypass alternative, while feasible, was very expensive. Please refer to the technical appendix for more information on this analysis.

The floodproofing program is found in BW 8. Controls on flood flows generated by new development are found in BW's 1 through 6.

Estimated Cost: One-time (purchase, floodplain reconfiguration and revegetation) = $14.5 million; Annual (program administration at 1.25 FTE; easement acquisition at 0.25 FTE) = $75,000. The extent of each of the program components will be itemized in subbasin recommendations in the Lower Issaquah (LI 2), East Fork (EF 3), and North Fork (NF 4) subbasins.

BW 8: Establishment of Floodproofing and Elevation Programs

Recommendation: King County and the City of Issaquah should offer technical and financial assistance to residents and business owners within floodplain areas to floodproof and elevate their homes and businesses. The City and County should be responsible for funding the program within their respective jurisdictions. The County should also provide technical assistance in the City. The programs should include:

1. Flood audits – King County Surface Water Management and the City of Issaquah should form a team to conduct structure-by-structure flood audits of homes and businesses within the 25-year floodplains of Issaquah Creek and its major tributaries. The audits, which should be available on request of the property owner, should include a property inspection and survey and would result in a report with recommendations for flood damage reduction. The recommendations for damage reduction should be implemented by the property owner or through the programs described below. Funding for this program should be sought from the Federal Emergency Management Agency, which funded a comparable audit process on the Chehalis and Skookumchuck rivers.

2. Loans for major floodproofing and elevation – King County and the City of Issaquah should establish, for their respective jurisdictions, programs to subsidize no-interest loans to floodplain property owners to floodproof or elevate their homes and businesses. Loan subsidies should be available to owners of all structures within the 25-year floodplain. Loans should be secured through a lien on the property and should be paid off on a payment schedule or prior to the sale

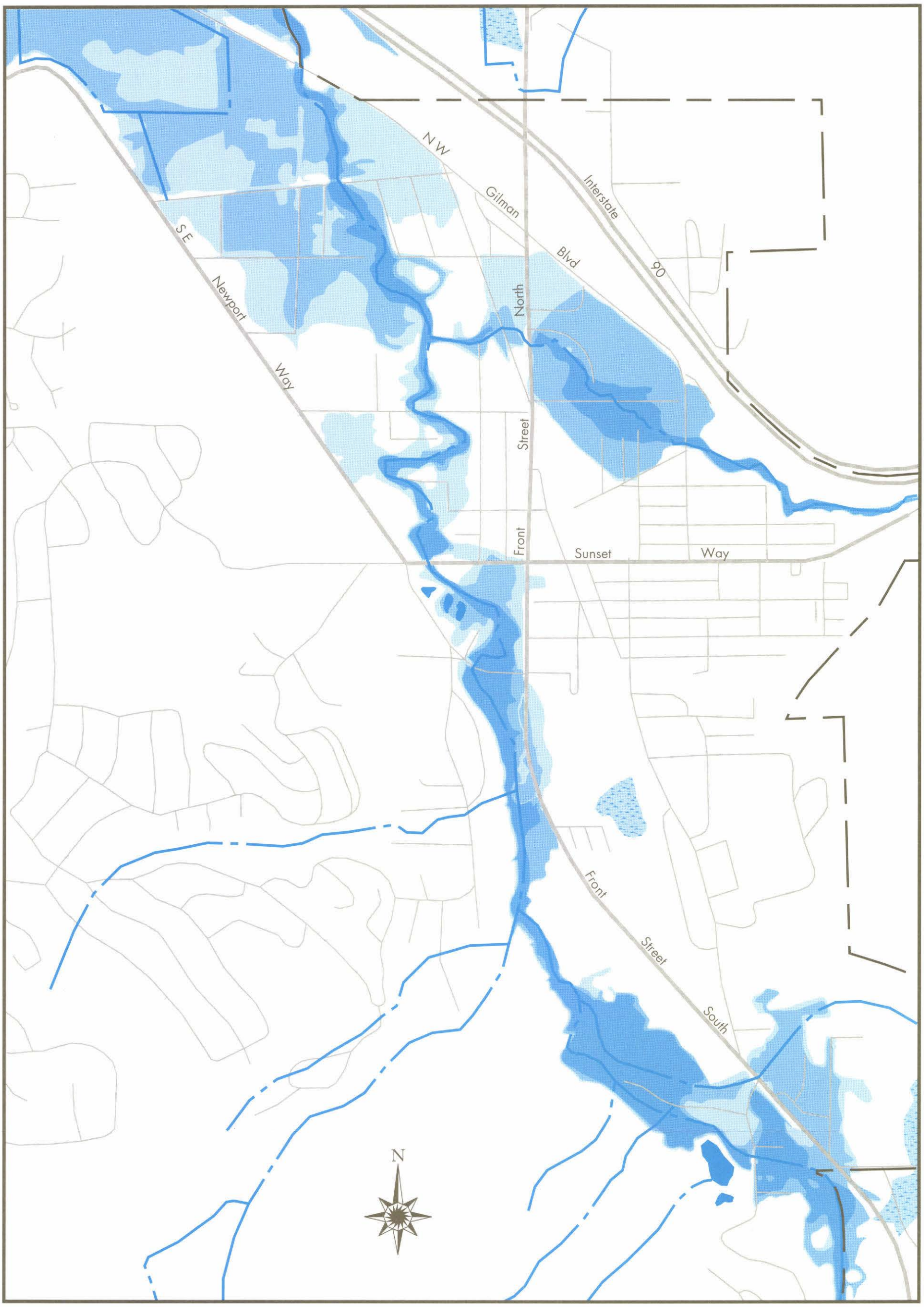
of the property. For homes identified as eligible for public purchase under BW 7, homeowners should be required to include within the lien an agreement to sell the property to the City or County for the appraised fair market value when the property is offered for sale. This is commonly known as a "right of first refusal." A mediation process would be established to resolve disagreements on property value. It is estimated that 286 properties would be eligible for this program, and, for costing purposes, it was estimated that 100 (35%) of eligible property owners would choose to participate in the ten-year life of the loan program.

3. Public floodproofing projects – King County and the City of Issaquah should continue to study potential locations for publicly funded and constructed floodproofing projects, including the construction of setback berms along streams. In certain locations (along the mainstem in particular), the 100-year floodplain is hundreds of feet wide and extends far beyond the 25- and 50-year floodplains (Figure 4-3). There has been extensive development in many of these areas. Berms located at the edge of the 25-year floodplain could reduce flooding in these homes and businesses, and may be possible without significant impacts on channel conveyance and flood elevations. Berms should be sited only in areas where there are no structures between the stream and berm location.

Discussion: As indicated in the discussion on BW 7, floodproofing of structures in the floodplain offers a fairly high level of flood protection at a very reasonable public cost. The cost-effectiveness of floodproofing has the added benefit of allowing the programs above to be made available to a much larger number of floodplain property owners than the purchase and relocation programs described in BW 7.

While floodproofing has many desirable qualities, it is not appropriate as a stand-alone solution to flooding problems in the Issaquah Creek basin. Floodproofed structures in floodplains would be subject to many of the safety hazards, property damages, and consequences to water quality and habitat that are common to homes and businesses in floodprone areas currently. The combination of floodproofing and the removal or relocation of floodplain homes (shown in Figures 4-4 and 4-5) is the only cost-effective solution to provide greater flood protection plus habitat and water quality benefits at a reasonable public cost.

Estimated Cost: Administrative costs are included in BW 7; capital costs are included in subbasin recommendations.



MODELED FLOODPLAINS

Issaquah Creek Basin

Figure 4-3

Figure 4-4 Example Implementation of BW 7 & 8

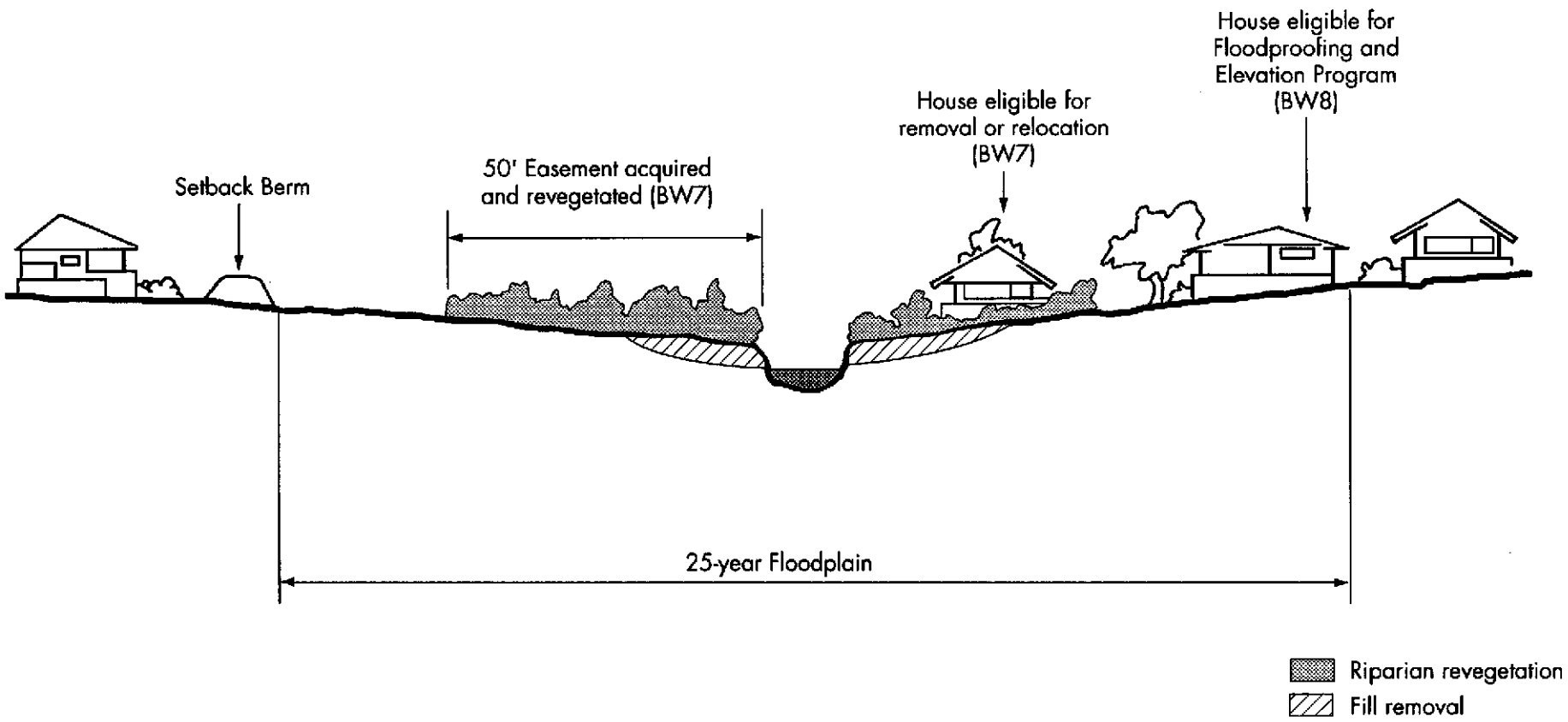
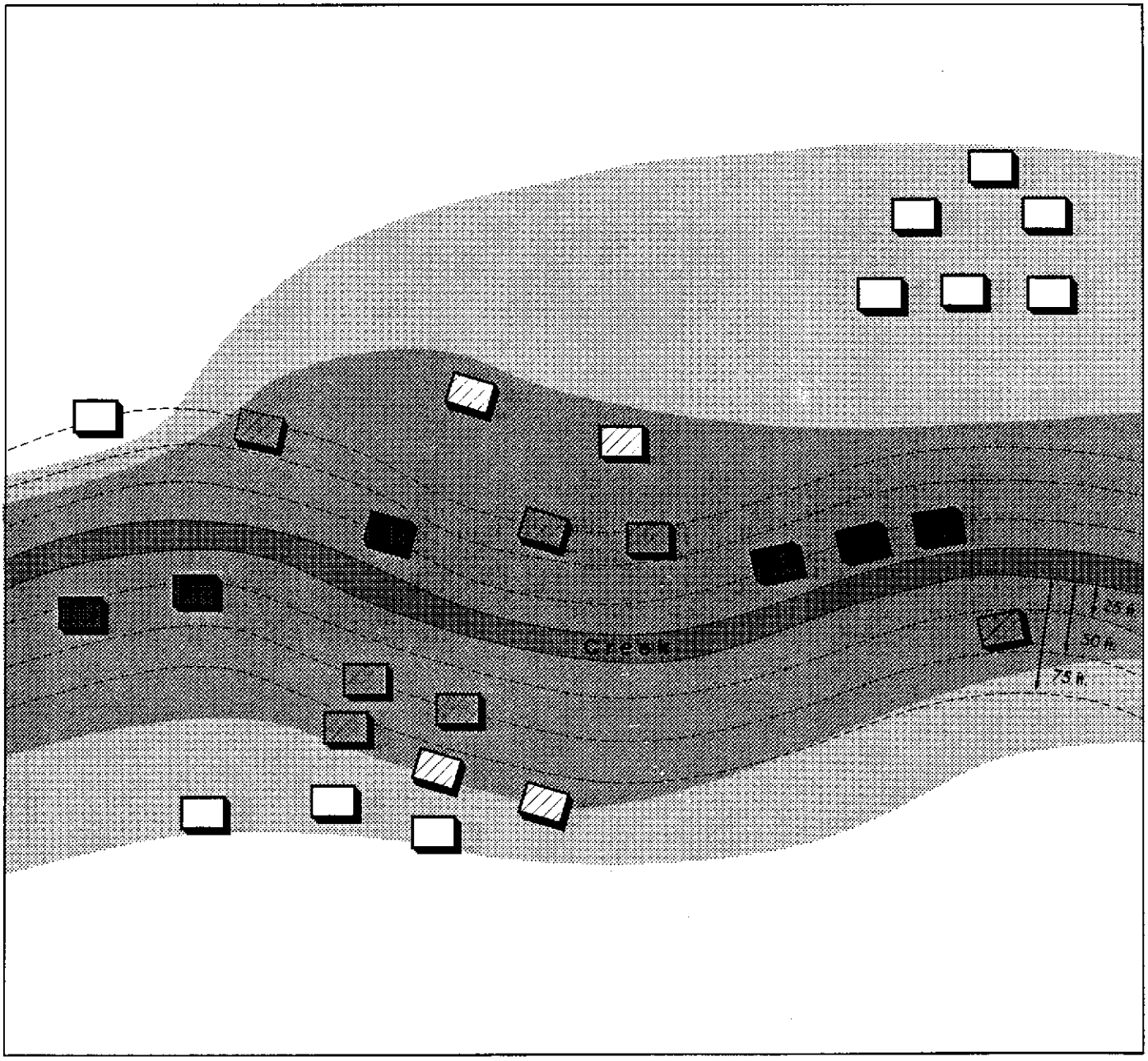


Figure 4-5 Typical Floodplain Plan



High priority for:
Removal or relocation *or*
Floodproofing and elevation (with restrictions)

Eligible for:
Removal or relocation *or*
Floodproofing and elevation (with restrictions)

Eligible for floodproofing & elevation

Ineligible for floodplain programs

25-yr Floodplain

100-yr Floodplain

25 ft. Distance from Ordinary High Water Mark (OHWM)

BW 9: Revision of Floodplain Mapping

Recommendation: In association with the adoption of the Critical Areas Ordinance, the City of Issaquah should adopt, for its floodplain map, the revised floodplain boundaries as defined in the basin plan. This will reflect the more accurate floodplain mapping compiled by King County SWM in the production of this plan. SWM should supply the City of Issaquah with the floodplain map in final form identifying the modeled 25- and 100-year floodplains. In the event that the flood audit recommended by this plan generates changes to this map, those changes should be incorporated by the City.

In addition, the City and County should consider expanding the floodplain modeling as necessary to meet Federal Emergency Management Agency (FEMA) requirements. If such modeling, or analysis of existing modeling, is determined to be feasible, the information should be developed and forwarded to FEMA so that their Flood Insurance Rate Maps (FIRM's) can be adjusted to reflect the more accurate floodplain. The City should be responsible for preparing a letter of map revision, with technical documentation, and submitting it to FEMA. The County should be responsible for providing technical assistance and data from the hydrologic and hydraulic studies.

Discussion: Floodplains for the lower segments of Issaquah Creek, the North and East Forks, and Tibbetts Creek were defined by King County SWM in the development of the basin plan. The basin plan floodplains, which were developed using HSPF hydrologic model and HEC-2 hydraulic modeling, are more accurate than the existing FEMA floodplain maps used in the City of Issaquah's development review processes. The new floodplains are also more extensive than previously drawn, indicating that there are large areas of the city that should be considered as floodprone but are not now designated or regulated as such. Revision of the floodplain maps will ensure that all future development in floodprone areas is recognized and regulated by appropriate standards.

Estimated Cost: One-time = $5,000.

BW 10: Improvement of Flood Warning System

Recommendation: The City of Issaquah Police and Public Works departments and the King County Department of Public Works should improve the existing flood warning system to warn people of flooding conditions in the Issaquah Creek basin. The intent of the warning system is to inform basin residents of hazardous flooding conditions and reduce the potential for injuries.

The improved warning system should include the following two elements:

1. The existing communication network should be improved to better distribute warning information from the King County Flood Warning System (KCFWS) to basin residents and businesses. The KCFWS currently monitors two stream gauges on Issaquah Creek and notifies officials of several City and County agencies when

flooding is likely. The City of Issaquah should take the lead in establishing a telephone tree to distribute this information to residents of floodprone areas of the city. The results of the flood audit (BW 8) would help determine calling priorities for the telephone tree.

2. A permanent signing system along roads within the City and County should be established, notifying residents of likely locations for flooding, the potential for road closures, and alternate travel routes.

Discussion: The flood management programs in this plan will not eliminate flooding in the city and county. The potential for property damage and hazards to human life and health will remain. Fortunately, most of the hazards will continue to be localized in certain discrete areas and could be avoided if people were aware of dangerous conditions. The warning system is intended to notify people of these hazards.

The improved warning system is needed to transmit accurate information on the potential for, and likely severity of, flooding to people who live and work in the Issaquah basin. Similar flood warning programs on major rivers in King County, the first of which was established on the Snoqualmie River in 1959, have proven to be effective at communicating information on hazardous conditions and preventing flood-related injuries.

Estimated Cost: One-time (program setup at .20 FTE) = $10,000; Annual (program administration at .05 FTE) = $2,500.

BW 12: Proposal of Revised Stream Crossing Design Criteria

Recommendation: The King County Roads and Surface Water Management divisions should convene a committee to develop county-wide design standards for the construction of new and replacement structures at stream crossings. The committee should, at a minimum, include representatives of the Washington State Department of Fish and Wildlife; the Muckleshoot Indian Tribe; and King County Environmental, Roads, and Surface Water Management divisions. Committee recommendations should be adopted as revisions to the King County Roads Standards and the King County Surface Water Design Manual. The recommendations should specify criteria and standards to meet the following goals:

1. Crossings should allow unimpeded upstream and downstream passage of salmonids at all life stages at flows up to the 50-year flow for all Class 1 and 2 (with salmonid) streams. "Unimpeded" conveyance refers to the location of the crossing outside of the 50-year flow event without any headwater influences, accounting for predicted future sediment loads and debris considerations. The development of the design standards will be the objective and goal of the committee process.

2. Crossings should allow unimpeded conveyance of runoff and transport of current and predicted future sediment loads and debris at flows up to the 50-year flow.

Discussion: This recommendation is prompted by several problems associated with stream crossings in the Issaquah basin and other similar stream basins. As is the case with many streams in King County, Issaquah Creek and its basin are inherently rich in sediment. The transport of these sediments during storm events results in the deposition of material in culverts and over roadways, creating numerous problems such as culvert failure, flooding, erosion, debris on roadways, and blockage to fish passage. Previous basin plans indicate that these are widespread problems in sediment-rich stream basins throughout King County. Experience also indicates that these problems can be reduced or eliminated by designing and constructing stream crossings to allow unimpeded passage of flood flows, sediment, and fish.

The objective of the committee process will be to develop design standards for stream crossings that accomplish these goals. The other agencies and the Muckleshoot Tribe should be involved to ensure that the standards address the provisions of the King County Sensitive Areas Ordinance (K.C.C. 21.54.300 through .330) and the Revised Code of Washington 75.20, administered by the Washington State Department of Fish and Wildlife.

After the effective date of the King County Surface Water Design Manual and Roads Standards revisions, these criteria and methods should be administered by the Department of Development and Environmental Services (DDES), and used for the design of all Class 1 and Class 2 stream crossings throughout King County.

Estimated Cost: One-time = $20,000.

BW 13: Source Control Practices within Urban Areas

Recommendation: The City of Issaquah and King County SWM should take several actions to reduce nonpoint pollution from sources within the urban areas of the basin. Examples of these sources include pollutants associated with business operations and household activities (e.g., cleaning chemicals, hazardous wastes, pesticides, pet wastes, used motor oil and antifreeze). This recommendation includes the following components:

1. The City of Issaquah, in coordination with the basin steward, other SWM staff, and the Muckleshoot Indian Tribe, should sponsor education and public involvement activities focused on urban nonpoint pollution, including public workshops, storm drain stenciling projects, wetland naming projects, and mailings on nonpoint pollution control to area businesses.

2. SWM should assemble existing educational materials from the King County Solid Waste Division (KCSWD), Seattle-King County Department of Public Health (SKCDPH), Metro, the Muckleshoot Indian Tribe, and WDOE for distribution to

local residents and businesses. In addition, SWM should encourage the distribution of materials on nonpoint pollution using the KCSWD's Waste-Mobile, regular utility or hauler mailings, and newsletter mailings.

3. SWM should take the lead role in organizing and conducting training sessions for developers, permit reviewers, contractors, and businesses on new water quality and environmental requirements (e.g., industrial NPDES permits, K.C.C. Chapter 8.12 Water Pollution Control Requirements). Training should be offered on an annual basis.

4. The Issaquah Department of Public Works should increase the frequency of catch basin maintenance and ensure that oil/water separators are installed and maintained for all automotive businesses and high traffic parking areas associated with new construction (e.g., shopping centers, retail, and food businesses) before discharge to surface waters. During retrofitting of existing drainage systems, oil/water separators should be installed for all existing high traffic parking areas.

Discussion: Currently, all stormwater drainage from the City of Issaquah discharges directly to the Issaquah or Tibbetts Creek systems with little or no treatment. The recommendations above are intended to reduce water quality problems related to these discharges by reducing pollutants at their sources.

Improper waste disposal, materials handling, and storage are common problems associated with business activities in urban areas. In Issaquah, there are 825 businesses that potentially contribute to water-pollution problems. A 1991 survey of 50 of these businesses designed to look for illicit storm sewer connections (the survey included an interview with the manager, a facility tour, a visual inspection of the drainage system, and, in some instances, follow-up dye testing) revealed no illegal hookups. Poor housekeeping practices, however, were found at many sites. These included poor maintenance of dumpster areas, oil spillage and oil residues from automotive businesses, releases of fat and animal by-products from restaurants, and improper storage of inflammable liquids.

The cumulative impacts of these and other sources were illustrated by the fish kills that occurred during 1989 and 1990. High mortality of juvenile salmonids occurred in the North Fork of Issaquah Creek downstream of a storm drain outfall from the city's business district. Although specific sources of the pollutants responsible for these toxic conditions were not identified, they were attributed to the cumulative effect of nonpoint pollutants from the business district.

Estimated Cost: One-time (.38 FTE + materials) = $25,000; Annual (.35 FTE + materials) = $22,500.

BW 14: Control of Pollution from On-Site Septic Systems

Recommendation: The Seattle-King County Department of Public Health (SKCDPH) should enhance current educational efforts, pursue changes to existing

regulations, and identify funding sources for system maintenance and repair to reduce pollution from failing on-site septic systems in the Issaquah Creek basin.

1. Education – Educational efforts should include distribution of brochures and other informational materials to residents, contractors, and design firms on system siting, design, installation, operation, and maintenance. Local utilities could be contacted about obtaining their permission to distribute this information with utility bills. Trade groups should also be kept informed and utilized as distributors of information to the community. These efforts should be targeted towards residents of relatively high-density neighborhoods, areas subject to septic system failure (see Figure 9-3 of the *Issaquah Creek Current and Future Conditions Report,* KCSWM 1991), new home buyers, and areas where abandoned septic systems (after conversion to sanitary sewers) are an ongoing problem.

2. Title 13 Amendments – SKCDPH should evaluate the feasibility of amending Title 13 of the King County Code to require that as-built on-site septic system plans and locations be recorded documents that accompany the title transfer of property. SKCDPH should evaluate the feasibility of amending Title 13 to require that proof of on-site septic system maintenance be sent to SKCDPH every three years. If it is determined that this is feasible, residential units due for maintenance could be notified by SKCDPH three months prior to the end of each three-year period.

3. Incentives for System Repair – SKCDPH should continue to identify and inform septic system owners about sources of public funding for system maintenance and repair. In addition to exploring the use of the State Revolving Fund for these purposes, the agency should inform individuals with failing septic systems of the housing rehabilitation loan program offered through the King County Planning and Community Development Division and the King County Low Income Rehabilitation Program. Specific information on these programs is available through the Housing Hotline.

Discussion: About 5.5 percent of the on-site septic systems in the basin have failed or are failing, releasing bacteria and nutrients into surface waters that threaten public health and degrade water quality. The Issaquah and Tibbetts Creek basins have average on-site sewage system failure rates, and no special corrective actions are indicated with respect to design or siting. Future pollution problems, however, may occur as the density and age of on-site septic systems increase. Therefore, the recommendations focus on public education and ongoing maintenance. Public education programs that emphasize the importance of regular system maintenance will prevent moderate- and low-risk areas from becoming high-risk areas. Additionally, information on funding sources will enable homeowners with limited incomes to get assistance with system maintenance and repair.

The SKCDPH has several ongoing programs to reduce nonpoint pollution from on-site septic systems, including: (1) monitoring the installation and performance of on-site systems through field reviews, (2) mailing as-built drawings of each new system to homeowners during system installation and again after three years, and

(3) enforcing state regulations (248-96 WAC) that require repair of failing on-site septic systems. The above recommendations will supplement these existing programs.

Estimated Cost: One-time (.25 FTE = materials) = $14,500; Annual (0.1 FTE) = $5,000.

BW 15: Improvement of Farm Practices

Recommendation:

1. The recently adopted King County Livestock Ordinance (#11168; KC Chapter 21A.30) could substantially reduce nonpoint pollution in the Issaquah Creek basin by improving animal keeping practices. King County should cooperate with the King Conservation District to encourage early compliance with the ordinance.

To accomplish this, the KCD should hire a conservation plan specialist to work with owners of farms and pasture land in the Issaquah basin to develop and implement conservation plans. The conservation plan specialist should provide technical assistance on best management practices and seek funding to provide grants and loans to farmers and pasture owners to develop and implement the plans. The specialist should also recognize farms that follow approved conservation plans as model farms and should develop voluntary provisions for farm operators without plans to participate in programs to improve water quality on their farms. As part of the process of developing conservation plans, KCD should also develop an inventory of farms in the basin that includes information on farm size, number of animals, subbasin location, and mailing address.

2. In cooperation with the King County Solid Waste Division (KCSWD), SKCDPH, and KCD, SWM should continue to pursue the feasibility of incorporating farm animal manure into the existing KCSWD yard waste composting program, or develop a separate composting program specifically for animal manure. Concurrent with the pursuit of an animal waste disposal program, KCD should provide information to farm and pasture owners about existing manure processing opportunities available in King County.

Discussion: Poorly managed small farms and pastures are a significant source of nutrients, solids, and fecal material in this basin. Pasture management problems include overgrazing, improper spreading and timing of applications of manure, erosion caused by trampling of streambanks and wetlands, and excessive waterfowl on ponds. Limits on livestock access to streams and wetlands can help to reduce the introduction of animal-related pollutants to surface waters.

Poor or inappropriate animal-keeping practices also harm the quality of aquatic habitat in the basin. Streambanks are trampled and riparian vegetation cannot be maintained or enhanced. In such cases, the capability of riparian vegetation to filter out pollutants (sediment, bacteria, and nutrients) is reduced or eliminated, with detrimental consequences to aquatic habitat downstream.

The development of an animal manure disposal program is intended to reduce a significant source of nonpoint pollution originating from improper storage and disposal of animal waste on small farms. The King County Solid Waste Division and 11 cities within the county currently operate a successful yard waste composting program and the feasibility of incorporating animal waste into this existing program has been examined by the KCD. Many of these current collection service providers are eager to accept horse waste into their current composting programs. However, policy regarding acceptable materials (and collection rates) vary from city to city as well as in King County. Additionally, runoff from composting sites handling manure must be managed to prevent the creation of new pollution problems.

The development of a manure composting program would provide an opportunity for animal keepers to dispose of animal waste at a small cost. However, in order to implement animal waste collection and composting county-wide, it is necessary to correct identified problems, provide coordination among existing programs, and receive continued public support.

Existing programs that reduce nonpoint pollution associated with animal-keeping activities include public education, small farm inventories, and technical assistance through the KCD and the Cooperative Extension Service. These programs are limited in funding and rely on volunteer participation by farmers. The programs recommended in this plan will extend technical and financial assistance to many farmers who are not adequately served by existing programs.

Estimated Cost: One-time (plan development and staffing) = $55,000; Annual = $14,500.

BW 16: Establishment of Interagency Procedures for Administering Forest Practices

Recommendation: A memorandum of agreement (MOA) between King County and DNR concerning the administration of forest practices should be negotiated and approved. The agreement should include the following provisions:

1. The DNR should designate the entire basin west of the Timber Production Zone Boundary as an "area likely to convert" and require a Class IV DNR forest practice application (FPA) on any property in this area. This will require that most private forest harvest proposals be reviewed as if the land were going to be converted to other uses and thus require SEPA review, unless the landowner demonstrates his or her intent to remain in long-term forestry.

2. DNR should request King County participation in all watershed analysis projects established to guide timber management in the Issaquah Creek basin. In addition, DNR should invite King County and the Muckleshoot Indian Tribe to participate in formulating harvest plans for state-owned timber lands in the Issaquah Creek basin.

3. King County should assist in monitoring compliance with FPA requirements, and should refer possible violations to DNR for enforcement. DNR should notify King County Resource Planning of FPA violations in the Issaquah Creek basin.

Discussion: Outside of Tiger Mountain State Forest, which is owned and managed by DNR, there is relatively little commercial timber land in the Issaquah basin. Two large parcels in upper Holder Creek are owned by Weyerhauser and Manke Lumber Company, although the Manke property is proposed for conversion into a housing development. There are several smaller timber parcels in the East Fork drainage. All of these areas are subject to FPA regulations, which are administered by DNR.

Given the likelihood of residential development of these parcels at some time in the future, riparian and steep-slope protections for these sites should be consistent with those required for residential development. Timber practices on private land should be viewed as part of a continuous land conversion process. Because King County is the principal regulatory body for the bulk of this process, and has expertise in the analysis of conversion impacts and mitigation strategies, it is logical for the County to take the lead in review of these proposals.

Recent revisions to forest practice regulations mandate the creation of "watershed analysis teams" to guide timber harvest plans within watersheds. In the event that such analyses occur within residential basins of King County, the interests of King County and the Muckleshoot Indian Tribe warrant their participation on the analysis teams.

Estimated Cost: Annual (0.6 FTE) = $30,000.

BW 17: Improvement of Water Quality from Road Drainage Systems

Recommendation: The Washington State Department of Transportation (WSDOT), King County SWM and Roads Divisions, and the City of Issaquah should take several actions to reduce nonpoint pollution from road runoff and road-maintenance activities. These actions should include the following:

1. Memorandum of Understanding (MOU) – An MOU should be developed among the County, State, and City of Issaquah to establish a program to evaluate road-runoff impacts, implement source-control BMP's, and retrofit stormwater drainage systems as needed for water quality and quantity control. Each agency should perform a survey of its road-related drainage systems and outfalls to evaluate the need for implementing or improving source-control BMP's and to determine the potential for retrofitting drainage systems to improve water quality. The surveys should include a review of existing water quality and quantity data, site visits, and hydraulic reviews of the drainage systems. Retrofitting of existing road drainage systems for water quality treatment should be evaluated in conjunction with all road widening and improvement projects. Each agency should pursue funding to perform surveys, improve source control, and retrofit the systems where feasible.

2. Maintenance – Each agency should review and update its maintenance procedures for road-related drainage systems to minimize the impacts of maintenance activities on water quality. Programs should be reviewed to ensure there is adequate funding of maintenance programs. Where fish-bearing streams flow in roadside ditches, specific maintenance plans should be developed by King County Roads and SWM divisions. WSDOT should implement maintenance procedures being developed for the Highway Runoff Manual as part of WAC 173-270. Maintenance procedures for all agencies should be flexible enough so that specific basins can be targeted for special maintenance.

3. Vegetation Management – Each agency should work with sewer, water, and electric power utilities to evaluate and implement mechanical cutting and other non-toxic vegetation control methods, such as integrated pest management and adopt-a-ditch programs, instead of herbicides. When necessary to control noxious weeds or problem areas, herbicides should be used in accordance with RCW 17.10 and WAC 16-750 (roads and utility rights-of-ways). Specific herbicide use by utilities and private operators should be recorded with SKCDPH as a matter of public record.

4. Construction – Each agency should comply with all applicable erosion, sediment, and pollutant control requirements (equivalent to the Stormwater Management Manual for the Puget Sound Basin) for all road or facility-related construction projects (e.g., road widening, new road construction, construction of conveyance pipes or water quality facilities).

Discussion: There are numerous places in the basin where runoff from State, County, and City roads is discharged into the stream systems with little or no treatment. For example, on the 4.5-mile section of Interstate 90 along the East Fork, there are more than 50 outfalls where untreated road runoff is discharged. In the unincorporated portions of the watershed, there are numerous roadside ditches that discharge directly to surface waters. In the City of Issaquah, there are approximately one dozen outfalls that discharge untreated road runoff to the Issaquah and Tibbetts Creek systems. Individually these discharges may be insignificant, but the cumulative effect of this untreated stormwater from roads discharging to stream systems can be substantial.

King County and WSDOT are addressing water quality associated with road runoff as part of the NPDES permit program. The City will likely participate in the NPDES program in the future as the program shifts to a watershed focus. With greater emphasis being placed on watershed-based programs, there is a need for increased coordination and cooperation between different jurisdictions responsible for stormwater runoff from roads. The recommended MOU will help to facilitate this coordination so that evaluation efforts, source-control BMP's, and retrofitting of existing drainage systems can be carried out cost-effectively.

Proper maintenance of stormwater collection, conveyance, and treatment systems can help improve the water quality of road runoff discharging to the stream systems of the basin. This includes both the type and frequency of maintenance activities. Ongoing efforts to improve maintenance procedures and manuals will

help reduce impacts to receiving waters. In particular, increased use of vegetation and biofiltration can be effective for water quality treatment. The frequency of maintenance could also be increased in priority basins to optimize limited resources.

Stormwater collection and conveyance facilities such as ponds, catch basins, pipes, and ditches collect solids typically containing high concentrations of metals, petroleum hydrocarbons, oil and grease, and synthetic organics. These solids often exceed environmental criteria or standards, requiring disposal in specialized treatment facilities. Such facilities are designed to prevent residual materials from contaminating surface waters or groundwater. Coordination should continue between the County, WSDOT and the City on the *Interjurisdictional Decant/Sediment Disposal Plan* (WDOE Centennial Clean Water Fund grant) project currently managed by the SWM Division. This project will result in the siting and design of a treatment facility in or near the basin.

Construction site runoff from roads projects can result in sediment and other pollutants discharging to drainage and stream systems. By focusing efforts on erosion and sediment control (according to current requirements), it is possible to reduce substantially sediment losses from construction sites.

Estimated Cost: One-time (survey) = $60,000; Annual (improved maintenance at .4 FTE) = $20,000. No capital costs estimated for improvements.

BW 18: Development of a Spill Response Program

Recommendation: The City of Issaquah, in coordination with King County Roads and SWM divisions, and local (City and Fire District 10) fire departments should develop a coordinated spill response plan and team to prepare for and respond to spills in the Issaquah Creek basin. The spill response program should focus on two main areas:

1. Highway Spill Response Program - The City of Issaquah (fire and public works departments) should participate in the spill response program for Interstate 90 currently coordinated between WSDOT and WDOE. The City's proximity to Interstate 90 and the East Fork of Issaquah Creek would enable the City to respond quickly to spills in order to provide preliminary containment, thus protecting the East Fork and the groundwater resources of the area.

2. City/Basin Spill Response Program - The City of Issaquah, in coordination with King County and Fire District 10, should develop a spill response program for the City and the Issaquah Creek basin to improve response times for large spills, and provide cleanup for small spills (0-5 gallons). This program should be coordinated with WDOE's ongoing spill response program.

The initial program should include the following elements: training of fire department personnel in spill response (the minimum level of training for off-site emergency responders is defined in WAC 296.62.300-3112); purchasing spill

containment materials (absorbent, lights, polyethylene, booms, etc.); and establishment of a contract with a clean-up contractor for large spills within the City and the basin.

Discussion: WDOE is the coordinating agency for spill response and cleanup for hazardous and non-hazardous spills. WDOE works closely with local government (usually fire and public works departments) in responding to spills. On State highways and roads, WDOE coordinates with WSDOT's Incidence Response Team. This coordination with local government and other State agencies is critically important for spill response, because response time often determines the success of spill containment efforts. The establishment of contract with a clean-up contractor can help reduce response time.

Currently, the Issaquah Fire Department has no written protocol for hazardous materials and relies on the Bellevue hazardous materials team to respond to spills. The Issaquah Public Works Department has minimal cleanup materials due to budget constraints and relies on the Bellevue team and the Metro Trouble Call-Emergency Response Manual protocol for handling spills. This recommendation seeks to improve the City's current program through acquisition of necessary spill response equipment and training of staff for spill response. By developing a program to respond to and clean up spills, it will be possible to prevent degradation of surface and groundwater resources and protect public health.

Estimated Cost: One-time (study, training, and materials) = $25,000; Annual (program administration at .1 FTE) = $10,000.

BW 19: Water Quality Treatment Design Standards

Recommendation: The water quality treatment design standards of the King County Surface Water Design Manual are currently being updated. Following the update, developments in the Issaquah and Tibbetts Creek basins should be required to meet the proposed lake protection water quality treatment requirements for phosphorus removal (50% removal).

Prior to revision of the *Design Manual*, new developments in the Issaquah Creek basin that require drainage facilities under the current *Design Manual* should achieve phosphorus removal using one basic water quality facility (water quality swale or filter strip, sand filter, wet pond designed using a 2/3 of the 2-year, 24-hour storm, combined R/D and wet pond, constructed wetland, or infiltration) followed by an infiltration facility or sand filter. The second facility can be eliminated if some combination of site design alternatives are used that reduce the increase in phosphorus from a developed site. These include: native vegetation (e.g., forest) retention, extra detention, diversion of road runoff to pervious areas, and covered parking for multifamily or commercial developments. If site conditions allow for the construction of a single large wetpond or combined R/D and wetpond designed with a Vb/Vr ratio equal to 4.5, this can replace the two facility option. Finally, if it can be demonstrated by the applicant that an alternative facility

or combination of facilities is equally effective for phosphorus removal, then a variance request from this requirement can be submitted to the SWM Division for approval. Until the revisions are made to the Design Manual, guidance for the facility designs are available from the SWM Division.

SWM should continue to monitor the effectiveness of water quality treatment facilities through ongoing programs such as the Lake Sammamish Water Quality Management test projects and SWM's BMP monitoring program. SWM should incorporate the information from these studies into future updates of the Design Manual. As new treatment technologies are developed and current designs are improved, the water quality design standards should be updated to reflect the new information.

Discussion: Phosphorus control from developing lands has been identified as one of the key water quality goals for protecting the basin's surface-water features and Lake Sammamish from beneficial use impairment. Specifically, the Lake Sammamish Water Quality Management Project Technical Report (1989) identifies phosphorus control from new development as a key component for the protection program for Lake Sammamish. Because approximately 70 percent of the inflow to Lake Sammamish comes from the Issaquah Creek basin, it is important to minimize increases in phosphorus loading from this source

The effectiveness of water quality treatment facilities in controlling phosphorus and metals is currently being evaluated through the Design Manual update and several studies as noted above. The effectiveness of biofiltration systems, wet ponds, soil infiltration systems, constructed wetlands, sand filtration, alum treatment, and various combinations of these systems are being examined. The information generated from these projects will be used to develop and refine further the water quality treatment design standards applied in the Issaquah basin.

Estimated Cost: Covered by existing programs.

BW 20: Additional Water Quality Recommendations

Recommendations: The following additional water quality recommendations are proposed to address specific nonpoint source pollution problems (*see Chapter 6: Nonpoint Water Pollution*) not covered in BW's 13 through 19.

1. Seminar for Boaters and Lakeside Residents – The Washington State Parks and Recreation Commission and the Seattle-King County Department of Public Health, in cooperation with the King County SWM Division and Save Lake Sammamish should conduct an annual seminar to educate users of the Lake Sammamish State Park boat launch and lakeside (resident) users about their impact on lake water quality. The seminars should include information about proper sewage and garbage disposal, and the effects of oil, grease, gas, paint, and solvent residues on the lake.

Estimated Cost: One-time (workshop development) = $3,000; Annual = $1,000 + volunteer hours.

2. Sensitive Areas Brochure – The King County Environmental Division should prepare a brochure that describes and simplifies Sensitive Areas Ordinance requirements and tax relief programs. The brochure should be sent out by the King County Assessor with property tax statements. The brochure would help educate property owners about the types of activities that are allowed or prohibited on their land, particularly as related to buffer requirements and protection of aquatic resources.

Estimated Cost: One-time (brochure development and mailing) = $15,000.

3. Workshops on the Basin Plan – Upon adoption of the basin plan, the SWM Division should conduct workshops with contractors, developers, basin residents, and County staff (DDES, SWM and Roads divisions, SKCDPH, Community Planning) to provide education about the newly adopted basin plan requirements.

Estimated Cost: Covered by existing programs.

4. Use of Low Phosphorus Products – In accord with the phosphorus reduction goals for the Lake Sammamish Water Quality Management Plan, the City of Issaquah should encourage local business participation in a voluntary program to promote the sale and use of soaps, detergents, and organic lawn fertilizers that contain little or no phosphorus in areas that drain to Lake Sammamish.

Estimated Cost: One-time = $5,000; Annual = $2,500.

5. Business Compliance with NPDES Requirements – Businesses currently operating in unincorporated King County should ensure that they are in compliance with the water pollution control requirements specified in K.C.C. Chapter 8.12. The new King County Best Management Practices (BMP) manual (scheduled for completion in mid-1994) or the Stormwater Management Manual for the Puget Sound Basin provide information on the implementation of BMP's. Businesses that are required to get a permit from the Washington State Department of Ecology under the National Pollutant Discharge Elimination System (NPDES) industrial permit program should be in compliance. This includes the development of a pollution prevention plan by July 1994, and implementation of source- and treatment-control BMP's by July 1995 and 1996, respectively.

Estimated Cost: One-time = $7,000; Annual (monitoring, enforcement) = $4,500.

6. Stormwater Discharges from the Constructed Drainage Network – In response to requirements of the NPDES permit program, SWM and the City of Issaquah should inventory and map the constructed drainage network to trace sources of pollutants from developed areas to receiving waters. The major discharge points should be screened periodically during dry weather conditions for illicit, or non-stormwater, discharges. Pollutants discharging to receiving waters from the

constructed storm drainage system should be reduced to the maximum extent practicable using source- and treatment-control BMP's.

Estimated Cost: One-time (study and mapping) = $20,000.

7. **Information on Commercial Pesticide Applicators** - The Washington State Department of Agriculture (WSDA) should collect, monitor, and make available to SKCDPH (and other interested agencies) data regarding licenses issued to commercial pesticide applicators. Within legal constraints, and upon request by SKCDPH, information should be made available on the type of chemical applied, quantities, location of application, potential for public health effects, and emergency measures in case of poisoning or spills.

Estimated Cost: Covered by existing programs.

8. Secondary School Outreach - The SWM division, in association with the City of Issaquah, should annually conduct half-day secondary school education efforts to inform students about water quality issues. The program should be targeted at the appropriate grade level and carried out at all public schools in the Issaquah Creek basin. Other interested parties, such as the Muckleshoot Indian Tribe, the King Conservation District, and DNR should participate in this effort.

Estimated Cost: Covered by existing programs.

Total Estimated Cost of 1 through 8: One-time = $50,000; Annual = $8,000.

BW 21: Designation and Protection of Significant Resource Areas

Recommendation: King County, the City of Issaquah, and other relevant agencies should recognize and protect Significant Resource Areas (SRA's) in the Issaquah basin. SRA's are defined as aquatic or terrestrial habitats that are important to the viability of plant and animal species and populations because of the species' or population's value as a biological and social resource. Areas may be "Regionally Significant Resource Areas" (RSRA) or "Locally Significant Resource Areas" (LSRA) based not only on their intrinsic condition and value, which is typically related to the size, complexity, and functional attributes of the habitats, but also on the size, functional condition, and structural complexity of the surrounding watershed. These external elements depend largely on the existing degree of disturbance caused by development activity in and around the habitat and its basin. Detailed recommendations on protection of specific SRA's are found in the subbasin recommendations chapter. Further descriptions of the criteria and effect of designation can be found in *Appendix D: Significant Resource Areas* published in the *Appendix to the Issaquah Creek Basin and Nonpoint Action Plan.*

In the Issaquah basin, the following areas have been recognized as SRA's during the development of this plan (Figure 4-7):

Regionally Significant Resource Areas: Holder and Carey Creeks and their major tributaries; Issaquah Creek from the Holder-Carey confluence downstream to the confluence with Fifteenmile Creek; and North Fork Wetland 7 and Issaquah Creek Wetlands 1, 2, 18, and 19.

Locally Significant Resource Areas: Issaquah Creek from its confluence with Fifteenmile Creek to its mouth; Fifteenmile Creek; the East Fork of Issaquah Creek; and Wetlands North Fork 5 and Issaquah 10, 22, and 60.

The general approach to protection of SRA's in the Issaquah basin is to preserve both the structure and the functions of the area. Although SRA's themselves are specific wetlands, shorelines, streams, or other habitats, their function and structure depend on conditions often far-removed from their immediate boundaries. Two levels of these physical conditions are thus defined: **catchment** conditions, which affect the rate and volume of runoff, groundwater movement, water chemistry ("quality"), and sediment delivery; and **local** or adjacent conditions, which determine the degree of bank and buffer vegetation, the magnitude and frequency of human intrusions, and the presence of structural elements (such as large woody debris in streams and snags in wetlands).

Regionally Significant Resource Areas are highly dependent on both catchment and local conditions for their quality and integrity. Therefore, the RSRA's in the Issaquah basin must be protected through both catchment-level and local-level protection actions. Catchment-level actions apply to the entire tributary area and the drainage areas that drain to the tributaries, and they may include land-use restrictions or special detention standards among other controls. Local-level actions focus on areas adjacent to the feature and include such tools as fixed-width buffers (such as those prescribed by the SAO) and additional restrictions targeted to specific landscape features such as adjacent steep slopes, wooded areas, or swales.

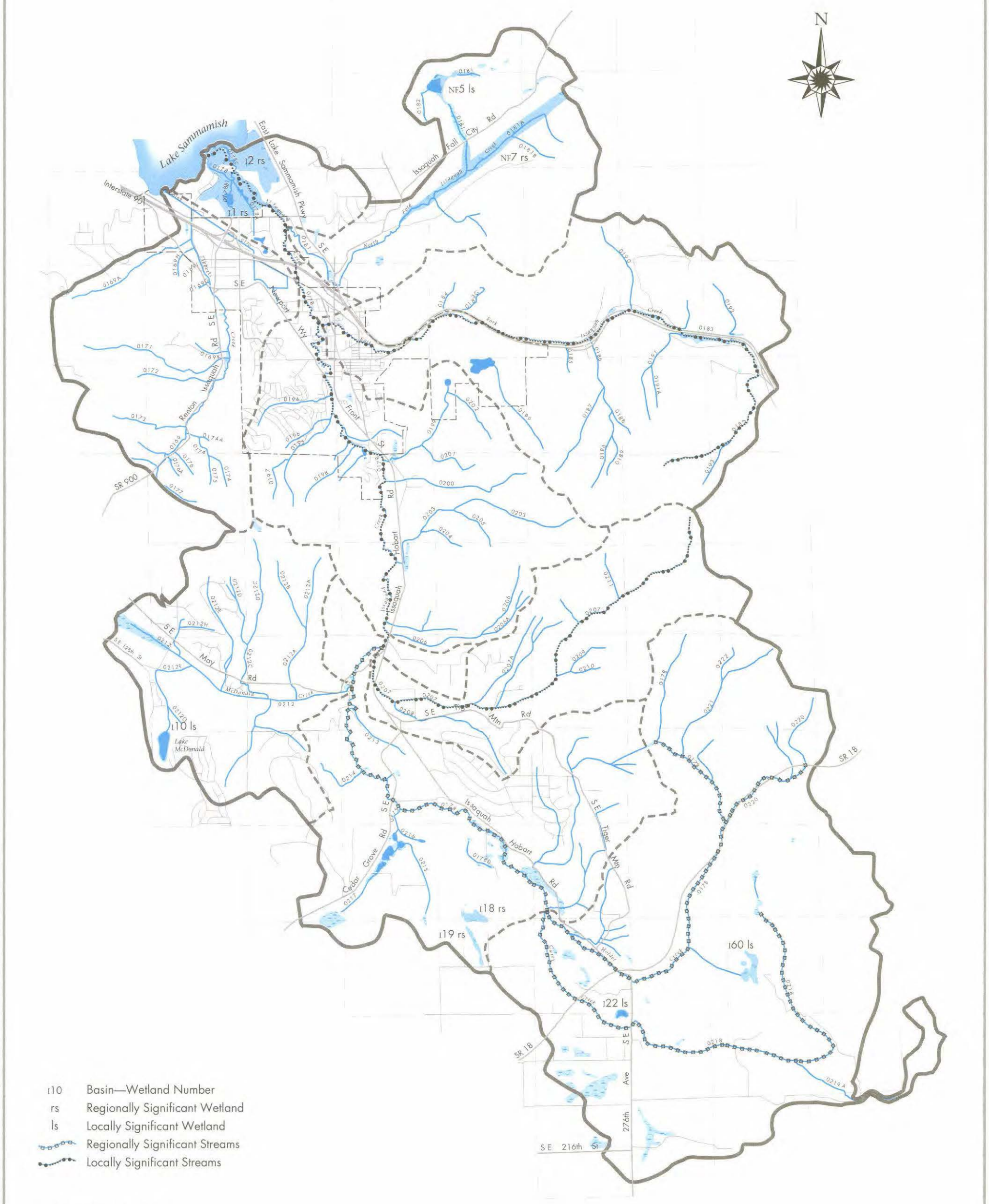
Discussion: The intended result of the designation and protection of SRA's is to minimize the effects of urban development and other disturbances on the functional and structural integrity of significant streams, wetlands, and riparian habitats within the basin. By doing so, the mosaic of habitats that support various plant communities, fish, other wildlife, and good water quality can be maintained for many decades. In addition, the potential damage associated with pollution, flooding, erosion, and sedimentation can be greatly reduced. Each stream reach designated as an SRA possesses unique conditions that are the result of processes that occur within the channel itself, within the adjacent riparian area, and across the landscape of the subcatchment. Protection of these conditions—more specifically of the processes that lead to the habitat conditions—depends on our ability to mitigate for various effects that alter these processes. Management programs within each RSRA or LSRA reflect the scale of dominant processes, and of our ability to mitigate effects imposed by changes in land use, habitat alterations, and the behavior of individuals.

The full functions of an aquatic system can be preserved or restored only through attention to both catchment and local levels of conditions and mitigation. No

degree of attention to local conditions alone can mitigate for a degraded catchment. This fact is reflected in the existing County drainage code, where on-site stormwater detention and water quality treatment is required for virtually all development, irrespective of distance between the edge of the development itself and the downstream water body.

However, catchment-level mitigation is often costly or burdensome; in many cases preexisting development renders more extensive efforts futile or ineffectual. As a result, this broadest level of resource protection has been recommended to exceed existing County codes only for RSRA's and less degraded LSRA's, choosing only those settings where the likelihood of successfully maintaining or recovering long-term resource function is high. More localized resource-protection measures have been recommended for LSRA's and RSRA's alike.

Estimated Cost: Itemized in relevant basinwide and subbasin recommendations.



REGIONALLY and LOCALLY SIGNIFICANT RESOURCE AREAS

Issaquah Creek Basin

Figure 4-7

BW 22: Development of Habitat Restoration and Enhancement Program

Recommendation: King County Surface Water Management should initiate and finance a program for completing small, simple habitat restoration projects throughout the Issaquah Creek basin. The program should focus on the installation of projects that require simple materials and manual labor, to complement the use of existing County and City of Issaquah capital improvement programs for more complex projects. Activities under this program should include small-scale bank stabilization, removal of non-native plants, revegetation of streams and wetlands, and other similar projects. The program should have the following characteristics:

Labor force – The program should use semi-skilled labor forces, such as those available through a conservation corps or trained volunteer groups, whenever possible. City and County work crews should supplement these workers only as needed to perform elements of the projects that require more highly skilled workers.

Eligibility and identification of projects – Assistance under the program should be available to public agencies and to private landowners with appropriate projects to restore or enhance aquatic and riparian habitat. SWM staff have developed and applied a convention in the Issaquah plan and other basin plans to identify simple, small-scale habitat projects using the XX99 numbering system. Most of these will be suitable for this new program.

Program management – The program should be managed by a team composed of the basin steward, SWM scientists and engineers, and local project co-sponsors.

Budgeting and funding – The program should be funded through a combination of SWM bond and fee revenues, grants, and contributions from project co-sponsors. Projects on private land should require a match of materials, funding, or in-kind assistance from the property owner.

Discussion: One of the major themes of the Issaquah Creek plan is restoration of aquatic and riparian habitat. The restoration program has several facets: removal of homes and restoration of the floodplain in the city, establishment of revegetation requirements in dedicated open-space tracts, and completion of individual restoration projects at specific sites. The individual restoration projects vary greatly in size and complexity, with simple, smaller-scale projects being numerous and widespread throughout the Issaquah Creek basin. These include recommendations for revegetation of channel and floodplain areas, removal of non-native species from wetlands, and simple bank stabilization projects.

The standard County techniques for constructing capital improvement projects have been developed with complex drainage and water quality facilities in mind, where a high level of sophistication is needed in project design, financing, and construction. Currently, many of these same techniques are used to develop small habitat projects; the resulting project costs are higher and progress is slower than desirable. The focus of the recommended program is to (1) decrease costs for

labor and project administration, and (2) speed the implementation process by simplifying design, construction, and administrative processes.

Estimated Cost: One-time (staff + materials) = $82,500; Annual (staff + materials) = $75,000.

BW 23: Establishment of Bank Stabilization Program

Recommendation: King County and the City of Issaquah should cooperate to establish a new program to encourage the use of soil bioengineering techniques for stabilizing eroding streambanks in the Issaquah Creek basin. This fulfills plan goals to promote environmentally sound techniques for bank stabilization and to restore aquatic habitats. The bank stabilization program should consist of three elements:

1. Development and distribution of technical assistance materials for streamside landowners and a design manual for engineers. These materials should be produced by King County SWM using information compiled for the bioengineering manual for large rivers.

2. Adoption of standards for bank stabilization work that would require the use of bioengineering techniques wherever possible. The standards should also limit the emergency use of riprap and concrete by requiring that all such materials, if installed at all, be temporary and replaced within two years using soil bioengineering techniques. Changes in standards should be undertaken by the City of Issaquah, King County, and the Washington Departments of Fish and Wildlife after review of the new standards by these agencies and the Muckleshoot Indian Tribe.

3. Adoption of requirements that all City and County public works or similar projects in stream corridors employ bioengineering methods for bank stabilization wherever possible.

Discussion: The need for bank stabilization is an inevitable outcome of development too close to Issaquah Creek and its tributaries. The streams naturally meander across their floodplains, eroding streambanks and depositing sediments in a constantly changing pattern. Development near these stream channels has had two effects. First, it has resulted in structures that are within these meander zones and that can be threatened by the natural migration of the stream. Second, the protection of individual structures through riprap, concrete, and other attempts at bank armoring has caused considerable damage to aquatic habitat while potentially increasing the propensity of the stream to meander upstream and downstream of the armoring.

The only complete solution to these problems is to prevent additional development in channel migration zones and remove the structures that have already been built in such areas. While this would be complementary with the flooding solutions discussed in flooding goals 1, 2, and 3, it is unlikely to occur

soon. In the interim, techniques must be found that provide control over bank erosion without sacrificing aquatic habitat.

The bioengineering methods that are recommended provide the habitat protection and restoration that is desired with the structural protection that is required. The use of vegetative techniques for riverbank protection and stabilization has a long history in Europe. The U.S. Army Corps of Engineers has developed various techniques using plant material and geotextile fabrics for bank protection and King County SWM has prepared a manual for river management using similar techniques. Although originally intended for moderate to large rivers, these techniques seem to be particularly beneficial for streams the size of Issaquah Creek where the provision of streamside vegetation has significant benefits for in-stream habitats.

Estimated Cost: One-time (publications and regulatory changes) = $45,000; Annual (program administration and staffing at .2 FTE) = $10,000.

BW 24: Establishment of Issaquah Fishery Management Task Force

Recommendation: King County Surface Water Management should convene a task force composed of all parties with stock or habitat management responsibility for Issaquah Creek to develop a management plan for salmon in the Issaquah Creek watershed. The plan should address issues including:

1. Future management of the Issaquah Salmon Hatchery.

2. Potential for additional escapement of spawning salmon to the upper basin.

3. Habitat protection and restoration in the basin.

4. Research and data collection needs: habitat, limiting factors.

5. Consistency with fishery management goals and programs in the entire Lake Washington basin.

The task force should, at minimum, include representatives of the National Marine Fisheries Service; the U.S. Fish and Wildlife Service; Washington Departments of Fish and Wildlife (WDFW) and Ecology (WDOE); the Muckleshoot Indian Tribe; King County Surface Water Management and the Environmental Divisions; the City of Issaquah; and Friends of Issaquah Salmon Hatchery (FISH). Implementation of task force recommendations pertaining to fishery management will be contingent on approval by the WDFW and the Muckleshoot Indian Tribe, the agencies responsible for co-management of salmon and trout in this area.

If possible, agency representatives should be the same as those on the Lake Washington Ecosystem Research group to ensure that the Issaquah system is examined in the proper context of the larger Lake Washington system, of which it is a critical part.

Discussion: This recommendation is motivated by two issues. First, the conditions analysis in the basin planning process indicated that the abundance and quality of spawning and rearing habitat in the upper Issaquah Creek basin are sufficient to support more salmon than are currently allowed to migrate upstream of the Issaquah Salmon Hatchery. Second, the deterioration of the facilities and problems with water quality have led the Washington Department of Fish and Wildlife to propose that the hatchery be closed. While the Department has relented due to public outcry over the closure, the future of the hatchery remains uncertain.

The task force process will convene all of the agencies and tribes with roles in fishery and habitat management to discuss how to respond to these issues. Among the options that have already been discussed are changes in the hatchery mission to emphasize education, rare stock recovery, and/or research. Any of these options may provide the opportunity to allow more salmon to spawn naturally in the upper basin. Ultimately, any recommendations that would affect the fishery of Issaquah Creek or of the Lake Washington basin as a whole would require state and tribal approval.

In comments on a previous draft of this recommendation, the Muckleshoot Indian Tribe emphasized the need to develop a baseline of information on the salmon use in the Issaquah Creek system in order to gauge the effectiveness of fishery management actions. The planning team concurs with this recommendation, and the initiation of projects to collect baseline information should be a top priority of the task force.

Estimated Cost: One-time (.6 FTE) = $30,000.

BW 26: Completion of Wetland Inventory

Recommendation: To improve the protection of wetlands and associated aquatic resources such as streams and water quality, the King County Environmental Division, with the assistance of the King County Surface Water Management Division and the City of Issaquah, should complete field data collection and classification of wetlands throughout the basin planning area in order to prepare a unified and comprehensive inventory of wetlands in the Issaquah Creek basin.

The recommended inventory work will be used to update the two existing wetland inventories: the King County Wetlands Inventory and the City of Issaquah Wetlands Inventory.

Discussion: Wetlands are a critically valuable resource in the Issaquah Creek basin. Protection of wetlands is essential in order to maintain, and restore valuable functions such as flood storage and stormflow attenuation, water quality purification, groundwater exchange, streamflow maintenance, and fish and wildlife habitat.

A major factor contributing to loss of wetlands in the Issaquah Creek basin is inadequate information about the location and characteristics of wetlands,

particularly the forested, headwater, and riparian systems, which are not well-documented in the National Wetlands Inventory. The reason for this is that such systems typically are not readily distinguished using infrared aerial photography, on which the National Wetland Inventory is based. Thus definitive identification of these systems requires on the ground field surveys.

Effective implementation of the basin plan programs and enforcement of wetland regulations requires that information about the wetlands in the Issaquah and Tibbetts basins be as complete as possible. A basinwide wetlands inventory and the resulting maps and computerized database, which would be made available to the City, are critical to wetland protection efforts. Without this information, wetland and other water resource losses will continue.

Estimated Cost: One-time (survey and documentation) = $27,500.

BW 27: Aquatic Resource Mitigation Banking

Recommendation: In order to incorporate the Issaquah Creek basin into the emerging county-wide program for mitigation banking, SWM should complete the following tasks:

1. Inventory and evaluate potential banking sites. A basinwide inventory should be compiled using existing data. Sites already identified, including the lower reaches of tributary 0203 and North Fork Issaquah Creek Wetland 7, should have functional assessments completed and be analyzed further to determine mitigation actions and costs.

2. Identify upcoming development projects. Public agencies with potential construction projects within the basin should be queried to determine the likelihood for projects suitable for mitigation banking.

3. Acquire and restore sites that are suitable for mitigation banking. Based on the anticipated needs for mitigation banking, appropriate sites should be purchased and restored. Reimbursement of capital costs will occur as a condition for permitting of the relevant project or projects.

Discussion: A mitigation banking pilot program has recently begun in the East Lake Sammamish basin. If successful, the program will probably expanded into a county-wide effort. Mitigation banking is an innovative approach to the permitting process for a proposed construction project, in which a permitting agency associated with a project may opt to have the construction agency contribute to an off-site mitigation project in lieu of typical on-site mitigation measures. When applied to habitat restoration, mitigation banking accomplishes two things: (1) it provides a way to compensate for habitat disturbance on a construction site with the restoration of higher quality habitat in off-site areas, and (2) it provides a mechanism to substitute a single, large restoration project for many smaller restoration projects. The benefit of this approach is that restoration efforts can be

targeted to stream and wetland habitats that are larger and have greater potential for restoration.

Several promising sites for mitigation banking have already been identified in the Issaquah Creek basin. Identifying mitigation banking needs and evaluating other sites will allow the mitigation banking program to be initiated in the Issaquah basin as quickly as possible.

Estimated Cost: One-time (.63 FTE) = $31,500.

BW 28: Identification of Channel-Migration Hazard Areas

Recommendation: King County SWM and the City of Issaquah should prepare assessor-scale maps that designate the areas of the Issaquah Creek system that are subject to channel migration. If necessary both jurisdictions should adopt regulations to ensure that such areas remain undeveloped. Such restrictions should require that applicants for development within these areas conduct site-specific studies to determine the setback necessary to achieve adequate safety, without bank armoring, before construction can proceed.

Discussion: Along several reaches of the East Fork, Tibbetts, and mainstem Issaquah Creek, channel shifting is readily apparent from sequential aerial photographs. The most rapid shifting has occurred on the mainstem, particularly near the mouth of Issaquah Creek, above the Sycamore development between RM 5.5 and 7.6, and along much of the Middle Issaquah subbasin. Although most of the areas of past or plausible future channel encroachment are fully contained by the 100-year floodplain or the Sensitive Areas Ordinance 115-foot channel-setback and buffer, in some locations the chance of future impacts to otherwise unconstrained property is high.

Three distinct, yet related, development conditions are found in channel-migration zones. The first consists of existing structures that are within the boundaries of the 100-year floodplain. They are at obvious risk of inundation; they also may suffer from scour and collapse during such flows. The second condition includes those existing structures above the elevation of the floodplain but adjacent to a bank of the channel that either has recently, or could potentially, be scoured away by high flows. The third condition includes that property that lies within the migration zone but above the 100-year floodplain and greater than 115 feet from the stream channel. In the absence of additional regulation or recommendations, sites in this third category could be developed because they lie outside of SAO-mandated buffers but would still be at risk from future migration. In total, these properties line at least one side of several miles of channel in the basin.

The strategies for these three types of conditions should differ. Those structures within the 100-year floodplain are addressed by BW 7 (Floodplain Restoration) and BW 10 (Flood Warning); those above the 100-year floodplain but still at potential risk from channel migration are addressed by BW 23 (Bank Stabilization). The several thousand feet of channel bank that is subjected to potential channel

encroachment but is otherwise unconstrained by existing regulations should be mapped and flagged; additional study of the hazards, and additional setbacks as needed should be imposed on a site-specific basis at the time of development application.

Estimated Cost: One-time (studies and mapping) = $12,000.

BW 29: Establishment of Basin Steward Position

Recommendation: King County SWM should hire a basin steward for the Issaquah basin. The duties of the basin steward should include:

1. Providing technical assistance to basin residents to prevent nonpoint pollution, revegetating disturbed areas, and pursuing other topics related to basin plan implementation.

2. Serving as liaison between basin residents and City, County, State, federal, and tribal agencies, and among the agencies themselves, on topics related to the Issaquah basin.

3. Assisting in monitoring of water quality and habitat conditions in the basin and in the identification of code violations.

4. Assisting with revegetation projects using a conservation corp or volunteer groups.

5. Convening and chairing an interagency committee to coordinate agency activities in implementing this plan.

6. Informing basin residents of available incentive programs for water quality enhancement.

7. Developing an annual report at the end of each water year. The report should describe the status of, and schedule for, plan implementation (including the status of capital projects, educational and enforcement efforts, and overall program accomplishments); interpret monitoring results and identify significant changes in the condition of the basin; and based on these changes, identify appropriate responses for basin management program changes, such as basin plan amendments, capital projects list changes, added costs, and staffing changes.

8. Developing a process for resolving disputes about plan implementation.

Discussion: Many actions recommended in the plan require the active participation of citizens working with agencies and organizations. This is particularly true for the water quality and habitat restoration elements of the plan. The basin steward will coordinate many of these cooperative actions. In addition, the steward serves as the principal contact between basin residents and City and

County agencies. In this capacity, the steward responds to public questions and concerns, and relays information to the appropriate agencies.

The steward also serves an essential function in coordinating agencies in the implementation of the plan. Representatives from the Muckleshoot Tribe, Washington Department of Natural Resources, Washington State Parks Department, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, Washington State Department of Transportation, City of Issaquah, King Conservation District, King County DDES, King County Environmental Division, King County Roads and Engineering Division, Seattle–King County Department of Public Health, local sewer and water districts and other affected parties should be invited to participate in an interagency committee to review basin plan implementation. The steward will keep these agencies updated as to activities that affect their respective agencies and will hold committee meetings as required. The annual report referenced above will serve as a means to establish goals and schedules for upcoming work and evaluate performance for the preceding year. The report will also serve as the annual report required by the nonpoint planning rule. WDOE will use this report to assist in its biennial audit of the plan implementation.

Estimated Cost: Annual (staffing + materials) = $62,500.

BW 30: Basin Plan Monitoring

Recommendation: King County SWM and the City of Issaquah should establish a monitoring program to assist in the evaluation of the basin and nonpoint action plan. The focus of the monitoring program should be to identify changes in basin conditions, including hydrology, water quality, aquatic resources, and land use. This information should be used to update or modify specific elements of the plan. The monitoring program should include the following components:

1. Hydrologic Monitoring – Three sets of continuous flow and precipitation recording gages should be established at selected sites in the basin (preliminary sites are at the mouth of Issaquah Creek, on the East Fork, and Middle Issaquah Creek). These gages should be monitored for at least five years to determine whether flows increase in a manner predicted by hydrologic modeling. An assessment of the change in flows in relation to land-cover changes should be conducted using the HSPF model at the end of the five years.

2. Wetlands Monitoring – The hydrology, vegetation, and wildlife of selected Class 1 wetlands in the basin should be monitored according to the following schedule. Staff and crest stage gages should be installed and read quarterly. Vegetation community composition and species cover and wildlife censuses should be measured annually. Additional wetlands should be monitored using existing inventory data and color and infrared aerial photos to determine vegetation and wetland class (e.g., scrub–shrub, emergent) changes over time.

3. Stream Habitat and Fish Monitoring – Core habitat sites should be monitored biannually for canopy cover, condition of riparian vegetation, pool:riffle ratios, residual pool depth, and large woody debris. Fish counts, including spawner and out-migrant counts and spot electrofishing for juveniles should also be carried out annually. Chosen sites will focus on stream-related RSRA's and LSRA's.

4. Channel Monitoring – At selected channel morphometry sites, monitoring should be carried out biannually to measure channel cross sections and sediment size distribution and to determine rates of channel migration.

5. Water Quality and Sediment Monitoring – At selected core sites in the basin, water quality monitoring should be performed to determine turbidity, dissolved oxygen, temperature, conductivity, and pH. Stream samples should also be collected during several baseflow and storm events each year to determine phosphorus concentrations at the core sites, because of their impact on Lake Sammamish. Sediment samples should be collected biannually.

6. Development Monitoring – Development data should be reviewed annually to determine the number of new lots (formal and short plats), new impervious areas, sewers, and roads, conditions imposed relative to basin plan recommendations (e.g., clearing limits, open-space retention), and the status of zoning and adopted regulations.

7. CIP Monitoring – Selected monitoring of capital improvement projects should be coordinated with all ongoing basin monitoring. Specific CIP monitoring may include several components of the recommendations outlined in 1-5 above.

8. Citizen Monitoring – Whenever possible, citizens should be encouraged to participate in the monitoring recommendations noted above (e.g., reading of staff gages in wetlands), or provide additional monitoring to supplement ongoing efforts.

9. Database Development – A basin-specific database, including existing data and data collected as part of this recommendation, should be developed and updated at least annually. The database should be computerized, geographically-based, and readily available to interested agencies.

10. Monitoring Report – A report on all monitoring will be included in the annual report prepared by the basin steward (see BW 29).

Discussion: By monitoring the many interrelated elements of the watershed, the plan recommendations can be updated via the basin steward's annual report as changing conditions mandate. Monitoring of channel incision provides a direct indicator of the effectiveness of upstream flow controls. Monitoring of channel stabilization projects also will track the success of these projects and indicate if the method needs adjustment.

The water quality monitoring will help to identify nonpoint sources of pollution, evaluate the effectiveness of BMP's, and establish a data base to document water

quality changes in the basin. It is anticipated that this program will also include a NPDES monitoring site to be located in the basin. The annual report will provide the interagency committee identified in BW 29 with the information they need to identify any necessary management program adjustments. This report will also serve as the annual report required by the nonpoint planning rule.

Estimated Cost: Annual (staffing at .1 FTE and materials) = $65,000.

BW 31: Basin Plan Enforcement

Recommendation:

1. Enforcement Protocol – The King County SWM Division should initiate efforts to establish an enforcement protocol that is consistent with the goals and objectives of section 319 of the 1987 Clean Water Act. This protocol should identify a lead enforcement agency and the specific roles and responsibilities of Metro; the Department of Ecology; King County SWM, Environmental Division of DDES; DNR; SKCDPH; and KCD in responding to spill reports, animal-keeping-related pollution, forest-practice violations, septic-system failures, or other explicit water quality violations. This process should replace the current Interagency Water Quality Trouble Call/Emergency Response Program that is coordinated by Metro.

2. SWM Division Enforcement – The SWM Division Drainage Investigation and Regulation (DIR) Unit should expand their responsibilities to include inspection and enforcement of water quality BMP requirements related to the NPDES permit program. The DIR Unit should coordinate with DDES enforcement staff to report and enforce violations of SAO requirements, clearing and grading requirements, and animal-density limits.

3. DDES Inspection and Enforcement – King County DDES inspection staff have responsibility for ensuring compliance with clearing, grading, and SAO requirements in the basin. DDES should allocate sufficient inspection staff to enforce these requirements. Whether additional staff are necessary to provide adequate inspection should be determined through analysis of workloads and examination of required inspection frequency.

4. Violation Reporting – The SWM Division should simplify the reporting of surface-water-related code violations by publishing a central telephone number for reporting such violations in the blue pages of the telephone book.

Discussion: Many streams, lakes, and wetlands have changed substantially in recent time due to human activities. Wetlands have been dredged or filled; small headwater streams have been piped or channelized. Sediment from poorly managed construction sites has filled stream channels. Lakes have been degraded by polluted runoff from urban lands. Many of the activities that cause these changes continue unchecked, despite numerous local, state, and federal laws aimed at controlling these harmful activities.

Enforcement of existing laws has been hindered by several factors. In most jurisdictions, the number of enforcement and inspection staff usually is insufficient to identify all violations. The enforcement authority of various agencies often is unclear to citizens who attempt to report violations. Many violators may also feel that the benefits of violation outweigh the risks: with few enforcement staff, the risk of being caught is low; if violators are caught, the penalties are not sufficient to deter violation.

Estimated Cost: Annual (at .75 FTE) = $37,500.

BW 33: Development of Guidelines and Standards for Site Design

Recommendation: King County SWM should develop a report on guidelines and standards for site development to minimize impacts on surface-water quantity and quality. The report should identify and evaluate ways to minimize development-related increases in runoff and pollutants through the location and design of new construction. An advisory group composed of representatives of the development community, private community and environmental organizations, and permitting agencies should be convened to assist in the evaluation. The process should result in a publication of site-design guidelines and standards that is oriented to the development community and site design professionals.

Discussion: The impacts of new development on surface-water quantity and quality vary greatly depending on the location and design of structures and roads on the development site and the treatment of unbuilt areas on the site. The analysis of forest retention strategies conducted in the preparation of this plan indicates that siting and designing new construction to reduce site disturbance and retain natural hydrologic processes will significantly reduce runoff and pollutant loading to nearby streams and wetlands. In most cases, this will translate directly into a reduction in the number and size of drainage and water quality facilities needed for treating surface water, a significant cost savings to the site developer.

This recommendation is focussed on advancing the awareness and understanding of site design techniques for reducing surface-water impacts. It is oriented as much to process as to product. The project would bring surface-water managers together with representatives of several key constituencies involved in site development—the development community, citizen organizations, and permitting agencies—to discuss and evaluate possibilities. If successful, the process should result in agreement on-site design guidelines and standards suitable for the publication that is proposed.

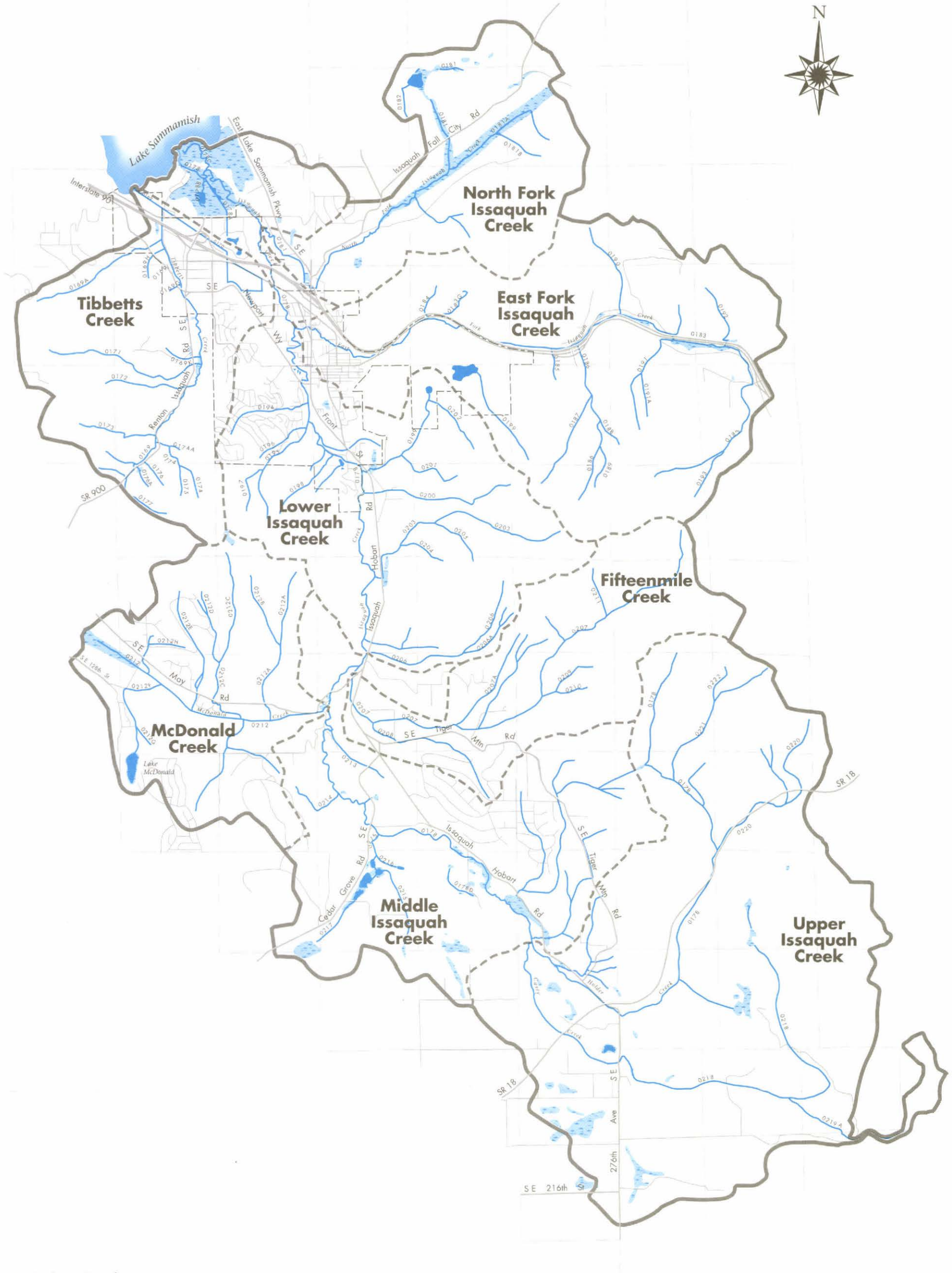
Estimated Cost: One-time (contract costs for study plus publication) = $30,000.

Chapter 5

Subbasin Recommendations

Chapter 5: Subbasin Recommendations

The basinwide recommendations discussed in Chapter 4 address surface-water problems that are common throughout the 61-square-mile Issaquah Creek basin or to many of the subbasins. This chapter provides solutions to problems that are specific to areas within each of eight subbasins: Upper Issaquah Creek, Fifteenmile Creek, Middle Issaquah Creek, McDonald Creek, East Fork Issaquah Creek, North Fork Issaquah Creek, Lower Issaquah Creek, and Tibbetts Creek (Figure 5-1).



SUBBASIN BOUNDARY MAP

Issaquah Creek Basin

Figure 5-1

Upper Issaquah Creek Subbasin
(Holder and Carey Creeks)

PREFACE

The Upper Issaquah Creek subbasin is formed by the drainages of Holder and Carey creeks (tributaries 0178 and 0218) and covers an area of some 11,540 acres, approximately 18 square miles, in the southeastern quarter of the Issaquah Creek basin (Figures 5-2 and 5-3). The steep bedrock topography of Tiger and Taylor Mountains, which forms the upper subbasin, gives way at lower altitudes to narrow, alluvium-filled valleys that merge to form the main Issaquah valley, northwest of Hobart.

Holder Creek originates on the steep southeastern slopes of Tiger Mountain and on the southwestern slopes of South Taylor Mountain and flows some 7 miles to its confluence with Carey Creek. It is steep for most of its length, dominated by boulders and cobble. Patch gravels are common, but extensive spawning beds are rare except upstream of debris jams and in the flatter, lowermost reaches. The system provides spawning and rearing habitat for steelhead, searun and resident cutthroat trout, and coho salmon. Anadromous fish cannot ascend above the SR 18 crossing at RM 16.4, but resident cutthroat were observed throughout the upper reaches to just above the East Tiger Mountain Road.

Carey Creek originates in a broad saddle on the southeastern slopes of South Taylor Mountain and flows 7 miles to the confluence with Holder, forming the mainstem of Issaquah Creek. Carey Creek is the quintessential salmon stream for most of its length. It is a low-gradient stream with extensive pool and riffle complexes and abundant large woody debris providing structure and stability. A series of cascades occur at RM 5.2, blocking anadromous fish from the upstream reaches. Nevertheless, the lower reaches provide spawning and rearing habitat for coho salmon, steelhead, and both searun and resident cutthroat trout and, occasionally, searun Dolly Varden charr. Upstream of the cascades, resident cutthroat occupy the system to its headwaters.

This subbasin is heavily forested, mainly by second-growth timber; forestry uses dominate the current land use surrounding both tributaries. The Washington State Department of Natural Resources (DNR) operates the Tiger Mountain State Forest at the headwaters of Holder Creek, while the headwaters of Carey Creek are in private ownership. The lower subbasin is occupied by livestock farms and scattered dwellings. Future land use provides for rural-density single family (1 du/5 acres) in the lower subbasin and throughout a significant portion of the middle and upper reaches of Carey Creek. This zoning and land-ownership pattern suggests that there will be a major reduction in forested lands in the upper Carey Creek system. Overall, forest land cover is expected to be reduced from the current level of 80 percent of the subbasin to 50 percent. Of particular significance is a proposed development of some 1,700 acres and 347 homes in upper Carey Creek.

The Upper Issaquah subbasin is largely undeveloped and represents the most abundant and relatively undamaged salmonid habitat in the Issaquah Creek basin. Landscapes within this watershed, having mostly recovered from logging effects earlier in the century, exhibit conditions of hydrology, water quality, and habitat that benefit salmonid production. Particularly in the Carey Creek system, aquatic and terrestrial habitats are occupied by diverse species and life histories of salmonids and a number of animals: elk, deer, bear, and various avian species and amphibians. Such conditions are increasingly rare in the urbanizing areas of King County.

Future problems stem mainly from development activity in the Upper Issaquah Creek subbasin. Hydrologic modeling suggests that as the upper subbasin builds out, the 25-year peak flow will increase by about 26 percent, an absolute increase of some 413 cubic feet per second, driven mainly by changes in land use in the Carey Creek basin. Thus, changes to stream habitat structure, sedimentation and erosion rates, and water quality parameters—particularly turbidity, phosphorous, and alkalinity—should be expected for this system. Without considerable mitigation, adverse impacts to salmonid resources will likely be significant and enduring.

Current problems in this subbasin include local bank erosion in Holder Creek, particularly where SR 18 impinges on the creek; high sediment delivery to the lower reaches of Holder Creek; fish passage barriers on Holder Creek due to SR 18 culvert crossings on the mainstem and a tributary; a diversion out of upper Holder Creek into Pheasant Creek; sedimentation into Carey Creek from a diversion out of the Cedar River watershed; and under-utilization of extensive stream habitat by anadromous salmonids.

Particularly in the Holder catchment, the steep topography of the Upper Issaquah subbasin limits the formation of extensive wetlands. However, Carey Creek begins in a large, beaver pond-dominated wetland complex on South Taylor Mountain and passes through other wetlands as it flows downstream. Upstream of the cascades at RM 5.2, narrow riparian wetlands and at least one other beaver pond can be found. The downstream reaches flow through extensive riparian wetlands, mostly unmapped, that occupy the broad floodplain.

RECOMMENDATIONS

Regulations

UI 1 Basinwide Regulations as Applied to Upper Issaquah Subbasin

1. Zoning Changes in Critical Areas (See also BW 6)

Recommendation: This recommendation provides more detail on how Basinwide Recommendation 6 applies in this subbasin. Pursuant to BW 6, the Metropolitan King County Council should consider rezoning the "arm" of G-5 zoning (see Figure

5-6) surrounded on three sides by forest zoning east of Hobart from the current rural (G-5) to forest resource zoning (F) or lower-density rural zoning (RA-10) if the currently vested plat loses its vested status or the plat application is withdrawn. Should this occur, a plan amendment study should be conducted jointly by Community Planning and SWM Basin Planning, with recommendations presented to the Metropolitan King County Council for adoption.

Discussion: The Holder and Carey Creek subbasins contain some of the highest water quality and most pristine salmonid spawning and rearing habitat in the Puget Sound region, and certainly in King County. About 75 percent of the headwater areas of these subbasins are underlain by highly erodible soils, according to the King County SAO map folio. In addition, much of this area is above 1,000 feet in elevation, and therefore receives substantially higher rainfall than other areas of the Issaquah Creek basin.

Given these natural characteristics, development in these subbasins must be planned and designed to minimize impacts on the hydrology, water quality, and aquatic habitat of the stream system. The open-space retention policies and transfer of development credits from the subbasin are expected to provide basic protection to these resources. Based on fieldwork and modeling conducted for this plan, the potential consequences of development of the "arm" parcel at 1 du/5 acres are serious enough to warrant further analysis of downzoning of the parcel in addition to these measures. This analysis should be conducted through a plan amendment study if the existing vested development proposal is not constructed. Long-term forest production or lower density residential uses would be more compatible with the sensitivity of subbasin resources.

Estimated Cost: Covered by existing programs.

2. Open-Space Retention Requirements (See also BW 3)

Recommendation: DDES should require the site development standards articulated in BW 3 in this subbasin.

Estimated Cost: Estimated in BW 3.

3. Erosion Protection On-Site Detention Standard (See also BW 2)

Recommendation: In this subbasin, where stream stability and habitat are highly sensitive to higher future flows, on-site R/D facilities should be designed to the erosion protection standard specified in BW 2, which will be administered by DDES.

Discussion: Design of facilities to this standard will prevent erosion of stream channels and sedimentation of streambeds in areas of exceptional habitat value, as well as provide flood-control benefits. Application of this standard is most critical in the uppermost headwaters of the basin where runoff enters the stream system

in numerous small streams and rivulets that are very sensitive to changes in flow regime.

Estimated Cost: Covered by existing programs.

UI 2 Standards and Performance Goals for New Subdivisions and Segregations

Recommendation: If the current residential zoning remains in effect in this subbasin (see UI 1, #1 above), all new subdivisions and segregations in this subarea should comply with the following conditions in addition to those specified in UI 1 #2 and #3. Compliance should be ensured by DDES through permitting processes.

A. Impervious Surface: Impervious surfaces within the subdivision or segregation, including surfaces associated with all structures, driveways, and roads within the development, should be limited to a maximum of eight percent. Impervious area restrictions should be applied to common facilities (roads, community structures) through the plat approval process, with the remaining impervious area regulated through deed restrictions on subdivision or segregation lots.

B. Lot Siting: Subdivisions and segregations should be designed to avoid siting of residential lots in the steep inner gorge of Carey Creek.

C. Road Crossings: New road crossings associated with subdivision or segregation development should utilize bridges that fully span the stream channels of Holder and Carey creeks.

D. MDP and EIS Requirements: In addition to the above requirements, all developments that are partially or wholly within this subbasin that meet requirements for preparation of a Master Drainage Plan (MDP) or Environmental Impact Statement (EIS) under King County codes should include the following elements within the scope of the MDP and/or EIS:

a. The impact of development on natural hydrologic processes in the Holder and Carey Creek subbasins, as evaluated by predicted post-development changes in the magnitude and duration of high and low flows;

b. The impact of development on natural hillslope-sediment processes in these subbasins, evaluated by predicted post-development changes in the quantity of hillslope erosion and the rate of sediment delivery into stream channels;

c. The impact of development on water quality in Holder and Carey Creek and subbasin wetlands, evaluated by predicted post-development changes in water chemistry.

Estimated Cost: Covered by existing programs.

Programs

UI 3 Purchase of Property and Transfer of Development Credits

Recommendation: King County should acquire part or all of the Hobart Properties site to provide added protection to sensitive streams and wetlands and allow for public use and enjoyment of the area.

In addition, within the context of the Transfer of Residential Development Credits (TDC) chapter (21.36) in the King County zoning code adopted in June 1993, the Hobart Properties site should be designated as a sending area. The receiving area should be the urban portion of the basin within the City of Issaquah or other urban areas outside of the basin. The intent of this designation should be to divert development away from environmentally significant and sensitive areas to less important resource areas and less environmentally constrained areas. This should help ensure that the more important resource areas and more heavily constrained areas receive fewer impacts from development.

Discussion: The cataclysmic losses in Puget Sound salmon populations in the last century have been driven largely by the loss of suitable spawning and rearing habitat. This habitat is the result of a complex set of conditions, including conditions in the stream, in the riparian zone along the stream, and in the watershed as a whole. Once disturbed, many of these conditions cannot be restored, and the value of the stream as salmon habitat is reduced or eliminated.

The loss of salmon populations in King County has been accelerated by the rapid and widespread development of forested watersheds in King County in the last decade. Development of these watersheds has altered patterns of hydrology, sediment transport, and stream biology that have developed over millennia, and has fundamentally and irretrievably altered the conditions required for salmon spawning and rearing. As a result, several stocks of salmon within the Lake Washington basin are perilously close to extinction.

This critical situation calls for immediate and concerted action to protect the high-quality salmon habitats that remain in King County. While much of the Issaquah Creek basin is used by salmon and anadromous trout, the lower portions of Carey Creek are exceptional in habitat diversity and integrity. Acquisition of part or all of the Hobart Properties site, which is in the most sensitive headwater areas of the Carey Creek system, would ensure that these values are permanently protected.

Recognizing that the purchase of all of the site may be impossible, the County should encourage the transfer of development credits from the Hobart Properties site to a receiving site under the recently-enacted county-wide transfer of development credit program. This would reduce the extent of site development and, coupled with sensitive siting of homes under the performance goals described in UI 1, #4 above, would give added protection to the exceptional salmon habitat of lower Carey Creek.

In order to accomplish the transfer of densities, a market needs to exist for the development credits through the availability of density bonuses or other incentives in "receiving" zones. Areas such as the City of Issaquah and other urban areas of King County would be appropriate receiving areas. The market for credits provides the mechanism for the property-owner-to-property-owner transactions that are common in transfer of development credit programs.

Estimated Cost: Transfer of development credits program = no change; Purchase = unknown.

UI 4 Riparian Buffers on Forest Land

Recommendation: For timber harvest and other forest management activities in this subbasin that are not subject to or associated with a watershed analysis, DNR should establish buffers consistent with King County stream classifications and regulate activities within these buffers in accordance with the King County Sensitive Areas Ordinance. For management activities subject to a watershed analysis, DNR should request King County participation in the analysis team, and the team should evaluate the appropriate buffer sizes for affected streams.

Discussion: Given the significance and sensitivity of the aquatic habitat of Holder and Carey Creeks, it is appropriate that stream buffers be at least as large within state forest lands as they are along less sensitive stream reaches elsewhere in the basin. When applied uniformly throughout the basin, King County SAO classifications and standards will provide a consistent level of protection to riparian areas. Where watershed analysis is conducted on state forest lands, the county, DNR, and other participants should do a more detailed analysis of the appropriate buffer widths.

Estimated Cost: Included in BW 16.

Capital Improvement Projects

2542 Hotel Creek Diversion

Recommendation: A historic diversion of Hotel Creek in the Cedar River watershed into Carey Creek should be re-diverted by the Seattle Water Department into Webster Creek—its original channel—to prevent further sediment delivery into Carey Creek and the consequent burial of salmonid rearing habitat.

Discussion: This project is the result of a decades-old diversion of Hotel Creek in the Cedar River watershed from its original course. The diversion was intended to address past water quality impacts from the now-abandoned Taylor townsite on drinking water supplies in the watershed. Hotel Creek can be returned to its original connection with Webster Creek now that the water quality problem no longer exists, the townsite having been abandoned some 50 years ago. With the

proposed diversion, a sediment pulse such as the one generated in 1990 will no longer occur, and salmonid habitat—especially pool habitat—will reestablish in the mid-reaches of Carey Creek.

This diversion channel is not, itself, accessible to anadromous fish nor does it appear to have a resident salmonid population. The channel dries completely by about mid-June of each year and does not contribute flow to the Carey Creek system until late October or mid-November of most years. Loss of the contributing flow will not significantly affect the flow regime of Carey Creek, because this diversion accounts for less than 10 percent of the watershed area at the confluence.

Estimated Cost: One-time (labor and materials) = $10,000.

2543 Upper Holder Fish Passage

Recommendation: WSDOT should immediately install four weirs on the apron of the SR 18 concrete box culvert at RM 16.4 to produce a backwater sufficient to pass salmonids across the apron into the culvert fishway.

Discussion: The apron at the outlet of the 12-foot wide box culvert has insufficient water depth to pass fish into the culvert. It is an upstream passage barrier for anadromous and resident fish. In particular, steelhead (which preferentially use the Holder Creek system) are prevented from ascending into approximately 1.5 miles of mainstem and tributary habitat. The habitat in upper Holder Creek is critical for steelhead and searun cutthroat production. Lowland habitat for these two species has been decreasing rapidly over the past 10 years and these species may be lost altogether in some lowland streams.

Fish passage projects have a high priority in the Issaquah Creek basin, particularly in the Significant Resource Areas. The channels of the Upper Issaquah subbasin are recognized as regionally significant resource areas (RSRA) and, therefore, passage of anadromous species into accessible habitat is of paramount concern where artificial barriers exist. Projects 2543, 2544, and 2545 address culvert barriers caused by SR 18 as it crosses Holder Creek and a tributary.

Loss of access to suitable habitats has deleterious effects on populations of anadromous fishes, of course, but can have equally harmful effects on resident populations as well. Isolation of small populations can lead to extinction of these sub-populations due to insufficient reproductive capability and inability to recruit new members. Moreover, storm events can scour a stream and destroy isolated populations; barriers prevent downstream fishes from re-inhabiting these reaches. Such barriers lead to cumulative loss of even resident populations.

Estimated Cost: One-time (labor and materials) = $3,500.

2544 Tributary 0220 Fish Passage I

Recommendation: WSDOT should fit the lowermost of the two 56-inch-diameter culverts with baffles to permit movement of salmonids upstream.

Discussion: The twin corrugated culverts are an impassable barrier to the upstream migration of salmonids. As a temporary measure, the lower culvert should be fitted with baffles to permit upstream movement. During the widening of SR 18 in this location, both culverts should be replaced with a bridge or other full-spanning structure that permits a gravel bedded channel.

Estimated Cost: One-time baffle placement (labor + materials) = $30,000.

2545 Tributary 0220 Fish Passage II

Recommendation: WSDOT should fit the single 56-inch-diameter culvert with baffles to permit movement of salmonids upstream.

Discussion: The baffle placement should be considered a temporary measure. During widening of SR 18 the culvert should be replaced with a bridge or other full-spanning structure.

Estimated Cost: One-time baffle placement (labor + materials) = $30,000.

2546 Holder/Pheasant Creek Diversion

Recommendation: The DNR should replace an existing culvert that serves as an equalizing conduit for flows between the Otter Lake wetland and Holder Creek and construct a non-erosive channel from the culvert outlet to Holder Creek.

Discussion: This project addresses an inadvertent diversion of a portion of the headwater area of Holder Creek into Pheasant Creek (tributary 0178E). During the January 1990 storm, a buildup of debris caused the channel to shift slightly from its normal course to Holder Creek and flow around a shallow hillock and drain through the western-most of two culverts underneath the West Side Road, which feeds the headwaters of Pheasant Creek. The result was a significantly greater flow of water into this tributary and the consequent transport of large amounts of gravel and debris down the steep channel. Much of the channel was severely eroded and flooding occurred at the Issaquah-Hobart Road. This project will replace an existing culvert located on a spur road just south of the West Side Road. The culvert presently serves as an equalizing culvert for low flows between the Otter Lake wetland and Holder Creek. To facilitate higher flows and prevent excess runoff into the Pheasant Creek drainage, the existing culvert will be removed and replaced with a larger culvert and a constructed downstream channel to Holder Creek. The downstream channel configuration will serve as the control for the newly placed culvert. The culvert will be set at an elevation slightly lower than the Otter Lake wetland outlet. This project will maintain the hydrologic integrity of the

wetland and Holder Creek, and greatly reduce the potential for erosion and flooding problems in Pheasant Creek. Without this project, future storm flows will continue to have a significant impact on Pheasant Creek and the Issaquah-Hobart Road and will also reduce the summer flow into upper Holder Creek.

Estimated Cost: One-time (labor and materials) = $10,000.

2547 Carey Creek Fish Passage at SE 240th Street

Recommendation: King County SWM should replace the two 48-inch-diameter culverts with a bottomless vault that fully spans the stream channel.

Discussion: Resident and anadromous fish passage into the upper Carey Creek basin is presently impeded, but not halted, by this failing culvert installation. However, complete failure or formation of a complete barrier to passage is likely. Flows from the 1990 storm eroded the upstream banks causing large riprap to slide into the stream. Sediment deposition patterns suggest that the road was overtopped by this storm. Proper installation of a bottomless culvert will restore fish passage and reduce flooding.

Upper Carey Creek is part of the Upper Issaquah Regionally Significant Resource Area and is used by coho salmon, sockeye salmon, and steelhead and cutthroat trout for spawning and rearing. Salmonid habitat through this upper reach has been altered by sediment inputs from road construction, forestry and tributary incision. In spite of these disturbances, recovery of pool structure and instream cover is well along. With time, these reaches will reform as high quality habitats for the variety of species provided further such disturbances are mitigated.

In 1991, King County SWM placed baffles in the box culvert under the Issaquah-Hobart Road to aid passage of adults and juveniles into the upper watershed; this project would extend that effort, making the SE 240th Street crossing passable to all species.

Estimated Cost: One-time (labor + materials) = $380,400.

2599E Holder Creek Sediment Management and Habitat Enhancement

Recommendation: Throughout the Holder Creek ravine, from the mainstem crossing of SR 18 at RM 16.4 downstream to the Issaquah-Hobart Road at RM 14.0, SWM should reestablish large woody debris jams to trap sediment that now passes rapidly through the ravine.

Discussion: This project will create debris jams throughout the Holder Creek ravine in an attempt to capture sediment that now passes rapidly down the creek, coming to rest in the lower gradient reaches downstream of the Issaquah-Hobart Road. This deposited sediment reduces channel capacity, results in scoured banks, and buries pools, resulting in degraded water quality and habitat as well as stream

destabilization. In undisturbed forest streams, such debris jams--composed of large trunks and limbs--form low-rise dams that trap sediment in a wedge, thinning upstream. Such debris dams occur frequently in forested streams, on average, every five to ten stream widths. In Holder Creek, such dams are essentially absent or are composed of small alder, structurally inadequate to form long-lived debris dams.

This project will use existing and imported timber to recreate debris jams throughout the Holder Creek ravine. Using hand labor, crews will cut selected trees and pull them into place to form the basic structure of a debris jam. Floatable debris will then accumulate upstream of the logs and sediment transport, in turn, will be modified. Approximately 45 debris jams would be formed in this project.

Without such a project, the lower reaches of Holder will continue to be affected by sediment deposition and may require dredging at road crossings. A regular program of dredging would likely be quite expensive and would severely disrupt the stream habitat.

Estimated Cost: One-time (labor and materials) = $135,000. This cost may be offset in part by funding of BW 22.

2599F Stream-Corridor Riparian Wetland Revegetation

Recommendation: SWM should revegetate the corridor of Issaquah Creek from RM 0.0 to 0.2 on Holder tributary 0178A and from 0.0 to 2.3 on Carey Creek through a phased, multi-year program, using methods described in BW 22 and BW 23.

Discussion: Revegetating the stream corridor and adding large woody debris to the stream channel offers both immediate effectiveness and long-term benefit. These efforts will decrease the damage caused by episodic high flows by reducing the erosive energy of the water while simultaneously increasing the resistance of the banks, and also begin the process of rebuilding the still-valuable resources of this stream system to their yet higher historic levels. The reestablishment of a mature vegetative riparian corridor is generally considered to be a long-term requirement of high-quality aquatic ecosystems in lowland streams of the Pacific Northwest. More traditional engineering efforts can attain only a fraction of the benefits that accrue from widespread revegetation; and the benefits of such engineering, mainly local bank stability, are also achieved by revegetation as well.

Estimated Cost: One-time (labor and materials) = $183,700. May be offset in part by funding of BW 22.

2599G Holder Creek Stream Channel Enhancement

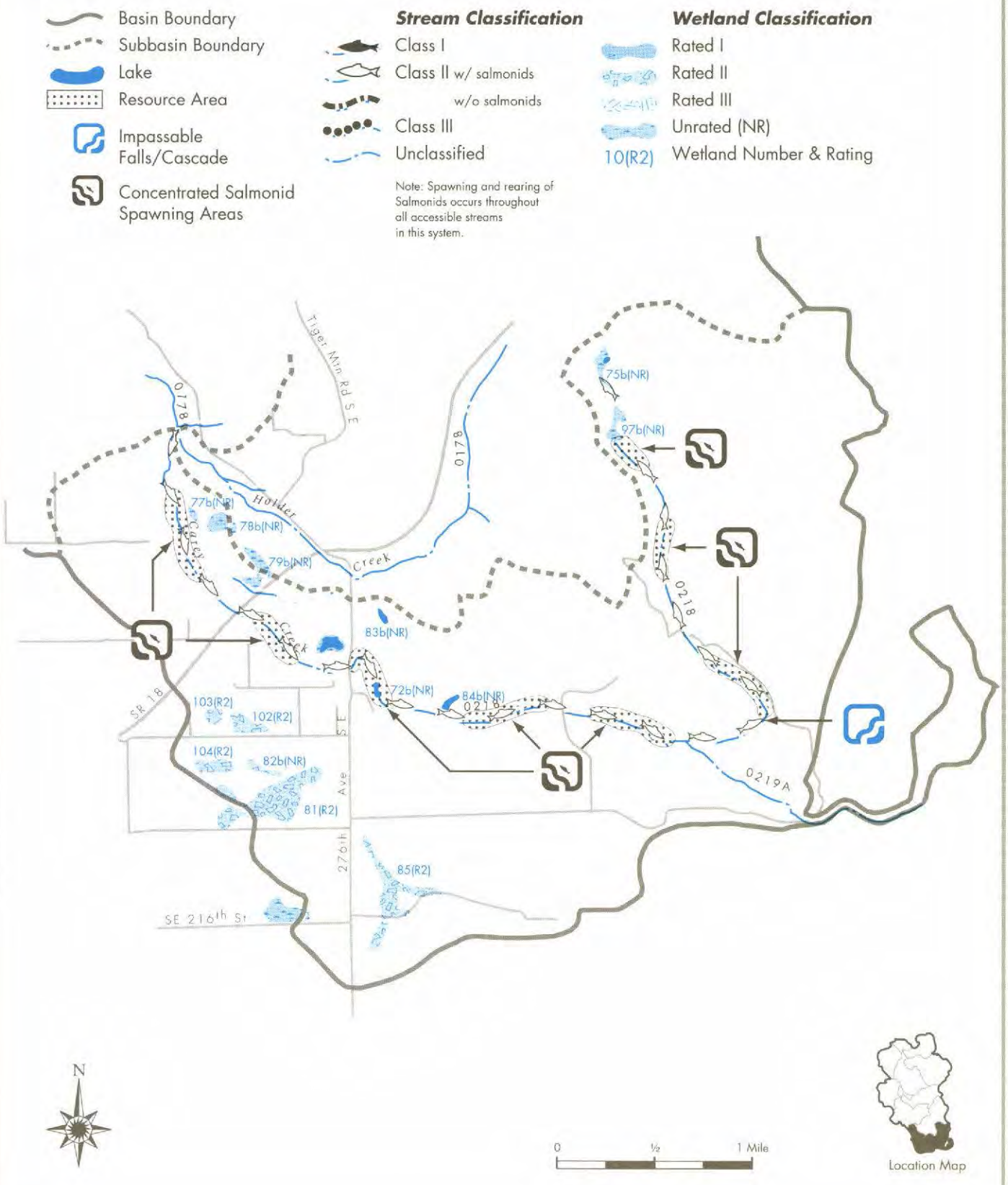
Recommendation: Throughout the reach between RM 13.8 and 13.9, SWM and the property owner should replace the rock-work at inside bends and

constrictions with bioengineered streambanks. The reconstructed banks should be shaped to provide streamside terraces and allow the formation of point bars at inside bends that provide increased floodway capacity during flood flows. Moreover, provisions should be made to improve in-stream and riparian habitats related to fisheries concerns.

Discussion: Eroding streambanks throughout the Issaquah Creek basin are generally repaired using riprap. Banks are thereby hardened and the stream through that section is effectively channelized, often reducing the cross-sectional area and exacerbating flooding. Erosive forces are redirected to the bed and to upstream and downstream banks that remain unprotected.

This reach of stream exhibits all of these effects from extensive channel hardening. In particular, the channel banks have been hardened along a significant length of stream and the cross section decreased by encroachment of the rock. This has resulted in a house and other structures being endangered by overbank flooding.

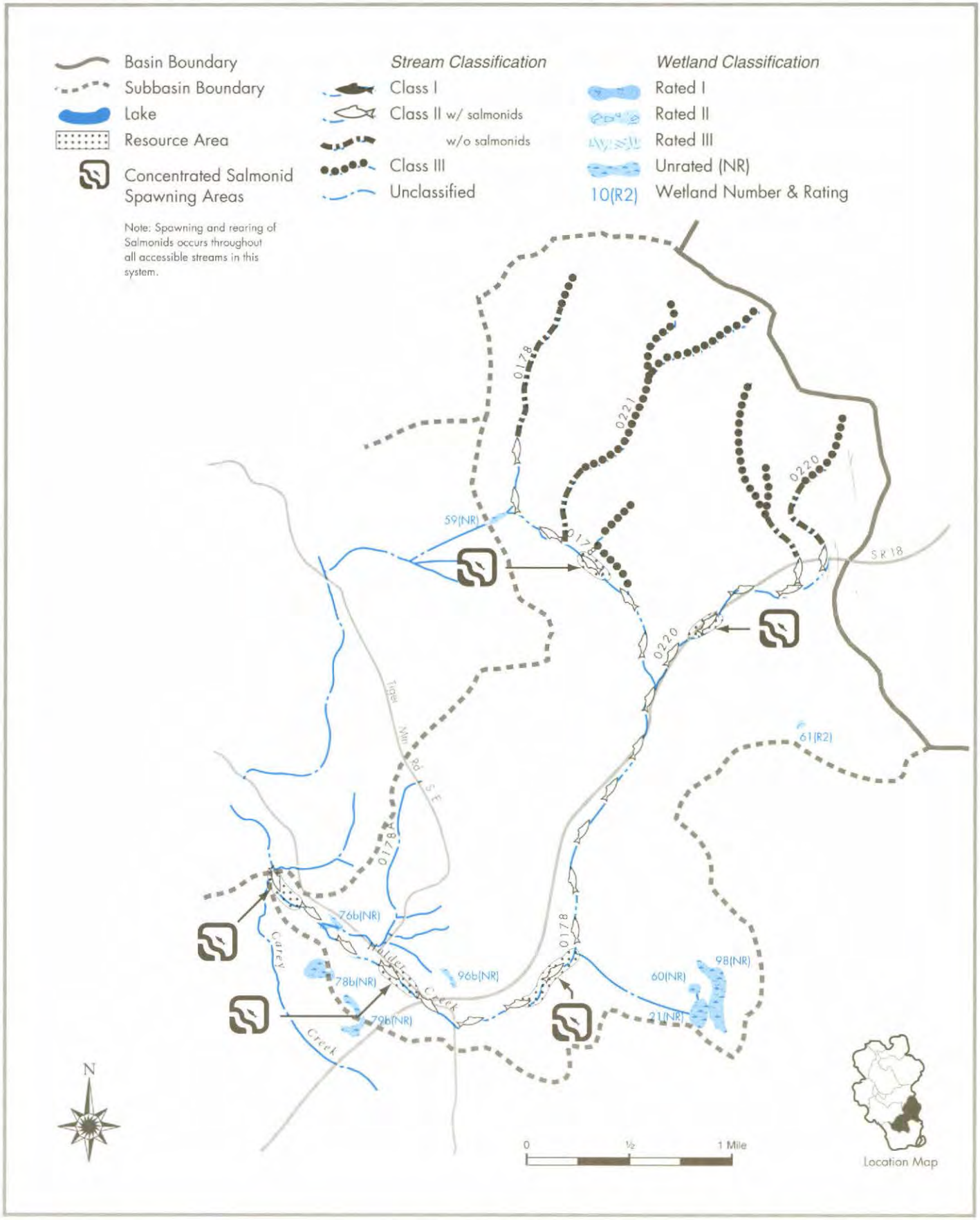
Estimated Cost: One-time (labor + materials) = $214,200.



UPPER ISSAQUAH CAREY CREEK SUBBASIN RESOURCES

Issaquah Creek Basin

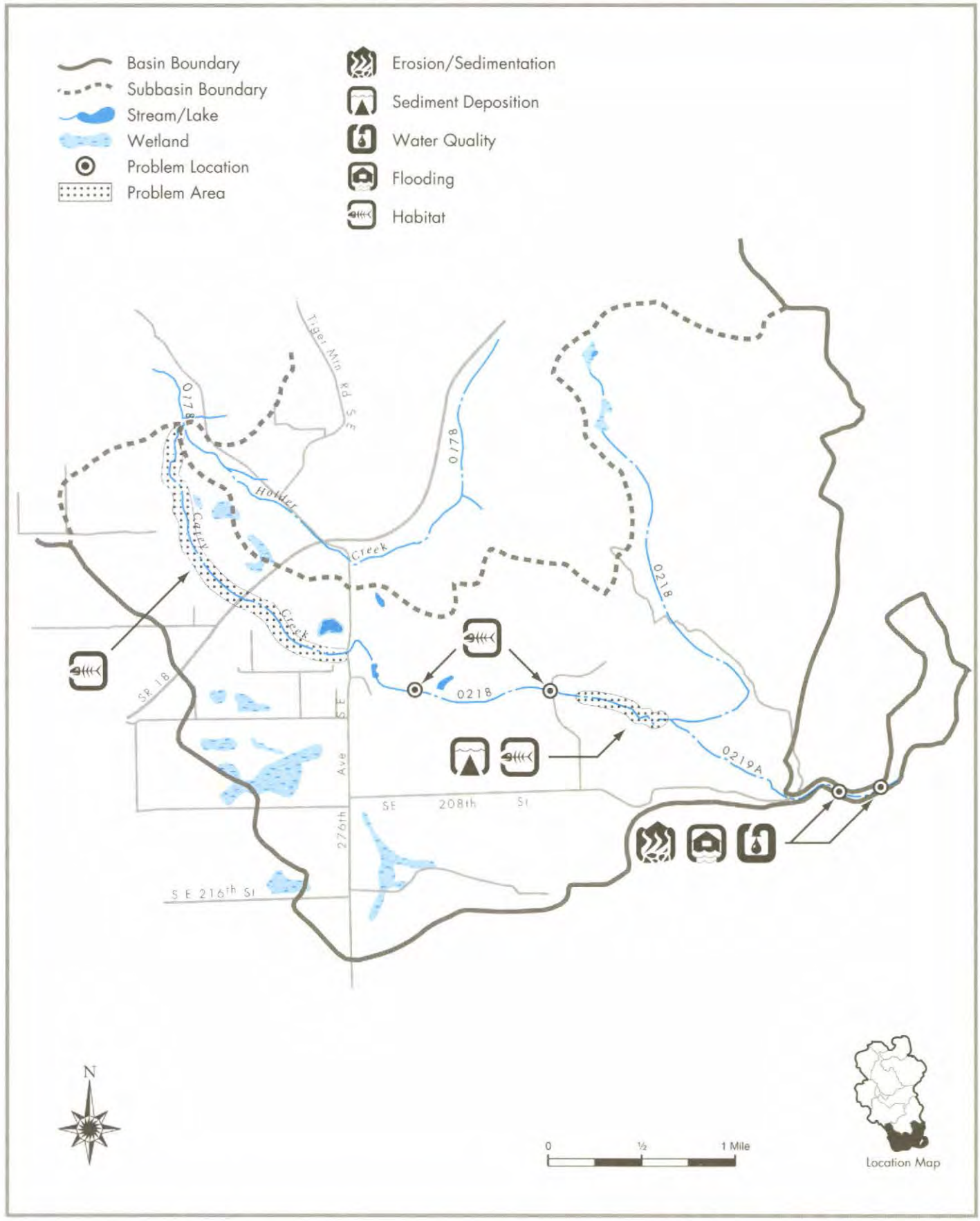
Figure 5-2



UPPER ISSAQUAH HOLDER CREEK SUBBASIN RESOURCES

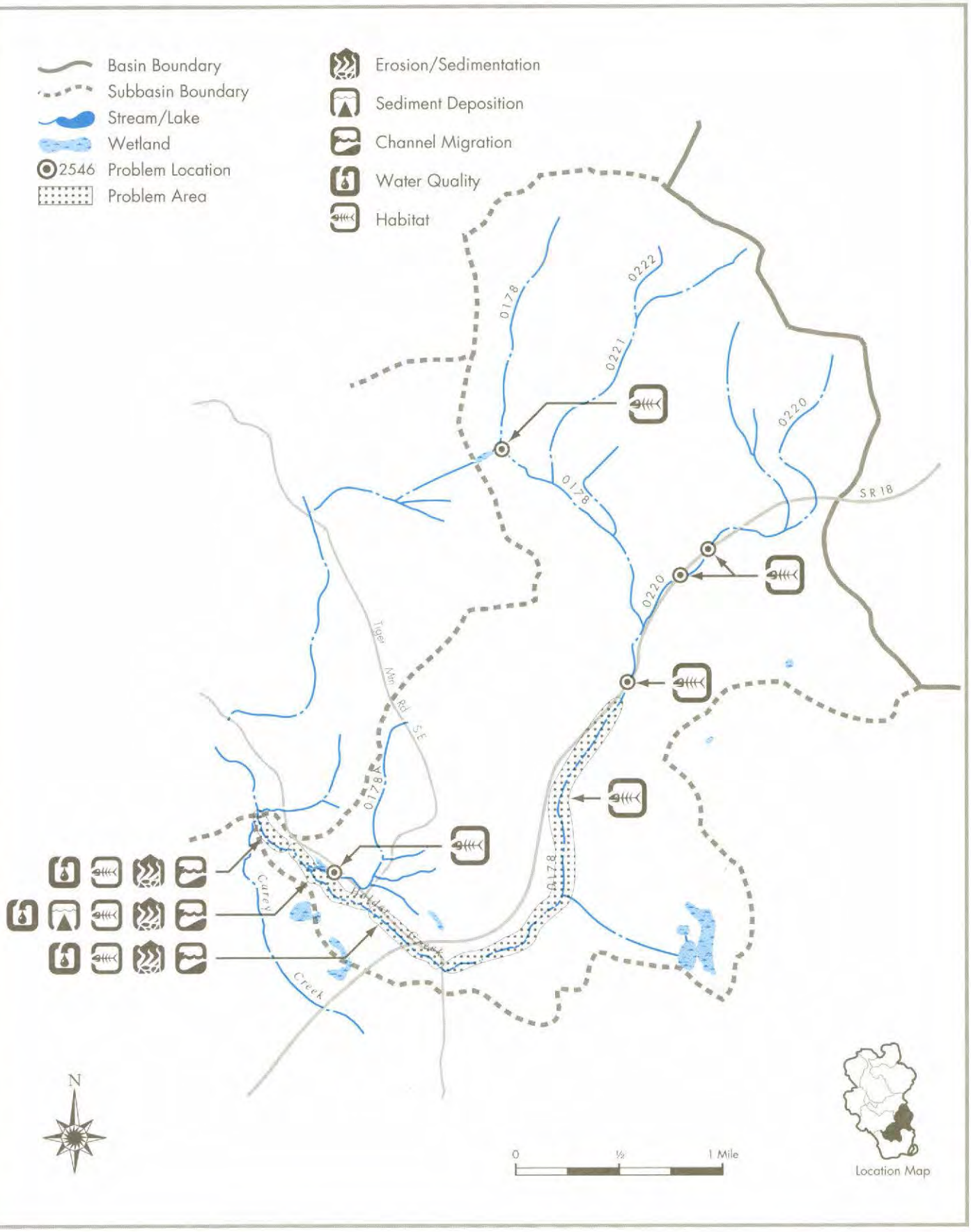
Issaquah Creek Basin

Figure 5-3



UPPER ISSAQUAH CAREY CREEK SUBBASIN PROBLEMS
Issaquah Creek Basin

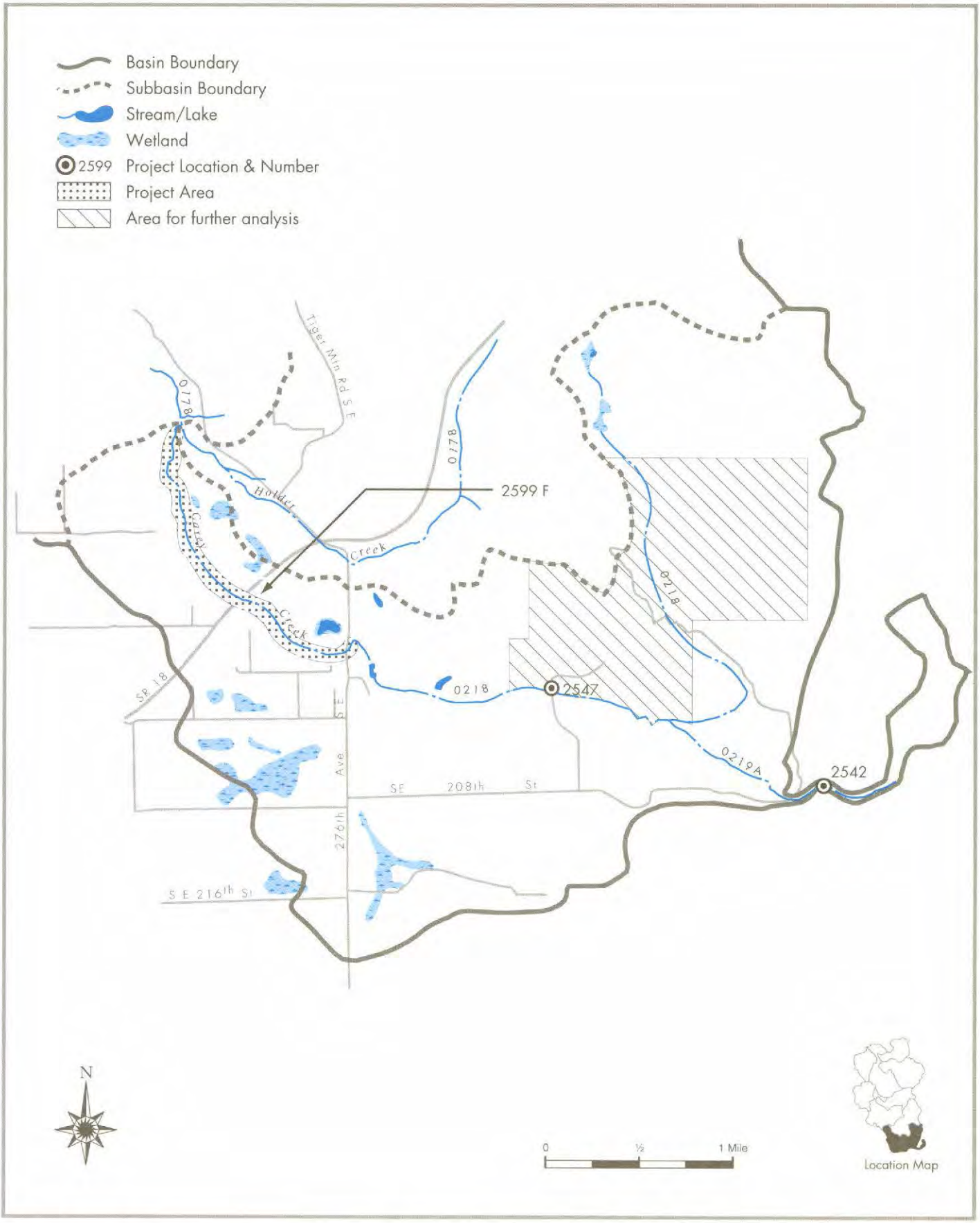
Figure
5-4



UPPER ISSAQUAH HOLDER CREEK SUBBASIN PROBLEMS

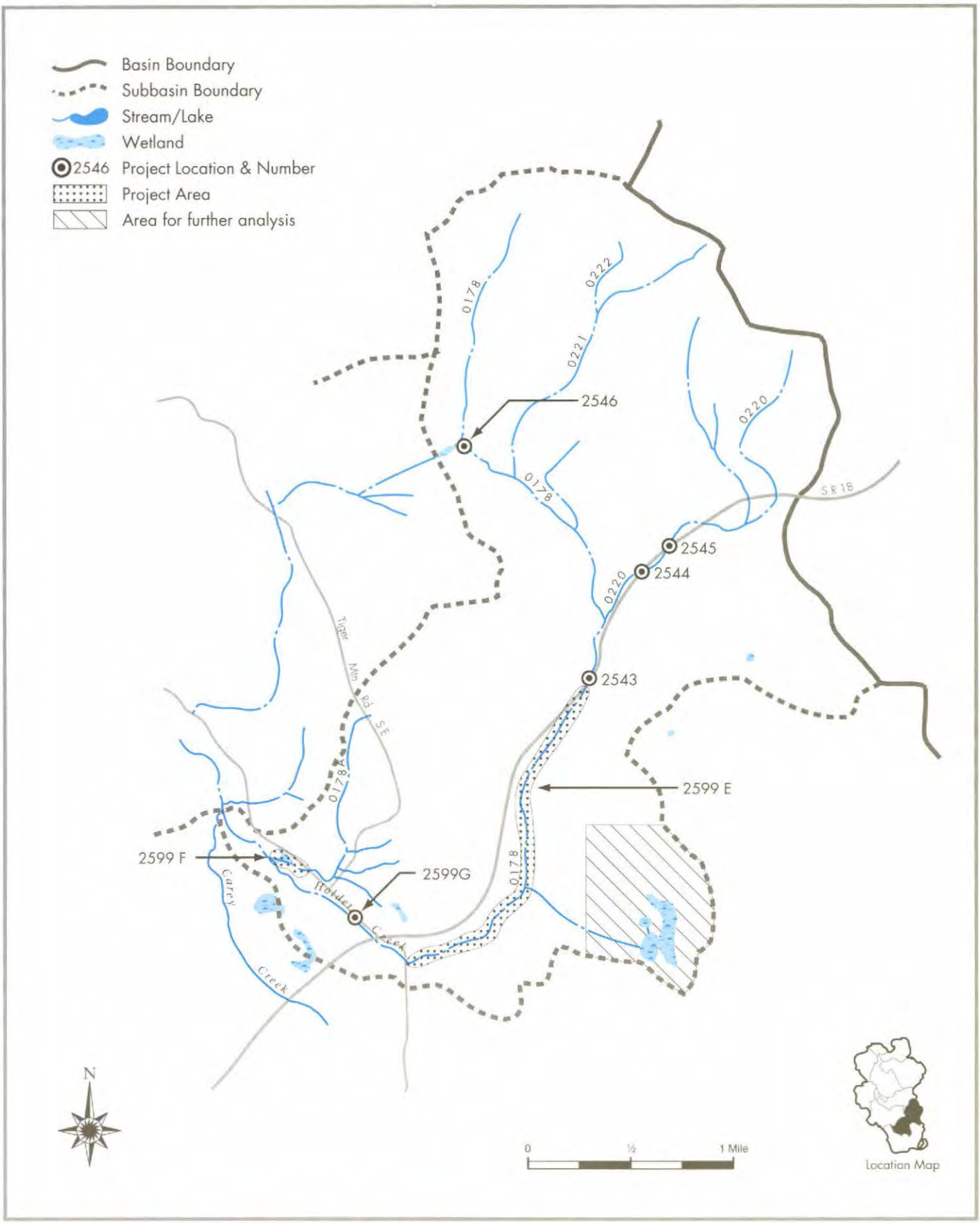
Issaquah Creek Basin

Figure 5-5



UPPER ISSAQUAH CAREY CREEK SUBBASIN RECOMMENDATIONS
Issaquah Creek Basin

Figure 5-6



UPPER ISSAQUAH HOLDER CREEK SUBBASIN RECOMMENDATIONS
Issaquah Creek Basin

Figure 5-7

Fifteenmile Creek Subbasin

PREFACE

The Fifteenmile Creek subbasin covers 2,928 acres (approximately 4.6 square miles) in the eastern central Issaquah Creek basin (Figure 5-8). The creek has its headwaters on the southeastern slope of West Tiger Mountain. The mainstem, its three main tributaries, and several smaller channels compose ten miles of stream channel, most of it high gradient and dominated by boulder and cobble cascades. Ninety-five percent of the basin is presently covered by forest. This is expected to be reduced to about 72 percent over the next 10 to 25 years, primarily by logging in the Tiger Mountain State Forest. The 25-year peak flow is presently about 388 cubic feet per second (cfs); that is expected to increase to 443 cfs—a 14 percent increase, relatively modest in comparison to the other subbasins in the planning area.

With an average slope approaching ten percent, this is one of the steepest subbasins in the Issaquah Creek basin. Specific problems here are predominantly the result of this topography and the resulting high energy of Fifteenmile Creek. The January 1990 storm washed out a private culvert and associated fill on 252nd Place SE that provided sole access for 15 houses. Localized areas of channel erosion, common throughout the system, are problematic in the vicinity of 240th Avenue SE, where development is encroaching on the stream corridor. The most immediate threat to a residence exists at the mouth of Fifteenmile Creek, where a house was built with insufficient setback from the active channel and has subsequently required extensive bank armoring to maintain channel stability.

In spite of both natural and human-generated erosion and sedimentation, there have been few reports of flooding in this subbasin. This condition probably is explained by the relatively low rate of development that prevails here, a condition that is likely to continue.

A barrier to anadromous fish exists at RM 1.5 in the form of a bedrock cascade, which is topped by an abandoned water-supply dam. The reaches of the stream below the barrier are characterized by gradients of 1 to 1.5 percent in a near-continuous, high-gradient riffle. Despite the continuous presence of a well-vegetated riparian corridor, large woody debris is rare and unevenly distributed as a result of both natural and human factors. These conditions make habitat in this creek best for steelhead and searun cutthroat trout, rather than salmon, and warrant the designation of the channels of this subbasin as a locally significant resource area (LSRA).

RECOMMENDATIONS

Regulations

FM 1 Basinwide Regulations as Applied to Fifteenmile Creek Subbasin

1. Open-Space Retention Requirements (See also BW 3)

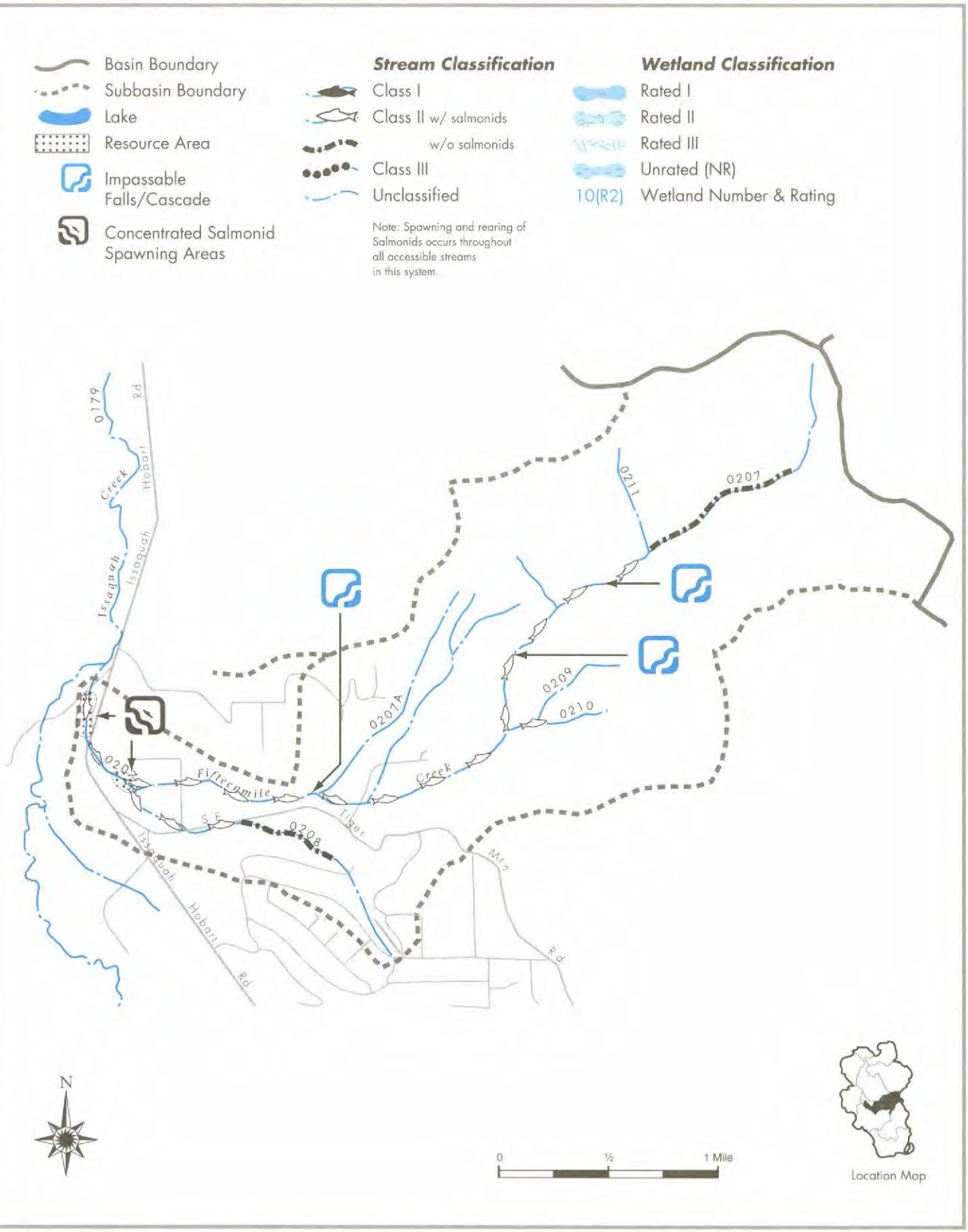
Recommendation: DDES should require site development standards pursuant to BW 3 in this subbasin.

Discussion: Although the basinwide benefits of open space retention require that the 65 percent base requirement apply in this subbasin, the lowlands in this subbasin east of the Issaquah-Hobart Road combine the favorable characteristics of moderate slopes, relatively infiltrative soils, and distance from major streams and wetlands that will allow use of density bonuses. DDES will administer these standards.

Estimated Cost: Estimated in BW 3.

Capital Improvement Projects

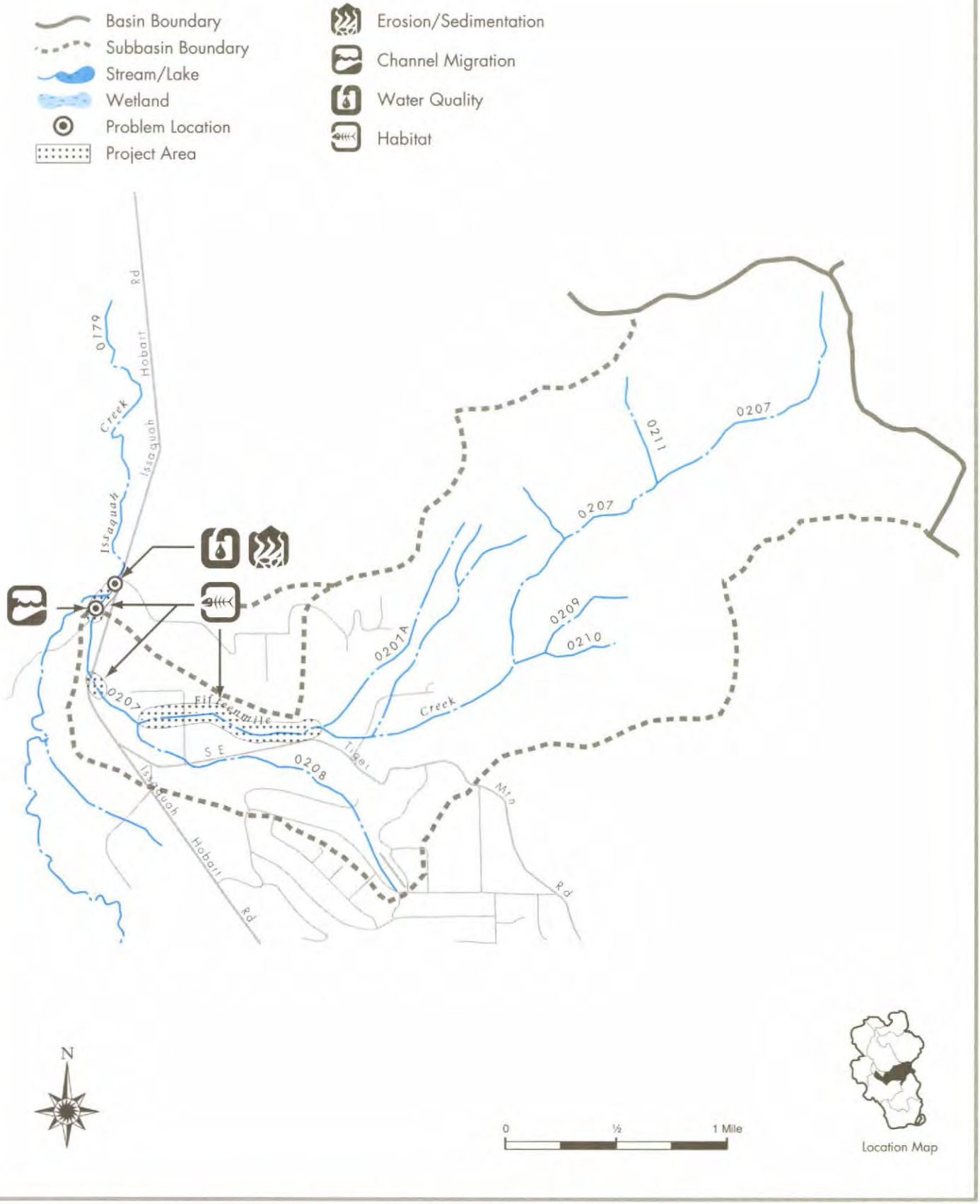
—None in this subbasin—



FIFTEENMILE CREEK SUBBASIN RESOURCES

Issaquah Creek Basin

Figure 5-8



FIFTEENMILE CREEK SUBBASIN PROBLEMS

Issaquah Creek Basin

Figure 5-9

Middle Issaquah Creek Subbasin

PREFACE

The Middle Issaquah Creek subbasin covers an area of 3,238 acres (Figure 5-10), 80 percent of which is presently forested. The subbasin is mainly in agricultural and low-density single-family residential land uses at present. Future land uses will allow for a major increase in low-density single-family residential development, reducing forest land by up to 50 percent. As a consequence of these local changes, the 25-year peak flow in this subbasin is modeled to increase to almost 2,855 cubic feet per second, a 29-percent increase. This increase in surface-water flows will accelerate flooding and channel migration in existing problem areas as well as in presently problem-free areas.

This subbasin has a history of both lowland and localized flooding, particularly at the Mirrormont development and near the confluence of Issaquah and Pheasant creeks (tributaries 0178 and 0178E). King County projects in 1986 and 1988 have addressed several local problems here; however, at least two private residences continue to be flooded and several roads, both public and private, have been blocked or washed out by sediment and high flows.

The main channel of Issaquah Creek actively migrates throughout much of this subbasin. Numerous locations show lateral channel shifts from the two 1990 storms of a few feet up to several tens of feet, with even larger changes accumulating over the last several decades. Although examples of such movement are scattered throughout this subbasin, the most damaging have occurred in the Four Creeks Ranch area (RM 8.2-8.8), where development has encroached upon a zone of active channel migration. The most severe erosion problem here shifted the active channel to within a few feet of a house foundation during the November 1990 flood, following a pattern of channel migration evident over the preceding decades. Just upstream, longer-term channel migration has left steep embankments along the right bank, a portion of which failed catastrophically in March 1991 and temporarily dammed mainstem Issaquah Creek.

This reach of mainstem Issaquah Creek forms a moderate-gradient system that supports a regionally significant salmonid fishery, in spite of low-level land-use impacts from livestock farming, road building, and floodplain encroachment. The gradient throughout this reach of the Issaquah mainstem (RM 7.7 to RM 12.8) is slightly less than 1 percent. Gravels are free of fines and are unconsolidated, providing excellent spawning conditions. An uneven pool:riffle character predominates, and riffles appear to be slightly more common than pools due to the paucity of large woody debris in this reach. Braiding is apparent in many sections, particularly near RM 9.6 and RM 10.5, providing excellent summer rearing habitat and refuge from high winter flows for juveniles. The riparian corridor also contains large forested wetlands, unmapped during the King County inventory. These wetlands serve as floodwater and sediment storage areas during the winter and may act as stream recharge areas during other seasons.

RECOMMENDATIONS

Regulations

MI 1 Basinwide Regulations as Applied to Middle Issaquah Subbasin

1. Open-Space Retention Requirements (See also BW 3)

Recommendation: DDES should require the site development standards articulated in BW 3 in this subbasin.

Discussion: Because the medium-density Mirrormont subdivision comprises a significant portion of this subbasin, this subbasin has one of the lowest percentages of forest cover of all of the subbasins. Outside of Mirrormont, however, the Middle Issaquah subbasin still has some fairly significant wooded areas remaining, especially west of Issaquah Creek. Therefore the site development standards of BW 3 and the accompanying reforesting requirements in this RSRA should make significant strides toward protecting and enhancing forest cover of this subbasin.

Estimated Cost: Estimated in BW 3.

2. Erosion Protection On-Site Detention Standard (See also BW 2)

Recommendation: In this subbasin, where stream stability and habitat are highly sensitive to higher future flows, on-site R/D facilities should be designed to the erosion protection standard specified in BW 2, and administered by DDES.

Discussion: Design of facilities to this standard will prevent erosion of stream channels and sedimentation of streambeds in areas of exceptional habitat value, as well as provide flood control benefits. Application of this standard is most critical in the uppermost headwaters of the basin where runoff enters the stream system in numerous small streams and rivulets that are very sensitive to changes in flow regime.

Estimated Cost: Covered by existing programs.

Studies

MI 2 Mirrormont Drainage Study

Recommendation: King County SWM should conduct a study of the Mirrormont subdivision to determine how to upgrade the drainage system and reduce downstream impacts. The study should be conducted by the Drainage Investigations and Regulations unit.

Discussion: Mirrormont was developed without ample stormwater control including undersized roadside ditches. Uncontrolled runoff from the Mirrormont subdivision drains to three ravine areas located below SE 158th Street/SE 159th Street and above the Issaquah-Hobart Road. Results of this uncontrolled runoff are the overtopped roadside ditches above SE 158th/SE 159th streets and Issaquah-Hobart Road. The drainage system in the this area is complex, and detailed analysis of drainage problems and alternative solutions was beyond the scope of this plan. The recommended study would provide the information that is necessary to justify future capital improvement projects (see 2532 below) to solve these problems.

Estimated Cost: One-time = $200,000.

Capital Improvement Projects

2532 Mirrormont Erosion Control

Recommendation: Within the Mirrormont subdivision, King County Roads and/or SWM should improve the ditch and driveway culverts as needed along SE 159th and SE 158th streets. Pipe the flow underneath SE 158th Street and into an enlarged, riprap armored ditch along 252nd Avenue SE. At the end of the cul-de-sac, collect and tightline flows down an eroding unused county road right-of-way. Install a new culvert underneath the Issaquah-Hobart Road to convey runoff to the existing ditch system. To help slow the rate of sidewall failure, fell trees, currently cantilevered over the edge of the slide, into the ravine. Use the trunks and branches to protect the slope base and bed from erosive action. King County Roads and SWM will negotiate the scope as well as the cost sharing for this project.

Discussion: Mirrormont was developed without adequate stormwater control, including undersized roadside ditches. One result of this uncontrolled runoff is severe erosion in a ravine between SE 159th Street and the Issaquah-Hobart Road. During the January and November 1990 storms, the sediment blocked the Issaquah-Hobart Road.

This project will reduce the rate of erosion in the ravine and safely convey much of the storm runoff from SE 159th Street around the site via a tightline and underneath the Issaquah-Hobart Road. As a result, the road will not be affected by sediment during storm events.

Estimated Cost: One time = $305,000.

2533 Embankment Stabilization of 231st Place SE

Recommendation: The King County SWM Division should reconstruct the road embankment adjacent to mainstem Issaquah Creek in the upper Four Creeks Ranch development, in accord with the bank stabilization recommendation (BW 23).

Discussion: Currently, 231st Place SE is undermined due to channel migration. If the embankment is not stabilized, the road surface will likely begin to fail within 1–2 years.

Estimated Cost: One-time = $158,000. This cost may be offset in part by funding of BW 23.

2534 Embankment Stabilization of SE May Valley Road

Recommendation: The King County Roads Division should reconstruct the left-bank, upstream road embankment at the bridge over Issaquah Creek, in accord with BW 23.

Discussion: Channel migration is threatening the stability of SE May Valley road. If left untreated, the road may be undermined within the next ten years.

Estimated Cost: One-time = $106,600. This cost may be offset in part by funding of BW 23.

2546 Holder/Pheasant Creek Diversion

Recommendation: This project spans two subbasins: Middle Issaquah Creek subbasin and Upper Issaquah Creek subbasin. For the complete recommendation see "2546 Holder/Pheasant Creek Diversion" in the *Upper Issaquah Creek Subbasin* section of this chapter.

2599B Stream-Corridor Riparian Wetland Revegetation

Recommendation: King County SWM should revegetate the corridor of Issaquah Creek from RM 11.1 to 11.7 through a phased, multi-year program.

Discussion: Revegetating the stream corridor and adding large woody debris to the stream channel offers both immediate effectiveness and long-term benefit. These efforts will decrease the damage caused by episodic high flows by reducing the erosive energy of the water while simultaneously increasing the resistance of the banks, and also begin the process of rebuilding the still-valuable resources of this stream system to their yet higher historic levels. The reestablishment of a mature vegetative riparian corridor is generally considered to be a long-term

requirement of high-quality aquatic ecosystems in lowland streams of the Pacific Northwest. More traditional engineering efforts can attain only a fraction of the benefits that accrue from widespread revegetation; and the benefits of such engineering, mainly local bank stability, are also achieved by revegetation as well.

Estimated Cost: One-time = $120,300. This cost may be offset in part by funding of BW 22.

2599C Pheasant Creek Cooperative Bank Stabilization

Recommendation: In a cooperative project between the landowner and King County SWM, replace the existing rocked streambanks with stabilization by bioengineering methods.

Discussion: After the severe storm of 1990, significant damage to the streambanks of Pheasant Creek immediately downstream of the Issaquah-Hobart Road was repaired with traditional rocked revetments. This method resulted in a narrowed, confined channel with no bank vegetation and little habitat value for salmonids. Although intermittent, the stream is used by considerable numbers of salmon during the winter migration.

The rock revetments should be removed in a cooperative effort between SWM and the appropriate property owner. In their place, SWM should provide—under the BW 22 and BW 23 programs—technical and construction assistance to rebuild the banks using bioengineering techniques.

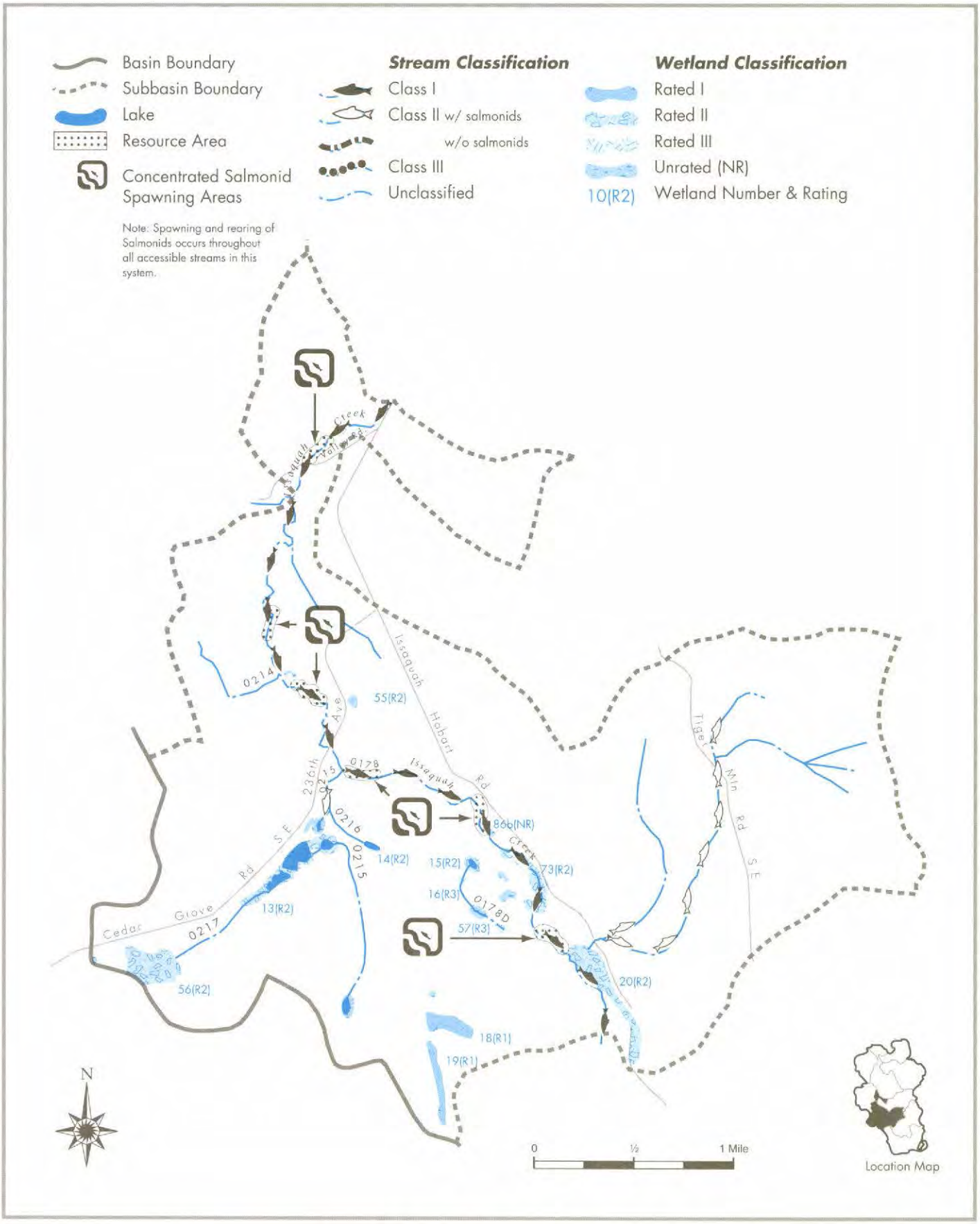
2599D Four Creeks Ranch Cooperative Bank Stabilization

Recommendation: King County SWM should replace the most recent rockwork on Issaquah and lower McDonald Creeks with bioengineering methods.

Discussion: Sections of the mainstem Issaquah Creek and lower McDonald Creek through the Four Creeks Ranch subdivision were rocked following damage caused by the 1990 flood events. While these revetments have proven somewhat effective in protecting the banks from further erosion, streamside and instream habitats have been degraded by their construction and by the hydraulic effects associated with such bank hardening. SWM and the land owners should undertake a cooperative effort to replace the rockwork with bioengineered banks in these areas.

It is important to note, however, that much of the work was apparently unpermitted and questions related to its disposition must be settled before any funds are appropriated.

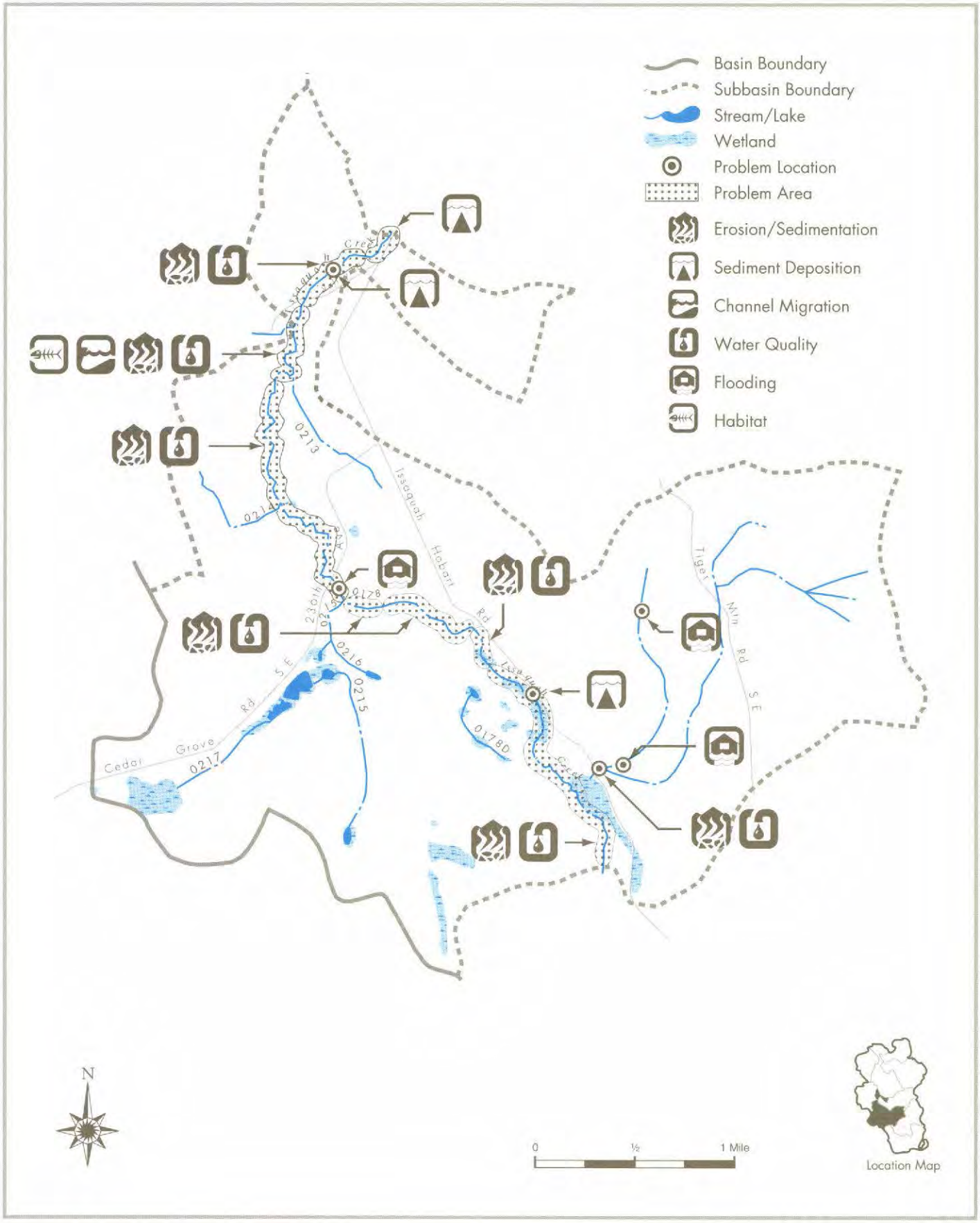
Estimated Cost: One-time = $240,800. This cost may be offset in part by funding of BW 22 and 23.



MIDDLE ISSAQUAH CREEK SUBBASIN RESOURCES

Issaquah Creek Basin

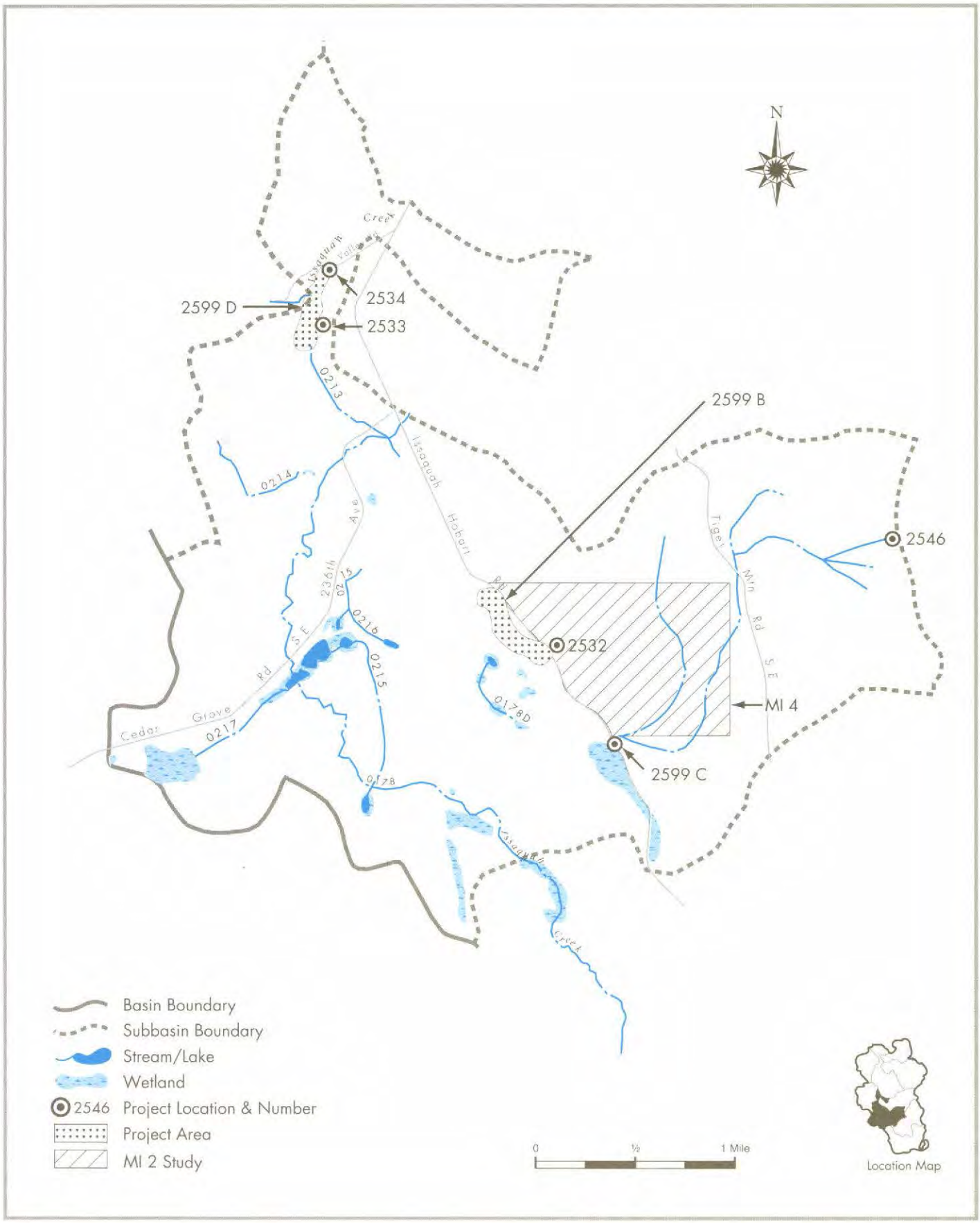
Figure 5-10



MIDDLE ISSAQUAH CREEK SUBBASIN PROBLEMS

Issaquah Creek Basin

Figure 5-11



MIDDLE ISSAQUAH CREEK SUBBASIN RECOMMENDATIONS
Issaquah Creek Basin

Figure
5-12

McDonald Creek Subbasin

PREFACE

The McDonald Creek subbasin covers 3,200 acres (5 square miles) in the southeast portion of the Issaquah Creek planning area (Figure 5-13). The headwaters of the creek (also called Mason Creek) drain from Lake McDonald in the south, and from the Cedar Hills upland. Most of the main channel is low gradient. Drainage is characterized by extensive wetland areas that have been filled and drained for agricultural and residential development.

Flooding in this subbasin is significant and has occurred in two main locations, the High Valley subdivision and the Sunset Valley Farms subdivision. Sunset Valley Farms is situated in a broad floodplain along McDonald Creek, portions of which are expected to extend up to 450 feet in width as the subbasin builds out. Surface-water flow is expected to increase significantly as development occurs and natural features are replaced with impervious surfaces and lawns. When the subbasin is built out, the current average 25-year peak flow of 226 cubic feet per second (cfs) could increase to as much as 358 cfs, a 58 percent increase.

The McDonald Creek valley has been the historical recipient of large amounts of sediment from the steep mountain slopes that drain into it from the north. Sediment from the tributaries on Squak Mountain has accumulated in a fan shaped deposit almost one mile wide and over 2,000 feet long between the foot of Squak Mountain and McDonald Creek. This is a zone of pervasive, chronic sediment deposition, because here, where the stream gradient levels out, there is a decrease in sediment transporting ability. In recent decades this natural sedimentation process has been escalated by upstream development and forestry practices.

The area near Lake McDonald is one of three major regions in the Issaquah Creek basin designated for urban development by the 1985 King County Comprehensive Plan. The 1992 Growth Management Act update of that plan proposes that this area be redesignated to rural. However, much of the area around Lake McDonald has already been subdivided into suburban-sized lots as has much of the area north of SE May Valley Road and in the valley itself. As a result, forest lands will be reduced from their present 75 percent to an estimated 15 percent of the subbasin in the process of development, and peak flows can be expected to increase dramatically.

McDonald Creek is used by anadromous and resident fish. Coho salmon have been observed using tributaries 0212C, 0212E, and 0212I. In addition, coho also use the reach of McDonald Creek at about RM 0.75. Here, the creek assumes a low-gradient riffle character with pools at outbends and at obstructions, and the corridor becomes densely wooded.

McDonald Creek (along with Tibbetts Creek) has the poorest water quality of all the creeks in the Issaquah Creek system, according to 1989-90 Metro storm

monitoring data. In particular, the Cedar Hills landfill seems to be an occasional source of high levels of turbidity.

RECOMMENDATIONS

Regulations

MD 1 Basinwide Regulations as Applied to McDonald Creek Subbasin

1. Zoning Changes in Critical Areas (See also BW 6)

Recommendation: During revision of the King County Comprehensive Plan and subsequent amendments, King County should consider converting the areas currently zoned Suburban Cluster (SC) south of McDonald Creek to residential (RA-5).

Discussion: The subdivisions in the McDonald Creek Valley are prone to severe and frequent flooding, and because the SC-zoned area is on one of the steep, erosion-prone slopes that constitute the headwaters of McDonald Creek, a rezone here would be consistent with BW 6. In addition, recent subdivision activity in this area has resulted in parcels of around five acres, which is more consistent with the residential rural zone than the SC suburban residential zone. This is in contrast to the SE and RS-15000 zones in this subbasin, which have been largely built out.

Existing subdivisions in the valley have been built within the floodplain of the channelized creek and are good examples of the large-lot suburban patterns of development that should be avoided. Nevertheless, the lowlands in this subbasin outside of sensitive areas such as floodplains, steep slopes, and wetlands, are relatively unconstrained and will be appropriate for additional development in residential zones with the inclusion of large, forested open-space tracts.

Estimated Cost: Covered by existing programs.

2. Open-Space Retention Requirements (See also BW 3)

Recommendation: DDES should require site development standards pursuant to BW 3 in this subbasin.

Estimated Cost: Estimated in BW 3.

3. Erosion Protection On-Site Detention Standard (See also BW 2)

Recommendation: In this subbasin, where stream stability is highly sensitive to higher future flows, on-site R/D facilities should be designed to the erosion protection standard specified in BW 2 and administered by DDES.

Discussion: Design of facilities to this standard will prevent erosion of stream channels and sedimentation of streambeds in areas of exceptional habitat value, as well as provide flood control benefits. Application of this standard is most critical in the uppermost headwaters of the basin where runoff enters the stream system in numerous small streams and rivulets that are very sensitive to changes in flow regime.

Estimated Cost: Covered by existing programs.

Programs

MD 2 Floodproofing and Elevation

Recommendation: The floodproofing and elevation program established under BW 8 would apply in this subbasin. There is at least one structure in the 25-year floodplain that should be eligible for flood audits and floodproofing and elevation.

Estimated Cost: One-time audit = $700; One-time floodproofing and elevation = $7,500.

Studies

MD 3 High Valley Drainage Study

Recommendation: King County SWM should conduct a study of the High Valley development on the southwest flanks of Squak Mountain to determine how to upgrade the drainage system and reduce downstream impacts. The study should be conducted as part of the Neighborhood Drainage Assistance Program (NDAP) by the Drainage Investigations and Regulations unit.

Discussion: Inadequate control of runoff from the High Valley development into tributaries 0212H, 0212E, 0212D, and 0212C causes extensive stream channel erosion, contributing large quantities of sediment to the lower segments of these tributaries and to McDonald Creek itself. This sediment increases flood hazards within the Sunset Valley Farms development and degrades aquatic habitat in the tributaries and the middle and lower segments of McDonald Creek. The drainage system in the High Valley area is complex, and detailed analysis of drainage problems and alternative solutions was beyond the scope of this plan. The recommended study would provide the information that is necessary to justify future capital improvement projects to solve these problems.

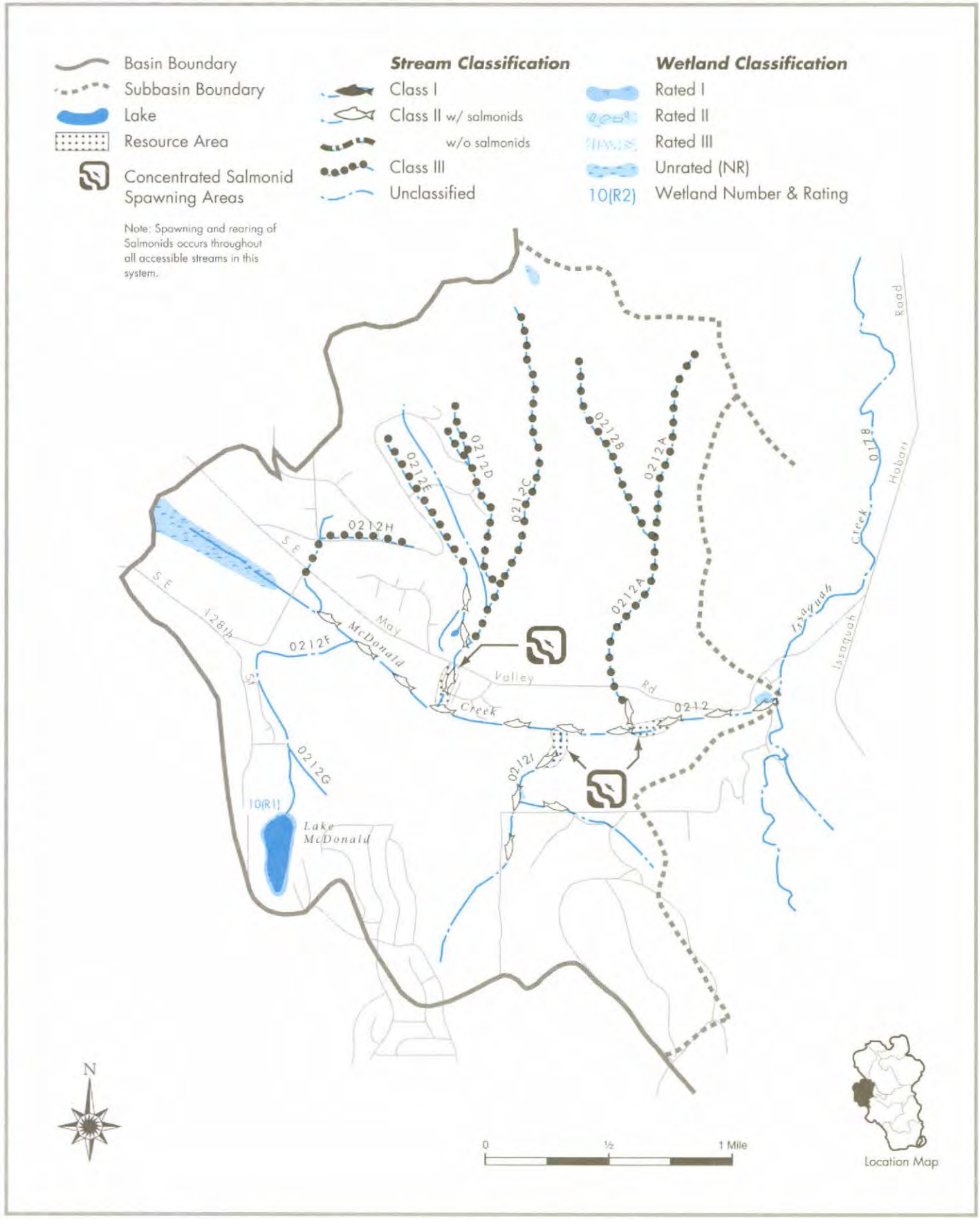
Estimated Cost: One-time = $122,600.

2557 Improve Turbidity Control for Stormwater from Cedar Hills Landfill

Recommendation: The King County Solid Waste Division should evaluate the effectiveness of existing controls and the need for additional stormwater controls to reduce turbidity in discharges from the Cedar Hills Landfill. This effort should be carried out as part of the NPDES permit process and the development of a pollution prevention plan for the site.

Discussion: Analysis of water quality data in the Conditions Report indicated that soil borrow and stockpile activities at the landfill contributed to sediment loads into an unnamed tributary and McDonald Creek. Recent water quality data collected as part of routine monitoring and stormwater monitoring for the NPDES permit indicates that erosion and sediment controls, including the implementation of daily management practices, have been effective in reducing turbidity from the landfill entering the unnamed tributary. Isolated incidents of high turbidity, however, indicate there is a continuing need to evaluate the effectiveness of both management and structural BMP's that are currently in place. KCSWD should address these issues in the development of its pollution prevention plan and comprehensive set of BMP's for its NPDES permit. This effort should include evaluating the effectiveness of existing controls and the need for additional controls.

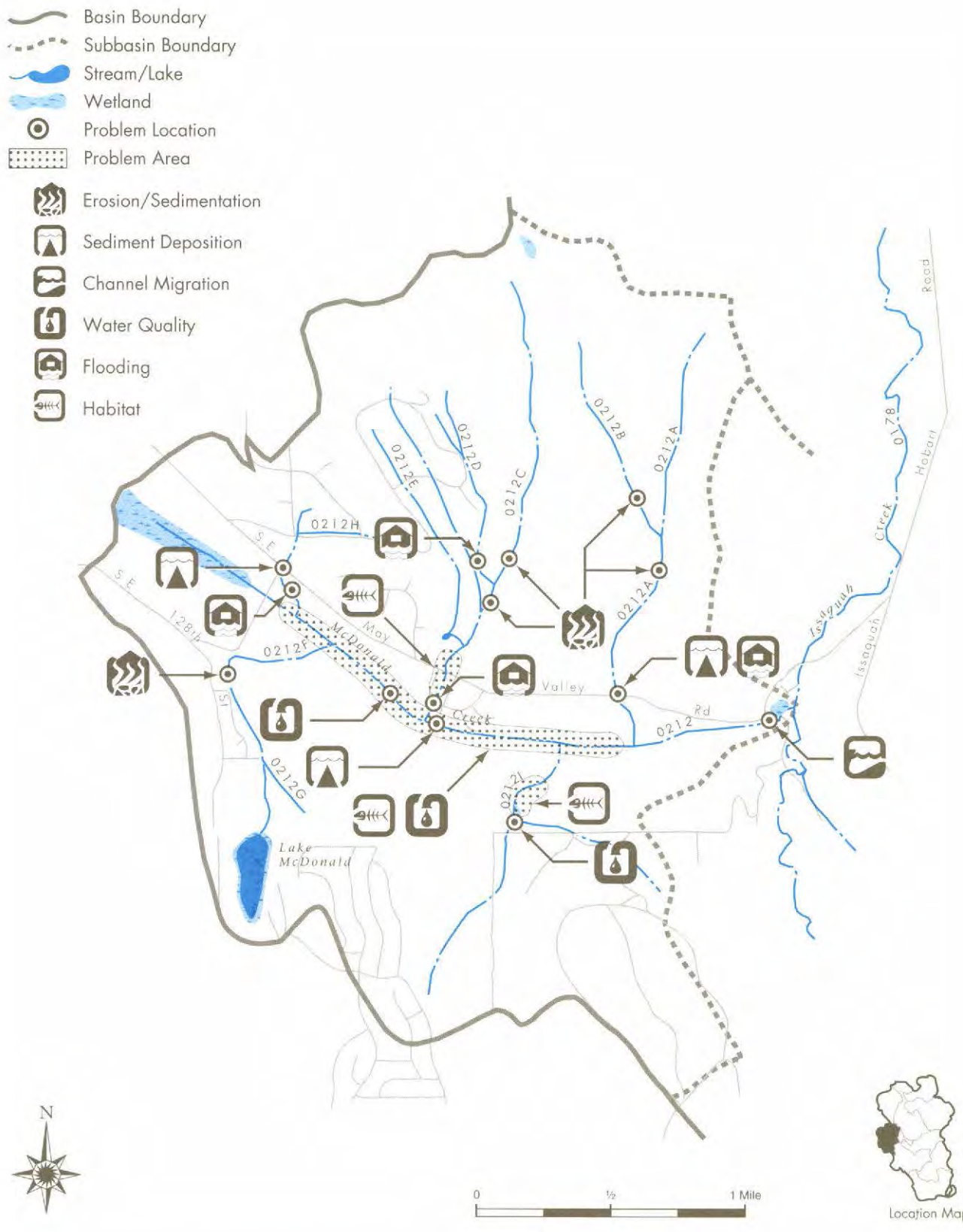
Estimated Cost: One-time (labor + materials) = $25,000.



McDONALD CREEK SUBBASIN RESOURCES

Issaquah Creek Basin

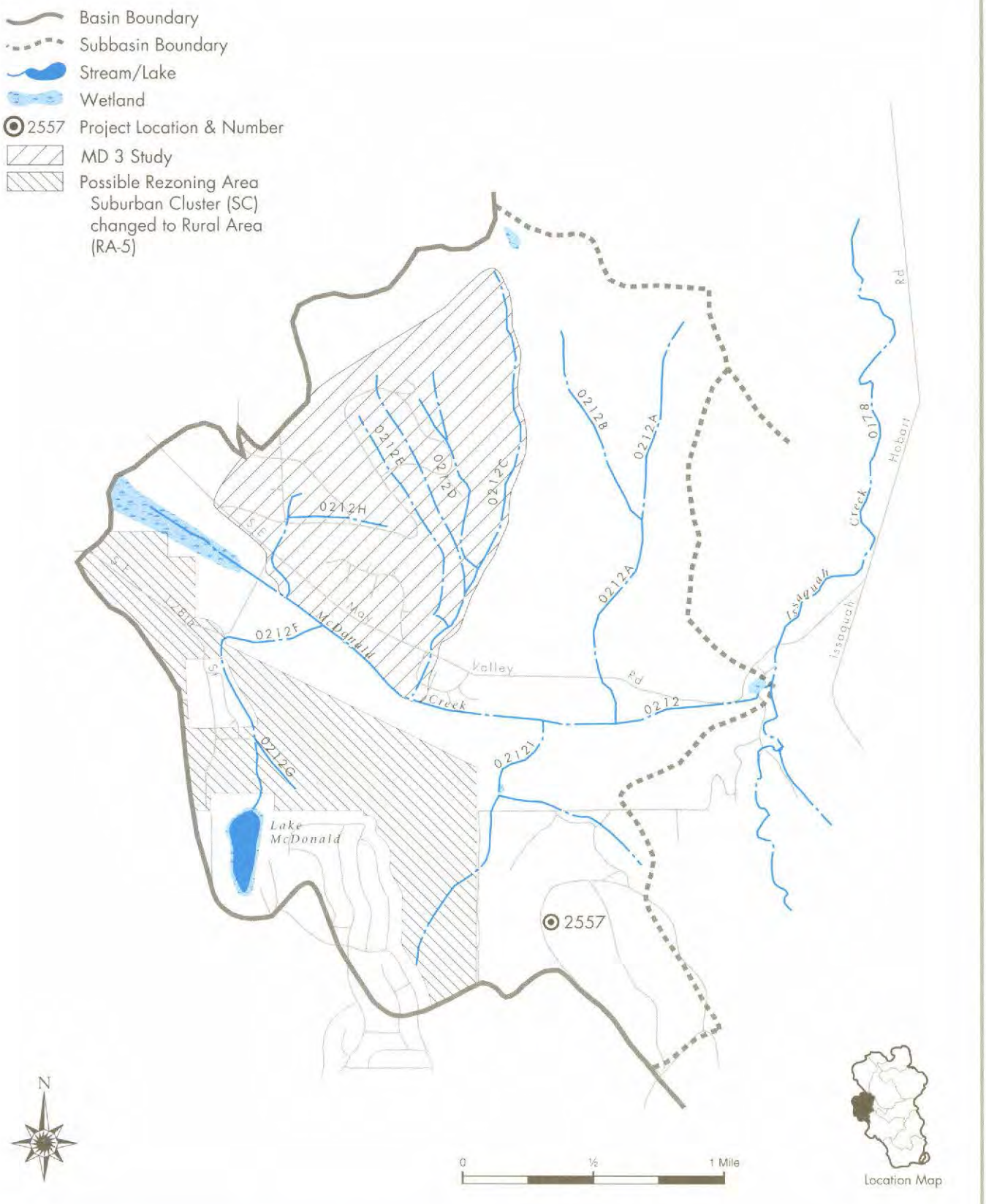
Figure 5-13



McDONALD CREEK SUBBASIN PROBLEMS

Issaquah Creek Basin

Figure 5-14



McDONALD CREEK SUBBASIN RECOMMENDATIONS

Issaquah Creek Basin

Figure 5-15

East Fork Issaquah Creek Subbasin

PREFACE

East Fork Issaquah Creek originates on the north slopes of Tiger Mountain and flows down steep mountainsides in a relatively narrow channel to its confluence with the mainstem in the much broader valley below (Figure 5-16). Throughout most of its 7.2-mile length, East Fork Issaquah Creek is a relatively energetic stream, which is expressed by numerous examples of recent bank erosion in its middle and upper reaches. As the creek emerges from this confining valley onto the floor of the main Issaquah Creek valley, much of the sediment eroded from upstream in the last several thousand years has formed a lobe-shaped alluvial fan underlying about 100 acres of the City of Issaquah, just west of the Sunset Way interchange.

Under projected unmitigated land-use changes in the East Fork Issaquah Creek subbasin, the current 25-year peak flow of 742 cubic feet per second is expected to increase by 22 percent. Floodplain modeling on the East Fork predicts that as many as 84 single-family residences, one multi-family residence, one public building, and nineteen commercial buildings could be at least partially flooded by 100-year future flood conditions, even with mitigation applied to new development. Depth of flooding could increase by as much as 0.7 feet, and the floodplain width is predicted to increase by as much as 180 feet in the lower portion of the stream.

The East Fork probably has seen greater physical alteration than any stream in the Issaquah Creek system, beginning with its early use as a flume for the transportation of logs during the 19th Century. Early logging practices were generally destructive to the forests and streams in the subbasin, and although present-day forest practices have improved somewhat, they still typically result in some stream-system degradation. A notable exception is occurring in the Tiger Mountain State Forest, where innovative forest management techniques are being tested.

Construction of Interstate 90 in the 1970's generated another set of problems for this stream system. During construction, the creek was diverted and confined in many locations. Runoff from Interstate 90, which is not detained for water quantity control or otherwise treated for water quality control, adds to the impacts on the system. The lack of quantity and quality control along Interstate 90 increases the likelihood of a significant impact to the East Fork if a chemical spill occurs.

The land surrounding the East Fork Issaquah Creek is at great risk of flooding. Two distinct flooding areas are identified and include the upper portion of the creek above High Point Road (overbank flooding in pasture and Interstate 90 areas during the January and November 1990 storms) and the area below the Sunset Way entrance to Interstate 90. Throughout this lower mile, the stream has been

armored and further constricted to facilitate home, road, and commercial construction. Many of the residential, commercial, and industrial structures located in the subbasin lie in the floodplain and experience frequent flooding.

Local bank erosion in the upper reaches of the East Fork is common, particularly where the reconstructed channel has been excessively confined by adjacent roadway fills. Erosion is also evident on many of the northern tributaries that flow steeply off Grand Ridge, especially those draining areas of past disturbance near the western subbasin boundary. Deposition of eroded sediment is not presently causing significant conveyance problems, except near the mouth of the creek at the Rainier Boulevard N bridge. However, zones of substantial sand deposition above the High Point interchange on Interstate 90 and local infilling of pools throughout the lower channel have probably reduced the habitat value of this stream.

Habitat in the East Fork system is in generally good condition and supports steelhead and resident anadromous strains of cutthroat trout throughout the system, as well as significant runs of sockeye, coho, and some chinook salmon in the lower reaches. Salmonids are prevented from moving farther upstream than RM 5.5, where a water intake dam has been constructed. This dam probably has only limited effect on fish production as stream gradients above the dam are quite steep, ranging up to 10 percent, and habitat is more suited to trout. Below this barrier, fish habitat is generally quite good, except for some severely channelized reaches in the lower portion of the stream within the City of Issaquah. The East Fork Issaquah Creek subbasin is designated a locally significant resource area (LSRA) in this plan.

RECOMMENDATIONS

Regulations

EF 1 Basinwide Regulations as Applied to East Fork Issaquah Creek Subbasin

1. Open-Space Retention Requirements (See also BW 3)

Recommendation: DDES should require that development of rural, residential land in this subbasin comply with the development standards specified in BW 3.

Discussion: In order to maintain the excellent water quality and aquatic habitat of the East Fork and prevent increases in downstream flooding, measures must be taken to limit the clearing of forest lands associated with residential development. The site development standards will ensure that large areas of forest land are preserved and disturbance to the natural hydrologic regime is minimized during and after development.

Estimated Cost: Estimated in BW 3.

EF 2 Factors for Evaluation of Master Planned Developments

Recommendation: The following factors should be considered by applicants and county review staff in scoping, preparation, and review of all proposed developments within this subbasin that meet requirements for preparation of a Master Drainage Plan (MDP) or Environmental Impact Statement (EIS) under King County codes.

1. The impacts of site development on the diversity, productivity, resilience, or habitat value of North Fork Wetland 7.

2. The impacts of site development on phosphorous loading from the tributaries draining to the North and East Forks of Issaquah Creek.

3. The impacts of site development on stream-channel erosion and transport of sediment to the North and East Forks of Issaquah Creek or Patterson Creek.

4. The impacts of site development on diversity and abundance of anadromous fish in the North and East Forks of Issaquah Creek or Patterson Creek; and

5. The impacts of site development on the frequency and duration of flood flows in the North and East Forks of Issaquah Creek.

Discussion: These evaluation factors are intended to provide guidance on particularly sensitive features of the East Fork and North Fork of Issaquah Creek to applicants and reviewers working on development of Grand Ridge and other potential Master Planned Developments in these subbasins.

Estimated Cost: One-time (permit review, development of mitigation measures at .5 FTE) = $30,000. Private costs and capital costs associated with mitigation not included.

Programs

EF 3 Channel and Floodplain Restoration

Recommendation: In order to implement the channel and floodplain restoration program defined in BW 7, the City of Issaquah, with technical assistance from King County SWM, should undertake the following actions in the East Fork subbasin:

1. Removal of homes from floodplains: Preliminary mapping indicates that there are 34 homes eligible for consideration in the purchase or relocation program. To estimate the cost of this program, the only houses included were those within a 125-foot-wide corridor that shifted laterally to include as few houses as possible. In this subbasin there are 20 homes within this assumed corridor. Estimated Cost (assuming 55% participation rate and $259,000 per home): $2,848,000.

2. Acquisition of Easements: Easements should be purchased on approximately 28 streamfront parcels along the East Fork. Estimated Cost (assuming 60% participation rate and $13,100 per easement): $221,000.

3. Removal of fill and bank stabilization structures and restoration: Most of the homes that should be purchased along the East Fork have fill, riprap, or revetments along their streambanks. Unless the stability of the channel prohibits, this material should be removed. All purchased property (including easements) should be regraded to natural contours, if necessary, and replanted in native riparian and floodplain species. On streamfront parcels that are not acquired, residents may seek assistance to remove fill and structures and revegetate the corridor through the programs defined in Basinwide Recommendations 22 and 23. Estimated Cost: $1,165,000.

4. Improvements in public access: The purchase and removal of homes along the stream between NE Creek Way and Front Street would create a continuous publicly-owned corridor, portions of which may be suitable for public access and recreational use. The proximity of this segment to downtown Issaquah increases its importance for public access. Estimated Cost (assuming development of one site): $100,000.

EF 4 Floodproofing and Elevation

Recommendation: At this time there are an estimated 96 structures in the 25-year floodplain that would be eligible for flood audits and loans for floodproofing and elevation under the program defined in BW 8. As the restoration recommended in EF 3 is carried out, the width of the floodplain may be reduced, and fewer structures may require floodproofing.

Estimated Cost: One-time audit = $67,200 ; One-time floodproofing and elevation (35% participation) = $252,000.

EF 5 Retrofitting of Interstate 90 Stormwater Drainage System

Recommendation: The Washington State Department of Transportation, in coordination with SWM, should establish retrofit priorities for the Interstate 90 drainage systems that discharge to East Fork Issaquah Creek. This effort should focus on the feasibility of retrofitting for water quality control and preliminary cost estimates. Subsequently, WSDOT should pursue funding to retrofit the identified priority systems. When and if funding from the State legislature is authorized for implementation of the Puget Sound Highway Runoff Program (WAC 173-270) and NPDES requirements, the East Fork Issaquah Creek portion of Interstate 90 should receive priority, on a region-wide basis, for retrofit of the stormwater drainage system. Detailed design of the retrofits would follow.

Discussion: This recommendation would involve retrofitting the existing stormwater drainage system along Interstate 90 for water quality treatment to reduce heavy metal and sediment loadings to the East Fork. There are approximately 50 outfalls from Interstate 90 in this subbasin from which highway runoff is discharged. Only a few outfalls receive treatment via biofiltration swales prior to discharge to the creek. Outfalls draining substantial road areas where retrofitting is feasible should be prioritized for capital improvement projects to perform these retrofits. These retrofits might include maximizing runoff treatment in existing vegetated swales in the median or along shoulders, planting wetland vegetation in some swales, and riprap protection of outfalls. Preliminary field work by SWM staff has identified potential sites for retrofitting.

Estimated Cost: Unknown (dependent on eventual project scope).

Capital Improvement Projects

1411 NE Dogwood Street Bridge Hydraulic Constriction Elimination

Recommendation: The City of Issaquah should reconstruct the NE Dogwood Street bridge to improve conveyance.

Discussion: Channel constriction and past bank armoring have caused severe channel constraints that contribute to bank destabilization, channel erosion, and localized flooding. Conveyance improvements for the NE Dogwood Street bridge are recommended to eliminate several problems associated with the present hydraulic constrictions to higher flows. As a integral part of the conveyance improvements analysis, both upstream and downstream impacts from changes in the bridge geometry should be evaluated to avoid worsening any existing problems. All work should be performed to minimize stream habitat disturbance and with the appropriate permits from WDFW.

Estimated Cost: One-time = $250,000.

1412 Bar Scalping at RM 0.75 and 1.00

Recommendation: The City of Issaquah should perform bar scalping to remove past sediment accumulation at RM 0.75 and 1.00. The bars should be scalped above the summer water surface elevation to remove approximately 200 cubic yards of sediment.

Discussion: Sediment accumulation represents a serious problem only in several localized areas of the East Fork and, thus, only limited removal or bar scalping is recommended. These sites, at RM 0.75 and 1.00, provide the best opportunity for significant sediment removal with minimal environmental impact. All work should

be performed to minimize habitat disturbance and with the appropriate hydraulic approvals from WDFW.

Estimated Cost: One-time = $44,2000.

1413 Dogwood Street Bank Stabilization

Recommendation: The City of Issaquah, using the guidelines developed in BW 23, should insure the stability of streambanks adjacent to public roads, targeting first the area of most severe risk for bank failure (approximately 50 lineal feet along Dogwood Street just below the Crescent Street footbridge).

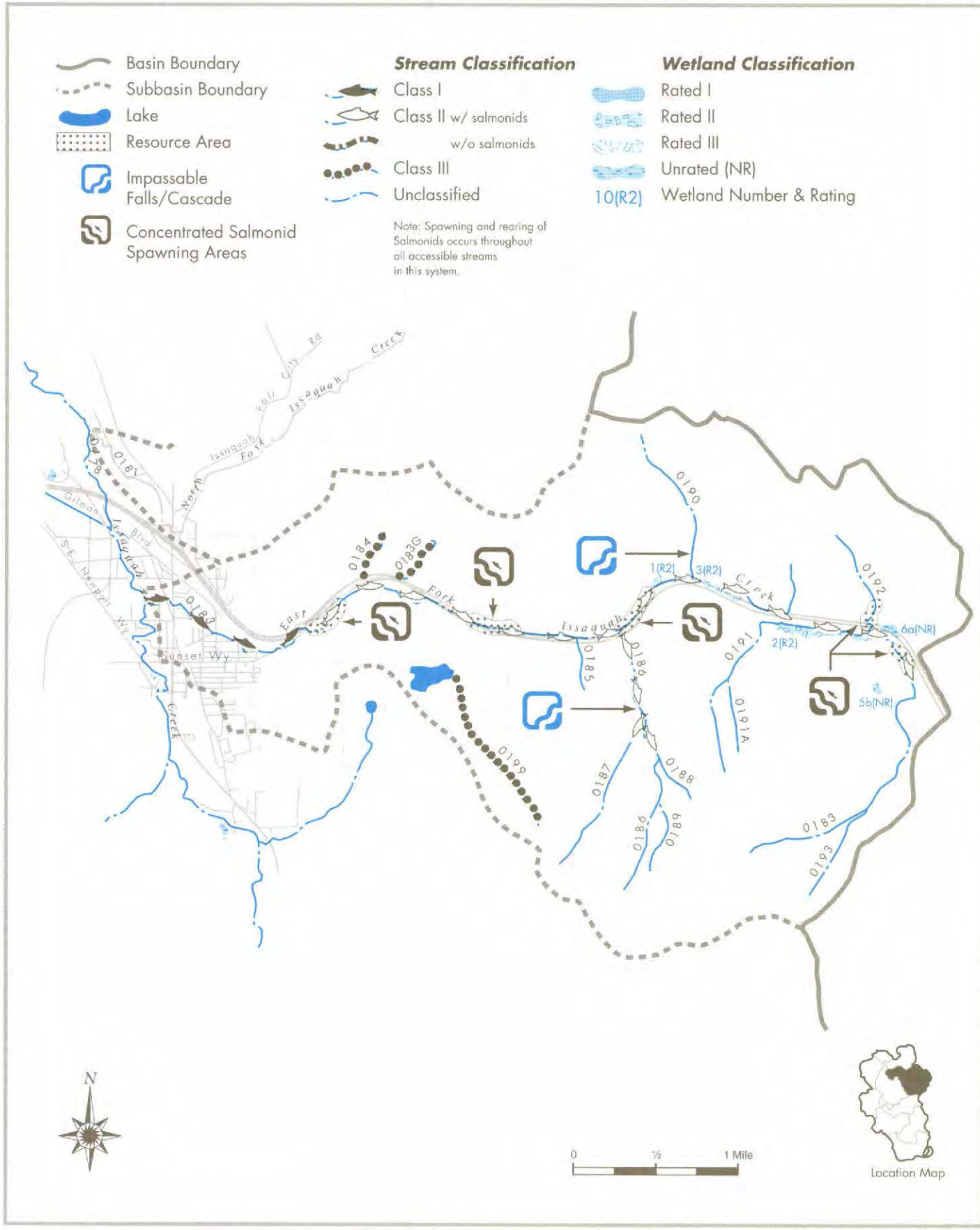
Estimated Cost: One-time = $95,800. This cost may be offset in part by funding of BW 23.

1499 Large Woody Debris Placement

Recommendation: The City of Issaquah and King County SWM should restore aquatic habitat by placing large woody debris in the channel.

Discussion: Sediment deposition in the lower East Fork of Issaquah Creek has caused localized flooding problems in the City of Issaquah. This project calls for the placement of large woody debris elements in the middle reaches of the East Fork (various locations RM 0.8-6.2) in order to stabilize the channel bed and aid in the retention of gravel in the channel. (See also BW 22.)

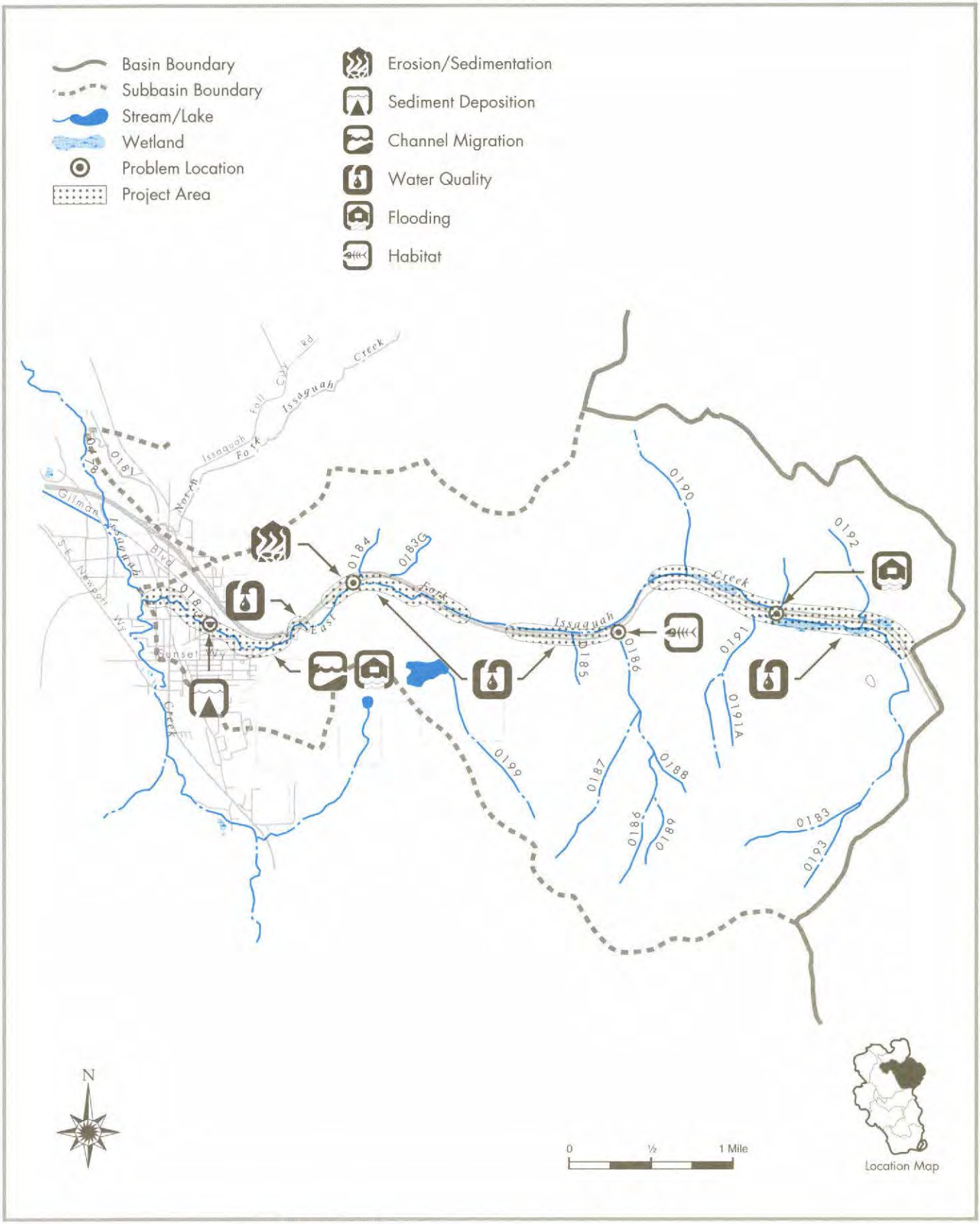
Estimated cost: $71,100. This cost may be offset in part by funding of BW 22.



EAST FORK ISSAQUAH CREEK SUBBASIN RESOURCES

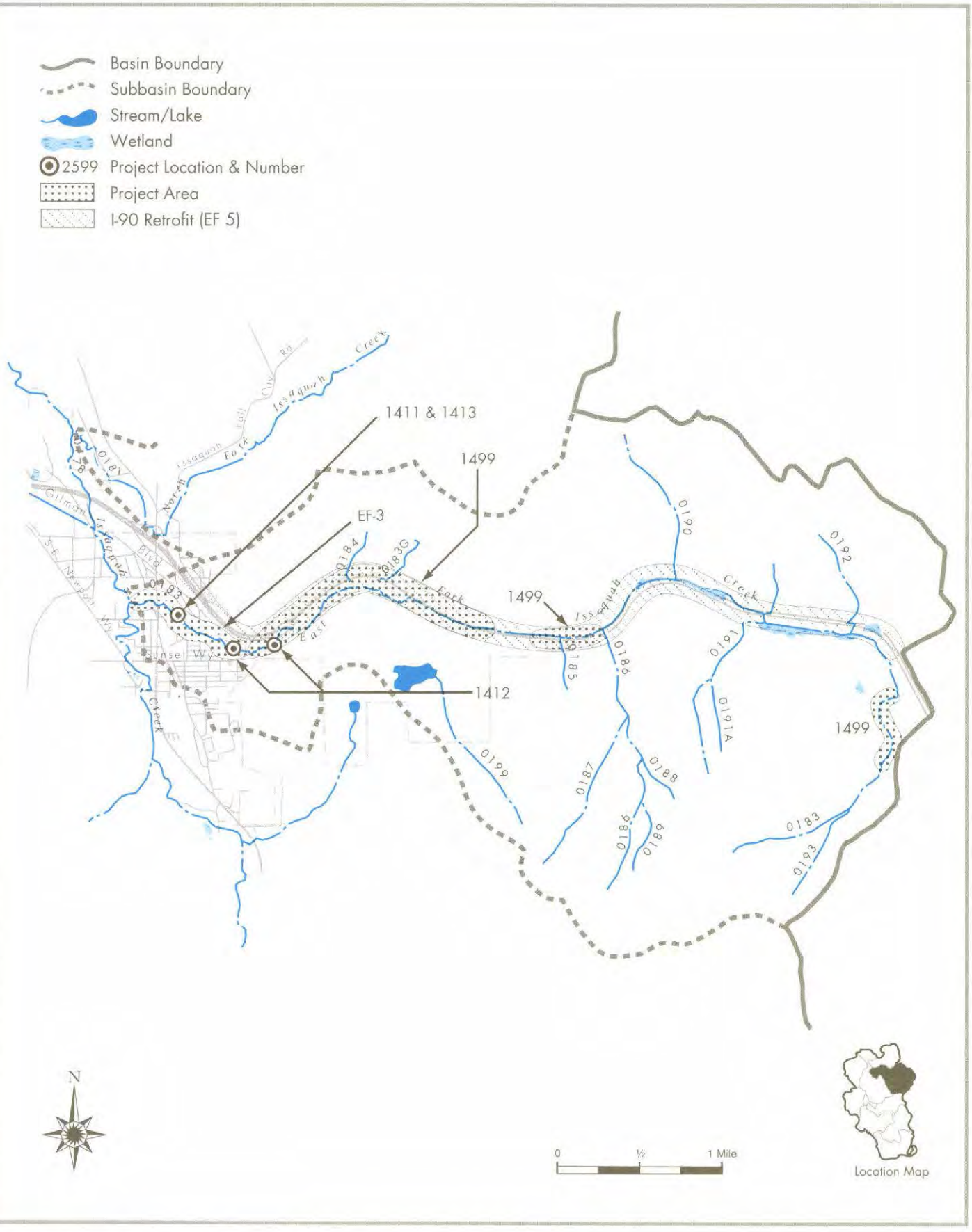
Issaquah Creek Basin

Figure 5-16



EAST FORK ISSAQUAH CREEK SUBBASIN PROBLEMS
Issaquah Creek Basin

Figure
5-17



EAST FORK ISSAQUAH CREEK SUBBASIN RECOMMENDATIONS

Issaquah Creek Basin

Figure 5-18

North Fork Issaquah Creek Subbasin

PREFACE

This subbasin covers 2,855 acres (4.5 square miles) of mainly low elevations (Figure 5-19). The North Fork Issaquah Creek, also known locally as Jordan Creek, begins at Yellow Lake on the forested slopes of Grand Ridge and flows 3.7 miles to its confluence with mainstem Issaquah Creek at river mile 1.8. The upper reaches of the North Fork occupy a prehistoric glacial meltwater channel, forming a low-gradient stream fed by four much steeper lateral tributaries. The lower North Fork channel, in contrast, cuts down at the edge of the valley, abruptly dropping 200 feet at a 10-percent gradient to the valley floor.

At present, flooding is confined largely to the lower portion of the channel below East Lake Sammamish Parkway SE. The gradient in this portion of the stream is relatively flat, and residences are constructed close to the banks of the channel. At least nine houses and several commercial structures (storage buildings) are within the future 100-year floodplain on the North Fork.

Approximately 72 percent of the subbasin is presently covered by forests, the remainder consisting of high-density single-family residential subdivisions and a gravel mining operation. If the subbasin is fully developed according to existing zoning, the amount of forested land could drop to less than half its present level, and impervious surfaces could increase from three to near eighteen percent. Under these future conditions, the presently low peak flows, which are a result of current land cover, are expected to increase substantially. For example, the current 2-year peak flows of 73 cubic feet per second (cfs) would nearly double to 130 cfs. This is a worst-case analysis of the present zoning, without detention facilities to reduce flows.

The forests of the North Fork include substantial, Class 1 wetlands, particularly North Fork Wetlands 5 and 7. Aside from hydrologic benefits, these wetlands provide habitat for an unusually large number of wildlife species, including pileated woodpecker, white-tailed deer, coyote, cutthroat trout, and black bear. The rapid development that characterizes the North Fork Issaquah Creek subbasin, poses a threat to these remarkable wetland resources.

Increasing development of this subbasin is likely to change its hydrology, changing the patterns that presently support valuable wetland habitats, provide flood storage capacity, and maintain water quality. Although development will unavoidably increase the impervious surfaces and decrease vegetation, these detrimental effects can be alleviated by a combination of corrective actions for off-site problems and an on-site strategy that minimizes detrimental impacts. Because development is expected to have a significant impact on the hydrologic systems in general, as well as on the wetlands, zoning decisions are of great concern in this subbasin.

RECOMMENDATIONS

Regulations

NF 1 Basinwide Regulations as Applied to North Fork Issaquah Creek Subbasin

1. Open-Space Retention Requirements (See also BW 3)

Recommendation: DDES should require that development of rural, residential land in this subbasin comply with the development standards specified in BW 3.

Estimated Cost: Estimated in BW 3.

NF 2 Factors for Evaluation of Master Planned Developments

Recommendation: The following factors should be considered by applicants and county review staff in scoping, preparation, and review of all proposed developments within this subbasin that meet requirements for preparation of a Master Drainage Plan (MDP) or Environmental Impact Statement (EIS) under King County codes.

1. The impacts of site development on the diversity, productivity, resilience, or habitat value of North Fork Wetland 7.

2. The impacts of site development on phosphorous loading from the tributaries draining to the North and East Forks of Issaquah Creek.

3. The impacts of site development on stream channel erosion and transport of sediment to the North and East Forks of Issaquah Creek or Patterson Creek.

4. The impacts of site development on diversity and abundance of anadromous fish in the North and East Forks of Issaquah Creek or Patterson Creek; and

5. The impacts of site development on the frequency and duration of flood flows in the North and East Forks of Issaquah Creek.

Discussion: These evaluation factors are intended to provide guidance on particularly sensitive features of the East Fork and North Fork of Issaquah Creek to applicants and reviewers working on development of Grand Ridge and other potential Master Planned Developments in these subbasins.

Estimated Cost: One-time (permit review, development of mitigation measures at .5 FTE) = $30,000. Private costs and capital costs associated with mitigation not included.

NF 3 Wetland 7 Management Area

Recommendation: In order to prevent further degradation of North Fork Wetland 7, the largest riparian wetland in the Issaquah Creek basin, the following performance standards should apply to all new subdivisions, short subdivisions, and Master Planned Developments in the area draining to the wetland:

1. Impervious surfaces within the subdivision or short subdivision, including surfaces associated with all structures, driveways, and roads within the development, should be limited to a maximum of eight percent.

2. For all lands draining to Wetland 7, on-site R/D facilities should be designed to the standard specified in BW 2. In addition, the stormwater conveyance, detention, and discharge facilities should maximize infiltration potential to recharge the groundwater on which Wetland 7 depends. Whenever possible, the drainage system should use perforated pipes in gravel trenches for stormwater conveyance and dispersal systems in undisturbed vegetation for stormwater discharge, and the detention ponds should be designed to encourage infiltration.

Discussion: This Class I wetland exhibits a variety of high quality habitat types and plant communities, including a section of forested peat bog. It is heavily used by birds, large mammals, and beavers. The wetland is very sensitive to the inevitable increases in flow volumes that result from development. Because these volumes are not adequately controlled by standard detention or other engineering mitigations, the amount of impervious area draining to the wetland must be tightly limited to protect this wetland's function.

Estimated Cost: One-time (permit review at .25 FTE) = $15,000. No capital costs for mitigation to standards are included.

Programs

NF 4 Channel and Floodplain Restoration

Recommendation: In order to implement the channel and floodplain acquisition program defined in BW 7, King County SWM should undertake the following actions in the North Fork subbasin:

1. Removal of homes from floodplains: Preliminary mapping indicates that there are four homes eligible for consideration in the purchase or relocation program. To estimate the costs of this program, the only houses included were those within a 125-foot-wide corridor that shifted laterally to include as few houses as possible.

In this subbasin there are two homes within this assumed corridor. Estimated Cost (assuming 50% participation rate and $180,000 per home): $180,000

2. Acquisition of Easements: Easements should be purchased on approximately 22 streamfront parcels along the North Fork. Estimated Cost (assuming 60% participation rate and $13,000 per easement): $172,000.

3. Removal of fill and bank stabilization structures and restoration: Many of the properties along the North Fork proposed for purchase of property or easements have fill, riprap, or revetments along their streambanks. Unless the stability of the channel prohibits, this material should be removed. All purchased property (including easements) should be regraded to natural contours, if necessary, and replanted in native riparian and floodplain species. On streamfront parcels that are not acquired, residents may seek assistance to remove fill and structures and revegetate the corridor through the programs defined in Basinwide Recommendations 22 and 23. Estimated Cost: $510,000.

4. Improvements in public access: No improvements in public access are likely along the North Fork. Estimated Cost: $0

NF 5 Floodproofing and Elevation

Recommendation: At this time there are an estimated 3 structures in the 25-year floodplain that would be eligible for flood audits and loans for floodproofing and elevation under the program defined in BW 8. As the restoration recommended in NF 4 is carried out, the width of the floodplain may be reduced, and fewer structures may require floodproofing.

Estimated Cost: One-time audit = $2,100 ; One-time floodproofing and elevation (35% participation) = $7,500.

Capital Improvement Projects

4612 Water Quality Improvements for North Fork Wetland 5 (Yellow Lake)

Recommendation: King County SWM should undertake the following actions to improve water quality in Wetland 5.

1. Reinforce the eroded portion of an earthen berm separating the forebay and Yellow Lake with large riprap or appropriate bioengineering techniques to prevent erosion during peak flows.

2. Acquire and revegetate a 25-foot buffer with native vegetation along the tributary 0182 biofiltration swale in the Klahanie development.

Discussion: This project addresses water quality degradation of Wetland 5 through improved treatment of stormwater and reduction in potential pollutant sources. Reinforcing the eroded portion of the earthen berm will reduce erosion during peak flows and trap sediments during lower flows. Revegetation of the swale buffer will improve runoff quality through stormwater filtering and reduced erosion.

Estimated Cost: One-time = $60,000.

4613 Habitat Improvements for North Fork Wetland 5 (Yellow Lake)

Recommendation: King County SWM should undertake the following actions to improve habitat in Wetland 5. Where possible, improvements should be required as mitigation for continuing development in Klahanie.

1. Restore and, where possible, widen existing buffers by replanting degraded or excessively narrow buffer areas with native vegetation. Buffer areas near trails could be restored by cessation of mowing.

2. Collect and dispose of trash during annual "Spring Clean" and other volunteer events.

3. Eradicate purple loosestrife by hand pulling, and, if necessary, spot treatment with an approved herbicide.

4. Post interpretive signs explaining wetland and buffer functions and requesting that people approach the wetland only at formal viewing areas. At least one of the signs should identify purple loosestrife and what to do if it is seen.

Estimated Cost: One-time = $36,000.

4614 North Fork Wetland 7 Habitat Improvements

Recommendation: King County SWM should undertake the following actions to improve habitat in Wetland 7:

1. Where easements or rights-of-entry can be acquired, remove fill, restore hydrology by plugging old wetland drainage structures, and replant disturbed portions of Wetland 7 and its buffer. Emphasis should be placed on use of cedar and spruce seedlings to accelerate restoration of forested swamp conditions.

2. Collect and dispose of trash during annual "Spring Clean" and other volunteer events. Prevent continued dumping by gating off powerline rights-of-way and other unpaved roads in Wetland 7 and its buffer.

3. Post interpretive signs explaining wetland/stream and buffer functions. At least one of the signs should identify purple loosestrife and what to do if it is seen.

Discussion: Numerous large conifer stumps, snags, and downed logs are present throughout the wetland, attesting to its recent history and future restoration potential as a cedar swamp. Protection of the wetland's hydrology, restoration of forested conditions, trash cleanup, and prevention of noxious plant invasion will help protect and restore this regionally significant resource and the vital functions it performs within the watershed.

Significant opportunity remains to protect and restore Wetland 7 through a combination of catchment-level and local-level mitigations aimed at protecting its most vital element: wetland hydrology.

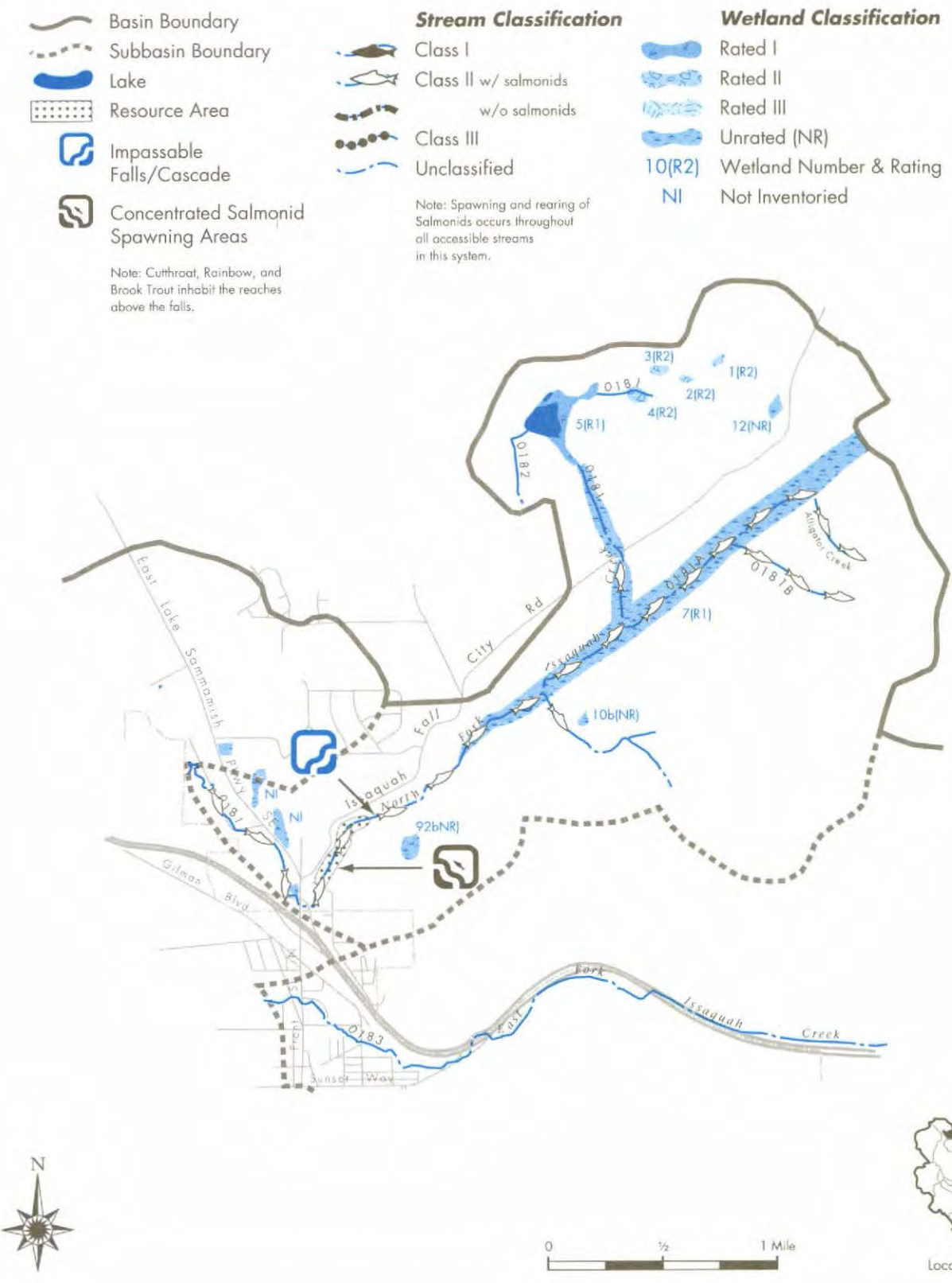
Estimated Cost: One-time = $287,900.

4615 Klahanie Stormwater Facility Improvements

Recommendation: Four or five stormwater facilities in the Klahanie development should be retrofitted to provide enhanced water quality treatment of stormwater. To determine where the greatest water quality improvements could be attained cost-effectively, King County SWM should conduct a limited study to evaluate existing detention ponds, wet ponds, ditches, and swales.

Discussion: Many stormwater facilities in the Klahanie development were designed and constructed prior to the development of the existing Surface Water Design Manual. Several of these facilities could be retrofitted to provide greater water quality treatment. Potential retrofits include small-scale revegetation of swales and ponds, outlet structure modifications, and increasing existing pond volumes. Preliminary field evaluations have identified candidate stormwater facilities for retrofitting to improve their water quality effectiveness.

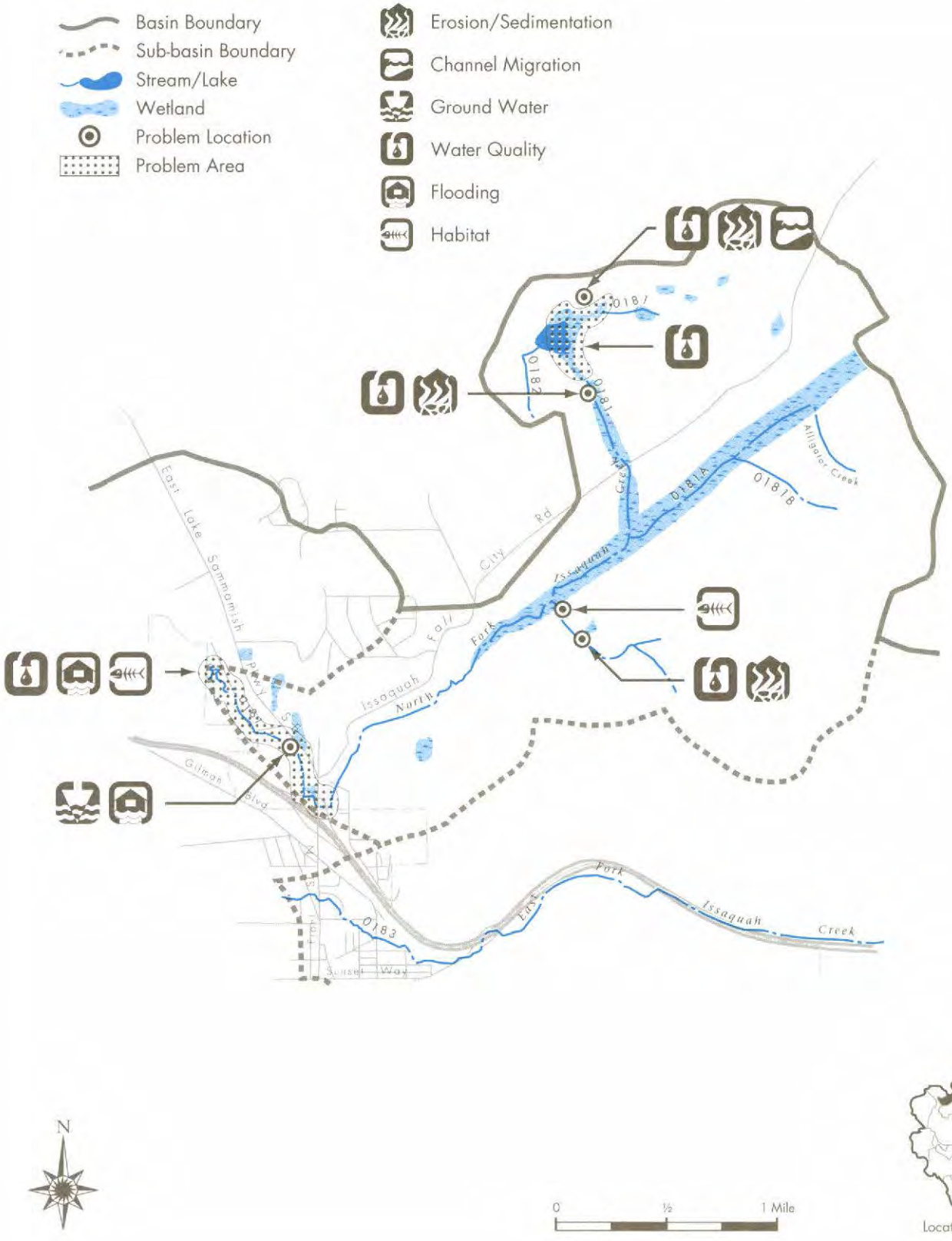
Estimated Cost: One-time = $200,000.



NORTH FORK ISSAQUAH CREEK SUBBASIN RESOURCES

Issaquah Creek Basin

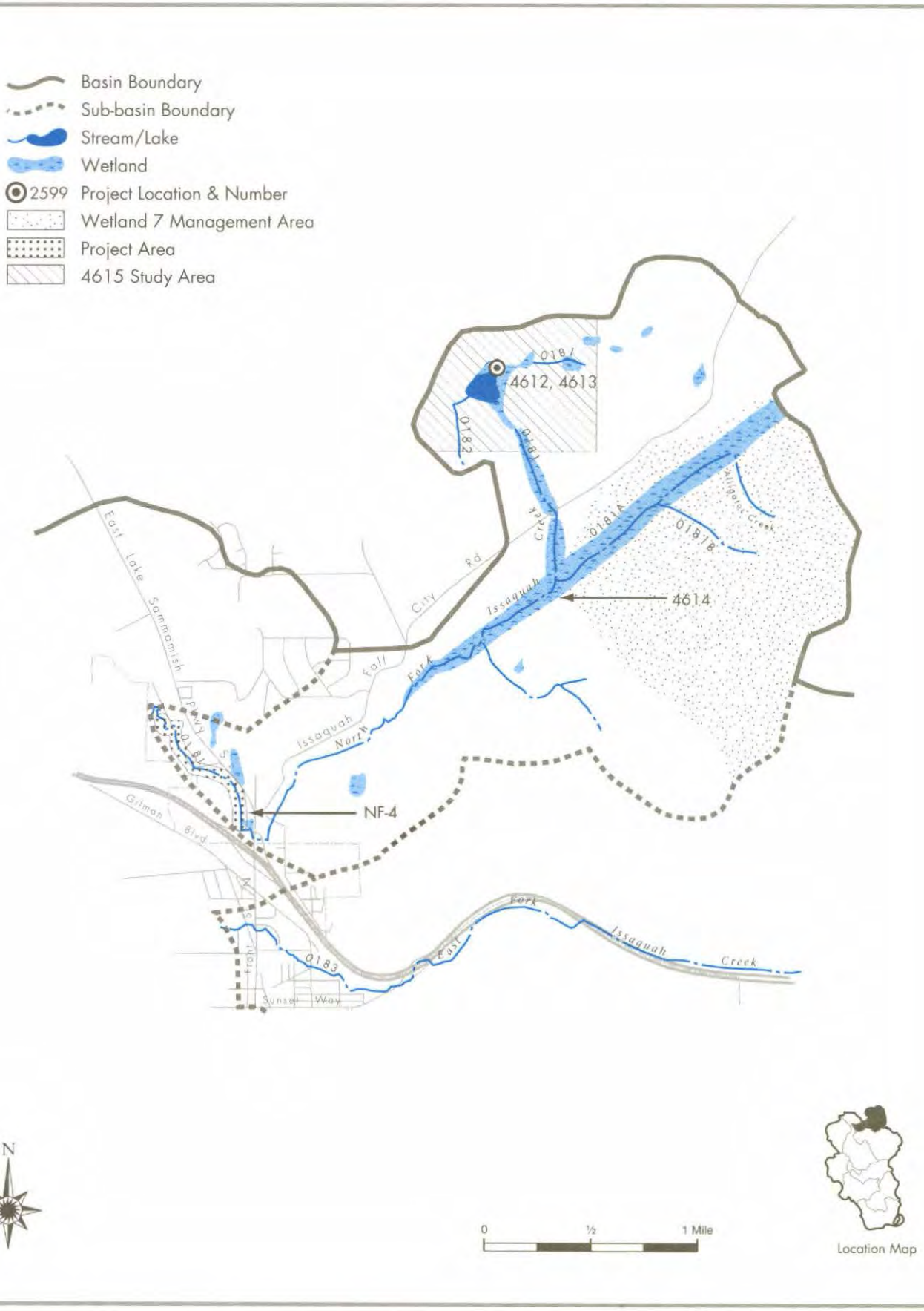
Figure 5-19



NORTH FORK ISSAQUAH CREEK SUBBASIN PROBLEMS

Issaquah Creek Basin

Figure 5-20



NORTH FORK ISSAQUAH CREEK SUBBASIN RECOMMENDATIONS
Issaquah Creek Basin

Figure 5-21

Lower Issaquah Creek Subbasin

PREFACE

The Lower Issaquah Creek subbasin covers 5,708 acres within and just upstream of the City of Issaquah in the narrow valley between Squak and Tiger Mountains (Figure 5-22). The City of Issaquah and its associated development dominate much of this subbasin, which has been severely altered by both natural processes and human activities over the last several decades. In Issaquah Creek's lower reaches, the most important of the natural processes are stream-channel migration and high levels of sedimentation and flooding. Historic and present development has exacerbated these conditions, and the subbasin is confronted by a future in which existing problems will worsen as streamflows increase.

The Lower Issaquah Creek subbasin experiences the most serious flood damage of any subbasin. Property losses from flooding are the most extensive in the Issaquah Creek basin. The worst damage occurs in the reach between NW Clark Street and NW Holly Street. Flooding of roads regularly occurs at NW Clark Street, Front Street S, and Gilman Boulevard. Culverts conveying streams underneath the Issaquah-Hobart Road often clog with sediment resulting in road closures and periodic maintenance. The stream channel adjacent to Front Street frequently overflows its right bank, flooding several homes. Residential, commercial, and public buildings from SE Sycamore Place to Gilman Boulevard are sandbagged during major storms to minimize flood damage. Pasture and yard flooding, as well as bank erosion, occur during major storms along Issaquah Creek from the confluence of McDonald Creek to SE Sycamore Place. If the entire basin were to build out to current zoning, but without mitigation, the 25-year peak flow at the mouth of Issaquah Creek is predicted to increase 21 percent from the current 3,478 cfs to 4,210 cfs. Such peak flows would cause corresponding increases in floodplain elevations, especially if current land uses continue to intensify adjacent to the creek.

The lowermost seven-mile-reach of Issaquah Creek, together with its local tributaries, include some of the most active channel conditions in the basin. Channel infilling, bank erosion, and channel migration are all active in portions of this subbasin. Infilling of the channel by sediment through the City of Issaquah is reducing flood capacity, a growing problem primarily because of the severe encroachment into the floodplain of Issaquah Creek by roads, houses, and commercial buildings.

Lateral tributaries flowing off Squak Mountain carry significant amounts of sediment into Issaquah Creek. In part, this is the result of headwater development with minimal or no detention. No Name and Nudist Park Creeks are major contributors to the sediment load to the valley of lower Issaquah Creek. Sediment originates in their headwaters where extensive, recent logging has induced erosion in steep channels. Problems of erosion and deposition in the steep tributaries, and migration and infilling of the mainstem, are largely driven by the magnitude of

flows in the channel. Development-induced flow increases are likely to accelerate the rate of these processes without effective mitigation.

The section of the mainstem from its confluence with Lake Sammamish to SE 56th Street (RM 1.7) serves primarily as transport and rearing habitat for salmonids and provides spawning areas for bass, perch, and suckers from the lake. Throughout this reach, mean stream width is over 30 feet, and pools often exceed six feet in depth and 2,000 square feet in surface area. The streambed is mostly fine sand and silt. The stream flows over floodplain sediments of its own deposition. Operation of the State fish hatchery has also been affected by sediment loads. Coarse sediment descending Cabin Creek has contributed to partial clogging of the main hatchery water intake.

Upstream, toward SE 56th Street, the channel assumes a pool:riffle character excellent for spawning salmonids, as evidenced by the number and size of the redds (salmonid egg nests) and by the presence of juvenile chinook, coho, steelhead salmon, and adult resident cutthroat and rainbow trout. Residences line the banks above SE 56th Street and reduce the riparian habitat to less than 100 feet in most places. Habitat is sufficient for chinook, coho, and sockeye to be observed spawning throughout this reach. Upstream of Interstate 90 (RM 2.3), to about SE 96th Street, the creek flows through the main portion of the City of Issaquah. Lack of cover in this reach provides little habitat for fish or riparian-zone wildlife species.

RECOMMENDATIONS

Regulations

LI 1 Basinwide Regulations as Applied to Lower Issaquah Subbasin

1. Open-Space Retention Requirements

Recommendation: DDES should require site development standards pursuant to BW 3 in this subbasin.

Discussion: The site development standards of BW 3 would allow additional development over what is currently allowed in the residential zones if the bonusing provisions are enacted, while keeping more land in forest uses. Outside of sensitive areas such as floodplains, steep slopes, and wetlands, the lowlands in this subbasin are relatively unconstrained. Additional development in residential zones could be permitted if large (80% of plat area), forested open-space tracts are included for the basinwide hydrologic benefits of forest land cover. DDES will administer the new zoning and standards.

Estimated Cost: Included in BW 3.

Programs

LI 2 Channel and Floodplain Restoration

Recommendation: In order to implement the channel and floodplain acquisition program defined in BW 7, King County SWM and the City of Issaquah should undertake the following actions in the Lower Issaquah subbasin:

1. Removal of homes from floodplains: Preliminary mapping indicates that there are 44 single-family and seven multi-family homes eligible for consideration in the purchase or relocation program. To estimate the costs of this program, the only houses included were those within a 125-foot-wide corridor that shifted laterally to include as few houses as possible. In this subbasin there are 25 single-family and three multi-family homes within this assumed corridor. Estimated Cost (assuming 55% participation rate and $298,000 per home for single-family property and 33% participation and $2,043,000 per multifamily building): $6,140,000.

2. Acquisition of Easements: Easements should be purchased on approximately 107 streamfront parcels along the lower mainstem. Estimated Cost (assuming 60% participation rate and $13,000 per easement): $835,000.

3. Removal of fill and bank stabilization structures and restoration: Most of the homes that should be purchased along the lower mainstem, and some of the properties eligible for easement purchase, have fill, riprap, or revetments along their streambanks. Unless the stability of the channel prohibits, this material should be removed. All purchased property (including easements) should be regraded to natural contours, if necessary, and replanted in native riparian and floodplain species. On streamfront parcels that are not acquired, residents may seek assistance to remove fill and structures and revegetate the corridor through the programs defined in Basinwide Recommendations 22 and 23. Estimated Cost: $2,087,000.

4. Improvements in public access: Two areas along the lower mainstem of Issaquah Creek, upstream of the Clark Street Bridge and within the Sycamore subdivision, have many contiguous houses that are recommended for removal or relocation. Portions of these and other areas should be evaluated for improvements in public access and use. Estimated Cost (assuming development of two sites): $200,000

LI 3 Floodproofing and Elevation

Recommendation: At this time there are an estimated 113 structures in the 25-year floodplain that would be eligible for flood audits and loans for floodproofing and elevation under the program defined in BW 8. As the restoration recommended in LI 2 is carried out, the width of the floodplain may be reduced, and fewer structures may require floodproofing.

Estimated Cost: One-time audit = $79,100; One-time floodproofing and elevation (35% participation) = $297,000.

LI 4 Management of the Issaquah Hatchery

Recommendation: Under the provisions of BW 24, a task force should be convened to develop recommendations for harvest management, hatchery operation (including outplanting), habitat protection, and wild stock identification and protection within the Issaquah watershed. This task force should be a subset of members of the Lake Washington Ecosystem study steering committee that is to be established as a coordinating body for comprehensive studies of the Lake Washington watershed. Among other issues, the task force should investigate the potential of modifying the management of the hatchery to emphasize research, education, and natural salmon production in the Issaquah basin. This task force would present these recommendations to the co-managers of the Issaquah salmonid stocks for consideration.

Discussion: For more information on this recommendation, see BW 24.

Estimated Cost: Included in BW 24.

Capital Improvement Projects

2522 Tributary 0199 Fish Passage Enhancement

Recommendation: King County Roads and SWM should replace the undersized culverts that carry tributary 0199 underneath 238th Way SE and Issaquah-Hobart Road with utility vault structures (three-sided concrete box culverts) designed to allow the channel to function as a natural stream system.

In addition, a 30' by 200' area overgrown by blackberry bushes on both sides of tributary 0199 from the Issaquah-Hobart Road to the confluence with the mainstem of Issaquah Creek should be cleared. This area should be revegetated with native riparian plants and coniferous trees.

Discussion: Tributary 0199 is engulfed by blackberry bushes from its mouth to the Issaquah-Hobart Road crossing. The intertwining growth of vines has encroached upon the natural channel and hinders passage of salmonids. Removal of the blackberry bushes and the subsequent revegetation of the adjacent riparian corridor will improve fish passage and provide shade cover for salmonids and other species of flora and fauna.

Replacement of the culverts underneath Issaquah-Hobart Road and 238th Way SE is also necessary to reestablish fish passage (for all species of concern) to the upper watershed. These improvements made to ensure the passage of salmonids

beyond 238th Way SE are vital to the success of project 2599H, which is a pilot for cumulative restoration of habitats in the Issaquah Creek basin.

Estimated Cost: One-time = $297,400.

2523 Tributary 0200 Sediment Management

Recommendation: King County Roads and SWM should replace the tributary 0200 culverts underneath 238th Way SE and Issaquah-Hobart Road with utility vault structures (three-sided concrete box culverts) sized to accommodate sediment transport through the reach.

In addition, between 238th Way SE and Issaquah-Hobart Road, an area approximately 4' deep by 30' wide and 100' long should be excavated to function as a sediment trap with sloped sidewalls to provide access. Maintain the trap by periodically removing the accumulated sediment. Also remove sediment from the deposition zone upstream of 238th Way SE.

Discussion: The change in channel gradient just upstream of 238th Way SE forms a natural zone of sediment deposition that extends to Issaquah-Hobart Road. The natural sediment-transport and alluvial fan processes of tributary 0200 have been interrupted by the construction of roads and the ornamental channelization of the stream through private properties. During the 1990 storm events, copious amounts of sediment settled out in the deposition zone, overtopping both Issaquah-Hobart Road and 238th Way SE. After the storms several cubic yards of material were removed from private property above and below 238th Way SE. During the removal process the existing channel was obliterated and graded into a flat channel-less wide area that is being invaded by blackberry bushes. The utility vault replacements at 238th Way SE and Issaquah-Hobart Road and excavation of a sediment trap will allow transport of sediment and eliminate road overtopping.

Estimated Cost: One-time = $335,000.

2524 Tributary 0203 Stream Channel Relocation/Restoration

Recommendation: With design assistance from King County SWM, the Roads Division should relocate the stream away from a roadside ditch by constructing a new fish-passable crossing underneath the Issaquah-Hobart Road and a 1000-foot section of channel with a riparian corridor in an adjacent field. The new channel would be designed to integrate in-stream diversity features, along with pool:riffle habitat, into the riparian zone.

Discussion: Degraded habitat is apparent throughout the subbasin. This project will create a 1000-foot section of channel and riparian corridor through a nearby open field, restoring an historically important aquatic resource.

Estimated Cost: One-time (labor and materials) = $491,700. May be partly offset by funding for BW 22.

2525 Nudist Park Creek Fish Passage

Recommendation: In the summer of 1993 the King County Roads Division replaced the two culverts underneath the Issaquah-Hobart Road with one bottomless box culvert. Upstream of the road crossing, they removed the 4' to 5' vertical rock wall and constructed a series of boulder-cobble stream terraces to provide fish passage. This project should be monitored for at least two years after construction to evaluate the effectiveness of the fish passage project and the upstream sediment control (project 2599A) during the five-year or greater storm event. King County Surface Water Management provided technical assistance and will do the monitoring and any additional fish passage work needed.

Discussion: In emergency repair work following flood damage in the November 1990 storm, the King County Roads Division cleaned the existing culvert and installed a new 24 inch culvert under the Issaquah-Hobart Road. Using FEMA money, Roads replaced these culverts with a box culvert in the summer of 1993.

Efficient fish passage through the new culvert and the problem area upstream is a Washington State Department of Fisheries condition of this culvert replacement. Upstream of the culvert, the removal of the rock wall and the placement of the boulder terraces should allow fish passage by creating a series of chutes and eddies. Approximately one mile of useable spawning and rearing habitat should become available.

Estimated Cost: One-time = $450,800 (does not include future fish passage modifications).

2599A Nudist Park Creek Large Woody Debris Placement

Recommendation: In coordination with the culvert replacement under Issaquah-Hobart Road and the Nudist Park Creek restoration project carried out by the Roads Division of King County, SWM should continue the placement and monitoring of large woody debris in Nudist Park Creek that was begun in the fall of 1990.

Discussion: In the autumn of 1990, King County SWM, with the cooperation of the King County Roads Division, began an experimental project to control stream channel erosion in the reach of Nudist Park Creek upstream of the Issaquah-Hobart Road and thereby reduce deposition to the downstream channel. The project involved felling streamside trees into the stream channel in an attempt to speed the formation of debris and sediment dams, thereby halting channel incision by initiating streambed recovery. During the first phase of the project, 12 pieces of woody debris were placed in the channel and a monitoring program began to measure their effectiveness. Early data suggests that the deposition and

recovery process is beginning and areas of the channel show small, but measurable debris formations. The winter of 1991, however, was essentially without significant flows in this stream and failed to provide an adequate test. The placement already carried out was intended to be a first phase in a two phase project. Approximately 12 more pieces of LWD remain to be placed in the channel within and downstream of the Phase 1 placement.

Estimated Cost: One-time = $4,000.

2599H Tributary 0199 Cooperative Stream and Riparian Enhancement

Recommendation: With the cooperation of the landowners along the banks of tributary 0199, King County SWM should plant the upper reach stream sides with shade-tolerant trees and shrubs under the existing canopy; add large woody debris to selected sites; assist in the development of a pasture management plan; revegetate the mid-reach of the stream through the pasture with shrubs and trees. To improve fish passage, King County Roads and SWM should replace the culvert at 238th Way SE (see project 2522).

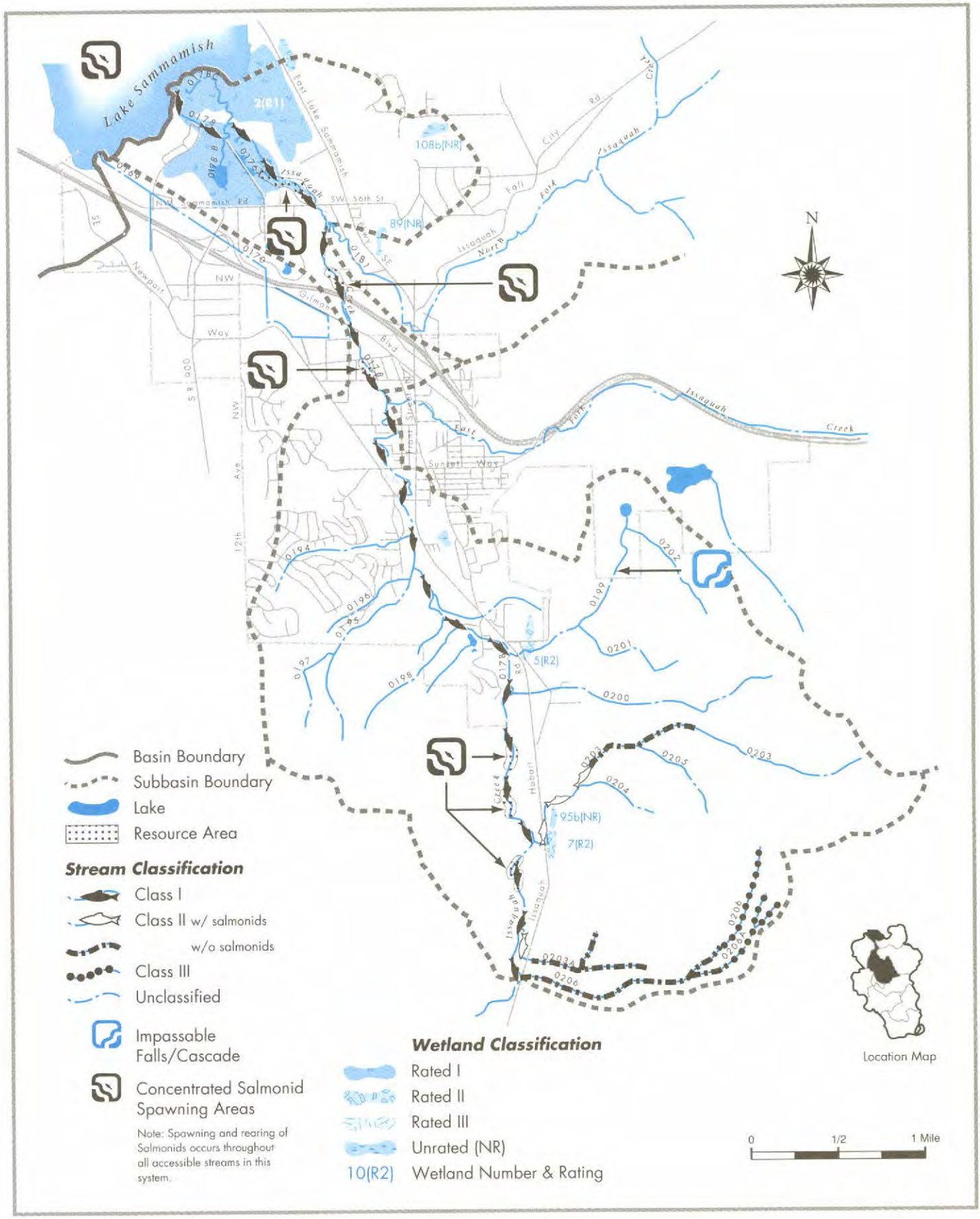
Discussion: A project with many parts, 2599H will serve as a pilot for cumulative restoration of habitats in the Issaquah Creek basin. With the cooperation of the affected landowners—one of whom has obtained open-space taxation for much of the stream and its riparian zone—the relatively short stream may be enhanced to restore use by anadromous salmonids in its lower and mid-reaches. Two project objectives must be met:

1. The pastureland in the mid-reach must be made hospitable to salmonids by revegetation and management of livestock access;

2. Large woody debris elements must be added to the upper and mid-reaches, and some understory planting should occur in the upper reach.

At least some cooperation is ensured by a condition of the open-space designation of the upper reach. This use should be pursued for the mid-reach as well. The project should be carried out over a period of three years using volunteers, conservation corps workers (see BW 22), and landowner participation.

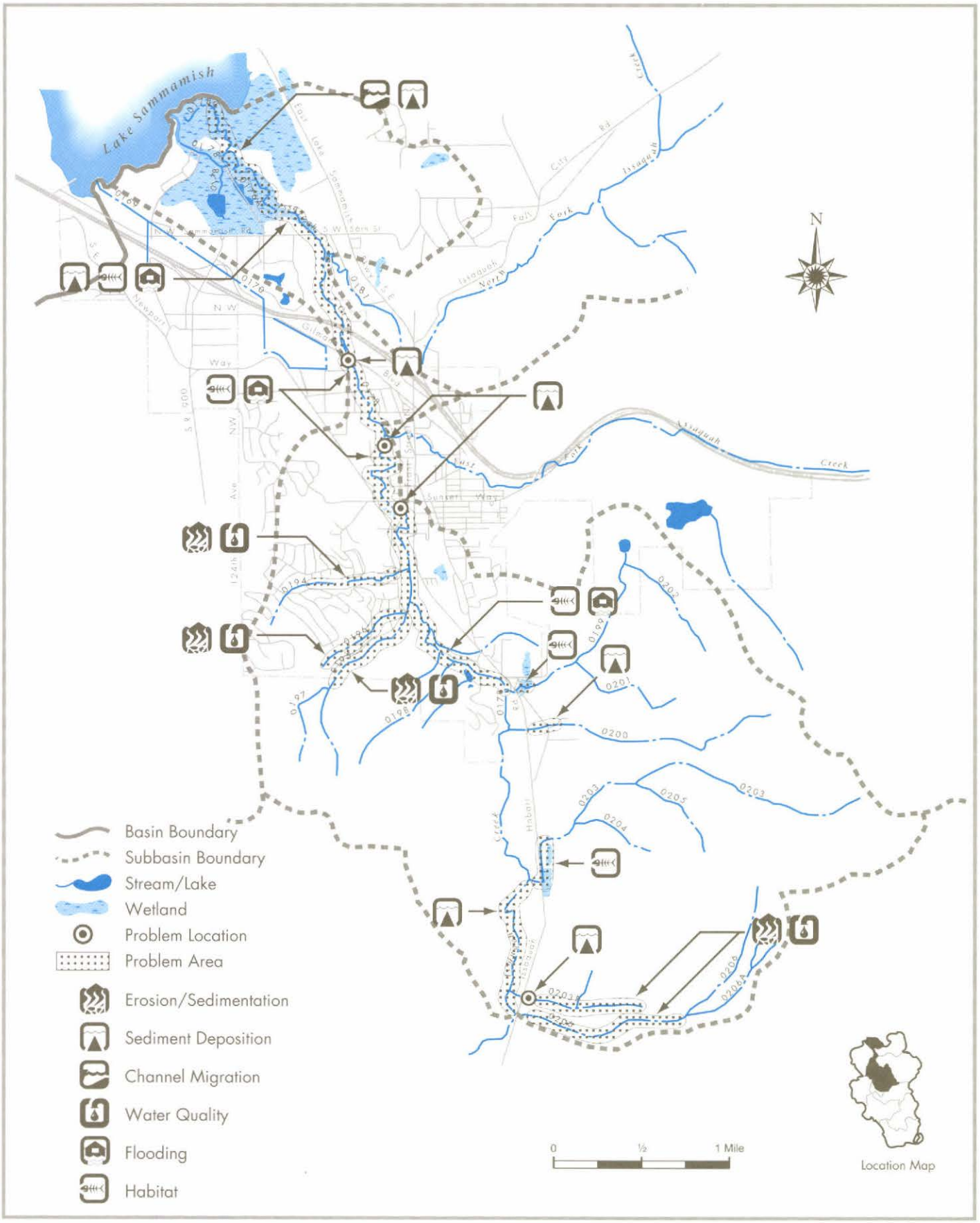
Estimated cost: $10,000 over three years. This cost may be offset in part by funding of BW 22.



LOWER ISSAQUAH CREEK SUBBASIN RESOURCES

Issaquah Creek Basin

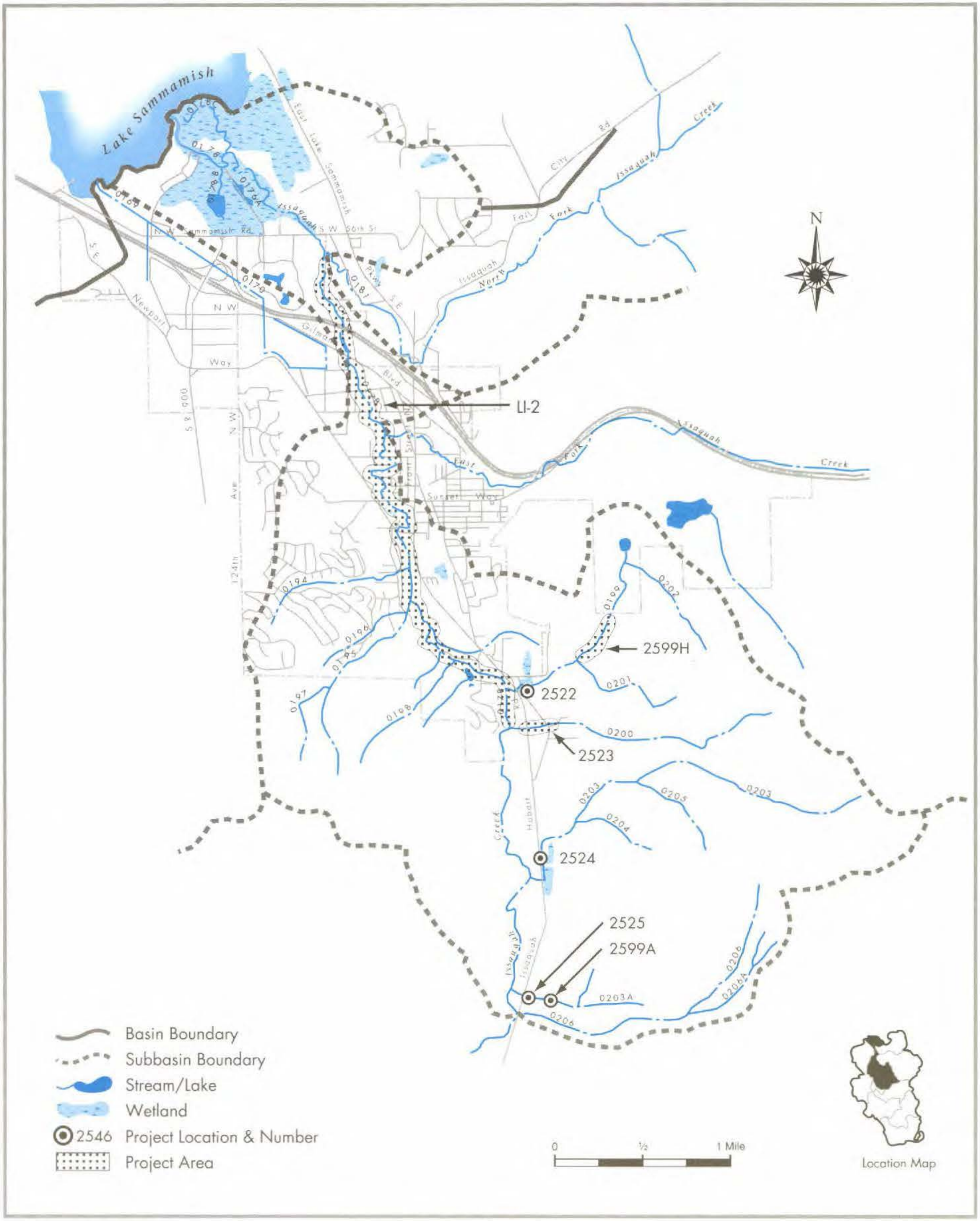
Figure 5-22



LOWER ISSAQUAH CREEK SUBBASIN PROBLEMS

Issaquah Creek Basin

Figure 5-23



LOWER ISSAQUAH CREEK SUBBASIN RECOMMENDATIONS
Issaquah Creek Basin

Figure 5-24

Tibbetts Creek Subbasin

PREFACE

The Tibbetts Creek basin covers 3,640 acres (about 6 square miles) and is located west of downtown Issaquah (Figure 5-25). Tibbetts Creek begins in the steep uplands of Squak and Cougar Mountains, drops rapidly into the valley, and loses velocity where an alluvial fan has been deposited. The creek flows through the floodplain that it shares with Issaquah Creek and eventually discharges to Lake Sammamish. The gradient of the upper reaches results in a very energetic system with generally faster erosion and sediment transport rates than Issaquah Creek, resulting in relatively rapid sediment deposition in the lower valley.

Land use in the subbasin varies dramatically, from light industrial areas along the lower creek to mining at Sunset Quarry and agricultural and forestry uses: the forests comprising 80 percent of the subbasin. At maximum buildout under current zoning, rural land would be reduced to approximately 30 percent due to residential, commercial, and roadway construction. Without proper detention, this could result in a 43-percent increase in the 25-year peak flow, aggravating existing flooding problems and introducing flooding into previously flood-free areas. In addition to rising floodwater levels, the duration of flooding will also increase, as will severity of erosion and sedimentation.

In this subbasin, the sedimentation and flooding problems are interrelated. The lower reach is a zone of chronic, long-term, natural deposition. Were the channel unconfined, infilling of the channel would eventually result in shifting of the channel to a new location. However, development on this alluvial fan has now fixed the channel into its current location by a combination of culverts and channel armoring. As a result, the inevitable deposition is localized within the immediate zone of the channel.

Because major channel shifts are no longer possible, sedimentation controls must be implemented. Dredging or sedimentation ponds address some degree of the problems directly but are expensive, environmentally damaging, and require perpetual maintenance. Reduction of the sediment input into the main channel provides a partial solution to the problem.

Current habitat throughout the drainage ranges from fair to very poor. Reduced stream-channel stability and increased substrate mobilization caused by mining activities and logging operations have dramatically affected habitat. In the upper watershed, forestry, mining, hobby farming, eroding banks, lack of streamside vegetation, and loss of instream habitat complexity have had severe impacts on habitat. At RM 1.4, where the creek flows onto the historic alluvial plain formed by Tibbetts and Issaquah Creeks, local floodplain development and stream channelization have greatly reduced habitat complexity and severely lowered salmonid productivity.

Although Tibbetts Creek is classified as Class AA (extraordinary) or Class A (excellent) by the Department of Ecology, the waters rarely meet these standards, particularly during storms. Beneficial uses are affected by sediment, animal feces, and phosphorus. Total phosphorus loads to Lake Sammamish are predicted to increase by 155 percent, the second highest rate in the basin. Two significant sources of pollutants are Kelly's Stable, where pastures are overstocked and contribute runoff laden with nutrients, bacteria, and sediment; and Sunset Quarry, where stormwater and sediment control ponds have failed repeatedly. In addition, an earthslide on the Interpace mining property contributes sediment to the stream.

RECOMMENDATIONS

Regulations

T 1 Basinwide Regulations as Applied to Tibbetts Creek Subbasin

1. Open-Space Retention Requirements (See also BW 3)

Recommendation: All residential subdivisions and short subdivisions at rural densities should comply with the open-space requirements of BW 3.

Estimated Cost: Estimated in BW 3.

T 2 Site Development Requirements

Recommendation: All new residential or mixed-use developments in this subbasin that meet requirements for preparation of a Master Drainage Plan (MDP) under King County drainage code should comply with the following standards. Compliance should be evaluated by King County Surface Water Management in the scoping, review, and approval of the MDP.

1. Stormwater discharges from developed areas must bypass the steep channel reaches of Cougar and Squak Mountains by continuous pipeline to the valley floor. Detention to the standards of BW 1 must also be provided.

2. In order to control erosion and sediment transport to downstream areas, no more than 60 percent of the site should be cleared of its natural vegetation. Uncleared land should be located in one or more open space tracts. No subsequent clearing of these tracts should be allowed. In addition, a stringent temporary erosion and sediment control plan should be initiated to minimize construction-related erosion.

3. Approval for the Master Drainage Plan should be contingent on the completion of those downstream flood control and drainage projects that are deemed

essential by SWM and the City of Issaquah to control current surface--water problems.

Discussion: A large portion of the Tibbetts Creek subbasin has been designated as urban in the King County Comprehensive Plan and has urban reserve zoning under the Newcastle Community Plan. Development of this area at the urban densities allowed in the community plan has the potential to aggravate the serious flooding and sediment problems in lower reaches of Tibbetts Creek. It is assumed that any urban development would require the preparation of a Master Drainage Plan and would comply with the specified standards.

The upper slopes of the Tibbetts Creek subbasin are among the most problematic in the entire basin planning area. They are very difficult to develop without significant downstream impacts, particularly erosion of the steep channels tributary to Tibbetts Creek and transport of sediment into the mainstem, because of the high rainfall, steep topography, and thin soils. The approach chosen for this recommendation, that of mitigation but not downzoning, is predicated on the relative lack of high-quality downstream resources--future development under the existing zoning of the subbasin will almost certainly result in further downstream degradation, even with these stringent development standards. Contingency of development on downstream improvements in Tibbetts Creek is necessary because existing flooding problems in the lower subbasin are already severe, even without the additional runoff that future development will introduce.

Estimated Cost: One-time (permit review at .25 FTE) = $15,000. No private costs or capital costs of mitigation included.

Programs

T 3 Channel and Floodplain Restoration

Recommendation: King County SWM should continue to work with the City of Issaquah and Rowley Enterprises, a major landowner along lower Tibbetts Creek, on a solution to widespread flooding problems in the floodplain. Unlike the lower mainstem of Issaquah Creek and the East Fork, lower Tibbetts Creek has little development along its banks, eliminating the need for purchase and removal of structures. The restoration program in this subbasin should focus on restoring the natural configuration of the stream channel and recreating a floodplain that will convey flood flows safely from upstream of Newport Way to the confluence with Lake Sammamish. In addition, the program should improve channel and floodplain habitat and provide for public access and recreational use.

The channel and floodplain restoration program should be accomplished through a cooperative program to improve conveyance at stream crossings, realign the channel, construct setback berms along the edge of the floodplain, revegetate the floodplain, and reduce sediment loading. The mechanism for cooperation should be established in an agreement among the participating agencies and property

owners. Details of the program are described further in capital improvement projects 6711, 6713, and 6714.

Discussion: The recommended projects will continue a cooperative effort to restore lower Tibbetts Creek that was begun by the County, City of Issaquah, and Rowley Enterprises in 1992. An agreement signed by the parties in 1993 committed each to cooperate on predesign studies and an Environmental Impact Statement for the project. The next agreement, to proceed with design and construction of the channel and floodplain from Tibbetts Manor to Lake Sammamish, should include these parties and the Washington State Department of Transportation, the Washington State Parks Commission, and Metro. If this project continues on schedule, it should be constructed in 1995 and 1996.

Estimated Cost: Unknown.

T 4 Floodproofing and Elevation

Recommendation: At this time there are an estimated 73 structures in the 25-year floodplain that would be eligible for flood audits and loans for floodproofing and elevation under the program defined in BW 8. As the restoration recommended in T 3 is carried out, the width of the floodplain may be reduced, and fewer structures may require floodproofing.

Estimated Cost: One-time audit = $51,100; One-time floodproofing and elevation (35% participation) = $192,000.

Additional Permit Conditions

T 5 Sunset Quarry Water Quality Restoration

Recommendation: King County DDES should condition all new operating and grading permits for Sunset Quarry on the development of an explicit, enforceable plan for assuring that the surface-water discharge from this site complies with State water quality standards. SWM and DDES technical staff should cooperate on development of specific standards for operation of the quarry that are consistent with this objective. The plan should specify the proposed actions for disposing of spoils, reclamation of disturbed areas, installation and maintenance of adequate drainage and water quality facilities, and the relocation of Tibbetts Creek around the open mining area. The plan must also detail the monitoring procedures necessary to demonstrate compliance with water quality regulations. SWM should review and approve the plan prior to DDES permitting action.

Discussion: The quarry is a major source of fine sediment to Tibbetts Creek. The sediment from this source is a significant component of the degradation of water

quality and habitat in Tibbetts Creek. On-site stormwater and sediment control ponds have repeatedly failed.

The quarry has recently changed managers and submitted a proposed operating program to DDES. The proposed program includes removal of spoils, improvements to the on-site drainage system and expansion of mining operations into an area adjacent to the existing mined area.

Permit approval for expansion of mining operations should be contingent on implementation of an approved management plan for the site. The drainage and sediment control systems must have capacity for the proposed expansion area.

Estimated Cost: Included in BW 29 and BW 31.

T 6 Mutual Materials Company's Newcastle Pit Stormwater Management

Recommendation: King County DDES should condition new operating or grading permits for the Mutual Materials Company's clay mine on the development and implementation of a pollution prevention plan for the site. The plan and schedule for plan development should correspond to the industrial NPDES requirements for mining operations as outlined by the Washington State Department of Ecology. The plan should specify the proposed actions for disposing of spoils, reclamation of disturbed areas, and management of stormwater, including erosion and sediment controls, and construction and maintenance of water quantity and quality controls. The plan should also include monitoring to demonstrate compliance with water quality standards.

Discussion: The large area of exposed, fine grained soils at the Mutual Materials clay mine makes this site a potentially major source of fine sediments and other associated pollutants to Tibbetts Creek. Recently modified drainage facilities at the mine have not been tested in a large storm event. Existing on-site stormwater and sediment control facilities should be checked for structural integrity and compliance with the new industrial NPDES requirements for mining operations. The facilities should be designed and maintained in order to handle and treat the volume and quality of site runoff. The existing stormwater pond appears to be undersized and poorly maintained. Substantial sedimentation in the inflow cell of the pond has reduced pond volume. The side walls of the berm in the main pond are sloughing and require additional stabilization.

The industrial NPDES permits require application by October 1994 and the development of a pollution prevention plan for the site by April of 1995. Non-capital BMP's, such as source control, should be implemented by October 1995 and capital BMP's should be installed by April 1996.

Estimated Cost: Included in BW 29 and BW 31.

T 7 Harris/Interpace Mine Stormwater Management

Recommendation: King County DDES should condition all **new operating and grading permits** on the Harris/Interpace mine site on the development of an explicit, enforceable plan for assuring that the surface-water discharge from this site complies with State water quality standards. SWM and DDES technical staff should cooperate on development of specific standards for operation that are consistent with this objective. The plan should specify the proposed actions for disposing of spoils, reclamation of disturbed areas, and management of stormwater (including erosion and sediment controls), and construction and maintenance of water quantity and quality controls. The plan should also include monitoring to demonstrate compliance with water quality standards.

DDES should condition any further work under the **existing grading permit** on submittal of a revised operating plan that provides reasonable assurance that further operations on this site will not result in sediment or pollutant discharge to Tibbetts Creek. Such a plan would require a sophisticated sediment control strategy combined with careful phasing of site development. Experience on the adjacent Sunset Quarry suggests that development of such a plan will be difficult.

DDES should also require the permit holder on the Harris/Interpace site to develop and implement a plan to stabilize an existing earthflow, and to restore the channel and riparian zone of Tibbetts Creek Tributary 0174 adjacent to this site.

Discussion: The Harris/Interpace Mine is a source of sediments and other associated pollutants to Tibbetts Creek. Areas of the site that are not actively being worked should be stabilized and vegetated to minimize erosion and off-site sediment transport. On-site stormwater and sediment control facilities should be constructed to manage the volume and quality of site runoff in accordance with the new industrial NPDES requirements for mining operations. The industrial NPDES permits require application by October 1994 and the development of a pollution prevention plan for the site by April 1995. Non-capital BMP's, such as source control, should be implemented by October 1995 and capital BMP's should be installed by April 1996.

A large mining spoils pile on the south side of the Harris/Interpace Mine has failed and is actively moving downslope as an earthflow. Tibbetts Creek Tributary 0174 is located at the toe of this earthflow. Sediment discharge from erosion of the toe of the slide results in very high rates of sediment discharge to Tibbetts Creek. The spoils pile is a result of mining activities that were subject to the King County Grading Code and the permit under which this mining was performed remains open.

Estimated Cost: Included in BW 29 and BW 31.

Capital Improvement Projects

6711 Conveyance Improvements on the Mainstem

Recommendation: The following stream crossings along Tibbetts Creek should be upgraded to the standards specified in BW 12 by the designated agencies to increase their capacity to pass flood flows, sediment, and debris and to improve fish passage.

A. NW Sammamish Road/SE 56th Street Culvert Replacement

The City of Issaquah should replace Tibbetts Creek culverts beneath NW Sammamish Road (SE 56th Street) with a larger capacity bottomless culvert or a spanning structure. Estimated Cost: One-time = $415,800

B. Interstate-90 Culvert Replacement

WSDOT should replace the culverts at the crossing of Interstate 90 and Tibbetts Creek with a bridge or other spanning structure. The culverts underneath Interstate 90 restrict high flows and cause backwater flooding of upstream businesses. Coupled with channel improvements in Lake Sammamish State Park (project 6713A), this project is necessary to reduce the current flooding and prevent even worse flooding in the future. Estimated Cost: To be determined.

C. NW Poplar Way Culvert Replacement

The City of Issaquah should replace the culvert at the NW Poplar Way crossing of Tibbetts Creek with larger capacity culverts. Estimated Cost: One-time = $167,000

D. SE Newport Way Culvert Replacement

The City of Issaquah should replace the undersized twin box culverts at the SW Newport Way crossing of Tibbetts Creek with a larger capacity culvert or a spanning structure. The culverts underneath SW Newport Way currently cause flooding and hamper fish passage. Estimated Cost: One-time = $308,800

E. State Route 900 Fish Passage

WSDOT should replace the long concrete box culvert at the SR 900 crossing of Tibbetts Creek with a spanning structure. The stream channel should be restored to a more natural state at the conclusion of the project. This should be accomplished as part of the ongoing project to improve the segment of SR 900 between Issaquah and Renton. In the interim, baffles should be placed in the culvert and a weir on the concrete apron should be installed to ensure fish passage. Estimated Cost: One-time (baffle placement) = $14,000.

Discussion: These conveyance improvements are part of the channel and floodplain restoration recommended in T 3.

6712 Conveyance Improvements on Tributaries

A. Newport Way Crossing Replacement at Anti-aircraft (0169A) Creek

The City of Issaquah should realign the Newport Way crossing of Anti-aircraft Creek (Tributary 0169A) with an upgraded box culvert. This project would remove the sharp bend in the stream created when the Summerhill subdivision was developed, eliminating flooding and deposition of sediment on Newport Way. Estimated Cost: One-time = $163,500.

B. SR 900 Fish Passage and Stream Modification at Tributary 0171

The existing box culvert on tributary 0171 is a barrier to upstream migration of adult and juvenile salmonids. WSDOT should rebuild the crossing and the adjacent stream reaches to allow free access to the upper tributary system. This should be accomplished during the SR 900 improvements. Estimated Cost: One-time = $393,000.

6713 Channel and Floodplain Reconstruction

Recommendation: The following projects should be undertaken by the agencies identified to reconstruct the natural functions of the stream channel and floodplains of lower Tibbetts Creek.

A. Lake Sammamish State Park Channel Capacity

The Washington State Parks and Recreation Commission should provide increased capacity for flood conveyance in the reach of Tibbetts Creek that passes through park land. This project should incorporate habitat enhancement, such as placement of in-stream log structures, as feasible. When the channel and floodplain restoration recommendations in T 3 are complete, high flows will no longer be partially diverted from Tibbetts Creek (0169) into tributary 0170, but will be conveyed directly into the main channel. While this will reduce flooding within the park along 0170, the increased capacity in the park will be needed to convey these increased flows in the mainstem of Tibbetts Creek and prevent flooding of park roads and buildings. Estimated Cost: To be determined.

B. Tibbetts Creek Relocation and Floodplain Restoration

With the cooperation of the City of Issaquah and King County, the Rowley Agency should relocate Tibbetts Creek away from its present location in a roadside ditch along 19th Avenue NW into a reconstructed channel. A prescribed floodplain should be created with setback berms to convey flood flows. The reconstructed floodplain should be revegetated with native species. This project is currently (1994) in detailed environmental review. Estimated Cost: To be determined.

C. Tibbetts Manor Flood Setback Berm/Dredging

The City of Issaquah should construct setback berms along this segment to create a prescribed floodplain along the stream and reduce the diversion of flood flows into the large commercial areas within the Tibbetts Creek floodplain. The reconstructed floodplain should be revegetated with native species. If necessary, the channel should be dredged to increase conveyance. This project is currently (1993) in detailed environmental review. Estimated Cost: To be determined.

Discussion: These conveyance improvements are part of the channel and floodplain restoration recommended in T 3.

6715 Ficker Tributary Revegetation

Recommendation: King County SWM should revegetate the banks of upper Ficker Creek (a tributary to 0169A) by hydroseeding and conifer planting.

Discussion: The steep upper reaches of this tributary to 0169A have areas of low growing or no vegetation. This has led to surface sloughing and severe erosion in this tributary with a 36–40 percent gradient. This project would revegetate the upper reaches by hydroseeding and planting evergreen trees to reduce the erosion and slow the sheet flow over the steep slope.

Estimated Cost: $88,400.

6716 Kelly's Ranch Riparian Zone and Floodplain Restoration

Recommendation: The Kelly's Ranch riparian zone along Tibbetts Creek should be restored by King County SWM in cooperation with the land owner to improve fish habitat, water quality, and floodplain functions. Animal access to the creek should be limited to specific stream crossing and watering points by fencing the riparian zone.

Discussion: Overstocking of pastures adjacent to Tibbetts Creek by horses results in substantial nutrient, bacteria, and sediment loadings to the creek. Lack of riparian vegetation along this section of the creek also results in increased water temperatures and habitat degradation. The riparian zone on both sides of Tibbetts Creek should be fenced to limit animal access, and revegetated to provide improved fisheries habitat.

Estimated Cost: $100,000.

6717 Bianca Mine Spoils Remediation

Recommendation: The King County SWM Division should stabilize the stream banks and stream channel through the stream reach adjacent to the Bianca Mine

spoils piles. The spoils should be regraded to move the toe of the actively eroding spoils away from the toe of the slope and reduce the inclination of the spoils pile. The regraded slopes should be vegetated and the channel stabilized by placing boulders and large woody debris throughout the reach.

Discussion: Investigation of sediment discharge in this basin indicates that this site is the largest single source of stream sediment in the basin, contributing up to 30 percent of the course sediment load. Stabilization of this area would significantly reduce the sediment discharge to the enhancement projects proposed downstream.

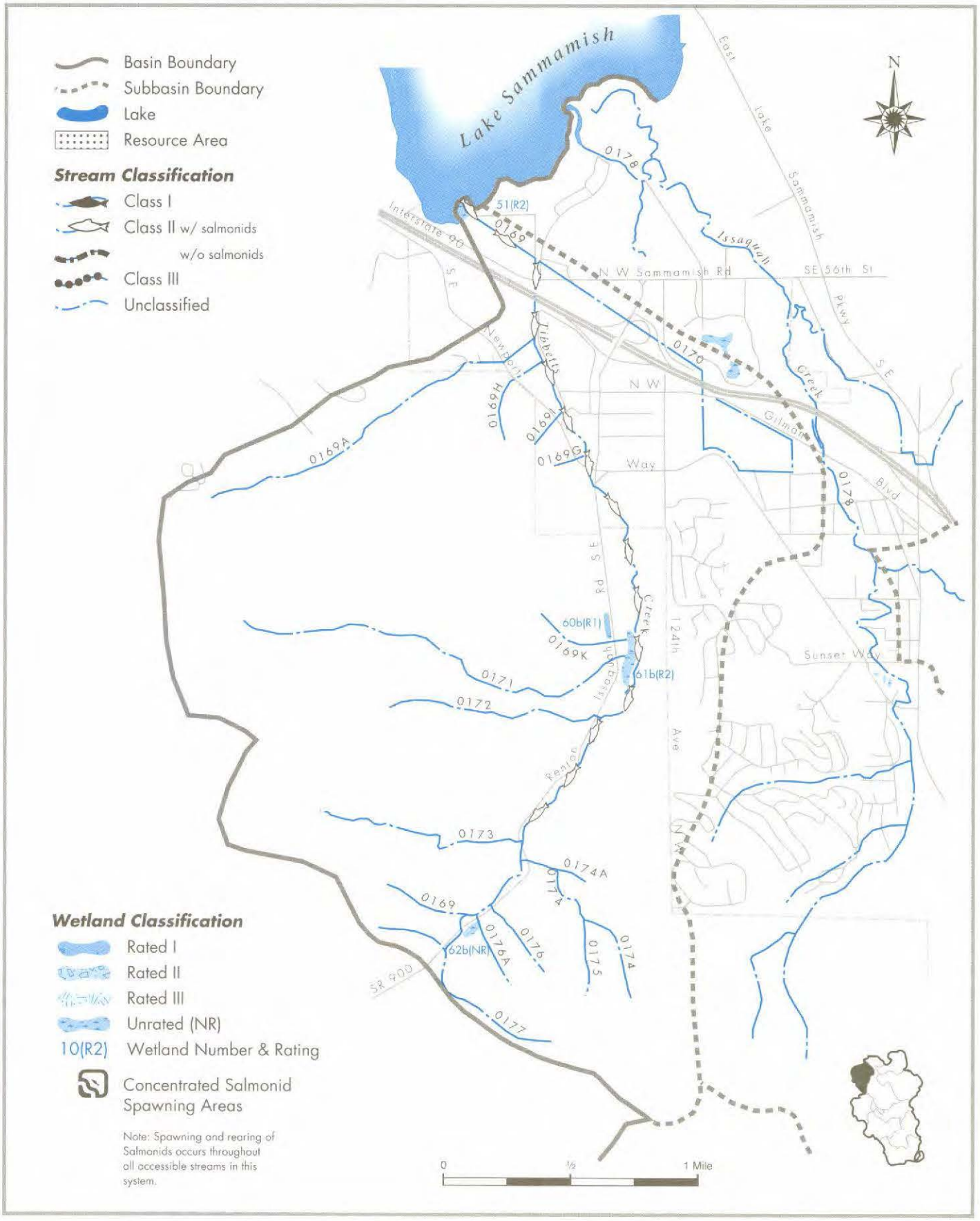
Estimated Cost: $ 700,000.

6718 Large Woody Debris Placement

Recommendation: The King County SWM Division should install roughness elements (large woody debris and boulders) in the channel for 1500 feet downstream from the Bianca Mine spoils site.

Discussion: Increasing the roughness of this channel will help stabilize sediment in the existing channel and will encourage additional sediment deposition. It will also increase channel complexity through this reach and thereby improve fisheries habitat.

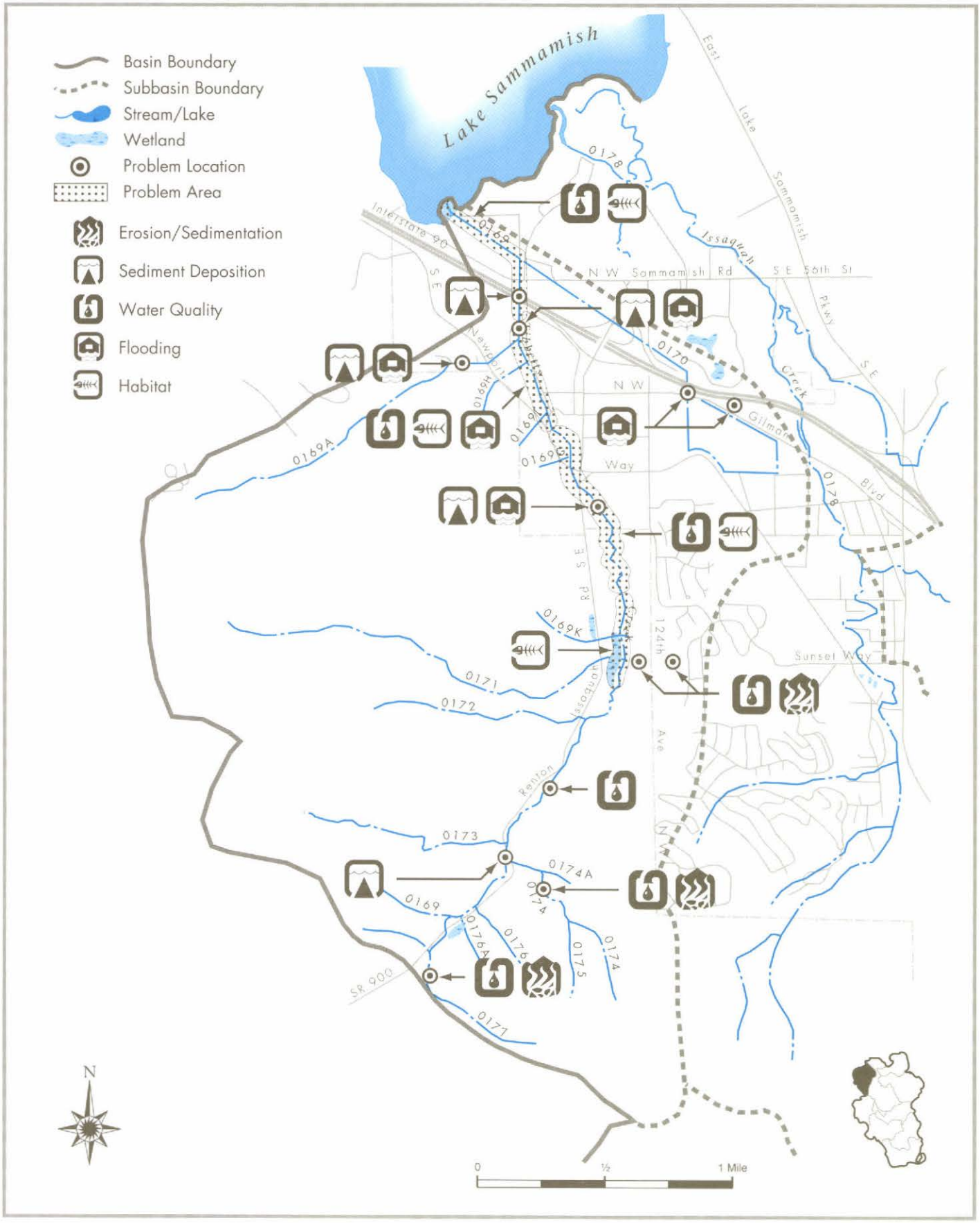
Estimated Cost: $100,000.



TIBBETTS CREEK SUBBASIN RESOURCES

Issaquah Creek Basin

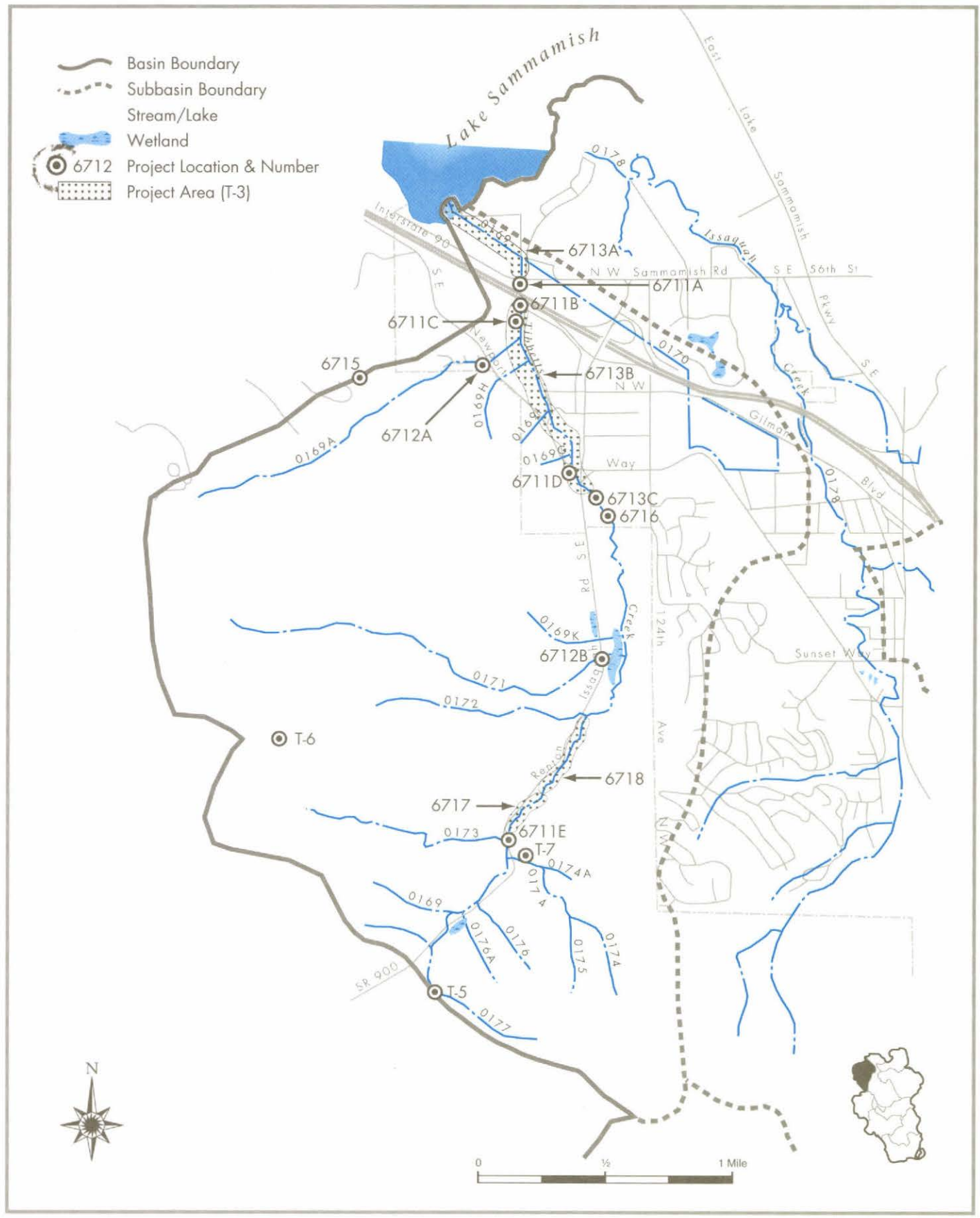
Figure 5-25



TIBBETTS CREEK SUBBASIN PROBLEMS

Issaquah Creek Basin

Figure 5-26



TIBBETTS CREEK SUBBASIN RECOMMENDATIONS

Issaquah Creek Basin

Figure 5-27

Chapter 6

Nonpoint Water Pollution

Chapter 6: Nonpoint Water Pollution

This chapter characterizes the nonpoint pollution sources in the Issaquah and Tibbetts Creek basins, and proposes basinwide and source-specific goals and objectives for controlling these sources. While these issues have been addressed in previous chapters of the plan, the more detailed treatment here is provided for compliance with the nonpoint watershed planning rule (400-12 WAC). The source assessment is summarized from the *Issaquah Creek Basin Current/Future Conditions and Source Identification Report* (King County, 1991). The source assessment, goals, objectives, recommendations and monitoring program were developed by the Issaquah/East Lake Sammamish Watershed Management Committee with staff support from the lead agency, King County Surface Water Management (SWM) Division, the King County Resource Planning Section, and the Seattle-King County Department of Public Health in accordance with the watershed planning process defined by the state of Washington (400-12 WAC). A citizen-based Basin Advisory Team and a technical advisory committee also participated in the development of this plan.

Additionally, this chapter represents a portion of the nonpoint source pollution action plan funded in part through a Washington State Department of Ecology (WDOE) Centennial Clean Water Fund grant. In an effort to more thoroughly integrate nonpoint water quality planning into King County's overall basin management program, the WDOE nonpoint action plan and the County basin plan have been combined into a single watershed management plan. The water quality goals and approaches are presented in *Chapter 3: Problems, Goals, and Approaches*, and the water quality recommendations for nonpoint source control are included in the basinwide and subbasin recommendations detailed in *Chapter 4: Basinwide Recommendations* and *Chapter 5: Subbasin Recommendations*. A long term monitoring program to assess the effectiveness of the watershed management plan (BW 30: Basin Plan Monitoring) can be found in *Chapter 4*.

DEFINITIONS

Nonpoint source pollution is defined as pollution not originating from a specific point such as a pipe, ditch, or other discrete conveyances. Instead, nonpoint source pollution originates from diffuse sources that enter surface waters and, in combination, degrade water quality. The difficulty in identifying, isolating, and if necessary, treating or eliminating nonpoint pollution sources adds to the complexity of managing these sources. Solutions focused on source control hold the most promise for addressing nonpoint source pollution problems.

Potential sources of nonpoint pollution in the Issaquah and Tibbetts Creek basins include urbanization (e.g., construction and stormwater runoff), on-site septic systems, agriculture (commercial and small farms), pesticide/fertilizer applications, forestry operations, landfills, sand and gravel mining, hazardous wastes,

underground storage tanks, and boating. Each nonpoint source will be discussed in the problem definition and source identification section.

As noted above, point source pollution originates from a defined source such as a pipe, and can be traced to a particular site, business, or activity. Point source pollution can therefore be treated or controlled directly at the source. There are several businesses in the Issaquah basin that are known point source dischargers. Lakeside Sand and Gravel, Consolidated Dairy Products, Washington State Department of Fish and Wildlife, and Sunset Quarry all have National Pollutant Discharge Elimination System (NPDES) permits on file with the WDOE (Devitt, pers. commun., 1990).

BENEFICIAL USES

Introduction

One of the main objectives of the basin plan and nonpoint action plan is to protect the resources and beneficial uses of the Issaquah basin. The two criteria primarily used to identify resource degradation are beneficial use impairment and exceedence of water quality standards. The former is the topic of the present section, the latter will be discussed in the water quality assessment section.

In order to assess and solve water quality problems, the various beneficial uses must first be defined. The Water Resources Act of 1971 (Water Quality Laws and Regulations, Chapter 90.54 RCW), originally defined the "fundamentals for utilization and management of waters of the state," to include domestic water supply; agricultural water supply; stock watering; industrial water supply; commercial water supply; mineral extraction; commerce and navigation; hydroelectric power production; thermal power production; salmonid migration, rearing, spawning, and harvesting; recreation; wildlife maintenance and enhancement; aesthetic values; and all other uses compatible with the enjoyment of the public waters of the state.

For the Issaquah and Tibbetts Creek basins, beneficial uses fall into five main categories: water supply, fisheries and wildlife, recreation, wetlands, and aesthetics.

Fisheries and wildlife beneficial uses in the basin are described in detail in Chapter 8 of the *Current/Future Conditions & Source Identification Report* for the Issaquah basin. A discussion of the beneficial uses of wetlands and their role in water quality can be found in Chapter 10 of the same report. The remaining beneficial uses found in the basin are discussed below.

Water Supply

Two water districts (Sammamish Plateau Sewer and Water District, King County Water District 90) and the City of Issaquah serve parts of the Issaquah basin.

Other small water supply groups such as Mirrormont Service serve consolidated residential areas in the southern end of the basin. The remaining water supply for basin residents is obtained through private residential wells. The source of all water for all of these users originates exclusively from groundwater aquifers in the basin.

Recreation

The streams and lakes in or along the Issaquah and Tibbetts Creek basins provide for many recreational uses. These uses include swimming, wading, water skiing, and skin or scuba diving (primary contact) and hiking, fishing, and boating (secondary contact). Hiking trails cross or border many of the streams in the basins.

The mouths of both Tibbetts and Issaquah Creek are located in an extensive State park system at the south end of Lake Sammamish. The lake, which is the receiving water body for both basins, is used almost exclusively for recreation. The only commercial boats using the lake are those associated with Indian fishing (Metro, 1983) and pile driving.

Several other small lakes can be found in the Issaquah Creek basin including McDonald, Tradition, Round, and Yellow lakes. McDonald Lake does not have public access, thereby restricting its primary recreational uses to lakeside residents. Tradition Lake, on the other hand, has public access via hiking trails connected with Tiger Mountain State Forest. The third small lake in the basin, Yellow Lake, is a number-one-rated wetland that has well-developed public recreational access with trails and viewing platform. Yellow Lake provides habitat for many species of wildlife, although much of the surrounding upland habitat has been lost to development.

Aesthetics

The Issaquah and Tibbetts Creek basins have more than 40 wetlands (38 inventoried), several small lakes, and a major state park located on the shores of Lake Sammamish. The wetlands provide particular enjoyment for nature watching as these aquatic systems supply a wide range of habitat for a variety of mammals, birds, insects, amphibians and other wildlife. The visual amenities and options for public utilization of the lakes in the basin are confirmed by the high number of residences surrounding each and the number of people who enjoy the surface waters throughout the year.

NONPOINT POLLUTION SOURCES

Introduction

Several categories of nonpoint water pollution have been identified and characterized in accordance with Chapter 400-12 WAC. The categories of nonpoint pollutant sources evaluated in this plan include urbanization (e.g.,

construction and stormwater runoff), on-site septic systems, agriculture (commercial and small farms), pesticide/fertilizer applications, forestry operations, landfills, sand, rock, and gravel mining, hazardous wastes, underground storage tanks, and boating.

Development, Urbanization, and Stormwater Runoff

Land development and associated construction activities are two of the major contributors of nonpoint pollution in the Puget Sound area. Natural erosion rates from forested or well-sodded prairies vary from 0.01 to 1.0 tons per acre per year while construction sites lacking effective erosion and sedimentation control measures erode soil at the rate of 50-500 tons per acre per year (WDOE, 1988b).

Stormwater runoff represents both a quantity and quality problem in urban areas where land use has been converted from primarily forested and open-space land use to impervious surfaces in residential, commercial and industrial areas. High streamflows associated with urbanization and large impervious surfaces result in streambed scouring, erosion, and degradation of spawning and rearing habitat for fish.

Typical pollutants found in surface-water runoff in urbanized watersheds include solids, nutrients, bacteria, oxygen-demanding materials, heavy metals, petroleum hydrocarbons, and synthetic organics. During the development phase of a watershed, construction activity typically results in increased sedimentation and nutrient release from bare soil. In heavily urbanized areas, pets usually replace farm animals as a source of fecal pathogens.

One interstate (I 90), two State roads (SR 900 and SR 18), and one major County road (Issaquah-Hobart Road) are located in the basin. In many places where streams and roads cross, untreated road runoff is discharged directly to the streams. Petroleum products and by-products, heavy metals, and sediments are the common pollutants contained in this runoff.

Currently, the Washington State Department of Ecology, under the direction of the 1989 Puget Sound Water Quality Management Plan, is developing stormwater management guidelines for implementation by local jurisdictions and the Washington State Department of Transportation. Highway runoff will be an important focus of the program. These guidelines will be particularly relevant to the management of stormwater runoff from Interstate 90, SR 18, and SR 900.

Urban watersheds are also characterized by many types of impervious surfaces, including rooftops, driveways, buildings, sidewalks, parking lots, and highways. Sediment and a variety of accumulated chemicals tend to build up on these surfaces. These elements are washed off into storm drains and/or directly into streams during storms. Surface runoff, then, becomes the principal method by which pollutants are transported to lakes and streams.

Atmospheric deposition of dust, volatilized hydrocarbons, and a variety of other airborne pollutants also contribute to degraded water quality. Galvin and Moore (1982) characterized the sources of toxicants from urban runoff to include both street dust and atmospheric suspended particles. In their study, the average concentration (in undiluted stormwater) for five metals (cadmium, copper, lead, nickel, and zinc) exceeded both chronic and acute water quality criteria. This is typical of many urbanized basins in the Puget Sound area.

The conversion of forest land to residential developments and the conversion of non-forested lowland into commercial land use are the most common land-use changes presently occurring in the basin. A survey of the basin identified many new developments less than ten years old, including Sunset Valley Farms, Cascade Condominiums, Hunter's Ridge, and many more sites currently under construction. Sediment and nutrients are typical pollutants associated with forested land use. As urbanization occurs, however, the pollutant types become more complex and variable as described above.

Many programs are already in place to reduce urban stormwater-related nonpoint pollution. The 1990 King County Surface Water Design Manual requires water quality facilities to be built in conjunction with many new developments. Currently, the manual is being revised to address water quality controls more thoroughly. However, these structural controls do not perform well if design standards are not properly enforced, facilities are not properly maintained, or if pollutants are entrained in systems for which they were not designed. To ensure that pollutants concentrated in drainage facilities are not reintroduced into the natural system somewhere else, the sediment and residues from maintenance activities must be disposed of properly. Furthermore, construction of water quality facilities cannot address the problem associated with individual basin residents introducing nonpoint pollutants into the drainage systems. Education programs that focus on specific groups, including residents, businesses, schools, agencies, and developers, can reduce nonpoint pollution at its source (see *Chapter 4*, BW 13).

On-Site Septic Systems

A typical on-site sewage disposal system consists of a septic tank and drainfield. The system provides initial treatment of liquid-borne wastes and settling of solids before purification occurs in native soils. If adequately maintained, on-site septic systems are designed to serve the wastewater treatment needs of a building/facility for the life of the structure.

The identification of on-site sewage disposal systems as a nonpoint source of pollution to groundwater and surface waters can generally be attributed to failing systems. By traditional definition, a system failure occurs when the volume of effluent exceeds the absorbent capacity of the soils and results in a backup in the building plumbing or the release of partially-treated effluent onto the ground's surface. Pre-failing on-site systems are identified as those displaying one or more of the following characteristics: 1) heavy lush growth over the drainfield area, which indicates sewage may be rising near the surface of the ground; 2) wet or

swampy areas adjacent to or in the drainfield area; and/or 3) profuse growth of wetland plants over the drainfield area. The most obvious sewage system malfunction, inadequate treatment of effluent by surrounding soils and thus the potential contamination of groundwater, is not addressed by the above definitions.

The ability to treat and absorb sewage effluent is dependent on the receiving depth, structure, and texture of the soil. Soils such as clays, or clay loams (*e.g.*, Kitsap series) are efficient in filtering and attenuating contaminates but are limited in their ability to absorb effluent. Coarse soils (*e.g.*, Everett series) have a substantial capacity to accept effluent, but the high permeability of the soil is ineffective in removing contaminates. Septic systems installed on these highly infiltrative soils (rocky or sandy) or on steep slopes may fail due to the inadequate ability of the soil to absorb the effluent. System failures are usually due to poor soil conditions, inadequate design, inadequate construction, lack of maintenance, and/or abuse of the system.

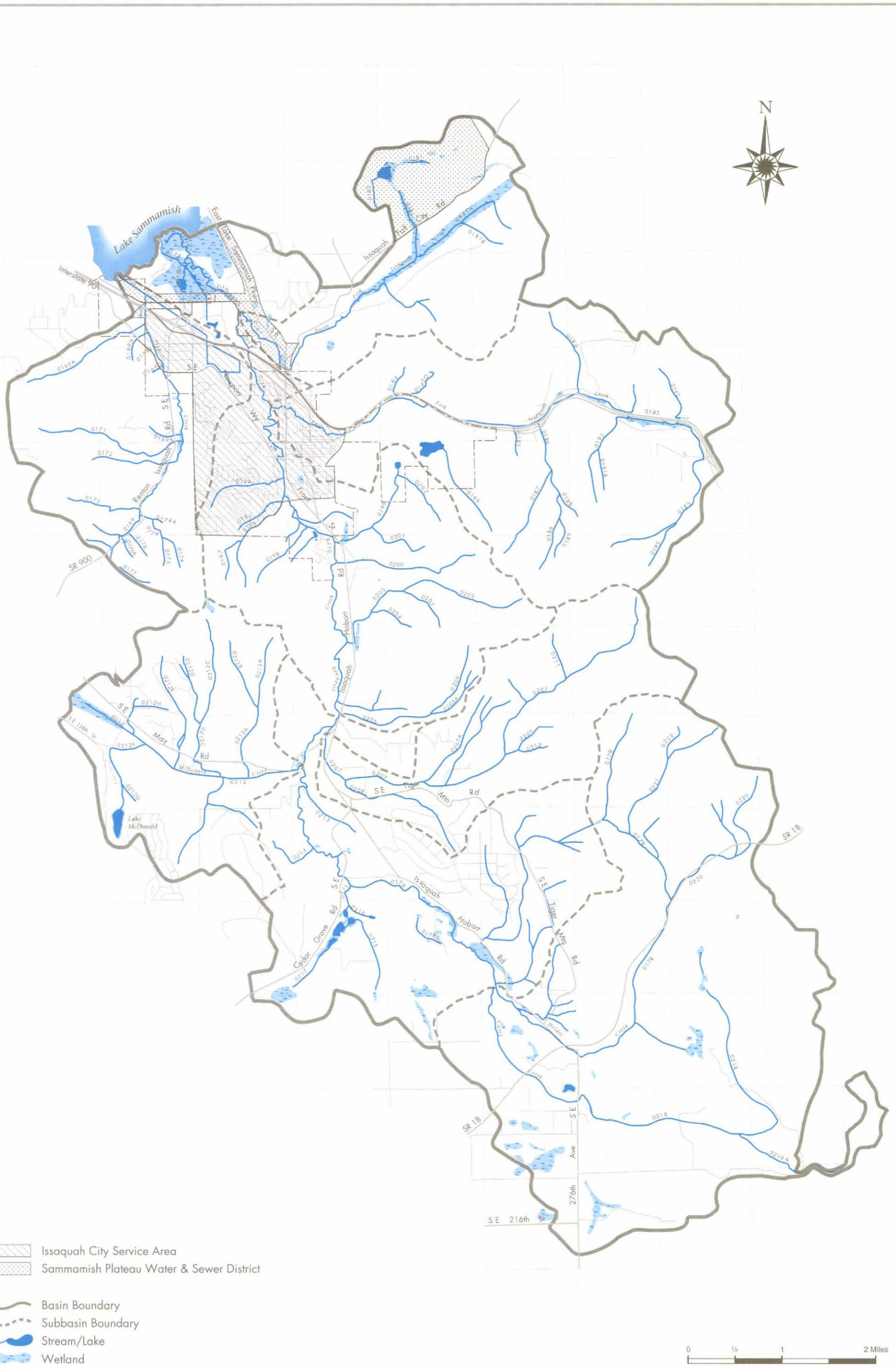
The Washington State Department of Health has determined that a minimum of 3 feet of unsaturated soil is needed to assure adequate treatment of effluent and to protect potable groundwater aquifers (WAC 248-96-100). This minimum depth, in certain instances, may be reduced by the health officer. This depth of soil is most often limited by high seasonal water tables. Most soils in the Issaquah basin are characterized as moderately drained (Alderwood series) underlain by shallow, slowly permeable glacial till with seasonal water-table depths of 24-40 inches.

Prior to July 1987, the Seattle-King County Department of Public Health (SKCDPH) allowed conventional gravity-type on-site disposal systems to be placed on sites with 30 inches of suitable soil. A minimum of 18 inches of native permeable soil between the drainfield and any evidence of groundwater or other restrictive layer was required. In July 1987, the minimum separation between drainfield and restrictive layers was increased to 36 inches for gravity systems and 24 inches for pressure distribution systems.

The limitations of soil types and depth on sites within the basin are identified by the Seattle-King County Department of Public Health during the initial design phase of newly proposed projects. The use of a mound system or other alternative type of system may be required at that time to assure both treatment and disposal concerns are met.

The Issaquah and Tibbetts Creek basins are currently served by two sewer and water districts. The North Fork subbasin is served by Sammamish Plateau Sewer and Water District. The East Fork, Issaquah Creek, and Tibbetts Creek subbasins are served by the Issaquah Sewer District. Figure 6-1 shows the extent of existing public sewers. The remainder of the basin has approximately 1965 households using on-site sewage disposal systems (King County, 1986; Anderberg, 1991).

The status of on-site sewage disposal systems was reviewed and analyzed by the Health Department. The review included examination of past surveys, a record review, and a 1990 field survey of 192 septic systems. Based on file reviews of



EXISTING SEWER SERVICE

Issaquah Creek Basin

Figure 6-1

1432 systems, the Health Department estimated a failure rate for the basin to be 5.5 percent (Anderberg, 1991). This failure rate is slightly higher than the 3-5 percent failure rate for the entire Puget Sound area (PSWQA, 1989a). The field survey revealed an overall 9 percent failure rate and a 5 percent prefailure rate. The combined failure rate for file and field failures is 5.7 percent. However, current failures comprised only 1.6 percent of the field survey results. The limited sample size (192 systems) may account for the difference in failure rates seen for the file and field survey. Or, more importantly, the fact that failures are less likely to be reported than seen in field visits may account for the overall higher failure rate seen in the field survey results.

Perhaps a more accurate picture is given by field results because not all failures are reported or documented. A current failure rate of 1.6 percent is not excessive. Also, failure rates of 5.5 percent and 5.7 percent are consistent with the average failure rates. There is no indication that the septic systems within the Issaquah and Tibbetts Creek basins present a significant threat to groundwater and surface-water quality when adequately maintained and repaired.

The SKCDPH has several programs in place to reduce nonpoint pollution from on-site septic systems in the basin. The SKCDPH currently monitors on-site septic systems through field reviews such as operational checks, building applications, complaint investigations, repairs, and alternative systems monitoring. However, this program requires adequate funding for support staff and a more unified and efficient approach between the WDOE and the SKCDPH for record keeping and identifying problems. The SKCDPH also mails as-built drawings of each new system to homeowners both at the time the system is installed and again after three years as part of their monitoring program. However, there is currently a less than 50 percent return rate on the three year as-builts mailing and increased clerical support is needed to verify accurate mailing addresses.

To encourage proper maintenance of septic systems, the SKCDPH has several public education efforts underway. Educational brochures are available to help the public in locating their septic systems and properly maintaining their septic tank and drainfield. Additionally, SKCDPH staff are available to speak to community groups about on-site sewage maintenance. Educational efforts will need to be expanded in these basins as more on-site septic system-dependent houses are built and the educational need of homeowners grows. Additionally, other ways of improving individual homeowner maintenance, such as development and implementation of maintenance regulations, formation of Local Improvement Districts (LIDs), incentive programs such as King County Low Income Rehabilitation Program, low-interest loans, coupons, subsidies and refunds, combined with the education and monitoring programs should be considered. BW 14 addresses most of the important issues noted above.

Agricultural Nonpoint Sources

Agricultural activities associated with nonpoint pollution in the Puget Sound region can be divided into two main groups: animal keeping and crop production. These

range from large, commercial ventures to small-acreage farms. Commercial agriculture is defined by the State Department of Agriculture as those farms selling, or capable of selling, $1000 (or more) of agricultural products per year (Puget Sound Water Quality Authority [PSWQA], 1986).

Sediment, nutrients, bacteria, organic material, and pesticides are the typical pollutants associated with farming activities in Western Washington. Improper pasture management (too many animals and overgrazing), lack of sacrifice areas (confinement), unlimited animal access to streams, and excessive numbers of waterfowl on ponds, are particular sources of nonpoint pollutants originating from (but not limited to) farms. Other agricultural practices or sources from which nonpoint pollutants originate are improperly managed row cropping, inadequate waste storage facilities, improper soil tillage, and improper timing and application of animal manure, fertilizers, and pesticides.

Nonpoint pollution from farm fields becomes a problem when sacrifice areas and overgrazed pastures receive large amounts of precipitation during a relatively short period of time during the winter months. During these wet periods, the ground is saturated and infiltration rates are low. Improper spreading and timing of animal manure applications, excess runoff generated from over grazed pastures, trampling of streamside vegetation, and direct access to streams by animals are poor practices that can result in water quality degradation.

In a recent King Conservation District (KCD) survey of the agricultural activity in the Lake Sammamish basin (which included East Lake Sammamish, East Fork Issaquah Creek, Issaquah Creek, and Tibbetts Creek [survey did not include North Fork Issaquah]) nearly 100 percent of the farming practices were characterized as consisting of small commercial operators and the "hobby farmer" (Minton and Fitch, 1988). Hobby farms, by far the most common agricultural activity in the basin, include horse boarding and training, cattle pasturing, orchards, llama farms, goat farms, poultry farms, and back yard gardens. In the KCD survey, only 10 to 20 percent of the pasture land being used by animals was considered adequately protected to reduce off-site impacts. Overstocking was the most commonly-noted problem. Animal numbers were estimated for the four drainage basins (East Lake Sammamish, East Fork Issaquah Creek, Issaquah Creek, and Tibbetts Creek) in the KCD survey. Estimates for Issaquah and Tibbetts Creek drainage basins were combined with field surveys conducted by SWM division staff and are approximated as follows: 750 horses, 500 cattle, 300-400 goats, and 25-50 llamas. These livestock generate approximately 80,000 lbs/day of manure (15,000 tons/year).

During field reconnaissance, many small farms throughout the basin were noted as having denuded pastures, overgrazed pastures, lack of adequate pasture size or overstocked pastures, and improper facilities for animal waste storage. Although the size of non-commercial farm operations were typically small compared to those of larger commercial farms, the observed frequency of degraded pasture conditions on small farms points to the significant pollutant contribution non-commercial farms cumulatively have to surface waters in the basin.

The findings in the Issaquah basin are consistent with WDOE's (1986) statewide assessment of nonpoint pollution that stated, "the primary water quality threat created by hobby farms was due to poor animal-keeping practices."

The agricultural trend in this basin has been towards smaller land ownership, which in turn has resulted in higher animal densities on smaller acreage. The basin's streams provide a convenient and inexpensive source of water for livestock and other farm animals and in some areas, unrestricted animal access to streams is provided by the farmer who is probably unaware of the impact that this has on downstream water quality.

Some programs exist in King County to reduce pasture maintenance-related nonpoint pollution. However, these programs are voluntary and receive limited funding and have not been adequate in controlling agricultural nonpoint sources. Both the King Conservation District and Cooperative Extension Service conduct a variety of programs including public education and involvement, small farm inventories, technical assistance for small farm BMP implementation, and federal funds distribution for fencing and other BMP's. BW 15 builds on these programs through the development of new animal-keeping regulations, the use of a conservation plan specialist, and a study of future options for animal waste management.

Pesticides

The use of pesticides on agricultural lands for roadside maintenance and by individual homeowners presents a potential nonpoint pollution source in the Issaquah and Tibbetts Creek basins. The usage of pesticides in the basin, however, is not well-documented. Nevertheless, the potential for groundwater contamination from chemical residuals and surface-water contamination from over-sprays and over-application is a concern relative to the long-term protection of these resources. Basinwide recommendations that address the use and application of pesticides in the basin include BW 13 (Household and business usage), BW 17 (Roadside maintenance usage), and BW 20 (Information on commercial pesticide applicators).

The application of pesticides within the basin is governed by WAC 16-288 (WDOE, 1989). These laws and regulations apply to labeling, ingredients, distribution, transportation, application, use restrictions, and disposal. The Washington State Department of Agriculture is responsible for the issuance and monitoring of statewide pesticide use permits. All commercial applicators are required to obtain licenses and keep records on the types, amounts, and locations of pesticides. Records are not available from the Department of Agriculture concerning location or amounts of pesticides used within the state.

King County Department of Public Works operates a roadside herbicide spraying program within the basin boundary. Herbicides applied in 1989 included Simazine, Atrazine, and Diuron. These chemicals have been declared "restricted use"

pesticides for the protection of ground water in the state and may only be distributed to, and applied by, certified pesticide applicators.

In 1990, herbicide applied in the area included approximately 450 pounds of Diuron and Atrazine, and less than five gallons each of Glyphosate and Dicamba (Anderberg, 1991). These herbicides were sprayed over approximately 240 miles of roadside within the study area. The amount of applied herbicide residual has steadily decreased in the last several years as a result of better application methods including dilution and decreased application volumes (SKCDPH, 1989).

The SKCDPH has an ongoing soils and water monitoring program to determine the residual levels of pesticide within the areas sprayed and to monitor their degradation over time. The conclusions of the 1989 report (SKCDPH, 1989) states "the spray operation appeared to be well-managed." No herbicide residuals were identified in any surface-water samples obtained. Low concentrations of herbicides, as expected, were detected at soil test depth of 4 inches. There is an increased concern at both the state (Department of Agriculture) and federal (EPA) levels about the continued use of Atrazine, Simazine, and Diuron, and further restricted use may be forthcoming.

The Washington State Department of Agriculture reports that although accurate use figures are not available, the majority of pesticide and herbicide use within the Issaquah basin is through household applications. When properly applied, this type of application should not pose a threat to water quality (Wick, 1990). The apparent limited application through agricultural and road-side spraying does not appear to pose a significant threat to water quality at this time (Anderberg, 1991).

Washington State Department of Transportation (WSDOT) is responsible for chemicals applied to those sections of I-90, SR 900, and SR 18 that are within the basin. In 1990 WSDOT applied a variety of chemicals including Fosamine Ammonium, Glysphosate, Dicambia, Triclopyr, Diuron, and Diquat over 12 miles of highway within the Issaquah and Tibbetts Creek basin areas. Limited amounts are applied for problem vegetation. Records of use are available at the WSDOT maintenance yard in Bellevue.

Forestry

Forest practices associated with the growing and harvesting of timber can contribute to nonpoint pollution. Logging road construction, maintenance, and accompanying vehicular traffic are commonly the dominant activities influencing accelerated erosion and sediment (Swanson, 1988). These activities alter the timing and volume of runoff, and expose large areas of soil to varying degrees of erosion as a function of rainfall, soil type, and topography (Geppert, 1984). The direct effect on water quality includes increased water temperature, and increased sediment and nutrient concentrations (Geppart, 1984), which can be detrimental to fish and other aquatic life.

Timber harvesting also has a tremendous effect on water movement, which directly affects water quality. Elevated quantities of sediment and runoff are produced during storm events leading to alteration of stream channel morphology. Annual water yields may increase by as much as 36 percent in a completely clearcut watershed. Under clearcut conditions, low summer streamflows will increase immediately following harvest and then decrease slowly over time. Continued harvesting of small watersheds within a large basin results in a persistent increase in the flow peaks of the mainstem during average autumn and winter storms (Geppert, 1984). Additionally, forest practices can result in elevated quantities of sediment and runoff during storm events, and subsequently alter stream channel morphology by disrupting the balance of sediment input and deposition. These trends will be magnified when forested land is developed into other land uses, resulting in complete clearcutting, with removal of understory and stumps.

The 61 square miles of the Issaquah and Tibbetts Creek basins are forested primarily with native tree species including Douglas fir (Pseudotsuga menziesii), western hemlock (Tsuga heterophylla), red alder (Alnus rubra), western red cedar (Thuja plicata), and big leaf maple (Acer macrophyllum). At the present time, 22.5 square miles (35% of the basin) are used for commercial forestry. Washington State Department of Natural Resources (DNR) manages Tiger Mountain State Forest, a 15-square mile tract within the watershed. Weyerhaeuser operates a tree farm on 2 square miles within the watershed. Both of these areas are south of the East Fork and east of mainstem Issaquah Creek.

The Weyerhaeuser property within Holder Creek (all located within Sections 20, 28 and 29 of Range 7, Township 23) is nominally on a rotation length of 50 years. However, three quarters of the 1,200 acres were harvested in the 1982-86 period and will be unavailable for any commercial harvest until after the year 2020 (Ryon, 1990).

Approximately 3500 acres (9% of the total forested land) are registered under the Forest Land Taxation Act and are considered part of the total commercial forestry base. These holdings consist of land development company ownership of 500 acres in the North Fork and of 1,070 acres in the East Fork as well as almost 2000 acres dispersed throughout the watershed in individually owned tracts as small as 20 acres.

In 1984, the state of Washington adopted a sustainable harvest base that uses a 60-year rotation limiting clearcuts (0- to 10-year age class) to 16 percent or less in each of the four forest drainages (DNR, 1986). At present, 125 acres are scheduled to be harvested annually, amounting to 1250 acres per decade for all mainstem creeks.

One means of estimating the area's long-term commitment to forestry activities is through the numbers of landowners who have sought the tax-relief option. Both RCW 84.33 - Forest Land Taxation (20-acre minimum) and RCW 84.34 - Open Space Act (5-acre minimum) allow land to be assessed on the basis of its current use, rather than its highest and best use. King County Assessor's Office records were researched to determine how much of the watershed was classified in this

tax deferred category and what trends, if any, were detectable. The forest land acreage has remained constant with the exception of the North Fork subbasin, where 26 percent of the tax deferred land was withdrawn. Non-commercial forested lands registered under Open Space Taxation (as of 1990), which are protected from significant logging in the basin, include one hundred forty acres of the mainstem drainages, Squak Mountain and a portion of Cougar Mountain State Parks (1.0 and 0.75 square miles, respectively), and almost 0.75 square miles of forest, park and protected watershed maintained by the City of Issaquah.

The Issaquah subbasin had four times as many Forest Practice Application (FPA) as the other subbasins combined. For the Tibbetts and Issaquah Creek subbasins, conversions were only a quarter of all the FPA's. Most logging did not occur on slopes considered sensitive (over 40% steepness). Complete clearcuts were uncommon; most sites were cut between 60 and 80 percent.

Logged volumes in the Issaquah Creek basin were 1,540,000 board feet; 5,440,000 board feet; 234,000 board feet, and 1,2270,000 board feet for 1987 through 1990, based on Forest Practice Application records. Volume on some of the smaller, private sites, subject to conversion, was as little as 5,000 board feet per acre while commercial forest land produced as much as 38,000 board feet per acre. These private site logging figures indicate a history of frequent harvesting of immature timber and land disturbance occurring on a frequency greater than the minimal standard industry rotation of 40 years.

The stabilization and maintenance of logging roads and the preservation of riparian buffer zones are activities requiring special attention in the review of FPA's. Most FPA's did not indicate any road building distances in spite of the fact that it is necessary to provide road access to most sites. Four and one-half miles of road building (Issaquah Creek, 1988) was the highest mileage reported for any year. Where stream protection was listed on the FPA, there was a trend toward wider and more consistent stream buffers for harvesting.

A large percentage of the watershed (27%) is committed to long-term forest rotations, which allow sites to recover from forest practices. Forestry activities, including harvesting, generally have less impact than other active land uses, such as mineral extraction, agriculture, and residential development. However, nonpoint water quality problems have been documented for Class II and III forest practices, as well as for Class IV conversions. The data analysis and field reviews show that logging into sensitive areas is no more likely to occur for land conversions than for forest practices on land committed to forestry.

There are some programs in existence to regulate forest practices. Enforcement functions, permit compliance, and coordination of forest practice review with other local jurisdictions such as the City of Issaquah is to be performed by DNR. King County review of Class IV DNR conversions and application of its SEPA and Sensitive Areas Ordinances can minimize water quality problems when linked to a series of land-use approvals leading to greater site utilization. An increase in enforcement and greater agency coordination are needed to minimize forest practice impacts on water quality (see BW 16).

Landfills

Landfills are potential sources of nonpoint pollution. Major earth-moving activities are a part of the day-to-day operations of a landfill. Inadequate erosion and sedimentation control can result in excessive quantities of sediments being entrained in storm water. Improper management of landfill leachate can also lead to nonpoint pollution. Additionally, leachate that is not collected, treated, and disposed of properly can result in surface-water contamination.

Landfill leachate is the wastewater that is generated from the decomposition of the wastes that have been disposed of in the landfill. Any water from external sources, such as precipitation or groundwater intrusion, that comes into contact with the wastes is also considered to be leachate. Leachate from municipal landfills typically exhibit high specific conductivity and high concentrations of iron, manganese, zinc, biological oxygen demand (BOD), chemical oxygen demand (COD), ammonia, coliforms, and several volatile and semi-volatile organics such as methylene chloride, acetone, benzene, toluene, and phenols. The nutrient phosphorus is normally detected in very low concentrations in landfill leachate.

The Cedar Hills Landfill operates on a 920-acre site approximately 4 miles south of the City of Issaquah, 3 miles north of Maple Valley, and 6 miles east of Renton. Cedar Hills is the regional municipal solid waste landfill for King County. It is operated and managed by the King County Department of Public Works Solid Waste Division.

At Cedar Hills, an extensive leachate collection and pretreatment system has been constructed. The leachate collection system consists of a network of perforated collection pipes located in and around active and inactive landfilling areas. The leachate is conveyed to two aerated lagoons where it is treated for organic waste strength and solids reduction prior to being discharged into the Metro sewage collection system. Because solids reduction by the aerated lagoons is minimal, there are currently no solids handling or testing procedures. The treated leachate is routinely monitored to ensure that it is meeting all the requirements of the Metro-administered industrial wastewater discharge permit.

Cedar Hills is divided into two separate surface-water drainage basins. The northern half of the site is located in the Issaquah Creek basin and the southern half is included in the Cedar River basin. The primary objectives for the surface-water control system at Cedar Hills are 1) to collect stormwater runoff from nonwaste and nonactive (closed) waste areas, 2) to prevent leachate from entering the stormwater collection system, 3) to convey runoff to stormwater detention basins for peak flow attenuation and sediment removal, 4) to release flows from detention basins at rates that are less than predevelopment rates, and 5) to minimize on-site erosion as well as erosion and sedimentation in downstream areas.

The Cedar Hills site originally consisted mostly of forest land use. As the landfill has developed, the forested areas have been cleared, and waste disposal areas have

been constructed and brought into active operation. There are five waste disposal areas at Cedar Hills that are located in the Issaquah Creek basin.

As areas of the landfill are completed, an impermeable clay and high-density polyethylene (HDPE) cover is constructed, which prevents surface water from infiltrating the buried refuse and generating excess quantities of leachate. Recent studies at Cedar Hills have shown that the quantity of surface water generated by rainfall increases because of the cover, while the quantity of ground water decreases.

Surface water that is not impacted by landfill operations is directed to on-site stormwater detention lagoons for sediment and silt removal and control of the peak release rates. There are several lagoons on-site, two of which are in the Issaquah Creek basin. The lagoons are designed and constructed for peak rate control. Although the lagoons at Cedar Hills were constructed prior to 1990, their design was based upon the anticipated 1990 design standards. Currently, these facilities are being evaluated to confirm that they are meeting all of the new standards.

Several key components are currently missing from the evaluation of landfill impacts on water quality. First, the absence of storm water quality sampling data makes full evaluation of nonpoint impacts qualitative at best. Second, without the collection of hardness data during sampling events, potential metal toxicity evaluation is complicated. In 1992, Cedar Hills will have to comply with NPDES stormwater discharge program and obtain a surface-water discharge permit for the landfill. In meeting the requirements of the permitting process, current storm water quality will be evaluated and the question of whether or not nonpoint impacts exist can be answered. However, King County Solid Waste Division to date has already made extensive efforts to control, treat, and evaluate point and nonpoint pollution at the Cedar Hills site. CIP No. 2557 in the McDonald Creek subbasin addresses the treatment of stormwater discharging from the Cedar Hills landfill (See *Chapter 5*).

Resource Extraction

Gravel mining is the leading form of mineral extraction in Washington State and occurs primarily west of the Cascades (WDOE, 1988). Sediment is the most common pollutant associated with gravel mining. During the extraction process, large areas of rock and soil are mined and sorted according to size. Fine silts and sands that result from this separation process are then washed into streams or into the drainage system during storm events producing significant amounts of surface-water runoff. Downstream, these silts and sands are deposited into the large pores found in gravel beds, often resulting in the "cementing" of salmon spawning beds and other aquatic habitat.

In the Tibbetts and Issaquah Creek basins there are four active mining operations, Sunset Quarry, Lakeside Sand and Gravel, Mutual Materials mine pit, and the Interpace Mine. Sunset Quarry, located on Squak Mountain along tributary 0169,

is a major source of silt, sand, and sediment to Tibbetts Creek. The ongoing problems with runoff discharges from Sunset Quarry to Tibbetts Creek (and May Creek) have resulted in substantial water quality and habitat degradation. *Chapter 5: Subbasin Recommendations* includes a subbasin recommendation (T 5) requiring a comprehensive, long-term water quality management plan for Sunset Quarry to address the chronic sediment problems.

An enforcement action by King County Department of Development and Environmental Services (DDES) requires the owner to prepare drainage, erosion, and sediment control plans and to provide enhancement and stream restoration to Tibbetts Creek (as well as to May Creek, south of the quarry). The new management of the quarry submitted proposed drainage and expansion plans to DDES in Summer 1992 that are currently being reviewed by DDES, SWM, and WDOE. After mining operations cease, the DNR is responsible for permitting and monitoring site restoration and closure plans.

In the past, Lakeside Sand and Gravel Company, located on tributary 0181 at river mile 1.30, was an ongoing source of silt, sand, and sediment. However, the drainage system has been redesigned and all of the site runoff is now infiltrated. The company has recently installed a state-of-the-art wash water recycling system, which has substantially reduced their need to infiltrate wastewater, consequently providing additional capacity for stormwater treatment and reducing their overall groundwater consumption.

The Mutual Materials Company's Newcastle Pit is located on tributaries 0171 and 0172 in the Tibbetts Creek subbasin. The mine has been in continuous operation since 1960. The mine is a source of fine sediments and other associated pollutants to Tibbetts Creek. The on-site stormwater and sediment control facilities were constructed recently, but they have been poorly maintained. The Interpace Mine has been active at various times throughout this century for coal and gravel mining. An operating permit was recently received by DDES to begin active mining at the site. Areas of the site that are to remain inactive in the new operation should be stabilized and vegetated to minimize erosion and off-site sediment transport. Stormwater and sediment control facilities should be constructed to manage the volume and quality of site runoff for the new operations. Subbasin recommendations T 6 and T 7 address these two sites. The recommendations focus on compliance with the new industrial NPDES requirements for mining operations outlined by the Washington Department of Ecology.

Small Quantity Hazardous Waste Generators

Small quantity hazardous waste generators (SQHWG) were investigated by the Health Department as a potential source of nonpoint pollution in the basin. The increased use of chemicals in the home and in small businesses has resulted in growing amounts of leftover wastes. Auto service and repair shops, print shops, dry cleaners, beauty salons, medical facilities, and school shops, are some of the businesses that are potential SQHWG in the basin. Because this emerging problem

may have a serious impact on ground water and surface-water supplies, it must be considered as a potential threat within the basin (Anderberg, 1991).

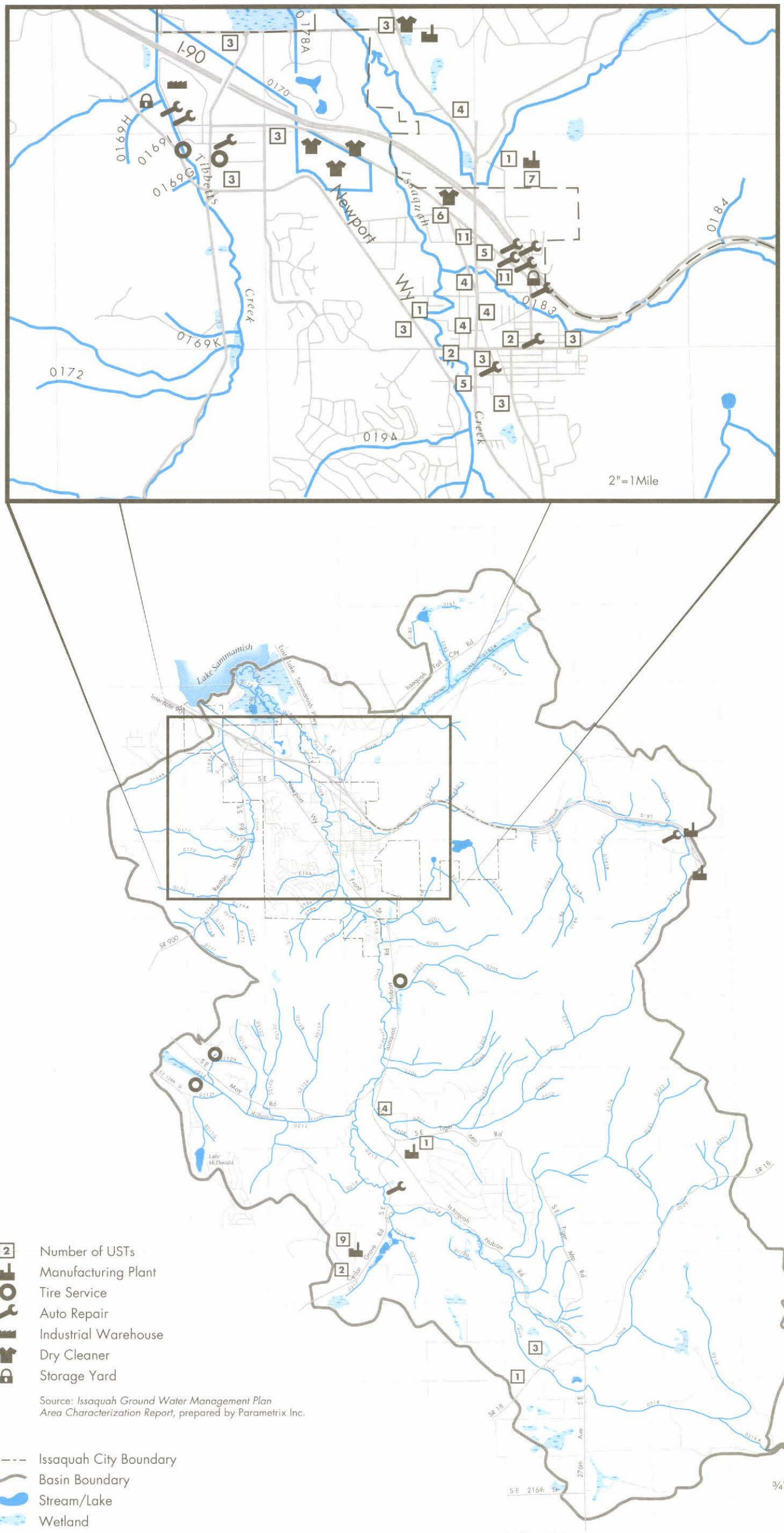
Currently, there is no accurate estimate of the amount of hazardous waste disposal in the Issaquah and Tibbetts Creek basins. Some of the existing SQHWG, primarily concentrated in the downtown Issaquah area, are shown in Figure 6-2. The Health Department, in conjunction with Metro, is developing a list of small hazardous waste generators in the county. Within King County, though, it is assumed that there are 20,000 businesses that may be small quantity generators. An unknown but probably small percentage of these generators are located in the Issaquah basin planning area. The disposal of household hazardous wastes poses a current threat to water quality and will increase with population growth in the basin (Anderberg, 1991).

Existing programs to reduce nonpoint pollution from small quantity hazardous waste generators include the SKCDPH "Hazards Line," which answers questions from the public and responds to complaints about the use and misuse of household chemicals. This program is funded by the SKCDPH through the King County Solid Waste Division fees and general County funds. The King County and Seattle Solid Waste Divisions also operate a hazardous waste collection program using a roving "Waste Mobile". In 1990, the hazards line professionals answered more than 15,000 calls from the public regarding chemical use and disposal. Brochures used in the program are made available through the Metro service area. However, limited funding restricts the effectiveness of these programs. BW 13 is designed to supplement these programs in order to improve the management of hazardous wastes by businesses and the general public.

Underground Storage Tanks

Underground storage tanks (UST's) were investigated by the Health Department as a potential source of nonpoint pollution in the basin. UST's are used for the storage of petroleum and other regulated substances and pose a threat to public health through potential pollution of groundwater aquifers. Because the majority of the population in the Issaquah basin is dependent on groundwater as a drinking water source, serious consideration should be given to the condition of UST's in the basin. The EPA has estimated that as many as 25 percent of all UST's may be leaking nationwide (EPA, 1988). Tank leakage may be caused by deterioration of the tank, improper installation, pipe failures, and/or spills and overfills.

The Department of Ecology has identified and registered 123 UST's in the basin (Figure 6-2). This list is not all-inclusive, but does include the majority of underground tanks in the area. Exempt from WDOE registration are the thousands of underground heating oil storage tanks not covered by WDOE's UST regulations. There is some discrepancy between the number of the UST's shown on the map



POTENTIAL POINT CONTAMINANTS* & UNDERGROUND STORAGE TANK(UST) LOCATIONS

Issaquah Creek Basin

Figure 6-2

and the number positively identified, due to the recent removal of UST's to comply with WDOE's upgrading of construction and monitoring standards. Many of the UST's are in the 6-to-20 year age bracket, with 43 percent of those 11 to 20 years old. Eleven percent of the tanks are more than 30 years old. Based on size classification, 25 percent of the tanks fall within the range of 10,000 to 20,000 gallons. Additionally, leaded, unleaded, and diesel fuel account for 77 percent of the compounds stored in UST's in the Issaquah basin.

Single-walled, bare steel tanks without corrosion protection, particularly those that have been in the ground over 15 years, are the most vulnerable to leakage. A recent WDOE survey of UST's in the Issaquah area indicates that of the 75 UST's older than 15 years and of known tank material, 57 (76%) are steel tanks. Twenty-two (39 %) of those steel tanks are further documented as single-wall tanks. UST's without special leak containment or leak detection systems represent a potential for surface-water and groundwater contamination. The WDOE has found that 37 percent of the listed UST's in the Issaquah basin do not have leak detection systems. Deterioration of the tank, improper installation, pipe failures, spills or overfills may all contribute to tank leakage.

The WDOE is currently implementing a program of identification and registration of unregistered UST's and enforcement of construction upgrades and monitoring systems on tanks covered under Resource Conservation and Recovery Act Subtitle I.

Although it is clear that UST's may represent a severe threat to groundwater in the region, it is less clear that they represent a significant threat to surface-water quality. The extent of the problem depends on the types of contaminants that are leaked, the migration patterns of the groundwater, and the sensitivity of the resources. UST's found in close proximity to surface-water features could pose a significant threat to water quality. Within the Issaquah basin, the UST's are concentrated in the business center of Issaquah. Tibbetts Creek, and the North and East Forks of Issaquah Creek flow through the City of Issaquah and are therefore the surface waters most susceptible to contamination.

In April 1991, WDOE notified the Sammamish Plateau Water and Sewer District (SPWSD) that a shallow aquifer near Interstate 90 and Front Street was being contaminated by a leaking UST at the ARCO service station. The extent of contamination is still being determined through test-well sampling. Since then, SPWSD has stopped pumping wells that could potentially be affected by the aquifer contamination. Contaminated soils were originally detected in April 1990 but little concern was raised at that time. In November 1990, the tanks were replaced and 1500 yards of contaminated soil removed. During routine testing in February 1991, detectable levels of hydrocarbons were found.

This particular contamination of groundwater by a leaking UST in downtown Issaquah points to how easily such contamination may occur and go undetected or unannounced for extended periods. Groundwater quality contamination has occurred and will remain a threat given the number of older tanks in the basin.

Some programs exist to reduce nonpoint pollution from UST's in the basin. The WDOE currently enforces federal and State UST-related regulations and deadlines. The regulations require all tanks to be registered before they can legally be filled. In order to receive a permit, a UST must be in compliance with State rules and pay annual tank fees. Additionally, all existing tanks installed prior to December 22, 1988 must be upgraded according to schedule (173-360 WAC) to include leak detection devices. When UST violations are detected or reported, WDOE should immediately involve local jurisdictions, fire departments, potentially affected water districts or other affected parties.

The King County Solid Waste Screening Section determines the ultimate disposal of contaminated soils when UST's are removed or upgraded, and when leaks or spills have occurred. However, no comprehensive local monitoring programs have been established. Additionally, no agency currently registers, regulates or tracks homeowner fuel tanks that may leak or spill pollutants into surface and ground waters.

Boating and Marinas

Recreational boating and associated facilities, (e.g., marinas, launching/access sites) can contribute pollutants to lake systems. The most common concern associated with boating activities is the discharge of untreated or partially treated human waste (PSWQA, 1989b). Other nonpoint contaminants from marinas and recreational boating activities include: oils and greases, petroleum hydrocarbons; detergents; solvents; paints; antifouling agents (e.g., tributyltin [TBT], which is highly toxic to aquatic life); and litter (particularly plastics and styrofoam).

There are presently no marinas in the Issaquah basin. Lake Sammamish State Park, near the south end of the basin, is the only boating facility in the vicinity listed in the publication "Public Boating Facilities in Washington State" (1988). The Lake Sammamish State Park has nine boat launching lanes and parking space available for 250 vehicles. Boat launch attendance for 1989 was 606,777 people and 173,363 vehicles. Between the months of April through September, 85 percent of the park's boat launch activities occur. During peak use in the month of July, boat launch parking capacity is exceeded by a factor of four (Benson, 1990). Small pleasure craft owners are the dominant users of the launching facility (Bjorkland, 1990). Public restrooms are available at the site, but there is no pumpout facility available to boaters with holding tanks.

Currently, nonpoint pollution originating from boating activities is probably minimal as compared to other land-use practices and activities in the basins. However, marina and boating related nonpoint pollution may pose a future problem in the basins as usage of the area lakes for recreation increases. A 100-unit condominium project that includes a marina and restaurant has been proposed near the state park in the Tibbetts Creek basin. If completed, boating and marina nonpoint pollutants will increase in Lake Sammamish. BW 20 addresses potential boating impacts through an annual education seminar at the Lake Sammamish State Park boat launch. The *East Lake Sammamish Basin and Nonpoint Action Plan*

also calls for the installation of an informational gazebo at the boat launch that includes water quality brochures and displays.

WATER QUALITY ASSESSMENT

Introduction

In addition to identifying the potential range of nonpoint problems in the basins, significant water quality problems were also identified in the Issaquah and Tibbetts basins using historical data, baseflow data (non-storm), storm water quality sampling results (1989-1990), and field surveys. Additional information is available from the Issaquah hatchery, which has been collecting influent water samples from Issaquah Creek as part of the NPDES waste water discharge permit process. Comparison of water quality results were made using Washington State water quality standards for Class AA (Extraordinary) and A (Excellent) waterbodies (Chapter 173-201 WAC), EPA water quality criteria, and State Board of Health Drinking Water Regulations. A brief discussion of these standards is presented here.

Base and storm flow water quality data are available for both Issaquah and Tibbetts creeks. Because Lake Sammamish is the receiving water body for both Issaquah and Tibbetts creeks, activities in the basins influence the water quality of Lake Sammamish. A brief summary of Lake Sammamish historical water quality is therefore included. A more detailed analysis of Lake Sammamish water quality, future conditions, and management alternatives is presented in another study conducted by Metro (1989). Bioavailable phosphorus loading estimates are summarized below. Additional water quality data relevant to the basin from WDOE and King County Solid Waste are also presented.

Standards

The water quality standards for the state of Washington are defined in Chapter 173-201 of the Washington Administrative Code (WAC). This chapter establishes the water quality standards for surface waters of the State that are consistent with public health and enjoyment and the protection and propagation of fish, shellfish, and wildlife.

All waters in the Issaquah Creek and Tibbetts Creek basins are classified as Class AA (Extraordinary) or Class A (Excellent). Waters under AA classification are characterized as "markedly and uniformly exceeding the requirements for all or substantially all uses" (*i.e.*, beneficial uses). Class A waters are characterized as meeting or exceeding the requirements for all or substantially all uses. State water quality criteria (WDOE, 1988a) are defined for fecal coliforms, dissolved oxygen, temperature, pH, and turbidity. Other water quality variables, such as phosphorus and nitrogen, do not have State water quality criteria established.

EPA's water quality criteria (1986) establish acute and chronic concentrations for both freshwater and marine systems for a variety of constituents including most heavy metals, some pesticides and a few organics. These include cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc, and suggested guidelines for phosphorus.

For two constituents (nitrate+nitrite-nitrogen, and total suspended solids), no State or federal criteria exist. For the purpose of this report, a basin plan "threshold value" was set to allow comparisons of sampling sites and to identify problem areas. These threshold values were determined by King County SWM water quality staff following review of other studies (Gammon, 1970) and monitoring results.

Metro Monitoring Program

The Department of Metropolitan Services (Metro), as part of its annual quality of local lakes and streams program, monitors several sites within the watershed on a monthly basis during baseflow conditions. Monitoring sites include three sites on Issaquah Creek and one site on Tibbetts Creek. Since 1987, grab samples have been taken during high flow or storm events by Metro including one site located on Issaquah Creek. During the 1989-1990 water year (October 1 through September 30), a storm water quality sampling program was conducted by Metro, at five sites located throughout the basin. Samples were collected during five storm events.

As part of Metro's major and minor lakes surveys, monthly or bimonthly water quality sampling is currently being performed for Lake Sammamish. This monitoring work is part of a long-term monitoring program for lakes that have public access. Lake Sammamish has been the subject of many water quality monitoring programs conducted by Metro and the University of Washington. The most recent study completed (Metro, 1989) has proposed specific management alternatives to reduce phosphorus concentrations in urban runoff and subsequent degradation of lake water quality.

Water Quality Analysis

Metro 1989–1990 Baseflow

As part of their 1989-1990 Freshwater Assessment Program, water quality conditions during baseflow were monitored at two sites on the mainstem of Issaquah Creek, one site on the North Fork Issaquah Creek, one site on Tibbetts Creek, and three sites in Lake Sammamish (Metro, unpublished data, 1990). Since 1987, Metro has conducted a limited wet weather sampling program that includes ten river and stream sites throughout the county. Issaquah Creek is one of the streams sampled in this program. Discussion of wet weather monitoring contained in this Metro status report will be included in the supplemental storm monitoring section below.

Water quality variables routinely monitored in Metro's program (streams) include temperature, pH, conductivity, turbidity, total suspended solids, alkalinity, ammonia, dissolved oxygen, nitrate+nitrite-nitrogen, ortho-phosphate, total phosphorus, cadmium, chromium, copper, iron, mercury, nickel, lead, zinc, fecal coliform, and enterococcus bacteria. Chlorophyll a and transparency, as well as some of the above parameters, are routinely monitored in lakes.

Both fecal coliform and enterococcus bacteria were sampled at five sites (Figure 6-3) in the study area during Metro's ongoing baseflow monitoring program. Fecal coliforms, while generally not harmful themselves, are an indicator organism used to identify the presence of fecal matter (originating from warm-blooded animals, including humans) in waterbodies. Enterococcus is also an indicator of fecal matter, but it is thought to correlate better with human health effects associated with fecal contamination.

Dry season (April-September), wet season (October-March) and yearly fecal coliform geometric means were calculated for five stream locations. Dry season geometric means exceeded State water quality standards at all sites except the East Fork Issaquah Creek site. Dry season geometric means exceeded State standards by a factor of seven at the Tibbetts Creek site. At the remaining sites, the criterion was only slightly exceeded or exceeded by a factor of two. Yearly geometric means exceeded the standard at three of the five sites while wet season geometric means exceeded the standard at the Tibbetts Creek site. Generally, it appears that fecal coliform standards are exceeded in the basin during baseflow conditions.

Yearly dry season (April-September) and wet season (October-March) enterococcus geometric means were also calculated for the five stream sites and compared to EPA criteria for enterococcus. The steady state geometric mean criteria require a statistically sufficient number of samples (generally not less than five) equally spaced over a 30-day period. Geometric mean comparisons to the federal criteria were made even though samples were collected on a monthly basis. All geometric means, except the wet season means for Tibbetts Creek and Issaquah Creek above the fish hatchery, exceeded the steady state geometric mean indicator density of 33 organism per 100 ml. Based on EPA's "Single Sample Maximum Allowable Density for Moderate Full Body Contact Recreation" of 89 organisms per 100 ml, Tibbetts Creek, North Fork Issaquah Creek, Issaquah Creek at SE 56th Street, and Issaquah Creek above the fish hatchery, exceeded the federal criteria five times, twice, twice, and once, respectively. The frequency of enterococcus standard exceedence is typical of slightly urbanized basins but does not necessarily indicate nonpoint pollutants due to sources such as failing septic systems.

The conditions study included the evaluation of baseflow total metal concentrations. Copper, chromium, iron, nickel and zinc concentrations were all below their respective toxic criteria (using an estimated hardness value of 100 mg CaCO3/l). Cadmium, mercury, and lead concentrations where all less than their respective detection limits of 0.002, 0.0002 and 0.03 mg/l (using the Inductively Coupled Plasma method). Baseflow metal concentrations do not appear to represent a current threat to water quality.

Nutrients such as nitrogen and phosphorus do not have specific State or federal standards but are used as indicators of water quality problems. To reduce algal growth and maintain water clarity, total phosphates (TP) as phosphorus (P) should not exceed 50 ug/l in any stream at the point where it enters any lake reservoir (EPA, 1986). Baseflow yearly mean TP concentration exceeded this guideline at Tibbetts Creek only.

A basin plan threshold value of 1,250 ug/l as nitrate+nitrite-nitrogen has been set by SWM staff. Annual baseflow concentrations exceeded this value at two sites, Tibbetts Creek, and East Fork Issaquah Creek.

Metro 1988-1989 Status Report

Issaquah Creek: Four indicator parameters (fecal coliform, temperature, dissolved oxygen, and turbidity) were chosen by Metro to evaluate water quality for contact recreation, salmonid rearing, and general instream disturbances or impacts (Metro, 1990). During the 1988-1989 monitoring season, fecal coliform counts exceeded water quality standards four and six times out of 12 samples for sites 0631 (mainstem at SE 56th Street) and A632 (North Fork), respectively.

Tibbetts Creek: Exceedence of water quality standards for dissolved oxygen, temperature and fecal coliforms has occurred on Tibbetts Creek. General baseflow water quality is characterized by variable turbidity with high levels in the late winter and summer periods, high fecal coliform counts, wide temperature range, and a lower dissolved oxygen content than characterized by Class AA waters. Specifically, during the 1988-1989 monitoring season, fecal coliform counts were exceptionally high during November, May, and June and exceeded water quality criteria seven of 12 times. Dissolved oxygen similarly failed to meet State water quality criteria five of 12 times.

Tibbetts Creek water quality continually fails to meet Class AA standards and has failed to meet such standards throughout the Metro freshwater monitoring program. Metro in their 1988-1989 Status Report (Metro, 1990) characterized Tibbetts Creek water quality as "fair". Under WAC 173-201-070, Tibbetts Creek is classified as Class AA because all feeder streams to lakes are classified as Class AA unless specifically identified in WAC 173-201-080. Issaquah Creek is one such stream that is specifically classified as Class A. However, it usually has better overall water quality and rating (consider "very good" in the Metro, 1990) than Tibbetts Creek. Classification of both Tibbetts and Issaquah Creeks should be reviewed by WDOE. If enforcement of standards cannot be performed to meet water quality goals (for Tibbetts Creek especially), then the current classification process should be reevaluated.

Lake Sammamish: Lake Sammamish is rated as mesotrophic (medium productivity) based on water quality data collected from three lake sites. The annual mean volume-weighted total phosphorus (TP) concentration was 21 ug/l in 1989. This concentration is approximately 3 ug/l higher than that of its historical mean (1979-1988) but remains substantially lower than the presewage diversion (1964-1966) concentration of 33 ug/l. Generally, winter TP concentrations of

WATER QUALITY SAMPLING LOCATIONS

Issaquah Creek Basin

Figure 6-3

20-30 ug/l and summer chlorophyll a concentrations of 6-10 ug/l characterize eutrophic (high productivity) waters (Welch, 1980).

Annual mean transparencies in Lake Sammamish in 1988-1989 ranged from 3.4 to 4.1 meters, which are slightly less than the historical range of 3.6-4.5 meters. Generally a summer secchi disk transparency of 3 to 5 meters characterizes oligotrophic (low productivity) waters (Welch, 1980). Although TP concentrations alone place Lake Sammamish water quality in the eutrophic category, relatively good water clarity remains giving the lake its current mesotrophic rating.

Lake Sammamish Water Quality Management Project, 1989

Bioavailable phosphorus (BAP) was calculated for the basin for present and future land use using loading estimates from the Lake Sammamish Water Quality Management Project (Metro, 1989). Present BAP from the Issaquah basin was computed as 4,164 kg BAP per year or 67 percent of the total (6,175 kg BAP per year) external lake BAP loadings. Future (build-out conditions) loadings are expected to increase to 7,335 kg BAP per year for the basin or 70 percent of the total (10,431 kg BAP per year) external lake loadings. Based on current and future BAP estimates, a 57 percent future increase in BAP loadings will occur. This increase represents 70 percent of the total increase in BAP loadings to Lake Sammamish.

Algal growth in the lake is phosphorus limited. Increases in phosphorus concentrations can result in increases in algal growth, which in turn, can lead to decreases in water clarity and dissolved oxygen, surface scums, foul odors, foul tastes in fish, and ultimately, a shift in lake trophic structure. It is probable then, under future build-out conditions with no water quality controls, that water quality degradation of Lake Sammamish will occur as a result of increased phosphorus loadings from the Issaquah basin. Localized beneficial use impacts (e.g., increased macrophyte densities and algal blooms) to the lake in the vicinity of the State Park and along the lake shore where the basin's drainages enter are likely to appear first. Impacts to regional beneficial uses of the lake will likely be noticed as decreases in water clarity and increases in whole lake algal blooms occur.

Supplemental Storm Monitoring Data 1989-1990

Previous storm data collected by Metro beginning in 1987 for Issaquah Creek (one site) were of limited value for basinwide water quality assessment. Subsequently, storm water quality samples were collected by Metro from five locations in the study area (Figure 6-3) during five storm events during 1989-1990. Average suspended solids, fecal coliform, nitrate+nitrite-nitrogen, and total phosphorus values were measured at the five sampling sites. "Pollution Points" were assigned to average storm concentrations for each parameter and the water quality at each site ranked from high to low. Total points were added for each variable and the sites were then ranked accordingly. McDonald Creek (0635) and Tibbetts Creek (E630) were the highest scoring sites and exhibited the worst water quality of all sites measured. Issaquah Creek (0631) also exhibited poor water quality and ranked third among the five sites. East Fork Issaquah Creek (0633 and 6314) water

quality had the lowest storm concentrations for three of the four variables used for storm water quality evaluation, suggesting a limited number of pollutant sources in the subbasin.

Storm-event water quality was also compared with baseflow water quality where sampling sites were the same (Figure 6-3). Total suspended solids concentration were 12 and 17 times higher during storm events at stations 0631 and 0633, respectively. Generally, where data were available for comparing storm and baseflows, storm pollutant concentrations were higher than baseflow concentrations.

Fecal coliform concentrations during storm events exceeded water quality standards at all five sites. At McDonald Creek, average storm fecal coliform concentration (as a geometric mean) was 1535 organism/100 ml, which exceeds water quality criteria by a factor of 15. Average nitrate+nitrite-nitrogen concentrations at Tibbetts Creek (E630) and at Issaquah Creek (0631) were 1425 and 1224 ug/l, respectively, and were close to exceeding or exceeded recommended criteria (1,250 ug/l) during storm events. Total phosphorus concentrations exceeded recommended criteria (50 mg/l) at all five sites during storm events.

Cadmium, chromium, copper, mercury, nickel, lead, zinc, and iron concentrations were measured during five storm events. Using a representative hardness value of 20 mg CaCO3/l during storms, metal toxicity was evaluated. Most sites did not show any acute or chronic standard violations except during the December 4, 1989 samples. Site 0635 (Figure 6-3), however, showed chronic standards violation during most sampling events for cadmium, chromium, copper, nickel, and zinc. The high concentrations of metals are particularly interesting given the land use of this site. The site is located on McDonald Creek, which drains primarily residential land use. Road runoff may be one source of these concentrations. Higher flows at the remaining sites may dilute and subsequently mask metal concentrations at other sites. The timing of sample collection is another factor that may affect the concentrations recorded.

Fish Kill Data 1990

The WDOE and City of Issaquah Public Works Department conducted an investigation into the fish kills on the North Fork Issaquah Creek, which occurred during storm events in late March and early April of 1990. Water and tissue samples of fish were collected after the second event. Pollutants including metals, ammonia, sulfides, 1,2 Benzenedicarboxylic Acid, and Diisonyl Ester are believed to have acted in combination with low hardness to result in the death of juvenile salmonids (Devitt, unpublished data, 1990). Source identification focused on the storm drainage system that enters the North Fork Issaquah Creek at RM 0.2. Sediment samples that were collected in storm drains several weeks after the event failed to identify the source of the above mentioned pollutants.

Issaquah Salmon Hatchery management believe that toxic conditions exist year round downstream of RM 0.2. These conditions, however, are only noticed after

fish release (and death) from the hatchery occurs. An in situ fish bioassay using juvenile coho was used to evaluate the year round potential toxicity. In the autumn of 1990, two bioassays were conducted. In both cases, fish in cages located downstream of the outfall (RM 0.2) died shortly after placement in the stream, while fish in upstream cages remained healthy (S. Lynne, pers. commun., 1991).

Reid Sand and Gravel, 1990

During supplemental storm water quality sampling in the East Lake Sammamish basin (April 24, 1990), one water quality sample was obtained from a drainage ditch (Figure 6-3, site LSG) in front of the Reid, Sand and Gravel property along East Lake Sammamish Parkway. Concentrations of 374 ug/l total phosphorus, 278 mg/l total suspended solids, 320 NTU turbidity, 24.8 ug/l copper, 7.4 ug/l lead, and 19 ug/l zinc were recorded. The gravel mining operation has been a historical source of sediment to the North Fork Issaquah Creek. Phosphorus, suspended solids, turbidity, and copper (based on 20 mg $CaCO_3$/l hardness) concentrations exceeded standards or recommended guidelines.

Cedar Hills Landfill, King County Solid Waste, 1990

Surface-water quality is monitored predominately during baseflow conditions at Cedar Hills. There are approximately 20 monitoring stations surrounding the site, 11 of which are in locations that discharge to the north (towards McDonald Creek). A majority of these stations are sampled as frequently as once per month. Constituents analyzed include pH, conductance, ammonia, nitrite, nitrate, chloride, cyanide, fluoride, sulfate, chemical oxygen demand (COD), solids, turbidity, alkalinity, heavy metals, volatile and semi-volatile organics, pesticides and herbicides.

Water quality monitoring data collected during 1989 for four stations (CHN-1, CHN-4, CHN-5, and CHW-1) located in the Issaquah Creek basin at Cedar Hills were evaluated. No specific effort was made by King County Solid Waste Division to collect stormwater runoff samples. Consequently, much of the water quality data consists of baseflow sampling. Additionally, water quality for cadmium, mercury, and lead were not evaluated because criteria concentrations were below the laboratory detection limits. Metal toxicity evaluation was further limited because the water quality criteria are dependent on water hardness data that are currently not collected at Cedar Hills. Chromium, copper, iron, nickel, and zinc concentrations were therefore evaluated using an assumed baseflow hardness value of 100 mg/l as CaCO3. The 1989 monitoring data for the four stations evaluated were compared with the chronic water quality criteria for this hardness value. One of the four monitoring stations is located in a drainage channel leading onto the Cedar Hills site and was therefore used as a background comparison (CHW-1). Although concentrations in excess of the water quality criteria were noted for iron and copper, these compounds were also found in the background samples but at lower concentrations. Cadmium, mercury and lead were usually undetectable at all sites.

The 1989 monitoring data for the four sites evaluated were also compared with Class A State water quality standards for pH, turbidity, and dissolved oxygen. Single samples from CHN-1 and CHN-4, and two samples from CHW-1 (the background station), violated pH standards. The background station also had a single sample that exceeded the upper pH standard.

Monitoring station CHN-5 exhibited dissolved oxygen concentrations below the standards; however, dissolved oxygen concentrations at CHN-1 (downstream of CHN-5), which is the ultimate discharge point for surface waters leaving the Cedar Hills site, were above the recommended standard.

Surface water leaving the Cedar Hills site during baseflow usually does not show leachate impacts. However, increased sedimentation, presumably produced by earth-moving operations during landfilling, has been observed. Fine silt and clay particles become suspended in the storm water and are very difficult to remove. Past experience has indicated that sedimentation facilities are only marginally effective in removing silt and clay size particles. Turbidity readings from the north monitoring stations were as high as 120 NTU between 1987-1989. The State turbidity standard is written such that "turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase when the background turbidity is more than 50 NTU."

Examination of Issaquah Creek baseflow turbidity values over 11 years for several sites in the basin show turbidity values less than 10 NTU. Based on a basinwide background turbidity reading of 10 NTU, it seems that the Cedar Hills Landfill discharge would violate State turbidity standards for Class A waters. To address this ongoing turbidity problem, King County Solid Waste Division adopted an erosion and sedimentation control plan that places primary emphasis on source control. Additionally, the Division is conducting an extensive surface-water quality study to evaluate additional measures for removing suspended particles.

Beneficial Use Impairment and Threat

Areas of natural erosion, construction sites, urbanization, gravel mining operations, and agricultural practices are the major sources of nutrients, sediments, and fecal coliforms in the Issaquah and Tibbetts Creek basins. Construction practices, combined with subsequent urbanization, represent major nonpoint sources in the basins, particularly in the lower portion of each basin.

As forested lands are logged or pasture lands are converted to residential and commercial developments, increasing amounts of sediments, nutrients, heavy metals (primarily from the downtown area), and other toxins are transported to the surrounding streams. Reduction of fish spawning and rearing habitat along with an overall loss in biological usage occurs. Degraded microhabitat (localized conditions such as depth, velocity, substrate, and cover) and macrohabitat (those characteristics of the environment that affect the distribution and abundance of species such as water quality, temperature, particle size and discharge) for both anadromous

and resident fish and other aquatic species are the cumulative impacts of increased urbanization and nonpoint pollution. The absence of large woody debris and riparian shading, particularly on the lower stream reaches, limits fish usage.

The increase in impervious surfaces associated with urbanization also degrades water quality. Pollutants, including sediment (primarily during construction), metals, oil, grease, nutrients and fecal coliforms are concentrated in urban watersheds and are washed into the storm drains and streams during storm events. Accumulation of pollutants in storm drains in the downtown area has resulted in significant beneficial use impairment including fish kills on the North Fork Issaquah Creek. Based on State standards for Class AA and A waters, water quality associated with these classifications is degraded in the basins. Fecal coliform counts, temperature, and dissolved oxygen concentrations fail to meet standards during portions of the year.

High nutrient levels in Lake Sammamish, McDonald Lake, Yellow Lake, and all tributary waters, are also a threat to water quality and beneficial uses. Increased nutrient concentrations, particularly phosphorus, can result in increased algal growth, increased aquatic macrophyte densities, decreased dissolved oxygen content, and subsequent water quality degradation. Beneficial uses, including swimming, boating, fishing, scuba diving, water skiing, wildlife, and fisheries, can be severely impacted in basin streams, Lake Sammamish, and other basin lakes.

Future Water Quality Conditions

In the Issaquah basin, land use is changing from largely agricultural and forested land to residential, non-commercial farming, and light commercial development. New developments in the downtown area and along the I-90 corridor, such as the I-90 Corporate Center, Sammamish Park Place, and Brown Bear Car Wash, are currently impacting surface-water quality and will continue to do so as the sites are graded, paved, and landscaped. This change in land use has resulted in, and will continue to result in, increased stormwater flows and concentration and transport of nonpoint pollutants to the basin's streams, lakes, and groundwater. Increases in water quantity and decreases in water quality are of concern now, and will continue to be of concern in the future.

Several studies have characterized pollutants associated with stormwater. Richey (1982) examined the effects of urbanization in Kelsey Creek, Bellevue, Washington, and found the concentrations of nutrients and suspended solids to increase with urbanization. The EPA has characterized pollutants found in stormwater that are associated with several urban land uses. The concentrations as a function of land use are shown in Table 6-1.

Table 6-1 Stormwater Pollutant Concentrations (mg/l) Versus Land Use

Urban Land Use	TSS+	BOD*
Residential	240	12
Commercial	140	20
Industrial	215	9
Other developed areas	17	1

+ Total Suspended Solids, standard 50 mg/l
* Biochemical Oxygen Demand

Source: Sullivan et al., 1977.

Tibbetts Creek and McDonald Creek already exhibit average TSS concentrations of 236 mg/l and 241 mg/l, respectively, during storm events. These concentrations are comparable to those found by EPA in residential land use (240 mg/l). As residential development increases along other stream systems in the basin (e.g., North Fork Issaquah Creek and Issaquah Creek), increases in TSS concentrations could be expected as well.

Recent fish kills on the North Fork Issaquah demonstrate the relevance of metal toxicity as a current and future water quality problem. Beneficial uses are already being impacted. It could be expected that even with the implementation of BMP's, changes in land use described above will result in increased concentrations of these and other pollutants.

Mean pollutant concentration for the five Issaquah and Tibbetts Creek basin sites were compared to ten Metro high flow sampling sites (Table 6-2). Metro (1989) collected six high flow events between April 1987 and March 1989 from ten sites (Bear-Evans Creek, Cedar River, Coal Creek, McAleer Creek, Middle Green River, Soos Creek, and Springbrook Creek).

Table 6-2 Mean stormwater concentrations for ten Metro sites and five Issaquah Basin sites (including Tibbetts Subbasin)

Variable	Unit	Metro 10 Station Mean*	Issaquah Basin 5 Station Mean**	Standard***
TSS	mg/l	39	132	50
Turbidity	NTU	14	55	15
Fecal Coliforms	organ-isms/ 100ml	474	442	100
Ammonia	ug/l	64	295	---
Nitrate	ug/l	894	1018	1250
Phosphorus	ug/l	104	193	50

* Based on six storms
** Based on five storms
*** See text

Issaquah and Tibbetts Creek basins pollutant concentrations were typically higher than the combined Metro sites except for fecal coliform and nitrate concentrations. Concentrated agricultural activity along two of the Issaquah and Tibbetts Creek basin sites (McDonald Creek and Tibbetts Creek) in part may explain the relatively high combined site averages recorded for the nutrient variables. The threefold difference in TSS concentration seen for the Issaquah and Tibbetts Creek basins might also be explained by agricultural activity (e.g., worn pastures), mining, forest practices, and channel failure, combined with highly erodible soils. As current land use shifts to more impervious surfaces in the future, a decrease in the above pollutants may occur while metal, oil and grease, and other more toxic pollutant concentrations may increase.

Current water quality analysis based on Metro's baseflow and storm flow monitoring programs, and WDOE's North Fork Issaquah Creek water quality analysis, suggest that suspended solids, fecal contaminants, nutrients, metals, and sulfides, are the major nonpoint pollutants in the basin. Suspended solids, fecal contaminants and nutrients will most likely continue to be the most common nonpoint pollutants in the basin. Heavy metal toxicity, as well as other forms of chemical toxicity, will become an increasing water quality concern in the future as the number of businesses and acreage of impervious surface increases in the downtown area of Issaquah.

As development continues in the basin, impacts to beneficial uses will continue, particularly from increases in fine sediment into fish spawning habitat and increased algal blooms from nutrient enrichment.

Although large-scale commercial agricultural land use has significantly decreased in the basin, numerous small farms operate in low-density zoned areas. These small farms frequently present the potential for nonpoint pollutant problems due to overstocking of pastures that lead to overgrazing and denuding. Denuded pastures then become a source of sediment and nutrients because there is nothing to hold the soil in place. Based on historical trends, hobby farms will likely increase in areas zoned for low-density development and therefore have the potential to increase water quality impacts in the future.

The quality and quantity of water received by downstream systems will be altered as development occurs. Proper implementation of BMP's and other controls can significantly reduce the impacts from nonpoint pollutants. Beneficial use impairment will occur at a substantially reduced level than would occur without any mitigation.

GOALS AND OBJECTIVES FOR NONPOINT SOURCE POLLUTION REDUCTION

Introduction

The goals and objectives for reduction of nonpoint pollution sources in the basin were developed by the Issaquah/East Lake Sammamish Watershed Management Committee in conjunction with the Basin Advisory Team, King County SWM Division, King County Resource Planning Section, and the Seattle- King County Department of Public Health in accordance with the State watershed planning process. These goals and objectives address the significant nonpoint pollution problems identified in the source-by-source water quality assessment completed for this plan (King County, 1991). The Watershed Management Committee considered State water quality and pollution reduction standards (173-201 WAC and 90-48 RCW) during development of these goals and objectives. The goals and objectives were adopted by consensus by the Watershed Management Committee and Basin Advisory Team in accordance with 400-12 WAC.

Basinwide Goals

1. Protect and enhance water quality by minimizing sources of water pollution to surface water and groundwater;

2. Protect and enhance beneficial uses including swimming, fishing, boating, aquatic habitat (fisheries and wildlife), water supply and aesthetics in Lake Sammamish, Lake McDonald, Lake Tradition, Issaquah Creek, Tibbetts Creek, critical aquifer recharge areas, wetlands, and all tributary waters in the basin; and

3. Protect and enhance water quality through corrective and preventive methods including best management practices (BMP's), education, planning, regulation, enforcement, incentives, capital projects, natural and constructed system maintenance, and restoration of degraded natural and constructed systems.

Source-specific Goals and Objectives

I. Urbanization

A. Stormwater and Phosphorus

1. Ensure stormwater enters the natural drainage in such a condition that beneficial uses and water quality are protected;
2. Secure appropriate land-use density controls for groundwater quality protection in areas of critical aquifer recharge;

3. Adopt and implement the nonpoint and point source control strategies from the Lake Sammamish Water Quality Management Project for protection of Lake Sammamish water quality; and
4. Eliminate illicit hookups in the Issaquah and Tibbetts Creek watersheds.

B. Land Clearing and Grading

1. Develop and implement a clearing and grading education program for developers, construction workers, enforcement officers, and citizens seeking building permits;
2. Implement land clearing BMP's to minimize erosion and sediment impacts to water quality from land clearing;
3. Improve code enforcement by DDES for clearing and grading standards and BMP's; and
4. Establish appropriate land-use density controls for water quality protection.

C. Small Quantity Hazardous Waste Generators

1. Develop and implement an education program for watershed residents and businesses regarding the impacts of small quantity hazardous waste generation on water quality;
2. Assist in the collection and proper disposal of household hazardous waste;
3. Promote the use of alternative cleaning products and hazardous waste substitutes;
4. Encourage the use of the Waste Information Network and the Industrial Material Exchange (IMEX); and
5. Accelerate and improve compliance with existing State and local regulations.

D. Underground Storage Tanks (UST's)

1. Ensure the completeness of UST registration and inspection with WDOE;
2. Implement educational and maintenance programs for UST users; and
3. Improve compliance with existing State regulations.

II. Animal Keeping

1. Implement small farm education and BMP programs to inform livestock owners about their impacts on water quality and to correct existing problems; and
2. Ensure compliance with existing regulations and programs.

III. On-site Septic Systems

1. Evaluate the feasibility of establishing a regular homeowner proof of septic system maintenance program that identifies failing or pre-failing systems;
2. Implement existing educational programs for homeowners and other on-site septic operators regarding location of drainfields and proper maintenance and functioning of septic systems;
3. Expedite repair and replacement of pre-failing and failing on-site septic systems and promote the use of alternative systems where needed; and
4. Ensure compliance with existing regulations for on-site septic systems.

IV. Boating and Marinas

1. Implement an education program for boat owners and users, covering the use, handling, storage, and transfer of above ground fuel;
2. Minimize/eliminate trash, sewage, and other pollutant discharge to Lake Sammamish from boating-related activities; and
3. Ensure compliance with existing boating and water quality regulations.

V. Forest Practices

1. Maintain a viable forestry land use in the basin by converting all FR zoning to F zoning;
2. Designate all zoning except those area zoned for forest production (F-zone) as areas likely to convert;
3. Attain full conformance with the County's Sensitive Areas Ordinance through participation in SEPA review for all areas designated as likely to convert;
4. Ensure County participation in the Watershed Analysis Teams as established by the Department of Natural Resources for the evaluation of forest practices in designated county watersheds; and
5. Establish County monitoring support to assist DNR in identification of violations of the Washington State Forest Practices Rules and Regulations.

VI. Other Nonpoint Sources

A. Pesticides

1. Reduce road maintenance, commercial, and residential use of pesticides and fertilizers through development and implementation of education programs, technical assistance, and use of alternative methods;

2. Encourage the proper application and timing of pesticides and fertilizers; and
3. Achieve commercial, public, and private compliance with existing regulations through education programs.

B. Landfills

1. Achieve compliance with existing surface water and NPDES stormwater regulations through improvement in or additions to existing surface/stormwater treatment systems that minimize nutrient, sediment, and turbidity impacts to McDonald Creek and headwater wetlands; and
2. Increase the scope of landfill water quality monitoring to include sampling for off-site impacts during storm events.

C. Sand, Rock, and Gravel Quarries

1. Achieve compliance with existing surface water and NPDES stormwater regulations through improvement of existing stormwater treatment systems and/or construction of additional treatment systems that minimize nutrient, sediment, and turbidity impacts to the North Fork Issaquah Creek and Tibbetts Creek.

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ACRONYMS AND ABBREVIATIONS

BAT	Basin Advisory Team
BMP	Best Management Practice
BW	Basinwide Recommendation
CIP	Capital Improvement Project
COE	U.S. Army Corps of Engineers
DDES	Department of Development and Environmental Services (King County)
DIR	Drainage Investigation and Regulation (SWM)
DNR	Department of Natural Resources (State of Washington)
DOH	Washington State Department of Health
EIS	Environmental Impact Statement
EF	East Fork Issaquah Creek Subbasin
EPA	Environmental Protection Agency (United States)
FEMA	Federal Emergency Management Administration
FM	Fifteenmile Creek Subbasin
FWS	Fish and Wildlife Service (United States)
GMA	Growth Management Act (State of Washington)
HEC-2	Hydrologic Engineering Center model version 2
HPA	Hydraulic Project Approval
HSPF	Hydrologic Simulation Program - Fortran
K.C.C.	King County Code
KCD	King Conservation District
KCSWD	King County Solid Waste Division
KCFWS	King County Flood Warning System
LI	Lower Issaquah Creek Subbasin
LSRA	Locally Significant Resource Area
LWD	Large Woody Debris
MD	McDonald Creek Subbasin
MDP	Master Drainage Plan
Metro	Department of Metropolitan Services (King County)
MI	Middle Issaquah Creek Subbasin
MIT	Muckleshoot Indian Tribe
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPD	Master Planned Development
NEPA	National Environmental Protection Act
NF	North Fork Issaquah Creek Subbasin
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
PSWQA	Puget Sound Water Quality Authority
RCW	Revised Code of Washington
R/D	Retention/Detention
RM	River Mile
RSRA	Regionally Significant Resource Area
SAO	Sensitive Areas Ordinance (King County)
SBUH	Santa Barbara Urban Hydrograph
SCS	Soil Conservation Service
SEPA	State Environmental Protection Act
SCKDPH	Seattle-King County Department of Public Health
SQHWG	Small Quantity Hazardous Waste Generators
SLS	Save Lake Sammamish
SRA	Significant Resource Area
SWD	Seattle Water Department
SWM	Surface Water Management Division (King County)
PSWSD	Puget Sound Water and Sewer District
TDC	Transfer of Development Credits
TESC	Temporary Erosion and Sedimentation Control
T	Tibbetts Creek Subbasin
UI	Upper Issaquah Creek Subbasin
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife (formerly WDW and WDF)
WDOE	Department of Ecology (State of Washington)
WMC	Watershed Management Committee
WSDA	Washington State Department of Agriculture
WSDOT	Washington State Department of Transportation
WSPRC	Washington State Parks and Recreation Commission