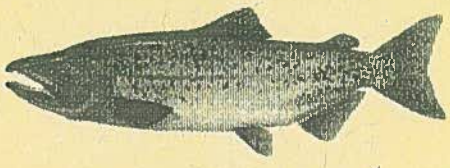
FINAL

Lakepointe Technical Report on Natural Resources

Section 3.0



Fisheries

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22140
27 April 1998

beak

FINAL
LAKEPOINTE TECHNICAL REPORT ON NATURAL RESOURCES

SECTION 3.0

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27 April 1998
Project No. 22140

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PREFACE

This revision to Chapter 3.0 of The Lakepointe Technical Report on Natural Resources was prepared in response to comments on the DEIS and as the result of subsequent consultations occurring during January and February 1998 with Washington Department of Fish and Wildlife, the Muckleshoot Indian Tribe and King County. This revision includes changes to the marina design in the Kenmore Inner Harbor and to related modifications to sections addressing aquatic resources and fish habitat near the Lakepointe site.

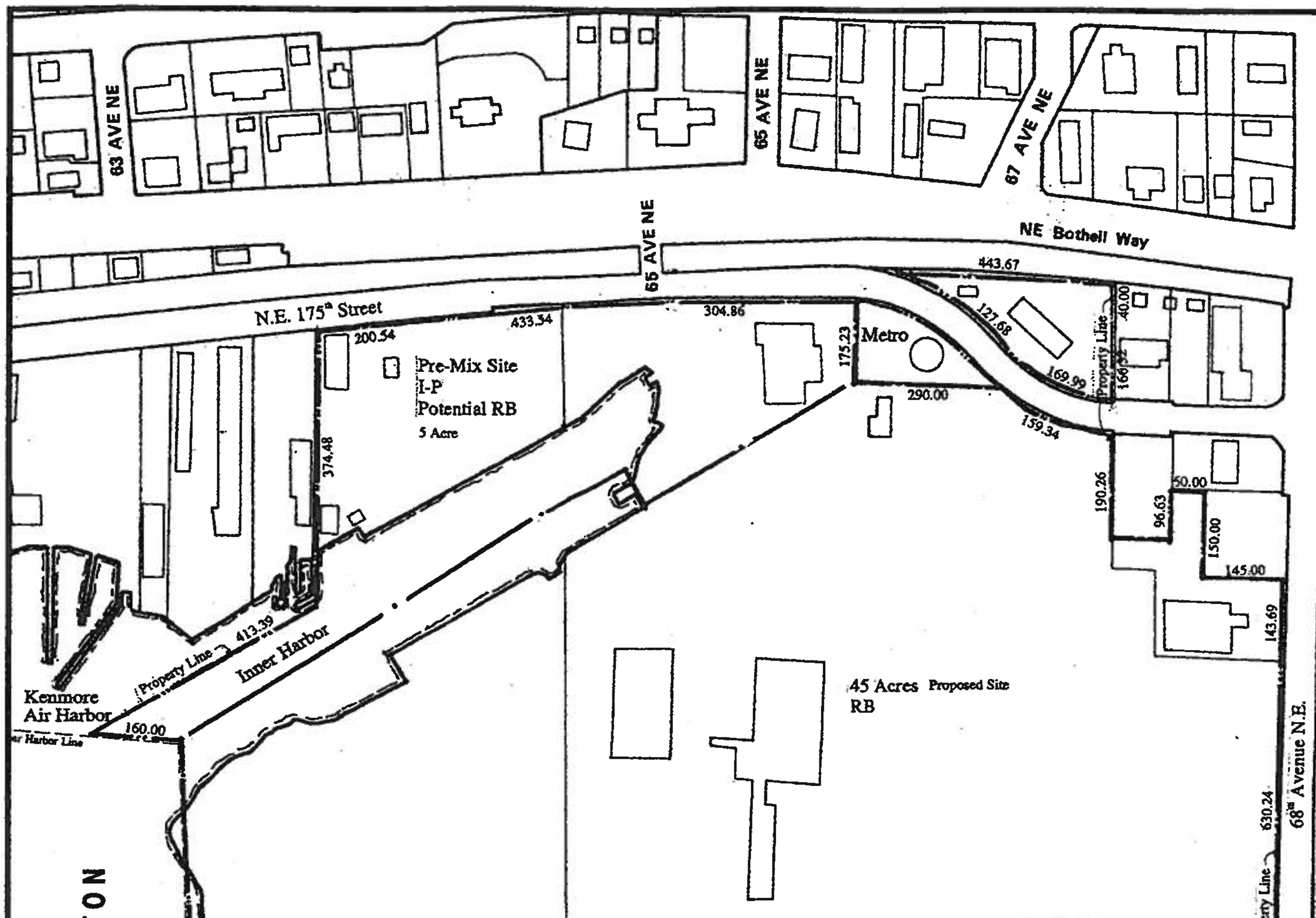
3.0 FISHERIES

3.1 AFFECTED ENVIRONMENT

The proposed Lakepointe development is a mixed-use community that combines professional office, retail and commercial space, residential units, park facilities and a private and public moorage marina. The project would be developed at the northeast end of Lake Washington on the property commonly known as the Kenmore Pre-mix site (Figure 3-1). The Kenmore Pre-mix site is a peninsula with water on its south, west and north sides. The south edge of the property forms the north bank of the Sammamish River where it enters Lake Washington. The west edge contains shallow, sloping Lake Washington beach habitat. A heavy industrial harbor (the "Inner Harbor") is currently located on the northern portion of the site.

The Kenmore Pre-mix property is currently used by various industries. Barges and tugs frequently enter and exit the Inner Harbor to unload sand and gravel at Kenmore Pre-mix located on the north shore of the Inner Harbor. The middle of the harbor is dredged to provide large boat and barge access. Small boat traffic is associated with the operations of Waterfront Construction, a business located along the south shore of the Inner Harbor. Fishing boats and large commercial vessels are also moored on the south shore. The majority of the property located south of the Inner Harbor contains large amounts of industrial solid waste that had been dumped on the site by businesses occupying the site.

Large-scale development of the site may affect fisheries resources, including the potential for predation on salmonid fishes as well as adverse effects on salmonid rearing and migration. A particular concern is the potential expansion of habitat for ambush predators, such as largemouth (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieui*), which may prey on juvenile salmonids. If ambient light conditions are increased by project lighting, that may also extend feeding periods for these predators. This evaluation compares existing and proposed conditions and evaluates effects of the project on salmonid fish resources and habitat in the area. Mitigation is proposed in response to anticipated impacts.



LAKEPOINTE
PIONEER TOWING COMPANY

FIGURE 3-1

THE PROPOSED LAKEPOINTE PROPERTY

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3.1.1 Species Use

Salmonid Fishes

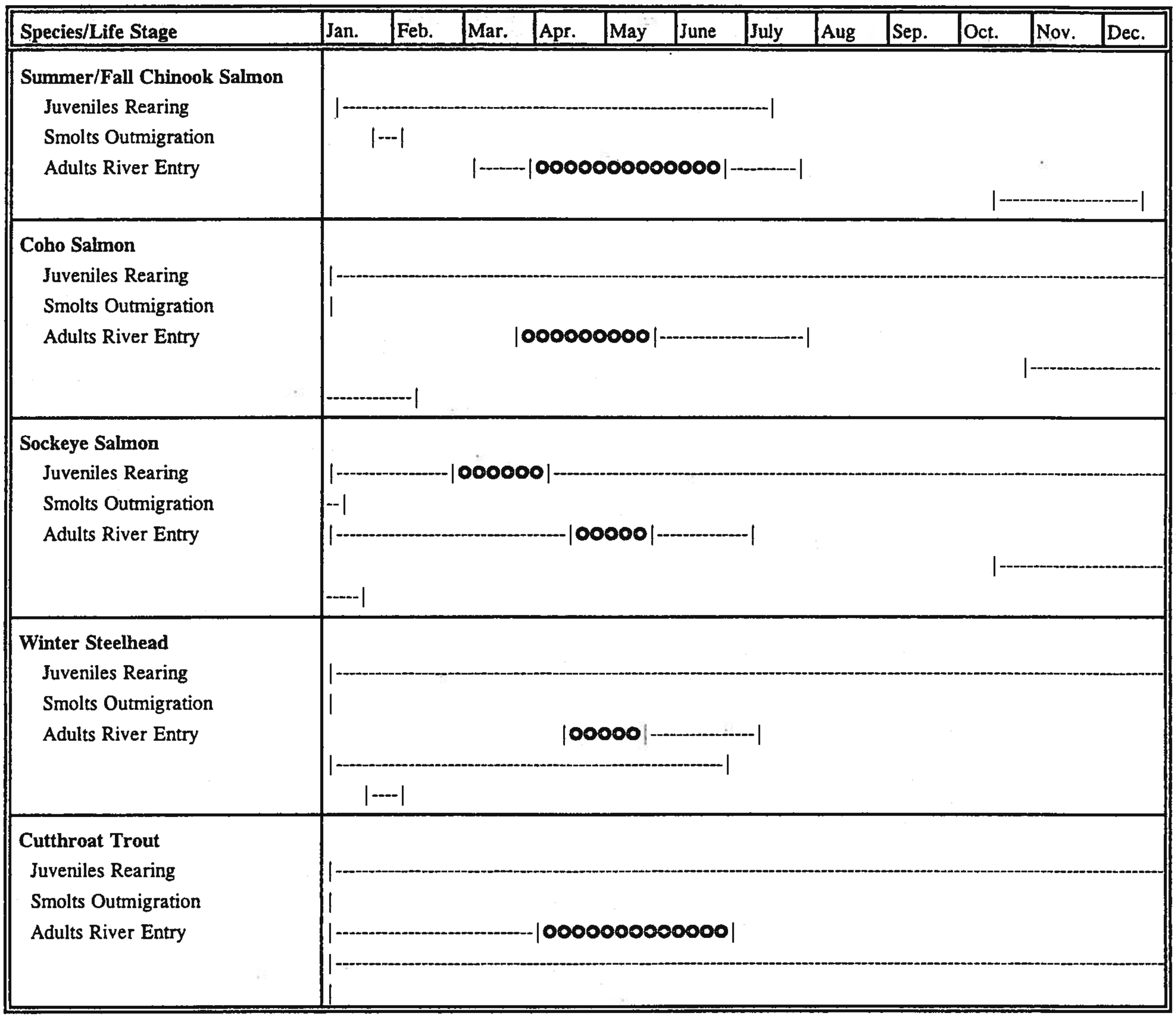
The Sammamish River basin supports a variety of anadromous salmonids, including chinook (*Onchorhynchus tshawytscha*), coho (*O. kisutch*), and sockeye salmon (*O. nerka*) and steelhead (*O. mykiss*) and cutthroat trout (*O. clarki*) (Williams et al. 1975; Washington Department of Fish and Wildlife et al. 1994). The Sammamish River system also supports runs of non-anadromous kokanee (*O. nerka*) salmon and ad-fluvial cutthroat trout (King County 1993). The mouth of the Sammamish River provides rearing habitat for salmonids and is a migration corridor for adult and juvenile salmon.

The majority of spawning and rearing of early life history stages of salmon and trout migrating past the Lakepointe site occurs in tributaries to the Sammamish River, and Lake Sammamish, including Issaquah, North, Swamp, Bear, Little Bear, Thorton, McAleer and Cottage Lake Creeks. Both natural and artificial production occurs in Issaquah Creek. Timing of the various life history stages of each species is shown in Figure 3-2 and described below.

Anadromous juveniles produced in this system emigrate through the Sammamish River, passing by the Kenmore Pre-mix property, before reaching Lake Washington. Washington Department of Fish and Wildlife (WDFW) personnel suspect that outmigrating juvenile salmonids may temporarily hold in the shallow beach area at the western edge of the Lakepointe Property before migrating through Lake Washington (Fisher, pers. comm., 5 January 1996).

Adult chinook salmon enter Lake Washington in early July and river entry and upstream spawning occurs from mid-September through October (Williams et al. 1975; Washington Department of Fish and Wildlife et al. 1994). Juvenile chinook generally rear in tributaries for three months before migrating to sea (Williams et al. 1975), but some juveniles in the Lake Washington system may remain in freshwater for longer periods given the rearing environment provided by the lake (Wydoski and Whitney 1979). Seaward migration occurs from early March to early July (Williams et al. 1975; Martz. et al. 1996).

Figure 3-2. Temporal presence of salmonids at various life stages in the vicinity of the Lakepointe project. Adult presence corresponds to Sammamish river entry.



Sources:
Williams et al. 1975 (WRIA 08); Washington Department of Fish and Wildlife et al. 1994; Wydoski and Whitney 1979, Martz et al. 1996a.
|O| peak period of downstream movement.

Adult coho salmon enter Lake Washington as early as August (Williams et al. 1975). River entry and spawning in north Lake Washington tributaries occurs from late October to mid-December (Washington Department of Fish and Wildlife et al. 1994). Coho juveniles rear throughout the year in Lake Washington and its tributaries. Coho smolts migrate to sea between early March and early July (Williams et al. 1975).

Adult sockeye enter Lake Washington in mid-June and the river entry and spawning in Lake Washington/Sammamish tributaries takes place from early September through November (Williams et al. 1975; Wydoski and Whitney 1979; Washington Department of Fish and Wildlife et al. 1994). Lake Washington shoreline spawning occurs between November and mid-January (Wydoski and Whitney 1979; Washington Department of Fish and Wildlife et al. 1994). Sockeye produced in tributaries migrate to the lake between January and April, with the peak of outmigration occurring from late February to mid-March. Sockeye juveniles rear in the lake for one year or more before migrating to the sea from January to late June with the peak smolt migration occurring late April to mid-May (Martz et al. 1996a).

Adult steelhead enter Lake Washington in mid-December and spawning in lake tributaries takes place from early March to early June (Washington Department of Fish and Wildlife et al. 1994). Steelhead juveniles typically rear in streams for one to three years. Seaward migration of smolts occurs from April through June, with the peak of outmigration taking place in mid-April (Wydoski and Whitney 1979).

Both anadromous and resident forms of cutthroat trout exist in the Lake Washington basin (King County 1993). Some residents may spend their entire lives in the same stream, others may grow to maturity in Lake Washington and return to the streams where they were born to spawn. Sea-run cutthroat spawn from late December to February, whereas resident cutthroat typically spawn from April to early May. Seaward migration of smolts occurs from January through June, but the majority migrate from April through June (Wydoski and Whitney 1979).

The timing of juvenile salmon entry into Lake Washington for the various species is a function of stream temperatures during and after egg incubation, food supply, population density, and other abiotic and biotic factors. The spring smolt outmigration period for most species generally lasts through the month of June (Figure 3-2).

The size at migration of juvenile salmonids varies between species and among stocks within a population. Fry typically enter the lower Sammamish River and Lake Washington at a relatively small size. The salmon fry are weak swimmers compared to larger yearling outmigrants and are particularly susceptible to predation.

Salmon and Steelhead Stock Inventory

The Washington Department of Fish and Wildlife and western Washington treaty tribes jointly assembled specific information for the Lake Washington basin in developing a Washington State Salmon and Steelhead Stock Inventory (SASSI). The current status of salmon and steelhead stocks in the basin was evaluated as of 1992 (Washington Department of Fish and Wildlife et al. 1994) as summarized in Table 3-1 and described below:

Chinook Salmon: Three stocks of summer-fall run chinook salmon have been identified by state and tribal biologists in the Lake Washington System (Washington Department of Fish and Wildlife et al. 1994); including the Issaquah Creek, the Cedar River, and the North Lake Washington tributary chinook stocks. The status of the Issaquah Creek stock is healthy and this stock is supported by hatchery production. The status of the other native stocks are unknown. Chinook in the Lake Washington System are managed by WDFW and the tribes as a single unit. Escapement goals in the Lake Washington System for naturally produced fish have been set at 1,550 adult chinook per year. Escapement goals have not been met since 1987 and have dropped below 800 adults since 1990 (Washington Department of Fish and Wildlife et al. 1994).

Coho Salmon: There are two stocks of coho salmon identified in the Lake Washington System, including the Lake Washington/Sammamish tributaries, and the Cedar River stocks (Washington Department of Fish and Wildlife et al. 1994). The status of the Lake Washington/Sammamish River stock is depressed, while the Cedar River stock is healthy. Both of these stocks are of mixed (native & non-native) production. The total natural escapement goal is set at 15,000 fish per year by WDFW and the tribes. Escapement goals have not been met since 1978. Due to a severe short-term decline in escapement the Lake Washington/Sammamish tributary stock has been classified as depressed. Hatchery and harvest management emphasis in the basin has precluded compliance with the escapement goal for naturally spawning coho (Washington Department of Fish and Wildlife et al. 1994).

Table 3-1. Summary of SASSI information for anadromous stocks of salmonid fish stocks in Lake Washington.

SPECIES	STOCK	STOCK STATUS	STOCK ORIGIN
Summer/fall chinook	Issaquah Creek	Healthy	Non-native
Summer/fall chinook	North Lake Washington tributaries	Unknown	Native
Summer/fall chinook	Cedar River	Unknown	Native
Coho	Lake Washington Sammamish River tributaries	Depressed	Mixed
Coho	Cedar River	Healthy	Mixed
Sockeye	Lake Washington Sammamish River tributaries	Depressed	Unknown
Sockeye	Lake Washington Beach spawning	Depressed	Unknown
Sockeye	Cedar River	Depressed	Non-native
Winter Steelhead	Lake Washington	Depressed	Native

Sockeye Salmon: There are three stocks of Sockeye salmon identified in the Lake Washington basin, including the Cedar River, Lake Washington/Sammamish Tributaries and Lake Washington beach spawning. Sockeye were introduced into Lake Washington in 1935 from descendants of the Baker River stock and planting of sockeye in the lake continued until the early 1960's. There is some evidence the beach spawning and northern tributary spawners may have been native but their stock origin is classified as unknown (Washington Department of Fish and Wildlife et al. 1994).

Typical of sockeye, the Lake Washington run size estimates have varied substantially over the years ranging between 98,000 and 621,000 fish. The best production years can produce an order of magnitude more returning fish than poor years. Approximately 70 percent of these fish spawn in the Cedar River. The escapement goal of 350,000 sockeye was met in 1988 and again in recent years. However, all three stocks are considered depressed based on declining escapements with four of five recent years run sizes below 100,000 fish.

Steelhead Trout: No summer and only one winter steelhead stock has been identified in the Lake Washington basin. This stock is considered a distinct wild winter native steelhead run although hatchery smolts were also stocked in the lake between 1982 and 1992 (Washington Department of Fish and Wildlife et al. 1994). Wild winter steelhead escapement has ranged from 474 to 1,816 fish since 1983. An escapement goal of 1,600 wild winter steelhead was set for the Lake Washington System in 1985. Escapement since 1985 has averaged 868 fish and only exceeded the goal one time. The status of the stock is considered depressed.

Other Fish Species

Lake Washington also contains a wide variety of non-salmonid fish species, some of which are considered "warm water" species. Easy access to the Sammamish River from Lake Washington makes it likely that many of these lake species make at least temporary journeys into the river. Non-salmonid fish inhabiting Lake Washington and the Sammamish River are both native and non-native in origin, and include Pacific, river and western brook lamprey; speckled dace; three-spine stickleback; northern squawfish; yellow perch; black crappie; pumpkinseed; peamouth; brown bullhead; largemouth and smallmouth bass; largescale sucker; tench; and prickly sculpin (Wydoski and Whitney 1979; Pfeifer and Weinheimer 1992; King County 1993).

The greatest predation rates on juvenile salmonids in Lake Washington are likely from other adult and pre-smolt salmonids fishes, primarily resident cutthroat and rainbow trout (Beauchamp et al. 1992; Beauchamp 1994, Tabor and Chan 1996b). However, some warm water species may also occasionally prey on juvenile salmonids including, northern squawfish, largemouth and smallmouth bass, pumpkinseed, black cappie, catfish, prickly scuplin, brown bullhead and yellow perch. Of these piscivores, the squawfish, bass and sculpin are thought to offer the greatest potential to occasionally prey on small salmonid outmigrants in Lake Washington (Forester 1968; Stein 1970; Bartoo 1972; Olney 1975; Eggers 1978; Eggers et al. 1978; Tabor and Chan 1996b; Martz et al 1996a,b; Fayram 1996).

Threatened, Endangered and Candidate Species

Listed species

There are presently no aquatic species in the Lake Washington/Sammamish River System listed as threatened or endangered under the federal Endangered Species Act (ESA) or under the Washington Administrative Code (WAC 232-12-297). Several Pacific Salmon species are currently under review for listing and Puget Sound fall chinook were formally proposed for listing as a threatened species on February 1998 by National Marine Fisheries Service (NMFS). It is possible one or more of the salmon species will be listed by 1999.

Candidate Species

Candidate species are species that may be proposed or are under review for possible future listing as a threatened or endangered species. Three of the anadromous fish species that are present near the site including coho, and chinook salmon and sea-run coastal cutthroat trout are under further review for possible listing under the federal ESA (Table 3-2).

The Washington State Department of Fish and Wildlife publishes a state Species of Special Concern (SSC) list that includes native Washington species listed as State Endangered, State Threatened, State Sensitive, or State Candidate as established by Washington Administrative Code (WAC 232-12-297), as well as species listed or proposed for listing under the federal ESA (discussed in the previous section). Currently, there are no additional Lake Washington fish species on the state SSC list that are not included in the federal list.

Table 3-2. Federal ESA listing status for aquatic species of concern in the Snohomish River system.

SPECIES	FEDERAL ESA STATUS
Chinook salmon	Under review for listing; Proposed Threatened
Coho salmon	Under review for listing
Sockeye	Not Proposed for listing
Sea-run cutthroat trout	Under review for listing
Pacific lamprey	Species of Concern
River lamprey	Species of Concern
Bull trout	Species of Concern

3.1.2 Study Methods

To evaluate potential effects of the Lakepointe development on fisheries resources, physical and biological surveys of the site were completed using the EIS scope of work agreement as a guideline (King County 1996). Surveys of the physical characteristics of the site were conducted in January 1996. Biological surveys were completed in the spring and early summer of 1996 and in the spring of 1997. A description of the physical and biological methods and results is provided below.

Surveys of the physical and biological characteristics of shoreline areas along the Kenmore Pre-mix property were designed to establish baseline conditions. These data aid in the assessment of potential project impacts, and allow project proponents, resource agencies and tribes to minimize impacts to fisheries resources.

<u>Physical Sampling Program</u>

The objective of the physical surveys was to characterize existing shoreline habitats. This characterization described industrial shoreline treatments, substrate and vegetation types, the number and location of artificial in-water structures that may serve as salmonid-predator habitat, and the area of open water that is covered by an artificial structure ("shaded" open water). Survey design was modified from criteria for King County Level III stream surveys (King County 1995).

Physical survey transects were established approximately every 150 feet (50 meters) along the north bank of the Sammamish River from the Juanita Drive NE/68th Avenue Bridge to the Lake Washington confluence [a distance of ≈ 2000 feet (600 m)] and along the Lake Washington shoreline on the western property boundary shoreline [distance ≈ 525 feet (160 m)]. On 3 January 1996, data were collected at each transect characterizing substrates, riparian vegetation, nearshore topography, water depths, nearshore fish habitat, and the location and number of significant in-water structures. Between transects, riparian vegetation, nearshore fish habitat, and the location and number of significant in-water structures were described.

On 12 January and 21 August 1996 shoreline surveys of the Inner Harbor were made, describing substrate and riparian vegetation types, total linear feet of bulkhead, number and location of significant in-water structures, area of temporary floating structure, and area of shoreline overhang. Snorkeling was performed on 26 May 1996 to inventory underwater structures in the Inner Harbor, the Lake Washington shoreline, and the Sammamish River.

Biological Sampling Program

Spring 1996

Electrofishing

The biological surveys were designed to describe fish use in littoral areas (0-50 ft. [0-15 m] from shoreline, depending on water depth) along the Kenmore Pre-mix site. The degree of salmonid fry use of nearshore areas surrounding the proposed Lakepointe development was estimated by nighttime electrofishing using a backpack-mounted Smith-Root model 15B programmable electrofisher. Stunned fish were collected using 0.4 m x 0.6 m dip nets with 3 mm mesh. All collected fish were identified to species; lengths to the nearest 5 mm and any external abnormalities were recorded. Data were primarily collected by nighttime electrofishing but were supplemented by ancillary surveys, including: nighttime seining, daytime electrofishing, and daytime snorkeling. Nighttime electrofishing was the primary method of fish sampling because salmonid fry are more likely to migrate downstream and use nearshore areas under the cover of darkness (Foerster 1968; Burgner 1991; Healey 1991). Sampling during a full moon was avoided because bright moonlight has been shown to influence the downstream migration of salmonids (Pritchard 1944; Kobayashi 1960; Reimers 1971).

Nighttime electrofishing began one hour after sunset and was performed approximately every two weeks from late March through mid-June. This period coincided with the peak outmigration of naturally spawned salmonids in the Sammamish River system and the releases of hatchery-spawned coho and chinook salmon from the Issaquah Salmon Hatchery (Table 3-3).

Table 3-3. Issaquah Salmon Hatchery releases of young chinook and coho salmon into Issaquah Creek in 1996.

Date Released	Age and species	Number released	Fork Length (mm)
02/08/96*	yearling coho	100,000	125
03/06/96	subyearling coho	169,000	32
03/20/96	subyearling coho	163,000	38
03/20/96	subyearling chinook	158,000	42
04/15/96	yearling coho	436,000	135
05/06/96	subyearling coho	202,000	88
05/24/96	subyearling chinook	1,000,000	80
06/03/96 and 06/05/96	subyearling chinook	1,033,000	80

*Fish released as a result of heavy February rainfall that flooded holding pond.
Source: Issaquah Salmon Hatchery, pers. comm., 15 August 1996.

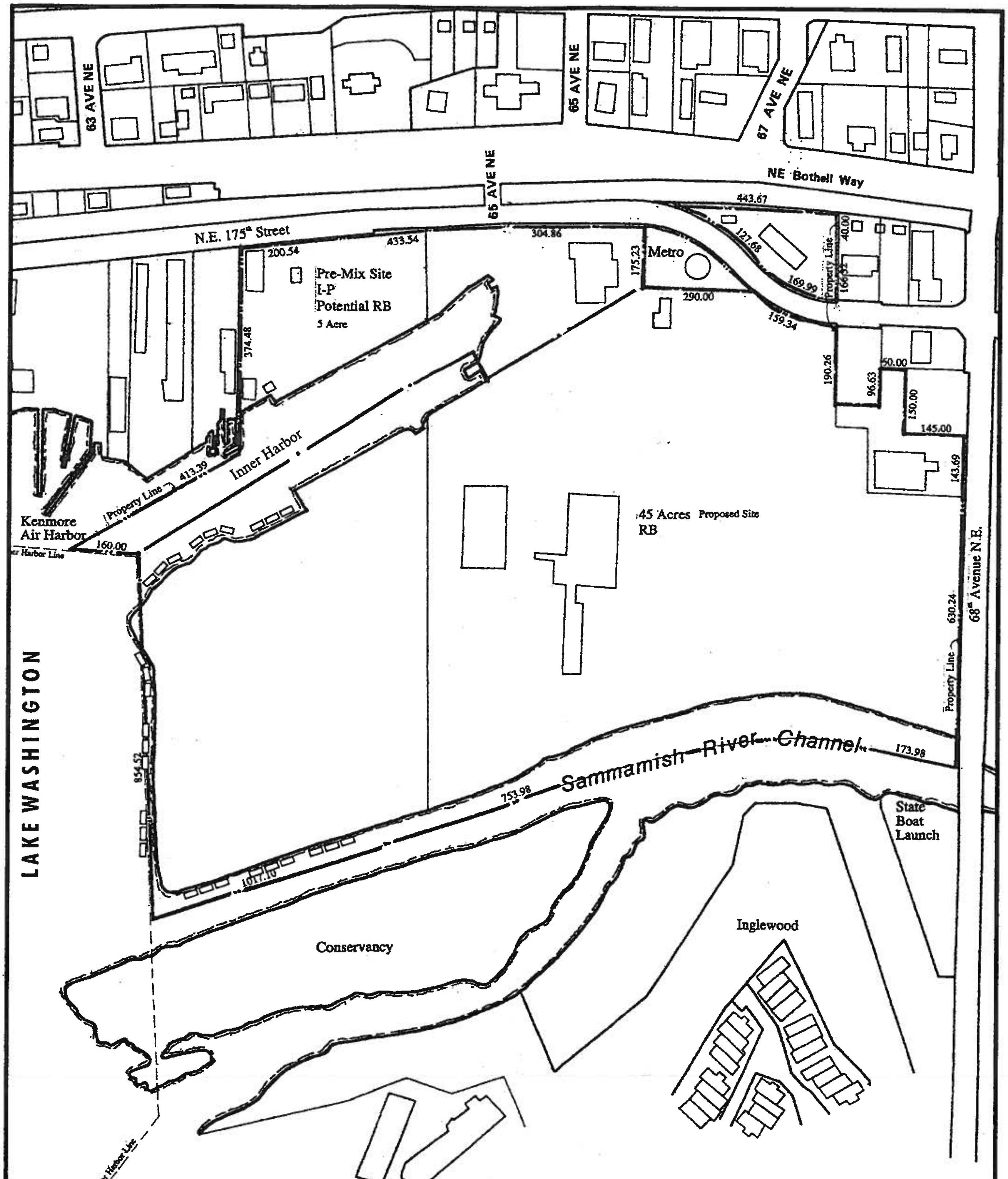
Water temperature, Secchi depth, and observations of avian predators were recorded at sunset prior to each evening survey. While taking physical measurements, shoreline areas were visually checked for schooling salmonids. Backpack electrofishing was performed in 1996 only when water transparency measurements (Secchi depth) exceeded 3.0 feet, permitting the most successful collection of stunned fish.

Electrofishing was conducted in three general areas: 1) on the north bank of the Sammamish River to a point approximately 980 feet (300 meters) upstream from its confluence with Lake Washington; 2) on the shoreline of Lake Washington between the Sammamish River and the Inner Harbor; and 3) along the south shore of the Inner Harbor, west of the westernmost bulkhead. Three sites in the Inner Harbor, three sites along the Lake Washington shoreline, and three sites along the north shore of the Sammamish River were sampled (Figure 3-3).

Electrofishing was performed parallel to the shoreline and covered areas within four meters of the shoreline in the Sammamish River and the Inner Harbor, depending on water depth. Areas electrofished along Lake Washington extended from the shoreline to a distance of up to 50 feet (15 meters) from shore due to the shallow character of the beach. Nearshore habitat sampled along the lakeshore and Sammamish River included areas with overhanging vegetation, undercut banks, and submerged and emergent wooden pilings. Nearshore habitat sampled in the Inner Harbor included areas underneath floating structures and under shoreline overhangs. Each of the nine sites was electroshocked for approximately 4 minutes.

Beach Seining

Concurrent with the evening electrofishing surveys, beach seining was conducted using a 21 m x 1.2 m net with 3 mm Ace mesh. Due to the potential for net snagging, seining was necessarily restricted to sites that contained relatively few pieces of underwater debris. In Lake Washington, seining was conducted at the north end of the shoreline, where the seine was set with two people approximately 100 feet (30m) from shore and then pulled perpendicular to shore. In the Sammamish River, seining was performed approximately 900 feet (275 m) west of the Juanita Drive NE bridge where the seine was set with two people approximately 20 feet (6 m) from the bank and then pulled at a 45° angle to the bank. No locations in the Inner Harbor were accessible to beach seines. All fish collected from the Lake Washington shoreline and the Sammamish River were identified to species; lengths and any external abnormalities were recorded.



Electrofishing Sites

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LAKEPOINTE
PIONEER TOWING COMPANY

FIGURE 3-3
THE PROPOSED LAKEPOINTE PROPERTY, SHOWING ELECTROFISHING SITES IN THE INNER HARBOR, THE SAMMAMISH RIVER & LAKE WASHINGTON-1996

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Snorkeling

Daytime snorkeling of the Inner Harbor, the Lake Washington shoreline and the north bank of the Sammamish River was performed once in late-May when water transparency was sufficient for accurate fish observation and species identification. Snorkeling supplemented the daytime electrofishing surveys and documented daytime fish use of nearshore areas. It also completed the inventory of any underwater structures that were not observed during the physical surveys conducted in winter.

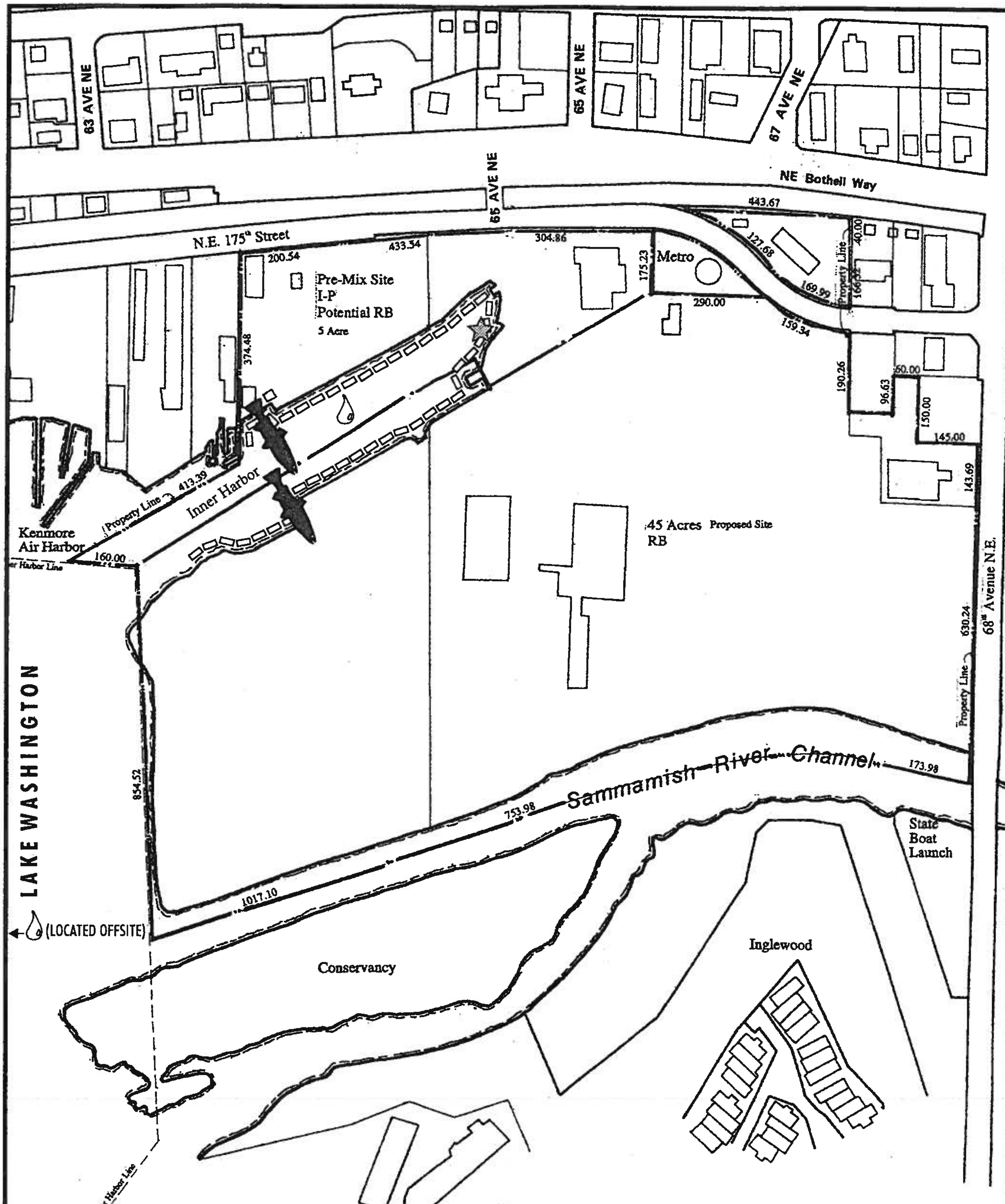
Spring 1997

Additional physical and biological sampling was performed on a limited basis during the 1997 spring outmigration period to improve the understanding of fish utilization of deep water habitats in the Inner Harbor and to further identify the period of possible temporal and spatial overlap between juvenile salmonids and large predators such as squawfish and bass. Water quality and temperature measurements and various fish sampling methods were employed as described below:

Water Quality and Temperature Monitoring

Continuous temperature monitoring was designed to increase understanding of the range of temperatures in the Inner Harbor during a period of potential temporal overlap between outmigrating juvenile salmonids and predator species. Two continuous thermographs, one located just under the waters surface and one located near the bottom, were installed in the eastern corner of the Inner Harbor (Figure 3-4). The thermographs were submersed on 29 April 1997 at 2040 hours and were removed from the water on 20 May 1997 at 1030 hours. The thermographs were programmed to record instantaneous water temperatures every 30 minutes.

Prior to installation of the thermographs, temperature and dissolved oxygen profiles were taken in the Inner Harbor on 16 and 25 April 1997 with a YSI meter and a Hydrolab Scout, respectively. Profiles were monitored from bulkheads or other floating structures along the south shoreline at three different points (easternmost, center and westernmost points of the south shoreline). Similarly, in association with biological surveys performed on 29 April, 12 May and 19 May 1997, temperature, dissolved oxygen, pH, and conductivity profiles (top to bottom) were



Continuous Recording Thermograph

Gillnetting Sites

Electrofishing Area

Temperature and Water Quality Profile Stations

N

LAKEPOINTE

PIONEER TOWING COMPANY

FIGURE 3.4

THE PROPOSED LAKEPOINTE PROPERTY, SHOWING LOCATION OF WATER QUALITY & FISHERIES SAMPLING STATIONS IN THE INNER HARBOR - 1997

PROJECT NO.: 22140	28 MAY 1997
2140-34.CDR/VGP	CHECKED: EBK

beak

measured at 1 foot intervals with a Hydrolab Scout in the Inner Harbor and in Lake Washington near Metro monitoring station 0804. Water transparency was also measured with a secchi disk these locations prior to each electrofishing survey.

Electrofishing

Salmonids and predators were sampled in the Inner Harbor using a boat electrofisher. Electrofishing occurred parallel to and as close to the shoreline as possible (Figure 3.4). The entire perimeter of the harbor was surveyed to the extent possible. Surveys were limited by floating and submerged structures and the location of various vessels. Areas adjacent to existing bulkheads, floating structure and emergent piling structure were specifically targeted for sampling. Electrofishing occurred on 29 April, 12 May, and 19 May 1997. This period followed a large release of subyearling coho salmon fry from the Issaquah Salmon Hatchery (Table 3-4). Sampling occurred at night, starting at approximately one hour after sunset.

Table 3-4. Issaquah Salmon Hatchery releases of young coho salmon into the Lake Washington Basin, February through June, 1997.

Date Released	Age and species	Number released	Mean Length (mm)
2/18/97	subyearling coho	370,900	32
2/24/97	subyearling coho	349,920	32
3/10/97	subyearling coho	49,900	32
4/07/97 thru 4/14/97	yearling coho	505,216	124
4/23/97 thru 4/28/97	subyearling coho	1,297,544	45-50
5/25/97 thru 5/30/97	subyearling chinook	1,121,000	90
6/02/97 thru 6/03/97	subyearling chinook	573,052	87
6/17/97	subyearling coho	79,900	73

Source: Issaquah Salmon Hatchery, pers. comm., 23 May 1997 and 18 March 1998.

Electrofishing was conducted at sub-lethal levels. Stunned fish were collected, identified, measured and their condition examined. Stomach contents of a representative number of predator species were analyzed to assess prey item frequency.

Gillnetting

Floating and sinking variable mesh gill nets were used as an ancillary method to sample predator populations. Mesh size ranged from 1.5 to 5-inch stretch mesh. The placement of gillnets was largely dictated by boat and barge traffic. Gillnets were deployed perpendicular to the shoreline in two locations where the nets would not (or only temporarily) extend into shipping lanes.

The floating gillnet was set immediately west of the burned wooden platform located along the north shore of the Inner Harbor (Figure 3-4). After deployment, the floating gillnet extended into the direct path of barges and tugs entering and exiting the Inner Harbor. Because of barge and tug activity scheduled after dark in the Inner Harbor, the floating gillnet was not left overnight on any of the sampling dates. The floating gillnet was set at sunset and retrieved after the night's electrofishing was completed. The floating gillnet fished from two to four hours before retrieval.

The sinking gillnet was set immediately west of the timber bulkhead located along the south shore of the Inner Harbor. The sinking gillnet was set just before sunset, left overnight (since it was not in the direct path of barge or boat traffic), and retrieved the following morning.

The sinking gillnet was set in relatively deeper water than the floating gillnet to ensure deep waters of the Inner Harbor were sampled. Both gillnets were set so panels with the largest mesh were in the deepest water. This orientation increased chances of capturing adult predators known to inhabit deep waters. All fish caught in the gillnets were enumerated and measured. A representative number of salmonid predator species were kept for stomach content analyses.

Stomach Content Analyses

Salmonid predators kept following electrofishing and gillnetting were examined as soon as possible after collection (usually the afternoon following collection). Fish were eviscerated and stomach and anterior gut segments were removed by dissection and placed into a dissection pan.

Stomachs and anterior gut segments were cut open lengthwise and their contents removed. Gut analysis specifically looked for the presence of salmonids in stomach contents. No other food items were enumerated.

Literature Review

Biological surveys were supplemented with a review of published literature concerning life histories, habitat preferences and behavioral response of fish species present in the lower Sammamish River and/or the northeast end of Lake Washington. The review specifically included literature discussing the interactions between bass, squawfish, other piscivorous fish and salmonid fry, and the seasonal distribution of fish species at piers and bulkheads.

Applicability of literature to the site varies with respect to the species, life-history stage and water characteristics in question and should be interpreted with the following priority wherever possible:

Highest	Freshwater lake	- Northeast end of Lake Washington
Applicability	Freshwater lake	- Other areas of Lake Washington
↓	Freshwater lake	- Other Regional lakes
↓	Freshwater lake	- Lakes outside the region
↓	Freshwater Reservoirs	- Pacific Northwest
Lowest	Estuaries	- Puget Sound
Applicability	Marine Waters	- Puget Sound

Use of the literature for site applicability requires assumptions in all cases, as described with the appropriate text in subsequent sections.

3.1.3 Results

Results of the physical, and biological sampling efforts conducted during 1996 are presented in this section in accordance with the three habitat types surrounding the Kenmore Pre-mix site; the industrialized Inner Harbor, the shallow sloping Lake Washington beach habitat and the north bank of the Sammamish River. Results of additional biological and chemical sampling that occurred in the Spring of 1997 are incorporated in the Inner Harbor characterization.

Inner Harbor Characterization

Physical Conditions

The middle of the Inner Harbor is dredged to allow access for barges. As a result, water depth drops sharply from the shoreline towards the center of the harbor. Water depth at the edge of existing bulkheads ranges from 15 to 17 feet at ordinary high water. Depth contours of the Inner Harbor are portrayed in Figure 3-5. Representative cross section profiles of the southwest shore (west of bulkhead) of the Inner Harbor are displayed in Figure 3-6. The southwest shore is the area of the Inner Harbor that has the most extensive littoral zone.

The substrate along the shoreline is characterized by soft to hard mud, with small patches of cobble and gravel. The cobble and gravel are fill or material that likely fell off barges during unloading operations at Kenmore Pre-mix. Blackberry bushes and reed canary grass dominate the riparian vegetation. The majority of the riparian zone of the Inner Harbor has been altered by shoreline treatments.

The majority (64%) of shoreline treatments along the Inner Harbor is bulkhead. Bulkhead is a vertical wall of concrete or wooden pilings creating an artificial shoreline. Bulkhead extends along portions of both shores of the Inner Harbor (Figure 3-5). The majority (55%) of bulkhead is located on the southeast shore (Table 3-5). The total length of bulkhead along the Inner Harbor is 1,131 feet (345 m). In some locations, water intrudes behind the bulkhead for an unknown distance. The material on the inside of the bulkhead is fill.

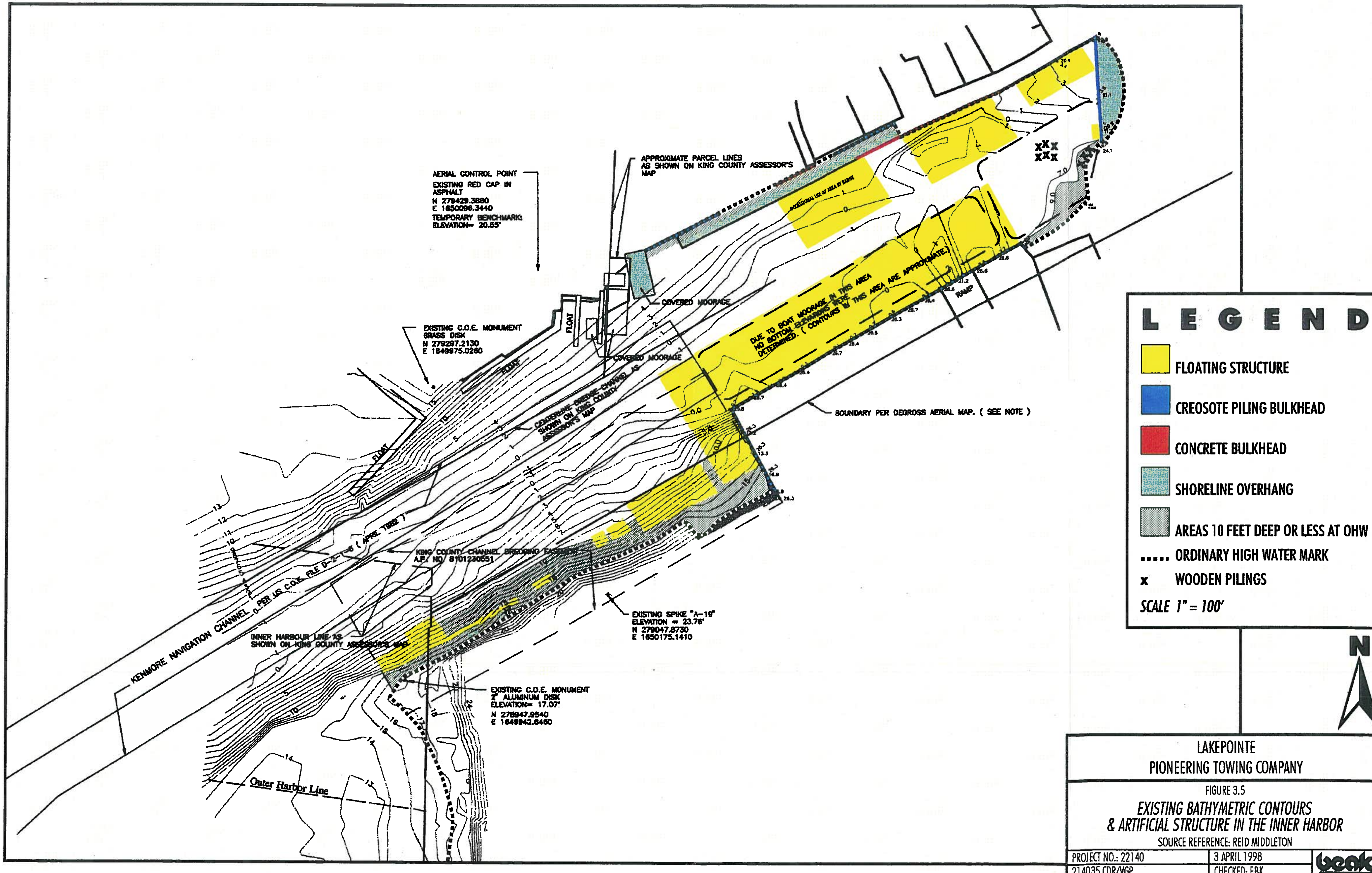


FIGURE 3.5
EXISTING BATHYMETRIC CONTOURS & ARTIFICIAL STRUCTURE IN THE INNER HARBOR
SOURCE REFERENCE: REID MIDDLETON

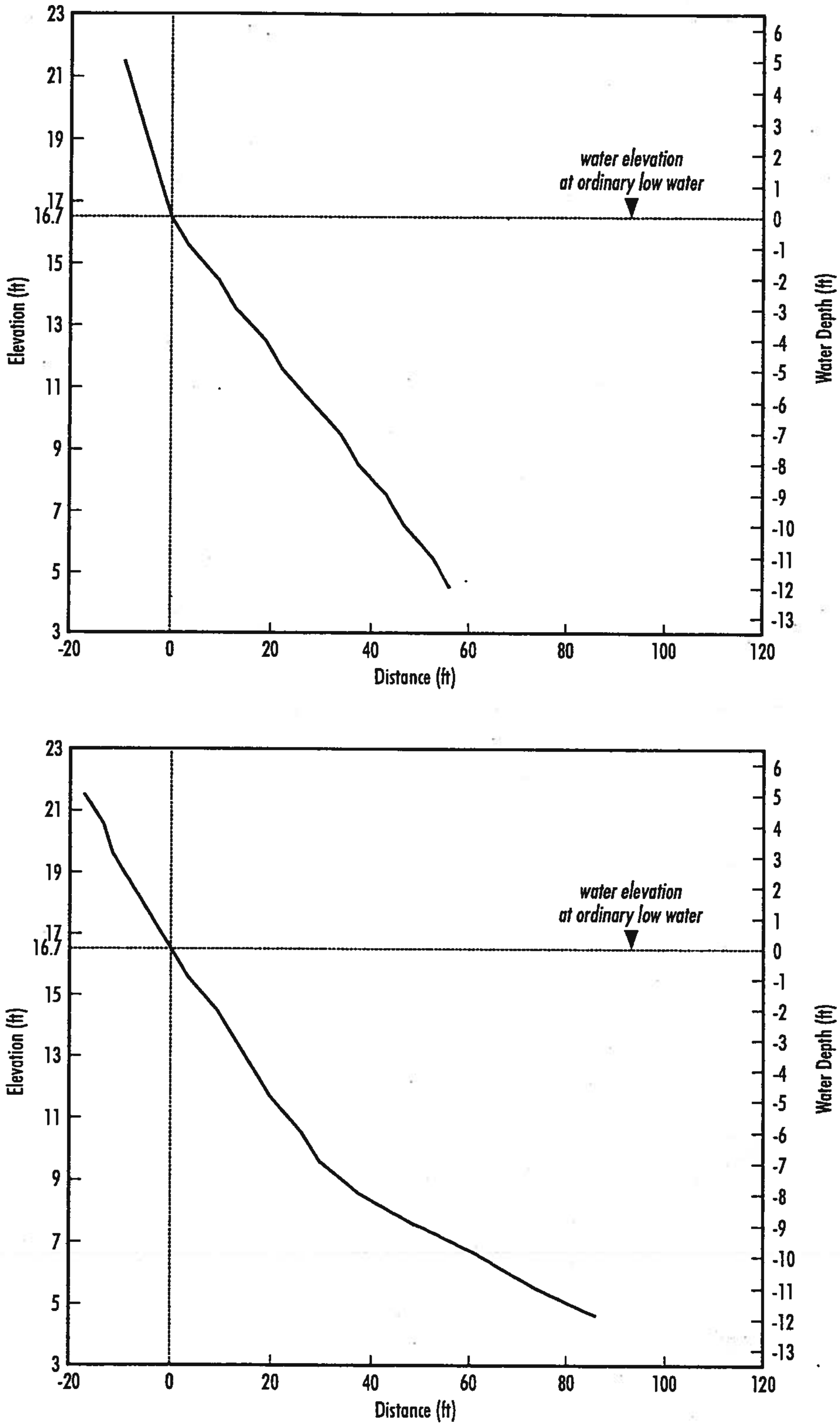


Figure 3-6. Cross-section profiles at two representative transects along the southwest shore of the Inner Harbor. Distances are relative to the waterline at ordinary low water (+16.7 ft. project datum; +20 ft. Mean Low Low Water USCOE datum). Elevations are relative to water surface at ordinary low water.

Table 3-5. Summary of measurements characterizing bulkhead in the Inner Harbor.

Bulkhead Description	Inner Harbor Location	Length (ft)
Creosote Timber (1-foot diameter)	Southeast Shore and East Corner	627 (191 m)
Creosote Timber (1-1.5-foot diameter)	Northeast Shore	200 (61 m)
Concrete (9.5x2x5-foot blocks)	Northeast Shore	250 (76 m)
Rotted Timber (1-foot diameter)	Northwest Shore	54 (16m)
Total		1,131 (345 m)

In addition to bulkhead, artificial overhangs also line the Inner Harbor. Shoreline overhang shades the water, making such habitat less biologically productive than unshaded areas of the Inner Harbor. The shoreline is covered by artificial structures in four areas (Figure 3-5). One shaded area occurs in the eastern corner, where a cement platform is fixed 1.5 feet above the water's surface at ordinary high water (Table 3-6). The cement overhang is supported by a row of vertical wooden pilings (1 foot in diameter) 0.5 feet apart. The estimated area of the Inner Harbor covered by this cement platform is 3,080 ft^2. Another source of shoreline overhang is an unused wooden platform and a covered boat moorage along the northwest shore of the Inner Harbor. The area of this shoreline overhang is 4,722 ft^2. Less prominent shoreline overhangs are located along the southwest shore of the Inner Harbor (Table 3-6).

Offshore in the Inner Harbor there are numerous fixed in-water structures (Figures 3-7 through Figure 3-11) that provide ambush habitat for salmonid predators. A total of 377 in-water vertical wooden pilings or pier supports are present (Figure 3-5). Of these, 258 emergent wooden pilings support the burned and unused wooden platform running parallel to the northshore of the Inner Harbor. The diameter of the pier supports is from 1 to 1.5 feet. The majority of the pilings are burned and in various stages of decay. Underneath the unused platform are 63 decayed bulkhead stumps. A total of 26 and 30 vertical wooden pilings are located in the southeast and northwest corners of the Inner Harbor, respectively. These 56 pilings do not support any structure.

Table 3-6. Summary of measurements characterizing artificial overhangs in the Inner Harbor.

Overhang Description	**Inner Harbor Location**	**Height (ft) Above Ordinary High Water**	**Shaded Water Area (ft^2) From Artificial Overhangs**
Cement Platform	East Corner	1.5	3,080 ($286m^2$)
Wooden Platform	Northwest Shore	7.5	3,426 ($318m^2$)
Covered Boat Moorage	Northwest Shore	1.5 to 2.0	1,296 ($120m^2$)
Steel Girders	Southwest Shore	1.5 to 2.0	345 ($32m^2$)
Wooden Ramp	Southwest Shore	1.0 to 1.5	140 ($13m^2$)
Wooden Platform	Southwest Shore	1.5 to 2.0	651 ($60m^2$)
Total			8,938 ($830m^2$)

Photo A

Photo B

Figure 3-7. Photos A and B) Existing nearshore floating and in-water structures in shallow water habitat along the southwest shore of the Inner Harbor.

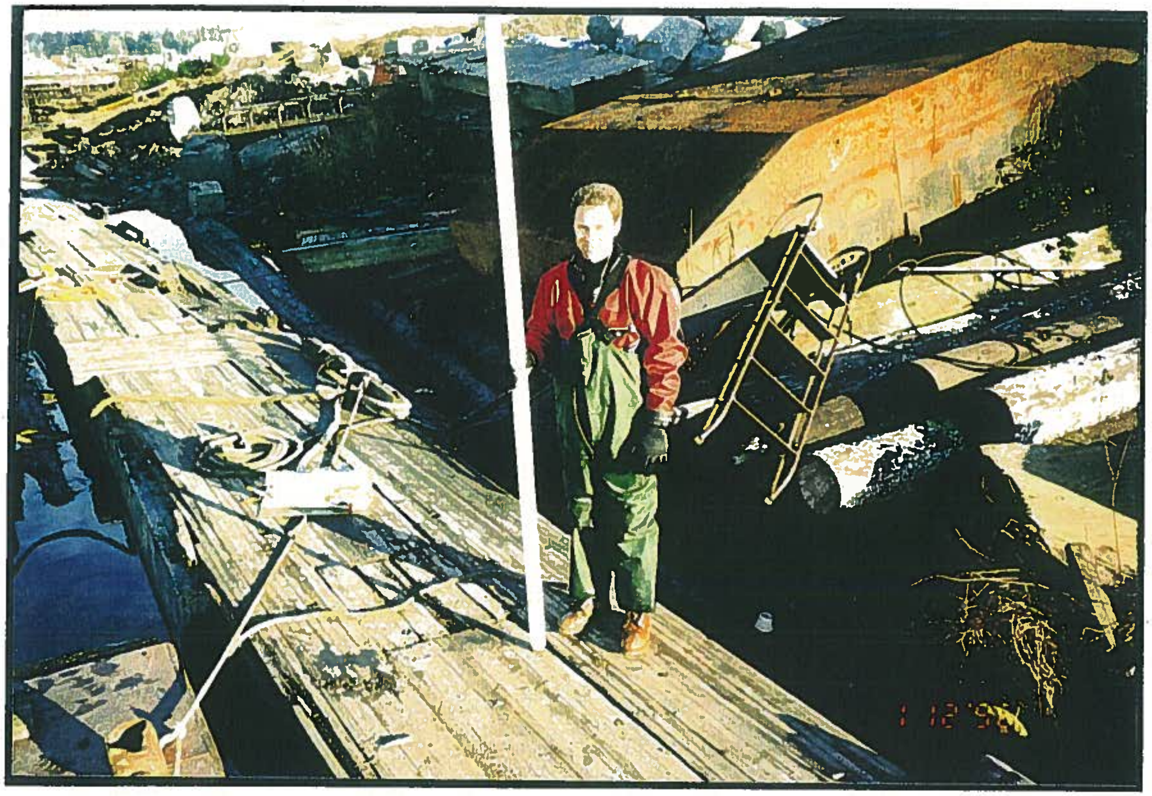


Photo A

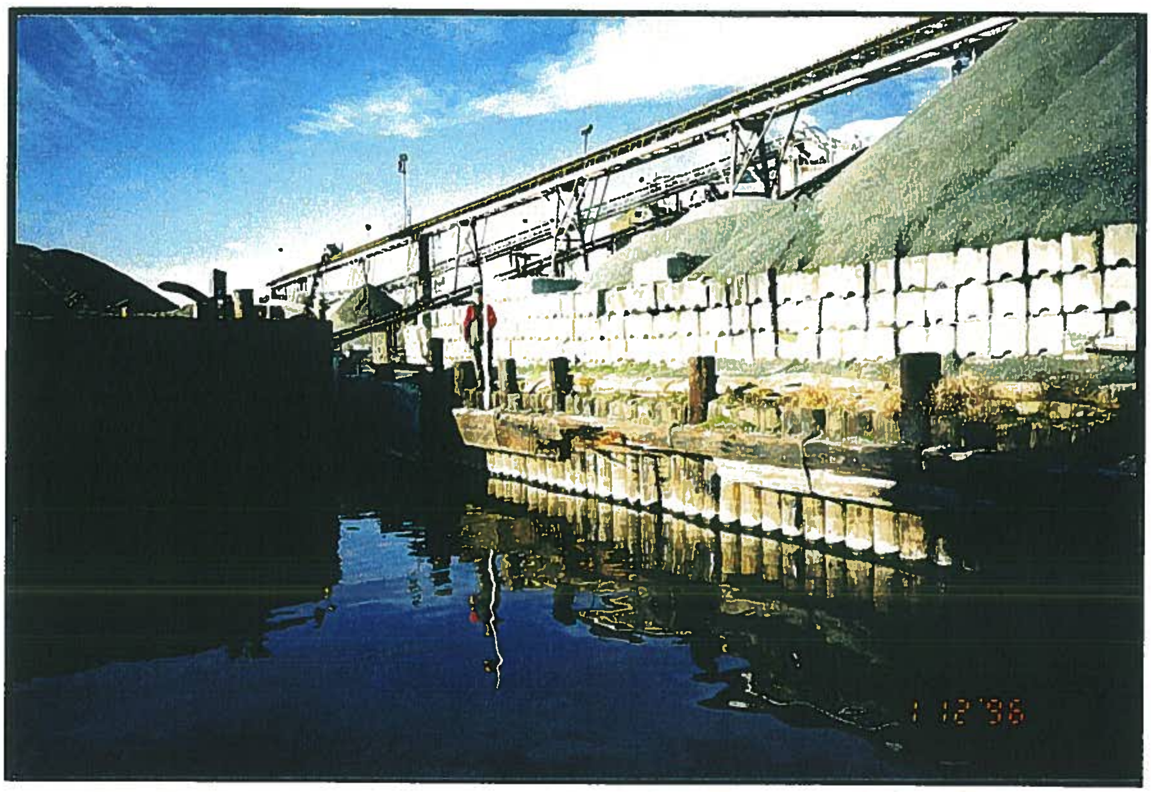


Photo B

Figure 3-8. Photo A) Existing floating walkway along southwest shore of Inner Harbor. Photo B) Existing timber bulkhead and barge offloading area at Kenmore Pre-Mix site along north shore of Inner Harbor.

Photo A

Photo B

Figure 3-9. Photo A) East Harbor bulkhead site showing existing water behind wooden piles and covered by a concrete apron. Photo B) Looking east along southwest shore of Inner Harbor showing existing areas of active fill, floating materials and commercial vessel berthing area B.

Photo A

Photo B

Figure 3-10. Photo A) Looking east along southwest shore of Inner Harbor showing existing areas of in-water structures, floating materials and commercial vessel berthing area B. Photo B) Looking west from eastern corner of the Inner Harbor showing tug and barge mooring and commercial vessel berthing area A.

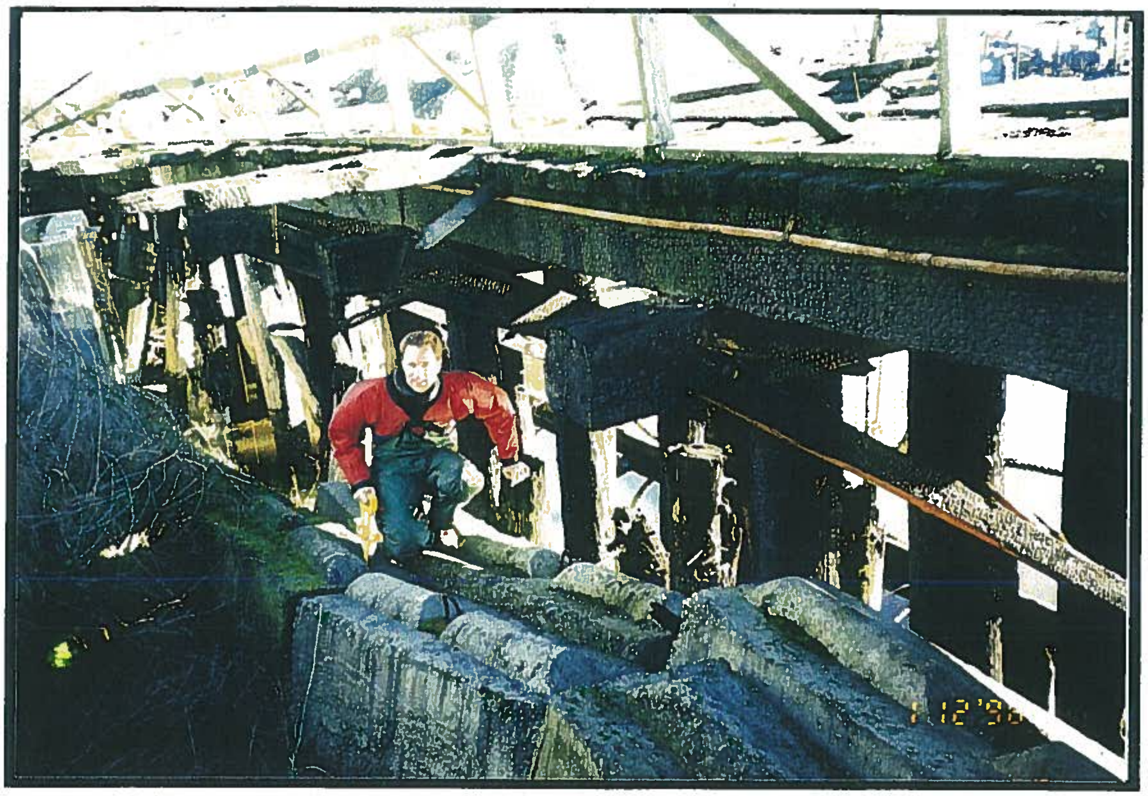


Photo A

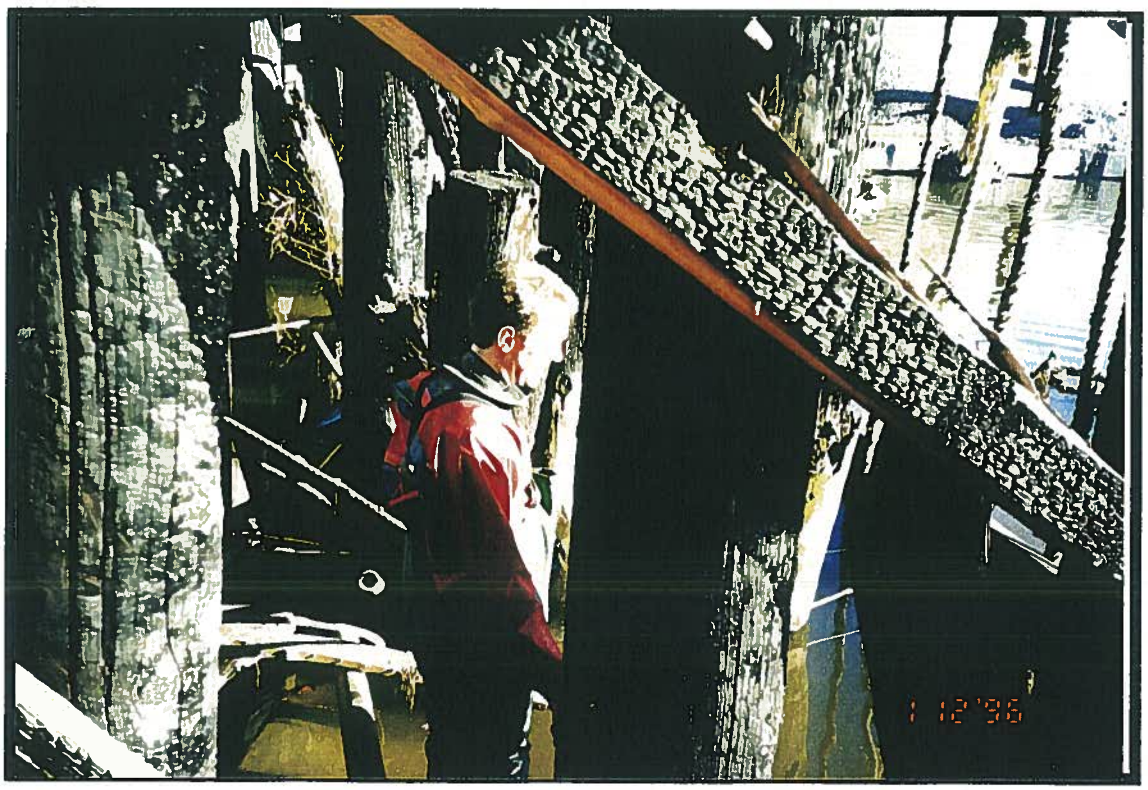


Photo B

Figure 3-11. Photo A) Looking southeast at concrete blocks and burned wooden platform along north bank of inner harbor. Photo B) Looking southeast at wooden piling supporting burned wooden platform along north bank of inner harbor.

In addition to the fixed structures, unfixed structures such as boats and other floating material are also present in the Inner Harbor (Table 3-7). Two barges, regularly used to transport gravel to Kenmore Pre-mix, are temporarily moored in the Inner Harbor, covering a 13,200 ft^2 area (Gleason, pers. comm., 26 August 1996). The barges are alternatively unloaded and moored in the Inner Harbor every two to four days. Because the barges are not always present, their operations are estimated to result in a 13,200 ft^2 area being occupied 50 percent of the year (annual shading equivalent of 6,600 ft^2). Likewise, large fishing boats and commercial vessels moored in the Inner Harbor are estimated to occupy a 39,317 ft^2 area 59 percent of the year for an annual shading equivalent of 23,048 ft^2 (Table 3-8). More permanent floating structure is located along the southwest shore of the Inner Harbor., totaling approximately 7,795 ft^2. However, the size of this floating island of material fluctuates depending on the operations of the Inner Harbor industries. The location of these floating structures is displayed in Figure 3-5.

Table 3-7. Summary of shade estimates from floating material in the Inner Harbor.

Description	**Inner Harbor Location**	**Shaded Water Area (ft^2) from Floating Materials**
Barges	Northeast Shore	6,600 (613m^2)*
Commercial vessels	Southeast Shore	23,048 (2,140m^2)*
Wooden Decking/Platform	Southwest Shore	5,740 (533m^2)
Hollow Metal Tubes	Southwest Shore	1,355 (126m^2)
Cabled Logs	Southwest Shore	400 (37m^2)
Unused Barge	Southwest Shore	300 (28m^2)
Total		37,443 (3480m^2)

*Annual shade equivalent (See text and Table 3-8 for calculation of area)

Table 3-8. List of Commercial Vessels moored in the Inner Harbor during Spring 1996, and estimates of Annual Shading Equivalents.

Vessel	Class	Estimated Size L (Ft.)	Estimated Size W (Ft.)	Shaded Area (Sq. Ft.)	Occupancy (%)	Annual Shading Estimate (Sq. Ft.)
Commercial Berthing Area A		375	80	30000	60	18000
Reliance	Drill Rig Supply Boat					
Lower	Tender					
Polar Bear	Marco-Class Crabber					
Clover Leaf	Marco-Class Crabber					
Shirley R	Limit Seiner					
Queen	Limit Seiner					
Commercial Berthing Area B		150	45	6750	50	3375
Erin Lynn	Coastal Freighter					
Polar Lady	Macro-Class Crabber					
Miscellaneous Berthing Areas						
Large Tug	Ocean Tug	85	25	2125	60	1275
Small Tug	Harbor Tug	15	6	90	90	81
WFC[1]	Work Boat	32	11	352	90	317
Total Shading				39317	59	23048

[1] WFC = Waterfront Construction

The existing level of nighttime lighting along the industrial waterfront and along the river bank is high at the Lonestar Cement Plant. There are five light standards, 30 feet high, supporting high pressure sodium lamps, which are likely 250 watts each (Sparling and Candela 1996). The lights include "cutoff" type fixtures with flat, clear lenses. The cement plant has numerous other site lights and building safety lighting, including flood lights mounted to the sides of many buildings. Therefore, large surfaced areas of the cement plant incorporate flood lighting. Many of these lights are adjacent to and illuminate the Inner Harbor.

Due to infrequent spacing of lights, the measured light intensity at ground level varied considerably. The general area had an average light level of 2.5-foot candles with high spots exceeding 5.0-foot candles one night in November 1996 (Sparling and Candela 1996). During the spring of 1996 and 1997, existing lighting in the Inner Harbor and along the Sammamish River at night was sufficient for field personnel to perform sampling functions and prepare notes without the use of headlamps.

Light and dark cycles are important factors in the diel movements of aquatic biota (Fox 1925, Emery 1973; Elliott 1976; Dobble and Eggers 1978; Eggers 1978; Levy 1987, Helfman 1981). Most biological response to light is movement to deeper positions in the water column during daylight and shallower positions during darkness.

Fish have specific habits of diurnal, twilight and nocturnal activity in freshwater lakes (Emery 1973). During periods of twilight, diurnally-active and nocturnally-active fish species engage in a characteristic transitional behavior as they "change over" between modes of foraging and resting. At dusk, diurnally active lake fishes progressively increase swimming until one hour before dark, cease feeding, disband schooling behavior, slow swimming and finally stop approximately one hour after dark to rest for the evening (Emery 1973; Helfman 1981). By day, nocturnally active fishes rest, and increase their movements as light begins to fade. Predators are usually most active and successful during twilight periods.

In Lake Washington, the salmonids, yellow perch and smallmouth bass are considered diurnal species, while the largemouth bass (>200 mm), black crappie and bullheads are considered nocturnal. Largemouth bass can be considered both diurnal and nocturnal feeders (Heidinger 1975).

Sockeye in Lake Washington school during daylight and disperse at night due to lost visual acuity (Eggers 1978). Salmonids terminate schooling behavior at 10^{-4} foot candles which is between starlight and full moon light (Whitney 1969). Without schooling behavior to avoid predators, fish seek and disperse to shallow nearshore areas to minimize predation. Levy (1987) also postulated that these diel vertical migration of juvenile sockeye in relation to light were related to predator avoidance. Juvenile sockeye feeding does not occur at any time in hours of darkness in Lake Washington (Dobble and Eggers, 1978).

Salmonids use the cover of darkness at night to rest along the nearshore areas of rivers (Campbell and Nuener 1985; Campbell and Eddy 1986) and lakes (Warner and Quinn 1995). Artificial lighting along the waterfront at night could expose juvenile salmonids to avian predators in the shallow water or fish predators if they move into deep water to avoid the light. Fish exhibit a period of increasing "wakefulness" under the influence of artificial night light and they move away from the light (Emery 1973). Tabor and Chan (1996) postulated that artificial lighting may increase predation of sockeye fry in the Cedar River. Given the high level of existing night lighting in the Inner Harbor, its value as resting and nighttime refuge habitat for juvenile salmonid fishes is presently diminished compared to unlit sections of the lake.

Biological Conditions - 1996

A summary of the Lakepointe biological sampling effort during the Spring of 1996 is presented in Table 3-9. Electrofishing was the most effective method of fish sampling because nearshore habitats posed a number of constraints to other sampling methods, including: 1) underwater debris and steep, blackberry-laden banks, which made beach seining impractical in the Lake Washington beach area and the Sammamish River; 2) above water and underwater structures that limited the use of a seine net and a boat-mounted electroshocker along nearshore areas of the Inner Harbor; and 3) turbid water which made accurate fish observation by snorkeling ineffective from late March through mid-May. Backpack electrofishing was the only sampling technique that could be used effectively in the nearshore habitats of all three areas. Therefore, this type of electrofishing was selected as the primary method for reporting results.

Given the biases inherent in fish sampling techniques, this section discusses species collection by sampling method during the spring of 1996. Relative abundance information can only be compared among data collected from the same sampling method for each fish species. Fish presence can be confirmed, but fish absence cannot be assumed with these data.

Nighttime electrofishing surveys in the Inner Harbor in 1996 captured primarily warmwater fish species. Among the warmwater species, three-spine stickleback, prickly sculpin, juvenile northern squawfish, and juvenile pumpkinseed were found in greatest abundance nearshore with a backpack electrofisher (Table 3-10). Daytime electrofishing and snorkeling survey data confirm that the Inner Harbor is frequently used by warmwater species. Prickly sculpin, three-spine

Table 3-9. Summary of Lakepointe fisheries surveys including sampling dates; sampling methods; and Secchi transparency and water temperature measured in the Inner Harbor, Lake Washington and Sammamish River during the surveys.

		Secchi depth (feet)			Surface water temperature (°C)*	
Date (time)	Sampling method	Inner Harbor	Lake Washington	Sammamish River	Inner harbor	Sammamish River
3/29/96 (Evening)	Electrofishing, seining	3.0	4.5	NM	NM	11
4/12/96 (Evening)	Electrofishing	3.5	3.4	4.4	NM	13
4/29/96 (Evening)	Electrofishing	3.8	3.5	4.3	17	15
5/06/96 (Evening)	Electrofishing, seining	5.0	4.5	5.2	17	15
5/26/96 (Day)	Snorkeling	9.0	>6.5	5.5	8.5	NM
5/27/96 (Evening)	Electrofishing	7.5	NM	>6.0	14	14
5/30/96 (Day)	Electrofishing	6.0	6.0	>4.5	16.5	16
6/14/96 (Day)	Electrofishing	8.0	NM	>4.5	18	19
6/24/96 (Evening)	Electrofishing	6.4	6.2	>4.5	21	19.5
4/29/97 (Evening)	Electrofishing, gillnetting	1.7	3.0	2.5	15	14
5/12/97 (Evening)	Electrofishing, gillnetting	8.0	7.5	NM	19	NM
5/19/97 (Evening)	Electrofishing, gillnetting	6.0	NM	NM	18.5	NM

NM = Not measured
* = Measured with hand-held thermometer, see Figures 3-12 and 3-13 for temperature profiles and continuous temperature gauge readings during Spring of 1997.

□ = "unlikely" result, possible equipment malfunction

Table 3-10. Results of night electrofishing, night seining, day electrofishing, and day snorkeling efforts associated with Lakepointe fisheries studies occurring March through June 1996.

	Night electrofishing			Night seining[1]		Day electrofishing			Day snorkeling		
Species	**Inner Harbor**	**Lakeshore**	**Sammamish River**	**Lakeshore**	**Sammamish River**	**Inner Harbor**	**Lakeshore**	**Sammamish River**	**Inner Harbor**	**Lakeshore**	**Sammamish River**
Chinook salmon	0	10	3								
Coho salmon	3	12	7	1							
Sockeye salmon	0	6	3						60[2]		
Cutthroat trout*	3	9	9							1	2
Rainbow trout*	5	4	6						2		
Total salmonids	**11**	**41**	**28**	**1**	**0**	**0**	**0**	**0**	**62**	**1**	**2**
Northern squawfish*	53	8	1	3		6	0	0			
Largemouth bass*	4	0	0						2		
Pumpkinseed*	32	1	0			7	0	0			1
Prickly sculpin*	136	115	134	5	X	55	45	15			6
Three-spine stickleback	181	67	43	3	X	17	8	7	X	X	17
Pacific lamprey	7	0	0			2	0	0			
W. brook lamprey	0	0	1								
Brown bullhead*	5	0	0								
Yellow perch*	0	5	1						3	14	
Largescale sucker	0	0	1								
Total non-salmonids	**419**	**196**	**180**	**8**	**X**	**97**	**53**	**22**	**X**	**X**	**24**

[1] Seining was not practical in the Inner Harbor area.
[2] School of approximately 60 salmonids, believed to be sockeye.
X - Species present, but not enumerated.
* - Potential salmonid predators

stickleback, juvenile northern squawfish and pumpkinseed were collected during daytime electrofishing surveys in the Inner Harbor. No salmonids were collected from the Inner Harbor during daytime electrofishing.

Three-spine stickleback were the most frequently observed species during snorkel surveys but their abundance was not enumerated. A school of approximately 60 (1+ age) juvenile salmonid smolts (≈150-200mm) was observed in the northeast end of the Inner Harbor. However, it was impossible to swim close enough to the school during snorkeling for positive species identification. The juveniles were believed to be sockeye salmon. Two largemouth bass (≈100-150 mm) were observed during snorkel surveys near the vertical wooden pilings in the southeast corner of the Inner Harbor. Three yellow perch (≈125mm) were also seen in the east corner of the Inner Harbor. Of the three areas studied, the Inner Harbor is the only location where largemouth bass were observed. Only juvenile bass were encountered nearshore and they were not common.

Three-spine stickleback may have been more common in the Inner Harbor because the soft organic substrate along the shoreline provided spawning habitat for the adults. Many, if not all, of the stickleback collected by electrofishing and observed by snorkeling were ripe females or males in spawning colors.

The Inner Harbor is typical of preferred spawning and nursery areas for largemouth bass (Pflug 1981; Fayram 1996). Largemouth bass move from offshore areas in the lake to spawning sites in calm coves and wave-protected beaches when temperatures exceed 13°C. Spawning begins earliest in coves and shallow littoral areas in Lake Washington where temperatures are generally 1 to 3°C warmer than the main lake (Wydoski and Whitney, 1979). Spawning is initiated when temperatures are between 13 and 16°C. Spawning was noted to occur in Lake Powell when water temperatures at nesting depths were 14.4 to 15°C and continued continuously from late April through mid-June (Miller and Kramer 1970).

Bottom temperatures rose and stayed above 13°C generally in mid-May in the Inner Harbor. The following impact analysis assumes the backwater cove offers spawning and fry rearing opportunities for largemouth bass in May and June annually.

All of the northern squawfish collected nearshore in 1996 were juveniles (the largest fish was 80 mm). Young squawfish are known to inhabit the shallow waters of lakes until they mature and move offshore (Scott and Crossman 1973). In Lake Washington, young squawfish inhabit shallow waters over sand and mud bottoms (Wydoski and Whitney 1979), which is typical of nearshore areas sampled along the Inner Harbor. Northern squawfish are considered abundant in Lake Washington. Adult squawfish move from deep-portions of the lake in fall and winter to lake shorelines in spring to embayments in summer (Bartoo 1972). Squawfish are present in bays generally only during the summer as temperatures reach 22°C. Squawfish prefer waters up to or warmer than the maximum available in Lake Washington (Bartoo 1972). Movements to lake shorelines and embayments may be spawning behavior (White 1975; Taylor nd; Martz et al. 1996a). Jeppson (1957) notes squawfish spawn in shallow waters over rock and rubble during the summer. Presumably squawfish move inshore in Lake Washington near the project site during summer to spawn, however the amount of rock and rubble substrate in the Inner Harbor is quite limited. Squawfish use of the Inner Harbor may be primarily related to juvenile rearing.

Coho salmon fry and juvenile/adult rainbow and cutthroat trout were collected in the Inner Harbor, but based on nearshore electrofishing data (Table 3-10) and catch per unit of effort data (Table 3-11), they were not as abundant as they were along the Lake Washington shoreline or the Sammamish River. Sockeye salmon were not collected by electroshocking, but a school of approximately 40 fry was observed during late afternoon on 29 April 1996 while conducting ancillary surveys in the Inner Harbor. Twenty individuals from a school of approximately 40 were collected with a dip net and positively identified. Similarly, a school of yearling salmonid smolts was also observed while snorkeling, as noted above. Although limited sampling detected fewer salmonids in the Inner Harbor than elsewhere near the site, a considerable portion of the spring outmigrants follow the Lake Washington shoreline north from the Sammamish River and will enter and migrate through the Inner Harbor.

Summary of Physical and Biological Conditions

The majority of shoreline treatments, in-water structure and floating structure located along the Kenmore Pre-mix property was found in the Inner Harbor. Warmwater fishes were found to use shoreline areas of the Inner Harbor more frequently than the other two areas. Salmonids were found to use the shoreline of the Inner Harbor during their spring outmigration period.

Table 3-11. Comparison of nighttime electrofishing catch per sampled unit of effort between three locations near the Kenmore Pre-Mix Property.

	Total fish collected	Salmonids collected	Shocking seconds	Fish per second	Salmonids per second	Fish per ft²	Salmonids per ft²	Fish per ft	Salmonids per ft
INNER HARBOR									
Length of shoreline shocked = 350 ft									
Area shocked = 4,200 ft²									
29 March 1996	49	1	720	0.0681	0.0014	0.0117	0.0002	0.1400	0.0029
12 April 1996	71	3	742	0.0957	0.0040	0.0169	0.0007	0.2029	0.0086
29 April 1996	98	1	733	0.1337	0.0014	0.0233	0.0002	0.2800	0.0029
6 May 1996	115	1	747	0.1539	0.0013	0.0274	0.0002	0.3286	0.0029
27 May 1996	50	3	757	0.0661	0.0040	0.0119	0.0007	0.1429	0.0086
24 June 1996	47	2	760	0.0618	0.0026	0.0112	0.0005	0.1343	0.0057
Totals	430	11	4459	0.5793	0.0147	0.1024	0.0026	1.2286	0.0314
Mean	72	2	743	0.0965	0.0022	0.0171	0.0004	0.2048	0.0048
LAKESHORE									
Length of shoreline shocked = 450 ft									
Area shocked = 5,400 ft²									
	Total fish collected	Salmonids collected	Shocking seconds	Fish per second	Salmonids per second	Fish per ft²	Salmonids per ft²	Fish per ft	Salmonids per ft
29 March 1996		2	923	0.0000	0.0022	0.0000	0.0004	0.0000	0.0044
12 April 1996	48	7	751	0.0639	0.0093	0.0089	0.0013	0.1067	0.0156
29 April 1996	25	1	748	0.0334	0.0013	0.0046	0.0002	0.0556	0.0022
6 May 1996	57	6	781	0.0730	0.0077	0.0106	0.0011	0.1267	0.0133
27 May 1996	56	18	816	0.0686	0.0221	0.0104	0.0033	0.1244	0.0400
24 June 1996	50	7	739	0.0677	0.0095	0.0093	0.0013	0.1111	0.0156
Totals	236	41	4758	0.3066	0.0520	0.0437	0.0076	0.5244	0.0911
Mean	47	7	793	0.0511	0.0087	0.0073	0.0013	0.0874	0.0152
SAMMAMISH RIVER									
Length of shoreline shocked = 350 ft									
Area shocked = 4,200 ft²									
	Total fish collected	Salmonids collected	Shocking seconds	Fish per second	Salmonids per second	Fish per ft²	Salmonids per ft²	Fish per ft	Salmonids per ft
29 March 1996		7	1284	0.0000	0.0055	0.0000	0.0017	0.0000	0.0200
12 April 1996	34	1	753	0.0452	0.0013	0.0081	0.0002	0.0971	0.0029
29 April 1996	55	3	752	0.0731	0.0040	0.0131	0.0007	0.1571	0.0086
6 May 1996	66	5	738	0.0894	0.0068	0.0157	0.0012	0.1886	0.0143
27 May 1996	24	10	768	0.0313	0.0130	0.0057	0.0024	0.0686	0.0286
24 June 1996	21	2	751	0.0280	0.0027	0.0050	0.0005	0.0600	0.0057
Totals	200	28	5046	0.2669	0.0332	0.0476	0.0067	0.5714	0.0800
Mean	40	5	841	0.0445	0.0055	0.0079	0.0011	0.0952	0.0133

Biological Conditions - 1997

Additional physical and biological sampling occurred on a limited basis during the spring of 1997, to gather further information on deep water habitats in the Inner Harbor.

Water Quality and Temperature Monitoring

Continuous recording thermographs deployed from 29 April through 20 May 1997, recorded mean daily water temperatures at the surface of the Inner Harbor between 12°C and 17.6°C. The instantaneous maximum during this period was 20.6°C. Temperatures near the bottom of the Harbor averaged approximately 1.4°C cooler than the surface temperatures (Figure 3-12). Temperature profiles at spot locations in the Inner Harbor prior to deployment of continuous thermographs, were relatively uniform between surface and bottom (Figure 3-13). A layer of slightly warmer surface water was apparent in mid-May, as confirmed by the continuous thermographs.

In situ water quality data collected concurrently in the Inner Harbor and at Lake Washington (Metro monitoring station 0804) suggest that the entire water column in spring is well oxygenated (>9.3 mg/L), with moderate conductivity (107 to 131 μmhos/cm) and near neutral pH (5.7 to 8.2) (Appendix B).

Biological Sampling Program

Gillnetting and Electrofishing: Fish sampling surveys revealed the presence of various warmwater and cold water species in the Inner Harbor during April and May. The cold water species were all salmonid fishes including juvenile chinook, coho, sockeye and resident adult rainbow and cutthroat trout. The juveniles were collected along the perimeter of the Inner Harbor, usually within 30 ft of the shore via electrofishing, whereas the resident adults were captured by gillnets in deeper more offshore positions than the juveniles. Coho salmon smolts (110-160 mm) were collected in the greatest abundance (Table 3-12). The dominance of coho smolts in the catch on 12 May 1997 was most likely the capture of yearling coho salmon released from the Issaquah Salmon Hatchery into tributaries of Lake Sammamish, the Sammamish River

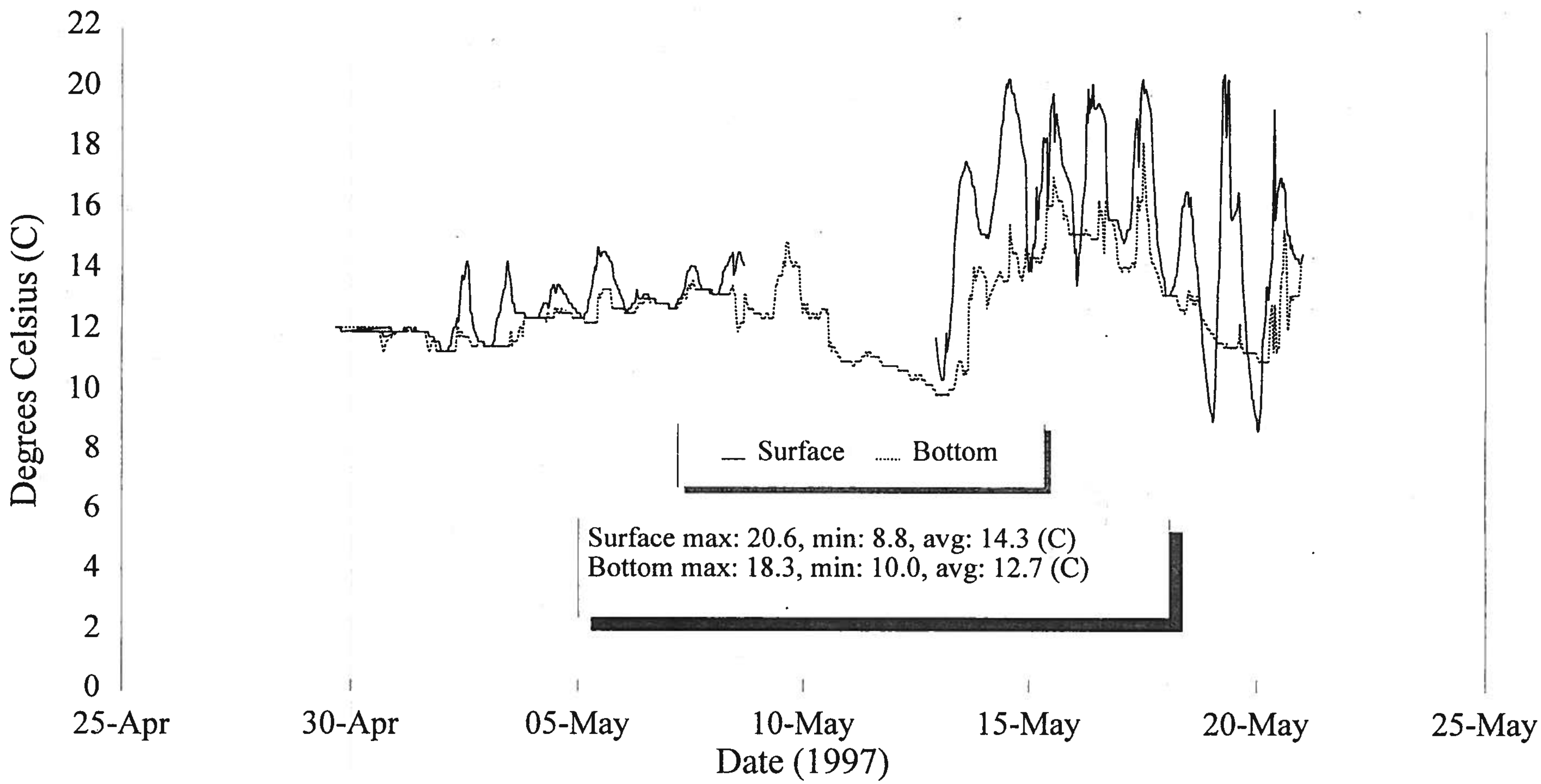


Figure 3-12. Spring Water Temperatures in the Kenmore Inner Harbor near Lakepointe
Missing surface temperature data due to equipment malfunction

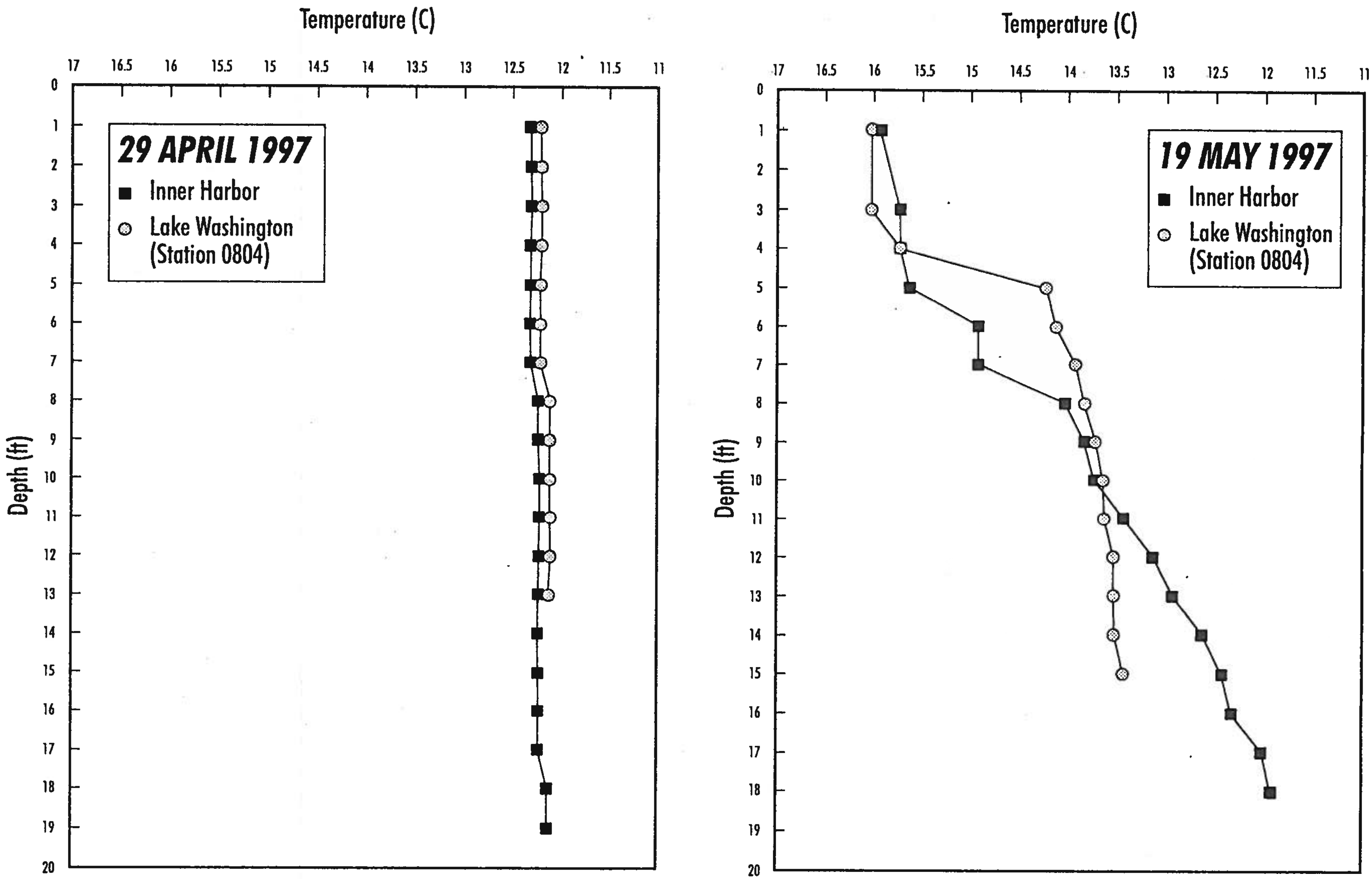


Figure 3-13. Spring 1997 water temperature profiles in the Inner Harbor and at Lake Washington metro monitoring station #0804 near Kenmore, WA.

Table 3-12. Results of night electrofishing and night gillnetting in the Inner Harbor, April through May, 1997.

	April 29		May 12		May 19	
	Night Electrofishing	**Night Gillnetting**	**Night Electrofishing**	**Night Gillnetting**	**Night Electrofishing**	**Night Gillnetting**
Chinook salmon	0	0	0	0	1	0
Coho salmon	2	0	85	0	6	0
Sockeye salmon	5	0	0	0	2	0
Cutthroat trout*	0	0	0	1	0	0
Rainbow trout*	0	1	0	0	0	0
Total salmonids	**7**	**1**	**85**	**1**	**9**	**0**
Northern squawfish*	0	0	0	3	1	0
Largemouth bass*	0	0	0	0	0	0
Pumpkinseed*	0	0	0	0	0	1
Prickly sculpin*	0	0	0	0	1	0
Three-spine stickleback	2	0	6	0	1	0
Pacific lamprey	0	0	0	0	0	0
W. brook lamprey	0	0	0	0	0	0
Brown bullhead*	0	0	0	1	3	0
Yellow perch*	0	0	0	0	1	0
Largescale sucker	1	0	3	2	0	3
Black crappie*	1	0	1	0	0	0
Tench	0	1	0	2	0	1
Peamouth	0	0	0	0	2	0
Total non-salmonids	**4**	**1**	**10**	**8**	**9**	**5**

* - Salmonid predators

and north Lake Washington from 7 through 14 April 1997 (Table 3-4). The sockeye collected were young-of-the-year fry ranging in size from 45 to 70 mm.

Catch per unit of sampling effort (CPUE) for all salmonids and total number of fish collected during electrofishing in 1997 is shown in Table 3-13. Collection of salmonids between April and May in the Inner Harbor was greater in 1997 than 1996. Peak collections occurred in mid-to late May in both years following hatchery releases.

Table 3-13. Comparison of nighttime boat electrofishing catch per sampled unit of effort on three dates during spring 1997 in the Inner Harbor.

INNER HARBOR							
Length of shoreline shocked = 1,515 ft							
	Total fish collected	Salmonids collected	Shocking seconds	Fish per second	Salmonids per second	Fish per ft	Salmonids per ft
29 April 1997	11	7	3,600	0.0031	0.0019	0.0073	0.0046
12 May 1997	95	85	4,200	0.0226	0.0202	0.0627	0.0561
19 May 1997	19	9	4,200	0.0045	0.0021	0.0125	0.0059
Totals	125	101	12,000	0.0302	0.0243	0.0825	0.0667
Mean	42	34	4,000	0.0101	0.0081	0.0275	0.0222

Among the warmwater species, three-spined sticklebacks and largescale suckers were collected most frequently. Tench, brown bullhead and northern squawfish were also observed in moderate densities. Sticklebacks were only captured by electrofishing techniques and tench were only collected via gillnetting. The other noted warmwater species were collected by both methods.

Stomach Content Analysis

The only potential predators collected in the Spring of 1997 large enough to prey on juvenile salmonids were the resident cutthroat and rainbow trout, brown bullhead, northern squawfish, black crappie, and pumpkinseed. The stomachs of one rainbow, three squawfish and one bullhead were dissected. None of the stomachs contained any salmonid fishes. The squawfish and bullhead were ripe. Females possessed well developed eggs and the males supported extended gonadal development. Many warmwater species curtail or reduce feeding activities during spawning periods (Stein 1970; Helfman 1981). Although this limited sampling showed no evidence of salmonids fishes in predator stomachs, the following impact analysis assumes a level of predation still occurs or could occur in the Inner Harbor.

Fish habitat in the Inner Harbor is not functioning properly for the production of salmonid fishes. It is currently a heavy industrialized site with the following habitat conditions:

1) No natural habitat conditions remain in the Inner Harbor. All shoreline materials are either fill (including solid wastes) or bulkheads,

2) Shallow water habitat, extensively used by juvenile salmonids, is limited. Only 36 percent of the existing shoreline offers beach conditions. The remainder has various degrees of shoreline treatment in the form of bulkheads, creating deep-water habitats. On an area basis, shallow water habitat (defined as less than 10 feet) totals 24,936 ft^2 or approximately 0.57 acres (14% of the Inner Harbor area).

3) The Inner Harbor includes a dredged navigation channel, and all nearshore banks have been altered. Shallow water habitat has been cut back at 4:1 side slopes.

4) The bottom sediments contain hydrocarbons, and petroleum odors are present. Hydrocarbons are likely present in harbor sediments as a result of the historic use of the site as a lumber mill.

5) There are no shoreline trees in the Inner Harbor, so an effective riparian zone does not exist. Small amounts of blackberry bushes and weed canary grass occur adjacent to some of the beach areas. These species comprise the only riparian vegetation.

6) Water conditions are highly turbid following tug deployment to transport barges and as a result of stormwater runoff from adjacent industrial land uses (including truck washing facilities).

7) The artificial shading over the Inner Harbor is currently high, 46,381 ft^2 of surface area (1.1 acre), representing approximately 26 percent of the Inner Harbor.

8) In-water structures including free-standing wooden pilings and decaying submerged piles are prevalent. The total Inner Harbor count includes 377 pilings offering potentially favorable cover conditions for ambush-style predators.

9) The Inner Harbor is a warm, backwater area. Surface water temperatures were generally the same or slightly higher (≈1.0°C) than river temperatures during the spring of 1996 and 1997. Summer temperatures frequently exceed the upper range of metabolic optima for salmonid fishes (18.5°C). Project fish studies measured surface water temperatures in the Inner Harbor at 21°C in late June 1996. Bottom water temperatures were generally the same or slightly cooler (1.4°C) than at the surface. Salmonid fishes have shown a general level of avoidance for water temperatures exceeding approximately 19°C - 21°C depending upon the species size and season (Brett 1971, Coutant 1977, McMichael and Kaya 1991). Late-June is assumed to be the end of salmonid residence in the Inner Harbor, annually

10) There is a high degree of artificial lighting from the concrete plant operations adjacent to the Inner Harbor. Added light can extend predation periods of visual sight feeders (diurnal feeders) throughout the evening.

As such, the Inner Harbor does not currently offer quality rearing habitat conditions for salmonid fishes. It is used seasonally (March-June) by juvenile salmonids during their outmigration. Residence time for individual fish in the Inner Harbor is unknown, but at a minimum this area will serve as a transit zone to other littoral areas in northeastern Lake Washington. Secondarily, it may offer limited seasonal rearing opportunities for salmonid juveniles while they are present.

Lake Washington Shoreline Characterization

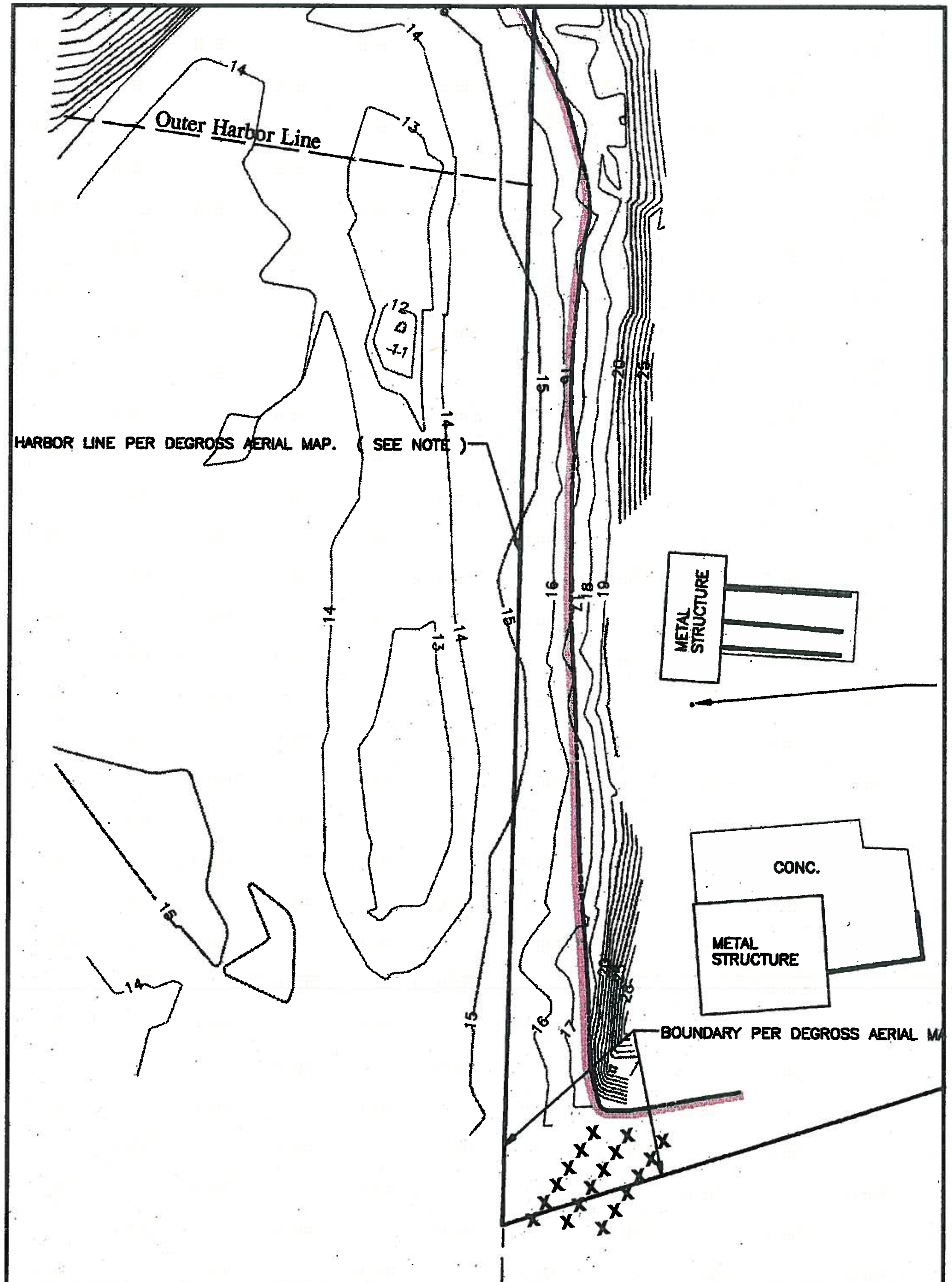
Physical Conditions

Approximately 500 (152 m) feet of Lake Washington shoreline borders the western edge of the Kenmore Pre-mix property. The Lake Washington shoreline gradually increases in depth from the shore westward towards the center of the lake. Depth contours along the Lake Washington shoreline are displayed in Figure 3-14. Representative cross section profiles of the shoreline are presented in Figure 3-15. The Lake Washington shoreline has a considerable area of littoral zone relative to the other two areas bordering the property (Figure 3-16).

The substrate is small gravel and sand at the wave-swept shoreline. However, it is predominately sand and mud farther from shore. Several large logs lie parallel to the shore along the waterline. A band of Eurasian milfoil (*Myriophyllum spicatum*) extending from the shoreline to at least 50 feet (15 m) from shore was observed in May and June.

The riparian buffer between industrial areas and the lakeshore is approximately 45 feet (14 m) wide and is dominated by reed canary grass and blackberry and also includes mature Douglas fir, red alder, black locust and cattails. The Douglas fir grow in a single row parallel to the lakeshore and are approximately 45 feet (14 m) from shore. The reed canary grass and blackberry grow right to the shoreline and overhang the water.

Unlike the Inner Harbor, the Lake Washington shoreline contains no bulkhead, no area of artificial shoreline overhang, and no floating structures. Submerged car tires, cement blocks, and other industrial debris are present along the entire length of the shoreline. There are 18 emergent and submerged wooden pilings located offshore near the confluence with the Sammamish River. The pilings at the Sammamish River mouth do not support any structure. Perimeter lighting on tall light standards occurs along the Lake Washington shoreline illuminating the nearshore habitat.



LEGEND

ORDINARY HIGH WATER MARK

x WOODEN PILINGS

N

LAKEPOINTE PIONEERING TOWING COMPANY	
FIGURE 3.14 *EXISTING BATHYMETRIC CONTOURS & ARTIFICIAL STRUCTURE ALONG LAKE WASHINGTON SHORELINE* SOURCE REFERENCE: REID MIDDLETON	
PROJECT NO.: 22140	27 APRIL 1998
2140314B.CDR/VGP	CHECKED: EBK

beak

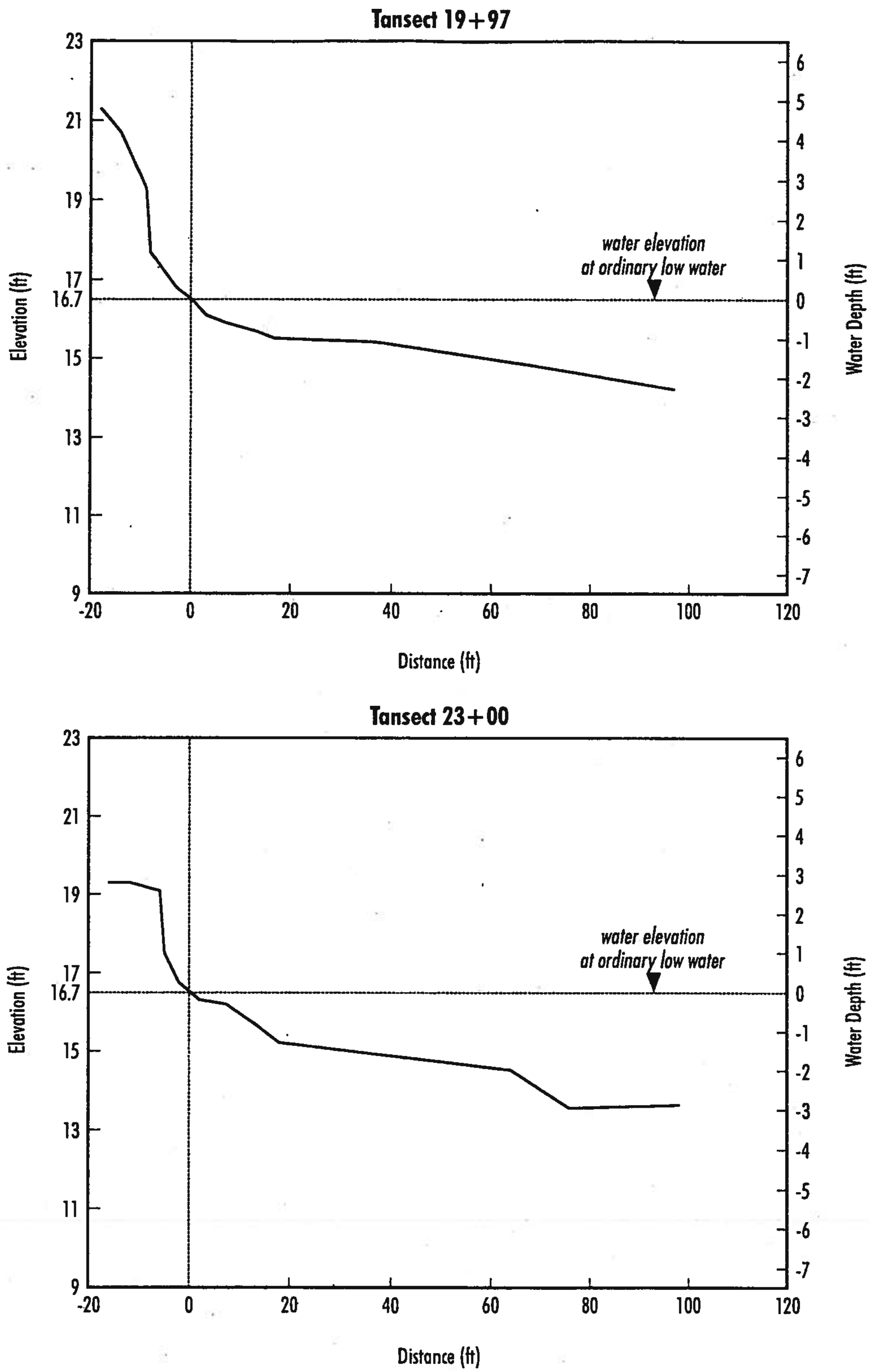
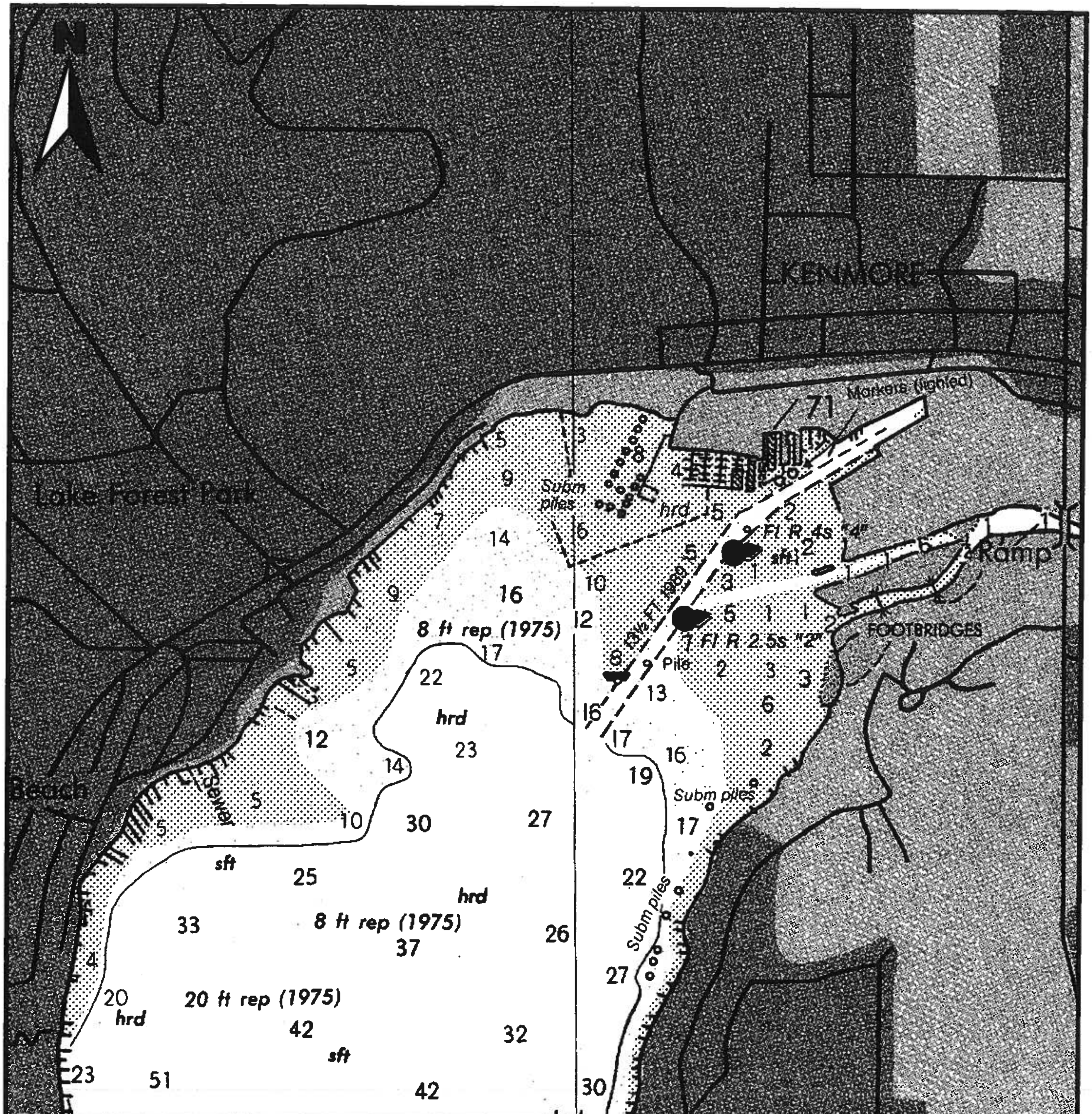


Figure 3-15. Cross-section profiles at two representative transects along the Lake Washington side of the proposed Lakepointe property. Distances are relative to the waterline at ordinary low water (+16.7 ft. Project Datum; +20 ft. Mean Low Low Water US COE Datum). Elevations are relative to water surface at ordinary low water.



SHALLOW LITTORAL AREA

LAKEPOINTE
PIONEER TOWING

FIGURE 3-16

SHALLOW (0-10FT.) LITTORAL AREA ALONG NORTH LAKE WASHINGTON IN THE VICINITY OF THE SAMMAMISH RIVER AND KENMORE HARBOR

PROJECT NO.: 22140	27 APRIL 1998	beak
2140-316.CDR/VGP	CHECKED: JBF	

Biological Conditions

Nighttime electrofishing surveys found prickly sculpin and three-spine stickleback as the most common species along the Lake Washington shoreline (Table 3-10). Prickly sculpin were collected nearly as often along the lakeshore as they were in the Inner Harbor. Northern squawfish were collected infrequently, but not in the vicinity of the wooden pilings located near the mouth of the Sammamish River. Yellow perch were collected in May and June along the lakeshore in areas of fresh milfoil (*M. spicatum*) growth. Yellow perch move into shallow water in the spring to spawn and use vegetation or submerged brush as egg attachment sites (Wydoski and Whitney 1979). The yellow perch were likely spawning on or amongst the milfoil.

Anadromous salmonids, including juvenile/adult rainbow and cutthroat trout, sockeye fry, coho fry, chinook fry and coho juveniles were collected at the Lake Washington sites (Table 3-10). More juvenile anadromous salmonids were collected during limited sampling along the Lake Washington shoreline than in the Inner Harbor or along the Sammamish River (Table 3-11). Resident cutthroat and rainbow trout were collected nearly as frequently along the lakeshore as in the Sammamish River.

Evening seining survey data were similar to the evening electrofishing survey results. Two seine hauls were attempted along the north end of the shoreline, but the net snagged numerous times on underwater debris and had to be lifted during retrieval. Lifting the seine allowed fish to escape the net. Five prickly sculpin, three northern squawfish, and two three-spine stickleback were collected on the evening of 29 March. One yearling coho and one three-spine stickleback were collected on the evening of 6 May 1996.

Daytime electrofishing surveys detected only prickly sculpin and three-spine stickleback. Yellow perch were the most common fish species observed while snorkeling. The perch were scattered along the bottom among fresh milfoil growth. One juvenile/adult rainbow trout was observed during snorkeling. No largemouth bass, pumpkinseed or northern squawfish were observed along the Lake Washington shoreline during daytime snorkeling or daytime electrofishing.

The Muckleshoot Indian Tribe used a boat shocker to sample salmonid predators in the Sammamish River and along the Lake Washington shoreline at the western edge of the Kenmore

Pre-mix property on the evening of 10/11 June 1996 (Malcom 1996). The boat was operated within two to four meters from shore. Because the survey targeted salmonid predators rather than salmonids, collection of all stunned salmonids was not attempted. Therefore, species identification of all salmonids was not possible. A subsample of collected salmonids indicated that the majority of observed juveniles were chinook and the majority of observed fry were coho. Nonetheless, the single survey found that compared to seven other sites located in the Sammamish River, the Lake Washington shoreline contained the highest density of salmonid fry and juveniles. The Tribe concluded that significant numbers of juvenile salmon use the beach area along the shoreline of Lake Washington (Malcom 1996).

Summary of Physical and Biological Conditions

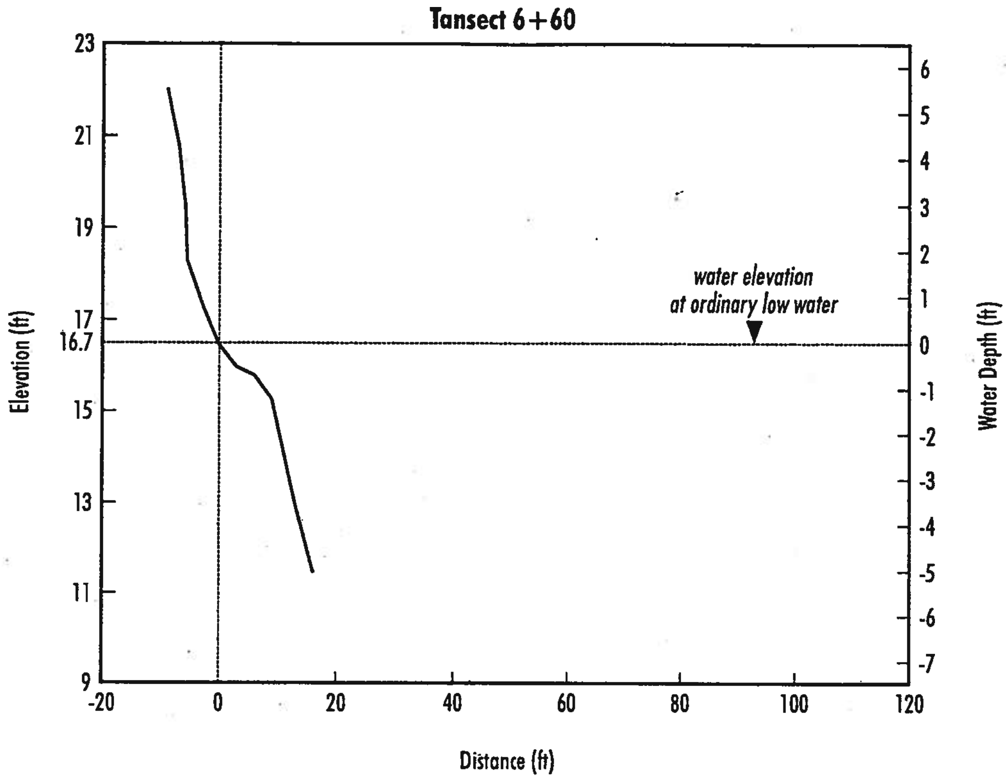
The lakeshore contains no shoreline treatments, no floating structure and the only significant in-water structure is near the Sammamish River mouth where 18 wooden pilings are located. The lakeshore has an extensive littoral zone. Of the three study areas, salmonids were collected in greatest abundance along the Lake Washington shoreline. This finding supports results from the Tribe's study (Malcom 1996). The primary value of the shallow shoreline habitat is for salmonid rearing and possibly staging prior to further migration offshore into the lake.

<u>Sammamish River Characterization</u>

Physical Conditions

Approximately 2,000 feet (610 m) of the north bank of the Sammamish River border the Kenmore Pre-mix property. Lights atop poles as high as the tallest trees shine brightly for the entire length of the Kenmore Pre-mix property that lies along the north bank. The north bank has a narrow band of shallow beach habitat until the point where the channel is influenced by dredging activity; then the depth abruptly increases (Figure 3-17). The nearshore substrate is influenced by wave action from Lake Washington, and consists of small gravel and sand. Outside the zone of wave influence, the substrate is dominated by sand. It progressively includes a higher proportion of soft or hard silt as the water deepens.

The riparian buffer between developed areas and the Sammamish River is approximately 25 feet (8 m) wide. Riparian vegetation includes a single line of mature Douglas fir and black



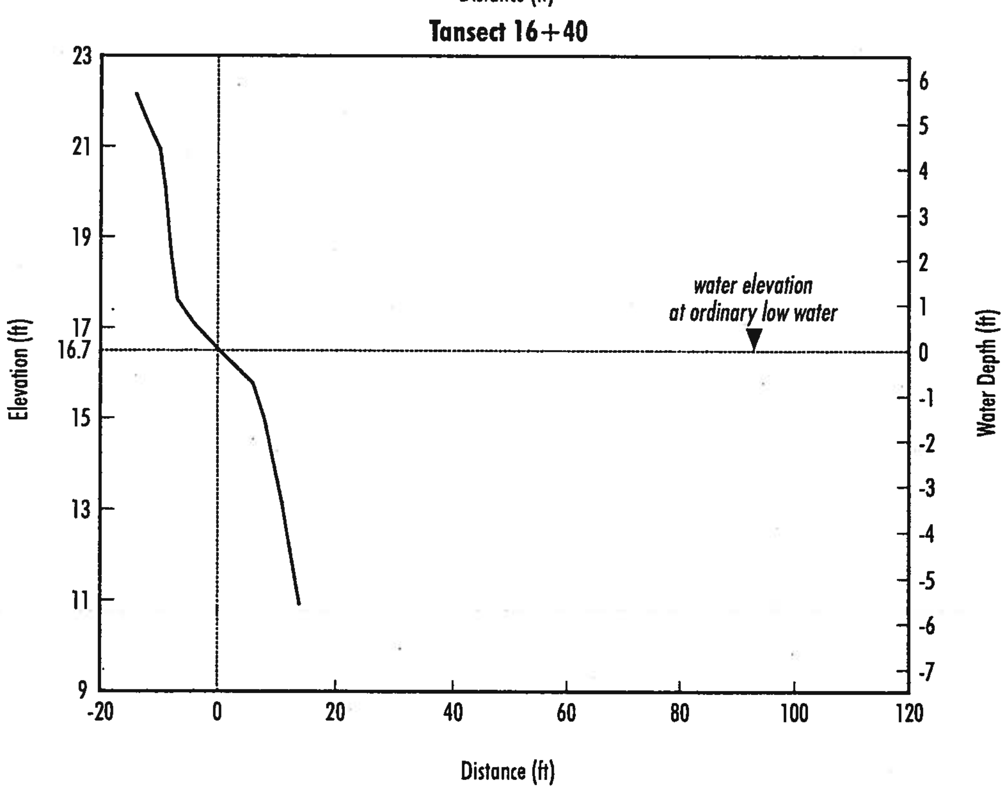


Figure 3-17. Cross-section profiles at two representative transects along the Sammamish River side of the proposed Lakepointe property. Distances are relative to the waterline at ordinary low water (+16.7 ft. Project Datum; +20 ft. Mean Low Low Water US COE Datum). Elevations are relative to water surface at ordinary low water.

cottonwood, but it is dominated by reed canary grass and dense blackberry bushes that overhang the bank. Due to the width of the Sammamish River at the confluence with Lake Washington and the aspect of the river to the sun, the thin band of Douglas fir and black cottonwood provides minimal shading of the river from solar radiation. Such riparian habitat conditions are not exclusive to the Sammamish River mouth, as fish habitat along the entire length of the Sammamish River is limited by warm water temperatures in the summer and a lack of bank cover (King County 1993).

The Sammamish River along the Kenmore Pre-mix property contains no bulkhead, no area of artificial shoreline overhang, and no floating structures. Root masses and single wooden timbers are present at various points along the north bank and they provide the only in-channel cover in nearshore areas.

Biological Conditions

The most common species collected during limited nighttime electrofishing surveys were prickly sculpin followed in abundance by three-spine stickleback (Table 3-10). Yellow perch were collected in the Sammamish River in May and June. Warmwater species were collected as frequently in the river as they were along the lakeshore.

Five species of salmonids were collected between March and June including juvenile chinook, coho and sockeye salmon and resident cutthroat trout (Table 3-10). All adult and juvenile salmonid fishes produced in the Sammamish River Basin will pass by the site during either upstream or downstream migration, respectively.

On 29 March 1996, one seine haul was completed perpendicular to the bank, but the net snagged numerous times on underwater debris. The net had to be lifted to be freed, allowing fish in the net to escape. Prickly sculpin and three-spine stickleback were collected, but were not enumerated.

Daytime electrofishing surveys collected only prickly sculpin and three-spine stickleback. Three-spine stickleback were the most frequently observed fish species during snorkeling surveys. One adult pumpkinseed was observed in a small floating patch of vegetation. Snorkel surveys detected two juvenile/adult salmonids. No largemouth bass or northern squawfish were observed in the Sammamish River, during these surveys.

Summary of Physical and Biological Conditions

There are no shoreline treatments, no floating structure or no significant in-water structures along the north bank of the Sammamish River. The river area along the Kenmore Pre-mix site is occasionally dredged to maintain a small boat navigation channel. Salmonids were present along the north bank of the Sammamish River between March and June, with peak abundance in late May following upstream hatchery releases. The primary utility of the river is an unimpeded migration corridor for adult and juvenile salmonids. The secondary value is for salmonid rearing, but habitat is limited by warm water temperatures in the summer and a lack of instream or bank cover.

3.2 SIGNIFICANT FISHERIES IMPACTS

The proposed Lakepointe development specific to shoreline areas surrounding the Kenmore Pre-mix property includes: 1) a public shoreline park along the north bank of the Sammamish River; 2) a fixed moorage pier and ADA access ramp adjacent to the lakehouse in the Inner Harbor; 3) public plazas and view points along the north eastern shore of the Inner Harbor; and 4) floating moorage slips in the eastern half of the Inner Harbor. The effects of these development features upon salmonid fish habitat are addressed below. The test of significant effects and the stated project design criteria is that post-development habitat conditions for salmonid fishes in the Inner Harbor would be an improvement compared to existing conditions.

3.2.1 Lake and Stream Function

The proposed development would not include structures below OHWM along either the Sammamish River or the Lakeshore. Therefore, physical and biological functions of the lake and the river would not be altered from current conditions. The shoreline park is not expected to modify the riparian zone to a great degree. Three (one 16" and two 12" dbh) Douglas fir along the north end of the Lake Washington shoreline would be removed during construction of the public access trail and firelane. Such removal is not expected to affect the function of the riparian zones in these areas for fish species since the trees currently provide little, if any, thermal protection for the river or bankside cover for fish.

The Inner Harbor would be cleaned up (removal of wood debris, unused pilings and piers) and built out including structures below OHWM as delineated in Fish Impact Section 3.2.3 below. The Inner Harbor is a backwater area of the lake that primarily functions as a warmwater species spawning and rearing area. It also offers protection from storm waves along the high energy, open areas of the lake. Its value to salmonid fishes is related to a seasonal juvenile rearing and nighttime resting area as well as migratory transit area during their spring outmigration. The biological function of the embayment to provide backwater rearing habitat for salmonid fishes is presently limited due to the industrial built out nature of the harbor. A severely reduced littoral zone and lack of a riparian zone in the Inner Harbor, due to prior shoreline modifications and dredging, decreases the aquatic productive capacity compared to an undeveloped backwater area.

The proposed development would reduce the amount of fixed overhanging and floating surfaces and the number of piles in comparison to existing conditions. It would also increase the amount of shallow beach area in the Inner Harbor. As such, the function of the backwater area to support juvenile salmonids during their outmigration will be improved compared to existing conditions.

3.2.2 Dredging

Maintenance dredging of the Kenmore navigation channel occurs irregularly and it was recently approved and scheduled for dredging to -17 feet (below OHWM of 18.7 ft. Project Datum) (SAIC 1996). To assess the potential impacts of this dredging, the US Army Corp of Engineers undertook sediment sampling along the navigation channel. Sediments from cores in the Inner Harbor were characterized as sandy-silt with abundant organics and wood fiber/chips with a wet brown to olive color. Petroleum odor was noted to increase with sediment depth in the core samples (SAIC 1996).

Sediment testing for open water disposal at the PSDDA site in Elliott Bay, revealed slightly elevated concentrations of poly-aromatic hydrocarbons (PAHs) above PSDDA screening levels in the Inner Harbor. However, the sediments passed biological testing and were approved for open water disposal. PAHs are likely present in the harbor sediments due to the historic use of the site as a lumber mill. No other priority pollutants were found above PSDDA screening levels.

No dredging of the Inner Harbor for marina development is anticipated. It is unknown whether maintenance dredging for the marina would be required in the future. Should it become necessary, the sediments to be removed would require analysis for disposal options and impact assessment. Given the results of the recent ACOE study for sediments in the Inner Harbor, it is assumed any future maintenance dredging would be approved for open water disposal and sediment disturbance would not pose a toxic risk to aquatic organisms. Temporary increases in turbidity would occur during any future maintenance dredging operations for the marina. Increases in turbidity and re-suspension of sediments should be similar in effect to the current operation of re-suspending sediments via the prop wash of tug boats during barge movements in the harbor (Figure 3-18). Tug activity occurs approximately once every four days between November and April and once every two days between May and October. As a result, re-suspension of sediments during potential (infrequent) maintenance dredging, would have less adverse effect on biota of the Inner Harbor, than currently occurs from tug prop wash every few days.

3.2.3 Structures

As previously stated, no in-water or over-water structures are planned for the north shore of the Sammamish River or along the Lake Washington shoreline area west of the property. Anticipated structures in the Inner Harbor include:

- Marina fixed piers, and public promenade with ADA access ramps
- Marina floating piers

<u>Bulkheads</u>

Existing bulkheads in the Inner Harbor would be used in conjunction with the proposed floating moorage and fixed wharf structures. No new bulkheads within OHWM are proposed with this action. Therefore, no further loss of shallow water habitat (< 10 ft. deep) for fish rearing and

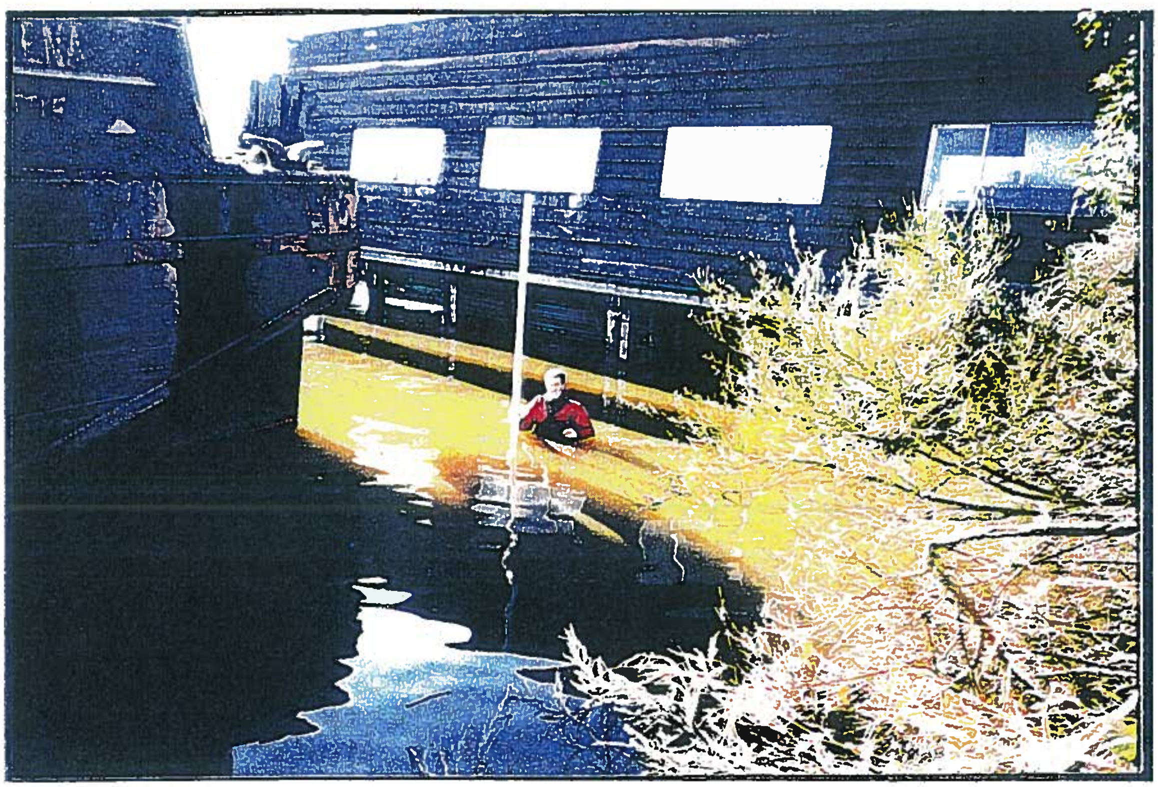


Figure 3-18. Turbid water conditions following tug deployment in the Inner Harbor.

refuge due to bulkhead construction would occur as a result of this development. As discussed in subsection 3.3; Fish Habitat Mitigation, 115 lineal feet of existing bulkhead along the eastern shore would be removed to create approximately +5,100 ft^2 of shallow water habitat for juvenile salmonids. Thus, approximately 10 percent less bulkhead will occur with project development compared to the existing length of bulkhead in the Inner Harbor.

Over-water Structures

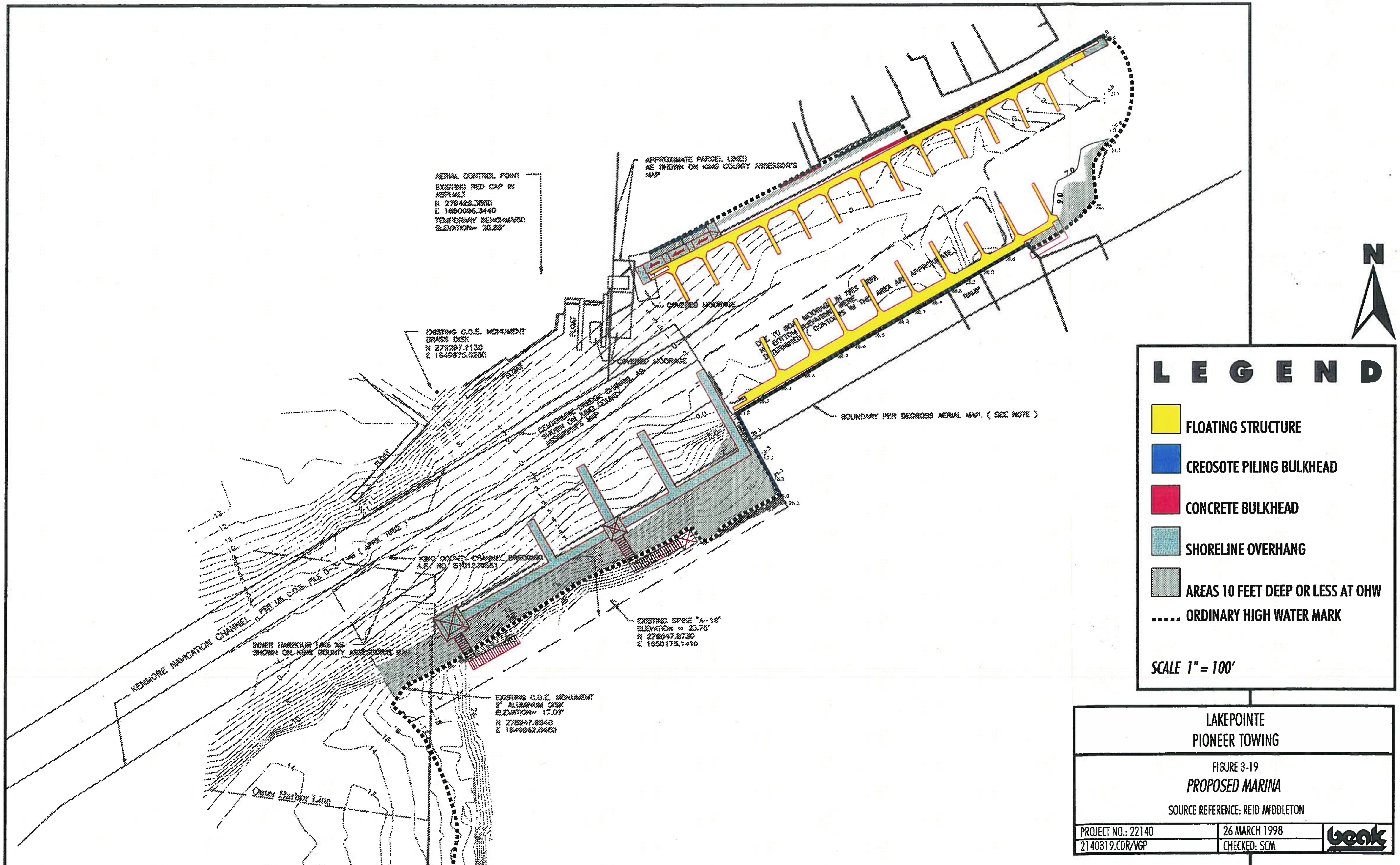
Approximately 9,500 ft^2 of fixed surface area and 9,340 ft^2 of floating surface area are planned to be constructed over the surface waters of the Inner Harbor as shown in Figure 3-19 and listed in Table 3-14. An additional annual equivalent of 26,045 ft^2 of floating surfaces from boats moored in the marina are estimated with project development. The proposed over-water structures would cast approximately 3 percent less shade than the existing fixed and floating structures in the harbor, as shown in Table 3-14.

Table 3-14. Summary of existing conditions and predicted post-development shoreline treatments and water structures associated with the Lakepointe Property.

	Existing	**Post development**
Area of surface water overhang (ft^2)	8,938	9,504
Area of floating material (ft^2)	37,443	35,385
Total shaded area	46,381	44,885
Linear feet of bulkhead	1,131	1,016
Number of in-water pilings	395	255

Fixed Structures (Overhang)

The fixed wharf structures would be built approximately 5 feet above OHWM and shoreline overhang would vary from 6 to 10 feet in width (Figure 3-20). The height of the structures would allow more light to penetrate the water compared to near surface structures, especially along the north shore of the Inner Harbor where the aspect of the sun would provide substantial underwater illumination. To preclude adverse effects of shading, all overhanging structures would be designed to pass ambient light by means of openings, gratings, or glass prisms (clearstory) in the

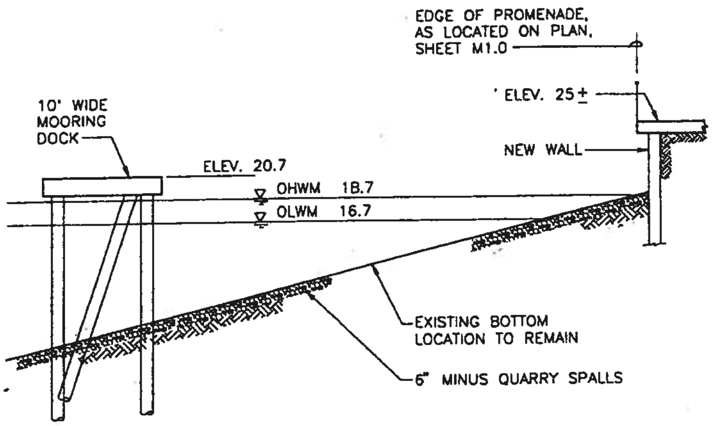


LAKEPOINTE
PIONEER TOWING

FIGURE 3-19
PROPOSED MARINA
SOURCE REFERENCE: REID MIDDLETON

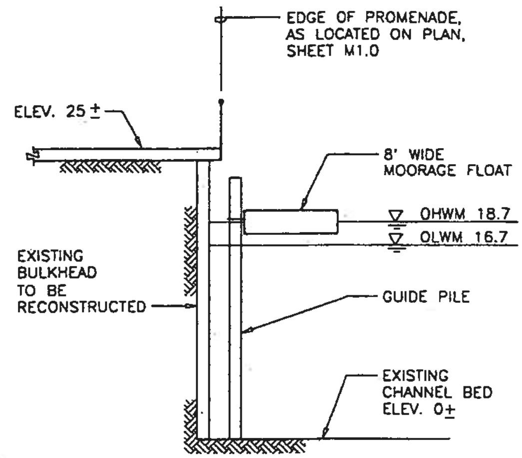
PROJECT NO.: 22140	26 MARCH 1998
2140319.CDR/VGP	CHECKED: SCM

beak



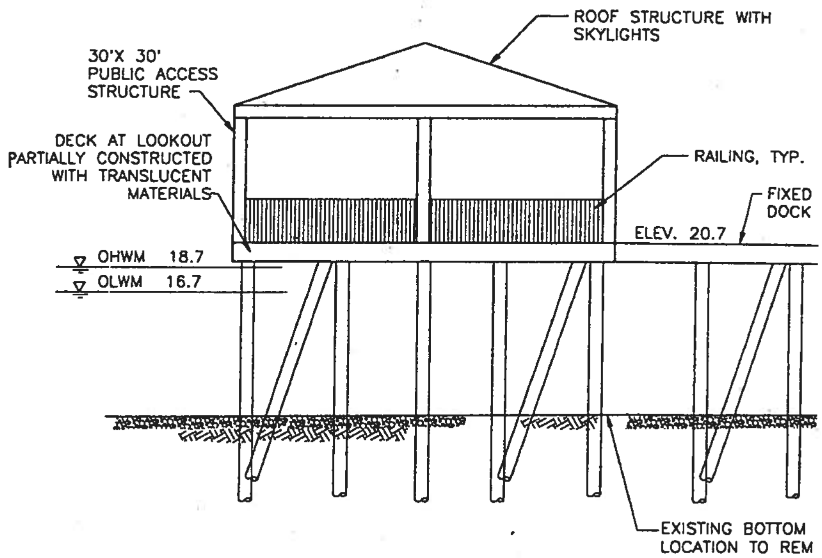
SECTION A (SOUTH SHORE)

SCALE IN FEET
5 0 5 10



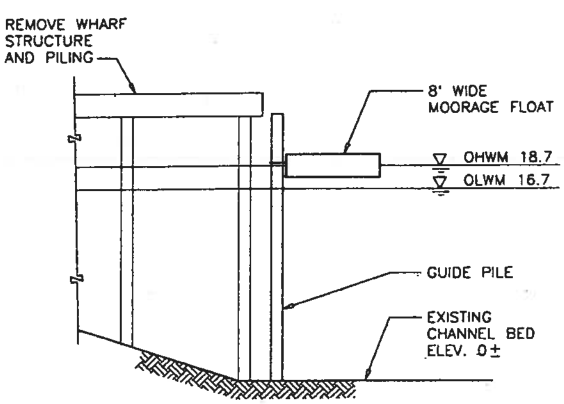
SECTION B (EXISTING BULKHEAD)

SCALE IN FEET
5 0 5 10



SECTION D (PUBLIC LOOKOUT)

SCALE IN FEET
5 0 5 10



SECTION C (EXISTING TRESTLE)

SCALE IN FEET
5 0 5 10

LAKEPOINTE
PIONEER TOWING

FIGURE 3-20
MARINA SECTIONS

SOURCE REFERENCE: REID MIDDLETON

PROJECT NUMBER: 22140	24 MARCH 1998	beak
2140-320.CDR/VGP	CHECKED: RFC	

decking. The fixed moorage pier and public promenade has been designed approximately 35 feet offshore to allow unhindered light penetration to a majority of the shallow water littoral zone located on the southwest shore (Figure 3-19).

High amounts of shading can reduce aquatic growth in the littoral zone with an ultimate reduction in fish production compared to open water shorelines of the lake. Areas where light rarely penetrates to the bottom can become relatively sterile. Additionally, salmonid fish are thought to avoid dark areas without light to guide them past the darkness. A direct estimate of lost productivity potential from current shaded conditions is not feasible due to the high prevalence of turbid water conditions resulting from barge offloading and tug activities in the harbor. High levels of turbidity also reduce the available light for aquatic productivity narrowing the littoral zone and reducing fish production.

Most (83%) of the proposed overhanging structure lies over water greater than 10 feet deep. Only a minimal, 1,650 ft^2 (<0.04 acres), of shallow water will be crossed to access deep water moorage ships. These crossings are designed perpendicular to shore to minimize the amount of shallow water coverage. Shallow water habitat (< 10 ft.) is believed to be the primary migratory zone for small salmonid fry. It allows quick access for fry to the shallowest nearshore regions offering refuge from large predatory fish. This zone is also the most biologically productive region due to the greatest amount of light penetration. Shallow beach habitat is currently limited in the Inner Harbor. Only 24,936 ft^2 (0.57 acres) presently exists due to the industrial nature of he harbor. Proposed overhanging structures would cover less than seven (7) percent of the existing habitat. This amount is substantially less than the current coverage of overhanging structures in shallow water that total 4,176 ft^2 or 17 percent of the existing habitat. The proposed development represents 60 percent reduction in the surface area of existing structures overhanging shallow water.

Floating Structures

Marina finger piers, access floats and moored boats would also cast shade. The annual shade equivalent post-project development from floating surfaces is estimated to be 35,385 ft^2 or approximately 0.8 acres. This amount is approximately 5 percent less than the current coverage (37,443 ft^2) of floating structures, commercial vessels and barges in the Inner Harbor. All of the floating structures and boats in the post-development marina would occur over water greater than 10 feet deep. There will be no future shallow water beach coverage compared to approximately 5,067 ft^2 (0.12 acres) of existing floating surfaces over shallow water areas. The existing structures cover approximately 20 percent of the available shallow water habitat in the Inner Harbor.

Fishery concerns related to floating objects are two fold. Shade cast by the structures decreases light penetration, potentially decreasing biological productivity and may also increase hiding locations for predator fish. The scientific literature offers mixed interpretations on the predator/prey advantages for floating objects, as shade with overhead cover is also known to provide predator protection for small prey species. Juveniles of various salmonid species can be readily found using marina floats and low piers in marine waters of the Pacific Northeast (Heiser and Finn 1970; Weitkamp 1982; Ratte and Salo 1985; Taylor and Willey 1997). It is assumed salmon fry in Lake Washington would similarly use floats and near surface overhead cover as predator avoidance behavior.

Predators may benefit to a greater degree as floating objects become large in size and the shading becomes darker than with small floating surfaces. The current shaded condition includes two very large barges (~6,600 ft^2 each) multiple deep draft commercial vessels and tug boats (up to 6,800 ft^2 each) a covered boat house (1,300 ft^2) and miscellaneous floating docks and surfaces (individually up to 5,700 ft^2). This condition would be altered post-development to multiple small (8 ft. wide) floating finger piers (up to 360 ft^2), narrow (8 ft.) connecting walkways up to 4,800 feet squared and smaller v-shaped hulled pleasure craft (up to 1,000 ft^2). Light penetration will be much greater with these surfaces compared to existing conditions.

Therefore, the floating surface coverage is not only less post-development, but the individual surfaces area smaller and will pass more light than the current structures in the Inner Harbor. As described in Section 3.3, clear glass prisms will be incorporated into the walking surfaces to provide additional light penetration beneath the floats and overhanging piers to further minimize the potential for predation on salmonid fishes. Based on the reduction in floating surfaces and the shift to smaller surfaces that allow greater light penetration than current conditions, there will be less predator ambush habitat as a function of shade post-development than presently exists.

In-water Structures

The fixed over-water structures would be supported by pilings at an average rate of one pile per 100 ft^2. Pilings would also be used to anchor floating moorage structures. A 35 percent decrease in the number of pilings over the current level of pilings is anticipated with project development (Table 3-14). If cement piling structures are used they will be pre-cast so only cured cement would come into contact with surface waters, precluding any influence in pH from the cement.

Pilings would support a food base for fish and would add structure and cover for various species. Pilings and overhangs are thought to be preferred by warmwater species over salmonids and have been shown to increase smallmouth bass spawning potential in Wisconsin lakes by adding protection to nest sites (Hoff 1991).

Although literature documentation is lacking, there is a general perception that piling structures provide ambush cover for salmonid predators and would lower the value of the Inner Harbor for salmonid use. Three studies addressing the topic were found including White (1975) in Lake Washington, Beauchamp et al. (1994) in Lake Tahoe and Ratte and Salo (1985) in the estuarine waters of the Port of Tacoma. None of these studies showed an increase use of piers or pilings by predator species or more susceptibility of juvenile salmonids to predation. Cooper and Crowder (1979) state that habitat structures can serve as refuge for prey and predator alike. Ratte and Salo (1985) speculated *"it is plausible that piers sometime serve as refuge for juvenile salmonids"*. Nevertheless, these studies are not conclusive with respect to species use of the north shore of Lake Washington and although unproven, the hypothesis of greater predation on outmigrating salmonids with in-water structures remains plausible.

Project studies collected various fish species regarded as potential salmonid predators (Tables 3-10, 3-12). The literature concerning salmonid predation in the lake suggest the northern squawfish, largemouth bass, smallmouth bass, resident trout and prickly sculpin have the capacity to take significant quantities of juvenile salmonids under certain situations. Squawfish, resident trout and sculpin are considered abundant in Lake Washington, largemouth and smallmouth bass are not (Bartoo 1972; Fayram 1996; Martz et al. 1996a). Of these species, only the bass are considered to be attracted to and use in-water structure as habitat. Fayram (1996) noted largemouth bass were more associated with habitat structure than smallmouth bass. However, structure in this case was undefined and was not specific to pilings. A review of each of the major predator species is provided below:

Northern Squawfish: Project studies collected juvenile squawfish (40-80 mm) in the shallow nearshore areas of the Inner Harbor during spring. Adult squawfish (120-470 mm) were first collected in the Inner Harbor in mid-May at a surface water temperature of 16°C. They were located slightly deeper in the harbor than the juveniles. The timing of squawfish in the Inner Harbor was similar to the noted presence of squawfish in nearshore areas of southern Lake Washington (Martz et al. 1996a).

Squawfish are voracious predators on small fishes, but are primarily pelagic feeders targeting longfin smelt and juvenile sockeye salmon in offshore areas of the lake during fall, winter and spring. According to life history studies of northern squawfish in Lake Washington, squawfish overwinter in deep portions of Lake Washington and do not move into shoreline littoral zones until May or June each year (Bartoo 1972; Olney 1975). Sockeye predation may be seasonal (Levy 1987). As squawfish move inshore in late spring and summer their diet changes to alternate, more profitable, benthic species and insects in the littoral zone (Ricker 1941; Bartoo 1972; Olney 1975; Eggers 1978; Levy 1987). They especially exploit the abundant prickly sculpin in Lake Washington (Eggers 1978; Eggers et al. 1978).

Movement to inshore areas appears to be primarily related to spawning (Jeppson 1957; Bartoo 1972; White 1975; Martz et al. 1996a). Squawfish spawn over large rock and rubble (Wydoski and Whitney 1979), a substrate that is not prevalent in the Inner Harbor. Many freshwater species are known to reduce or cease feeding during the spawning season (Stein 1970, Helfman 1981; Martz et al. 1996a). Limited project studies showed no evidence of salmonids in stomachs of squawfish collected from the Inner Harbor and all squawfish were noted to be in spawning condition. No literature or information was found indicating squawfish use in water structures as ambush cover.

Thus, salmonid predation by squawfish in the Inner Harbor can be summarized as follows:

1) The spatial timing of habitat use between squawfish and salmonids overlap for a brief period at the end of the juvenile outmigration (mid-May to mid-June).

2) Adult squawfish presence in the Inner Harbor during this overlap period may be primarily related to spawning although such habitat is limited. It is assumed feeding during the spawning period is reduced.

3) Squawfish shift their diets during the seasonal inshore phase to focus on benthic littoral fish, primarily prickly sculpin, and insect species.

It is concluded the late spring movement of squawfish to the Inner Harbor is primarily spawning related and that this area may serve as an initial rearing area for juvenile squawfish. Summer residence is assumed in this warm backwater area, since squawfish seek preferred water temperatures > 22°C (Bartoo 1972). However, target food sources during this period are non-salmonid. It is concluded that a decrease in in-water structures with project development is unlikely to alter the existing predator-prey relationship between northern squawfish and juvenile salmonids. Similarly, such a decrease in structures should not improve spawning or rearing habitat conditions for squawfish in the Inner Harbor, leading to an increase in lake wide production of this species.

Largemouth Bass: Project studies collected or observed yearling largemouth bass (90-150 mm) in the shallow regions of the Inner Harbor during spring. No young-of-the-year fry or adult bass were observed by any of the sampling methods conducted either year. Nevertheless, it is assumed adult largemouth bass would utilize the Inner Harbor at least during certain times of the year, as described below.

During winter, largemouth are usually dormant and are generally inactive < 10°C. They enter deep water in the lake and feeding is limited (Wydoski and Whitney 1979). As waters warm in the spring they move to the shoreline areas of the lake and begin feeding. Martz et al. (1996a) collected low numbers of largemouth at night in the littoral zone of south Lake Washington shorelines beginning late-May and June.

Bass are generally found in the lake, at the lower portions of the littoral zone near slope breaks and near the lower line of vegetation (12-20 ft. deep). Largemouth bass occupy lake habitat that provides moderate to dense growths of aquatic vegetation and substrates composed of silt and sand (Pflug 1981). Many authors have noted that largemouth exhibit a general permanence of station within a small home range; reported along Lake Washington shorelines to be less than 400m (Fayram 1996).

Spawning migrations are initiated as water temperatures exceed 13°C and they migrate to calm, wave protected beaches and coves that warm slightly sooner than the main portion of the lake. Spawning typically occurs when water temperatures at the nest site reach 14.4 to 15.0°C (Miller and Kramer 1970) or as reported for Lake Washington when surface temperature lie between 15.5 and 18.3°C (Wydoski and Whitney 1979). These temperatures are met in the Inner Harbor in mid-May through June.

Nests are frequently constructed in depths > 5 feet to protect against wave action. Nests are built under large broken boulders, and rubble at the base of ledges to take advantage of protection offered by slopes, boulders, ledges, overhangs and submerged vegetation (Miller and Kramer 1970; Wydoski and Whitney 1979). Pflug (1981) noted largemouth bass typically used soft-bottom substrates in shallow weedy bays for spawning in Lake Sammamish. The Inner Harbor offers suitable characteristics for largemouth bass spawning. It is assumed bass will be present mid-May through June for spawning.

Logs and dead heads provide excellent cover for bass (Stein 1970). Nyberg (1971) states largemouth bass are most successful in warm, quiet water where they locate preferentially near shelter. Fayram (1996) also observed the preference of largemouth bass to orient with shoreline structure. Such preference for cover is why piling structures are thought to offer increased ambush feeding opportunities for largemouth bass.

Juvenile salmonids use the Lake Washington lakeshore and the Inner Harbor during outmigration from the Sammamish River in late winter and spring when shoreline water temperatures are in their preferred temperature range. Bass prefer warmer water temperatures and occupy shoreline habitats when temperatures increase in late spring and early summer. The occurrence of potential predator and salmonid prey are assumed to generally overlap between mid-May and mid-June, annually. After which the water temperatures in the Inner Harbor are not favorable to coldwater species. Quiescent backwater areas with piling structure are known spawning areas for largemouth bass. The use and timing of abundance of these fish in the Inner Harbor may be more directly related to spawning, nest protection and juvenile rearing, but adult foraging is a possibility. Foraging markedly decreases during spawning and nest guarding periods (Stein 1970; Helfman 1981).

Largemouth bass are primarily benthic carnivores feeding on both fish and invertebrates. Largemouth bass are known to consume juvenile salmonids, but not in large numbers. In Lake Washington, Stein (1970) found bass, greater than 100 mm in size, consumed mostly fish. Sculpins were the dominant species fed upon, appearing in 28 percent of the stomachs analyzed. Crayfish were the next most important food item, occurring in 11 percent of the stomachs. Bass fry were the second most frequently found fish occurring in 7 percent of the stomachs. Only 2 percent of the bass stomachs contained coho and 1 percent, each had rainbow or sockeye juveniles. Thus, a total of 4 percent of the bass stomachs sampled had evidence of salmonid fishes. Stein (1970) states the value of salmonids as forage for largemouth bass in Lake Washington is thought to be quite limited.

From diet analysis of a limited number of largemouth bass in Lake Washington, Fayram (1996) similarly found largemouth (163-475 mm) utilized fish more than any other prey item. Cray fish, zooplankton and other invertebrates were also frequently consumed and dominated the prey items taken during certain times of the year. A portion of their diets during the months of May and June was comprised of juvenile salmonids. Even during the period of overlap with outmigrating salmon, nearly 80 percent of largemouth diets were non-salmonid and other prey items. The peak month was June where 25 percent of the bass sampled had evidence of salmon in their diets and salmon comprised 12.8 percent of the diet by weight. The author concludes the overall impact of bass on juvenile salmonids in Lake Washington seems to be relatively small.

Largemouth bass are known to be actively feeding during twilight periods and into the evening. The behavior of salmonids seeking shallow resting spots nearshore at night where large predators cannot maneuver, may reduce the probability of contact with bass.

Thus, salmonid predation by largemouth bass in the Inner Harbor can be summarized as follows:

1) Largemouth bass are not abundant in Lake Washington, and there is evidence there are fewer largemouth currently than in the past (Fayram 1996).

2) The timing of habitat use between bass and salmonids likely overlap for only a brief period at the end of the juvenile outmigration (mid-May to mid-June).

3) The Inner Harbor offers suitable characteristics and water temperatures for largemouth bass spawning beginning in mid-May annually. It is assumed bass use this area for spawning and for foraging. However, bass feeding is reduced during the spawning and nest guarding season.

4) Lake Washington largemouth bass are not specifically targeting juvenile salmonids but they are opportunistic feeders. They are thought to be ambush-style predators and potentially use in-water structures for cover.

5) Salmonid nighttime and predator avoidance behaviors may reduce interaction with bass.

It is concluded a 35 percent decrease in in-water structures with project development will decrease the potential ambush habitat and spawning cover for largemouth bass, related to pilings. Thus, largemouth bass predation on juvenile salmonids and bass spawning habitat will be reduced compared to current conditions. No site-specific or lake-wide increase in predation pressure form this species is expected to result from the 35 percent reduction in in-water structures.

Smallmouth Bass: A non-native species, smallmouth bass may have been introduced in the Lake Washington system during the 1950s to early 1960s (Pflug 1981; Fayram 1996). Smallmouth occur in Lake Washington today, but they are not abundant (Bartoo 1972; Wydoski and Whitney 1979; Fayram 1996).

No juvenile or adult smallmouth bass were collected or observed during limited field sampling in the spring of 1996 or 1997 during project studies near the Kenmore Pre-mix Property. Similarly, Pfeifer and Weinheimer (1992), Malcolm (1996) and Fayram (1996) did not collect smallmouth bass while sampling along the north end of Lake Washington near Kenmore. Such results are not surprising since smallmouth bass have a strong preference for rocky substrate with little aquatic vegetation for both rearing and spawning and have limited home ranges (Pflug 1981; Pflug and Pauley 1984; Fayram 1996). The Kenmore area supports silty substrates with some growth of macrophytes.

Smallmouth bass prefer clear areas of lakes with some degree of water movement (Wydoski and Whitney 1979). They are typically found over rocky or gravelly shoal areas in lakes (Wydoski and Whitney 1979; Pflug and Pauley 1984). In Lake Sammamish, Pflug and Pauley (1984) noted that adult smallmouth bass exhibited unmistakable habitat preferences for prefer hard substrate combined with a drop off from an overbank and the absence of aquatic vegetation. They state: .. *"smallmouth bass display a definite predilection for shoreline areas devoid of vegetation and composed of gravel and cobble with a gradual slope and a drop off."* In recent surveys of south Lake Washington, Tabor and Chan (1996a) and Martz et al. (1996a) found smallmouth bass during the months of April, May and June mostly along the eastern shore between Gene Coulon Park and Point Coleman over gravel, cobble and rubble substrate. No smallmouth were collected over organic, silty or muddy lake bottom types.

Smallmouth bass exhibit a precise home range and, unlike largemouth bass, do not travel long distances for spawning. Movements of smallmouth are generally less than 0.75 mile (1200 m) (Wydoski and Whitney 1979). During mark and recapture surveys in south Lake Washington, six of seven smallmouth were recaptured in the same location. One fish traveled 636 m prior to recapture (Tabor and Chan 1996a). Fayram (1996) also noted a high degree of habitat homing and reported that smallmouth bass were restricted to the littoral zone of lake in small ranges between 400 m along the shoreline out to approximately 10 m in depth.

Smallmouth bass prefer warm lake water temperatures, generally between 21°C and 27°C (Wydoski and Whitney 1979). However, the selection of temperatures can change seasonally especially in temperate lakes, like Lake Washington, where large seasonal temperature swings occur in surface waters . When water temperatures are generally below 15.5°C, smallmouth can be found in deep water, moving to shoreline areas as waters warm in the spring (Wydoski and Whitney 1979). Barans and Tubb (1973) noted preferred temperatures for smallmouth in spring between 18 - 26 °C. Reutter and Henderoff (1974) measured slightly lower final preferred spring temperatures for smallmouth from 15 - 16°C.

Spawning also occurs in spring, between 12.8 and 18.3°C (Wydoski and Whitney 1979; Pflug and Pauley 1984) and generally peaks when temperatures reach 16 - 18°C (Scott and Crossman 1973). These temperatures typically occur mid-May through June in the Lake Washington system. Spawning habitat is similar to preferred adult habitat; shoal sites with hard substrate, near steep drop offs in areas without aquatic vegetation (Pflug and Pauley 1984). However, nest sites are usually associated with benthic structure like isolated boulders, logs or dock pilings. Nest sites in Lake Sammamish were never observed in silty habitats (Pflug and Pauley 1984). The male digs a shallow depression in the substrate for a nest and guards it until the young leave. Nest guarding can occur for up to seven days after hatching depending upon water temperature.

Pflug (1981) described unmistakable differences in the preferred residence habitat of smallmouth bass and largemouth bass, effectively segregating the two bass species from each other. As previously stated, smallmouth bass reside in rocky substrate rather than soft substrate that supports growths of aquatic vegetation. In contrast, largemouth bass were shown to occupy habitat providing moderate to dense growths of aquatic vegetation. Many of the preferred residence areas for largemouth bass exhibited substrates composed of silt and sand. Pflug (1981) noted *"both bass species will co-occupy an area together when a mixture of both types of preferred habitat coincide."*

With respect to spawning, smallmouth and largemouth bass similarly used habitats that were spatially exclusive of each other, thereby precluding competition for spawning sites. Smallmouth used gravel and cobble shoreline areas for nest building, whereas largemouth typically used backwater areas with soft-bottom substrates and aquatic vegetation for spawning in Lake Sammamish (Pflug 1981)

Therefore, the author concludes habitat differences create spatially segregated distributions of each species within Lake Sammamish. This high degree of habitat partitioning between the two bass species presumably precludes direct competition for available food, habitat and spawning sites.

In Lake Washington, Fayram (1996) collected few smallmouth bass over soft substrates and based on tracking studies noted that where smallmouth and largemouth overlap, *"largemouth bass seemed to be more structurally oriented, while smallmouth bass seemed to orient to a more limited amount of structure"*. These habitats may have been separated by a distance of only 50 m or less in the lake.

Smallmouth bass are not known to be large salmonid consumers (Martin and Fry 1972; Poe et al. 1991; Bennett et al. 1991; Tabor and Chan 1996 a,b; Fayram 1996) and some authors have suggested smallmouth may actually benefit salmonid species by preying heavily on other piscivorous species (Bennett et al. 1991; Fletcher 1991). Nevertheless, smallmouth bass are opportunistic feeders and under the right circumstances can take substantial quantities of juvenile salmonids (Warner 1972; Pflug and Pauley 1984; Tabor et al. 1993). An artificial influx or concentration of young salmonids in a body of water, like hatchery releases or at points concentrated at downstream dam passage sites or at lake outlets, will yield a higher than normal predation rate by smallmouth bass (Warner 1972; Pflug and Pauley 1984; Tabor et al. 1993; Fayram 1996). In other instances where the natural distributions of juvenile salmon and smallmouth bass have overlapped, smallmouth bass have not been important predators on salmonids (Poe et al. 1991; Tabor and Chan 1996a,b).

Thus, salmonid predation by smallmouth bass in the Inner Harbor can be summarized as follows:

1) Smallmouth bass are not abundant in Lake Washington.

2) Smallmouth bass have not been historically collected along Kenmore and the silty substrate of the Inner Harbor embayment is not preferred smallmouth bass rearing or spawning habitat.

3) Largemouth and smallmouth bass co-exist in temperate lakes by habitat segregation and resource partioning. Habitat in the Inner Harbor is more conducive to largemouth than smallmouth bass.

4) Smallmouth bass consumption of juvenile salmonids in Lake Washington has been assessed to be of minor significance (Tabor and Chan 1996 a,b; Fayram 1996).

It is concluded that project development leading to less structure in the Inner Harbor will not alter habitat conditions in a manner to attract or increase production of smallmouth bass on a site-specific or lake-wide basis. It is unlikely to change the existing predator-prey relationship between smallmouth and juvenile salmonids along the northshore of Lake Washington.

Resident Trout: Both yearling and adult resident rainbow (130-355 mm) and cutthroat trout (120-420 mm) were collected in small numbers during spring sampling in the Inner Harbor. These fish have been reported to consume large numbers of juvenile salmonids in Lake Washington. However, in-water structure has not been reported to increase or decrease their advantage as a predator. As such, it is concluded a decrease in in-water structures with project development is unlikely to alter the existing predator-prey relationship between resident trout and juvenile salmonids.

Prickly Sculpin: Prickly sculpin are abundant in Lake Washington and ubiquitous in habitat distributions. They can be found in rivers, along the littoral zone and active in pelagic regions of the lake as well. Prickly sculpin are known to be a predator on juvenile salmonids (Tabor and Chan 1996 a,b). Although prickly sculpin consumption rates of salmonid fry are generally low, they may be an important predator because of their abundance (Tabor and Chan 1996a). Project studies collected an abundance of prickly sculpin (10-130 mm) throughout the sampling period (March to June) at all three study sites near the proposed Lakepointe development (Sammamish River, Lake Washington shoreline and Inner Harbor).

No literature has been located to date suggesting in-water or over-water structures offer a predation advantage to sculpin or improved habitat conditions for the increased production of prickly sculpin. As such, it is concluded a decrease in in-water and over-water structures with project development is unlikely to alter the existing predator-prey relationship between prickly sculpin and juvenile salmonids.

Given the current abundance of potential predators in this location, salmonid fishes are likely exposed to a greater incidence of predation in the Inner Harbor than elsewhere in the vicinity of the proposed project. This situation may be especially true since prey have little access to shallow shoreline areas for cover. The decrease in proposed in-water structures in the Inner Harbor would likely decrease spawning opportunities and ambush cover for bass in the Inner Harbor.

Marina

The proposed marina would add narrow fixed piers along the south end of the harbor and floating piers around the perimeter as shown in Figure 3-13. Slips for approximately 50 recreational boats between 40 and 70 feet in length would be provided. Transit moorage fora small number of boats is available at the fixed moorage pier adjacent to the lakehouse. There would be no live-aboard residents. Similarly, no pump out, fueling or haulout facilities would be incorporated into this plan, since they exist nearby at marina facilities to the west of Kenmore Air Harbor. Issues related to salmonid fish production and migration include surface water shading and predation, and water quality.

Shading/Predation

The effects of fixed and floating piers from the marina have been included in the previous discussion in this section (Over Water and In-water Structures). All of these structures are narrow longitudinal features. The fixed piers are 10 feet wide to accommodate public and ADA access as well as to support larger craft than the floating portion of the marina. The floating finger piers are 8 feet wide. Although some shading of the surface waters would occur with these features, the shading would alternate with lighted portions of the harbor and should not extend to the bottom. Salmonids of all size classes are known to frequent and use the floating structures of marinas for feeding opportunities and for cover. Predators may also use these structures, but an increase in predation over current levels is not anticipated (see Section 3.2.3; *Floating Structures*). Heiser and Finn (1970) concluded that predation upon salmon fry within marinas in the marine waters of Puget Sound region was much less than formerly thought and may have been less than in comparable adjacent beach areas. It is reasonable to assume these observations in marine waters would be similarly applicable to the same situation in freshwater.

Marina structures have also been hypothesized to add perching surfaces for avian predators, but an extensive study to monitor avian abundance and feeding behavior in marine waters at the Port of Seattle's Bell Street Marina showed no concentration of avian predators or increase in feeding behavior at the marina facility during the 1996 juvenile salmonid migration period between April - July (Hotchkiss, pers. comm., 20 June 1996; Taylor and Willey 1997).

Water Quality

The water quality issues of the marina related to fish include turbidity, water temperature, dissolved oxygen, fecal coliforms, petrochemical byproducts, and anti-fouling bottom paints. Anticipated changes to each water quality issue with the proposed marina are discussed below.

Turbidity: The present industrial use of the harbor and deployment of deep draft tugs creates turbid conditions in the Inner Harbor. Turbid water scatters light, reducing the depth of light penetration and could decrease aquatic productivity substantially compared to clear lake conditions. The proposed marina would increase boat traffic, but the recreational vessels at slow speed would have near-surface propellers that should not scour and re-suspend bottom sediments given the depth of the Inner Harbor. The proposed use should offer considerable improvement in the frequency of turbid water conditions in the Inner Harbor.

Water Temperature: Existing late-summer water temperatures are presently warm in Lake Washington in the vicinity of the Inner Harbor and may seasonally exceed thermal optima for coldwater species (see Fish Impact Section 3.2.5). Marina activities are not anticipated to increase water temperatures of the Inner Harbor. If anything, the small amount of surface shading from the marina structures should decrease temperatures. Regardless, the overall effect of this shading is likely not measurable.

Dissolved Oxygen: Seasonally low dissolved oxygen (DO) concentrations are also present in the vicinity of the Inner Harbor from July through September. DO levels in water are inversely related to water temperature, since warm water is unable to hold as much dissolved oxygen as cool water. The relative amounts of photosynthetic activity and organic decomposition are also factors influencing overall DO levels. Since the marina would not increase water temperatures and should not add organic materials increasing biochemical oxygen demand, it is unlikely to affect dissolved oxygen concentrations in the harbor.

Fecal Coliforms: Bacterial levels from warm blooded animals including humans are high in the Sammamish River near the mouth at Lake Washington. It is assumed the sources generally occur upstream in the Sammamish River basin. Water quality data available from Metro indicate that overall levels of fecal coliform have declined noticeably over the last ten years. There are no known fecal coliform sources entering the Inner Harbor. The marina would include onshore restroom facilities as well as boats with waste water holding tanks, both potential sources of fecal coliforms. Both sources should be contained and should not have waste water entering the harbor. The restrooms are sewered, and attached to Metro's Northshore system. The discharge of boat holding tanks is regulated by the US Coast Guard and Ecology and open water disposal is prohibited (US Coast Guard 1995). Holding tank pump out facilities are not incorporated into the marina plan, so spillage is not an issue. Existing pump out facilities are available at the marina immediately west of the Inner Harbor making disposal handy.

Marinas with live aboard residents often support higher bacterial levels in the water than marinas without onboard residents. The proposed marina operations would preclude onboard residents. As a consequence, the planned marina and associated operations should not have a measurable increase in existing fecal coliform levels in the Inner Harbor or in Lake Washington.

<u>Petrochemical Byproducts</u>: No data currently exist on the level of oil and grease, gas or related hydrocarbons in the water column of the Inner Harbor. Elevated levels of PAHs occur in the bottom sediments and petroleum odors were noted in deep sediment cores related to historic use of the site (SAIC 1996). Given the current industrial use and boat moorage occurring in the Inner Harbor it is safe to assume a high background of hydrocarbons occur in the water. The marina would increase the numbers of boats using the Inner Harbor and could be expected to periodically release oil or gas products to the water surface. No fuel dock is proposed with the plan, so accidental spillage of oil products would be vastly reduced compared to marinas with fuel facilities. Similarly, the size of the boats anticipated for the marina would likely by predominated by inboard diesel powered engines. Inboard engines discharge far less oil residues to surface waters than outboard engines. The change from industrial uses to light recreational craft would likely not have a measurable change in existing hydrocarbon levels and should not alter the current conditions for salmonid fishes.

<u>Anti-fouling bottom paints</u>: Boats kept in the water year-round often have bottom paints laden with anti-fouling compounds to limit the growth of fouling organisms. Often these paints are comprised of soft materials that are easily eroded and toxic compounds (active ingredients) leach into the water column. Anti-fouling compounds have been a typical contaminant at marinas, especially if a boat yard occurred in conjunction with the marina. Runoff from boat yards contains concentrated levels of metals and other toxic compounds.

Use of anti-fouling bottom paints is not as intense in freshwater environments as in marine waters. Nevertheless, tributyltin, a common ingredient in bottom paints until restricted by Congress in the Organotin Antifouling Paint Control Act in 1988 (U.S. Code Title 33), was found in elevated levels in the Kenmore Navigation Channel, immediately south of the existing marinas.

The proposed Lakepointe development would not include a boat yard or haulout facility. In addition, the current strength and availability of anti-fouling compounds are substantially restricted compared to recent history. No measurable effect of leaching of anti-fouling compounds from bottom paints upon salmonid fishes in the Inner Harbor is anticipated.

3.2.4 Lighting

The existing level of nighttime lighting along the industrial waterfront is high at the Lonstar Cement Plant with average ground light levels of 2.5-foot candles and high spots exceeding 5.0-foot candles one night in November 1996 (Sparling and Candela 1996).

This existing illumination is hypotherized to extend feeding periods of visual sight feeders including both salmonids and salmonid predators into the evening. Extended feeding periods may result in increased consumption of salmon fry known to use the shallow nearshore areas in the evening.

Post-development lighting associated with the buildings as well as safety lighting for the marina, walkways and trails have the potential to illuminate of the surface waters somewhat in the project vicinity. There has not been a study of forecasted lighting from future buildings with project development. Given the existing high level of artificial lighting, this analysis assumes project-associated lighting would not increase illumination in the Inner Harbor. Existing industrial lighting would be removed when the cement plant is phased out.

Safety lighting associated with the trails is not expected to increase illumination of the river given the current level of illumination provided by on-site lights. Nighttime illumination of the river may decrease if existing lights are removed and trailside lighting is beneath and amongst trail side trees and if shading devices are used on the water side of the lamps to deflect glare from the water. Overwater lighting could be minimized by installing tinted windows in the buildings, lampshades that cover the water side of the walkway lamps and thus, shade the adjacent water, and by keeping pedestrian lighting low on the moorage docks.

3.2.5 Water Temperature

The highest annual water temperatures for the Sammamish River are typically recorded in July or August and generally range from 18.4° to 22.0°C (King County 1993). High seasonal temperatures are due primarily to the warm surface water of Lake Sammamish flowing into the river and also to the scarcity of riparian trees and shrubs along the banks of the river to provide shade. These high temperatures exceed the thermal optima for most coldwater salmonid species and may impede migration of adult sockeye and chinook salmon in the late summer and early fall. They may also reduce the feeding and growth potential of rearing juvenile salmonids. These temperature recordings do not exceed lethal temperatures reported in the literature to occur around 24°C for the most sensitive salmonid species (U.S. Environmental Protection Agency 1986; Bell 1990).

Surface water temperatures in the backwater area of the Inner Harbor are anticipated to be similar to or slightly warmer (~ 1°C) than temperatures in the river. Measurements taken during fishery studies recorded temperatures up to 21°C in June 1996. Deep waters in the Inner Harbor averaged approximately 1.4°C cooler than surface waters during Spring 1997, and may offer some thermal relief. But since coldwater salmonids show a general avoidance of 19°C and higher, it is assumed the backwater area of the Inner Harbor is not conducive to juvenile salmonids during the summer months.

Project development is not anticipated to increase water temperatures in the Inner Harbor. Removal of a few Douglas fir, black locust and black cottonwoods may be required during trail construction and during construction of the amphitheater along the lakefront. Such removal is not expected to affect water temperatures in these areas since the trees presently provide little, if any, thermal protection for the river. Given the aspect of the sun to these shorelines, the wide surface area of the river and the extensive flat shallow area adjacent to the lakeshore, measurable water temperature changes in these areas are not anticipated.

3.2.6 Boat Traffic

Boat traffic in the Kenmore Navigation Channel would change from industrial use (barge, tug and large commercial vessels) to light recreational (private craft 40 to 70 ft. in length) with the proposed development of a moorage facility in the Inner Harbor. The number of craft would increase, but use would change from deep draft to shallow draft boats. Anticipated harbor speeds would likely be less than 5 knots and traffic would be concentrated in the middle of the harbor. No data are available indicating vessel traffic has an adverse effect upon fish species. Weitkamp (1982) indicated that juvenile salmonids in marine environments near piers returned to their normal behavior immediately after a boat passed. There are no anticipated impacts to fish from boat traffic in the Inner Harbor.

A WDFW public boat launch is located on the south bank of the Sammamish River immediately downstream of the 68th Ave. NE bridge. The boat launch is frequently used by sport anglers and by recreational boaters and jet ski enthusiasts bound for Lake Washington. As a result, boat traffic in the lower reaches of the Sammamish River can be heavy during periods of suitable weather. There is no anticipated change to salmonid behavior in the river from current conditions related to increased boat traffic from the proposed marina.

3.2.7 Shoreline Recreational Use

Promenade

Public use of the fixed pier in the Inner Harbor would increase the level of human disturbance over the waterway. The primary disturbance would be noise and vibration as discussed in Fish Impact Section 3.2.8, below.

Public Access Trail/Firelane

The public access trail/firelane along the north shore of the Sammamish River and the Lake Washington shoreline is more than 100 feet and 45 feet, respectively inshore of the OHWM. Salmonid use of the nearshore areas occurs primarily during the night, when these species move inshore for resting purposes. Little, if any, human disturbance to salmonid use of the Sammamish River is anticipated since the peak period of disturbance would not overlap with nearshore salmonid use.

Fishing Pressure

There is no commercial or active tribal fishery in the Sammamish River. Although the Muckleshoot Tribe has an historic treaty fishery at the mouth of the Sammamish River, they have voluntarily ended the harvest until resource levels increase in the future. As such, there is no commercial or active tribal fishery in the Sammamish River area. Public access to any future fishery would be subject to fisheries resource agency and tribal evaluation. Boat traffic from the marina would be concentrated in the defined navigational channel and should not affect any future tribal net fishery.

Sport fishing remains a popular activity on the Sammamish River. The Kenmore area near the mouth of the Sammamish River was noted in a WDW gamefish guide as a good area in Lake Washington to catch largemouth bass and cutthroat trout. The Lakepointe development would not affect public access to Lake Washington from the WDFW boat launch and would not restrict fishing opportunities in the Kenmore area.

Shoreline recreational use would increase with the anticipated development. Increased public access would likely add to fishing pressure. Increased fishing access along the north shore of the Sammamish River is not regarded as an adverse effect upon salmonid populations. If spawning recruitment levels are not met, the fisheries resource agencies and Tribes would evaluate sport fishing closures on a species by species basis.

3.2.8 Noise

Fish detect and respond to sounds in their environment. Salmonids hear with a primitive version of an inner-ear and with the lateral line systems that runs the length of each side of the fish. The lateral-line is extremely sensitive to close-range pressure changes. Nevertheless, salmonids have relatively poor hearing on the basis of perceivable frequency range and sensitivity to sound pressure. The hearing ability of salmonids is limited in bandwidth and intensity thresholds compared to other fish.

Atlantic salmon juveniles cannot hear sound frequencies > 380 Hz (Hawkins & Johnstone 1978), whereas most other fish species can hear frequencies up to 1,000 Hz and some to 7,000 Hz. Salmonids are capable of hearing infrasound levels down to 1 Hz and actively avoid less than 10 Hz frequencies (Enger et al. 1993).

The classic fright response of salmonids to sound is not dramatic. Salmonids typically elicit a "startle" or "start" behavior involving a sudden burst of swimming that is short in duration and distance traveled (<2 ft) (Feist 1991). Without a conditioned response to the stimuli, they would rapidly habituate to the sound. Fish have shown a more pronounced reaction to pulses, similar to pile driving, rather than continuous pure sounds.

An increase in the level of noise and shallow water vibration will occur with human activity associated with the moorage facility in the Inner Harbor and during project construction, especially related to diving pilings that support the development. Marina activities occur primarily during daytime hours and salmonid use of marinas has not been shown to be curtailed in marine waters (Jones and Stokes 1996; Taylor and Willey 1997). No effect of noise from marina operations on salmonid use of the Inner Harbor is projected.

Use of the promenades will likely occur during both daytime and nighttime hours. Outdoor activities could include alfresco dining, bars and live outdoor music. Fish have highly developed sensory capabilities and are sensitive to vibrations in the water. They readily react to sharp vibrations or movement, which may increase their exposure to predation. There is no literature available regarding the response of resting salmonids to such nighttime noise disturbances. Thus, any anticipated effect is unquantifiable. Given the likely avoidance of this warm backwater area during warmest months of the year (July to September), this unquantifiable impact is deemed to be a minor and unavoidable project impact.

Pile driving has been hypothesized to adversely affect juvenile salmonids by startling them toward deeper water. Such departure from the protective confines of the nearshore area could place them at a disadvantage by prohibiting optimal foraging opportunities and by exposing them to increased predation. Habituation to the sound could mask sounds of approaching predators, reducing survivability.

The impact of pile driving on the distribution and behavior of juvenile salmonids was studied during construction of the US Navy Home Port in Port Gardener, Everett (Feist 1991). Salmonids have trouble detecting sound pressure levels < 100 dBs at frequencies between 20-40 Hz (Hawkins & Johnstone 1978) and sound shocks need to be 20-30 dBs higher than ambient to induce a behavioral response (Feist 1991). Sound levels from pile driving hollow and solid concrete piles at the Home Port site were in excess of 20 dBs above ambient and within the range of salmonid hearing. The author concluded it was conceivable the sound field generated by pile driving in marine water could be detected by salmonids within 300 m (1000 ft) radius from the source. The sounds may be audible, but the relevance of the pulsed signal to fish could not be determined. According to Fiest (1991), the effects of pile driving appear to be subtle and include changes in general behavior noted by short-burst responses laterally along the shoreline, reduction in sizes of schools and reduced presence in the near-field construction zone. However, the prevalence of fish schools near the site did not change significantly with and without pile driving. Schools of juvenile salmonids were observed during operations about the pile driving rigs themselves. There were no significant differences observed in fish distance from shore or changes in water depth as a function of pile driving. Without an observed startle response to deeper water, the anticipated increase in predation is judged to be unlikely. Thus, any impacts from pile driving on salmonid fishes are judged to be short-term and minor in nature.

3.2.9 Exotic Plants

Milfoil (*M. spicatum*) currently grows along the Lake Washington shoreline. This shallow stretch of shoreline is predominately a leeward beach on Lake Washington. It receives an accumulation of debris during southerly winds that serves as a constant source for milfoil recruitment. Although considered a noxious weed, the milfoil in this location is used by yellow perch as spawning substrate as noted during our surveys and could also offer limited amount of cover for salmonid fishes rearing in this area. No organized efforts are underway to remove the milfoil.

Improving water clarity and opening new shallow water beach areas along the north edge of the Inner Harbor may offer a limited amount of habitat for milfoil to colonize. The amount of shallow water habitat in the Inner Harbor is quite restricted, such minor habitat modification is not considered a significant project effect.

3.3 FISH HABITAT MITIGATION MEASURES

Fish mitigation for the Lakepointe Development would incorporate adverse impact avoidance, minimization and mitigation as well as habitat enhancement as described below. Significant impacts would be avoided where possible and efforts would be made to minimize impacts that cannot be avoided. A summary of impacts deemed significant is provided in this section. On-site mitigation for significant unavoidable adverse impacts are recommended through mitigative and enhancement measures within the Inner Harbor.

3.3.1 Significant Impacts and Associated Mitigation

Structures

Over-water structures

Shade cast from overwater and floating structures with the proposed project will be less than the existing condition. Nevertheless, the following mitigation measures are proposed in the design to maximize light penetration for increased biological productivity and for further reductions in predator refuge areas possibly created by shade:

Proposed Mitigation — The following are recommended for inclusion as proposed mitigation for over-water structures:

1) Provide large grated openings or glass prisms in above-water decking to allow ambient light to penetrate to the littoral zone. Such mitigative action has been successful at other marinas and wharfs to improve fish passage and utilization of habitat below pier structures. Glass prisms (4" x 6" blocks) have been found to provide as much light below floating deckwork as large 4 x 8 ft. grated openings (Fisher, pers. comm., 25 March 1998). This effort would increase aquatic productivity and would provide sufficient light for salmonids to enter and use this area.

2) Remove the bulkhead along the eastern shoreline where it is not functionally required for the proposed project. Return the beach area to a gradual 3:1 slope. This effort would create approximately

+5,100 ft² (a 20% increase) of additional littoral area that does not currently exist at this location. A plan view and cross sections of the mitigation beach are provided in Figures 3-21 and 3-22.

In-water Structures

In-water structure has been hypothesized to increase the abundance of predator fish habitat and potentially increase incidents of predation on juvenile salmonid fishes. The current situation in the Inner Harbor includes and abundance of in-water structure, 377 pilings, 1,131 ft. of timber supported bulkheads and various other structures (Figure 3-5, Table 3-5). Juvenile salmonids should be at less risk to predation following project development than under present conditions. Nevertheless, the following mitigation measures are proposed in the design to further reduce the effects of possible predator ambush habitat remaining post-development. The number of pilings in the Inner Harbor would decrease approximately 35 percent with the proposed action. The following three approaches are prevalent in the scientific literature to reduce potential predation on salmonid fishes:

1) Offer shallow water refuge habitat.

2) Offer greater habitat complexity nearshore in shallow water to increase visual cover means of rock surfacing, adding boulder clusters or by the addition of emergent/submergent vegetation.

3) Promote the production of three-spine sticklebacks. Salmonid aggregation with similar sized (60-80 mm) sticklebacks reduces the risk of predation.

Shallow Water Refugia: The presence of shallow water and cover significantly decreases predation rates on juvenile fishes. Vulnerable fish with no place to hide must make a trade off between feeding and avoiding predators (Eggers 1980). In open water, fish have no place to hide. Tabor and Chan (1996) conclude the highest predation risk for sockeye from predatory fish occurs in deep water. Selection of inshore shallow water for cover is believed to be primarily a response to greater predation risk in deep water (Tabor and Wurtsbaugh 1991; Beauchamp et al. 1994).

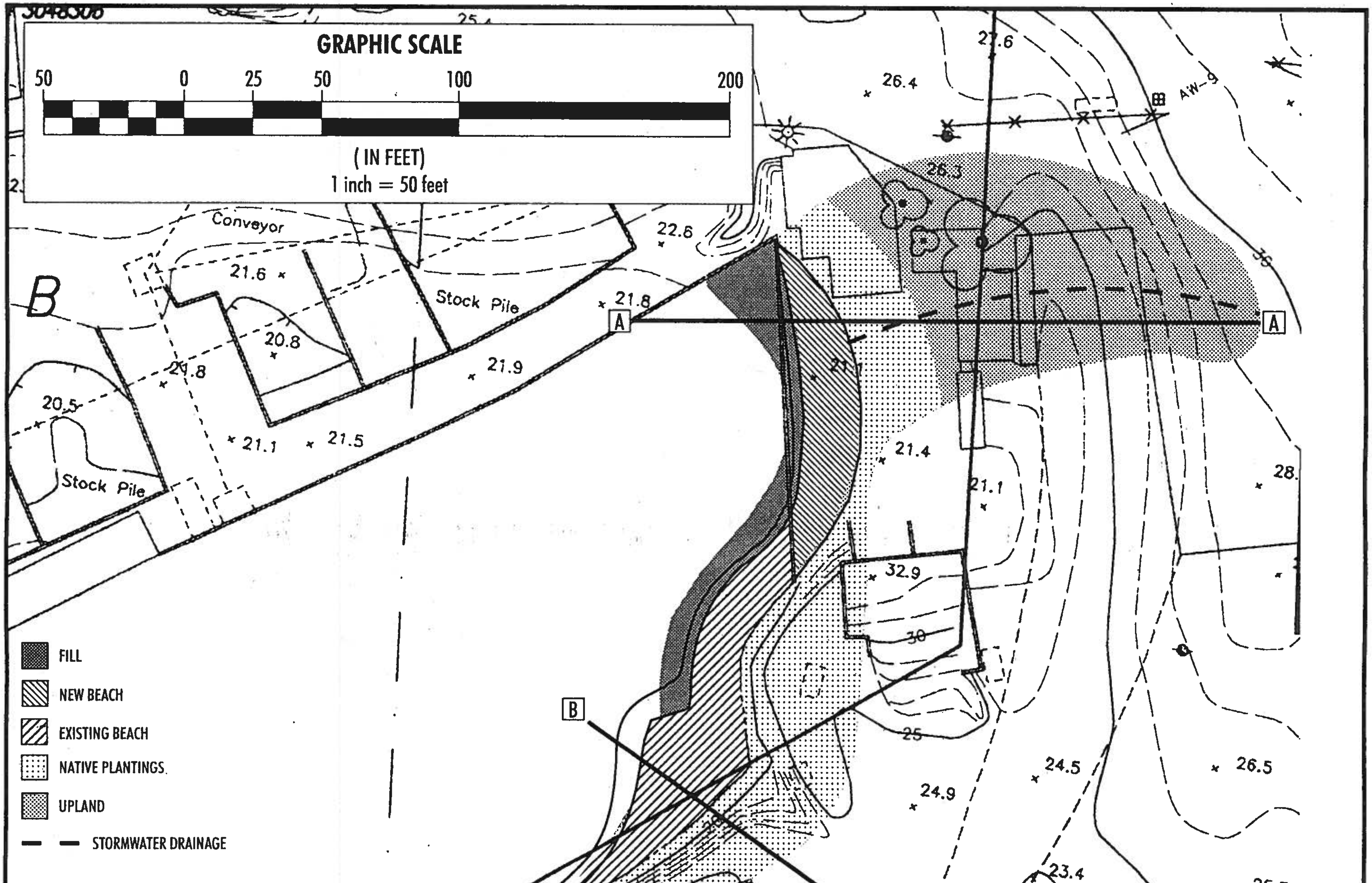


Figure 3-21
Approximately 540 yd³ of fill to achieve 3:1 Beach slope from OHWM

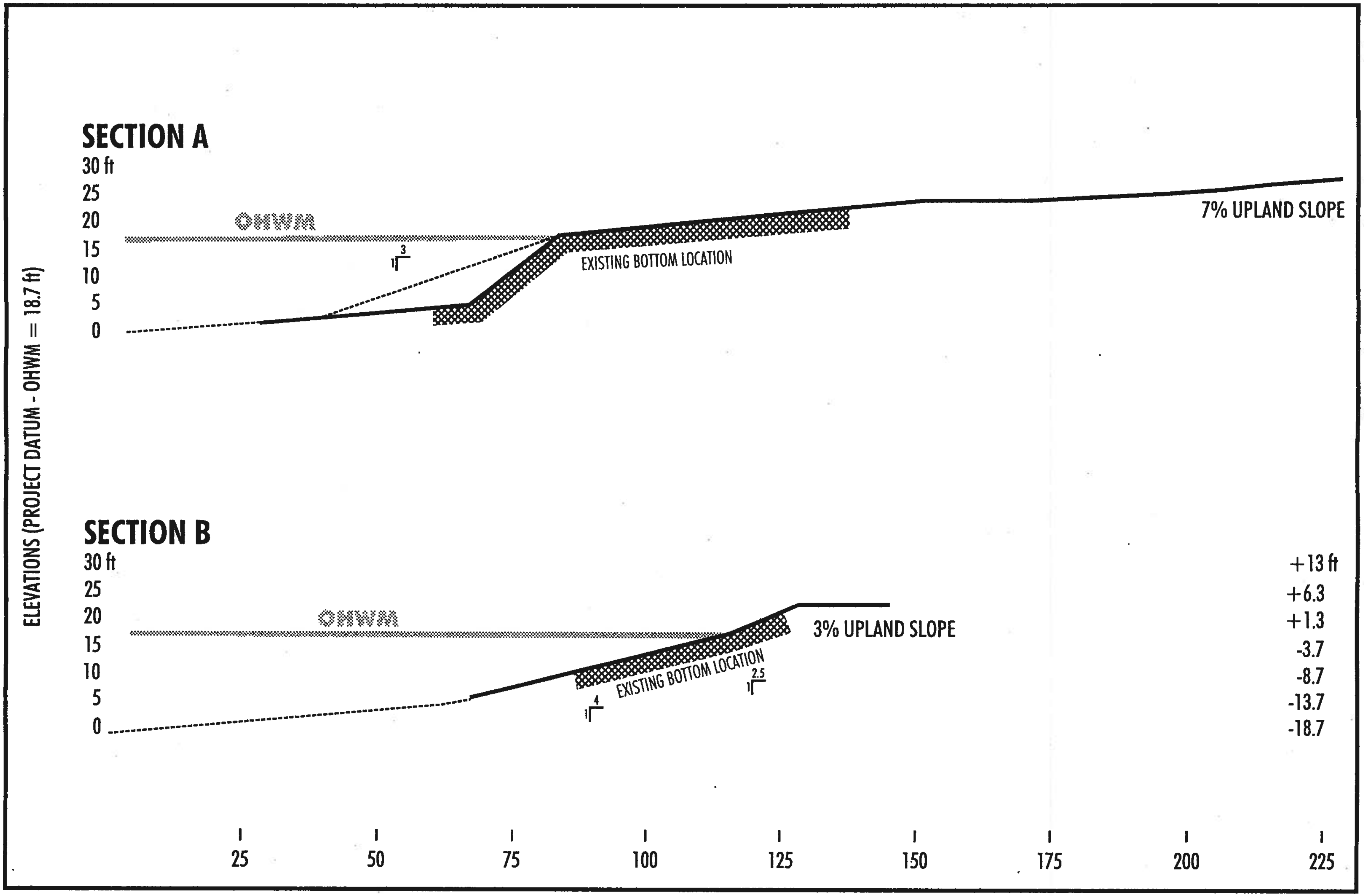


Figure 3-22. Mitigation Beach Cross Sections (Fill Option)

Habitat Complexity: Fish species and sizes most vulnerable to predation tend to associate more closely with structure (Stein 1979; Crowder and Cooper 1979; Beauchamp et al. 1994). Daily predator capture rates decrease with increasing habitat complexity since interstitial spaces with large particle substrates provide effective refugia for fish (Crowder and Cooper 1979). Crowder and Cooper (1979) also noted reduced largemouth bass capture rates with increased quantities of aquatic plants.

To avoid predation, fish often move to structurally complex habitats where predators cannot forage effectively (Glass 1971; Savino and Stein 1982; Tabor and Wurtsbaugh 1991; Beauchamp et al. 1994). Increased structural complexity reduces both attack rate and capture rate of largemouth bass (Glass 1971). In most of these studies, fish larger than 100 mm were not as vulnerable to predatory fishes, whereas small fish (<100 mm) were more vulnerable and remained in or near shallow nearshore water with complex habitat structure (Beauchamp et al. 1994).

Three-spine Sticklebacks: Ruggerone (1992) observed a considerable reduction (45%) in predation rates on juvenile sockeye in the presence of three-spine sticklebacks. Sockeye and sticklebacks are frequently sympatric in Pacific Northwest lakes. Many predatory fish appear to avoid three-spine sticklebacks primarily due to their dorsal spines. Sockeye aggregated with sticklebacks of the same size are offered similar protection.

Proposed Mitigation: The following are recommended for inclusion as proposed mitigation:

1) Increase the amount of shallow water habitat available for refuge from predators. Mitigation item #2 above for over-water structures increases shallow water habitat by approximately +5,100 ft^2 (+20%).

2) Surface the nearshore regions with fine sediment and organic materials to improve stickleback use and production.

3) Plant emergent vegetation along shallow nearshore beaches to increase habitat complexity and decrease predator capture rates.

4) Encourage dock-side fishing and support bass (or other warmwater fish) fishing tournaments focused on the Inner Harbor to reduce the potential predator base.

Marina

Marina issues related to floating and fixed structures have been incorporated in mitigation options above for over-water and in-water structures. Water quality mitigation options are discussed below:

Proposed Mitigation: The following are recommended for inclusion as proposed mitigation for the marina:

1) Preclude live-aboard residents.

2) Do not provide boat haul-out areas, boat yards and the like.

3) Do not provide fueling facilities.

4) Post, promote and educate boat owners about regulations concerning illegal discharges of waste holding tanks.

5) Prohibit underwater cleaning of the craft in the Inner Harbor.

Lighting

Increased illumination could extend feeding periods of both salmonids and salmonid predators into the evening. This extended feeding period could result in increased consumption of salmon juveniles known to use the nearshore areas along the Sammamish River and in the Inner Harbor in the evening. Options to minimize this effect include:

Proposed Mitigation: The following are recommended for inclusion as proposed mitigation for project lighting:

1) Remove existing lighting along the northshore of the Sammamish River along Lake Washington shoreline and along the Inner Harbor as industrial uses of the site are phased out.

2) Design safety lighting along trails and the marina piers low to the ground.

3) Install lampshades that cover the water side of the lamps to deflect glare from the water.

4) Provided shaded/tinted window surfacing for high rise buildings in the development.

It is recommended future lighting from all buildings and project features not exceed existing levels along the waterfront and shoreline areas surrounding the Lakepointe property.

Noise

The scientific literature concerning pile driving effects on juvenile salmonids is limited to a study in estuarine waters of Puget Sound (Navy Homeport). This study concludes salmonid fishes can hear and may briefly react to the noise and vibration of pile driving. However, no potential significant adverse impacts of the operation were noted. Juvenile salmonids were not driven into deeper water and an increase in predation was not anticipated. As such, noise from pile driving was not considered a significant adverse impact at the Navy Homeport Project in Everett.

This study was limited in its application to estuarine waters with only chum and pink salmon. It is prudent to assume juvenile salmonids would exhibit short-term disturbance behaviors during pile driving operations, but pile-driving is unlikely to have an adverse effect on the populations. An HPA would be required for all in-water construction and would likely preclude pile-driving during the juvenile outmigration period. Such impact avoidance is sufficient and further mitigation is not recommended.

3.3.2 Summary of Mitigation

Fish mitigation items are summarized below with respect to project avoidance, minimization, mitigation and enhancement. A tally of anticipated habitat changes following project development is summarized in Table 3-15. Further detail of the habitat changes and a listing of structures excluded from the DEIS plan are provided in Table 3-16. A summary of the net changes, mitigation and improvement measures is incorporated in Table 3-17.

Table 3-15. Summary of Anticipated Fish Habitat Features with the Lakepointe Development.

	Net Change Following Project Improvements			
Features	**Inner Harbor**	**Lakeshore**	**Sammamish River**	**Total**
Habitat Creation				
Shallow water (ft²)	+5,100	0	0	+5,100
Deep water (ft²)	0	0	0	0
Structures Overhanging OHWM				
Total shaded area (ft²)	-1,492	0	0	-1,492
In-water structures				
Bulkheads (ft)	-115	0	0	-115
Pilings (counts)	-122	-18	0	-140

Table 3-16. Lakepointe Marina Coverage Calculations*.

FLOATING AND FIXED STRUCTURE

Facility Name	Coverage, square ft. Reid-M Est.	Pilings
EXCLUDED from DEIS Plan		
SW Overhang	6,800	68
S Corner	3,300	33
S Bulkhead Overhang	5,600	56
SE Corner	3,000	30
NE Corner Wharf	700	7
Wharf N of trestle	1,500	15
Totals:	**20,900**	**209**
LEFT IN PLAN		
North float access ramps	1,380	28
North Floats	4,360	26
S. Public / Fixed Moorage	8,124	181
South Floats	4,980	20
Totals:	**18,844**	**255**
EXISTING SHADED AREA:		
Structure (float + fixed)	16,733	395
Boats	29,648	0
Total:	**46,381**	**395**
PROPOSED SHADED AREA:		
Structure (float + fixed)	18,844	255
Boats	26,045	0
Total:	**44,889**	**255**

BOATS (square feet)

Existing	29,648
Post-Development	26,045

PILING DETAIL

Area	Existing # removed	# added	Net Change**
Sammamish R./ Lk. Wash. Shore	18	0	-18
Inner Harbor S Shore	26	201	175
Inner Harbor N Shore	351	54	-297
Total:	**395**	**255**	**-140**

BULKHEAD

Area	Existing linear feet	Proposed linear feet	Bulkhead Removed**
Inner Harbor S. Shore	627	569	-58
Inner Harbor N. Shore	504	447	-57
Totals:	**1,131**	**1016**	**-115**

* preliminary estimations based on architectural drawings only.

** all removed bulkhead is creosote timber bulkhead. Approximately 60 additional pilings will be removed with bulkhead that are not included in the pilings count.

NET REDUCTIONS:	
Total Shaded Area	-3%
Total Pilings	-35%
Total Bulkhead	-10%

HABITAT CREATION/ENHANCEMENT (square feet)	
Enhanced, existing inner-harbor shallows < 10 foot depth:	24,936
Created habitat not previously existing < 10 foot depth:	5,100
Created upland habitat adjacent to created habitat <10 foot depth:	17,850

Table 3-17. Lakepointe Mixed-Use Development Summary.

Inner Harbor Shoreline Conditions North Shore	Existing Conditions	Proposed Project Features	Net Change Improvement/Mitigation
Fish Habitat Availability Shallow Water (0-10') (sq. ft.)	23,436 sq. ft. of dredged shoreline cut at 4:1 slope and surfaced with non-native materials.	28,536 sq. ft of shallow habitat including improved substrate materials and creation of new habitat.	+5,100 sq. ft. of new available shallow-water habitat with substrate improvements.
Surface Coverage - Overhang	1,906 sq. ft. of overhang including wooden ramps, old log cabled platform, steel girders, with limited light penetration and concrete platforms	1,565 sq. ft. of overhanging deck work and fixed piers including through deck openings to pass ambient light.	-341 sq. ft. now lighted rather than shaded.
- Floating	5,067 sq. ft. of floating structures including wooden docks, cabled logs and an unused barge with limited light penetration.	0 sq. ft. of marina floats and moored boats.	-5,067 sq. ft. adding more light to shallow waters.
In-water Structure - Bulkheads (ft)	86 ft. of creosote piling bulkhead limiting beach access.	86 ft. of unchanged creosote pilings.	0 sq. ft. No change.
- Pilings (count)	3 unused emergent pilings.	44 wooden, metal or concrete support pilings.	+41 support pilings. The impact of this increase is offset by an overall reduction in the number of shallow water pilings in the Inner Harbor.
Deep Water (>10') (sq. ft.)	77,590 sq. ft. of deep water, a majority has been dredged; bottom substrate consists of soft silty sediment.	75,490 sq. ft. of unchanged deep water area.	-2,100 sq. ft. of deep-water habitat converted to shallow habitat.
Surface Coverage - Overhang	770 sq. ft. of concrete decking overhang with no light penetration.	6,559 sq. ft of overhanging fixed piers including through deck openings to pass ambient light.	+5,789 sq. ft. now lighted rather than shaded. The impact of this increase is offset by an overall reduction in surface coverage in the Inner Harbor.
- Floating	2,728 sq. ft. of floating structures including wooden decking and an annual equivalent of 21,773 sq. ft. of fishing boats and commercial vessels with limited light penetration.	4,935 sq. ft. of marina floats and an annual equivalent of 14,813 sq. ft. of moored boats.	-4,753 sq. ft. adding more light to deep waters.
In-water Structure - Bulkheads (ft)	488 lineal ft. of creosote piling bulkhead.	430 lineal ft.	-58 ft. removal of creosote bulkhead.
- Pilings (count)	23 unused emergent pilings and dolphins.	176 wooden, metal or concrete support pilings.	+153 support pilings. The impact of this increase is offset by an overall reduction in the number of deep water pilings in the Inner Harbor.

Table 3.17. Continued.

Inner Harbor Shoreline Conditions North Shore	Existing Conditions	Proposed Project Features	Net Change Improvement/Mitigation
Fish Habitat Availability			
Shallow Water (0-10') (sq. ft.)	1,500 sq. ft. of shallow water behind burned out bulkhead and trestle supports.	1,500 sq. ft. of unchanged shallow water.	No change.
Surface Coverage - Overhang	1,200 sq. ft. of decking overhang with limited light penetrations.	40 sq. ft. of overhang fixed ramps to access marina floats.	-1,160 sq. ft. of overhang adding more light to shallow water.
- Floating	0 sq. ft. of floating structures in shallow water.	0 sq. ft. of unchanged floating structures.	No change.
In-water Structure - Bulkheads (ft)	104 ft. of concrete and creosote bulkheads limiting beach access.	104 ft. of unchanged concrete and creosote bulkheads.	No change.
- Pilings (count)	144 emergent and submergent un-used pilings.	2 wooden, metal or concrete support pilings with substrate improvements to create refuge habitat.	-142 pilings.
Deep Water (>10') (sq. ft.)	77,590 sq. ft. of deep water, a majority has been dredged; bottom substrate consists of soft silty sediment.	77,590 sq. ft. of unchanged deep water area.	No change.
Surface Coverage - Overhang	4,292 sq. ft. of decking overhang and covered boat moorage with limited light penetration.	1,340 sq. ft. of overhanging access ramps including through deck openings to pass ambient light.	-2,952 sq. ft. removal of shoreline overhang and covered boat moorage adding more light to the water column.
- Floating	7,875 sq. ft. of floating structures including barge and tug moorage with limited light penetration.	4,360 sq. ft. of marina floats and an annual equivalent of 11,232 sq. ft. moored boats.	+7,717 sq. ft. of floating structures. The impact of this increase is offset by an overall reduction in floating structures in the Inner Harbor
In-water Structure - Bulkheads (ft)	368 lineal ft. of concrete and creosote bulkheads limiting beach access.	311 lineal ft.	-57 ft. removal of creosote bulkhead.
- Pilings (count)	207 emergent and submergent un-used pilings.	52 wooden, metal or concrete support pilings	-155 pilings.

Table 3-17. Continued.

Lake Washington Shoreline Conditions **Phase 3**	**Existing Conditions**	**Proposed Project Features**	**Net Change Improvement/Mitigation**
Fish Habitat Availability			
Shallow Water (0-10')	382,500 sq. ft.	382,500 sq. ft.	0
Deep Water (> 10')	0 sq. ft.	0 sq. ft.	0

Sammamish River Shoreline Conditions **Phase 1 (east end), 3 (west end), 4 (central)**	**Existing Conditions**	**Proposed Project Features**	**Net Change Improvement/Mitigation**
Fish Habitat Availability			
Shallow Water (0-10')	40,500 sq. ft.	40, 500 sq. ft.	0
- Piling Count	18 unused emergent wooden pilings.	0	-18 wooden pilings removed.
Deep Water (> 10')	84,375 sq. ft.	84,375 sq. ft.	0

Avoidance

By project design, the Lakepointe development plans to avoid, wherever possible, direct effects on economically important salmonid fishes. The design intent is to improve fish habitat conditions compared to existing conditions and not to impede the regional goal to recover these vital populations. The following approaches shall avoid impacts:

- Project structures within or overhanging the OHWM along the Sammamish River and the Lake Washington shoreline, the two most sensitive fish habitat areas along the property, would be avoided.
- Post-project shade from overhangs and floating structures will be less than current conditions in the Inner Harbor.
- Post-project level of in-water structures will be less than current conditions in the Inner Harbor.
- Boat haul-out areas, boat yards and the like associated with marina development would be avoided.
- Fueling facilities at the marina would be avoided.
- Live-aboard marina residents would be precluded.
- In-water construction within the OHWM would be precluded during the juvenile salmonid outmigration period in accordance with future HPA conditions.

Minimization

Further design features and operational procedures are specifically incorporated in project development to minimize potential adverse effects on salmonid fishes, as follows:

- The overwater coverage of available shallow water habitat by floats within the Inner Harbor would be minimized.

- Access ramps to marina floats are designed perpendicular to shore to minimize the amount of shallow water coverage.

- The proposed project will eliminate lights protruding over water and will employ the following measures to minimize project lighting. The level of incident light reaching the shoreline and Inner Harbor areas, would be minimized through directional lighting and shading. Safety lighting along trails and the marina piers would be designed low to the ground and lampshades that cover the water side of the lamps to deflect glare from the water would be installed. Existing lighting along the northshore of the Sammamish River and along the Inner Harbor would be removed as industrial uses of the site are phased out. High rise building windows would be tinted.

- Illegal discharges of waste holding tanks from watercraft would be minimized by posting, promoting and educating boat owners about the appropriate regulations.

- The effects of leaching anti-fouling paints would be minimized by prohibition of underwater cleaning of watercraft in the Inner Harbor through moorage leasehold covenants.

Mitigation

Mitigation, including the creation of beneficial habitat conditions not currently present in the Inner Harbor is incorporated to further offset project influences as follows:

- The adverse effects of increased shading of shallow water habitat would be mitigated with large grated openings, clearstory and/or glass prisms in overwater decking.

- Further reduction in salmonid predator habitat would be accomplished by 1) increasing the amount of shallow water habitat available for refuge, 2) increasing habitat complexity by adding emergent vegetation for salmonid hiding/refuge habitat; and 3) encouraging dock-side fishing and supporting bass (or other warmwater fish) fishing tournaments focused on the Inner Harbor to reduce the potential predator base.

Enhancement

Fish habitat enhancement in the Inner Harbor is designed as an improvement to the existing physical setting , as follows:

- The amount of shallow water habitat in the Inner Harbor would be increased by (+5,100 ft^2) by removing 115 ft. of bulkhead along the eastern portion and returning the beach area to a gradual (3:1) slope. This effort would create additional shallow water (<10ft.) littoral area that does not currently exist (Table 3-17). The shallow nearshore region of the beach +17.7 project elevation will be vegetated with native emergent species appropriately selected from Table 3-18, to increase habitat complexity, adding cover and refuge habitat from predators for juvenile salmonid fishes. A 25 ft. zone of native vegetation included downed wood and trees upland of the OHWM will also be added (Figure 3-21). These native plantings will be protected from human intervention.

- The debris and unusable in-water structures including pilings and decaying bulkhead stumps in the river, lakefront and Inner Harbor areas would be removed (Table 3-16).

- Uncontrolled and untreated stormwater runoff entering the Inner Harbor with occasional high levels of fine sediment would be eliminated and adjacent industrial land uses including the need for harbor tugs and barges would be phased out. Such action would enhance the aquatic productivity potential in the harbor by decreasing turbid water conditions.

Table 3-18. Native Plant Species that could be used for restoration plantings in the Inner Harbor.

Deep Emergents[1]

Hard stem bul rush *(Scirpus acusts)*

Shallow Emergents

Water plantain *(Alisma plantago-aquatica)*
Slough sedge *(Carex obumpta)*
Common spike rush *(Eleocharis palustix)*
Western mannagrass *(Glyceria occidentalis)*
Water parsley *(Oenanthe sarmentosa)*
Small fruited bulrush *(Scirpus microcarpus)*
American brooklind *(Veronica americana)*
Arrowhead wapato *(Sagiltaria latifola)*

Wet Emergents[2]
Lady fern[3] *(Athyrium filix-femina)*
Oregon iris (*Iris tenax*)

Wetland Shrubs and Trees

Red osier dogwood[4] *(cornus stolonifera)*
Willow4 *(Salix hookeriara; S. lasiandra; S. scouleriana; S. sitchensis)*
Salmonberry *(Rubus spectabolis)*
Crabapple[5] *(Pyrus fusca)*
Block hawthorne5 *(Crataegus douglasii)*
Cascara5 *(Rhamnus purshiana)*
Peafruit rose *(Rosa pisocarpa)*
Nutka rose *(Rosa nutkana)*
Western redcedar *(Thya plicata)*

Upland Shrubs & Trees

Baldhip rose *(Rosa gymnocarpa)*
Snowberry *(Symphoricarpos albus)*
Hazelnut *(Coryhus cornuta)*
Vine maple *(Acer cirinatum)*
Mountain ash[6] *(Sorbus sitchensis)*
Quaking aspen *(Populus tremuloides)*
Douglas fir *(Pseudotsuga menziesii)*
Western hemlock *(Tsuga heterophylla)*

Use salal, ferns or other native upland ground covers as needed to create continuity with selected design.
Selectively place logs or stumps in the native plant communities to provide woody debris for wildlife habitat.

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[1] maximum growing season inundation depth of 1 ft.
[2] outside of inundated areas
[3] plant in shaded areas
[4] plant at water's edge or in seasonally saturated soils
[5] plant scattered individuals
[6] Scattered individuals

- The small amount of existing shallow beach habitat along the southwest shore of the Inner Harbor will be enhanced by removal of existing in-water structures and debris and with native emergent plantings between project elevation 17.7 ft. to the waters edge. Other species tolerant of seasonally wet soil conditions shall be planted at waters edge up to the bulkhead. (Table 3-18)

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