BELLEVUE CRITICAL AREAS UPDATE
STREAMS INVENTORY

March 2003

TABLE OF CONTENTS

List of Tables

1.0 INTRODUCTION

This inventory of Bellevue's streams has been prepared to support an update of policies and regulations for the management of critical areas in the City. Streams and their associated riparian areas are components of "fish and wildlife habitat conservation areas," a critical area defined by Washington's Growth Management Act. Fish and wildlife habitat conservation areas are defined as critical areas in Washington Administrative Code (WAC) section 365-190-080, and include the following components:

- Areas that have a primary association with endangered, threatened, and sensitive species;
- Habitats for species of local importance;
- Naturally occurring ponds under 20 acres and their submerged aquatic beds that provide fish or wildlife habitat;
- Waters of the state; and
- Lakes, ponds, streams, and rivers planted with game fish by a government or tribal entity.

In addition, the WAC states that cities must give "special consideration" to conservation or protection measures necessary to preserve or enhance anadromous fisheries (WAC 365-195-900 through 925).

Terrestrial wildlife species and their associated habitat are discussed in a separate inventory report and best available science paper. The remainder of this report provides an overview of stream functions and values, describes the stream assessment methodology used to conduct the inventory, and summarizes stream habitat conditions in each of the City's 22 storm drainage basins containing streams. A matrix containing a summary of conditions is included at the end of the report.

2.0 STREAM FUNCTIONS AND VALUES

The City of Bellevue contains 64 miles of stream ranging from short small streams that drain directly to Lake Washington and Lake Sammamish to larger, multi-ordered streams, such as Coal Creek and Kelsey Creek (The Watershed Company, 2001). Though degraded to various degrees by urbanization, Bellevue's various streams and their associated riparian areas provide multiple ecological functions that support fish and wildlife, and they provide social value for the residents of Bellevue. Functions and values of streams and riparian areas, particularly with respect to salmonids, are discussed in greater detail in the best available science paper following this report.

2.1 Fish and Wildlife Habitat Support

Salmonids inhabiting Bellevue's streams include four species of salmon (chinook, coho, sockeye, and kokanee); two trout species (steelhead, cutthroat); and numerous other non-salmonid species (e.g., stickleback, lamprey) (Table 1). Chinook salmon are listed as threatened under the federal Endangered Species Act (ESA), while coho are candidates for listing.

Salmonid species found in Bellevue's streams use different and specific rearing and residence areas but can be grouped into two general categories: those that migrate directly to nearshore areas of Lake Washington and Lake Sammamish after emergence, and those that rear within their natal stream system for a year or more. Sockeye salmon and kokanee salmon constitute members of the former category, while coho salmon, steelhead trout and cutthroat trout are members of the latter. Chinook salmon rear in both nearshore areas and natal stream systems.

Due to their listing as threatened under the ESA , Chinook have been the focus of many recent research efforts. In Bellevue, primary stream rearing habitats for chinook salmon are located in Kelsey Creek, the primary chinook-bearing stream in Bellevue, and its tributaries downstream of the upstream adult spawning location in any given year. Specific habitats used by juvenile chinook salmon in Kelsey Creek have not been identified, but on-going research in the Cedar River shows juvenile chinook salmon use off channel habitats such as sloughs and side channels extensively and prefer these habitats to main channel habitats (Peters et al., 2001). Juvenile chinook salmon in the Cedar River main channel prefer secondary habitats associated with banks, especially eddies.

Juvenile chinook salmon migrate from Bellevue streams to nearshore environments of Lake Washington within a week to several months after emerging. The specific outmigration timing of chinook salmon in Bellevue streams is not known but likely follows a similar pattern to Bear Creek. Bear Creek is a tributary of Lake Washington with geomorphic and flow conditions similar to Kelsey Creek. Bear Creek chinook exhibit an early and late outmigration, with most fish emigrating after mid-April (Seiler, 2001). The two outmigrations may be illustrating two types of life history patterns. The early peak consists of juvenile fish (fry) that migrate directly to nearshore areas after emergence, while the late peak consists of fish that spend up to four months in Bear Creek (smolts) before migrating to nearshore areas. If Bellevue's streams have these two life history forms, lake nearshore areas and natal streams are both important environments for rearing juvenile chinook.

Other studies outside of the greater Lake Washington watershed have shown that small tributaries and side-channels are important rearing habitat for juvenile chinook. Juvenile chinook will use non-natal tributary streams as refuge and foraging areas (Bustard and Narver, 1975; Murray and Rosenau, 1989; Scrivener et al., 1994). Tributaries may provide habitat complexity, reduced current velocities, and refuge from adverse conditions in the main river channel

The City's fish-bearing streams are generally low to moderate gradient, and their basins have relatively high impervious surface cover, altered hydrologic regimes, reduced floodplain connectivity, poor riparian conditions, and water quality problems (Kerwin 2001). However, in spite of these conditions, several areas in Bellevue with previously undetermined fish use were

found to support fish during stream typing surveys conducted in 2001. Over 50 percent of Bellevue's total stream miles support fish; Coal, Kelsey, and Lewis Creeks are particularly important in this regard (The Watershed Company, 2001). These streams and associated riparian areas also support other aquatic and terrestrial life such as benthic invertebrates, amphibians, and terrestrial wildlife. Several smaller streams that drain directly to Lake Washington or Lake Sammamish were found to have limited fish use with some exceptions: Vasa Creek and Phantom Creek (The Watershed Company, 2001) (Table 1, Figure S-1). Some sections of Bellevue's streams have been modified by culverts, which block upstream fish passage, suggesting that there are opportunities to increase fish distribution by addressing these habitat access issues. Fish distribution is discussed in greater detail in discussions of individual basins later in this report.

Table 1. Salmonid Distribution in Bellevue's Salmonid-bearing Streams.

	Species					
	Chinook	**Coho**	**Sockeye**	**Kokanee**	**Cutthroat**	**Steelhead**
Stream[1]						
Kelsey Creek	X	X	X		X	
Sturtevart Creek		X			X	
Richards Creek	X	X	X		X	
East Creek					X	
Sunset Creek		X			X	
West Tributary	X	X	X		X	
Goff Creek	X	X	X		X	
Valley Creek	X	X	X		X	
Sears Creek	X	X			X	
Coal Creek	X	X	X		X	X
Newport Creek		X			X	
Lewis Creek	X	X	X	X	X	
Tributary 0161		X			X	
Tributary 0160					X	
Vasa Creek		X		X	X	
Phantom Creek		X	X		X	
Yarrow Creek					X	
Meydenbauer Creek			X			

Source: The Watershed Company, 2001

1) Does not mean fish are distributed throughout the entire stream. See Figure S-1 for specific distribution.
2) Table does not include stream where no salmonids are known to be present.

2.2 Surface Water Conveyance/Flood Control

Streams and their associated wetlands and floodplains also function by conveying surface waters and attenuating flood waters during rain storms. In urbanized areas such as Bellevue, this flood water attenuation function can be particularly valuable at reducing hazards to life and property posed by flooding. Headwater and off-channel wetlands and riparian areas control stormwater flow by attenuating surface water runoff during and after storms and slowly releasing it to groundwater and/or to adjacent water bodies. Research has shown that this function can reduce

and desynchronize peak flood crests and flow rates of floods (Novitzki, 1979 and Verry and Boelter, 1979 *in* Mitsch and Gosselink, 1993).

The City of Bellevue's streams and their associated basins reflect the moderately to highly urbanized conditions present throughout the City. All of the City's stream basins have been impacted by urban development; impervious surface, which consists of residential and commercial buildings, roads, parking lots, and other paved or compacted gravel surfaces, ranges from a low of approximately 25 percent in the Coal Creek basin to a high of approximately 68 percent in the Sturtevant Creek basin. Impervious surface is discussed in greater detail for each storm drainage basin in subsequent sections of this report.

2.3 Riparian Functions

Riparian areas along streams also serve many important functions. The riparian area includes the stream channel between low and high water and extends outward to the limits of flooding and upward into the canopy of streamside vegetation. Riparian areas contain diverse composition, size, and structure due to interactions between soils/geomorphology, hydrology, biota, and climate. They are three-dimensional zones of direct interaction between terrestrial and aquatic ecosystems (Gregory et al., 1991 *in* City of Portland, 2001). Functions supported by riparian areas include:

- Organic inputs to streams from overhanging vegetation;
- Channel dynamics and morphology from large trees, off-channel areas and streambanks;
- Water quality filtering by vegetation,
- Flood water attenuation from uptake and storage of water;
- Microclimate effects on water temperature; and
- Wildlife habitat.

In many urban environments such as Bellevue, urbanization has impacted streams and riparian areas by altering stream hydrology (peak flows, low flows, total flow, volume and frequency of flooding) and degrading water quality from point and non-point sources of pollution. Urbanization also alters the delivery of organic material (such as wood) and sediments to streams from upland areas. Well-vegetated riparian areas, in combination with strategies to restore hydrology at a watershed level, can help address these issues.

Riparian cover along Bellevue's streams varies widely by stream basin. Along some streams, such as Lewis Creek and Coal Creek, coniferous riparian forest cover remains relatively intact, much of it protected in greenbelts and parks. Along other streams, such as Richards Creek, substantial areas of riparian cover have been replaced with impervious surface and with lawns and other non-native landscaping. Riparian corridors that once partially protected streams often have been modified through bank hardening; such as riprap or bulkheads. Vegetation has been reduced, and in some stream reaches completely removed. Functions of riparian areas and associated urban issues are discussed in greater detail in the best available science paper following this report.

2.4 Recreational/Aesthetic Benefits

Finally, streams also function by providing aesthetic and recreational benefits to Bellevue's residents. Stream corridors provide opportunities for greenbelts and open space, as well as opportunities for residents to learn about ecosystem functions and values. Bellevue has preserved many stream corridors as parks, greenbelts, and native growth protection areas. Healthy streams can also enhance the values of commercial areas of cities by attracting people to them (Riley, 1998).

3.0 INVENTORY PROCESS

3.1 Data Collection

Information for this report was obtained by reviewing documents, air photos, maps, and data provided by the City of Bellevue, as well as relevant data from the Washington Department of Fish and Wildlife, NOAA Fisheries, and other agencies. Discussions with Bellevue staff, personal communications with scientific experts, and reviews of selected literature were used to supplement this information. Background information provided by the City included a culvert inventory map, "report cards" summarizing watershed conditions and fish use in each of the city's storm drainage basins, stream gradient profiles, background studies on water quality and benthic biological integrity, and impervious surface layer geographic information system (GIS) coverages. One day of limited field reconnaissance was completed to spot-check selected stream conditions, particularly habitat suitability and fish access conditions between certain stream reaches.

Fish distribution information documented in this report is based on discrete observations of fish presence in Bellevue's streams from 1998 to 2001. Information on overall fish presence was provided by a Stream Typing Report prepared for the City in August 2001 (The Watershed Company, 2001), and from volunteer "salmon watcher" data compiled through a regional program (King County, 2000; King County, 2001). For the stream typing report, Bellevue's streams were sampled in the summer of 2001 to document the presence of both salmonids and other fish species; this information was used to determine the comparable typing of Bellevue's streams under Washington State's stream typing system. The stream typing report also includes information from previous fish-use surveys of the City's streams. Spawner surveys for chinook salmon have also been conducted and the results are documented in this report; however, these surveys were limited to the Kelsey Creek system (Taylor Associates, Inc., 2002).

3.2 Inventory Organization by Basin

The sections of this report discussing existing conditions are organized by the five major drainage basins in the City: East Lake Washington, Kelsey Creek, West Lake Sammamish, Lewis Creek, and Coal Creek. These larger basin units, shown on Figure S-1, were selected to maintain consistency with regional habitat assessment and salmon recovery efforts (Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002).

Bellevue manages surface water using a series of 26 smaller "storm drainage" basins. Of these 26 storm drainage basins, 22 contain streams; these basins range in size from the 300-acre Wilkins Creek basin to the 3,976-acre Coal Creek basin (Figure S-1). These smaller storm drainage basins were selected as a unit for compiling this inventory to ensure consistency with City surface water management programs, and because they are watershed systems where stream, wetland, steep slope, and wildlife habitats provide opportunities for an integrated approach to critical area management. These drainage basins and their individual streams are listed in Table 2.

Table 2. Bellevue's Major Basins, Storm Drainage Basins Containing Streams, and Stream Names

Regional Stream Inventory Basin	City of Bellevue Storm Drainage Basin	Primary Streams
East Lake Washington	Yarrow Creek	Yarrow Creek
	Meydenbauer Creek	Meydenbauer Creek
	Lakehurst Area	Lakehurst Creek Newcastle Beach Creek 60th Street Creek 64th Street Creek
Kelsey Creek	Mercer Slough	Mercer Slough
	Kelsey Creek	Kelsey Creek
	West Tributary	West Tributary
	Goff Creek	Goff Creek
	Valley Creek	Valley Creek
	Sears Creek	Sears Creek
	Richards Creek	Richards Creek
	East Creek	East Creek
	Sturtevant Creek	Sturtevant Creek
	Sunset Creek	Sunset Creek
Coal Creek	Coal Creek	Coal Creek
	Newport Area	Newport Creek
West Lake Sammamish	Ardmore Area	Ardmore Creek
	Wilkins Creek	Wilkins Creek
	North Sammamish Area	Idlywood Creek Sunich Creek Unnamed Creek Unnamed Creek Weona Park Creek
	Phantom Creek	Phantom Creek
	Vasa Creek	Vasa Creek
	South Sammamish Area	Reservoir Creek Unnamed Creek Sunrise Creek
Lewis Creek	Lewis Creek	Lewis Creek

3.3 Stream Assessment Approach

3.3.1 USBEM Methodology

For this inventory, Bellevue's streams were evaluated using a modified version of the Urban Stream Baseline Evaluation Method (USBEM). This method was developed for assessing the habitat condition of freshwater areas as part of the "Tri County" (King, Pierce, and Snohomish County) urban issues study for the region's response to the listing of chinook and bull trout under the federal ESA. Classification of baseline habitat is needed to define baseline conditions for chinook salmon and other species listed now or in the future under the ESA (R2 Resource Consultants, 2000).

The USBEM approach is based on a review of regional literature pertaining to the needs of salmonids; it is applied to freshwater streams to describe a consistent set of processes and attributes that influence habitat-forming functions in the region's streams. It incorporates aspects of several methods currently being used to describe salmon habitat in the Pacific Northwest into one that is relevant to urban and urbanizing streams in the Tri-County region (R2 Resource Consultants, 2000).

The USBEM uses a two-phased approach. For the purposes of this inventory, Phase 1 is used to evaluate aquatic habitat in Bellevue using coarse-scale indicators of salmon habitat use and suitability. This approach includes classifying fish habitat suitability according to stream channel type, watershed alterations from urbanization, and known or expected fish distributions. This approach allows stream habitats to be classified into three categories for planning purposes: 1) streams that are highly suitable to support salmonid species of concern; 2) streams that are unlikely to provide habitat due to geomorphic constraints high levels of alteration and/or natural barriers; and 3) streams that provide potentially suitable habitat. The two-phased approach allows more detailed future "Phase II" assessments to be conducted using more site-specific field study. Specific parameters used in the USBEM analysis are described below and summarized in Table 3.

Table 3. Parameters, Criteria, and Ratings for USBEM Stream Analysis

Ecological Factor	Parameter	Criteria	Ratings		
			Good	Moderate	Poor
Biological	Current Salmon Distribution*	% total channel used by any salmonid fish	>50% anadromous salmonids	>20-50% salmonids	>20% fish bearing
Physical	Channel modifications	% of streams in culverts	<10%	10-20%	>20%
	Flow modifications	Ratio of piped storm drainage network from terrestrial areas to open channel for watershed area	<5	5-10	>10
	TIA	% TIA within entire watershed area	<10% TIA	10-40% TIA	>40% TIA
	Riparian constraints	% TIA within 100 feet of stream	<10% TIA 100'	10-40% TIA 100'	>40 TIA 100'
	Riparian Breaks	Areas adjacent to stream with both sides impervious	<2 per mile	2-5 per mile	>5 per mile
Water quality	Water quality	303(d) water quality limited list	No listed reaches	1 listed reach	>1 listed reach
		B-IBI ratings (rating for within Bellevue only)	>20	15-20	<15

* Excluding reaches with a gradient above 12 percent.

= Good = Moderate = Poor

3.3.1.1 Channel Type

The USBEM divides stream channel types into seven categories, from palustrine (wetland channels, sloughs) to high-gradient (moderately to deeply incised channels). This parameter recognizes that the inherent suitability of a stream as fish habitat is largely shaped by its gradient (slope), landform (lowland, canyon, narrow valley, etc.), and channel form (single channel, braided, straight etc.) (R2 Resource Consultants, 2000). Channel type strongly influences the types of habitat available within each stream reach, the productive capacity of each habitat type, and the corresponding use by various salmonid species.

For the purposes of this analysis, five of the USBEM channel types were found to be applicable in Bellevue. Channel types were identified by overlaying stream gradient profiles for each of Bellevue's streams on topographic maps and identifying channel types at the reach and individual stream scale. For the purposes of this inventory, channel types are discussed throughout this report by generally referring to areas of each stream (upper, lower, etc.). Appendix S-1 contains a table listing channel types for each of Bellevue's streams and a table of habitat suitability by channel type.

3.3.1.2 Fish Distribution

Fish distribution is incorporated into the inventory by summarizing salmonid distribution information from the City's recently completed stream typing report (The Watershed Company, 2001) (Figure S-1). This GIS-based information is compiled and presented for each of the City's storm drainage basins as the percent of the total stream channel used by salmonids. Basins where more than 50 percent of the stream channel is used by salmonids are given a "good" salmonid use rating, while basins with salmonid use ranging from more than 20 to 50 percent of the channel are given a "moderate" rating. Basins containing channels with less than 20 percent salmonid use are assigned a "Poor" rating for salmonid use (Table 3).

3.3.1.3 Watershed Alterations

The next step in the USBEM methodology includes an assessment of large-scale watershed and channel alterations to incorporate urban development impacts on habitat conditions (R2 Resource Consultants, 2000). The set of attributes used to describe watershed and channel alterations were selected as indicators of physical, biological, and chemical conditions that can affect habitat quality, as described in the best available science paper for streams that follows this report. The four parameters evaluated in this report include:

Total Impervious Area. The influence of impervious areas on the hydrologic regime, water quality, and physical habitat in streams is well documented as described in the best available science paper for streams. For this evaluation, TIA is calculated for the watershed area, in this case the storm drainage basin, which contributes surface flow to each basin. Basin with less than 10 percent TIA are classified as "good," while basins with between 10 and 40 percent TIA are classified as "moderate." Basins with more than 40 percent TIA are classified as "poor" (Table 3). These ratings are based on research documenting the response of watersheds to various levels of urbanization (Mat et al., 1997). There are several ways to either control the

increase in TIA or to reduce existing levels of imperviousness. TIA in the City can be managed by reducing the "footprint" of new developments through incentives or regulations, or by retrofitting developed basins with stormwater controls. TIA can also be reduced by working with existing landowners during redevelopment to incorporate strategies to reduce impervious area using various methods, such as replacing pavement with more porous materials.

Channel Modifications. This USBEM parameter evaluates the relative level of stream channel alteration, by evaluating the extent of levees, revetments, bank armoring, and/or culverted stream. As discussed in the best available science paper for streams, bank hardening and culverts can disrupt gravel recruitment, block fish passage, and isolate off-channel refugia. USBEM categorizes channel and flow modifications as a combined parameter based on the total length of modified channel. The methodology assigns channels with more than 50 percent modification a "high" rating, channels with modifications of between 25 and 50 percent a "moderate" rating, and channels with less than 25 percent a "low" rating.

In this inventory, the USBEM methodology was adapted to make use of available data. The City has developed good information on the extent each stream system has been channeled into culverts. The extent of culverted stream in the stream system was used to assign "high," "moderate," or "low" ratings for channel or flow modifications.

Basins with less than 10 percent of total stream length in culverts are assigned a "low" alteration value, while basins with between 10 and 20 percent of stream length in culverts are assigned a "moderate" value. Streams with more than 20 percent of streams in culverts are assigned a "high" value (Table 4). Channel modifications can be reduced by developing incentives, regulations, or capital improvement programs that remove culverts, particularly those that block upstream fish passage.

No standards have been identified for the information available to rate Bellevue's streams. As a result, the following standards were developed using best professional judgment.

Table 4. Determination of the level of channel or watershed alteration.

Characteristic	Level of Channel or Watershed Alteration		
	High	Moderate	Low
	Two or more of the following	*One or more of the following*	*All of the following*
Impervious Area	>40%	40 – 10%	<10%
Channel and Flow Modifications*	>20%, in culverts and drainage network to open channel Ratio >10	10-20% in culverts and/or drainage network to open channel, Ratio 5-10 OR Only one "high" score.	<10% in culverts and drainage network to open channel, Ratio <5
Riparian Breaks/Constraints	>5 per mile or >40% TIA within 100'	2 -5 per mile or 10-40% TIA within 100'	<2 per mile or <10% TIA within 100'
303(d) Listing	More than one reach	One reach	No reaches

Source: modified from USBEM to incorporate available data. R2 Resource Consultants, 2000.

The City of Bellevue has conducted an assessment of all known culverts under the City's jurisdiction to identify those culverts acting as barriers to upstream and downstream fish passage (Figures S-1 and S-2). The City has placed culverts are in one of six categories:

- Passable;
- Partially Passable or Potential Barrier Flows;
- Impassable;
- Needs further Investigation;
- No Water in Late Summer; and
- Partially Passable Physical Obstruction.

The City is addressing identified needed culvert improvements in its Capital Improvement Program and taking steps to address culverts that affect fish passage as funding becomes available. Four culverts are currently in the permit process for improvement, including the Mercer Slough culvert under I-405. Culvert condition, while not a specific parameter in the USBEM methodology, is discussed where relevant throughout this report to identify potential opportunities to improve habitat access.

Flow modifications. To assess the relative alteration of stream hydrology by basin, the hydraulic alteration of a stream was correlated with the ratio of the piped storm drainage network in upland areas to the length of open stream channel for the basin (Johnson, 2002). Basins with a ratio of less than 5 were assigned a "good" value, while basins with ratios between 5 and 10 were assigned a "moderate" value. Basins with a ratio of greater than 10 are assigned a "poor" value (Table 3). These ratings were combined with channel modification ratings (see above) for a combined score (Table 4). Flow modifications can be addressed using strategies similar to those described under TIA, above.

Riparian breaks. As an indicator of the condition of riparian forest vegetation, this parameter evaluates the number of breaks in riparian cover from development, and from road and utility crossings. Tallies of riparian breaks are used as a measure of alterations to the longitudinal integrity or connectivity of the riparian corridor (May et al., 1997). Basins with fewer than two breaks per mile in forested riparian cover are assigned a "good" rating, while basins with between two and 5 breaks per mile in the riparian corridor are assigned a "moderate" rating. Basins with more than 5 breaks per mile are assigned a "poor" rating (R2 Resource Consultants, 2000). Until further evaluations of riparian conditions are completed, for the purposes of this analysis, all basins in Bellevue were assumed to have more than 5 breaks per mile due to the urbanized nature of the City (Table 3). Riparian breaks can be addressed using regulations or incentives that address the protection, enhancement, and restoration of riparian corridors.

Riparian constraints. The City has also mapped using GIS the distribution of total impervious area (TIA) in the City, including impervious surface within 100 feet of riparian corridors. The City has produced a GIS layer showing the distribution of impervious surface (including buildings, parking areas, roads, and compacted gravel surfaces) throughout the City,

including areas in riparian corridors. This information is used in the inventory to evaluate riparian "constraints" in each basin and the corresponding opportunities for riparian corridor restoration/enhancement. Following indices for assessing TIA at the basin level, basins with less than 10 percent TIA coverage within 100 feet of streams were assigned a "good" rating, while basins with between 10 and 40 percent TIA were assigned a "moderate" rating. Finally, basins with more than 40 percent TIA within 100 feet of streams were assigned a "poor" rating (Table 3).

Similar to riparian breaks, these constraints can be addressed using regulations or incentives that contribute to the protection, restoration, and enhancement of riparian constraints, particularly during redevelopment of presently paved areas in the riparian corridor.

303(d) Listing. The USBEM approach includes an evaluation of stream water quality by examining the number of streams listed under the state's "303(d)" listing. This measure includes the presence of streams or stream reaches that do not meet water quality standards under Section 303(d) of the federal Clean Water Act. A 303(d) listing of a water body is driven by where sampling is being conducted. As a result, there may be other impacted stream reaches but no sampling data available. Water quality data for Bellevue's streams has been collected in all of the City's major stream systems (e.g., Coal Creek, Kelsey Creek), but it is lacking in smaller streams (e.g. Lakehurst basin streams). Data also varies across basins by monitored water quality parameter. As discussed in the best available science paper for streams, poor water quality can have adverse effects on salmonids.

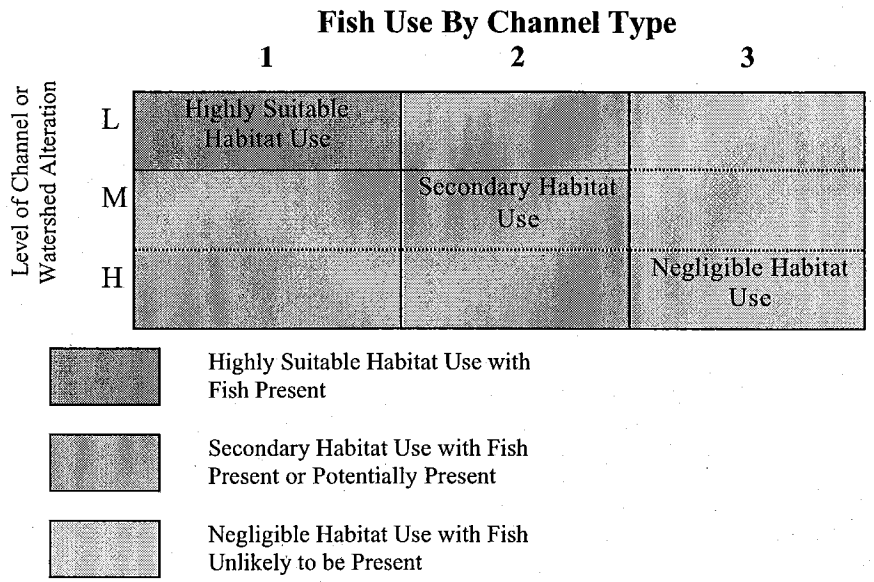
Available data were compiled for the inventory and are reported for each basin where relevant. For the purposes of this analysis, basins with no listed streams were assigned "good" rating, while streams with one 303(d) listing were assigned a "moderate" rating. Basins with more than one listing were given a "poor" rating (Table 3). Other available water quality data are also reported for each basin, as this information may be useful in evaluating basin-wide strategies for protecting and enhancing stream functions and values by improving water quality. Stormwater management and incentive programs that provide information to land owners about use of pesticides, fertilizers, and other pollutants can help to address these water quality issues.

B-IBI. Benthic invertebrates are used as an indicator of stream water quality and overall ecosystem health since they have varying sensitivities to pollution (Karr, 1999 *in* Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002). Identifying macroinvertebrate genus or species allows for the calculation of benthic indices of biological integrity (B-IBI) metrics to evaluate stream condition based on taxonomic composition, reproductive pattern, tolerance to disturbance, and feeding group. Undeveloped reference streams in the Puget Sound lowland generally have a score of greater than 33, while heavily impacted streams tend to have B-IBI scores below 15 (May, 1996 *in* Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002). For an analysis to give a relative score among Bellevue's streams, streams with a B-IBI rating above 20 were given a "good" rating, while streams with B-IBI scores of 15 to 20 were given a moderate rating. Streams with scores below 15 were given a "poor" rating.

3.4 Summary of Stream Quality Parameters

For each of the City's 22 storm drainage basins containing streams, the various parameters described above are compiled in the summary section at the end of this report to provide a basin-level assessment of the physical, chemical, and biological condition of Bellevue's streams. Following the USBEM methodology, these parameters can be compiled to determine the level of channel and watershed alteration in each basin as "high," "moderate," or "low" (Table 4). These determinations can then be matched with each basin's range of channel suitability conditions for various salmonid species to develop an overall habitat suitability rating of "Primary," "Secondary," or "Negligible" (Table 5). These latter ratings can then be used to prioritize constraints and opportunities and develop policies that give "special consideration" to anadromous salmonids based on potential fish use and factors contributing to channel and watershed alteration.

Table 5. Potential Species–Specific Use by Channel Type



3.4.1 Data Gaps

Although Bellevue is far ahead of many other jurisdictions in the region in its collection of baseline stream and fish distribution data, the City still lacks complete information for all its streams. Most notably, physical stream habitat data (e.g. pool/riffle ratios, large woody debris) are lacking for many of its streams, particularly smaller tributary streams. With the exception of the Kelsey Creek system, there is little information on specific salmonid spawning locations in Bellevue's streams. While the City's recent stream typing report documented fish presence, it did not identify specific spawning locations for various salmonid species (The Watershed Company, 2001). Where available for individual streams, this information is reported in the following sections to provide background information. This lack of information presently limits the applicability of several stream assessment methods, including Phase II of USBEM. Future stream surveys could be conducted to document current habitat conditions, particularly in major salmonid-bearing streams, and how they are changing over time.

4.0 EXISTING FUNCTIONS, OPPORTUNITIES, AND CONSTRAINTS: EAST LAKE WASHINGTON BASIN

The East Lake Washington basin includes three storm drainage basins containing streams: Yarrow Creek, Meydenbauer Creek, and the Lakehurst area basin. The East Lake Washington basin includes 4,000 acres and seven miles of stream draining west into Lake Washington. Land use in the basin consists of predominantly single-family residential development. The highest percentage of commercial and multi-family residential land use is located in the Meydenbauer Creek storm drainage basin.

4.1 Basin Functions and Values

4.1.1 Current Fish Distribution

4.1.1.1 Yarrow Creek

Resident cutthroat trout are present in Yarrow Creek from just downstream of State Route 520 upstream to 116th Ave N.E (Figure S-1). Overall, approximately 67 percent of the Yarrow Creek stream system is used by cutthroat trout (Table 6). Channel types in Yarrow Creek range from floodplain in lower reaches to moderate gradient, mixed control in upper reaches and tributaries (Appendix S-1). Migratory fish may be present downstream of an impassable culvert that is approximately 100 feet downstream of SR 520, but fish presence is unknown; this reach of stream is located in the City of Kirkland.

4.1.1.2 Meydenbauer Creek

Meydenbauer Creek contains cutthroat trout downstream of an impassable culvert at 102nd Avenue S.E., along with stickleback and sculpin; no fish were reported upstream of this culvert (The Watershed Company, 2001). Approximately 51 percent of this stream is used by salmonids, channel type is predominantly floodplain. Sockeye have been observed downstream of 102nd Avenue SE, but spawning is not documented because substrates in this stream are composed primarily of silt.

4.1.1.3 Lakehurst Creek

No fish were observed in any Lakehurst area stream during the 2001 stream typing study (The Watershed Company, 2001); as a result, none of the streams in this basin are reported to be used by salmonids. It is unlikely that flows are sufficient for salmonid survival (Paulsen, personal communication, 2002).

Table 6. Summary of Conditions: East Lake Washington Basin

Conditions	Basins		
	Yarrow Creek	Lakehurst	Meydenbauer Creek
Length of Stream (feet)	24,026	11,411	2,408
% Culverted in Stream with Salmonids	15	0	18
% of Stream Over 12%	12	17	9
% Length Used by Salmonid* Fish	67	0	51
% Length in Culvert	22	29	29
Ratio Drainage/Open Channel	4	6	76
TIA of Storm Drainage Basin	29%	36%	53%
Riparian Constraints (% TIS within 100')	27	24	36
Riparian Breaks			
Number of 303(d) Reaches	1	n/d	n/d
B-IBI	n/a	n/a	n/a

Excluding reaches with gradients over 12%.

= Good = Moderate = Poor

4.1.2 Channel and Flow Modifications

4.1.2.1 Yarrow Creek

Channel modification varies from high to low throughout Yarrow Creek; some reaches of the stream are completely piped, while others remain open channel. Overall, the basin has a moderate level of channel and flow alteration (Table 6). Favorable habitat conditions for cutthroat particularly in upper reaches of Yarrow Creek include pools, fine gravel, and sand substrate. Flow in tributaries, however, may provide less favorable habitat, as inadequate streamflow appears to limit fish use on upper tributaries (The Watershed Company, 2001).

Overall, approximately 22 percent of the Yarrow Creek system is contained in culverts. One culvert in a downstream reach (approximately river mile 0.2) has been identified as impassible, as well as several culverts in upper reaches of the stream (Figure S-1). There are two culverts on tributaries of Yarrow Creek that require further investigation before fish passability is determined. Culverts under driveways on upstream tributaries appear to be reducing fish use potential (The Watershed Company, 2001).

4.1.2.2 Meydenbauer Creek

Meydenbauer Creek is highly urbanized, flowing through commercial and multi-family land uses before flowing into Lake Washington at Meydenbauer Bay. It is a low-gradient stream (gradients ranging from 0 to 2 percent) with few riffles and a predominantly sandy substrate with a silt layer in some places. Directly upstream of 102nd Ave. S.E., instream habitat is of low quality. Downstream of 102nd Ave. S.E., in-stream habitat is of slightly higher quality, with more woody debris (The Watershed Company, 2001).

Two reaches of Meydenbauer Creek are largely piped, and approximately 29 percent of the total stream length is contained in culverts. The stream is blocked at approximately river mile 0.2 by a culvert. The stream also has a high ratio of storm drainage network to open channel, and an overall poor rating for channel and flow modifications (Table 6).

4.1.2.3 Lakehurst Basin

In the Lakehurst basin, four streams drain directly to Lake Washington. The northern stream, Newcastle Beach Creek located in Newcastle Beach Park, has gradients ranging from low to high with only small piped sections. Lakehurst Creek has a relatively constant moderate gradient in its upper 3,000 feet, averaging approximately 3 to 4 percent, while in the lower 1,000 feet of this stream gradients are high. The southern streams (60th and 64th Street Creeks) are seasonal, with gradients ranging from 10 to 19 percent. There is a lack of sufficient flow in Lakehurst streams (The Watershed Company, 2001).

Overall, with the exception of Newcastle Beach Creek, some reaches of all of these streams have been piped. In the basin overall, approximately 29 percent of total stream length is contained in culverts, but the ratio of storm drainage network to open channel is moderate, resulting in a moderate rating for the level of watershed alteration. The culvert that carries Lakehurst Creek under I-405 is considered impassable to fish.

4.1.3 Total Impervious Area

All three basins are rated as moderate to poor for TIA. Total impervious area for each of the three basins ranged from a low of 29 percent in the Yarrow Creek Basin (moderate) to 53 percent in the Meydenbauer basin (poor). The Lakehurst basin contains 36 percent TIA, a moderate rating.

4.1.4 Riparian Constraints

4.1.4.1 Yarrow Creek

Stream buffers in the Yarrow Creek basin range from degraded areas located in road rights-of-way to approximately 50-foot forested buffers bounded by I-405 and smaller road complexes. In general, Yarrow Creek's riparian corridor is highly disturbed by roads, office complexes, I-405, and residential lawns. Total impervious area within 100 feet of the stream corridor is 27 percent, a moderate rating. Most riparian vegetation throughout Yarrow Creek is deciduous with small

areas of mixed deciduous and coniferous trees. Maintained lawns and landscaped rights-of-way are present along the lower riparian sections of Yarrow Creek and its tributaries. Upper sections of Yarrow Creek are forested where it flows along the east side of I-405.

4.1.4.2 Meydenbauer Creek

Meydenbauer Creek's riparian corridor has been highly modified by residential development and road crossings. Total impervious area within 100 feet of the stream corridor is approximately 36 percent. Directly upstream of 102nd Ave. S.E., riparian buffers are narrow and are dominated by invasive plant species such as reed canarygrass and Himilayan blackberry. A wider deciduous buffer is present downstream of 102nd Ave. S.E., although invasive plant species are still common in the riparian corridor.

4.1.4.3 Lakehurst Basin

The number of riparian breaks is moderate to high along most streams in the Lakehurst basin. Overall, TIA is approximately 24 percent within 100 feet of streams in the basin, a moderate rating for riparian constraints.

4.1.5 Water Quality

4.1.5.1 Yarrow Creek

Yarrow Creek received one 303(d) listing on the 1998 list for fecal coliform. None of the streams in the Meydenbauer or Lakehurst basins are listed on the 303(d) list of water quality-impaired streams.

4.1.5.2 Meydenbauer Creek

Available monitoring data for Meydenbauer Creek indicates that the stream tends to have some of the highest automobile-generated pollutants in the East Lake Washington Basin due to its location in the central business district of Bellevue (Bellevue Utilities Department, 1995). Oils, greases, petroleum hydrocarbons, and chemical oxygen demand were found to higher at the Meydenbauer sampling station than at all other monitoring sites that were sampled for the study (Bellevue Utilities Department, 1995). Water quality monitoring has not been conducted in other streams in the basin.

No BIBI ratings are available for any of the streams in these basins.

4.2 Opportunities and Constraints

4.2.1.1 Yarrow Creek

Channel types in the Yarrow Creek basin range from floodplain in lower reaches to moderate gradient, mixed control in upper reaches (Appendix S-1). Floodplain channels are considered primary habitat areas for all salmonids, while moderate-gradient, mixed use areas are high use areas for cutthroat and steelhead. The basin, however, has extensive lengths of stream in culverts, a moderate level of total impervious area, and a moderate amount of riparian constraints.

Opportunities to address constraints on functions could include removing culverts, particularly the downstream culvert at river mile 0.2, which blocks passage to potential salmonid-bearing reaches upstream, protecting and enhancing riparian areas, and improving hydrologic processes at the basin scale.

4.2.1.2 Meydenbauer Creek

Overall, Meydenbauer Creek ranked poor for several parameters including length in culvert, ratio of drainage network to open channel, and total impervious area. While short sections of this stream do provide salmonid habitat and are classified as a floodplain channel type that is a primary use type for all salmonids, the high levels of impervious surface, along with intense land uses in the basin and the high ratio of piped drainage network to open channel, may limit opportunities to contribute to improved stream functions in this basin.

4.2.1.3 Lakehurst Basin

Streams in the Lakehurst basin are not known to contain salmonids and are not tributary to salmonid-bearing streams. Habitat use is also limited by high-gradient channels in some areas and an impassible culvert on lower reaches of Lakehurst Creek. While these streams do affect water quality in nearshore areas of Lake Washington that are important rearing areas for juvenile salmonids, relative to other streams in the City, these streams appear to provide fewer functions supporting salmonids and fewer habitat protection or restoration opportunities relative to other streams in the City.

5.0 EXISTING FUNCTIONS, OPPORTUNITIES, AND CONSTRAINTS: KELSEY CREEK BASIN

The Kelsey Creek Basin is composed of several streams, all of which drain to the west before entering the East Channel of Lake Washington at Interstate 90. The basin contains 10,870 acres and over 19 miles of stream including Mercer Slough, Sturtevant Creek, Kelsey Creek, Valley Creek, the West Tributary, Goff Creek, Richards Creek, East Creek, and Sunset Creek (Table 7) (Figure S-1). The mainstem of Kelsey Creek begins in the Phantom Lake and Larsen Lake/Lake Hills Greenbelt wetlands.

Table 7. Kelsey Creek Basin

Storm Drainage Basins	Mercer Slough	Kelsey Creek	East Creek	Goff Creek	Richards Creek	Sears Creek	Sturtevant Creek	Sunset Creek	Valley Creek	West Tributary
Length of Stream	15,526	52,056	10,020	9,684	12,180	3,326	7,893	12,193	15,566	17,791
% of Culverted in Stream with Salmonids	0	5	2	23	11	22	45	21	5	2
% of Stream Over 12%	0	8	25	0	0	0	0	0	0	0
% Length Used by Salmonid Fish	91	72	43	97	95	71	100	81	35	57
% Length in Culvert	0	12	12	23	12	43	45	21	15	15
Ratio Drainage/Open Channel	5	5	17	6	8	20	19	9	4	5
TIA of Storm Drainage Basin	35	42	48	30	45	64	68	44	32	44
Riparian Constraints (% TIA within 100')	6	21	28	45	24	48	57	31	23	29
Riparian Breaks										
Number of 303(d) Reaches	3	1	n/d	n/d	n/d	n/d	n/d	n/d	n/d	1
B-IBI	n/a	15	n/a	15	16	n/a	n/a	n/a	n/a	n/a

= Good = Moderate = Poor

Land use in the Kelsey Creek Basin is predominantly single-family residential, particularly in the Sunset Creek, Valley Creek and Goff Creek storm drainage basins. The Richards Creek basin contains the highest percentage of multi-family residential land use, while the highest percentage of commercial land use is located in the Sturtevant Creek and Sears Creek basins. The Mercer Slough area has the highest percentage of open space and has the lowest amount of impervious surface. Impervious surface cover is highest in the Sturtevant Creek and Sears Creek basins and the lowest in the Mercer Slough area.

The Kelsey Creek Basin is the most extensively evaluated basin in the City. Nineteen culverts, primarily on small tributaries in sub-basins, may be partial or complete barriers to salmonid passage (Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002) (Figure S-1). A number of concrete and rock wiers in the basin are also partial passage barriers. Fine sediments have been also identified as a limiting factor for salmonid production in Kelsey Creek, with fine sediment levels ranging from 22 percent in 1982 to 39 percent in 1996 (Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002). Average pool frequency in Kelsey Creek was less than 13 per mile, and average amount of woody debris was fewer than 17 pieces per mile. Assessments of tributaries have shown similar conditions. Even

with these conditions, however, the Kelsey Creek Basin is used extensively by salmonids, including chinook. Specific conditions are discussed below.

5.1 Basin Functions and Values

5.1.1 Current Fish Distribution

5.1.1.1 Kelsey Creek

Salmonids inhabiting Kelsey Creek include chinook salmon, coho salmon, sockeye salmon, and cutthroat trout; over 70 percent of streams in the storm drainage basin are used by salmonids (Table 7) (Figure S-1). The mainstem of Kelsey Creek contains floodplain channel type; this channel type is a primary use are for all salmonids (Appendix S-1). Historically, chinook salmon had access to the entire mainstem Kelsey Creek upstream to Phantom Lake. Currently, during years of high chinook salmon spawner escapement, these fish may be distributed on the mainstem upstream of Larson Lake; there are presently no documented observations for upper portions of Kelsey Creek. Observations by volunteers of adult salmon are available for approximately two miles of Kelsey Creek and its major tributaries. These data indicate that from 1996 to 1998 an average of 38 chinook returned per year. Chinook were observed in Kelsey Creek up to river mile (RM) 5.3 in 1998, RM 5.0 in 1999, and RM 3 in 2000. Washington Department of Fish and Wildlife (WDFW) spawner surveys indicated a return of 228 chinook in 1999, with 23 chinook in 2000 (Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002).

Coho salmon in Kelsey Creek have the same distribution as chinook salmon but are distributed further upstream in Richards and Sunset Creeks but not as far upstream on the mainstem of Kelsey Creek. Coho use is likely limited to reaches located downstream of I-90.

Sockeye salmon in Kelsey Creek have essentially the same distribution as chinook salmon; however, like chinook, sockeye salmon are not documented to be present in the upper Kelsey Creek mainstem.

Cutthroat trout are the most widely distributed salmonid in the Kelsey Creek system; this species has a resident form that can complete its life cycle in a very small reach of a stream. Kelsey Creek and its tributaries are primary stream rearing habitats for coho salmon and migratory cutthroat trout.

Non-salmonid resident fish in Kelsey Creek include bluegill, dace, sculpin, lamprey, sucker, and stickleback. Two chum salmon were also reported in Mercer Slough during volunteer surveys in 2000 (King County, 2002b).

Chinook salmon may also inhabit several tributaries of Kelsey Creek including the West Tributary, Goff Creek (a tributary of West Tributary), Valley Creek, Sears Creek (a tributary of Valley Creek), and Sunset Creek (a tributary of Richards Creek) (Figure S-1). Percentages of these streams used by salmonids ranges from 35 percent to 97 percent (Table 7), as discussed below.

5.1.1.2 Mercer Slough

Mercer Slough is likely inhabited by all fish species present in Lake Washington, and over 91 percent of its length is used by salmonids (Table 7). Mercer Slough has a palustrine channel type (Appendix S-1). Chinook, coho, and sockeye salmon, and cutthroat trout utilize Mercer Slough while migrating to spawning grounds in the Kelsey Creek system, and as rearing habitat during juvenile out-migration. Two minor tributaries flow from the east near the Bellefields Nature Trail (The Watershed Company 2001).

Salmonids inhabiting Richards Creek include chinook salmon, coho salmon, sockeye salmon, and cutthroat trout. Richards Creek contains a palustrine channel type. Approximately 95 percent of the basin's stream length is used by salmonids. Cutthroat trout and coho are found upstream in the headwaters near Factoria Road. Resident fish include lamprey, stickleback, and sculpin.

5.1.1.3 Sturtevant Creek

Sturtevant Creek is a tributary to Mercer Slough with coho salmon and cutthroat use downstream of I-405. Like Richards Creek, Sturtevant Creek contains a palustrine channel type. Peamouth chub have also been documented in this basin. Coho were reported to use the entire system in 1975 (Williams, et al., 1975 *in* The Watershed Company, 2001), and the entire stream length (100 percent) is reported to be used by salmonids (Table 7).

5.1.1.4 Sunset Creek

Sunset Creek is a tributary to Richards Creek and contains chinook, coho, and sockeye salmon and cutthroat trout. The channel type is moderate gradient, mixed control (Appendix S-1). Approximately 81 percent of this stream is used by salmonids. Chinook have been observed in the lowest reaches of the basin, with sockeye and coho use as far upstream as I-90. Cutthroat are present as far upstream as S.E. 42nd Street.

5.1.1.5 East Creek

East Creek flows into Richards Creek just north of I-90 and contains coho salmon in the lower segments and cutthroat trout throughout the basin. Lamprey are also present. Only 43 percent of this stream, however, is used by salmonids. The stream contains both floodplain and moderate gradient, mixed control channel types.

5.1.1.6 Valley Creek

Fish use in Valley Creek includes sockeye, chinook, and coho as far upstream as the golf course. Cutthroat are present in reaches south of the golf course. Bluegill and lamprey have been recorded in lower reaches. Approximately 35 percent of the basin is used by salmonids, the lowest utilization in the Kelsey Creek Basin. Valley Creek contains moderate gradient, mixed control channel types.

5.1.2 Channel and Flow Modifications

5.1.2.1 Mercer Slough

Mercer Slough is designated as a shoreline of statewide significance under the state's Shoreline Management Act. It is a large-volume waterbody connected to Lake Washington with very low gradient, slow flows, and a large volume of water with surrounding wetland habitat. This water body remains free of piped sections. Mercer Slough remains free of culverts and has a drainage to open channel ratio of 5, considered a moderate level of watershed alteration. Low flows may be limiting connections between the slough and adjacent wetlands (The Watershed Company, 2001).

5.1.2.2 Kelsey Creek

Kelsey Creek is a very low to low-gradient stream with several associated and protected wetlands throughout the watershed, providing water quality and quantity benefits as well as rearing habitat. The stream has a moderate level of channel and flow modifications; approximately 12 percent of the Kelsey Creek system is contained in culverts, with a ratio of drainage to open channel of 5 (Table 7).

A stream survey of Kelsey Creek and several tributaries, completed in 1996, documented degraded instream habitat conditions (May, 1996). In most reaches surveyed, riprap was common, bank stability was low, and embeddedness of riffle gravels was high. Excess fine sediments, limited floodplain connectivity, and insufficient large woody debris to sort gravel and form pool tailouts also limit salmonid production in Kelsey Creek (Kerwin, 2001; May, 1996; Scott et al., 1982). Habitat in portions of upper Kelsey Creek is of poor quality; habitat is overgrown with reed canarygrass and channelized (The Watershed Company, 2001).

The 1996 May report, however, also documented reaches of Kelsey and its tributaries that function closer to natural conditions than others (May, 1996). These include 0.8 miles of Kelsey Creek downstream of 148th Avenue NE, where riffle substrates were found to be less embedded, large woody debris was more abundant, pools were more frequent, and banks were more stable compared to other surveyed reaches. In 2001, most salmon and migratory cutthroat trout redd excavation in Kelsey Creek occurred in this reach (Taylor Associates, Inc., 2002).

Rip-rap is also present throughout the Kelsey Creek system (May, 1996). Exposed riprap may provide habitat for juvenile salmonids and increase densities in particular reaches on streams that have been degraded (Schmetterling et al., 2001). However, exposed riprap does not provide the specific habitat requirements provided by vegetated streambanks for several species or age classes. Streambanks with exposed riprap are less likely to contribute woody debris and organic matter to streams, have less low-overhead cover, and fewer undercut banks.

5.1.2.3 Sturtevant Creek

Sturtevant Creek flows along and under I-405 before entering Mercer Slough. Gradient in this stream is low. Channel and flow modifications are high in this basin; approximately 45 percent of the stream is in culverts, and the ratio of storm drainage to open channel is approximately 20 (Table 7). The two longest culverts span 37 percent of Sturtevant Creek's total length. Many

other culverts, some perched, create barriers to upstream migration. Headwater segments near Lake Bellevue were observed in 2001 to contain little water (The Watershed Company, 2001).

5.1.2.4 West Tributary

Habitat on the West Tributary ranges from slow moving, beaver-dammed reaches to pool-riffle sequences downstream. Channel and flow modifications in this stream are moderate, with approximately 15 percent of the stream in culverts and a ratio of drainage network to open channel of 5 (Table 7).

5.1.2.5 Richards Creek

Richards Creek downstream of the Lake Hills Connector is a low-gradient depositional area with limited spawning habitat. Upstream of the Lake Hills Connector to S.E. 26th Street, Richards Creek is a low-gradient wetland/beaver dam system with little salmon spawning habitat. However, this reach provides good salmonid rearing habitat (i.e. deep pools and slow moving water). Upstream of S.E. 26th Street, salmon spawning habitat is present (i.e. spawning gravels and appropriate water velocities). One reach of this stream of approximately 725 feet is piped. Upstream portions of Richards Creek have been observed to lack woody debris and well formed pools (The Watershed Company, 2001). Overall, the stream has a moderate level of channel and flow modifications (Table 7).

5.1.2.6 East Creek

Lower segments of East Creek have been heavily channelized around roadways and property boundaries, but the upper segments of the stream flow largely through deciduous forested areas. Wood and tree roots from the riparian buffer contribute to moderate pool formation in the upper segments. Stream gradients in East Creek system are very low to very high, ranging from 14.4 percent in the headwaters to 0.7 percent in lower reaches. There are seven culverts in the upper reaches that prohibit fish passage. On tributaries, culverts and channelization have modified habitat (The Watershed Company, 2001). The stream has a moderate level of watershed alteration; while only 12 percent of the stream is contained in culverts, it has a ratio of drainage to open channel of 17 (Table 7).

5.1.2.7 Sunset Creek

Sunset Creek flows through the commercialized I-90 corridor and residential neighborhoods before entering Richards Creek. Gradient in Sunset Creek ranges from 2 percent to 7.5 percent, with the highest gradients located in the middle reaches. Four major culverts with a combined length of over 2,000 feet limit fish passage. Pool formation in portions of the stream has been aided by woody debris. Overall, Sunset Creek has a moderate level of channel and flow modification; while over 20 percent of the stream is contained in culverts, the ratio of drainage to open channel is 9 (Table 7).

5.1.2.8 Goff, Valley, and Sears Creek

Goff Creek, Valley Creek, and Sears Creek stream gradients range from low to high; substantial portions of all of these streams have been piped (Table 7). The level of channel and flow modification is high in Sears Creek, with over 43 percent of the stream in culverts and a high

ratio of drainage network to open channel (Table 7). Sears Creek is channelized in its lower 1,000 feet before passing through a culvert upstream; vegetative cover and instream structural complexity is lacking in this reach of stream. A 1,200-foot section of vegetated riparian corridor is located upstream of this section, with better instream habitat structure (The Watershed Company, 2001).

Approximately 23 percent of Goff Creek has been placed in culverts, while 15 percent of Valley Creek is in culverts; both of these streams have a moderate level of channel and flow alteration. Goff Creek contains a 1,000-foot long culvert at Bellevue-Redmond Road. There is ample flow in this stream for fish use (The Watershed Company, 2001). Substrate in much of Valley Creek consists of gravel and pool-riffle sequences. There is also a 1,000-foot long culvert on this stream in the vicinity of the golf course (The Watershed Company, 2001).

5.1.3 Total Impervious Area

Total impervious area in the 10 storm drainage basins in the Kelsey Creek Basin ranges from 30 to 68 percent; as a result, all basins rate moderate to poor for total impervious area. The basins with the highest impervious area are Sears and Sturtevant Creek basins, while Valley and Goff Creeks have the least total impervious area in the basin (Table 7).

Total impervious area has been correlated with alterations in runoff frequency and volumes. Kelsey Creek has shown a very rapid response to rain storms; mean daily discharge, maximum mean daily discharge, water yield, and seven-day minimum flow data were collected on Kelsey Creek for the period of 1950s to the late 1990s. Flow gage data, however, show that Kelsey Creek 7-day low flows are increasing (Wetherbee, 2000).

5.1.4 Riparian Conditions

Riparian conditions are disrupted in all storm drainage basins of the Kelsey Creek Basin by residential development, road crossings, and commercial development. As shown in Table 7, the number of riparian breaks for each basin is considered high. Modified riparian conditions consisting of landscaped lawns and ornamental vegetation are present throughout the basins. Riparian vegetation along Kelsey Creek has been reduced in the vicinity of the golf course areas and in residential areas, but vegetated riparian corridors are relatively larger in City parks. Within the Larsen Lake area, large areas of blueberry farms dominate riparian vegetation along Kelsey Creek. May (1996) reported that large woody debris is lacking in Kelsey Creek and its West Tributary and is impaired by modified riparian zones, including the lack of mature trees.

Riparian vegetation along Sturtevant Creek has been degraded by impervious surface, ornamental vegetation and manicured lawns. Similarly, commercial development has resulted in highly modified riparian areas in the headwaters of Richards Creek and East Creek. The riparian corridors of Sunset, Richards and East Creek are modified in the vicinity of Interstate 90 (I-90) by road complexes and business parks; however, some forested areas of mixed deciduous and coniferous trees are present on the north side of I-90.

Riparian constraints in each storm drainage basin, characterized by total impervious area (roads, parking areas, and buildings) within 100 feet of each stream, ranges from low in the Mercer Slough basin to high in the Goff, Sears, and Sturtevant Creek basins (Table 7).

5.1.5 Water Quality

5.1.5.1 303(d) List

Mercer Slough was placed on the 1998 Section 303(d) list for exceeding fecal coliform, dissolved oxygen (DO), and pH standards (Table 7). Between 1987 and 1991, 28 excursions for DO beyond the state water quality criterion of 9.5 mg/L were observed. Another 17 excursions were observed between 1991 and 1997. Although Mercer Slough was placed on the 1998 Section 303(d) list for DO, it was noted that excursions beyond the criterion were due to natural decomposition of vegetation in a large cattail marsh upstream of the sampling station (Ecology, 1998).

Mercer Slough was placed on the 1996 list for excursions of the National Toxics Rule (40 CFR Part 131) criterion for the following pesticides: DDT, 4,4'-DDD, and Dieldrin. However, the sampled segment of Mercer Slough was taken off the list in 1998, because sampling indicated that toxic levels of these pesticides no longer existed within this segment of stream (Ecology, 1998).

Kelsey Creek was listed on the 1998 Section 303(d) list for fecal coliform and three pesticides: Dieldrin, Heptachlor epoxide, and DDT. However, the Kelsey Creek 303(d) list for pesticides was dropped due to sampling errors. Kelsey Creek flows through Larsen Lake, which was placed on the Section 303(d) list in 1996 for state water quality standard excursions of total phosphorous. Restoration efforts conducted in Larsen Lake were successful at lowering phosphorous levels, resulting in removal of the Lake from the Section 303(d) list in 1998. Bellevue has had an on-going water quality monitoring program for Larsen Lake since 1993.

5.1.5.2 Other Water Quality Findings

The Bellevue Urban Runoff Program (BURP) study (City of Bellevue, 1984 cited in Bellevue Utilities Department, 1995) found that Kelsey Creek was relatively degraded, but still supported a productive salmonid fishery. The study found that DO levels in the stream were sufficiently low to depress salmon embryo survival (City of Bellevue, 1984).

In 1998 and 1999, the University of Washington Center for Streamside Studies sampled temperatures at stations on Kelsey, Valley, and Richards Creek in the Kelsey Creek Basin. The study found that temperatures in Kelsey Creek were within state water quality standards in August 1998, but slightly exceeded the standards in August 1999. However, these temperatures were only taken one time in August of 1998 or 1999 and do not necessarily indicate chronic water quality impairment. The state 303(d) list indicated Kelsey Creek had one temperature excursion above the state water quality standards out of 72 samples, but this did not warrant listing (Ecology, 1998). Documented temperatures in Richards and Valley Creek exceeded the state water quality standards in August 1999. Temperatures, ranged in Richards Creek from 12.8° C to 14.2° C in 1998, and from 14.7° C to 16.2° C in 1999. In Valley Creek, temperatures

ranged from 12° C to 14° C in 1998, and from 16° C to 26.5° C in 1999. The Valley Creek high temperature, however, was recorded at a station in a silty, shallow, backwater off-channel area located on 40th Avenue NE, east of 140th Avenue NE.

The U.S. Geologic Survey (USGS) examined the West Tributary and Mercer Slough and detected 19 pesticides, some that may be at levels detrimental to aquatic life (Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002). Zinc and copper levels in storm flows have also exceeded water quality standards while other pollutants remain stable or, in the case of lead, declined.

According to the *Characterization and Source Control of Urban Stormwater Quality* (City of Bellevue, 1995), high turbidity and total suspended solids have been documented in upper reaches of the West Tributary of Kelsey Creek. These high levels were reportedly likely due to sediment inputs from gravel truck lots and a topsoil manufacturer near the sampling location. Fecal coliform concentrations were also reported to be high in the upper reach of the west tributary of Kelsey Creek, likely due to resident waterfowl in this area. Lead, nickel, and zinc concentrations were also high at the sampling location. Nearly all of the pollutants observed in the upstream reaches of the West Tributary were substantially reduced in the lower reaches due to dilution from Goff Creek (City of Bellevue, 1995).

Sturtevant Creek contained concentrations of suspended solids and turbidity above the average for all other streams sampled under this study. This study found that oils, greases, petroleum hydrocarbons and associated chemical oxygen demand were higher than the average for all sampling stations.

5.1.5.3 B-BIBI

Biologic integrity (B-IBI) ratings in Kelsey, Goff, and Richards Creeks range from 15 to 16, a moderate rating relative to other streams in Bellevue (Table 7). Biotic integrity, measured as B-IBI scores, was higher for three sites on Coal Creek (22 to 32) compared to Kelsey Creek (12 to 20). These B-IBI scores indicated a more degraded condition on Kelsey Creek. On Kelsey Creek, shaded sites showed greater biotic integrity. These findings suggest that even a very narrow riparian corridor can measurably improve biological condition of the stream. Sites with step weirs and riprap on Kelsey Creek did not have lower biotic integrity compared with similar sites without these features (Fore, 1999).

5.2 Opportunities and Constraints

5.2.1.1 Kelsey Creek

The mainstem of Kelsey Creek and the West Tributary contain predominantly floodplain channel type; floodplain channels are considered primary use areas for all salmonids. Tributaries range from palustrine to high-gradient contained. Kelsey Creek, along with other streams in the basin, is a high salmonid use stream, and the primary chinook stream in Bellevue with over 70 percent of its length used by salmonids. The Kelsey Creek and West Tributary storm drainage basins, however, contain a high level of impervious area, and moderate levels of length in culvert and

riparian constraints. Opportunities to address constraints on functions include removing partially passable culverts, particularly the partially passable culvert just upstream of Sturtevant Creek on Kelsey Creek (Figure S-1), reducing total impervious area in the basin, and addressing riparian constraints through enhancement of riparian vegetation.

5.2.1.2 Sears, Valley, and Goff Creeks

Sears, Valley and Goff Creeks are characterized by moderate-gradient, mixed control channels. These channel types are considered primary use for cutthroat and steelhead, and secondary use areas for chinook and coho. Substantial portions of Sears Creek, a relatively short stream, are located in culverts, and the basin contains over 60 percent impervious surface, suggesting that both of these factors pose substantial constraints on functions in this stream.

Approximately 90 percent of Goff Creek is used by salmonids. Nearly one-quarter of the stream is contained in culverts; one culvert exceeds 1,000 feet in length, and several block fish passage (Figure S-1). These culverts provide opportunities to re-establish upstream fish passage. The basin has substantially lower impervious surface than Sears Creek, although riparian constraints are high, suggesting that there are particular opportunities to contribute to improved riparian conditions. Valley Creek, with moderate amounts of stream in culvert, there are no identified blocking culverts, and a moderate amount of impervious surface; these conditions offer opportunities to enhance stream function through enhancement of riparian conditions and reduction of impervious surface.

5.2.1.3 East Creek

East Creek contains predominantly floodplain and moderate gradient, mixed control channel types. However, one-quarter of the stream has gradients exceeding 12 percent, limiting fish use in these reaches. East Creek also contains a high amount of impervious area at 48 percent and, next to Valley Creek, the least total length used by salmonids.

5.2.1.4 Sturtevant and Richards Creeks

Sturtevant and Richards Creeks contain palustrine channel types, areas of primary use for coho and sockeye and secondary use for cutthroat, steelhead, and chinook. Sturtevant Creek, however, is highly constrained by impervious area, riparian constraints, and culvert, particularly a blocking culvert on the lower one-third of the stream in the vicinity of I-405. Richards Creek, in contrast, has only 12 percent of the total stream in culverts (including two partially passable culverts in middle reaches), but a high amount of impervious surface.

6.0 EXISTING FUNCTIONS, OPPORTUNITIES, AND CONSTRAINTS: WEST LAKE SAMMAMISH BASIN

The West Lake Sammamish Basin contains several streams and tributaries including Idylwood Creek, Wilkins Creek, Phantom Creek, Vasa Creek, and several smaller streams directly draining to Lake Sammamish. The basin covers over 4,000 acres and 12 small streams. There are more

than 8 miles of stream, of which less than one mile is accessible to anadromous fish due to steep gradients, culvert blockages, and altered channel structure (Bellevue Utilities, 2000 *in* WRIA 8). Most streams are short and steep. Like other basins in Bellevue, most land use in this basin is comprised of single-family residential development. Commercial land use is highest in Vasa Creek, while impervious surface is highest in the Ardmore and Idylwood Creek storm drainage basins (over 42 percent), resulting in moderate to high levels of watershed alteration (Table 8).

Table 8. Small Lake Sammamish Tributaries

City Storm Drainage Basin	Ardmore Area	North Sammamish Area	Phantom Creek Basin	South Sammamish Area	Vasa Creek Basin	Wilkins Creek Basin
Length of Stream	14,254	6,778	4,046	17,884	18,614	1,742
% Culverted in Stream with Salmonids	0	0	7	15	4	0
% of Stream Over 12%	4	50	15	48	8	0
% Length Used by Salmonid* fish	0	0	100	55	44	0
% Length in Culvert	9	18	7	20	19	0
Ratio Drainage/Open Channel	11	10	9	9	5	23
TIA Storm Drainage Basin	42	33	38	31	40	41
Riparian Constraints (% TIA within 100')	9	3	20	16	17	15
Riparian Breaks						
Number of 303(d) Reaches	n/d	n/d	n/d	n/d	n/d	n/d
B-IBI	n/a	n/a	n/a	n/a	n/a	n/a

*Excluding reaches with gradients over 12 percent.

= Good = Moderate Poor

6.1 Basin Functions and Values

6.1.1 Current Fish Distribution

6.1.1.1 Phantom Creek

Fish distribution in West Lake Sammamish Basin streams varies substantially by stream. Phantom Creek is inhabited by coho and sockeye salmon downstream of an impassable culvert under West Lake Sammamish Parkway, and approximately 15 percent of the stream contains gradients exceeding 12 percent. Cutthroat trout are present in reaches upstream of West Lake

Sammamish Parkway to Phantom Lake. Warm water fish use from Phantom Lake may also be present in stream (Williams et al. 1975 in The Watershed Company, 2001). Overall, Phantom Creek has a high gradient, confirmed channel type (Appendix S-1).

6.1.1.2 Vasa Creek and South Sammamish Basin

Vasa Creek contains kokanee, coho salmon and cutthroat trout; tributaries to Vasa Creek contain cutthroat trout (Downen, 2000 *in* The Watershed Company, 2001). Vasa Creek has moderate to high gradient channel types (Appendix S-1). Cutthroat trout have been documented in lower reaches of two of the streams in the South Sammamish basin (Figure S-1).

6.1.1.3 Ardmore, North Sammamish, and Wilkins Creek Basins

Salmonids have not been documented in remaining streams in this basin, including the Ardmore, North Sammamish, and Wilkins Creek basins. Habitat in Wilkins Creek is limited by steep gradient, limited flow, and barriers from Lake Sammamish. Lack of water has also been documented as a limiting factor (The Watershed Company, 2001).

6.1.2 Channel Modifications

Vasa Creek and Phantom Creek are among the several streams draining directly to Lake Sammamish on the east side of Bellevue. Habitat in Vasa Creek, the longest stream system in the basin, includes a variety of conditions and gradients, from steep headwater reaches with bedrock substrate, to reaches with gravel substrates, to low-gradient reaches downstream of I-90 near Lake Sammamish. Portions of this stream have been piped. Approximately 7 percent of the stream is constrained by culvert (a good rating), while the basin has a moderate rating for the ratio of drainage network to open channel (Table 8). A culvert blocks fish passage at I-90.

Phantom Creek flows through a wooded ravine below Phantom Lake. Upstream of the lake, the stream consists of a narrow, sediment-filled channel with low flow. Phantom Creek has a moderate rating for flow and channel modifications; approximately 7 percent of the stream is contained in culverts, while the ratio of drainage network to open channel is 9 (Table 8).

Barriers, steep gradients, and lack of stream flow may limit fish use on reaches of stream in the South Sammamish basin. Nearly half of all stream length in the basin exceeds 12 percent gradient. In addition, approximately 20 percent of the streams are in culverts.

6.1.3 Total Impervious Area

Total impervious area in the West Lake Sammamish basin ranges from 41 and 42 percent in the Ardmore and Wilkins Creek drainage basins, respectively, to 31 percent in the South Sammamish basin. Overall, salmonid-bearing storm drainage basins have a moderate level of total impervious surface (Table 8).

6.1.4 Riparian Conditions

Riparian conditions are composed primarily of young trees, shrubs, exotic species and ornamental plantings in the West Lake Sammamish basin (Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002). Stands of maturing deciduous and coniferous trees are located in some of the ravine areas of the basin. Riparian constraints along salmonid-bearing streams in the basin range from 16 to 20 percent, a moderate level of constraint (Table 8).

Residential development has modified several riparian corridors in the West Lake Sammamish basin. Most riparian vegetation is comprised of mixed deciduous and coniferous forest located on steep slopes; West Lake Sammamish Parkway, road complexes, and driveways have also resulted in riparian corridor breaks. In southern portions of the basin, I-90 has modified the riparian corridors of Vasa Creek.

Above I-90, Vasa Creek flows through well-vegetated riparian buffers; however, portions of the riparian corridor contain a high number of riparian breaks. The riparian corridor of Phantom Creek is largely intact throughout Weowna Park but has been modified by residential development and road complexes above the park.

Forested riparian cover provides good habitat on portions of Ardmore Creek and contributes large woody debris to the channel, contributing to good channel conditions (The Watershed Company, 2001).

6.1.5 Water Quality

6.1.5.1 303(d) List and B-IBI

There are no streams in this basin listed on the 303(d) list, and there is no B-IBI information available.

Water quality in Phantom Creek has generally been found to be good, with the exception of turbidity and suspended solids (Bellevue Utilities Department, 1995). Turbidity and suspended solids were in the low range in base flow samples, but were moderately high in stormwater samples.

Suspended solids and turbidity were reported to be low in base flow samples of Wilkins Creek, but stormwater samples for suspended solids were among the highest of all sampled streams in the City (Bellevue Utilities Department, 1995).

6.2 Opportunities and Constraints

6.2.1.1 Ardmore, North Sammamish, and Wilkins Creek Basins

Streams in three of the storm drainage basins—Ardmore, North Sammamish, and Wilkins Creek basin–do not contain salmonids. All of these stream systems contain high-gradient, contained

channels that do not provide primary or secondary use for salmonids. The Ardmore and Wilkins Creek basins also have high levels of impervious surface and high ratios of drainage network to open channel, which may limit protection and restoration opportunities.

6.2.1.2 Phantom and South Sammamish

The Phantom and South Sammamish basins, while they may support fish use in lower reaches, are largely high-gradient, confined channels that do not support primary or secondary use by salmonids. These basins have a moderate level of channel and flow modifications as well as total impervious area; however, channel morphology limits their fish use potential.

6.2.1.3 Vasa Creek

Vasa Creek is a moderate gradient, mixed-control channel that provides secondary use for chinook, coho, steelhead, and cutthroat. It is the longest stream in the basin and contains a moderate level of flow and channel modification, moderate level of riparian constraints and moderate amount of total impervious area. A culvert under I-90 blocks upstream fish passage and provides opportunity to open upstream portions of the basin to salmonid use. However, low flows in the segment upstream of I-90 may be a concern (The Watershed Company, 2001).

7.0 EXISTING FUNCTIONS, OPPORTUNITIES, AND CONSTRAINTS: COAL CREEK BASIN

At approximately 5,820 acres, Coal Creek, along with Kelsey Creek, is among Bellevue's largest stream basins. The headwaters of the basin originate on the slopes of Cougar Mountain and the stream flows through a series of steep, narrow ravines before emptying into Lake Washington. Major streams include Coal Creek and its tributaries (Newport Creek and unnamed tributaries). Land use is predominantly residential. This basin also contains substantial areas of park including Cougar Mountain Park and Coal Creek Regional Park. Extensive coal mining has taken place in the basin, which has changed the course of streams, channelized reaches, and dumped mine tailings along stream banks (McDonald, 1987 *in* Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002).

7.1 Basin Functions and Values

7.1.1 Current Fish Distribution

7.1.1.1 Coal Creek

Over the last 10 years and in 2001 surveys, occasional adult chinook, coho, sockeye, and steelhead trout have been observed in Coal Creek below River Mile 2.5 (City of Bellevue, 2001) (Figure S-1). Overall, approximately 44 percent of streams in the Coal Creek storm drainage basin are inhabited by salmonids (Table 9). Cutthroat trout are currently found throughout the basin, particularly in mainstem Coal Creek, including upstream of natural barriers to anadromous migration.

Table 9. Coal Creek Basin

City Storm Drainage Basin	Coal Creek	Newport Area
Length of Stream	72,924	10,160
% Culverted in Stream with Salmonids	1	0
% of Stream Over 12%	18	4
% Length Used by Salmonid* fish	44	35
% Length in Culvert	5	7
Ratio Drainage/Open Channel	3	7
TIA Storm Drainage Basin	25	38
Riparian Constraints (% TIA within 100')	15	2
Riparian Breaks		
Number of 303(d) Reaches	1	n/d
B-IBI	>20	n/a

*Excludes stream reaches with gradients over 12 percent

= Good = Moderate Poor

7.1.1.2 Newport Creek

Newport Creek contains a large number of cutthroat, and juvenile coho have also been found in the stream during a previous survey effort. Overall, salmonids inhabit approximately 35 percent of this basin (Table 9). Coho salmon also inhabit Tributary 0275, a tributary of Coal Creek. Sculpin and lamprey are also present in the basin (The Watershed Company, 2001).

7.1.2 Channel and Flow Modifications

7.1.2.1 Coal Creek

Coal Creek stream gradient ranges from low to moderate; several of its tributaries in the upper watershed have high to very high gradients. Approximately 5 percent of Coal Creek is contained in culverts and the ratio of drainage network to open channel is 3; as a result, Coal Creek rates "good" for channel and flow modifications, one of the few streams in the City with such a rating. However, a culvert partially blocks fish passage on Coal Creek at the confluence with Newport Creek, as well as under Coal Creek Parkway (Figure S-1).

Instream habitat in Coal Creek consists of pool sequences created by weirs and woody debris. Several natural cascades on upper reaches of the stream serve as impassable barriers to fish migration. Several reaches of Coal Creek remain unmodified by stream piping; however, one lower reach of approximately 500 feet is piped, as is a section of Tributary 1. Between the lakeshore and I-405 there are pools created by wiers and woody debris. However, this reach has also been channelized and hardened, and the channel has been diverted twice near the mouth.

Woody debris was frequently encountered in middle reaches of Coal Creek but decreased in upper reaches. Portions downstream of 405 also lacked woody debris. Much of the woody debris appears to have originated from mature deciduous trees (City of Bellevue, 1998 *in* Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002).

Coal Creek has excessive sedimentation problems from streambank erosion and failure of old mine tailing slopes in headwaters and on steep slopes along the stream (Sturtevant, 2000 *in* Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002). May (1996) estimated that the stream's substrate contained greater than 50 percent fines in the reach downstream of Interstate 405 and 25 percent fines in upstream reaches of the watershed.

7.1.2.2 Newport Creek

Gradients on Newport Creek range from moderate to very high (over 40 percent). Approximately 7 percent of Newport Creek is contained in culverts; overall, the basin has a moderate rating for channel and flow modifications. Log wiers on upper Newport Creek have created upstream barriers and resulted in several isolated pools.

7.1.3 Total Impervious Area

Total impervious area is moderate in both the Coal and Newport Creek basins. Total impervious surface is approximately 25 percent in the Coal Creek basin and 38 percent in the Newport Creek basin.

7.1.4 Riparian Conditions

Coal Creek basin has the highest amount of undisturbed riparian corridors in Bellevue due to the extensive system of parks and open space in this basin. Total impervious area within 100 feet of the streams in the Coal Creek drainage basin is approximately 15 percent; however, total impervious area within 100 feet of Newport Creek is only 2 percent (Table 9). Most reaches of the mainstem of Coal Creek and Newport Creek have low numbers of riparian breaks relative to other streams in the city. Similarly, the riparian corridors of most tributaries appear to be intact. Riparian vegetation is primarily deciduous, with maple and alder as the dominant species.

7.1.5 Water Quality

7.1.5.1 303(d) List

Coal Creek was placed on the 1998 Section 303(d) due to 36 excursions from state water quality criterion for fecal coliform (WAC 173-201A).

Limited water quality data was collected in 1986 for the *Coal Creek Basin Plan and Final Environmental Impact Statement (EIS)*, (Bellevue and King County, 1987). Data was collected monthly during baseflow conditions and is generally incomplete. The *Coal Creek Basin Plan* (Bellevue and King County, 1987) concluded however, that water quality conditions for salmonids in the basin were excellent. The study found that pH, and metals occasionally exceeded King County criteria for good water quality, and it documented high suspended sediments in Coal Creek, particularly near the Newport Hills tributary. Fecal coliform levels were also found to be high (Bellevue and King County, 1987).

The University of Washington Center for Streamside Studies observed temperatures in Coal Creek in August 1999 that exceeded the state water quality standards of at four out of eight

sampling stations. Temperatures ranged from 15° C to 23° C in Coal Creek during the sampling period (University of Washington, 1999).

7.1.5.2 B-IBI

B-IBI ratings for Coal Creek are considered "good," for an urban stream system. In benthic surveys, dominant invertebrate species in riffles, were found to be comprised of predominantly pollution-intolerant types—stonefly, caddisfly, and mayfly. B-IBI scores ranged from 32 at the cinder mine area to 22 downstream of Coal Creek Parkway, indicating some degradation of the benthic community in lower reaches of the stream (Lake Washington Cedar/Sammamish Watershed WRIA 8 Steering Committee, 2002).

7.2 Opportunities and Constraints

7.2.1.1 Coal Creek

Coal Creek is a relatively large and complex stream system encompassing over 72,000 feet of stream. Channel types range from large, contained in lower reaches to moderate-gradient, mixed control and high-gradient channels in upper tributaries (Appendix S-1). Large contained channel types are primary use areas for steelhead and cutthroat, and they are secondary use areas for chinook and coho. Moderate gradient channel types are secondary use areas for coho, chinook, steelhead, and cutthroat (Appendix S-1).

Coal Creek is one of the few streams in Bellevue that rates "good" for channel and flow modifications. The basin, however, does have a moderate amount of total impervious surface and riparian constraints, suggesting opportunities for enhancing riparian areas and addressing impervious surface issues. Protecting and enhancing riparian areas and maintaining open channels would also help to provide linkages for wildlife, and would help to protect steep slopes as discussed in the wildlife and geologic hazards inventories. A partially blocking culvert in lower reaches of the Creek near I-405 and another culvert under coal Creek Parkway may also provide opportunities to increase upstream fish access in the basin.

7.2.1.2 Newport Creek

The Newport Creek basin is much smaller than Coal Creek and consists mainly of moderate to high-gradient channel; as a result, primary fish use is limited. The basin has a moderate amount of impervious surface, but only a small portion of the stream is contained in culverts. Additionally, the basin has among the lowest amount of riparian constraint of any basin in the City, suggesting opportunities in particular for protecting multiple riparian functions in this basin (Table 9).

8.0 EXISTING FUNCTIONS, OPPORTUNITIES, AND CONSTRAINTS: LEWIS CREEK BASIN

The Lewis Creek basin contains one stream system- Lewis Creek. The basin is approximately 1,400 acres (965 in Bellevue); land use is approximately 60 percent residential, four percent multi-family residential, and seven percent parks and open space.

8.1 Sub-Basin Functions and Values

8.1.1 Current Fish Distribution

Lewis Creek contains chinook salmon, coho salmon, sockeye salmon, cutthroat trout, and kokanee salmon. Anadromous and migratory fish distribution, however, is limited to reaches downstream of the impassable barrier culvert under I-90 (Figure S-1). Resident cutthroat trout are present upstream of this culvert. Lamprey and sculpin are also present in Lewis Creek. Cutthroat are found in only one tributary to the mainstem of Lewis Creek; others lacked water or had steep gradients, which are present in approximately 45 percent of the basin (Table 10).

8.1.2 Channel and Flow Modifications

Lewis Creek flows swiftly from its headwaters on Cougar Mountain to Lake Sammamish, with pool-riffle sequences in lower stream reaches transitioning into step pools in upper reaches. Stream gradients range from low to high; predominant channel types are moderate gradient, mixed control (Appendix S-1). Gradients of over 20 percent are common in tributaries to Lewis Creek. Overall, approximately 10 percent of Lewis Creek is contained in culverts; the ratio of drainage network to open channel is good at 2. Most of the mainstem of this stream is protected in public park and contains moderate amounts of large woody debris.

Table 10. Lewis Creek Tributaries

City Storm Drainage Basin	Lewis Creek
Length of Stream	48,520
% Culverted in Stream with Salmonids	0
% of Stream Over 12%	45
% Length Used by Salmonid* fish	33
% Length in Culvert	10
Ratio Drainage/Open Channel	2
TIA Storm Drainage Basin	28
Riparian Constraints (% TIA within 100')	18
Riparian Breaks	
Number of 303(d) Reaches	1
B-IBI	>20

*Excluding stream reaches with gradients exceeding 12 percent

= Good = Moderate Poor

8.1.3 Total Impervious Area

Total impervious area in the basin is moderate, at 28 percent.

8.1.4 Riparian Conditions

Riparian constraints in the basin are moderate; total impervious area within 100 feet of streams is approximately 18 percent (Table 10). Residential development has modified riparian corridors in the basin. Most riparian vegetation is comprised of mixed deciduous and coniferous forest located on steep slopes; West Lake Sammamish Parkway, I-90, other road complexes, driveways have also resulted in riparian corridor breaks. However, the number of riparian breaks in other portions of Lewis Creek is low.

8.1.5 Water Quality

8.1.5.1 303(d) List

King County conducted a *Small Streams Toxicity/Pesticide Study of Sammamish, Washington Analysis and Modeling Program* (Wilson et. al, 1999) of Lyon, Juanita and Lewis Creeks in the Lake Washington and Lake Sammamish Basins in the spring, summer and fall 1999. Pesticides were detected in all these streams; the greatest concentration and number of pesticides were detected in spring and summer. Lewis Creek was found to have toxic levels of pesticides in the spring when compared to a reference stream site in Rock Creek. Thirteen total metals were also analyzed; concentrations in Lewis Creek were reported to be within state water quality standards (Wilson, et al., 1999).

8.1.5.2 B-IBI

Lewis Creek had higher B-IBI scores than Goff, Kelsey and Richards Creek. In spite of urban development in its headwaters, Lewis Creek may be one of the healthiest streams in the City as indicated by B-IBI ratings.

8.2 Opportunities and Constraints

Lewis Creek largely contains moderate-gradient, mixed control channel type, providing no primary salmonid habitat, but rather secondary habitat for several salmonid species. The basin also contains a moderate to low level of channel and flow modifications; B-IBI scores also indicate that the stream is in good condition relative to other streams in Bellevue. While improving fish passage at the I-90 culvert on lower reaches of the steam would provide upstream passage for salmonids, low flows and high gradients in upper reaches of the steam likely limit fish use in these areas. Protecting and enhancing riparian areas would help to provide linkages for wildlife, and would help to protect steep slopes as discussed in the wildlife and geologic hazards inventories.

9.0 SUMMARY MATRIX OF VALUES, CONSTRAINTS, AND OPPORTUNITIES

Overall, in applying USBEM methodology and parameters, with the exception of Coal Creek Bellevue's streams largely have a moderate to high level of channel and flow modifications. Several sections of streams have been placed in culverts, and an extensive drainage network has been constructed, as is typical for urban areas such as Bellevue. The findings in the previous sections also show that all of Bellevue's basins have a moderate to high level of total impervious area due to past development in the City. Impervious area in some of the City's basins exceeds 60 percent, posing substantial challenges to restoring pre-development hydrologic characteristics.

Similarly, riparian areas in the City indicate extensive modification due to urbanization. All of the City's streams rate "high" for the number of riparian breaks, and, with the exception of the Mercer Slough, Ardmore, North Sammamish, and Newport basins, moderate to high for riparian modifications (total impervious area) within 100 feet of the stream. Water quality has also been identified as a concern to varying degrees as discussed for each basin above.

However, given these urban conditions and constraints, Bellevue's streams are supporting salmonids, including listed chinook salmon, and several of the City's streams are highly suitable for salmonid use based on channel type. While all streams are degraded to some degree, streams can be evaluated based on fish use and channel type, as well as specific opportunities for addressing constraints, to develop potential protection, enhancement, and restoration strategies. Streams with high suitability for fish use, as well as those streams with relatively less degradation of functions (e.g., channel and flow modifications on coal Creek) may offer the highest protection, restoration, and enhancement opportunities. Other streams for potential fish use improvement include upper Meydenbauer Creek, Sturtevant Creek, and upper West Tributary (The Watershed Company, 2001). Table 11, below, summarizes conditions in each major basin and storm drainage basin and discusses these opportunities.

Table 11. Summary of Conditions and Opportunities by Basin

Basin	Current Salmonid Use	Channel Type and Potential Species Use	Level of Watershed Alteration	USBEM Habitat Suitability (Based on Species Use and Watershed Alteration Level)	Other Constraints	Opportunities
Small Lake Washington Tributaries						
Lakehurst	None	Floodplain, lower reaches. High use for all salmonids. Moderate, mixed control, high gradient in upper reaches. Moderate gradient reaches are primary use area for cutthroat, steelhead and secondary use for chinook, coho. Negligible use for sockeye. High gradient areas negligible use for all salmonids.	**Moderate** Substantial lengths in culverts, high number of riparian breaks. Moderate TIA in basin and within 100 feet of stream. Moderate ratio of drainage network to open channel.	**Secondary** habitat use in floodplain and moderate gradient areas for all salmonids due to watershed alteration and/or channel type. **Negligible** salmonid habitat use in high-gradient areas.	Low flows likely insufficient for salmonid survival.	Manage for water quality, riparian function.
Meydenbauer	Cutthroat, sockeye	Floodplain. High use for all salmonids.	**High** Substantial lengths in culverts. High TIA in basin; moderate within 100 feet of stream. High ratio of drainage network to open channel.	**Secondary** habitat use, but potential to restore high habitat use conditions. High habitat suitability for all salmonids based on channel type, but high watershed alteration.	High level of commercial, multi-family development. Impassible culvert in mid-reaches of stream. Two reaches largely piped.	While channel type is suitable for salmonids, large sections of piping and high-intensity development in basin may limit enhancement/restoration opportunities.
Yarrow	Cutthroat	Floodplain (mainstem), moderate gradient, mixed control (tributaries). Floodplain high use for all salmonids. Moderate, mixed control channels high use for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye.	**Moderate** Substantial lengths in culverts. Moderate TIA in basin; moderate within 100 feet of stream. Good ratio of drainage network to open channel. One listed 303d reach.	**Secondary** habitat. Floodplain areas highly suitable for all salmonids but constrained by culverts, riparian breaks, TIA.	Impassible culvert near SR 520. Additional culverts on tributaries. Likely inadequate streamflow on upper tributaries.	Addressing impassible culvert downstream of SR 520 would improve upstream fish migration. Riparian enhancement opportunities.

Basin	Current Salmonid Use	Channel Type and Potential Species Use	Level of Watershed Alteration	USBEM Habitat Suitability (Based on Species Use and Watershed Alteration Level)	Other Constraints	Opportunities
Coal Creek						
Coal Creek	Chinook, coho, sockeye, steelhead downstream of RM 2.5. Cutthroat throughout basin.	Large, contained on mainstem; moderate gradient, mixed control and high gradient contained on tributaries. Mainstem is primary use area for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye. Moderate, mixed control channels high use for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye. High gradient areas have negligible use for all salmonids except steelhead (secondary use).	**Moderate** One 303d listed reach. Good ratings for length of stream in culverts and drainage network ratio. Moderate ratings for TIA. Moderate rating for TIA within 100 feet of stream. One of least disturbed riparian corridors in Bellevue.	**Secondary** habitat use for all salmonids due to combination of channel types and watershed alteration.	Partially blocking culvert near confluence with Newport Creek and under Coal Creek Parkway. Natural cascades on upper reaches limit fish passage. Lower reaches between lake and I-405 channelized and hardened. Excessive sedimentation issues from past mining.	Protect existing riparian corridor functions, enhance riparian vegetation to reduce sedimentation. Address impassible culverts on mainstem; may open additional habitat particularly for chinook and coho. Minimize additional culverts and maintain open channel.
Newport Creek	Cutthroat, coho.	Moderate gradient, mixed control, high gradient, contained. Moderate gradient channel high use for cutthroat, steelhead. Secondary use for chinook, coho. High gradient channel negligible use for all salmonids except steelhead (secondary use).	**Moderate** Good ratings for length of stream in culverts. Moderate rating for drainage network ratio. Moderate ratings for TIA. Good rating for TIA within 100 feet of stream. One of least disturbed riparian corridors in Bellevue.	**Secondary** habitat for all salmonids due primarily to channel type.	Log weirs have created upstream barriers. High gradients act as natural barriers.	Protection of multiple functions of existing riparian corridor. Improvement of upstream barriers by addressing log weirs.

Basin	Current Salmonid Use	Channel Type and Potential Species Use	Level of Watershed Alteration	USBEM Habitat Suitability (Based on Species Use and Watershed Alteration Level)	Other Constraints	Opportunities
Kelsey Creek						
Mercer Slough	Chinook, coho, sockeye, cutthroat.	Palustrine. Secondary use for chinook, cutthroat. Primary use for coho, sockeye.	**Moderate** Slough remains free of culverts; riparian constraints are low. Moderate ratio of drainage network to open channel, moderate TIA. Three 303d listings.	**Secondary** habitat use based on channel type and alteration levels. Potential primary use for coho and sockeye if alterations addressed.	None identified.	Potential to restore primary habitat use. Maintain open channel conditions; protect, enhance riparian functions for water quality and salmonid habitat. Explore opportunities to reduce TIA.
East Creek	Coho, cutthroat.	Floodplain (mainstem), moderate gradient, mixed control (portion of mainstem). High use for all salmonids in mainstem. High use for cutthroat, steelhead in moderate gradient areas. Secondary use for chinook, coho. Negligible use for sockeye in mixed control. Negligible use in high gradient areas. Moderate gradient, mixed control, high gradient (tributaries)	**Moderate** High level of TIA and high ratio of drainage network to open channel. Moderate riparian constraints and length of stream in culvert.	**Secondary** habitat use, due to channel type and watershed alteration, except **negligible** in high gradient reaches. Potential to restore primary use in floodplain channel type.	Lower reaches heavily channelized around roads and properties. Seven blocking culverts in upper reaches. Road complexes and business parks have modified riparian vegetation.	Potential to enhance primary habitat use, particularly in mainstem. However, high level of TIA poses constraint. Potential to enhance riparian corridor, particularly in lower reaches, to address multiple functions that support fish habitat.
Goff Creek	Coho, cutthroat (VERIFY). Potential chinook use.	Moderate gradient, mixed control. High use for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye.	**Moderate** Moderate TIA, and ratio of drainage network to open channel. High riparian constraints, high for length of stream in culvert.	**Secondary** habitat use based largely on channel type.	Substantial portions have been piped. 1,000 foot long culvert at Bellevue-Redmond Road and near golf course.	Potential to enhance secondary fish use habitat constrained by long culverts. High riparian constraints may offer opportunities for riparian enhancement during redevelopment.

Basin	Current Salmonid Use	Channel Type and Potential Species Use	Level of Watershed Alteration	USBEM Habitat Suitability (Based on Species Use and Watershed Alteration Level)	Other Constraints	Opportunities
Kelsey Creek						
Kelsey Creek	Chinook, coho, sockeye, cutthroat.	Palustrine, Floodplain (mainstem). Floodplain channel type high use for all salmonids. Palustrine channel type high use for coho, sockeye, secondary use for other salmonids. High gradient contained in tributaries; negligible use for all salmonids.	**Moderate** High TIA in basin. Moderate length in culvert, ratio of drainage network to open channel, riparian constraints.	**Secondary** use except high gradient areas, which have **negligible** habitat use. Potential to restore primary use in floodplain, palustrine channel types.	Documented degraded instream habitat conditions from riprap, sedimentation, lack of large woody debris, loss of floodplain connectivity. Landscaped lawns, reduced riparian vegetation throughout stream system. Four partially passable culverts, including one on lower reach at I-405.	Potential to restore primary habitat for all salmonids by enhancing riparian functions during development, and addressing blocking culverts, particularly on lower reaches. Reducing high TIA in basin may pose challenges.
Richards Creek	Chinook, coho, sockeye, cutthroat.	Palustrine channel type; secondary use for chinook, steelhead, cutthroat. Primary use for coho, sockeye.	**Moderate** High TIA, in basin. Moderate length in culvert, ratio of drainage network to open channel, riparian constraints.	**Secondary** habitat use based on alterations. Potential to restore primary use areas for coho and sockeye.	725-foot section of stream is piped; other partially blocking culverts present. Highly modified riparian corridor in headwaters. Road complexes and business parks have modified riparian vegetation.	Potential to restore primary habitat for coho by enhancing riparian functions during development. Long blocking culvert, high TIA in basin may pose challenges.

Basin	Current Salmonid Use	Channel Type and Potential Species Use	Level of Watershed Alteration	USBEM Habitat Suitability (Based on Species Use and Watershed Alteration Level)	Other Constraints	Opportunities
Kelsey Creek						
Sears Creek	Chinook, coho, cutthroat (VERIFY)	Moderate gradient, mixed control. High use for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye.	**High** High TIA, substantial portions in culverts, high riparian constraints and high ratio of drainage network to open channel.	**Secondary** habitat use based on channel type.	Ditched in its lower 1,000 feet. Vegetated corridor upstream of this section.	High levels of alteration pose challenges; TIA exceeds 60 percent. Potential to restore secondary use. Potential to enhance riparian constraints for multiple functions during redevelopment.
Sturtevant Creek	Coho, cutthroat	Palustrine channel type. Secondary use for chinook, steelhead, cutthroat. Primary use for coho, sockeye.	**High** High TIA, substantial portions in culverts, high riparian constraints and high ratio of drainage network to open channel.	**Secondary** habitat use based on alteration. Potential primary use area for coho.	Two long culverts span 37 percent of stream length. Several other culverts. Potential low flows in headwaters. Riparian corridor modified by lawns, impervious surface, ornamental vegetation.	High levels of alteration pose challenges; TIA exceeds 60 percent, and substantial lengths of stream are in culverts. Potential to restore primary use for coho. Potential to enhance riparian constraints for multiple functions during redevelopment.
Sunset Creek	Chinook, coho, sockeye, cutthroat.	Moderate gradient, mixed control. High use for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye.	**Moderate** High for length of stream in culverts, and TIA. Moderate for ratio of drainage network to open channel, riparian constraints.	**Secondary** habitat use based on channel type.	Four major culverts limit fish passage. Road complexes and business parks have modified riparian vegetation.	Potential to enhance secondary use area for salmonids by addressing blocking culverts, riparian constraints during redevelopment. Challenges posed by high TIA.

Basin	Current Salmonid Use	Channel Type and Potential Species Use	Level of Watershed Alteration	USBEM Habitat Suitability (Based on Species Use and Watershed Alteration Level)	Other Constraints	Opportunities
Kelsey Creek						
Valley Creek	Sockeye, chinook, coho, cutthroat.	Moderate gradient, mixed control. High use for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye.	**Moderate** Moderate for length of stream in culverts, TIA, and riparian constraints. Goode for ratio of drainage network to open channel.	**Secondary** habitat use based on channel type.	None identified.	Potential to enhance secondary use area for salmonids by addressing blocking culverts, riparian constraints during redevelopment.
West Tributary	Chinook, coho, cutthroat (VERIFY).	Floodplain channel tyoe; high use for all salmonids.	**Moderate** High TIA, in basin. Moderate length in culvert, ratio of drainage network to open channel, riparian constraints.	**Secondary** habitat use due to level of alteration. Potential to restore high use for salmonids.		Potential to restore high use for all salmonids; challenges posed by high TIA. Potential to address blocking culverts, riparian constraints during redevelopment.
Lewis Creek						
Lewis Creek	Chinook, coho, sockeye, cutthroat, kokanee.	Moderate gradient, mixed control. High use for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye.	**Moderate** Moderate ratings for length of stream in culverts, good for drainage network ratio. Moderate ratings for TIA. Moderate rating for TIA within 100 feet of stream. One 303(d) listed reach.	**Secondary** habitat use based on channel type.	Impassible barrier under I-90. High gradients, low flows in tributaries.	Addressing blocking culvert under I-90 may open upstream habitat to chinook and other salmonids. Opportunities to protect, enhance multiple function of riparian corridors, particularly on steep slopes.

Basin	Current Salmonid Use	Channel Type and Potential Species Use	Level of Watershed Alteration	USBEM Habitat Suitability (Based on Species Use and Watershed Alteration Level)	Other Constraints	Opportunities
Small Lake Sammamish Tributaries						
Ardmore	None	High Gradient, contained. Negligible salmonid use potential.	**Moderate** Good rating for length of stream in culverts, but high TIA in basin. Moderate ratio of drainage network to open channel. Forested riparian corridor on portions of stream.	**Negligible** habitat use based on channel type. No fish reported to be present.	None identified.	Low fish use potential, but opportunities to protect existing riparian functions and stream water quality.
North Sammamish	None	High gradient, contained. Negligible salmonid use potential.	**Moderate** Moderate rating for length of stream in culverts and TIA in basin. Moderate ratio of drainage network to open channel. Minimal riparian constraints within 100 feet of stream.	**Negligible** habitat use based on channel type. No fish reported to be present.	None identified.	Low fish use potential, but opportunities to protect existing riparian functions and stream water quality.
Phantom Creek	Sockeye, coho, cutthroat.	High gradient, contained. Negligible salmonid use potential.	**Moderate** Good rating for length of stream in culverts, moderate for TIA in basin. Moderate ratio of drainage network to open channel and riparian constraints.	**Negligible** habitat use based on channel type.	None identified.	Salmonids present, but overall low fish use potential. Opportunities to protect riparian functions and stream water quality.
South Sammamish	None.	High gradient, contained. Negligible salmonid use potential.	**Moderate** Moderate rating for length of stream in culverts, TIA, riparian constraints, drainage network ratio.	**Negligible** habitat use based on channel type.	Barriers, steep gradient, lack of stream flow.	Low fish use potential; may be some opportunities to protect existing riparian functions and stream water quality.

Basin	Current Salmonid Use	Channel Type and Potential Species Use	Level of Watershed Alteration	USBEM Habitat Suitability (Based on Species Use and Watershed Alteration Level)	Other Constraints	Opportunities
Small Lake Sammamish Tributaries						
Vasa	Kokanee, coho, cutthroat.	Moderate gradient, mixed control and high gradient contained channels. High use for cutthroat, steelhead. Secondary use for chinook, coho. Negligible use for sockeye in mixed control channels. Negligible use in high gradient areas.	**Moderate** Moderate rating for length of stream in culverts, TIA, riparian constraints, drainage network ratio. Portions of riparian buffer well vegetated.	**Secondary** habitat. **Negligible** use in high gradient areas.	Culvert blocks fish passage under I-90.	Moderate fish use potential. Potential to increase habitat area by addressing culvert under I-90. Opportunities to protect, enhance riparian corridor functions.
Wilkins	None.	High gradient, contained. Negligible salmonid use potential.	**Moderate** Stream is free of culverts, but basin has high TIA, moderate riparian constraints, high drainage network ratio.	**Negligible** habitat use based on channel type.	None identified.	Low fish use potential; may be some opportunities to protect existing riparian functions and stream water quality.

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FIGURES

APPENDIX S-1: STREAM CHANNEL TYPES AND SALMONID SUITABILITY

City of Bellevue Stream Channel Types

Stream Name	Stream Basin	City Storm Drainage Basin	Channel Type
Ardmore Creek	Ardmore Creek	Ardmore Area	High Gradient, Contained
Ardmore Creek Tributary 1	Ardmore Creek	Ardmore Area	High Gradient, Contained
Ardmore Creek Tributary 2	Ardmore Creek	Ardmore Area	High Gradient, Contained
Idylwood Creek	Ardmore Creek	Ardmore Area	High Gradient, Contained
Idylwood Creek Tributary 1 (Isolated)	Idylwood Creek	Ardmore Area	High Gradient, Contained
Idylwood Creek Tributary 2	Idylwood Creek	Ardmore Area	High Gradient, Contained
Idylwood Creek Tributary 3	Idylwood Creek	Ardmore Area	High Gradient, Contained
Idylwood Creek Tributary 4	Idylwood Creek	Ardmore Area	High Gradient, Contained
Coal Creek	Coal Creek	Coal Creek Basin	Large, Contained
Coal Creek (0276A)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 3 (0268Y)	Coal Creek	Coal Creek Basin	High Gradient, Contained
Coal Creek Tributary 4 (0268W)	Coal Creek	Coal Creek Basin	High Gradient, Contained
Coal Creek Tributary 5 (0268U)	Coal Creek	Coal Creek Basin	High Gradient, Contained
Coal Creek Tributary 6 (0268V)	Coal Creek	Coal Creek Basin	High Gradient, Contained
Coal Creek Tributary 7 (0268T)	Coal Creek	Coal Creek Basin	High Gradient, Contained
Coal Creek Tributary 8 (0268S)	Coal Creek	Coal Creek Basin	High Gradient, Contained
Coal Creek Tributary 9 (0268S)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 10 (0272)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 11 (0275)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 12 (0273)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 13 (O268D)	Coal Creek	Coal Creek Basin	High Gradient, Contained
O268D Tributary	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 14	Coal Creek	Coal Creek Basin	High Gradient, Contained
Coal Creek Tributary 15 (0274)	Coal Creek	Coal Creek Basin	High Gradient, Contained
0274 Tributary 1	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
0274 Tributary 2	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 16 (0276)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 17	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 19	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Headwaters 1	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Headwaters 2	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control

Stream Name	Stream Basin	City Storm Drainage Basin	Channel Type
Coal Creek Tributary 20 (0276A-5)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
0276A-5 Tributary 1	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
0276A-5 Tributary 2	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 21 (0276A-4)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 22 (0276A-3)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 23 (0276A-2)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
Coal Creek Tributary 24 (0276A-1)	Coal Creek	Coal Creek Basin	Moderate Gradient, Mixed Control
East Creek	Mercer Slough/Kelsey Creek	East Creek Basin	Floodplain
262 (East Creek)	Mercer Slough/Kelsey Creek	East Creek Basin	Floodplain
0263 (East Creek)	Mercer Slough/Kelsey Creek	East Creek Basin	Moderate Gradient, Mixed Control
East Creek Tributary 1	Mercer Slough/Kelsey Creek	East Creek Basin	Floodplain
East Creek Tributary 2	Mercer Slough/Kelsey Creek	East Creek Basin	Floodplain
East Creek Tributary 4	Mercer Slough/Kelsey Creek	East Creek Basin	Moderate Gradient, Mixed Control
East Creek Tributary 4 Tributary	Mercer Slough/Kelsey Creek	East Creek Basin	Moderate Gradient, Mixed Control
East Creek Tributary 3 (0263A)	Mercer Slough/Kelsey Creek	East Creek Basin	Moderate Gradient, Mixed Control
0263A Tributary 1	Mercer Slough/Kelsey Creek	East Creek Basin	Moderate Gradient, Mixed Control
0263A Tributary 2	Mercer Slough/Kelsey Creek	East Creek Basin	Floodplain
0263A Tributary 3	Mercer Slough/Kelsey Creek	East Creek Basin	Floodplain
0263A Tributary 1 Tributary	Mercer Slough/Kelsey Creek	East Creek Basin	High Gradient, Contained
Goff Creek	Mercer Slough/Kelsey Creek	Goff Creek Basin	Moderate Gradient, Mixed Control
Goff Creek Tributary	Mercer Slough/Kelsey Creek	Goff Creek Basin	Moderate Gradient, Mixed Control
Kelsey Creek Tributary 1	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Moderate Gradient, Mixed Control
Kelsey Creek Tributary 3	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Moderate Gradient, Mixed Control
Kelsey Creek Tributary 4	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	High Gradient, Contained
Kelsey Creek Tributary 5	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Moderate Gradient, Mixed Control
Kelsey Creek Tributary 6	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Moderate Gradient, Mixed Control
Kelsey Creek Tributary 7	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	High Gradient, Contained
Kelsey Creek Tributary 8	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Moderate Gradient, Mixed Control
Kelsey Creek Tributary 9 (0265N)	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Floodplain
Kelsey Creek Tributary 11 (0276A)	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Palustrine
Kelsey Creek Tributary 13	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Palustrine
Kelsey Creek Tributary 12	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Palustrine

Stream Name	Stream Basin	City Storm Drainage Basin	Channel Type
Kelsey Creek Tributary 12 Tributary	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Palustrine
Kelsey Creek Tributary 14	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Palustrine
Kelsey Creek Tributary 15	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Palustrine
Larson Lake Creek	Mercer Slough/Kelsey Creek	Kelsey Creek Basin	Palustrine
60th Street Creek (0281B)	60th Street Creek (0281B)	Lakehurst Area	High Gradient, Contained
64th Street Creek (0281C)	64th Street Creek (0281C)	Lakehurst Area	High Gradient, Contained
Lakehurst Creek (0281)	Lakehurst Creek (0281)	Lakehurst Area	Moderate Gradient, Mixed Control
New Castle Beach Creek	New Castle Beach Creek	Lakehurst Area	Floodplain
New Castle Beach Creek Tributary	New Castle Beach Creek	Lakehurst Area	Floodplain
Lewis Creek	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 1	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 2	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 3	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 4	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 5 (0162I)	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 6	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 6 Tributary 1	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 6 Tributary 2	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 7 (0162D)	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
0162D-3	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
0162D-3 Tributary 1	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
0162D-2	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
0162D-1	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 7 Tributary 4	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 8 (0162C)	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
0162C-1	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
0162C	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 9 (0162B)	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
0162B-2	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
0162B-1	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 10	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 11 (0162K)	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control

Stream Name	Stream Basin	City Storm Drainage Basin	Channel Type
0162K Tributary 1	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 12	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 13	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Tributary 14	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Lewis Creek Headwaters (Isolated)	Lewis Creek	Lewis Creek Basin	Moderate Gradient, Mixed Control
Mercer Slough East	Mercer Slough/Kelsey Creek	Mercer Slough Basin	Palustrine
Kelsey Creek	Mercer Slough/Kelsey Creek	Mercer Slough Basin	Floodplain
Mercer Slough East Tributary 1	Mercer Slough/Kelsey Creek	Mercer Slough Basin	Palustrine
Mercer Slough East Tributary 2	Mercer Slough/Kelsey Creek	Mercer Slough Basin	Palustrine
Mercer Slough West	Mercer Slough/Kelsey Creek	Mercer Slough Basin	Palustrine
Meydenbauer Creek	Meydenbauer Creek	Meydenbauer Creek Basin	Floodplain
Coal Creek Tributary 1(0268Z)	Coal Creek	Newport Area	Moderate Gradient, Mixed Control
Coal Creek Tributary 1 Tributary 1	Coal Creek	Newport Area	Moderate Gradient, Mixed Control
Coal Creek Tributary 1 Tributary 2	Coal Creek	Newport Area	High Gradient, Contained
Newport Creek	Coal Creek	Newport Area	Moderate Gradient, Mixed Control
Newport Creek Tributary	Coal Creek	Newport Area	Moderate Gradient, Mixed Control
Hale Creek	Hale Creek	North Sammamish Area	High Gradient, Contained
Sunich Creek (0151)	Sunich Creek	North Sammamish Area	High Gradient, Contained
0151 Tributary 1	Sunich Creek	North Sammamish Area	High Gradient, Contained
Weona Park Creek	Weona Park Creek	North Sammamish Area	High Gradient, Contained
Wortman Creek	Wortman Creek	North Sammamish Area	High Gradient, Contained
Phantom Creek	Phantom Creek	Phantom Creek Basin	High Gradient, Contained
Richards Creek	Mercer Slough/Kelsey Creek	Richards Creek Basin	Palustrine
Richards Creek Tributary 1 (Isolated)	Mercer Slough/Kelsey Creek	Richards Creek Basin	Palustrine
Sears Creek	Mercer Slough/Kelsey Creek	Sears Creek Basin	Moderate Gradient, Mixed Control
Lisa Creek	Lisa Creek	South Sammamish Area	High Gradient, Contained
Reservoir Creek (0160)	Reservoir Creek	South Sammamish Area	High Gradient, Contained
0160 Tributary 1	Reservoir Creek	South Sammamish Area	High Gradient, Contained
0160 Tributary 2	Reservoir Creek	South Sammamish Area	High Gradient, Contained
Sunrise Creek (0161)	Sunrise Creek	South Sammamish Area	High Gradient, Contained
Sunrise Creek (0161) Tributary 1	Sunrise Creek	South Sammamish Area	High Gradient, Contained
Sturtevant Creek	Mercer Slough/Kelsey Creek	Sturtevant Creek Basin	Palustrine
Sunset Creek	Mercer Slough/Kelsey Creek	Sunset Creek Basin	Moderate Gradient, Mixed Control

Stream Name	Stream Basin	City Storm Drainage Basin	Channel Type
Valley Creek	Mercer Slough/Kelsey Creek	Valley Creek Basin	Moderate Gradient, Mixed Control
Valley Creek Tributary 2	Mercer Slough/Kelsey Creek	Valley Creek Basin	Moderate Gradient, Mixed Control
Valley Creek Tributary 3	Mercer Slough/Kelsey Creek	Valley Creek Basin	Moderate Gradient, Mixed Control
Vasa Creek	Vasa Creek	Vasa Creek Basin	Moderate Gradient, Mixed Control
Vasa Creek Tributary 1	Vasa Creek	Vasa Creek Basin	Moderate Gradient, Mixed Control
Vasa Creek Tributary 2	Vasa Creek	Vasa Creek Basin	Moderate Gradient, Mixed Control
E Tributary Vasa Creek	Vasa Creek	Vasa Creek Basin	Moderate Gradient, Mixed Control
E Tributary Vase Creek Tributary 1	Vasa Creek	Vasa Creek Basin	High Gradient, Contained
Vasa Creek Tributary 4	Vasa Creek	Vasa Creek Basin	High Gradient, Contained
West Tributary	Mercer Slough/Kelsey Creek	West Tributary Basin	Floodplain
0264A	Mercer Slough/Kelsey Creek	West Tributary Basin	Floodplain
Wilkins Creek	Wilkins Creek	Wilkins Creek Basin	High Gradient, Contained
Yarrow Creek	Yarrow Creek	Yarrow Creek Basin	Floodplain
Yarrow Creek Tributary 1	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
256	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
0256 Tributary 1	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
0256 Tributary 2	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
254	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
0254 Tributary 1	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
Yarrow Creek Tributary 4	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
Yarrow Creek Tributary 5	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
Yarrow Creek Tributary 6	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
Yarrow Creek Tributary 6 Tributary	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
Yarrow Creek Tributary 7	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
Yarrow Creek Tributary 8	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control
Yarrow Creek Tributary 8 Tributary	Yarrow Creek	Yarrow Creek Basin	Moderate Gradient, Mixed Control

Predicted fish species habitat use by channel type.
Rank 1 = high use, 2 = secondary use, 3 = negligible use.

	CHANNEL TYPE						
Salmonid Species	**Palustrine**	**Floodplain**	**Alluvial Fan**	**Large Contained**	**Moderate Gradient Mixed Control**	**Moderate Gradient Contained**	**High Gradient Contained**
Chinook	2	1	1	2	2	2	3
Coho	1	1	1	2	2	2	3
Sockeye	1	1	3	3	3	3	3
Chum	1	1	3	2	2	3	3
Pink	1	1	3	2	2	3	3
Steelhead	2	1	2	1	1	2	2
Sea-run Cutthroat	2	1	2	1	1	2	3
Bull trout	2	1	2	1	1	2	2

Source: R2 Resource Consultants, 2000