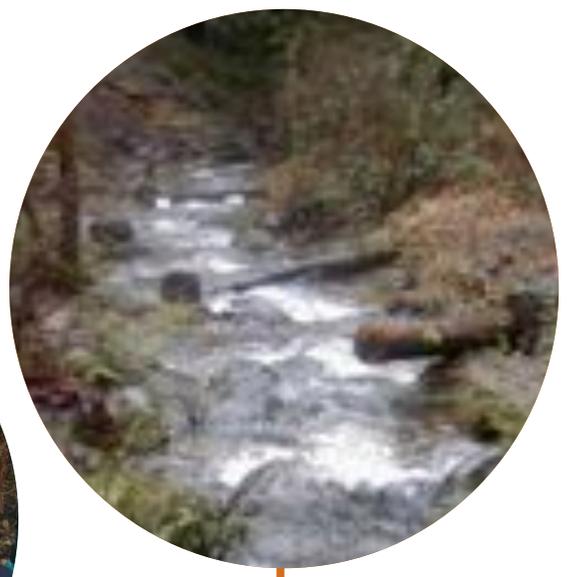


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Watershed Survey

O. O. Denny Creek





Denny Creek Neighborhood Alliance

*...to preserve, protect, and restore the natural resources of the area
and promote stewardship of wildlife and the environment.*

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King County
Department of
Natural Resources and Parks
**Water and Land Resources
Division**

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Executive Summary

O.O. Denny Creek, classified as a Type F stream¹, containing fish and fish habitat, is located in the WRIA-8² Lake Washington / Cedar / Sammamish Watershed and flows into the northeast end of Lake Washington. Cutthroat trout are resident in the stream and have been since earliest record. In a 1996 O. O. Denny Creek Fisheries Assessment³, Washington State fish biologist Gary Davis quotes the King County Sensitive Area Map Folio (1990) as indicating the presence of salmonids, as well. However, recent documentation of an adult Coho salmon spawning run did not occur until November of 2006. This absence of adult Coho salmon, and the absence of resident cutthroat trout in the upper part of the stream, has led to concern over the health of the stream and its immediate watershed of 860 acres.

Denny Creek Neighborhood Alliance (DCNA), a local nonprofit community organization, initiated a 3-year watershed assessment to analyze why the salmon have been absent from the stream in recent years. Some of these assessment tasks were to:

- Ground-truth the boundaries of the watershed and the present course of O.O. Denny Creek;
- Analyze the changes in surface water runoff that have occurred with residential development since 1936;
- Determine historical and current land use within the watershed;
- Analyze the biological health of the stream as measured by the Index of Biological Integrity (IBI);
- Measure the water quality of the stream at various times of the year;
- Evaluate stream water for chemical contamination;
- Make serial measurements of flow to determine the proportion of storm water runoff entering the stream at various points;
- Measure the range of flow from the dry season to heavy winter rainstorms;
- Catalog vegetation observed within the riparian zone of the stream;
- List wild fauna seen within the parks surrounding the stream;
- Conduct a wetland survey;
- Conduct an appraisal of retention/detention facilities;
- Map the storm water drainage system within the watershed;
- Accumulate hydrology data gathered using a local weather station;
- Establish a GIS data base for the watershed;
- Coordinate with other conservation organizations and cities.

As a result of this project, we have concluded that the water quality in the stream is adequate to support salmon spawning habitat. The stream is healthy, and it will support adult salmon migration and fry incubation and rearing. However, residential development has had several

1 King County Code 21A.24.355

2 Washington State Dept of Ecology's Water Resource Inventory Area

3 Fisheries Assessment of O. O. Denny Creek, Denny Creek Neighborhood Alliance, 1996

degrading effects. There has been a major change in the hydraulics of the watershed due to the loss of wetlands, diversion of historical watershed flows to other watersheds, and an increase in impervious surfaces. These factors, along with others, have resulted in low dry season flows and flash flooding during wet season storms. This flash flooding has resulted in erosion with the loss of much of a stream bed suitable for salmon redds. Significant improvements need to be made in the watershed: rainfall detention, surface water flow management, the control of in-flow of water into the stream, and prevention of further degradation of the watershed.

Several physical impediments to upstream fish migration have been identified. A fish ladder constructed just prior to this survey removed the largest obstruction, however access to the stream at its mouth remains impaired due to the lack of a protective riparian zone at that point. Additionally, the culvert under Juanita Drive presents an obstruction to fish passage. A similar obstruction at Holmes Point Drive has been mitigated by recent reconstruction of that culvert specifically intended to allow the passage of migrating fish.

Several actions are necessary to prevent the demise of this salmonid stream. This final report outlines nine recommendations that address physical enhancements/repairs as well as education and outreach. Improvements in the retention and detention of storm flows in the parks and private developments are needed. Several storm flow pipe outlets are in need of erosion control with an emphasis on water retention and energy dissipation. In addition, the riparian zone at the stream's mouth must be made more "fish friendly" to facilitate returning Coho salmon.

In order to raise awareness of the precarious state of this stream, it is critical to promote recognition of O.O. Denny Creek as a defining feature of the parklands through which it passes. Governmental agencies need to recognize that O.O. Denny Creek is an important salmonid stream and its habitat requires special protection from continued degradation.

DCNA is committed to a continuing role in the protection and enhancement of the habitat and the quality and flow characteristics within the watershed of O.O. Denny Creek.

Acknowledgments

Special thanks go to King County Councilmember Jane Hague for her leadership and support of the Denny Creek Neighborhood Alliance and of this project. The National Fish and Wildlife Foundation was also a source of financial support for this survey report as well as other watershed projects. Several staff members of King County and the City of Kirkland were extremely helpful in providing assistance to DCNA during the study.

A special thank you is extended to Eric Arneson, owner of the Finn Hill Shell Station, for providing us with office space to store our computer system and allowing us to install the DCNA weather station on the roof of his facility.

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(Photos by George Ploudre, Kurt Seiffert, and Jim Sproull)

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1. Introduction

O.O. Denny Creek, classified as a Type F stream¹, containing fish and fish habitat, is located in the WRIA-8² Lake Washington / Cedar / Sammamish Watershed. The main stream and its tributaries flow into the northeast end of Lake Washington, draining approximately 860 acres of land in unincorporated King County between Kirkland and Kenmore.

Although the stream's watershed is within the Seattle area urban growth boundary, much of the stream and its tributaries lie within parklands: the 47-acre O. O. Denny Park, an adjacent 7.5 acre parcel called the Susan MacDonald Memorial Forest, and the adjoining 218-acre Big Finn Hill Park. Trails within these parks reveal a heavily wooded, undeveloped park land that is ideal habitat for native flora and fauna, including bald eagles. Evaluation of habitat structures shows a wide and relatively undisturbed riparian zone protecting the lower 3/4 of the stream within the park boundaries, approximately 1.5 miles in length. A map of the O. O. Denny Creek watershed can be found in Appendix A. A partial

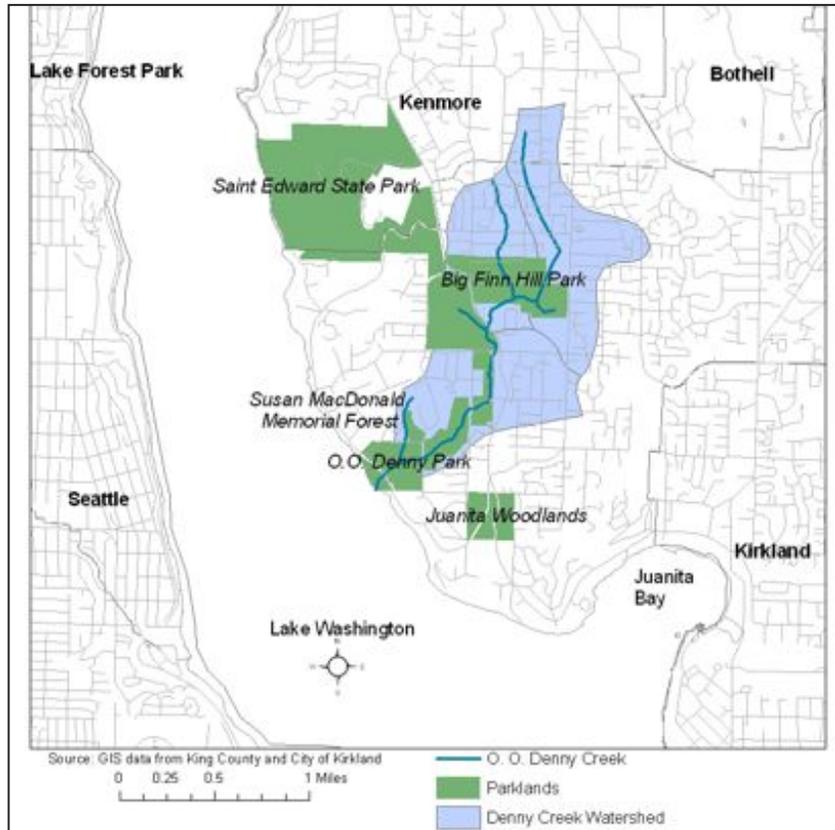


Figure 1 - Overview of O. O. Denny Creek Watershed

listing of native and invasive plants growing in the riparian zone is provided in Appendix B. Wild fauna observed in the parkland surrounding the stream are listed in Appendix C.

Development has increasingly encroached on the stream as neighboring steep slopes are cleared and drainage patterns are altered. In 1987, the Natural Resources and Parks Division and the Surface Water Management Division of King County conducted a comprehensive Reconnaissance of the Lake Washington Basin³. This report noted the threat of damage to property from erosion and the damage to fish habitat due to barriers to fish migration and degradation of water quality. Severe erosion with heavy siltation of the stream and the creation of a silt delta at the mouth of the stream in Lake Washington were also noted in the Reconnaissance Report, as well as in anecdotal reports from neighborhood residents of that time. Subsequently, some of their recommendations have been carried out and others have not.

Recognizing that the watershed was changing with no over-arching plan for the continued

1 King County Code 21A.24.355

2 Washington State Dept of Ecology's Water Resource Inventory Area

3 Reconnaissance Report #28 Lake Washington Basin, Natural Resources and Parks Division and Surface Water Management Division, King County, WA, 1987

health of the stream and its adjoining habitat, area residents in 1994 formed the Denny Creek Neighborhood Alliance (DCNA) to “preserve, protect, and restore the natural resources of the area and promote stewardship of wildlife and the environment.”⁴

Of the many projects spearheaded by DCNA⁵, one of the most capital-intensive was the construction, in collaboration with King County, of a fish ladder designed to enable fish to access the upper reaches of the stream.

A concrete bridge had been built over the stream sometime in the 1930’s, and erosion had gradually etched an 8-foot fall, effectively blocking fish passage. In 2000 - 2001 DCNA designed, and funded King County to construct, a fish ladder in Big Finn Hill Park below the concrete bridge. Funding for the project was secured by several government grants. The fish ladder project was completed in 2002.



DCNA’s Remote Site Incubator

With this impediment removed, indigenous cutthroat trout have populated the upper reaches of the stream as far as Juanita

Drive, where another obstruction exists. Starting in 2000, DCNA entered into a 4-year trial project to re-introduce Coho salmon into the stream, operating a state-permitted Remote Site Incubator (RSI). Each year of the project, 5,000 fertilized hatchery salmon eggs were received from the Issaquah Salmon Hatchery and incubated in the stream from late December through early February; salmon carcasses were introduced into the stream each fall to simulate the nutrient boost that the stream would receive from spawning salmon.

The estimated survival rate was over 90%. Salmon fry were observed in the stream throughout the 16 months of residency. Although the 2000 and 2001 hatch years were not observed returning to O. O. Denny Creek, probably due to low-flow years, November and December of 2006 saw returning salmon from the 2003 brood; one salmon carcass was found ¼ of a mile above the fish ladder. This success indicated a potential for the stream to serve as a link in the diversity and spatial distribution of habitat available to support a viable and resilient wild salmon population in the WIRA-8 watershed.

It was observations associated with this project that led to the realization of the need for an in-depth assessment of the O. O. Denny Creek watershed. This report presents the results of the 3-year assessment, which has contributed significantly to an understanding of the dynamics of the stream and its associated watershed. The remainder of this section outlines the purpose and goals of the assessment, offers a brief historical perspective, and provides a roadmap to the remainder of the document.

A. *Project Goals and Scope*

DCNA formed a Watershed Survey Team whose overall goal was defined as: To protect and,

⁴ Bylaws of Denny Creek Neighborhood Alliance

⁵ Refer to <http://www.dennycreek.org> for more information on related projects.

where feasible, enhance the habitat and the quality and flow characteristics of water in O. O. Denny Creek in order to have a healthy stream that fully supports native cutthroat trout, anadromous salmonid populations, and other residents of the stream and environs.

In support of this goal, the DCNA Watershed Survey team identified the need for a watershed assessment that would provide a sound basis for recommended preemptive and mitigation actions. The primary objective of this assessment was to evaluate the present condition of the O. O. Denny Creek watershed as habitat for salmonids. This evaluation was based in part on methods described in *The Streamkeeper's Field Guide*⁶ and the American Fisheries Society's *Aquatic Habitat Assessment - Common Methods*⁷.

In consultation with individuals within the King County Department of Natural Resources and Parks, the scope of the assessment was defined to include:

- reconnaissance and mapping of the present course of the stream, including reassessing the current boundaries of the watershed;
- analysis of the quality and quantity of water flowing in the stream throughout the year;
- assessment of the effect of urban development in the area, as well as the degree to which this development impact has been mitigated in its management, such as the government response to the 1987 Basin Reconnaissance Report.

The Watershed Survey team first met in November of 2003 and has been meeting monthly since that time. The team established an archiving system to store relevant data as they were collected, as well as procuring and installing hardware such as a computer, weather station, and monitoring devices. Assessment tasks included:

- Ground-truthing the boundaries of the watershed and the present course of O.O. Denny Creek;
- Analyzing the changes in surface water runoff that have occurred with residential development since 1936;
- Determining historical and current land use within the watershed;
- Analyzing the biological health of the stream as measured by the Index of Biological Integrity (IBI);
- Measuring the water quality of the stream at various times of the year;
- Evaluating stream water for chemical contamination;
- Making serial measurements of flow to determine the proportion of storm water runoff entering the stream at various points;
- Measuring the range of flow from the dry season to heavy winter rainstorms;
- Conducting a wetland survey;
- Conducting an appraisal of retention/detention facilities;

6 *Streamkeeper's Field Guide, Part Two - Your Stream's Health*, Murdoch and Cheo, Adopt-A-Stream Foundation, 2001

7 *Aquatic Habitat Assessment – Common Methods*, Bains and Stevenson, U. S. Fish and Wildlife Service, 1999

- Mapping the storm water drainage system within the watershed;
- Accumulating hydrology data gathered using a local weather station;
- Coordinating with other conservation organizations and cities.

Because the O. O. Denny watershed extends beyond unincorporated King County, coordination was accomplished with members of several local conservation organizations, including PERK (People for Environmentally Responsible Kenmore), Lake Forest Park Stewardship Foundation, Thornton Creek Alliance, and The Adopt-A-Stream Foundation. In addition, contacts were made with the City of Kirkland and the Northshore Utility District.

B. Historical Context

The earliest recorded activities in the watershed were those of logging, farming, and trade undertaken for half a century starting in the 1860's. In the early 1900's the area was logged and the logs were channeled down log chutes to Lake Washington. Development of the area continued but at a slow rate because of the long distances from the ferry docks and the bridges serving the Eastside.

In 1922, the Denny family of Seattle willed forty acres of land on the lake at the mouth of the stream to the City of Seattle to be used as a park. While still technically a City of Seattle park, Seattle contracted with King County to maintain and operate O. O. Denny Park until 2002, when it transferred this management responsibility to the Finn Hill Park District. In the 1970's the citizens of the area petitioned King County to acquire state DNR land and some private land to create the current Big Finn Hill Park. In 2003, a local family donated eight acres of undeveloped forested land adjacent to O.O. Denny Park to the Cascade Land Conservancy in honor of deceased DCNA member, Susan MacDonald (MacDonald Memorial Forest). Together these parks comprise about one quarter of the area of the watershed and provide a virtually contiguous riparian area for O.O. Denny Creek.

The only businesses within the watershed are in a strip mall north of the intersection of Juanita Drive and NE 141st Street. This strip mall area contains a QFC grocery store, a gas station, an athletic club and some other small businesses. Prior to 1952, the site was an eighty-six acre airport with a 2,600-foot runway.

Prior to 1977, there was no comprehensive development plan for this area. In 1977, King County adopted the Northshore Community Plan and Area Zoning that encompassed the watershed. This plan, modified in 1981 and again in 1993, established some environmental constraints and a requirement to plat for a minimum density of residences.

In 1993, in response to a grassroots effort initiated by DCNA members but supported overwhelmingly by the community, King County passed an ordinance to provide better retention of native vegetation and significant trees. This was implemented as a P-Suffix condition attached to the properties bounded by Holmes Point Drive and Juanita Drive, the majority of which are in the watershed. This suffix extended regulations concerning storm water retention, significant trees, and native vegetation. These requirements were enacted by King County Ordinance No. 13576, July 12, 1999.

C. Structure of this Report

This document serves as a report of the 2006 watershed assessment of O. O. Denny Creek.

A profile of the stream from its confluence with Lake Washington to its upper reaches in the residential subdivisions of Finn Hill is provided first. This profile is drawn heavily from a 2001 Fisheries Assessment of O. O. Denny Creek⁸.

This is followed by a discussion of the soil characteristics of the watershed, a history of various erosion events and mitigation projects, and observations regarding on-going risk.

An analysis of area land use follows. It first provides a history of area zoning. Then, analyzing land use changes from 1936 to 2002, an estimate of the impacts on surface water runoff, interflow (subterranean storm runoff), groundwater, and evapo-transpiration is provided.

A physical assessment of the stream follows next, including turbidity, chemical analysis, and in situ water quality.

The biological condition of the stream is then presented as the results from a series of indices of biological integrity (IBI).

The technical analysis then concludes with a hydrological and hydraulic analysis.

Finally, conclusions are drawn and a series of recommendations proposed.

8 Biological Assessment, O.O. Denny Creek Fish Passage Project, King County, Gary Davis April 2001

2. Stream Profile

Gary Davis, a Washington State fish biologist, conducted and documented a stream walk in O.O. Denny Creek in 2001. This profile is an excerpt from his Fisheries Assessment of O. O. Denny Creek⁹, updated by the Watershed Team to reflect projects undertaken since that time.

A. *Lake Washington to Holmes Point Drive*

Commencing at the stream's mouth, the riparian area consists of bulkhead lake frontage and mowed park lawns, with an over story of black cottonwood and alder. Stream banks are scattered with sword ferns and become greatly incised as you proceed upstream. Near the mouth of the stream, banks are undercut and erosion has resulted in the loss of mature canopy. Further upstream of the mouth, toward Holmes Point Drive, mature trees and vegetation provide adequate streamside cover. A stream restoration project during 1995 planted native species (including willow, Nootka rose, elderberry, snowberry, and cedar) along the stream banks below Holmes Point Drive. Currently this lower reach lacks adequate streamside cover and woody debris. Near the area where the stream enters the lake, some fencing, native vegetation, and a butterfly garden were added in 2006.



Native vegetation and butterfly garden at mouth of stream

The stream passes beneath Holmes Point Drive in a “fish friendly” 7-foot by 10-foot concrete box culvert. This culvert was installed in 2005 and contains gravel and boulder simulating the normal stream bed. Log weirs had been previously installed immediately downstream of the culvert to facilitate fish passage. Flow through the culvert is year round with summer low depth at approximately 1 to 2 inches through the culvert. This culvert does not present a fish passage barrier during any flows.

B. *Holmes Point Drive to Fish Ladder*

Upstream of Holmes Point Drive the gradient gets steeper. The riparian corridor is forested, consisting of mature canopy of Douglas fir, western red cedar, big leaf maple and alder, an under story of Indian plum, devils club, Japanese knotweed and salmonberry, and an herbaceous layer of creeping buttercups. Skunk cabbage is present in the riparian wetland areas. The stream splits into two or more distinct channels on five occasions. Seven springs or seeps enter the stream at various locations. There is excellent stream buffer with the exception of where the park trail follows the stream. Pools within this reach have good cover. Under-cut banks and erosion continue to be present.

9 Biological Assessment, O.O. Denny Creek Fish Passage Project, King County, Gary Davis April 2001

The distance from the mouth to the fish ladder is 2725 feet. Over the entire reach, bank full width ranges from 33 inches to 164 inches. Bank height ranges between 12 inches and 95 inches. Wetted depth ranges from 2 inches to 17 inches. Seventy-five percent of the habitat between the stream's mouth and the fish ladder is in a riffle.

The fish ladder consists of a concrete bridge entrance structure (constructed sometime in the 1930's) and 16 boulder step pools each dropping 8 to 12 inches and was completed in 2002. Just downstream from the fish ladder is the outfall for a tightline that drains 72nd Ave. NE on top of the hill.

C. Fish Ladder to Juanita Drive

Upstream of the fish ladder, the forest transitions from mature western red cedars to a deciduous forest of Oregon ash and alder and back to coniferous (Douglas fir,, Western red cedar) below Juanita Drive. Under-story vegetation is dominated by salmonberry, Devils club, Indian plum, huckleberry, and vine maples. The herbaceous layer consists of sword ferns, bracken, and lady fern, and stinging nettle. Hydrophytic vegetation is represented in two riparian wetlands by skunk cabbage and pig-a-back plant. Although streamside riparian vegetation is lush, there are exposed cliffs, exposed banks, and bank slumps through out this reach and heavy sediment flows enter the stream. Pools through this reach generally afford good cover. The stream channel splits once and there are seven springs or seeps entering the stream. The distance from the fish ladder to Juanita Drive is 4,203 feet. Bank full width ranges from 27 inches to 211 inches. Bank height ranges from 12 inches to 110 inches.

The stream passes under Juanita Drive through a 24-inch concrete pipe. The invert of the pipe outlet cascades the stream down 6 to 8 inches on top of a pile of rock/concrete debris which drains into a standing pool. This culvert presents an impasse for fish migration upstream.

D. Juanita Drive to Intersection of 78th Place NE and NE 135th Place

Upstream of Juanita Drive, O.O. Denny Creek levels out and meanders through a landscape disturbed by development that is dissimilar to the mature forest habitat that was predominant downstream. Terrestrial vegetation is scrub-shrub dominant, represented by Himalayan blackberry, salmonberry, vine maple, alder and snowberry. Wetland vegetation includes skunk cabbage and pig-a-back plant. Pools located within this reach have a medium cover. Immediately upstream of Juanita Drive, Himalayan blackberry provides a dense cover over the stream. Nearing NE 135th Place, the stream flows adjacent to residential properties.

E. Upstream of the intersection of 78th Place NE and NE 135th Place

The stream meanders through Big Finn Hill Park with two major channel splits in the stream. The north-most reach drains the park and a dense residential area. The south-most reach splits again draining a pond at the intersection of 84th Ave. NE and NE 141st St. and a large wetland that borders 84th Ave NE.

3. Soils, Erosion, Mitigation, and On-Going Risk

The deep, elongated trough occupied by Lake Washington was shaped mostly by glacial ice leaving unconsolidated glacial and non-glacial sediments in its wake. Finn Hill is composed of a till plateau with trough side slopes, eroded by the sides of the glacier lobes, that are very steep and generally have exposed the gravels, sands, and silts under the till. These bluffs have shown to have high levels of ground water seepage, are prone to landslides, and are the basis for many erosion sites.

Prior to the 1960's, the stream was routed through a flume constructed of logs upstream of the concrete bridge that is now the control structure for the fish ladder. A landslide about 150 feet upstream of the bridge destroyed the chute. The stream rerouted itself around the landslide.

The 1990's saw several erosion events as development intensified.

On January 9, 1990, following construction of a development east of 72nd Ave NE, an intense storm flow created a sixty-foot wide and twenty-five foot deep hole at the end of 72nd NE near NE 126th. King County's interim fix of the hole was rock fill at a cost of about \$40,000. This storm flow also cut a six-foot deep trough through the park and private

land for several thousand feet, diverting storm waters into the north branch of the stream, designated as tributary 0229 in the 1987 Reconnaissance Report. Volunteers from DCNA attempted to mitigate erosion in the north branch with a series of large rock check dams. These were ineffective. In 1997/98, King County constructed a permanent solution: a 435-foot 18-inch tightline costing over \$140,000. This 18 inch tightline conveys storm flows off the hill to an energy dissipater and then into the stream downstream of the fish ladder. This solution dramatically reduced this particular source of erosion and siltation.

Also in the late 1990's, another landslide occurred upstream of the concrete bridge after a storm drain failed. A major threat to collapse of the east side of the ravine from erosion during winter flash flood was mitigated by DCNA volunteers, armoring the stream banks and slightly altering the main channel of the stream.

Several other landslides have been recorded in the area. Most notably, a slide on the north end of Holmes Point Drive caused the road to be blocked and unusable for several weeks; repairs exceeded \$1,000,000.

King County's LIDAR Digital Ground Model (DGM) shows many potential landslides and existing erosion sites adjacent to Juanita Drive NE in the O. O. Denny Creek watershed. Most of these sites are continuing to erode, exacerbated by the channeling of storm flows through



Bank erosion cuts through trail

culvert outflows or increased flows due to the loss of forest cover to the impervious surfaces of new developments. Most of the steep hillsides within the watershed meet the definition of “sensitive areas” by County Ordinance 15051¹⁰ and are identified in the King County Landslide Hazard Areas Map¹¹. Land use and land use planning actions, however, have seemed to forget that increasing impervious surface and the removal of the vegetation on the uplands increase storm runoff, which is then channeled into existing erosion sites adjacent to Juanita Drive NE within the O. O. Denny Creek Watershed.

10 Ordinance 15051: Critical Areas Dated October 29, 2004

11 King County Sensitive Areas Ordinance Designations, Landslide Hazard Areas Map, produced October 31, 2006.
<http://www.metrokc.gov/ddes/gis/archive.htm>

4. Land Use Changes and Storm Water Runoff

A. Zoning and Enforcement

The Northshore Community Plan, adopted in 1977 by King County, established residential zoning of RS-15000 (one home per 15,000 square-feet, or about three homes per acre) for the majority of homes in the O. O. Denny Creek watershed. Waterfront lots however, were designated as RS-7,200 (six homes per acre). Many of the land holdings in the watershed were original sites of more than one acre tracts with a single home.

In response to the 1991 Washington State Growth Management Act, King County undertook a comprehensive planning study that resulted in a revised zoning classification for all of King County. In 1994, new zoning codes which were density based rather than lot-size based were enacted. Each RS code was replaced by a new R code equivalent. For example, the new code R-4, which replaced RS-15,000, will allow homes to be clustered tightly on small lots (five-feet from a property line) and a playground or retention pond on the remainder as long as the number of homes is approximately four per acre.

In 1993, in response to a grassroots effort initiated by DCNA members but supported overwhelmingly by the community, King County passed an ordinance to provide better retention of native vegetation and significant trees. This effort was proposed to improve retention of storm runoff, protect sensitive slopes and significant trees, and reduce impervious surfaces. Approximately one-third of the homes in the watershed are covered by this P-Suffix requirement.

Enforcement of land use rules and regulations has proven to be difficult and, at times, nonexistent. With the shortage of staff and the long distance from the Department of Development and Environmental Services (DDES) office in Renton, violations are mostly reported by neighbors or discovered after the fact. In a meeting with the Director of King County DDES and her staff, DCNA was informed that the current recourse is to have the developer either replace the lost significant trees with three or four saplings or to levee an insignificant fine on the contractor. This has not been a deterrent for someone who knowingly violates the ordinance. This lack of the enforcement has resulted in further degradation of the watershed's ability to absorb and retain rainfall, thus adversely impacting the flows in O.O. Denny Creek.

B. Land Use Analysis: 1936-2002

With increased residential development in the watershed over time, the impact of storm water runoff on Denny Creek has been dramatic. Erosion and flash flooding are seen with each winter storm. The loss of wetlands and decrease in ground water due to this development have resulted in very low flows during the dry summer months. In order to better appreciate the present status of the watershed, it was determined that learning more about its condition in the past was necessary. Anecdotal input from longtime residents was useful, however in order to better visualize the past, a series of aerial photographs was obtained to be compared with a more recent aerial map.

To estimate the magnitude of shifts in hydrology over time, a table attributed to Douglas Beyerheim and Joseph Brascher¹² was used as a reference to calculate how various land use

¹² Presented by Phil Noppe, a hydrologist with Adopt-A-Stream Foundation, in a lecture on Hydrology and

categories contribute to the distribution of flow of annual rainfall.

To simplify the analysis process, 5 land use categories were selected that seemed to comprise all of the major land uses in the watershed: forest, pasture, lawn/grass play fields, residential, and other impervious surfaces (primarily paved streets and parking lots). The distribution of flow of rainwater was divided into 4 categories: surface runoff, interflow (subterranean storm runoff), groundwater, and evapotranspiration.

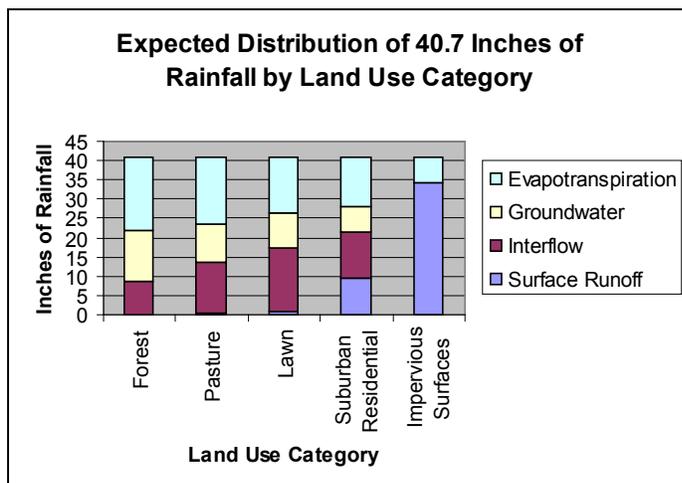


Figure 2 - Expected Distribution of 40.7 Inches of Rainfall by Land Use Category

Using the estimate of 40.7 inches for Seattle’s average annual rainfall, the graph at left shows the typical distribution of this annual rainfall for each land use category, in the general case.

To determine the percentage of the watershed that is in each of the 5 land use categories, a set of aerial photographic maps¹³ from the years 1936, 1960, and 1980, and a 2002 orthographic photo¹⁴ were analyzed. Using a grid on a clear acetate sheet, it was determined that the watershed consists of approximately 860 acres. This is consistent with King County GIS data that identifies three drainage basins (identification numbers 370, 378, and 401) encompassing the three main catchment tributaries that contribute to O. O. Denny Creek and drain the watershed: Tributaries 0228, 0228A, and 0229.

To facilitate comparisons across the four maps, the watershed was arbitrarily divided into 7 subareas. Each subarea was then carefully inspected on each map to get an approximation of the percentage of each land use category. Understandably, the results are only an estimate and are subject to many arbitrary decisions involving lumping and splitting, but it is a viable method to provide a basic understanding of the changes in the watershed. For example, impervious surfaces consist primarily of paved streets and parking lots; the length and width of these were estimated and not exactly measured. Also, suburban residential land use was estimated, using the overlying grid, and necessarily includes houses, yards, driveways, sidewalks, etc. The same general approach was used for all four years evaluated, so that errors should be relatively consistent throughout.

Stormwater Management 101, with reference to a presentation by Douglas Beyerheim and Joseph Brascher entitled “Traditional Alternatives: Will More Detention Work?”

13 Walker and Associates, 12652 Interurban Ave. S., Seattle WA 98168

14 Denny Creek Watershed KC Dept of Natural Resources and Parks Water and Land Resources Division (\\dnrp\projects\wlr\3102\Denny_Ortho.mxd)

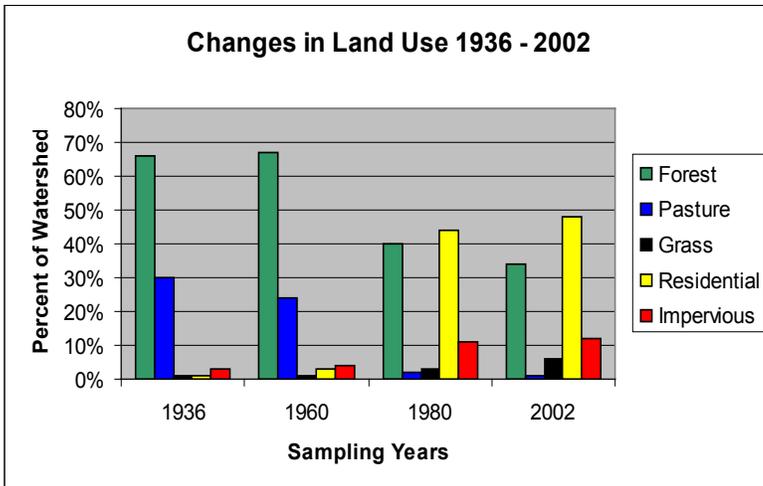


Figure 3 - Changes in land use 1936 - 2002

The percentage of the watershed fitting each of the 5 land use categories in each of these 4 years is shown in the graph at left. This is an attempt to quantify the shifts in land use that are known to have occurred.

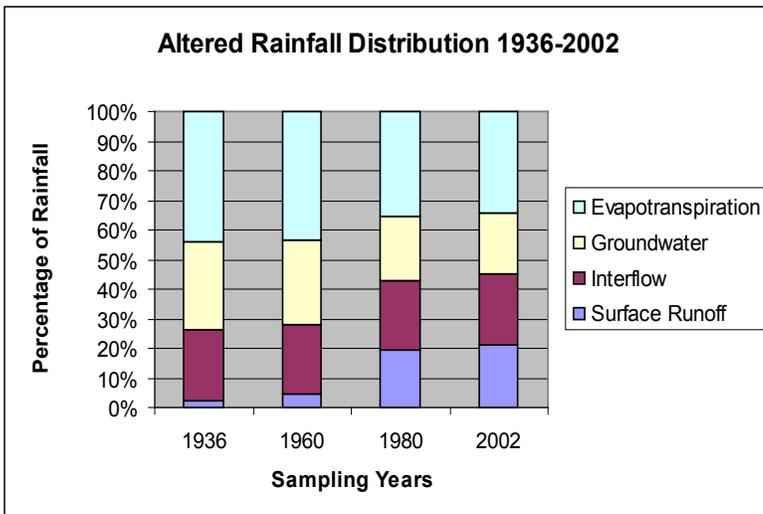


Figure 4 - Altered Rainfall Distribution 1936-2002

The land use data were then combined for each year to illustrate how the shifts in land use have altered the runoff of our annual rainfall. This is shown in the graph at left.

The most dramatic shift has been in surface water runoff. In 1936, this amounted to slightly over 2% of rainfall. By 2002, this had increased to 21.2% of rainfall. Another way to look at this is by calculating the average annual rainfall in acre feet (40.7" X 860 acres = 2917 acre feet/

yr.). In 1936, the 2%+ in surface water runoff was equal to 61 acre feet of water. The 21.2% in 2002 is equal to 618 acre feet of water, roughly 10 times as much.

The graph shows that dramatic changes in surface water runoff occurred between 1960 and 1980, corresponding with rapid suburban residential development. On the other hand, in comparing the 1980 figures with 2002, there is relatively little recent change, suggesting that the area has just about reached 'full build out'. The 2002 orthographic photo indicates that 34% of the watershed is still forested and approximately 233 acres, or 27% of the watershed, is protected park land which somewhat temporizes the total effect of suburban development. In conclusion, it is reemphasized that all of these figures are approximations; however the magnitudes of change shown are probably within reason. The data from which the graphs were built can be found in Appendix D.

In addition to this hydrologic analysis, the historical aerial photographs from 1936 have allowed us to confirm the presence of a pond in the lower reaches of the stream, reported to have served a fish hatchery function, and wetlands in the upper reaches of the stream which

have been lost to residential development.

C. Land Use Analysis: 2004

In 2004, a field team using slightly different land use classifications – 7 instead of 5 – surveyed the watershed of O. O. Denny Creek. This field study team visited 597 random points chosen from the watershed map and placed them each in one of the 7 categories. A summary of this field team’s findings is provided below (in order of decreasing percentage of total area):

Table 1 - 2004 field-based land use classification

Land Use	% of total area (860 acres)
Open space (all open urban lands, managed & unmanaged, not occupied by structures)	35%
Forest (tree canopy)	26%
Structures (residential and commercial)	20%
Impervious (primarily paved streets and parking lots)	13%
Riparian	3%
Marsh or pond	2%
Gravel road	1%

Although different classifications were used, a comparison of total area for like land use shows a high correlation between the 2002 map-based land use analysis and the 2004 field-based land use analysis, as shown below.

Table 2 - High correlation between independent land use studies

2002 map-based	2004 field-based	Approx percentage	
		2002	2004
Forest (34%)	Forest + riparian + marsh/pond (26%+3%+2%)	34%	31%
Residential + pasture + grass (48%+<1%+6%)	Open space + structures + gravel roads (35%+20%+1%)	54%	56%
Impervious (12%)	Impervious (13%)	12%	13%

5. Physical Characteristics of the Stream

The turbidity of the stream water and its chemical content have been measured. Turbidity during periods of low flow was found to be minimal, indicating no evidence of significant erosion. During maximum flows from heavy surface water runoff, turbidity becomes extreme from silt eroded from the banks of the stream below Juanita Drive. A series of turbidity readings has identified that the area between the Juanita Drive culvert and the concrete bridge at the top of the installed fish ladder is the portion of the stream where the greatest erosion is occurring (Table 2, Appendix E).

In situ measurements of water temperature, pH, conductivity, dissolved oxygen, and dissolved oxygen % saturation have been obtained frequently by the King County Dept of Transportation Road Maintenance Section, as well as on several occasions by our group. With very few exceptions, the results fell within the Washington State criteria (Table 3, Appendix E), indicating suitable water quality for salmon and trout spawning, rearing and migration.

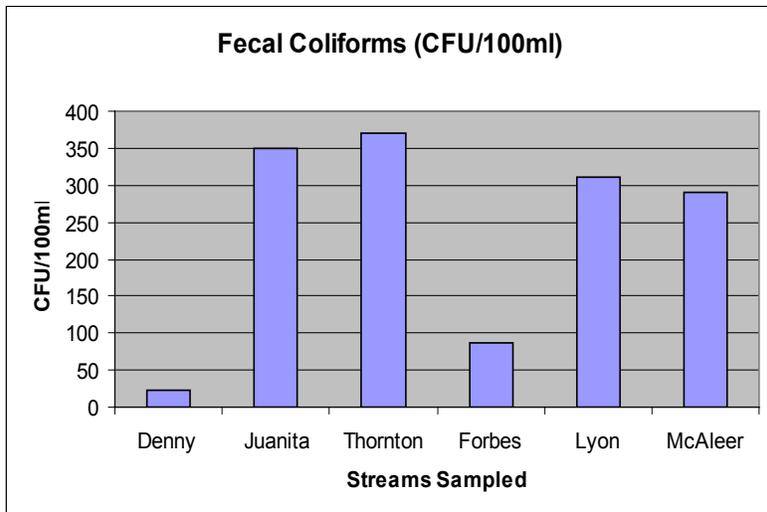
In 2006, two comprehensive chemical analyses of Denny Creek were performed¹⁵.

The first, in September 2006, was a baseflow water quality analysis. Compared to other north Lake Washington tributaries sampled on the same day, Denny Creek seems to have better baseflow water quality, at least on this single September sampling. Fecal coliform levels in Denny Creek were lower than any of the other tributaries sampled, indicating less bacterial contamination. Nutrient levels were also lower, suggesting less influence from urban run-off. In addition, total and dissolved metals values in Denny Creek during baseflow were low. All dissolved metals concentrations complied with state standards for toxicity, given the water hardness in Denny Creek at the times of sampling.

A summary of the baseflow water quality findings is presented in the sequence of graphs on the next page (drawn from data found in Appendix E).

The second, in October 2006, was performed following a storm on Oct 24, 2006. Bacteria, nutrient, and total metals concentrations in Denny Creek during stormflow were relatively higher than baseflow. This is not unusual, as stormwater delivers these parameters to Denny Creek from adjacent lands. Also, some parameters, like metals, are usually attached to suspended material; total suspended solids (TSS) during the storm sampling were several orders of magnitude higher than the baseflow TSS. Regardless, dissolved metal values remained low and complied with state standards. Fecal coliform levels, however, did not comply with the state standard during storm sampling. This is not unusual, as fecal coliform levels in urban streams frequently fail to comply with the state standard-especially following storms.

The storm water samples were also examined for pesticides and herbicides. None were detected.

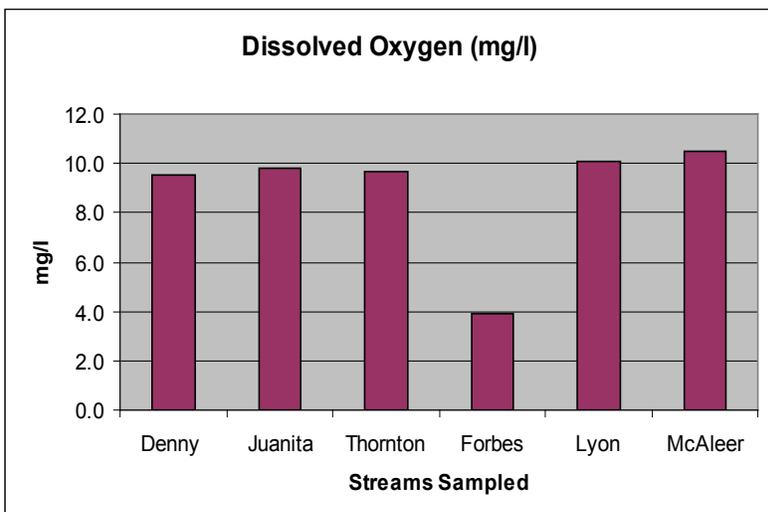


CFU = Colony-Forming Unit

Applicable WA standard for Primary Contact – Recreation “Fecal coliform ... must not exceed ... 100CFU/100ml”

(<http://www.ecy.wa.gov/pubs/0610091.pdf>)

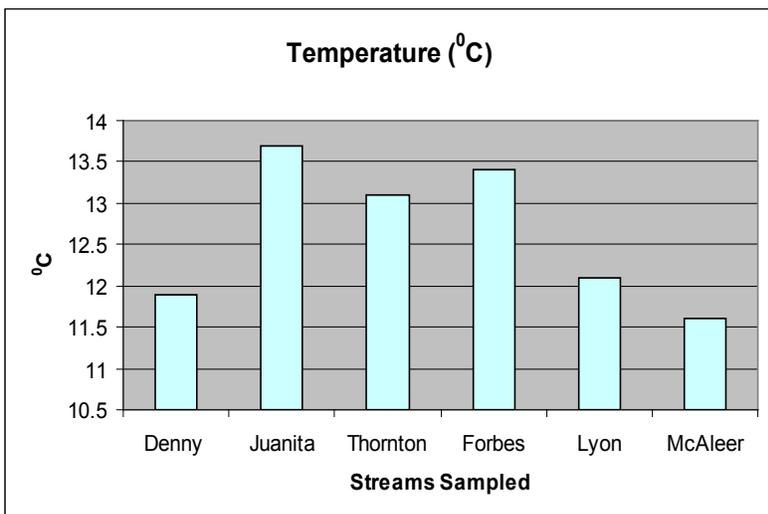
Figure 5 – Fecal Coliforms (CFU/100ml) of selected Lake Washington tributaries



Applicable WA standard for dissolved oxygen >8mg/l

(WAC 173-201A-200, or <http://www.ecy.wa.gov/programs/wq/plants/management/joysmanual/streamdo.html>)

Figure 6 - Dissolved oxygen values in selected Lake Washington tributaries



Applicable WA standard for water temperature <17.5°C

(<http://www.ecy.wa.gov/programs/wq/plants/management/joysmanual/streamdo.html>)

Figure 7 - Temperature values in selected Lake Washington tributaries

6. Biological Condition of the Stream

To determine the health of O.O. Denny Creek and its suitability as a spawning site for salmonids, sampling of benthic macroinvertebrates (BMIs)¹⁶ was carried out (Appendix F). An index of biological integrity (IBI) was obtained on several occasions and compared with reference data from streams in varying settings and with varying degrees of biological degradation.

The results of these samplings showed the biological condition to be in the range of slightly-to-moderately degraded; probably within an index value that could be expected to sustain a salmonid population and reproduction if other conditions were suitable. We believe that the protection that the stream receives from its substantial riparian corridor within the adjacent parklands ensures a biological condition and natural processes which are superior to neighboring streams that are absent a substantial natural buffer.



Watershed team conducts IBI

7. Hydrology/Hydraulics

A. Data Collection Methods

Holmes Point Gage - The King County Department of Natural Resources and Parks' Water and Land Resources Division installed a flow gage near the mouth of O. O. Denny Creek in October 1995. This gage has the capability of recording the stream flow at preset time intervals. Their historical records provided a twelve-year regime of flows for the stream. During the construction of the new environmental fish-friendly passage culvert under Holmes Point Drive in 2005, the existing County flow gage was destroyed. Because on-going flow data was desired, DCNA purchased and installed a Druck pressure transducer and a Basic Data Logger to be monitored by King County. The gage was in service to record winter/spring flows in 2006. Appendix G shows the maximum flow at the gage by month for over ten years.

Fish Ladder Weir – During the construction of the Denny Creek Fish Ladder in 2002, DCNA installed a trapezoidal-notched weir downstream of the concrete culvert as the stream enters the fish ladder. The weir is accurate for low flows but becomes less accurate when the flows exceed three times the height of the six-inch metal weir. Flow observations were made during the study and a rating curve was developed to determine flows. This curve is an approximation of the volume of water going over the weir. Water depths are measured about 1 ½ feet upstream of the weir. Use the first graph for depths under ½ foot and the second for depths over ½ foot (curve is not valid for depths exceeding 1 ½ feet).



Trapezoidal-notched weir

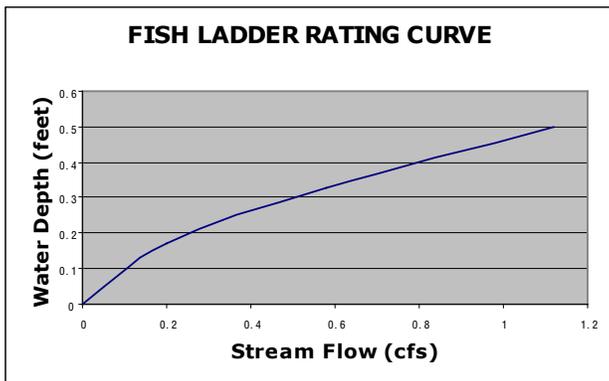


Figure 8 - Curve for water depths under 6 inches

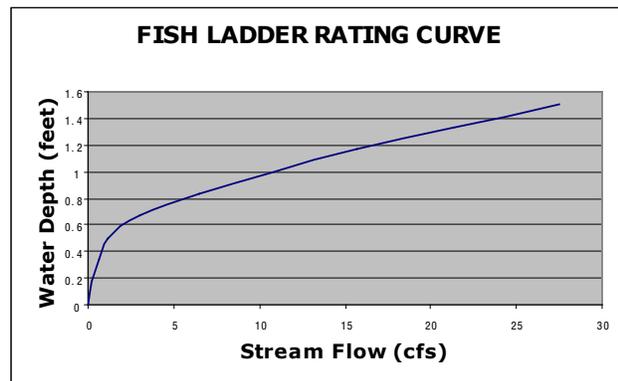


Figure 9 - Curve for water depths over 6 inches

By observing the depth of the water on the staff gage just upstream of the weir and finding this value on the vertical axis of the graph, stream flow is determined by the flow value directly below the intersection of the water depth with the rating curve of the graph. Full-page working graphs are provided in Appendix H.

Flow Probe – During the course of the study, two Global Water Flow Probes were purchased to study instantaneous and mobile stream flows. During rain storms these were employed to determine flows at several locations in the watershed. The meters are hand-held rods with a flow meter attached at one end. The meter reads instantaneous velocities of the stream and also accumulates the data as the probe is moved across the stream or culvert to obtain an average velocity. Flows are then computed by measuring the cross section area of the water in the pipe or in the stream and multiplying the area by the average velocity. Results of this effort can be seen in Appendix G.



Measuring stream flows

AquaRod – Upstream of the bridge/culvert entrance to the fish ladder, a Sequoia Scientific AquaRod was installed to measure stream stages every 15 minutes. Stage heights are converted to stream flows. Sedimentation has been a serious problem at this site filling the well point that houses the pressure transducer of the gage. The validity of the data collected from this gage is of concern and therefore not presented in this report. This accumulation of very fine sediments demonstrates the seriousness of erosion that is taking place within the basin.

Staff gages – Three USGS staff gages were installed to provide visual capability of determining stream heights during high flows, when it would be unsafe to get into the stream. These staff gages are also used as a reference datum for the automated gages and the weir.

Storm Drainage Survey – The firm Port Madison GIS/Johansen-Flynn conducted a manual inventory of storm water conveyances in the watershed to determine the sources of flows entering the stream via culverts or ditches. This included the determination of culvert sizes and types, their connections to manholes, ditches or catch basins, the flow directions and the various locations of catch basins, detention/retention ponds or vaults. This information was entered into the geographical information system (GIS), ArcInfo. Drainage areas were then isolated and analyzed for storm runoff at a single point of entry to the stream. King County Stormwater Department provided the survey team with copies of all storm drainage systems in the watershed that were in their files. King County Stormwater Department engineers also reviewed our inventory of the storm water conveyance for completeness and accuracy. The results of this survey can be found in the 11x17 storm water drainage maps on the accompanying CD.

Inspection of Retention/Detention Facilities – King County engineers and maintenance staff met with the Watershed Survey team on several occasions to inspect existing retention/detention ponds or vaults. Using current design criteria enabled the survey team to determine the current effectiveness of these facilities.

DCNA Weather Station – DCNA installed a weather station on the top of the Shell gas station on Juanita Drive NE. Due to the microclimates that this area experiences, we felt that it was most meaningful to get accurate weather data within our watershed. The station records rainfall, wind direction and speed, temperature and barometric pressure. Prior to installation of the

DCNA weather station, data were obtained from a Kirkland weather station which is within 10 miles of the watershed.

Wetland Survey - The firm Evergreen Aquatic Resource Consultants, LLC performed a wetland survey in the entire watershed. They identified and classified existing wetlands residing on private and public property, annotated on the map in Appendix A and on the storm water drainage maps included on the CD. Their technical input is summarized in Appendix I.

B. Data Analysis

Flow Regime - The flow regime was measured at several times throughout 2005 -2006, particularly during winter rainstorms, but also during prolonged rain-free winter periods and summer droughts (Appendix G). During the dry summer months, flows of less than 1 cubic foot per second (cfs) were recorded, while heavy winter rains yielded maximum flows approaching 40 cfs near the mouth of the stream.

Maximum Stream Flows in O. O. Denny Creek – The Holmes Point Gage recorded a maximum flow in O.O Denny Creek on January 1, 1997. The stream reached a peak flow of 56 cubic feet per second (cfs). Appendix G presents the maximum flows by month for the years 1995-2006. While the mean of these maximum flows is 33 cfs, which normally occur between November and February, low flows during those same months have been recorded at less than 1 cfs. Three days preceding the January 1997 recorded maximum, the flow in the stream was recorded as 0.07 cfs. This flashing of the stream is detrimental to the resident fry and needs to be reduced to aid in Coho salmon upstream migration.

Flow Frequency – In 1997, King County was designing a storm water conveyance pipe to carry storm flows from the hillside at 72nd NE and NE 126th Street. The outfall of the pipe flowed directly into O.O. Denny Creek. To determine the hydraulic effects on the stream, they used a hydrologic modeling tool, King County Runoff Times Series¹⁷, to determine the frequency of the flows in stream. The results of their analysis are presented in the table below. It shows the frequency in years that one could expect a given stream flow at the mouth of O.O. Denny Creek.

Table 3 - Expected flows at the mouth of the stream

Period of Return (years)	Expected Flows (cfs)
100	104.2
50	89.5
25	60.0
10	52.0
2	31.6
1	24.0

Stream Flow Peaks – O. O. Denny Creek has a tendency to peak relatively fast. On December 24, 2005 within a twenty-four hour period the flows went from 2.3 cfs to 20 cfs and down again to 7 cfs. On January 30, 2006 the flows within twenty-four hours went from 0.5 cfs

17 <http://directory.metrokc.gov/ProductDetail.asp?ProductID=178>

to 35 cfs to 17.05 cfs. To illustrate just how fast the stream can rise, the following graph shows recorded flows in fifteen minute intervals for December 21, 2005.

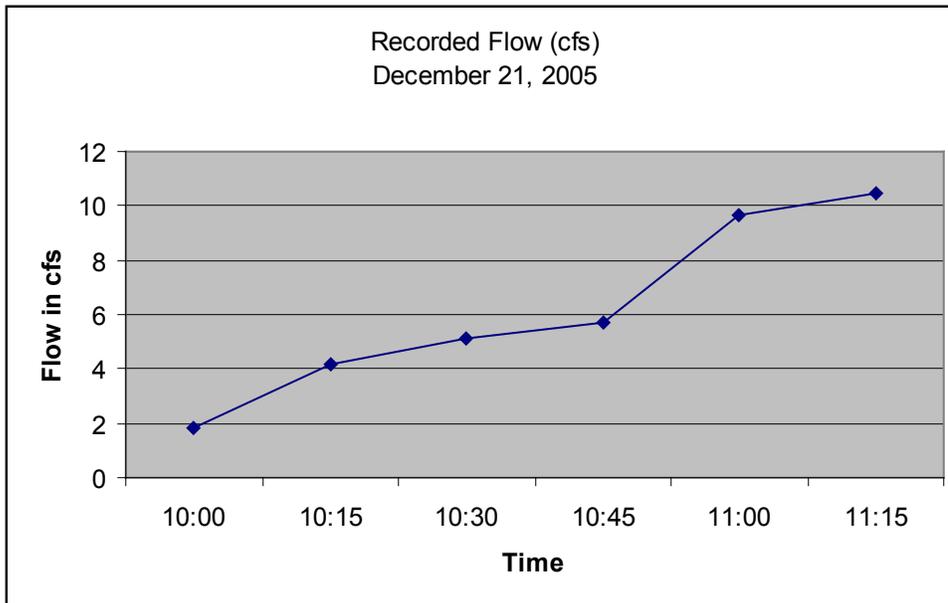


Figure 10 - Stream flows in 15-minute intervals for December 21, 2005

Storm Flow Contribution - During winter rain storms, Watershed Survey Team members used the FlowProbes to measure the flows at four locations. These locations were:

- Downstream end of the culvert through which O. O. Denny Creek passes under Juanita Drive NE;
- Downstream end of the culvert that passes under Juanita Drive NE at NE 128th and conveys stormwater runoff to the upper edge of the stream ravine;
- Downstream of the concrete bridge and upstream of the fish ladder;
- Downstream end of the culvert through which O. O. Denny Creek passes under Holmes Point Drive.

Travel time between these locations was minimized. This enabled accurate determination of flow contributions to the total flow at the mouth of the stream. The data are found in Appendix G.

C. Findings

Classified as a Type F stream, containing fish and fish habitat and having year around flows, O. O. Denny Creek has many ponds and holes to support fish and insects. Maximum stream flows from October through December are adequate to attract passing returning Coho salmon. However, in the years 2002 and early 2004 these flows may have been inadequate for Coho salmon to travel upstream and spawn. In November 2006, several Coho salmon were observed, one as far upstream as 1/4 mile above the fish ladder. The major issue identified during the study is the flashing or peaking of the flows of the stream after a rainfall. This peaking not only adversely affects the winter flows for returning salmon but also produces large amounts of

sediment in the stream covering gravels needed for rearing salmon eggs and washing eggs or smolts out of the stream. Additionally, this sediment transported by the stream is deposited at the mouth of the stream, contributing to an impediment to fish access, especially during low stream flows.

Coho Salmon Migration Flows – Returning adult Coho salmon require stream depths of at least 6 to 8 inches¹⁸ for attraction and to migrate upstream. This corresponds to flows greater than 9 cfs in the O.O. Denny Creek channel.

Coho salmon normally arrive in Lake Washington in late October or in November. The four-year Coho salmon remote site incubation trial begun by DCNA in 2000 would expect to generate some returns in October or November of 2003. Spawning surveys were conducted from 2003 to 2006 and only in 2006 were adult Coho salmon spotted in O.O. Denny Creek.

As November 2006 was the wettest month in history for this watershed, a review of other November flows was made to see if 2006 was an outlier year in terms of stream flows, or whether other years would have supported Coho salmon migration. It is speculative at best to try to place a minimum threshold on the number of days where the flow exceeds 9 cfs, to assure salmon migration: There are too many variables in the equation. It *can* be said that the greater the number of days, and the greater the number of *consecutive* days, where the flow exceeds 9cfs, the greater the probability of salmon migrating up the stream.

If we assume 5-10 days as a minimum range, the graph below showing the last twelve years for which we have flow data (records for 2005 are not available, as King County removed the

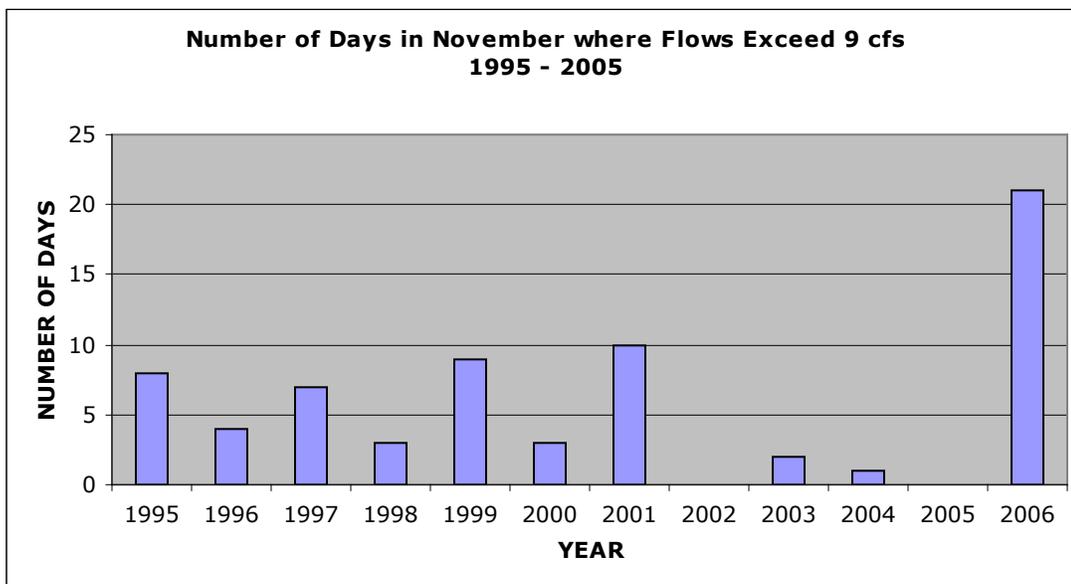


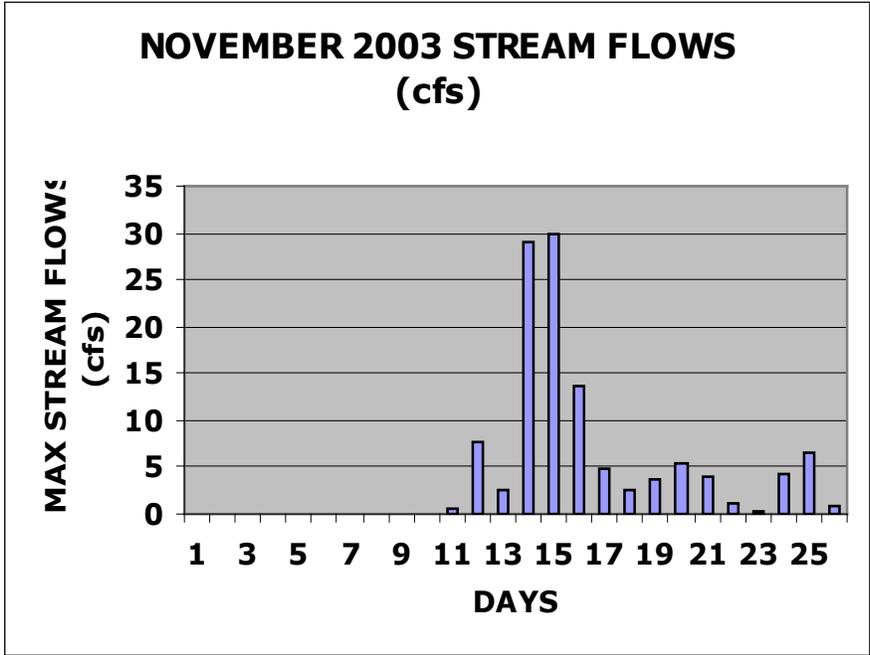
Figure 11 - Number of Days in November where Flow Exceeds 9 cfs 1995 – 2006

Looking specifically at the expected return years for eggs incubated in the stream (2003-2006) Denny Creek had adequate flow on a sufficient number of days only in 2006 (**as noted earlier, data are missing for 2005**). Recorded November flows for years 2003, 2004, and 2006 are depicted in the series of three graphs that follows.

gage for culvert construction) suggests that in five of those years there *may* have been enough days with flows exceeding 9 cfs to attract and facilitate the upstream migration of Coho salmon.

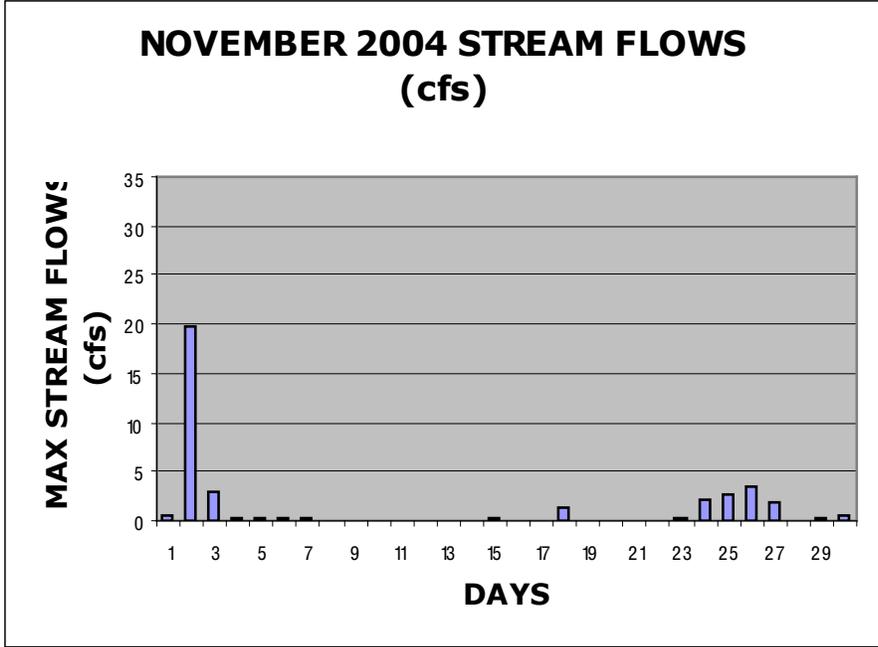
Looking specifically at the expected

18 Fishway Design Guidelines for Pacific Salmon, Washington Department of Fish and Wildlife, Bates, K.M., March 1992



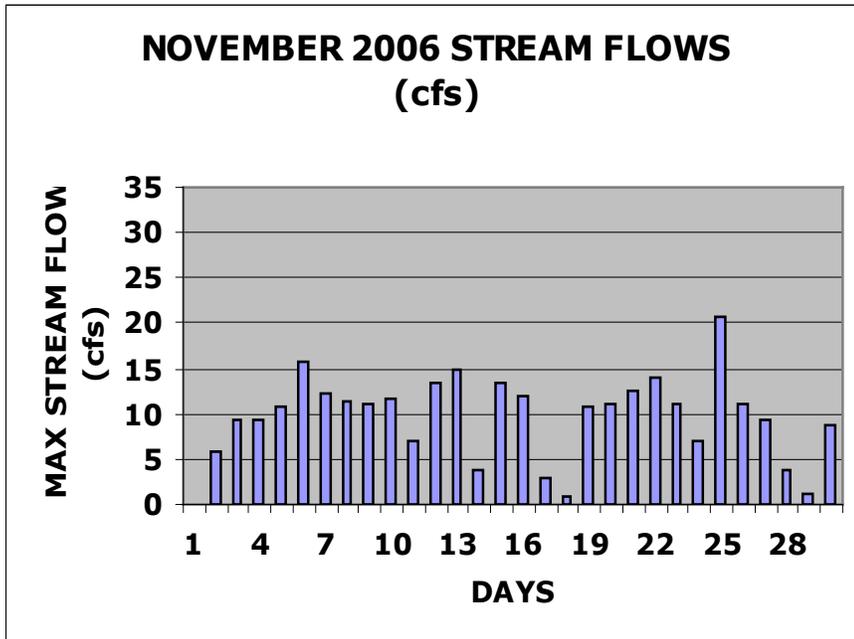
As shown in the graph for November 2003, there were only three days during that month that stream flows exceeded 9 cfs, and for only short periods of time.

Figure 12 - November 2003 stream flows (November 2003 rainfall of 6.77")



Year 2004 had only one day that met the desired flow.

Figure 13 - November 2004 stream flows (November 2004 rainfall of 3.16")



In contrast, November 2006 had 21 days where the flows met 9 cfs and three adult Coho salmon were observed, two upstream of the fish ladder.

Figure 14 - November 2006 stream flows (November 2006 rainfall of 15.63")

These wide fluctuations of monthly rainfall point out the need for a working wetland system. Wetlands store and slowly release excess rainfall as groundwater flows, thus leveling out the stream system. Because of the degradation of the watershed's ability to slow the flow of rainwater into the stream, which creates excessively fast and high peak flows, there is a lower probability of sufficient consecutive days with flows >9 cfs.

Storm Flows -- Surface water runoff entering the various reaches of the stream during heavy rains was estimated. These estimates indicate that 2/3 of the flash flow during storms enters the stream before it passes under Juanita Drive and 1/3 enters after the stream enters its deep ravine between Juanita Drive and Holmes Point Drive.

On January 30, 2006 the stream flow rate at peak time was changing 4 cfs every 15 minutes.



Stream flow at peak on January 30, 2006

A method to measure the time delay between peak rainfall and peak stream flow is currently under consideration. This could be done by comparing rainfall data collected at the weather station we have installed within the watershed at Juanita Drive and NE 122nd PI with flow data obtained from a permanent flow gage installed just upstream of the Holmes Pt. Dr. culvert. We believe this will support the premise that residential development has resulted in the loss of watershed water holding capacity which previously slowed the rate of surface water runoff.

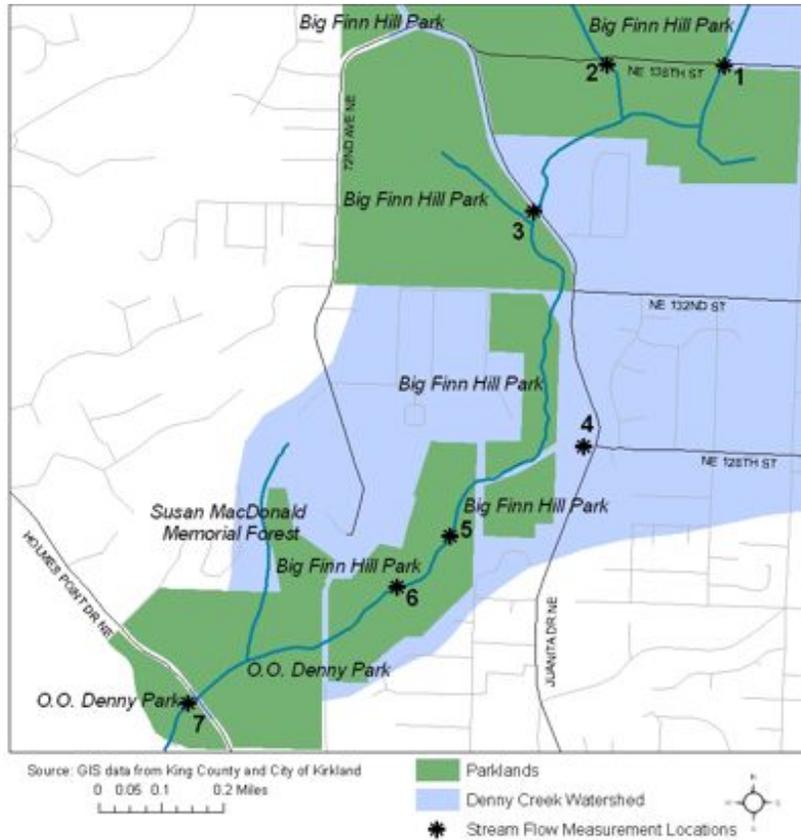


Figure 15 - Storm flow measurement locations

water is detained in the wetland so that it is functioning as a leveler of flow downstream during periods of high flow. This further illustrates the importance of wetlands in the system.

The following table lists all measured flows for 5/28/06, and as well lists the *average* percentage of flow at that location compared to the stream mouth. Storm events were categorized into Low (flows 3 -8 cfs) and High (flows over 8 cfs). Summer flows were considered dry when no flow was visible on the surface, although sub-terrain flows may have existed.

Table 4 - Average percentage of flow at selected locations compared to flow at stream mouth

Flow measurement location	Location Description	Measured flow (cfs)	Average percentage of flow compared to flow at stream mouth (%)		
			10am on 5/28/06	Summer	Low
1	Stream at NE 138th (east)	4.3	Dry	62-70	53-62
2	Stream at NE 138th (west)	0.6	Dry	8-10	7-8
3	Stream at Juanita Drive	4.5	Trickle	70-80	60-70
4	Culvert from NE 128th at Juanita Drive	*	Dry	10	7-9
5	Stream at fish ladder	5.2	97-99	94-96	88-90
6	72nd Street tightline exit	*	Dry	2-3	8-10
7	Stream at Holmes Point Drive	*	100	99	99

* Location not measured on that date

We are also mapping the storm water drainage system within the watershed (11x17 fold-out maps included on the accompanying CD). This will be used to make recommendations for more effective detention of surface water and possible ways to recover lost wetland and ground water holding capacity.

Watershed Boundaries – King County’s delineation of the boundaries for the watersheds of O.O. Denny Creek and adjacent basins was found to have major errors in several areas along with some minor deviations in other areas. These adjustments are noted as a dotted line on the map in Appendix A and in the 11x17 fold-out maps of the drainage system included on the accompanying CD. Most were in the east and west boundaries of the north-most portion of the watershed where storm water was either routed in or out of the watershed by culverts. A significant impact to the watershed is the storm water collection system for the development located at 76th NE Ave. and NE 126th Street (Map 10 of the 11x17 fold-out maps of the drainage system). This system and its related retention pond removes a considerable area out of O.O. Denny Creek watershed.

Field verification was accomplished by a DCNA team doing onsite visual and GPS elevation and slope determination and also by Port Madison GIS/Johansen-Flynn, the storm water survey contractor. The 11x17 fold-out maps included on the CD show the various storm water conveyances and retention facilities in the watershed. They also show where storm water is moved out of the basin utilizing various conveyances to an outfall located in another basin. The current development on 72nd Ave NE, as an example, placed a drain on the east side of 72nd Ave NE and transferred the water to a vault on the west side of the road which drains into another basin. This road (72nd Ave NE) is an actual basin boundary; all drainage east of the road was historically included in the Denny Creek watershed. Poorly defined watershed basins, or the lack of knowledge of the basin, has allowed planners and developers to unwittingly mine storm water systems and deplete watershed assets.

Erosion - Sediment buildup is significant at the stream’s entrance to Lake Washington; more importantly, heavy deposits of sands and gravels are being deposited at the Fish Ladder. These sediments are detrimental to the operation of the ladder and its associated gauging station. The automated staging gage upstream of the ladder is in constant threat of being filled over with fine-grained sediments from upstream.

Between Juanita Drive and the Fish Ladder, there are several deeply incised troughs being eroded by culvert outfalls along Juanita Drive. In particular, the NE 128th Street outfall is undermining the property of the resident living adjacent to the outfall flow.

Retention/Detention Facilities - Many of the retention ponds constructed in the past have been observed to be empty during periods of high runoff. Underground tanks and vaults were not inspected but there are concerns over the maintenance of these



Retention pond in Big Finn Hill Park

control devices. During the inspection of one retention pond the control valve was found to be shut off for an unknown reason.

The two retention ponds located in Big Finn Hill Park, according to a King County Senior Stormwater Engineer, would not meet current design standards and are inadequate to handle existing storm flows. The northern-most pond is in a deteriorating condition and is very ineffective in all but the smallest storm events. Another detention pond, the one located at 128th and Juanita Drive, was observed by DCNA team members to have no accumulated water during a heavy rain event.

Wetlands – The King County Sensitive Areas Map Folio identifies only two wetlands in the watershed: One in Big Finn Hill County Park and the other near the corner of NE 141st Street and 84th Avenue NE. Yet, in 1987, an additional seven wetlands in the O.O. Denny Creek system were identified during a reconnaissance survey of the Northeast Lake Washington Basin¹⁹. A National Wetlands Inventory²⁰ lists five wetlands in the basin. The two large wetlands in the northern portion may have been in the watershed at one time, but are no longer in this watershed.

Our wetland survey contractor, Evergreen Aquatic Resource Consultants, LLC, identified twenty wetlands during this study. These wetlands are shown on the map in Appendix A and on the storm water drainage maps included on the CD; a table in Appendix I lists the attributes of each wetland. Attributes include stormwater detention capability, water quality function, and wildlife habitat function. Two wetlands in the watershed have been lost to development and others have been destroyed or disturbed to a point where their functions have become minimal. As an example, Wetland 1 and Wetland 2 at one time were contiguous but a housing development severed the wetland and the development's drainage systems routed storm flows into the large wetland to the west that is outside of the O.O. Denny Creek watershed. Wetland 13 was destroyed in the construction of the baseball fields in Big Finn Hill Park. There appears to be no onsite mitigation for this loss.

Yet while some are minimal in function, they are providing some detention of the stormwater that is critical to maintain O.O. Denny Creek as a habitat for salmon spawning and rearing. Further degradation of these wetlands must not be allowed, as the balance of the system is dependent upon their existence. Installation of outlet control structures in almost all of the wetlands would improve their functions and provide the necessary detention required to slow the flashing of the stream. Potential sites that would have significant impacts are Wetlands 12 and 14, both in Big Finn Hill Park.

19 Reconnaissance Report No. 28, June 1987, Natural Resources and Parks Division and Surface Water Management Division, King County, Washington

20 National Wetland Inventory, April 2004, U. S. Fish & Wildlife Service, Department of Interior

8. Conclusions

1. The water quality in O. O. Denny Creek is adequate to support salmon spawning, rearing, and migration.
2. Efforts to re-establish a Coho salmon run through a Remote Site Incubator have demonstrated the ability of the stream to support salmon fry.
3. Fish access at the stream mouth from Lake Washington remains impaired due to the lack of a well-developed riparian zone along the final 50 yards of the stream's course.
4. The flow regime has been altered by residential development and this has been detrimental to the stream's ability to support salmon spawning and migration.
5. The loss of wetlands, native vegetation, and some sources of watershed water, combined with the increase in impervious surfaces in the watershed, has resulted in low flows during the summer and sometimes into the fall. This has imposed a stress on the existing fry in the stream and impaired the passage of returning salmon. Flash flooding during wet season storms has resulted in erosion and resultant loss of a streambed suitable for salmon redds. The gradual changes of stream flow once present with the varying weather conditions have been lost.
6. The construction of a fish ladder has removed the major impediment to upstream fish migration, although a significant obstruction still remains at the Juanita Drive culvert.
7. There has been insufficient monitoring of residential and commercial developments to assure adherence to land use regulations. Penalties for regulatory violations have been inadequate to prevent destructive violations.
8. O. O. Denny Creek can support a returning salmon run as was demonstrated by the upstream passage of Coho salmon in November of 2006 as far as 2/3 of a mile from the mouth of the stream and approximately 1/4 of a mile above the fish ladder. Sustained high November flows assisted the salmon's return.
9. There appears to be a lack of attention to, or knowledge of, the watershed boundaries by storm water designers and King County when designing and approving storm water drainage plans. Storm water is being moved to other watersheds by the drainage system.
10. The lack of understanding of the importance of various water sources of the O.O. Denny watershed has caused the loss of wetlands and wetland buffers by allowing variances to existing regulations which were designed to protect them.
11. Most retention/detention facilities in Big Finn Hill Park and on private developments are inadequate and do not conform to current codes.
12. Many storm water outfalls west of Juanita Drive NE are causing serious erosion of private property and park land. Besides the loss of land, this erosion is producing siltation problems in the fish ladder, the stream bed, and at the mouth of O.O. Denny Creek.

9. Recommendations

“How we build our communities, the land and resources we choose to protect, and the shoreline we select to restore all influence salmon habitat. The choice is up to the residents, businesses, and governments in WRIA-8.”²¹ In this spirit, the O. O. Denny Creek Watershed Survey team submits these recommendations to the King County Executive and King County Council, and other responsible entities, and asks that the responsible county departments, tentatively identified herein, be tasked with addressing these issues and take a lead roll in assisting other identified entities.

Table 5 - Checklist of recommendations

Recommendation	Responsible Entity
1. Promote recognition of O.O. Denny Creek as an important feature of the parkland through which it passes and counter the perception of it as a storm water drainage runoff ditch.	County Executive and King County Council
2. Update/improve all detention/retention ponds in the watershed to current code.	King County Department of Natural Resources and Parks (DNRP) Water and Land Resources Division (WLRD)
3. Increase the water detention capacity of the wetland in Big Finn Hill Park.	King County DNRP Parks and Recreation Department (PRD)
4. Mitigate the erosive effect of stormwater runoff by the use of tightlines, particularly at 128th St and Juanita Drive.	King County DNRP WLRD and PRD
5. Proactively enforce the Holmes Point Site Disturbance Ordinance (King County Ordinance No. 13576, of July 12, 1999).	King County Department of Development and Environmental Services (DDES)
6. Continue to monitor the parameters of water quality and flow to allow early recognition of further degradation of the stream as a salmonid habitat.	King County Department of Transportation (DOT) Road Services Division (RSD) Road Maintenance Section, DNRP WLRD, and Denny Creek Neighborhood Alliance
7. Educate residents of the watershed regarding methods to prevent degradation of the stream’s water quality.	Denny Creek Neighborhood Alliance (DCNA)
8. Continue to improve the riparian zone at the stream’s mouth.	Finn Hill Parks and Recreation District and DCNA
9. Continue to improve the condition of the stream bed to make it more ‘fish friendly’.	King County DNRP WLRD

21 King County Department of Natural Resources, Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan, Volume 1, 2005.