CHAPTER 3 - BASIN CHARACTERIZATION

This chapter describes the basins' physical setting and natural and cultural resources. Much of the natural resources information comes from the U.S. Soil Conservation Service (U.S. Department of Agriculture 1990) and from a field study of Woodland Creek conducted by students from the Evergreen State College (Dobbs 1977).

3.1 LOCATION

Woodland and Woodard Creeks are the largest of five major tributaries to Henderson Inlet, and drain eighty percent of the 29,275 acre Henderson Inlet watershed (Thurston Geographic Information Facility 1990). The other three major streams in the watershed, Dobbs Creek (aka East Creek), Meyer Creek (aka Snug Creek) and Sleepy Creek, drain small areas of the Dickerson Point and Johnson Point peninsulas to the north of the Woodland and Woodard Creek basins.

Henderson Inlet, located on the northern tip of Thurston County, is one of five inlets that form the southern terminus of Puget Sound. The inlet is about five miles long from Dickerson Point to South Bay, ranges from 1/4 to 3/4 miles wide, covers 2.5 square miles in area, has an average depth of 25 feet, and reaches its maximum depth of 60 feet near the mouth (Thurston Geographic Information Facility 1990; Washington Department of Ecology 1990). Woodard and Chapman Bays are the major undeveloped shoreline features of the inlet.

Woodland Creek empties into the southern tip of Henderson Inlet. Woodard Creek empties into Henderson Inlet midway along its western shore, at the estuary of Woodard Bay. The headwaters of both streams are in urban or developing areas of Lacey, Olympia and Thurston County. Maps 1-3 show the general location and boundaries of the basins.

3.2 CLIMATE

Woodland and Woodard Creek basins share the marine climate characteristic of all Thurston County. Summers are relatively dry and cool while winters are mild, wet, and cloudy. Annual precipitation averages about 51 inches (National Weather Service 1990). The winter precipitation usually consists of frequent, light-to-moderate intensity rainfalls rather than short, intense storms of the other seasons.

The prevalent winds approach from the southwest and have a mean hourly speed of 6.5 miles per hour. The average frost-free period is 150 to 200 days. Some snowfall, averaging between 10-15 inches per year in the basins, usually occurs between November and April (National Weather Service 1990).

3.3 TOPOGRAPHY

Woodland and Woodard Creek basins encompass 36.7 square miles of mostly level, glacially formed terrain south of Henderson Inlet (Thurston Geographic Information Facility 1990).

Most of the basin area lies at an elevation of less than 200′ above sea level. The basin rises to an indistinct line of low hills south of Pattison Lake, with a high point of 320′ above sea level. Woodard Creek basin also includes the southern portion of Dickerson Point, a level peninsula with steep, ravine-cut bluffs dropping to the marine shorelines. Several depressions contain small wetlands, and a slight rise on the peninsula forms the basin's western boundary.

The Woodland Creek basin constitutes the southern portion of the Henderson Inlet watershed. Four lakes connected by extensive wetlands form a horseshoe-shaped chain at the head of Woodland Creek. Hicks Lake flows into Pattison Lake and then Long Lake, and all three lie between 152′ and 157′ above sea level (United States Geological Survey 1989). Long Lake empties into Lake Lois, which lies at a slightly lower elevation of about 145′ above sea level. The creek carves a narrow, steep-sided ravine through second growth forest on the St. Martin's College campus, which broadens and flattens somewhat as it continues north through gently rolling hills before reaching the flats at the south end of Henderson Inlet.

Woodard Creek flows out of a 45-acre wetland contained in a small, steep-sided depression just south of the Pacific Avenue/Interstate 5 interchange, at an elevation of about 150′ above sea level (Thurston Geographic Information Facility 1990; United States Geological Survey 1989). The creek flows north through low-lying wetlands and enters a flat-bottomed ravine on St. Peter's Hospital property north of Martin Way. The creek winds through a strip of riparian wetlands, then the ravine narrows and steepens as it cuts through the Dickerson Point peninsula north of 36th Avenue NE.

3.4 GEOLOGY

Glacial ice scoured the Puget Sound lowlands at least four times, retreating most recently only 10,000-12,000 years ago. The Dickerson Point and Johnson Point peninsulas were formed at the beginning of the Ice Ages, an estimated 2.5 million years ago (Crandell et al 1965). Till (hardpan) and outwash-covered uplands characterize the Woodland Creek basin, underlaid at great depth by volcanic rock (US Department of Agriculture 1990).

The main glacial advances of the Salmon Springs glaciation and the later Vashon glaciation are most important to the watershed. Each time the massive glaciers advanced, they dammed the outlet of Puget Sound and created a vast lake which drained south into the Black River valley (Crandell et al 1965; Kruckeberg 1991).

"Rock flour," the finely ground remains of rocks pulverized by glacier action, settled on the bottom of this glacial lake. These deposits became the commonplace blue clays of the Puget lowlands. Each time the Ice Age glaciers advanced, their great weight compacted underlying sediments into a concrete-like material called "till". As the glaciers melted, the runoff deposited thick layers of sand and gravel known as "outwash."

Each of these glacially deposited materials - clay, till and outwash - is present in the basins in various combinations. They provide the formations that hold ground water, and the parent material for most of the different soils. Appendix E describes the major geologic and soil formations of Thurston County.

3.5 SOILS

The soils information in the plan is drawn from the *Soil Survey of Thurston County, Washington* (U.S. Department of Agriculture 1990). Soil is the product of processes acting on material deposited or accumulated through geologic or biological forces. The important factors in soil formation are parent material, climate, living organisms, topographic relief, and time. Woodland and Woodard Creek basins' soils, developed primarily from the glacial deposits described above, are categorized as Alderwood-Everett Association soils. Maps 6 and 7 depict the basins' soils.

Alderwood soils are formed on broad, glacial till plains. These soils are moderately deep and well drained. Typically, the surface layer and the upper part of the subsoil are gravelly sandy loam. The lower part of the subsoil is very gravelly sandy loam and below this is weakly cemented glacial till.

Everett soils are found on terraces and escarpments formed in glacial outwash. These soils are very deep and somewhat excessively drained. Typically, the surface layer is very gravelly sandy loam while the subsoil is extremely gravelly sandy loam.

This soil association includes small areas of the well drained Baldhill and Giles soils, the somewhat excessively drained Indianola soils, the moderately well drained Hoogdal and Kapowsin soils, and the poorly drained Bellingham, Everson, Norma, Mukilteo, and Skipopa soils.

3.6 VEGETATION

The plant communities of Woodland and Woodard Creek basins create a mosaic of forests, wetlands, riparian zones, and prairies. These interwoven communities offer diverse habitat for many mammal, bird, fish, and insect species. The vegetation and associated soils also provide important economic values to the local area.

3.6.1 Forests

Forest plants produce oxygen, collect rain water, feed soils, and provide habitat for large mammals and other wildlife. Forest products such as timber and christmas trees contribute significantly to Thurston County's economy.

Conifers, mixed forests, and remnant oak woodlands dominate upland forested areas in the basins. Second growth Douglas fir, western red-cedar, and western hemlock characterize the conifer forests. Mixed forests in the area include conifers and broad-leaf trees such as red alder and big leaf maple. Southern Woodland Creek basin contains remnant stands of old-growth Oregon white oak, which offer habitat for a high diversity of birds and mammals.

The natural vegetation of about two-thirds of the basin, as indicated by soils, was forests of western hemlock, western red-cedar and Douglas fir (US Soil Conservation Service 1990; Franklin and Dryness 1973). Most of the original forests were cut in the late nineteenth century, and much of the resulting second growth Douglas fir was cut again in the past 50 years. Douglas fir is the dominant tree species in immature forests of western Washington because it grows rapidly in the sunny conditions of disturbed areas (Franklin and Dryness 1973). Residences, commercial buildings, and roads are rapidly replacing much of the remaining forests.

3.6.2 WETLANDS

Wetlands remove sediment and pollution from surface water, provide habitat for fish, birds, and insects and serve as rearing habitat for coho salmon, which are important to the local commercial and sport salmon fisheries (McMillan 1988). Typical wetland vegetation in the basins includes Scouler's willow, western spirea, Hooker's willow, salmonberry, and herbaceous plants such as sedges, ferns, and skunk cabbage. The vegetation varies in relation to the degree of moisture in the soil. Wetter areas have cattails and bulrushes. Section 3.10.1 describes the legal definition of wetlands in Thurston County.

Wetlands of Woodland Creek Basin Woodland Creek basin contains about 545 acres of mostly freshwater (palustrine) wetlands, or about 2.9% of the total basin area, depicted in map 8 (Thurston Geographic Information Facility 1991). The major wetlands include areas around Hicks, Pattison, Long and Lois Lakes, near the St. Placid's property north of the Martin Way/I-5 interchange, and at the creek mouth. The area is rapidly developing and many wetlands have already been lost to filling. Construction threatens the remaining wetlands in the area by removing critical buffer vegetation and allowing sediment and pollutants to enter (Castelle et al 1992). Wetland loss in the basin has slowed since Lacey adopted a wetland protection ordinance in 1992 (Lacey Municipal Code 14.28).

Hicks Lake is at the upper end of the Woodland Creek basin. Water enters the lake mainly as groundwater seepage and surface flow. The lake discharges through a 38-acre palustrine wetland located on the southwest border of the lake.

A 162-acre palustrine wetland lies between Pattison and Hicks Lakes. The area is characterized by shrub and emergent cover and floods seasonally. The soil is quite rich, and the area was drained and used for agriculture at one time. Native vegetation was removed and replaced in places by pasture and crop fields. Most of the area has returned to native vegetation and no distinct stream channel remains.

A 119-acre palustrine wetland between Pattison and Long Lakes floods seasonally and has shrub cover. A ditch was constructed many years ago to float logs to Long Lake; the ditch still connects the two lakes, but some native vegetation remains. The north end of Long Lake contains a permanently flooded 39-acre lacustrine wetland.

From the Long Lake area, the stream flows north to a 70-acre palustrine wetland at Martin Way and Interstate 5, which floods seasonally. Various wetlands plants grow along the stream such as skunk cabbage, rush, willow, Oregon ash, and cottonwood (Dobbs 1977). Many smaller, spring-fed wetlands drain into the creek through its middle and lower reaches north of Martin Way, including a large, year-round spring that surfaces at the Nisqually Trout Farm just north of Martin Way. The groundwater feeding these wetlands helps dilute creek water which has been degraded by contaminated stormwater runoff from outfalls on Martin Way.

The mouth of Woodland Creek is a salt water (estuarine) wetland, currently protected as a county-owned natural preserve. The slope is mild and the tide influences the discharge in the creek. Sedges, saltgrass, pickleweed, and cattail can be found at this site. The site also contains skunk cabbage, salmonberry, and trailing blackberry growing in thickets.

Wetlands of Woodard Creek Basin The Woodard Creek basin contains about 334 acres of inventoried wetlands directly associated with the creek, or about 7.5% of the total basin area, depicted in map 9 (Thurston Geographic Information Facility 1991). The significant wetlands along and adjacent to the creek are mostly forested or shrub-covered palustrine wetlands.

Ground and surface water feed a 45-acre wetland at the headwaters of Woodard Creek, just south of Interstate 5 at the Pacific Avenue interchange. Forest covers about two-thirds of the wetland and shrubs cover the remainder. The city of Olympia has identified this wetland as significant wildlife habitat, targeted for acquisition or additional protection (City of Olympia 1994).

The Woodard headwater wetland has a history of human alterations. The culvert under the highway partially dammed the wetland's outlet and blocked anadromous fish access, eliminating coho rearing habitat. In 1979, a road was constructed across the wetland, fill material was placed in the wetland, and a culvert installed to convey creek water. After the adoption of the wetland regulations in 1983, one and one-half acres of fill material were removed. The industrial and commercial development on Fones Road and large, high-density commercial areas including the South Sound Mall and Olympia Square drain into the wetland through the Fones Road ditch. These alterations have severely changed the wetland's hydrology and effectively made the South Sound mall parking lot into the creek's headwaters. Further development threatens the forested uplands abutting the wetland.

About 179 acres of riparian wetlands between Pacific Avenue and South Bay Road also provide rearing habitat for coho salmon. These include a highly disturbed, shrub-covered wetland south of Martin Way, and a 44-acre palustrine wetland north of Martin Way on St. Peter's Hospital property. The city of Olympia has identified the wetland by St Peter's as significant wildlife habitat, and plans for a trail system to be located there (City of Olympia 1994).

The St. Peter's Hospital wetland is partly forested and partly open. Vegetation in the open, wet meadow area includes reed canary grass, spike-rushes, bulrushes, salmonberry, sedges and rushes, and large spiraea stands. Growths of small fir, willows and alder trees are scattered throughout. Peat bogs are located at the point where an unnamed tributary joins Woodard Creek from the southwest.

The mouth of Woodard Creek is an estuarine wetland, currently protected as a natural area by the Washington Department of Natural Resources.

3.6.3 Riparian zones

Vegetation along the stream corridors is called riparian vegetation, and serves an important purpose by stabilizing banks. When the vegetation is removed, the surrounding waters can become polluted through erosion. Riparian plants also provide fish, insect, and wildlife habitat, moderate stream water temperatures, and form travel corridors for wildlife (Gregory 1991).

Typical riparian vegetation in the basins includes a variety of willows, salmonberry, indian plum, snowberry, vine maple, red elderberry, salal, red huckleberry, and serviceberry. Open, disturbed areas of the riparian corridor are often dominated by reed canary grass, an aggressive, non-native species that displaces the natives.

3.6.4 Prairies

Grassy prairies have been used for agriculture since the middle 1900s. Some areas that are no longer being farmed may be changing to forest vegetation (Franklin and Dryness 1973). Grassy prairies are located in the southwest, south, and southeast portions of Woodland Creek basin. Prairies are dominated by a mixture of native and introduced grasses, with scattered broad-leaf trees, and wetland vegetation in the potholes.

3.7 WILDLIFE

The wildlife is a fundamental element of the complex ecosystem in the Woodland and Woodard Creek basins. Wildlife health, diversity, and population indicate the overall condition of the environment. Fish and shellfish contribute to the local economic wealth as well (see sections 3.8 and 3.9). The northern portion of Woodard Creek basin is sparsely developed, and still offers good wildlife habitat. The second largest harbor seal colony in southern Puget Sound occupies an old log loading area at the mouth of Chapman Bay, adjacent to Woodard Bay (Poultridge 1991). The mouth of Woodland Creek provides good habitat to shorebirds and wading birds such as great blue herons. Oak woodlands near the headwaters of Woodland Creek provide critical habitat for the western grey squirrel and a variety of birds, including woodpeckers and owls (Washington Department of Wildlife 1991).

Human disturbances and alteration of the landscape have driven many species of wildlife from the basins. Large animals and those needing large range areas, such as elk, black bear, cougar, and bobcat, can no longer find suitable habitat. Degraded habitat has reduced the wildlife populations still found in the basins.

Species in the Woodland and Woodard Creek basins listed as priority species by the Washington Department of Wildlife include bald eagles, osprey, purple martins, pileated woodpeckers, western bluebirds, great blue heron, and fishers (Dobbs 1977; Rodrick and Milner 1991; Washington Department of Natural Resources 1993). In addition, the waters of Henderson Inlet are important wintering habitat for shore birds. Appendix D contains the complete list of mammals and birds observed along Woodland Creek by students of the Evergreen State College in 1977.

3.8 SHELLFISH

Puget Sound is one of the most productive shellfish growing areas in the country. The shellfish resources within the Woodland and Woodard Creek basins include oysters, clams, mussels, and geoducks. Commercial oystering and clamming in Henderson Inlet date back to initial settlement of the area by Europeans in the 19th century.

Recreational clamming yields over 3.3 million pounds of clams annually in Washington (Washington Department of Fisheries 1987). The hardshell clam industry consists primarily of Manila and native Littleneck clams. Manila clams are the most important hardshell clam species in the steamer clam market and the primary species produced in south Puget Sound.

Henderson Inlet is one of Puget Sound's most productive shellfish harvesting areas. Oyster harvests there increased from 50,000 pounds in 1981 to more than 250,000 pounds in 1986 (Washington Department of Ecology 1987). Pollution from surface water runoff threatens this industry, worth more than $175,000 per year to the local economy.

One hundred and sixty-three acres of commercial shellfish beds at the mouth of Henderson Inlet have been closed or conditionally closed since 1983, due to pollution (Washington Department of Ecology 1992). This represents more then 20% of the total commercial shellfish beds in the inlet, with a potential economic value of $57,000 per year. Several water quality studies have identified Woodland Creek as the major source of fecal coliform contamination causing shellfish closures in Henderson Inlet (Taylor 1984; Harrison and Hofstad 1988; Davis and Coots 1989).

Harvesting shellfish from closed areas is prohibited, and harvesting from conditionally approved areas is prohibited for at least five days following a rainfall of 3/4" or greater within a 24 hour period. Rainfalls greater than 3/4" per day occurred 47 times during the three year period from October 1988 to September 1991, resulting in 235 days of closure (Thurston County Storm and Surface Water Program 1992). Fecal coliform levels often take five days or more to return to acceptable levels following such an event.

3.9 FISH

Fish harvesting has historically been one of the most important human uses of the Puget Sound area. Regardless of the effects of human activities, fish populations fluctuate greatly from year to year. It is nearly impossible to separate the effects of natural fluctuation, harvesting, pollution, and habitat loss on anadromous fish.

Increased winter flood flows have significantly degraded fish habitat in some reaches of both creeks. Extensive computer modeling of the stream systems indicated that the existing level of development in the basin has caused the peak stream flows in the two creeks to nearly double, compared to their natural condition (see section 3.11). Radically increased stream flows cause significant erosion and sedimentation, scour out spawning gravels, wash away large logs, wipe out redds, prevent spawning fish from migrating upstream, and reduce the available refuge. Analysis of Woodland Creek between Pleasant Glade Road and Draham Road indicated a sharp decline in all refuge habitat resulting from 1-year flood flows or greater (Johnson and Caldwell 1992).

Summer low flows that accompany urbanization can also reduce habitat. Extremely low flows in other areas have been shown to limit the ability of smolts to migrate to the sound, and prevent summer-run salmon from migrating up the stream. Young salmon may become stranded due to low flows. In recent years, Woodland Creek has dried up completely between Lake Lois and Martin Way for up to six months, significantly reducing habitat and fish productivity in the creek.

Both creeks have conditions in at least some of their reaches which provide both good spawning and rearing habitat for salmon and other anadromous fish: gentle to moderate gradient, good pool/riffle conditions, cold water and gravelly beds. The lower reaches of both creeks contain fairly pristine estuarine wetlands which offer good habitat for anadromous and resident fishes. Adjacent stream banks in the lower reaches of both creeks consist of open farmland and rural residences, interspersed with areas of mixed deciduous and coniferous forest. However, human encroachment is rapidly altering and destroying these fish producing areas.

Washington Department of Fisheries and Thurston County staff conducted a stream survey of selected sites along Woodland and Woodard Creeks, on November 28, 1990, which provided the information shown in table 3-1.

Table 3-1 Fish found in Woodland and Woodard Creeks, Nov. 28, 1990

ANADROMOUS FISH:	RESIDENT FISH:
Steelhead (Oncorhyncus mykiss)	Rainbow trout (Oncorhyncus mykiss)
Coho salmon (Oncorhyncus kisutch)	Cutthroat trout (Oncorhyncus clarki)
Chum salmon (Oncorhyncus keta)	Sculpins (Cottus sp.)
Chinook salmon (Oncorhyncus tshawytscha	Lampreys (Lampreta sp.)
	Sticklebacks (Gasterosteus aculeatus)
	Olympic mud minnow (Novumbra hubbsi)
	Yellow perch (Perca flavescens)
	Large scaled sucker (Catostomus macrochielus)
	Brown bullhead (Lchtalurus nebulosus)

3.9.1 WOODLAND CREEK FISHERIES

Map 4 depicts the river mile locations cited in this section. Consultants surveyed and analyzed the salmon habitat in 7,230 feet of Woodland Creek between Pleasant Glade Road and Draham Road in 1991, and discovered degraded habitat in the urbanizing area upstream of 21st Court NE. The survey indicated that the channel downstream of 21st Court is in fairly good condition. Removal of "large organic debris" (stumps and logs, etc) from the channel by property owners appeared to be a significant cause of the observed habitat degradation. Large organic debris is a fundamental component of refuge habitat. Appendix H contains the complete report.

Stream bed gravel appeared to contain a high percentage of sand, especially in Woodland Creek. This may be a natural characteristic of the basins, but soil erosion and increased stormwater runoff from urbanization have probably aggravated this situation.

Approximately 5.6 miles of the main stem of Woodland Creek are accessible to anadromous fish when flows are sufficient (Powers, Washington Department of Fisheries 1991). A short spring-fed tributary enters the stream at mile 3.3, and provides most of the summer low-flow for the lower 3.3 miles. The stream reach between mile 3.3 and Lake Lois (mile 4.6) often goes dry during summer and fall, although the reach between Long Lake (mile 5.6) and Lake Lois flows year-round.

Chum, coho, and chinook salmon spawn primarily below mile 3.3 and in the spring-fed tributary. However, Department of Fisheries staff have observed chum, coho, steelhead and sea-run cutthroat spawning as far upstream as mile 5.0. Juvenile chum and chinook may use the entire 5.6 miles for seasonal rearing habitat. Juvenile coho, steelhead, and cutthroat utilize the lower 3.3 and upper 1.0 miles for year-round rearing and the reach between 3.3 and Lake Lois for seasonal rearing (Powers, Washington Department of Fisheries 1991). Fish population studies performed on Woodland Creek since 1956 indicate a decline in coho salmon population (Baranski, Washington Department of Fisheries 1991).

3.9.2 WOODARD CREEK FISHERIES

Map 5 depicts the river mile locations cited in this section. Approximately 6.9 miles of the main stem of Woodard Creek are accessible to anadromous fish. The stream originates at mile 7.5 in a wetland south of Interstate-5 at the Pacific Avenue interchange. Between stream mile 3.5 (36th Avenue) and the headwaters, the stream has a low gradient and a pool/glide configuration with isolated riffles. Downstream from mile 3.5 the stream has a low to moderate gradient and a good pool/riffle configuration.

Chum and coho salmon and steelhead and sea-run cutthroat trout spawn primarily in the gravel riffles downstream of mile 3.5, but Department of Fisheries staff have observed them spawning as far upstream as mile 6.9, below the Pacific Avenue culvert, in isolated riffles. Juveniles utilize the entire 6.9 miles for both year-round and seasonal rearing (Powers, Washington Department of Fisheries 1991).

Fish population inventories of Woodard Creek have not been conducted frequently enough to determine a significant trend, but conversations with long-term landowners along the creek indicate a dramatic decline in salmon populations.

3.10 CRITICAL AREAS

The basins contain several types of critical areas as defined by the local jurisdictions' critical areas ordinances (summarized in chapter 1). Critical areas include wetlands, aquifer sensitive areas and flood hazard areas.

3.10.1 WETLANDS

Wetlands provide habitat for a complex web of wildlife species. At least one-third of Washington's threatened and endangered species require wetlands for their survival (Washington Department of Wildlife 1991). Eighty-five percent of all terrestrial vertebrate species in Washington State use wetlands and/or their buffers (Brown 1985). Their productivity makes them significant links in the food chain which many animals rely on for survival, including humans, salmon and shellfish. Wetlands also store and filter stormwater, remove sediments and pollution, and reduce flows that cause erosion (McMillan 1988).

The Critical Areas Ordinance of the Thurston County Code (TCC Chapter 17.15) defines wetlands as "ponds 20 acres or less, including their submerged aquatic beds, and those areas that are inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions," consistent with the federal Clean Water Act. However, the ordinance excludes wetlands smaller than approximately 1/4 acre within the Urban Growth Management Area, and smaller than approximately 1/2 acre elsewhere in rural Thurston County. The ordinance also excludes drainage ditches, stormwater ponds, farm ponds, and other artificial wetlands not created for mitigation purposes.

The Critical Areas Ordinance relies on a "wetland delineation" method published by the U.S. Army Corps of Engineers in 1989, to determine the physical extent of a wetland. The method hinges on measurement of three parameters: soil, vegetation, and hydrology. The specific requirements of the ordinance for a particular wetland also relate to the wetland's "class" as determined by a system derived from the Washington State Department of Ecology's method for rating the wetland's functions and values (e.g., wildlife habitat, stormwater detention, etc).

Lacey's wetland regulations utilize the same wetland definition and delineation method as Thurston County, and a similar functional evaluation method (Lacey Municipal Code 14.28, 1992). However, the minimum size for Lacey's regulated wetlands varies from 0 to 10,000 square feet (0.23 acres), according to the wetland class. Lacey's wetland regulation also applies to streams.

Maps 8 and 9 depict wetlands from the preliminary "National Wetlands Inventory" maps developed by the U.S. Fish and Wildlife Service in 1984, and hydric soils from maps prepared by the U.S. Soil Conservation Service in 1990, which relied primarily on low resolution aerial photography. In order to create more accurate maps, the Thurston Regional Planning Council re-mapped many of the county's wetlands in 1991-93, using sharper resolution aerial color-infrared photography and digital mapping techniques. The Woodland and Woodard Creek basins' wetlands were re-mapped, and several wetlands were field-checked, delineated and evaluated. The new maps are available by section from TRPC.

3.10.2 AQUIFER RECHARGE AREAS

Thurston County and Olympia Critical Areas Ordinances designate Aquifer Recharge Areas throughout the county, in order to comply with state growth management and water quality requirements. The ordinances assign one of four "aquifer susceptibility" categories to every area of the county, based on soil type, and defines allowable land uses and activities for each category. Most of southern Woodland Creek basin is designated as extremely susceptible, and northern Woodland and Woodard Creek basins are mostly moderately susceptible.

Lacey adopted aquifer protection policies in the *Environmental Protection and Resource Conservation Plan*, that use the same aquifer sensitivity maps and designations as Thurston

County and Olympia. Lacey's plan adopts the goal of "protect(ing) the quantity and quality of groundwater for all uses in the present and future."

The Thurston County Board of Health established a number of Geologically Sensitive Areas (GSAs) in the 1980s, in order to protect surface and ground water. Portions of the Lakes GSA and the Henderson and Eld GSA lie within the basins. These GSAs established on-site septic system standards for developments within 300 feet of the lakes, streams and marine waters. They were intended primarily to prevent surface water contamination from septic systems. The McAllister GSA, designated in 1988 and revised in 1990, placed limitations on certain commercial land use activities and increased septic system standards in order to protect the aquifer that feeds McAllister Springs.

Glacial plains cover most of north Thurston County, overlying several aquifers. These aquifers contain abundant ground water, with nearly 100% of the basin's domestic water supplies derived from these sources (Thurston County Health Department 1994). Ground water also supplies base flow to both Woodland and Woodard Creeks. The upper ground water-bearing strata is often shallow, and many wells in the basins are less than 50′ deep. Rain falling on all of north Thurston County recharges the shallow aquifers.

Recent, unpublished studies by the United State Geological Survey identify at least three aquifers in the Woodland and Woodard Creek basins. The Vashon recessional aquifer (named for the geological formation that contains it) underlies much of the basin and supplies water to the shallowest wells. The Vashon advance aquifer underlies most of the area south of Henderson Inlet, and supplies water to most of the wells and lakes in the basins. A layer of till of varying thickness separates these aquifers, but the till is absent from some areas, such as Hawks Prairie. An even deeper aquifer underlying the basin supplies water to McAllister Springs. Ground water travels laterally through the aquifers, and also moves downward between aquifers, especially through "windows" where no impermeable layers separate them.

Ground water in Thurston County is susceptible to pollution from surface sources (Brown and Caldwell 1990). Spills, dumping, on-site disposal systems, and agricultural practices have affected aquifers. High nitrate levels and pesticides have been found in wells drawing from the Vashon advance aquifer (Thurston County Health Department 1994). Further, salt has been found in a till-protected aquifer adjacent to industrial lands, which may indicate that the supposedly impervious layer of intervening till may not provide as much protection as previously believed.

3.10.3 FLOOD HAZARD AREAS

Thurston County and Olympia Critical Area Ordinances regulate land use activities in "frequently flooded areas". The modeling results provided some of the rationale for new provisions in the county's Critical Areas Ordinance, adopted in 1994, that prohibit most new construction in the 100-year floodplain. The county's building codes have not been revised to reflect this critical areas revision yet.

The local jurisdictions use the terms "flood hazard areas," "100-year flood plains" and "frequently flooded areas" interchangeably in various ordinances, to refer to those lands which can be expected to flood at a frequency of once every 100 years, or which are subject to a 1% or greater chance of flooding in any year (as defined by the National Flood Insurance Act of 1968). The local jurisdictions have adopted the federal definitions and provisions for flood hazard areas, and development standards for those areas, in order to qualify for the National Flood Insurance Program. For example, the building codes requires the lowest floor of new residences in flood hazard areas to be constructed above the 100-year flood elevation, so the homes will qualify for federal flood insurance.

The local ordinances rely on the Flood Insurance Rate Maps (FIRM) of the 100-year floodplain mapped by the USGS, which performed hydrologic and hydraulic analyses for Woodland and Woodard Creeks in 1980. They studied Long Lake, Pattison Lake, and part of Woodland Creek in detail, because high levels of development were expected in those areas. Maps 8 and 9 depict the FIRM 100-year flood plains.

County staff and consultants conducted additional hydrologic modeling for this basin plan, using 35 years of precipitation data and three years of continuous flow data. The modeling, discussed in more detail in the next section, resulted in updated flood flow and flood elevation information for the 100-year flood.

3.11 HYDROLOGY

The hydrology of Woodland and Woodard Creeks (flow frequencies and durations, flood elevations, water velocities) results from precipitation and ground water interacting with the soils, vegetation and structures that comprise the basin's landscape. The physical characteristics of the landscape components determine how much water infiltrates into the ground and how much becomes surface runoff. The most important factor determining the quantity of runoff that results from a given storm event is the percent imperviousness of the land cover (Woodward-Clyde Consultants 1989). Impervious land cover consists of pavement, rooftops, and all surfaces that water cannot penetrate easily.

Development of the natural, forested landscape increases the percent imperviousness of the land cover. Woodland and Woodard Creek basins range from highly developed in the urban core to sparsely developed in the rural fringes. The overall level of development is moderate in Woodard basin and moderate-to-high in Woodland basin, compared to other urban areas. Moderate development of a basin typically results in the following changes to stream hydrology (Schueler 1987):

- Increased peak stream flows.
- Increase volume of runoff produced by each storm.
- Decreased time needed for runoff to reach the stream, particularly if extensive drainage systems exist in the basin.
- Increased frequency and severity of flooding.
- Reduced streamflow during dry periods.
- Greater runoff velocity during storms.

Woodland and Woodard Creek basins were computer-modeled using the "Hydrologic Simulation Program - Fortran" (HSPF) to help analyze the effects of past human activities on the existing stream flows, and virtually all of these impacts were identified. Appendix C contains a detailed explanation of the model and how it was calibrated. Model input included 35 years of historical precipitation data from the NOAA Weather Service station at the Olympia Airport. Maps 10 and 11 depict the basins' land cover used for the model input, derived from 1987 aerial photographs. Natural, pre-development conditions were assumed to be either forest or grasslands, depending on the natural vegetation for each soil type according to the *Soil Survey of Thurston County, Washington* (U.S. Department of Agriculture 1990).

3.11.1 Hydrology of Woodland Creek

Woodland Creek's characteristic hydrology includes extremely high peak flows that develop quickly during heavy rains and decline rapidly when the rain slackens, and prolonged low flow or dry periods in the summer. The peak flows become more extreme near the mouth, and the dry reaches occur primarily from Lake Lois to just downstream (north) of Martin Way.

Woodland Creek flows out of a large wetland and lakes complex that includes Hicks, Pattison and Long Lakes. The soils, lakes, wetlands and flat topography of this area absorb large quantities of rainfall and help to mitigate the impacts of development on the headwaters of the creek. Downstream from Hicks Lake, the creek enters Lake Lois, which stores and detains most of the stream flow. Figures 3-1 and 3-2 illustrate the effects of development on Woodland Creek stream flows. The peak flows at the first two locations, Long Lake and Martin Way, exhibit relatively small increase over natural flows compared to downstream locations, because of the buffering effects of the wetlands.

Figure 3-1 Woodland Creek 2-Year Stream Flows, Natural vs. Existing

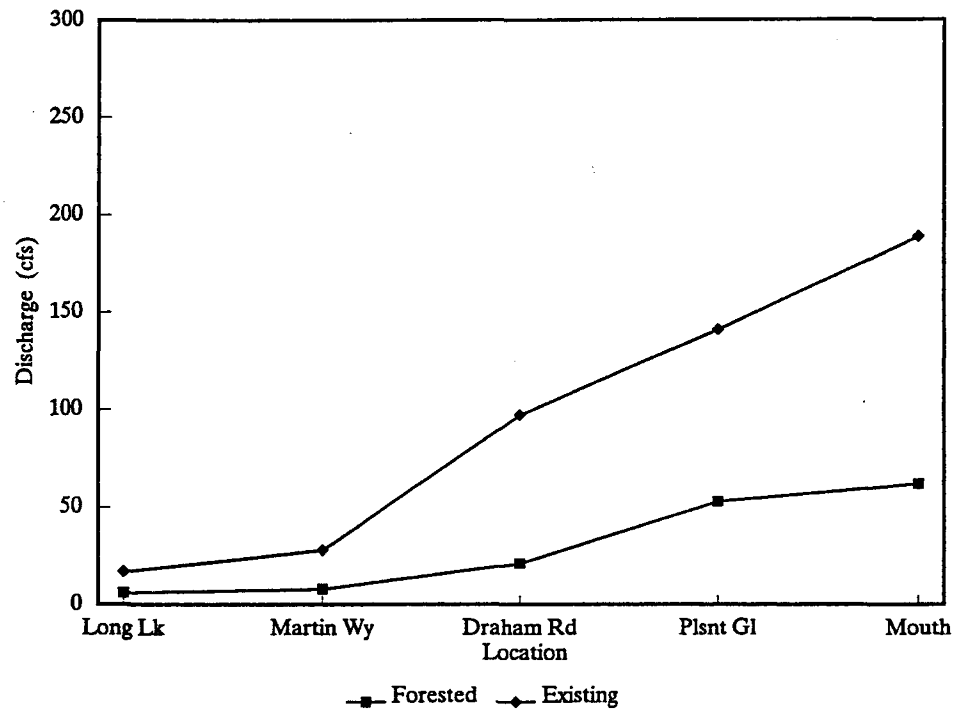
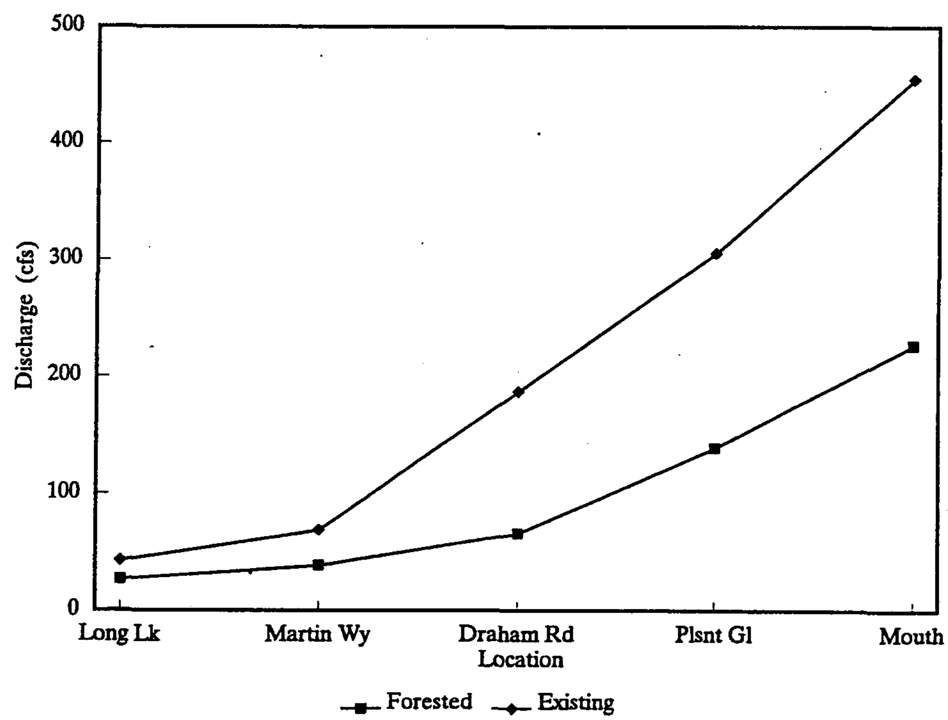


Figure 3-2 Woodland Creek 100-Year Stream Flows, Natural vs. Existing



Stream flows between Lake Lois and Martin Way vary widely according to season and quickly respond to individual rain storms. Stream flows at Martin Way correspond closely to precipitation levels, with the creek drying up for extended periods during dry years. Table 3-2 summarizes the continuous flow data for the creek at Martin Way. Flows from a major stormwater system that used to discharge to the creek below Lake Lois were diverted to the Woodland Creek Stormwater Treatment Facility beginning in late 1991. The stormwater treatment facility does not discharge any runoff to the creek except during heavy rain storms when the facility reaches capacity, which helps explain the reduction in maximum flows at Martin Way for 1992 and 1993.

The creek shows much less response to summer droughts farther downstream from Martin Way because extensive, groundwater-fed wetlands and a large, spring-fed tributary provide year-round base flow to the creek north of Martin Way. Between October 1, 1988 and September 30, 1993, the creek did not dry up downstream at Pleasant Glade Road, and the minimum flow was 7.8 cfs.

Table 3-2 Stream flow and precipitation summary for Woodland Creek at Martin Way

Water Year[1]	Total precipitation[2] (inches)	Average daily flow (cubic feet per second)	Maximum daily flow (cubic feet per second)	# of days with less than 1 cfs flow
1989	39.7	2.6	13.3	203
1990	49.6	8.4	29.1	156
1991	66.0	12.7	29.6	45
1992	64.0	4.9	14.8	117
1993	49.1	1.1	5.5	278

[1] Water year runs from October 1 to September 30. Water year 1989, for example began on October 1, 1988 and ended on September 30, 1989.

[2] Precipitation values from rain gauge at Thurston County Fairgrounds.

The creek responds more quickly to individual rain events downstream from Martin Way because several large stormwater systems drain directly to Woodland Creek or the College Creek tributary, in the vicinity of Martin Way. The systems include the Interstate-5, College Street, Sleater-Kinney Road and Martin Way storm drains, as well as several other outfalls with smaller tributary areas. These stormwater systems cause extremely high peak flows downstream during major storms. For example, the Thanksgiving Day storm in November, 1990 caused the stream flow to peak at 160.6 cfs at Pleasant Glade Road, almost 12 times higher than the average flow at that location for November, but upstream at Martin Way the stream flow peaked at 15.6 cfs, only 2.5 times higher than the average flow in November at that site.

Continuous flow data was not collected below Pleasant Glade, but modeling indicates that flows continue to increase toward the mouth of the creek. Figures 3-1 and 3-2 indicate that the estimated peak flows for all events have increased significantly from the pre-development, "natural" basin at the downstream locations on the creek. Several stormwater systems discharge directly to the creek along these lower reaches.

3.11.2 Hydrology of Woodard Creek

Extreme peak flows during heavy rains characterize the hydrology of Woodard Creek, but the effect is more pronounced near the headwaters. Peak stream flows moderate between the headwaters and the mouth of the creek. Groundwater feeds the creek at the headwater wetlands and provides year-round base flow in the creek.

Table 3-3 Stream flow and precipitation summary for Woodard Creek at 36th Avenue NE

Water Year[1]	Total precipitation[2] (inches)	Average daily flow (cubic feet per second)	Maximum daily flow (cubic feet per second)	# of days with less than 1 cfs flow
1989	44.2	6.6	27.4	0
1990	53.5	8.8	56.0	0
1991	66.0	17.2	90.0	0
1992	56.7	15.0	36.2	0
1993	42.0	13.9	31.02	0

[1] Water year runs from October 1 to September 30. Water year 1989, for example began on October 1, 1988 and ended on September 30, 1989.

[2] Precipitation values from rain gauge at 2306 12th Avenue.

Woodard Creek exhibits extreme sensitivity to individual rain events because stormwater runoff from a major, highly developed commercial and industrial area that includes South Sound Center, Olympia Square, Food Pavilion, Ernst, and Fones Road drains directly into the headwaters of the creek. For example, the November 1990 storm, which dumped more than 5" of rain on the basin, caused the stream flow at 36th Avenue NE to peak at 71.3 cfs, almost 13 times higher than the average flow for November at that location. During the following year, almost as much rain fell on the basin, but the largest individual rain storm deposited about 3.75" of rain in April, 1992, which caused the stream flow at 36th Avenue to peak at 36.2 cfs, which was only about twice as high as the average flow for the month at that site.

Figures 3-3 and 3-4 compare the estimated peak flows in Woodard Creek before the basin was developed with existing peak flows, for the 2-year and 100-year rain events. Peak flows for all rain events have increased considerably over the pre-development conditions. Development and clearing have made the largest impact on the more frequent flows, such as the 2-year events, which are more damaging to habitat than the rarer 100-year flows. At Interstate 5, 2-year flows have increased by a factor of greater than ten.

Extensive wetlands between Fones Road and St. Peters Hospital absorb runoff and reduce stormwater's impact on flows downstream. The railroad grade, Interstate-5, Pacific Avenue and Martin Way act as dams which further impound runoff and reduce downstream peak flows. A major stormwater system drains the commercial area along Martin Way east of the creek and discharges to the creek just above Ensign Road. The creek channel narrows below South Bay Road, where there are no wetlands to absorb the additional runoff. Figures 3-3 and 3-4 indicate that the peak flows at the mouth have increased to a proportionally lesser extent than upstream flows, because the downstream basin has not been developed as intensively as the upper basin.

Groundwater-fed springs maintain year-round base flow in Woodard Creek. Even during the drought years of 1989 and 1990, the stream flow never dropped below 2.2 cfs at 36th Avenue, and during more typical years such as 1992 or 1993, the stream flow generally stays above 9.0 cfs.

Figure 3-3 Woodard Creek 2-Year Flows, Natural vs. Existing

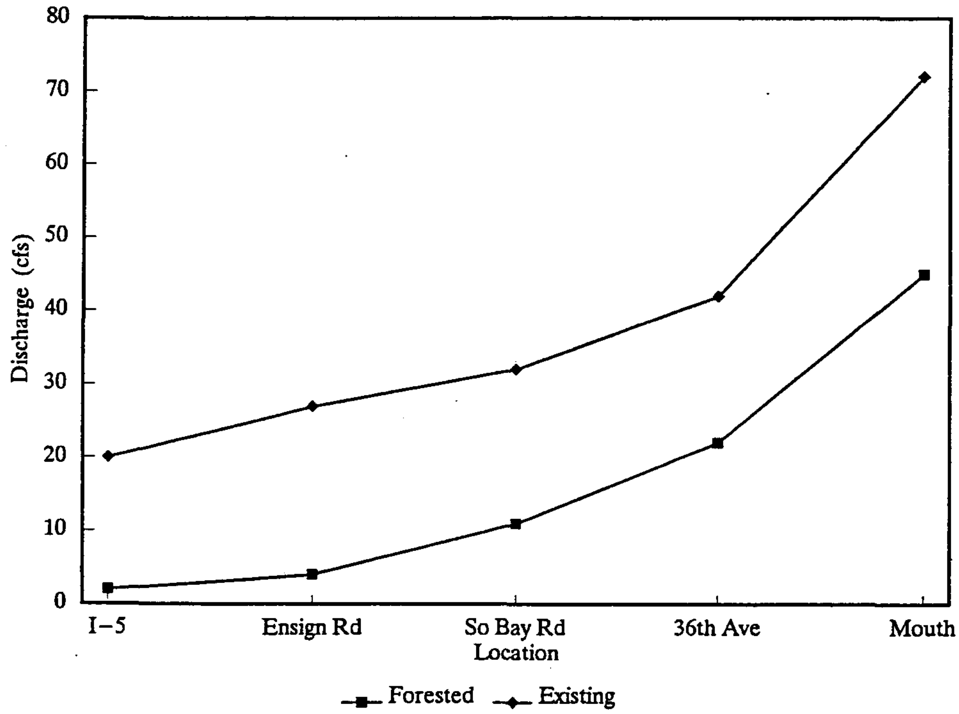
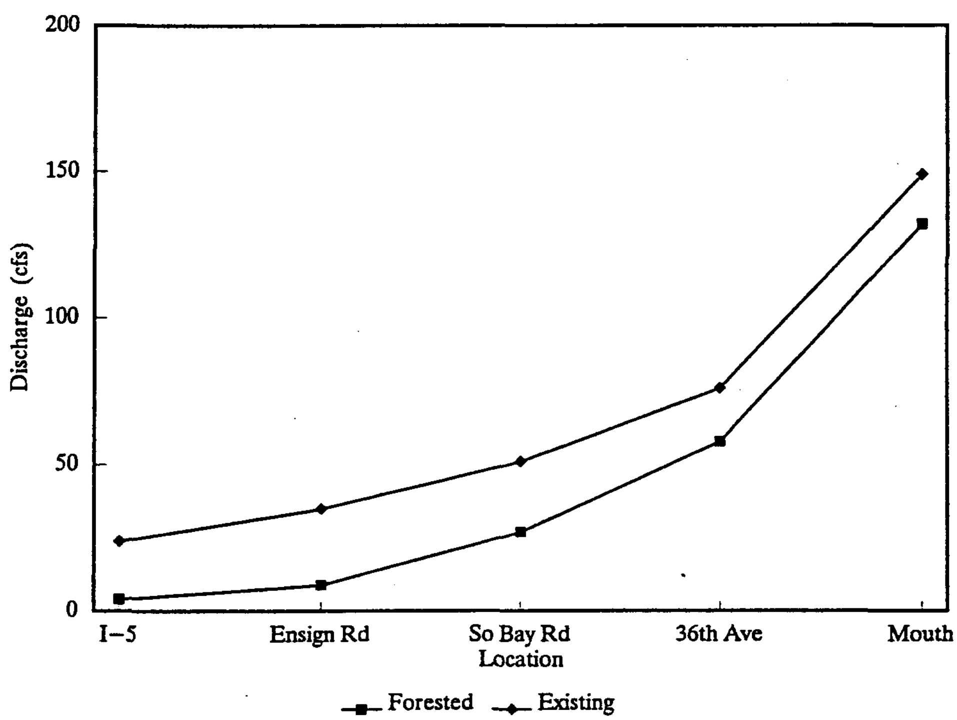


Figure 3-4 Woodard Creek 100-Year Flows, Natural vs. Existing



3.12 WATER QUALITY

The State of Washington classifies Henderson Inlet and its tributaries as "Class AA" waters, the highest water quality designation with the most stringent standards. Class AA designation mandates protection of most uses of the waterbody, such as shellfish and/or salmonid rearing, spawning, and harvesting.

In 1990, the Washington Department of Ecology identified the following water bodies as "water quality limited" under the definition in the federal Clean Water Act:

- Henderson Inlet: Designated uses are threatened for most of the Inlet
- Woodland Creek: Does not support 2 or more of its designated uses.
- Pattison Lake: Designated uses are threatened.
- Long Lake: Designated uses are threatened.

Since 1990, the Department of Ecology has removed Pattison and Long Lakes from the list by authority of federal regulation 40CFR130.7B1 because projects have been completed on the lakes to address the basis for the original listing. However, Henderson Inlet and Woodland Creek continued to be listed (Washington Department of Ecology 1994).

Failure of a water body to meet standards for its designated uses makes the overseeing agency subject to lawsuits by citizens or the state under the conditions of the federal Clean Water Act. The law gives anyone power through the courts to enforce measures to restore water quality to the level needed to support designated uses.

Several studies have evaluated water quality and identified pollution sources in the Henderson Inlet watershed, including: *The Henderson and Eld Inlet Water Quality Study*, M. Taylor (1984); *Henderson, Eld and Totten Inlets: 1986-1987 Water Quality Investigation*, B. Harrison and L. Hofstad (1988); *Woodland and Woodard Creek Basins Stormwater Quality Survey*, S. Davis and R. Coots (1989); and *Henderson Inlet and Watershed: 1987-1989 Water Quality and Remedial Action Report*, A. Starry (1990). These studies indicated that water quality in Henderson Inlet is deteriorating, and several land use activities that contribute to the contamination problems. Hofstad reported in *Watershed Implementation, Eld, Henderson and Totten/Little Skookum, 1990-1992, Final Report* (1993) that water quality samples from Henderson Inlet appear to have stabilized recently, but the samples were collected during drought conditions so the results may be misleading.

Fecal coliform contamination of shellfish beds in Henderson Inlet was a significant impetus for this basin plan and several of the studies cited above. Virtually all water quality studies of the watershed have concluded that stormwater is the major contributor of fecal coliform contamination in Henderson Inlet. Detailed stormwater analyses have also revealed high levels of heavy metals in the basin's urban runoff, as well as a few other toxins of concern. Chapter 4 identifies the specific water quality contamination sites in the basin and describes the water quality problems in greater detail. The stormwater study by Davis and Coots forms the basis for several recommendations presented later in this plan, and the results of that study are summarized in appendix B.

3.13 STORMWATER FACILITIES

Thurston County undertook a two year study to inventory detention and retention facilities in Woodland and Woodard Creek basins. The inventory is maintained by the Thurston County Storm and Surface Water Program. The current inventory does not include facilities at commercial establishments. Similar inventories are available for Lacey and Olympia drainage systems within the basins. Appendix I describes the types of stormwater facilities found in the basin in greater detail. Tables 4-3 and 4-5 in the next chapter list all the known stormwater outfalls that discharge directly to a stream or lake.

Thurston County completed an inventory of Woodland Creek basin roadside ditches in the public right-of-way in 1991. The county also maintains an inventory of catch basins and dry wells, and the cities of Lacey and Olympia have inventoried their conveyance systems. This information will assist road crews and stormwater planners to understand maintenance and system design needs in the basins. The information will become available to residents and agencies as it is mapped, digitized, and entered into the computer database.

Public stormwater facilities in the basins include roadside ditches, catch basins and pipes, culverts, and two regional stormwater treatment systems. Most of the roadside ditches in the basin discharge directly to streams or lakes with no treatment. Many of the piped catch basins also discharge directly to streams or lakes, including the systems that drain the runoff from Martin Way, Interstate 5, portions of Pacific Avenue, College Street, Sleater-Kinney, and Fones Road. Publicly owned stormwater treatment facilities include: a Lacey-owned facility to treat and infiltrate runoff from a neighborhood near 7th Avenue SE and Lacey Street; an Olympia-Lacey joint facility to treat stormwater runoff discharging to Woodard Creek in Fones ditch; and a county facility to treat runoff discharging into Woodland Creek at Pacific Avenue.

Each individual jurisdiction is responsible for maintaining its own facilities. Ditches and culverts are cleaned out periodically by the road maintenance crews of each jurisdiction. Within the past few years, each jurisdiction has begun scheduled cleaning of catch basins, and treatment of the resulting waste prior to disposal.

The basins contain hundreds of privately owned stormwater facilities. The oldest developments often have no stormwater facilities at all, or their facilities consist of pipes that discharge directly to streams or lakes. In developments with stormwater facilities, dry wells and infiltration trenches are most common. These facilities collect runoff and infiltrate it into the ground. Most of the runoff in developed areas flows into storm drains and through pipes to reach the infiltration facilities. Stormwater ponds are more common in the newer developments. Some stormwater ponds infiltrate runoff directly into the ground, while others store the runoff and meter it out slowly to streams or lakes.

A county inventory and assessment of stormwater facilities in the basin found that most of the basin's private stormwater systems are in poor condition. Hundreds of facilities need maintenance and are in imminent danger of failing.

Private facility ownership takes several forms, depending largely on when the facilities were designed and constructed. Old stormwater ponds may be owned in part-interest by every homeowner in a subdivision, in which case each homeowner pays taxes on a fraction of the pond. Newer facilities are usually owned by homeowner associations, many of which are defunct or very minimally organized. Homeowner associations frequently do not realize that they own stormwater facilities. A few facilities have been deeded to the county or city.

This haphazard pattern of ownership has led to poor maintenance or no maintenance of stormwater facilities. The county performed remedial maintenance on several stormwater ponds in the basin in 1993, and discovered that many facilities have been virtually abandoned and drainage easements have been encroached on by fences, driveways and buildings. Many ponds were so overgrown that they were almost impossible to find.

The soil type determines the effectiveness of the infiltration facilities in the basin. Infiltration facilities generally work well in the southern part of Woodland basin, where well-drained, sand and gravel soil predominates. Infiltration facilities fail frequently in central Woodland and southern Woodard basins, where shallow layers of impervious till underly the outwash soils. Infiltration facilities do not work well in the tight, poorly drained soils of the northern basins.

Certain construction practices drastically reduce the effectiveness of infiltration facilities. Stormwater facilities must be protected from sedimentation during construction, because the sediment-laden runoff from construction sites rapidly clogs the soils of an infiltration basin. Heavy equipment driven in bare infiltration ponds can compact the soil and make it impervious.

The cumulative impacts of extensive development have also affected stormwater facilities. Increased runoff in roadside ditches has caused extensive localized erosion. New impervious areas have changed patterns of groundwater recharge and forced surface flow and interflow into new locations, occasionally flooding out stormwater facilities.

3.14 CURRENT LAND USE

This section generally describes the existing land uses in Woodland and Woodard Creek basins. Maps 10 and 11 depict land use as of 1987, which were used to define land cover for the hydrologic simulation of existing conditions. Chapter 5 gives more detail about the hydrologic modeling, including the basic assumptions about the basins' zoning and its effects on future growth.

High density commercial and industrial areas dominate southern Woodard Creek basin and central Woodland Creek basin. The commercial cores of Lacey and Olympia's eastside along Pacific Avenue, Lacey Boulevard, Martin Way, and Sleater-Kinney Road cut a swath across both basins. Medium-to-high density residential areas encircle the commercial zones of both basins. Mostly sparse, rural areas with many large lots and small farms typify the northern half of Woodard Creek basin and the mouth of Woodland Creek basin. Residential subdivisions are spreading rapidly in the area around the lakes and near the mouth of Woodland Creek basin, while large tracts of second growth forest still cover northern Woodard Creek basin.

Problems associated with development in Woodland and Woodard Creek basins include increased runoff, contaminated runoff, decreased ground water recharge, encroachment into stream buffers and consequent water quality and habitat degradation. Specific land use activities of concern include:

- installing septic system drain fields in saturated soils, which can cause pollution during storm events.
- disposing yard waste along and in the stream channel, which can decrease dissolved oxygen and increase nutrients, harming fish and promoting weed growth.
- removing stream side vegetation, which can lead to erosion and cause water temperature rises that harm fish.
- over-applying lawn pesticides and fertilizers, which can wash into the stream and injure aquatic life.
- installing inadequate erosion controls on construction sites, which can result in degraded or destroyed fish spawning beds.

3.14.1 Woodland Creek Basin Land Use

Woodland Creek basin is one of the fastest growing areas in Thurston County, mainly because it is close to Lacey and Olympia commercial districts, has good access to major roads, and has large areas of undeveloped land. Thurston Regional Planning Council predicts that most of the basin's growth will occur in the southern sub-basins of Woodland Creek, while the northern sub-basins will develop at a slower rate (Thurston Regional Planning Council 1991). This growth will change the current land use patterns in the basin.

Woodland Creek basin still contains substantial areas of undeveloped forests, and the dominant land use is suburban-density residential development (see table 3-4). The rapidly developing area around Hicks, Pattison and Long lakes contains the headwaters of Woodland Creek. Farther downstream, the commercial zone along Martin Way drains to the creek.

Numerous individual residential properties, subdivisions and streets also drain into the creek.

The residential development is most dense in Lacey and in the Tanglewilde subdivision, and decreases to isolated subdivisions and rural homes farther north in the county. Homes and roads line 80% of the lake shorelines and 16% of the creek shorelines in the basin. The basin's soil limitations for septic systems have prevented some growth in the area east of Lacey Street and north of Pacific Avenue, which is not served by sewers.

Commercial land uses are centered in Lacey along the major arterial roads, including Sleater-Kinney Road, Pacific Avenue, Lacey Boulevard, Martin Way, Marvin Road and College Street. Two gravel mining operations occur near Draham Road and a few isolated commercial services are spread throughout the basin. The basin's northeast corner contains the county's sanitary landfill.

Agricultural and forest lands and large lot single family homes predominate in northern Woodland Creek basin. Tree farms, livestock pastures, and hay fields constitute typical agricultural uses. Livestock entering some parts of the creek and drainage channels in the northern basin trample the vegetation and contribute to stream bank erosion and water quality problems; however, much of the creek's shoreline is still forested.

3.14.2 Woodard Creek Basin Land Use

Woodard Creek basin contains large tracts of undeveloped forests, intensive commercial districts, and scattered residential development (see table 3-4). Forests still cover half the basin, and grasslands associated with agriculture or wetlands constitute an additional 22% of the basin. Developed areas are fairly evenly divided between commercial and residential uses, but residential development is much more dispersed throughout the basin.

The basin's highly developed commercial district straddles the Olympia-Lacey boundary, centered on Pacific Avenue, Martin Way, Lily Road and Fones Road. The area includes the shopping centers of South Sound Mall, Olympia Square and Food Pavilion, which drain to the wetland at the headwaters of the creek. An industrial area centered on Fones Road empties directly into the headwater wetlands. Residential developments are scattered throughout the basin, but most of the single family residences and large tracts of undeveloped land occur north of the Urban Growth Management Area boundary, in unincorporated Thurston County.

The unincorporated northern portion of the county is zoned primarily RRR 1/5 (Rural Residential/Resource) by Thurston County, which permits 1 dwelling unit per 5 acres. However, most of the unincorporated area within the long term Urban Growth Management Area (UGMA) is already broken into parcels less than 5 acres. Agricultural uses are permitted by definition. The density allowed by zoning is greater adjacent to the city limits of Olympia and Lacey, ranging from 4 to 6 units per acre. Within the cities, residential densities range from 6 to 20 units per acre.

Commercial uses are primarily limited to commercial centers within the cities, and the commercial strip along Martin Way. However, provisions in all three zoning ordinances allow limited commercial uses known as "home occupations" and "home-based industries" in residential areas. If development proceeds according to current comprehensive plans, virtually all remaining forests within the UGMA will be developed and most low-density residential areas will be converted to medium-density residential areas.

Table 3-4 Current Land Use in Woodland and Woodard Creek basins (1987)

Land Use	WOODLAND BASIN		WOODARD BASIN	
	Acres	% of Basin	Acres	% of Basin
Crops	883	4	0	0
Forest	8590	45	2348	52
Grass	2380	12	1018	22
Lakes	791	4	2	0
High density commercial	296	2	233	5
Medium density commercial	587	3	326	7
Medium density residential	487	3	434	10
Low density residential	810	4	5	0.1
Suburban residential	3818	20	102	2
Mining	241	1	0	0

3.15 POPULATION

Population growth in Thurston County slowed down to 30% in the 1980s after averaging 62% in the 1970s, when it was one of the fastest growing counties in the nation. Most of the growth in the 1970s occurred in unincorporated areas of the county, which experienced an amazing 99% increase in population. Economic recession and increasingly stringent zoning and land use regulations probably helped reduce the growth in the unincorporated county to 37% in the 1980s (Thurston Regional Planning Council 1991).

The following population projections for the Woodland and Woodard Creek basins are derived from growth modeling conducted by Thurston Regional Planning Council, to comply with state growth management planning requirements. The county-wide population forecast through the year 2015 was officially adopted by the local jurisdictions in 1993 for planning purposes. The forecast is based on birth and death rates, employment growth patterns, vacant buildable land, and historic growth trends for each one of 377 individual planning areas. The forecast will be updated every two years to serve as the basis for the county's capital facilities plan.

The basin population forecast was developed by placing the basin boundaries over the map of population planning areas (called Transportation Area Zones, or TAZs). Population forecasts for TAZs within the basin and fractional population forecasts for TAZs that lie partially within the basin were added to develop the basin population forecast.

Table 3-5 Population Forecast for the Woodland and Woodard Creek basins

YEAR:	1993	1995	2000	2005	2010	2015
POPULATION:	40,452	44,131	48,385	51,924	55,914	59,720

3.16 RECREATIONAL RESOURCES

The marine waters of Puget Sound provide a valuable aesthetic and recreational resource for residents and tourists. Demand is high for residences near the water. An estimated 36% of Puget Sound residents live within one-half mile of the Sound, and half of the state's residents see a shoreline on a daily basis (Puget Sound Water Quality Authority 1989). Puget Sound residents use shorelines heavily for recreation; 73% of Puget Sound area residents visit saltwater or a beach every year (Washington State Parks and Recreation Commission 1989). The state Comprehensive Outdoor Recreation Plan indicates that one-third of all outdoor recreational activities involve fresh or salt water. Woodland and Woodard Creek basins contain several parks and open space areas that contribute to the quality of life for Thurston County residents. Most streamside property is privately owned, which limits access to the streams.

At the south end of Henderson Inlet, Thurston County owns the 75-acre Woodland Creek Preserve. Other county recreational facilities include the county's fairgrounds near Long Lake. The state Department of Natural Resources (DNR) owns the Woodard Bay Natural Resources Conservation Area at the mouth of Woodard Creek. A recently constructed bicycle and pedestrian trail, owned partly by the county and partly by the DNR, leads from Woodard Bay to Lacey along an abandoned Weyerhauser railroad.

The four lakes of southern Woodland Creek basin are popular with sport fishermen since the Washington Department of Fish and Wildlife stocks the lakes with trout. Hicks, Pattison, and Long Lakes have public boat launch ramps. Private recreational sites in the basin provide walking and jogging trails, swimming, and lake access.

The Lacey Parks and Recreation Department maintains five parks in Woodland Creek basin: Wonderwood Park (40 acres), Lake Lois Park (6 acres), Homann Park (8 acres), Interstate 5 Park (1 acre), and Long Lake Park (10 acres). They provide recreational facilities including playground and picnic equipment, trails, swimming areas, open space, and sports fields. Lacey also owns several small, undeveloped community and neighborhood parks throughout the basin, and is currently developing a park on Woodland Creek south of Pacific Avenue.

The *Thurston County Comprehensive Parks, Recreation and Open Space Plan, 2010* contains policies, capital improvements, and standards for parks and open space. Lacey and Olympia have similar plans for park facilities and open spaces. Thurston County's subdivision and zoning ordinances (TCC Title 18 and Title 20) contain requirements for dedicating open space in residential developments. Lacey and Olympia also have open space requirements in their development regulations. The *Thurston County Open Space Tax Program* (Thurston County 1989) provides tax-reduction incentives for dedicating property to open space uses.

3.17 CULTURAL RESOURCES

Much of the information contained in this section comes from *Boomtime: A History of the Woodard Bay Natural Resources Conservation Area* (Poultridge 1991). The Woodland and Woodard Creek basins have a rich heritage of long use by several small bands of indians, known collectively today as the Nisqually Tribe. The Nisquallies lived for centuries in small groups along marine shorelines throughout northeast Thurston County, including the shores of Henderson Inlet. The Nisquallies' villages were usually located near stream mouths, which provided drinking water and access to salmon runs.

In 1854, George Gibbs, an agent of Territorial Governor Isaac Stevens, identified the people living in the South Bay area of Henderson Inlet as the Noosehchatl, with an estimated population of twelve. Ethnologist Marian Smith later called this village Tuts'e'tcaxt, and placed it between what were probably Woodland and Woodard Creeks. Another ethnologist, T.T. Waterman, said that the native people called the promontory between Woodard and Chapman bays, where the DNR buildings now sit, Su'pEks, translated as "blowing promontory". The head of Woodard Bay was called TsEle'xgwil, meaning "squeezing one's canoe", which refers to the narrowing creek channel at low tide.

The exact location of this village is no longer known, but it was a permanent village with two cedar-plank longhouses. The village provided refuge during bad winter weather, and served as a hub for hunting and other food gathering activities in fair weather. The primary summer hunting and food collecting area for the people of the village was on Anderson Island. Most of the Noosehchatl people returned to the village in the fall in time for the returning salmon.

The native people lived a fairly undisturbed existence at the village for many years. The village was probably sited carefully to be out of view from invading northern tribes such as the Haida, and from the influx of Europeans. The village was apparently never seen by the explorers Wilkes and Vancouver. The first European explorers to arrive in the area in the eighteenth century brought smallpox, which devastated the native people. By the time larger parties of settlers arrived in the nineteenth century, much of the population had been decimated by disease.

An ongoing study of Henderson Inlet by the Nisqually Tribe suggests that the entire shoreline is archaeologically sensitive, and may contain relics of village and burial sites. The shorelines contain several known shell middens, remains of native shellfish gathering activities.

Settlement by non-native people began with the George Bush party, which founded Newmarket in 1845, now known as Tumwater. A millwright from New York named Harvey Rice Woodard cleared 10 acres and built a home in 1853, next to the bay that now bears his name. The Woodards eventually moved into Olympia and the Nisquallies were forcibly moved, either to the Nisqually Reservation created by the Medicine Creek Treaty of 1854, or to Fox Island. The Woodards continued to log their property on Woodard Bay after they moved into Olympia. A small farm was located on the point south of Woodard Bay, and oysters were harvested commercially in the South Bay area.

The Weyerhauser Company purchased the property at Woodard Bay from the Capital City Oyster Company in 1924; a move that shaped the future of the bay and profoundly affected Thurston County. Throughout the mid-1920s, Weyerhauser bought up right-of-way for a railroad to connect Woodard Bay to their timber lands in Thurston and Lewis Counties. Weyerhauser had purchased vast timber lands from the Northern Pacific Railway, in an area with no mill. Weyerhauser's vision of a broad network of timber lands, railways, loading areas and mills represented the first attempt at large-scale, industrial forestry in the Pacific northwest. They chose Woodard Bay to construct the log dump which became the central shipping terminal for logs from their southwest Washington lands, bound for mills in Everett. The railroad, much of which is now a recreational trail through the basin, and the log dump were completed in 1928 and used by Weyerhauser until 1984. The DNR purchased the Woodard Bay log dump site from Weyerhauser in 1988, and much of the original Weyerhauser facilities still stand.

The history of the Woodland and Woodard Creek basins is closely associated with the log dump and railway. Other historical resources in the basins include residences, schools, grange halls, recreation halls, museums, churches, and cemeteries, which have been listed by the Washington Office of Archaeology and Historical Preservation, the Lacey Historic Register, the National Register, and the Thurston County Historic Register.