CHAPTER 2: BASIN CHARACTERIZATION

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This chapter describes the characteristics of the McAllister/Eaton Creek basin. The first section describes the natural resources of the basin, and the second section describes the cultural resources.

2.1 NATURAL RESOURCES DESCRIPTION

This section describes the basin's physical characteristics, including:

- Location
- Climate
- Topography
- Geology and soils
- Surface water bodies
- Vegetation
- Wildlife
- Fish

In general, basin planning areas are defined according to surface water drainage. However, much of the stormwater that falls in the eastern surface drainage basin of Woodland Creek infiltrates to ground water and travels toward McAllister Springs, which is the sole source of drinking water for most of Olympia. In other words, some rainfall in the eastern Woodland Creek basin migrates through the ground into McAllister basin.

This plan describes a unique geographic area that drains both surface and ground water to the interconnected stream and aquifer system comprised of Eaton Creek, Lake St. Clair, McAllister Springs, and McAllister Creek. **The plan includes the portion of Woodland Creek basin in the McAllister GSA which infiltrates stormwater to the McAllister basin aquifer system.** The significant threat to ground water quality from surface water infiltration requires that this area be included in comprehensive water resources management for the McAllister/Eaton Creek Basin. The actual drainage basin area described for the purposes of surface water planning covers only the surface drainage. Map 4 in Appendix A shows the sub-basin boundaries. The surface drainage encompasses a total of 20,467 acres, or 32 square miles, divided into the sub-basins listed in Table 2-1 on the next page.

The Fort Lewis potholes in the southeastern part of the basin, and the St. Clair potholes in the central basin are closed sub-basins with no surface water outlet. The Lake St. Clair/Eaton Creek drainage is also a closed sub-basin which infiltrates to an aquifer that feeds McAllister Springs.

Table 2-1: McAllister/Eaton Creek Sub-basin Areas

SUB-BASIN	% OF BASIN	AREA (sq mi)	AREA (acres)
McAllister Creek Sub-basin	22.5	7.20	4608.0
Medicine Creek Sub-basin	5.0	1.56	998.4
Little McAllister Creek Sub-basin	7.0	2.30	1472.0
MCALLISTER DRAINAGE SUB-TOTAL	**34.5**	**11.06**	**7078.0**
Lake St. Clair Sub-basin	16.0	5.10	3264.0
Eaton Creek Sub-basin	22.5	7.20	4608.0
ST CLAIR/EATON DRAINAGE SUB-TOTAL	**38.5**	**12.30**	**7872.0**
Fort Lewis Potholes	18.0	5.76	3686.4
St. Clair Potholes	9.0	2.86	1830.4
CLOSED POTHOLES SUB-TOTAL	**27.0**	**8.62**	**5516.8**
TOTAL		31.98	20467.2

2.1.1 Location

The McAllister/Eaton Creek basin lies in northeast Thurston County, and drains to the Nisqually Reach in Puget Sound. The basin spans a developing area between Lacey on the west, the Nisqually Indian Reservation on the east, and Fort Lewis Military Reservation on the south. The northern half of the basin drains to McAllister Creek, and the southern half drains to Eaton Creek, which empties into Lake St. Clair. Ground water also feeds Lake St. Clair, which drains into an aquifer (an underground, water-bearing layer of loose, gravelly soil) that feeds McAllister Creek (see Basin Boundaries Map 2 in Appendix A).

2.1.2 Climate

Marine weather from the Pacific Ocean creates northern Thurston County's climate. Most of the 51" average annual precipitation falls during the months of October through March. Winter storms are typically long-lasting and moderately intense. Spring and summer storms usually last less than 4 hours and contribute little water to runoff and infiltration. Rainfall patterns for individual years vary greatly from the average. Dry summers result in generally dry surface soils at the start of the rainy season. However, heavy winter storms often cause saturated soils by January, when the heaviest storms occur, especially in areas with a layer of densely compacted, impervious subsoil (till) close to the surface. A rainfall gauge has been installed on Eaton Creek near Yelm Highway.

The average winter temperature for the Olympia area is 39° F. Summer temperatures are relatively cool, and average 62° F. Summer temperatures vary daily by 25° to 30° F. Winter temperatures are mild, and vary daily by about 15° F.

Winds come predominantly from the southwest and have a mean hourly speed of 6.5 mph. The growing season averages 160 frost-free days. The basin experiences very little snowfall due to its low elevation, so stream flow peaks result almost exclusively from rainfall events.

2.1.3 Topography

The topography of the McAllister/Eaton Creek Basin includes flat to rolling expanses and landforms with sharp relief. The Vashon glacial advance and sediment deposition by creeks and rivers shaped the terrain. Glacial movements created a large plateau at about 200 feet above sea level, which forms the basin uplands, and sculpted some of the plateau's surface into steep-sided depressions and gravelly hills. Such glacier-formed depressions are often referred to locally as potholes. The plateau drops sharply off to the Nisqually Reach on the north and the McAllister/Nisqually delta on the east.

The St. Clair Potholes stretch across the central basin from Lake St. Clair to Lost Lake, dividing the basin into northern and southern portions at its narrowest point (see Potholes Map 5 in Appendix A). Isolated potholes also cover part of the southernmost basin within Fort Lewis. Lake St. Clair occupies the largest and deepest pothole in the basin, covering 268 acres and attaining a maximum depth of almost 100 feet. (Historic records indicate depths of up to 110 feet, but recent measurements showed a maximum depth of about 90 feet, indicating that the lake may be filling with sediment.) The surrounding hills rise steeply to a height of 145 feet above the lake surface for a total pothole depth of more than 240 feet. Lost Lake sits in a northeastern finger of upland plateau that separates Medicine and McAllister creeks.

In the northern basin, McAllister bluff runs for more than 5 miles from the mouth of McAllister Creek directly south to McAllister Springs, and further divides the northern basin into a northwestern highland and a northeastern lowland. The largely undeveloped bluff rises abruptly from the western shore of McAllister Creek to a height of 200 feet above the valley floor, and dominates the topography.

In contrast to the glacier-sculpted central basin uplands, rivers and streams deposited thick silt to form the flat, open valley floor east of McAllister Creek, which lies entirely below 20 feet elevation. Sediment deposition from McAllister Creek, Medicine Creek, and the Nisqually River built the delta after the Vashon glacier retreated and sea level reached its present position, about 6000 years ago. The delta area contains numerous wetlands where ground water, surface water, and marine water meet to create complex drainage patterns.

The southern basin lies at a higher elevation. The area draining to Eaton Creek south of Lake St. Clair consists primarily of glacially deposited soils forming the broad, level Evergreen Valley, at about 200 feet above sea level. Evergreen Valley is bounded by hills to the east and south, which reach heights of 400 to 500 feet above sea level. Lower hills form the west side of the valley. Fort Lewis encompasses the highest hills, including the basin's high point of 640 feet above sea level. These hills are interspersed with potholes and level out at the southern basin boundary, which also forms the northern edge of Weir Prairie.

2.1.4 Geology and Soils

History of Geology and Soils in the Basin

McAllister/Eaton Creek basin lies in the Puget Sound Trough, a broad depression created by the final geologic uplift which formed the Cascade mountain range about 11 million years ago. Volcanic bedrock probably sits at the base of the trough, but the overlying sediments are too thick to allow actual observation of the bedrock. In fact, glacial deposits have buried all the geologic formations in south Puget Sound, so their composition can only be supposed from exposed formations in the eastern Olympic Mountains, and south of the Black Hills.

Following the mountain uplift, glacial ice scoured the Puget Sound lowlands at least four times, retreating most recently only 10,000 to 14,000 years ago. The Salmon Springs glacier, the later Vashon glacier, and the ensuing erosion deposited the soils that comprise the existing McAllister/Eaton Creek basin. The Vashon glacier stopped advancing in the region of Thurston County about 14,000 years ago.

The Vashon glacier extended from the Cascade Mountains to the Olympic Mountains, damming the outlets to the north. This dam created a large lake, known as Lake Russell, in the location of what is now the Puget Sound lowlands. The lake surface reached an elevation of 160 feet before draining south through an outlet near Black Lake, south of Olympia, and into Gray's Harbor via the Black River and the Chehalis River.

When the Vashon glacier retreated, much of the world's ocean water remained frozen, so the sea level was about 200 feet lower than at present. The rivers and streams of the Nisqually basin began to erode a deep valley and deposit sediments at the mouth of the Nisqually River. Sea level rose as the world's ice sheets melted, submerging these early deltas. Sea level reached its present level about 6,000 years ago, and the present Nisqually Delta has formed from sediment deposition since that time.

Glacial "drift", the finely ground remains of rocks pulverized by glaciers, settled on the bottom of Lake Russell. Each time the Ice Age glaciers advanced, their great weight compacted underlying sediments into a concrete-like material often called "till" or "hardpan". Melting ice from the glaciers produced huge water flows that deposited "outwash" soils throughout the basin. Drift (clay), till and outwash are all present in the basin in various combinations. They compose the formations that hold ground water, and provide the parent material for most of the different soils.

Drift deposits contain large amounts of fine silt. These deposits became the common "blue clays" of the Puget lowlands. They are considered "aquitard", which means they prevent the downward migration of ground water.

Till soils consist of unsorted gravel, sand, silt, and clay, with fine silt predominating. Till soils range from moderately well drained to virtually impervious, depending largely on the amount of clay in the soil. Till layers in the basin vary widely in thickness, and are not continuous.

Outwash soils consist mainly of unconsolidated sand and gravel which drains rapidly, erodes readily, and has little capacity for holding water. Thurston County's prairies lie on outwash deposits. The deepest soils in the basin are sandy, well-drained layers of outwash more than 200 feet thick. Ground water seeping through these strata makes up the aquifer system.

Vertical Soil Profile of the Basin

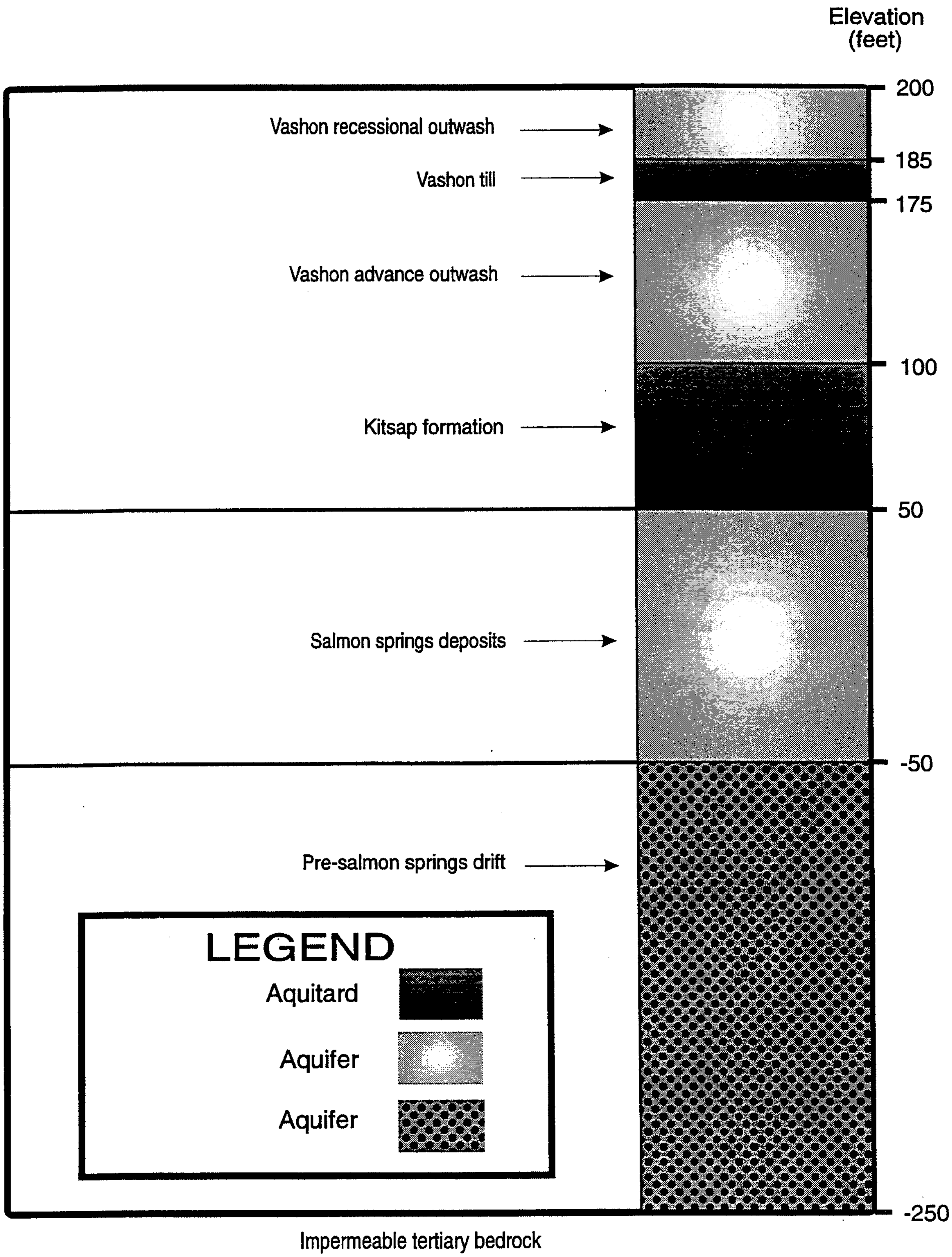
Repeated glaciation and erosion created a complex configuration of till and outwash throughout the basin. Most of the McAllister Springs area contains at least six different soil layers. Each layer varies significantly in depth and lateral extent throughout the basin. The deposits include (from youngest to oldest, or top to bottom):

- <u>Vashon Recessional Outwash</u> The recessional outwash consists of relatively loose coarse sand and gravel which is usually less than 30 feet thick and often mantles the higher areas in the McAllister GSA, such as Evergreen Estates and the Lakes region, and the upper Eaton Creek basin. These deposits were formed by the receding Vashon glacier, 10,000 to 13,000 years ago.

- <u>Vashon Till</u> Vashon till is an unsorted mixture of silt, sand and gravel deposited and compacted directly by glacial ice. Well logs frequently describe the till as hardpan or cemented gravel. The till usually ranges from 5 to 45 feet thick (but may be as thick as 175 feet) and occurs frequently beneath Vashon recessional outwash. The lakes of the Lakes region may be resting on this till layer. The Vashon till was formed as the glacier overrode sediments in its path, differentially eroded them, and compacted the finer materials.

- <u>Vashon Advance Outwash</u> Vashon advance outwash includes sands and gravels with variable silty layers, and may be more than 100 feet thick. Much of the advance outwash is relatively dense because it was overridden by ice. Well logs occasionally refer to the denser advance outwash as cemented gravel. The advance outwash was deposited by meltwater streams flowing off the advancing Vashon glacier.

Figure 2-1: Vertical soil profile of McAllister/Eaton Creek basin (approximate)



The Lake St. Clair area contains a modified outwash formation. Glacial drift several hundred feet thick in this area consists of poorly stratified sand and gravel with local layers of till, overlain by fine sand and silt several feet thick. Drift deposited in contact with melting ice formed the pothole topography. Lake St. Clair and the other potholes were formed when stagnant ice blocks buried in outwash gravel deposits melted, leaving large depressions. The outwash gravels around the lake are up to 250 feet thick.

- **Kitsap Formation** The Kitsap formation consists of layers of sand, silt, peat and some gravel near the base, deposited by erosion and sedimentation during an ice-free time period 15,000 to 35,000 years ago, before the Vashon glacier advanced to Puget Sound. The formation underlies the advance outwash (or till, where the advance outwash is absent), and is about 50 feet thick. The base of the formation appears to lie between sea level and 50 feet elevation in the McAllister GSA. The Kitsap formation is missing in some areas, such as beneath the Hawks Prairie Landfill.

- **Salmon Springs Deposits** Recent research indicates that this unit in Thurston County actually contains older soils than the true Salmon Springs deposits found in other parts of western Washington. They are a complex mixture of sands and gravels with some silts and clays, containing a major aquifer which feeds McAllister Springs. They were deposited at least 38,000 years ago by a lobe of the Cordilleran ice-sheet which advanced from the highlands of British Columbia to a point about 15-20 miles south of Olympia. The Salmon Springs drift is up to 100 feet thick, with the top lying at an elevation of about 50 to 75 feet above sea level. Salmon Springs deposits crop out along the base of McAllister bluff.

- **Pre-Salmon Springs Drift** These glacial and interglacial deposits are older than the Salmon Springs deposits, and consist of fine silts and clays with some sand and gravel.

Surface Soils in the Basin

The surface soils in the basin consist of glacial till, outwash, and drift; in addition, muck soils occur frequently throughout the basin, especially in the potholes and depressions and near the creeks. Mucks are dark, fine, dense and poorly drained soils with a highly decomposed organic content. They form out of accumulated decomposed plant material, and are often associated with wetlands. Mucks are "hydric" soils: they are frequently water-saturated, which deprives plant roots of oxygen during the growing season. They usually indicate a high water table that rises to or above the soil surface during the rainy season.

Six basic surface soil configurations influence the basin's hydrology:

1. Areas of surface or near-surface glacial till with very slow infiltration rates.

2. Mucks and poorly drained silt and clay loams collected in upland depressions, floodplains, and drainage ways.

3. Areas with fine sands that, when used for stormwater infiltration, can rapidly clog with sediments that impair the functioning of infiltration facilities.

4. Areas of surface outwash gravels and coarse sands with rapid infiltration rates.

5. Steep slope areas that cut across till and outwash deposits and tend to promote surface runoff.

6. The pothole area between Lake St. Clair and Lost Lake.

Appendix C lists the names, permeability, hydrologic classification, and general occurrence of the predominant surface soils in the basin as described in the Soil Survey of Thurston County, Washington, Soil Conservation Service, 1990. Map 6 in Appendix A contains a map of surface soils.

The upland areas include a complex combination of fairly impervious till and well-drained outwash soils. The pothole areas contain extensive near-surface till deposits which lakes and wetlands perch upon, surrounded by deep outwash gravels. Smaller perched till deposits occur throughout the upland areas. Surface outwash soils are typically shallow and low in organic content (except where muck has formed in boggy areas), though depth varies widely from site to site.

The Soil Conservation Service classifies soils hydrologically, according to how fast they infiltrate water. Although well-drained, hydrologic Class A soils occur throughout the basin, Map 6 shows a high frequency of hydrologic Class C and D soils exhibiting poor infiltration rates when wet. Runoff from undisturbed Class A soils should be minimal. However, development that disturbs these soils will dramatically increase runoff. Nisqually and Indianola soils are sandy Class A and B soils which occur frequently. These soils are moderately well drained in a natural state, but similar soils in the Portland, Oregon area have shown a strong tendency to become clogged quickly with sediment when used for infiltration facilities.

The soils in the upper portion of Eaton Creek include Norma silt loam, Tisch silt loam, and Dupont muck. The soils in the upper portion of McAllister Creek include Semiahmoo muck and Mukilteo muck. These soils, which predominate immediately adjacent to the creeks, have very poor infiltration capacity, and consequently high runoff. In addition, the mucks in the McAllister Creek area contain high levels of peat. Similar soils probably occur in most of the upland depressions, where water and organic material accumulate.

Soils of the McAllister/Nisqually delta alternate between layers of sand, silt, and clay to a depth of 135 feet. The tidal channel at the creek mouth is very sandy. East and west of the mouth, surface sediments contain up to 90% silt mixed with sand, clay, and organic matter.

2.1.5 Surface Water Bodies

Map 4 in Appendix A shows the names and locations of the basin's surface water bodies and their drainage boundaries.

McAllister Creek

McAllister Creek originates in a low lying horseshoe-shaped basin fed by three large springs and many small ones, and flows north for 6 miles to empty into the Nisqually Reach near Luhr Beach. Five reaches each display distinct characteristics, which are described below from headwaters to mouth. Mile 0 is at the mouth, Mile 6 is at McAllister Springs, and left and right bank refer to downstream orientation.

- **Reach 1** The creek is born at an elevation of only 6.7 feet above mean sea level, where water from an artificial lagoon surrounding McAllister Springs pours through a culvert into a large forested wetland. An estimated 20-40% of McAllister Springs' flow originates at Lake St. Clair. The springs are the city of Olympia's main drinking water source, and the city withdraws 16 million gallons per day from the springs during peak demand periods. The stream bed near the springs consists of good spawning gravels, giving way to sand, peat, and muck further downstream. Pools, springs, side channels and fallen trees offer good, diverse habitat.

  Abbott Springs, located east of McAllister Springs, contributes an estimated 7-10 cubic feet per second (cfs) of flow which joins McAllister Creek on the right bank about 0.15 miles downstream of the lagoon. Lodge Springs, located northwest of McAllister Springs, contributes an estimated 6 cfs to the creek. Numerous small springs and seeps feed the creek along the left bank. Because of the stream's extremely low gradient, the tide influences the creek all the way to its source, where 3-4 foot elevation changes have been observed. Reach 1 flows for about 0.4 miles through an undisturbed wetland owned by the city of Olympia. The temperature varies the least in this reach because ground water enters at a fairly steady temperature year round, and the dense shrub and tree canopy shades the creek. Salinity varies with the tide.

- **Reach 2** From Mile 5.6 to Mile 4.3, the creek flows through agricultural pasture lands until it reaches the Steilacoom Road bridge. This reach is lined by dikes with almost no tree or shrub cover for most of its length. The dikes and tidegates prevent saltwater from entering the adjacent agricultural lands. Numerous agricultural ditches drain into the creek on both banks in this reach. The flow direction changes with the tide from Mile 5.6 to the mouth, and water level fluctuates up to 5 feet at Mile 4.3. The temperature fluctuations increase dramatically through the reach because of low velocity and lack of canopy cover. Salinity also increases dramatically due to salt water intrusion from tides.

The stream bed through this reach is almost exclusively peat and muck with very high organic content. There are no riffles or large organic debris in this reach, and the habitat is extremely uniform: broad, slow moving water with little cover. As the creek nears Steilacoom Road, it draws near the base of McAllister bluff on the left bank, and the dikes on the left give way to somewhat better tree canopy. Numerous seeps draining into the creek from the bluff on the left bank offer a little more habitat diversity for fish here.

- <u>Reach 3</u> After crossing under Steilacoom Road at Mile 4.3, the creek passes a small residential development on the left bank, and traverses a fairly undisturbed forested area before entering a diversion channel under the Martin Way at Mile 3.65. The stream gradient increases through the development, and gravel deposits offer good spawning habitat. Large trees shade most of this reach, but homeowners have removed most of the overhanging streamside shrubs and large organic debris in the developed area. Numerous outfalls drain directly into the creek from houses in the development. The vegetation is fairly undisturbed and the habitat includes riparian wetlands and good canopy cover from the end of the development at Mile 4.1 to the diversion channel at Mile 3.65.

- <u>Reach 4</u> McAllister Creek enters a diversion channel under Martin Way at Mile 3.65, then flows into a newer diversion channel under I-5, and finally reenters the natural channel at Mile 2.4. Rock rip-rap lines the channel throughout this reach. Occasional trees provide some high cover, but there is almost no low overhanging vegetation.

- <u>Reach 5</u> After leaving an artificial channel under the highway, the creek flows through the Nisqually National Wildlife Refuge to the mouth near Luhr Beach. The right bank is diked all the way to the mouth. Tides have a major influence on the creek in this reach, and the vegetation is primarily estuarine wetland plant communities. Silt and muck comprise the stream bed, and there is virtually no gradient. The stream opens into a broad estuarine lagoon at the mouth, which becomes a network of braided distributaries and mud flats at low tide. This estuarine area probably serves as rearing habitat where salmon smolts can reside before entering Puget Sound.

<u>Human Alterations</u> McAllister Creek has a long history of human alterations. Reach 5 was diked in the early 1900s to drain the adjacent wetlands for agricultural use (see "Brown Farm", Section 2.2.4). Reach 4 consists entirely of artificial channel which has lengthened the creek by more than 0.5 miles and constricts flow, compared to the pre-diversion hydrology. Department of Fisheries staff believe the constriction may be reducing the stream's ability to flush out sediments and salt water, which could add to problems at the

McAllister Fish Hatchery. Reach 3 was cleared for agriculture on the east side early in the twentieth century. Aerial photographs show that McAllister Creek was not cleared until after 1960 from Mile 5.6, where it empties out of the city of Olympia watershed, to Mile 4.72.

Stream Flows The United States Geological Survey (USGS) maintained a continuous recording gaging station near the lagoon at McAllister Springs from 1951 to 1964, which registered an average flow of 24 cubic feet per second (cfs). A gage also operated infrequently downstream near the Steilacoom Road crossing, from 1941 to 1949. The peak flow at that location for the period of record was 132 cfs, and the minimum flow was 48 cfs. The records should be regarded as fair at best, because tidal backwater influences the gage's accuracy. Flow measurements made by the Department of Fisheries in Reach 2 during 1984 and 1985 ranged from 37.8 cfs to 51.6 cfs. These probably represent lower than average flows because 1984-85 was a severe drought season.

During the mid-1980s, the city of Olympia recorded an average flow of 16.7 cfs through a calibrated weir at the lagoon outfall, into the creek. The city of Olympia withdrew an additional 8.5 cfs on average for drinking water, or about 1/3 of the total flow from the springs. However, during peak demand periods the city withdrew up to 70% of the springs' flow. Drinking water withdrawal and ground water recharge have a significant effect on the stream flow.

The flow is substantially higher at the mouth because of numerous springs and seeps, and two major tributary streams. Medicine Creek is the longest tributary and drains a low floodplain east of McAllister Creek, adjacent to the Nisqually River. An unnamed tributary, referred to in this report as Little McAllister Creek, drains the area above McAllister bluff and west of McAllister Springs.

Water Quality The state classifies McAllister Creek as a Class AA water body. Water quality data for McAllister Creek is sparse. Most information comes from the city of Olympia's monitoring of McAllister Springs water, and the Washington Department of Fisheries' monitoring of water coming into the McAllister Fish Hatchery. The available data from the city of Olympia for water at the springs shows:

Parameters in compliance:		Class AA Standard
• Temperature:	10 - 11° C	16° C maximum
• pH:	6.7	6.5 - 8.5
• Turbidity:	0.150 NTU	5 NTU maximum[1]
• Fecal coliform:	1 fc/100 ml	50 fc/100 ml maximum

Parameters out of compliance:

- Dissolved oxygen levels often fall below state standard of 9.5 ppm.

[1] Turbidity must be less than 5 NTU above background levels

The data collected at the fish hatchery varies according to the time of year and the operations at the hatchery. Data collected at the intake during the period of January 10, 1991 through June 30, 1992 is shown below.

	Min	Ave	Max
Flow (MGD)	3.2	12.2	22.6
Temperature (°C)	5.5	10.3	18.0
Dissolved oxygen (ppm)	6.8	8.6	10.0

Dissolved oxygen and temperature levels vary widely over space and time. Levels below the state standard of 9.5 ppm occur regularly, and levels below 6 ppm, which may harm fish, occur occasionally.

The Department of Fisheries conducted two seasons of intensive study in 1984-1986 on Reaches 1 and 2, from the source to the hatchery on Steilacoom Road. The results showed generally good water quality near the source, with parameters such as salinity, temperature, and fecal coliform varying widely at downstream sites. The high fecal coliform count in 1984 was 760/100 ml near Mile 4.3, which the Fisheries Department attributed to the fall bird population. Fecal coliform at the same site registered 950/100 ml in April, 1986, which was attributed to manure-contaminated runoff from an adjacent field during a heavy rainstorm. Overall, the reports concluded that "results prove that present water conditions are unfit for summer rearing of fish at McAllister Creek Hatchery".

The state Department of Health conducted sampling in the marine waters at the mouth of McAllister Creek, which indicated high fecal coliform counts following rain storms. The Nisqually Indian Tribe is currently conducting intensive monitoring on McAllister Creek to pinpoint the source of contamination. This problem is described in more detail in Chapter 3, Section 3.2 (WQ-1: Fecal coliform at mouth of McAllister Creek).

Medicine Creek

Medicine Creek, the longest tributary to McAllister Creek, originates in floodplain wetlands near the Nisqually River, about 1/2 mile east of Lost Lake, and flows 3.5 miles to join the mainstem at river Mile 4.1. The flow at the mouth appeared gray in color during a reconnaissance in summer of 1992, but it ran clear during a follow-up trip in January of 1993. Medicine Creek's gradient is almost flat, and the creek has been extensively ditched and altered. Aerial photographs from 1960 show a distinct channel at least as far upstream as Mile 3. The creek has been highly disturbed as it passes through nine culverts in an area used for agriculture and residences. There is almost no canopy cover currently, and the channel is narrow, weed-choked, and frequently dry above the Steilacoom Road crossing at Mile 0.8. Historic reports indicate that Medicine Creek was a significant salmon stream at one time, but anadromous fish probably use it infrequently, if at all, now.

Little McAllister Creek

Little McAllister Creek originates in spring-fed wetlands west of McAllister bluff and drops 180 feet in two miles through a steep ravine and into agricultural ditches which drain through several outfalls on the left bank of McAllister Creek between Mile 4.72 and Mile 5.6. In its uppermost reaches, the ravine divides into two branches. The south branch begins in a ditched wetland south of Pacific Avenue, and the west branch originates in a forested wetland adjacent to the Meadows subdivision at the junction of Mallard Drive and Rockcress Drive. The Meadows stormwater drainage system also flows into the west branch.

Steep cascades and logjams block most of Little McAllister Creek to fish passage, but the lower 0.5 miles are accessible. In addition, a 6" fish was observed in the artificial ditch at the Pacific Avenue outfall to the south branch in 1993, despite the downstream blockages. The origin of the fish is not known. The stream bed is mostly gravel in the lower reach, and sand and gravel in the canyon. The stream cuts steeply through deep, unconsolidated outwash soils interspersed with hard till deposits. Many of the exposed banks are eroding at the outside bends. The vegetation consists of undisturbed second growth forest from the mouth of the canyon to the top of both branches, providing excellent wildlife habitat, except for a clearing where a Puget Power easement crosses the canyon. The creek corridor is generally undisturbed, with no road crossings and poor human access.

Aerial photographs from 1948 show the lower 0.5 mile of Little McAllister Creek ditched along an east-west line and entering McAllister Creek at about Mile 5.1, though the surrounding land was not cleared. Current USGS maps still show Little McAllister following that course, but field reconnaissance proved this false. As it nears the base of McAllister bluff, the creek has been diverted southward around the toe of the bluff by a dike. It flows south along the base of the bluff for about 0.3 miles, where it enters a network of agricultural drainage ditches separated from McAllister Creek by dikes and tidegates. The spring at the base of the bluff to the north is no longer connected directly to Little McAllister Creek. The maps in Appendix A show the creek's correct location.

Springs seep into the head of the natural ravine of the south branch, about 1000 feet north of Pacific Avenue. An artificial ditch drains the wetlands south of Pacific Avenue into the natural drainage, which has increased the length of the creek by about one mile and significantly increased surface runoff into the ravine. Runoff from the ditch has incised a deep, narrow cut into the head of the natural ravine.

The south branch was probably ditched before the turn of the century, at the time that Pacific Avenue was built. County records cite an 1894 lawsuit, apparently related to the ditch. The ditch and pipe under Pacific Avenue were enlarged by 1912, following a 1907 petition to the County Commissioners from G. Goranson, and the County Engineer's survey in 1908 confirmed that the ditch already existed at that time. The surrounding landowners paid for the work. Four landowners petitioned the County Commission in 1938 to form a drainage district and perform further "improvements" on the ditch. This petition was approved in

1939, and Goranson Ditch became part of "Drainage Improvement District Number Nine". Later that year, the WPA extended the ditch and enlarged the culvert, with the costs assessed to the landowners. Apparently, no work was performed on the ditch after 1939, and in 1961 the property owners deeded the ditch and a 30 foot right-of-way to the county.

Springs also seep into the head of the west branch ravine. The Meadows stormwater system has altered the west branch by adding surface runoff during storms. The rainfall probably infiltrated to a shallow aquifer which feeds the wetlands near the head of the canyon, prior to development.

Eaton Creek

Eaton Creek originates in a spring-fed wetland in the southwest corner of Evergreen Valley near Tucker Road, and flows 3.25 miles to empty into Lake St. Clair. The headwaters are 220 feet above sea level, and the creek loses less than 20 feet elevation over its upper two miles. The gradient steepens as the creek flows into a steep ravine just south of Yelm Highway, and drops 130 feet in less than a mile to its mouth. Raymond Ditch flows through the east side of Evergreen Valley for 1.25 miles to join Eaton Creek on the left bank at Mile 1.4. A network of ditches drain wetlands and pastures into Raymond Ditch, and the ditch dries up in the summer.

- **Reach 1** The stream flows through heavily forested riparian wetlands with skunk cabbage and vanilla leaf, from the source at Mile 3.25, a spring near Tucker Road, to Evergreen Valley Road. The stream bed is sandy and downed logs create occasional pools. The gradient is low, so the water moves slowly. Root tannins stain the water reddish brown. The Evergreen Valley Road culvert blocks fish passage. About 200 feet above Evergreen Valley Road, a small ditch drains a horse pasture on the right bank and the creek is partially diverted through a pond next to a home. Farther upstream, a ditch drains a lawn and garden area on the left, and a few hundred feet beyond, an old log bridge spans the creek. The stream passes through a 4 x 25 foot culvert under the bridge.

- **Reach 2** From Evergreen Valley Road at Mile 2.2 to Yelm Highway at Mile .75, the stream has been ditched as it passes through agricultural fields. Homes are gradually replacing farms in this area, the heart of Evergreen Valley. A narrow band of trees and shrubs lines the creek through some parts of this reach, and other banks have lost all cover due to unrestricted cattle. The reach has almost no large woody debris, and the stream bed consists of sand and volcanic ash, with occasional deposits of clay, gravel, and cobbles. The gradient is fairly low, but steep enough to produce good velocity. The Yelm Highway culvert blocks fish passage. The stream enters a forested ravine at about 0.1 mile above the culvert.

- **Reach 3** Between Yelm Highway and Lake St. Clair, Eaton Creek drops through a densely forested ravine with excellent canopy cover consisting of native shrubs and trees. The stream bed consists of gravel in the fast stretches and sand in the pools. Several complex log jams create alternating pools and riffles accessible to fish. The banks are steep, sandy, and prone to sliding, and the water appears stained reddish brown, probably from root tannins.

Stream Flows The USGS operated a crest gauge on Eaton Creek from 1949 to 1986 which recorded only maximum flows, unlike the continuous recording gauge on McAllister Creek which recorded all flows. The average annual maximum flow on Eaton Creek for the period of record was 40 cfs. The gauge was located downstream from the confluence of Raymond Ditch. In 1992, Thurston County, in cooperation with Olympia and the USGS, installed a continuous recording stream flow gage on Eaton Creek at Yelm Highway. However, a rating curve to convert the recorded data to actual flows has not been developed yet.

Water Quality The state classifies Eaton Creek as a Class AA waterbody. There is little historical water quality data on Eaton Creek. Samples collected by trained Stream Team volunteers from two sites on Eaton Creek in September 1992 indicated:

Eaton Creek mouth		Class AA Standard
• Temperature:	12° C	16° C maximum
• Dissolved Oxygen:	9.0 mg/ml	9.5 mg/ml minimum
• Conductivity:	143.0 μohms/cm	NA
• pH:	7.0	6.5-8.5
• Turbidity	1.0 NTU	5 NTU maximum[1]
• Fecal coliform:	180 fc/100ml	50 fc/100ml maximum[2]
Eaton Creek headwaters		
• Temperature:	11° C	16° C maximum
• Dissolved Oxygen:	9.0 ppm	9.5 mg/ml minimum
• Conductivity:	116.5 μohms/cm	NA
• pH:	7.0	6.5-8.5
• Turbidity	0.3 NTU	5 NTU maximum[1]
• Fecal coliform:	350 fc/100ml	50 fc/100ml maximum[2]

[1] Turbidity must not exceed 5 NTU above background level
[2] Geometric mean must not exceed 50 fc/100ml and no more than 10% of samples may exceed 100 fc/100ml

Chapter 3, Section 3.3 contains more information on Eaton Creek fecal coliform levels.

Lake St. Clair

Lake St. Clair is the largest water body in the drainage basin. The lake surface elevation is approximately 68 feet above sea level. The lake surface covers about 261 acres, and the lake is nearly 100 feet deep at one point. A volunteer who lives on the lake is recording lake level data for the county. The lowest level was 66.25 feet above sea level and the high was 69.75 feet above sea level between June, 1988 and October, 1992. The average lake level during this period was about 68 feet, which is 2-4 feet lower than historical levels reported by lake residents. However, the gauge was not read between August, 1990 and February, 1992, a period which included the heaviest rains on record in Thurston County.

Members of the Lake St. Clair Organization began a volunteer lake monitoring program in 1992. Volunteers collected water quality data twice per month from April through October, and collected samples for further lab analysis. The lake temperature differed about 20° F between the surface and the bottom, and dissolved oxygen levels dropped to near zero at the bottom. These findings indicate that little water mixing occurs during the summer season, which might cause nutrient flushes and algae blooms when the waters mix in the fall. The table below presents the other results of sampling. All parameters meet state standards.

Table 2-4: Water quality in Lake St. Clair, April - October, 1992

PARAMETER	UNITS	RANGE	AVERAGE
pH		6.0 - 7.5	6.7
Clarity (Secchi disk)	feet	2.5 - 14.0	7.4
Turbidity @ surface	NTU	0.38 - 5.85	1.32
Turbidity @ depth	NTU	0.55 - 9.65	3.53
Nitrate @ surface	mg/l	0.002 - 0.056	0.021
Nitrate @ depth	mg/l	<0.01 - 0.155	0.067
Phosphorous @ surface	mg/l	0.025 - 0.428	0.121
Phosphorous @ depth	mg/l	0.050 - 0.691	0.215

Most of these results are characteristic of other Thurston County lakes. The one exception is surface phosphorous, which is close to ten times higher than the average for other area lakes. Additional quality control checks on the results are being conducted before drawing conclusions from this finding.

2.1.6 Vegetation

The plant communities of the McAllister/Eaton Creek basin constitute a mosaic of forests, wetlands, riparian zones, and prairies. Diverse vegetation provides the best habitat for fish and wildlife, and contributes to the local economy and quality of life.

Forests Before European settlers arrived in the early 1800s, ancient forests of western hemlock, western red-cedar and Douglas-fir probably covered most of the watershed area. The ancient forests consisted of trees of all ages from saplings to mature trees many centuries old. These forests contained a high diversity of species. Slower growing western hemlock tended to replace Douglas-fir eventually, because of its ability to tolerate the shady growing conditions of the forest floor better than Douglas-fir. However, natural processes such as fire, wind, drought, insect damage and disease created openings where Douglas-fir flourished. The resulting forest had a canopy of multiple layers, which intercepted large quantities of rainfall, reduced air and soil temperatures, created habitat for a wealth of wildlife, and offered excellent conditions for numerous mosses and ferns. These were some of the most productive forests in the world.

Most of the original forests were logged in the late nineteenth century, and forests of red alder and Douglas fir grew rapidly in the altered, sunnier conditions. Much of the second-growth Douglas-fir was cut again within the past 50 years. Very few examples of ancient forest systems remain anywhere in the Puget trough. No ancient forests remain in the McAllister/Eaton Creek basin, except for a few isolated stands and individual specimens of old trees, such as the protected maturing forest surrounding McAllister Springs that still contains some old-growth areas. The existing second and third growth forests are structurally much less complex than the forests they replaced, so they offer less stormwater protection and habitat diversity. Nevertheless, these forests significantly reduce stormwater runoff. Residences, commercial buildings, and roads are rapidly replacing much of the existing forests.

Conifer forests, mixed forests, and remnant oak woodlands comprise the upland forested areas in the McAllister/Eaton Creek basin. Second growth Douglas-fir, western red-cedar, and western hemlock dominate the conifer forests. Mixed forests in the area include conifers and broad leaf trees such as red alder, big leaf maple, vine maple, quaking aspen, and black cottonwood. The Fort Lewis property south of Evergreen Valley contains the largest unbroken forest in the basin.

The southern basin contains remnant stands of mature Oregon white oak growing alone and in association with Douglas-fir and/or Oregon ash. The oak woodlands are critical habitat for many birds and mammals. Numerous studies have found that oak woodlands are some of the most important wildlife habitats in North America, supporting almost 400 bird and mammal species.

Wetlands Wetlands remove sediment and pollution from surface water, prevent floods by storing and slowly releasing stormwater runoff, and provide habitat for fish, bird and insects. Freshwater wetlands serve as rearing habitat for coho salmon, which are important to the local commercial and sport salmon fisheries. Studies have shown salt water marshes to be among the world's most productive ecosystems. Map 7 in Appendix A shows the basin's wetlands, and Appendix B contains lists of wetland plants in the basin.

Thurston County classifies wetlands according to the system developed by the US Fish and

Wildlife Service (Classification of Wetlands and Deepwater Habitats of the United States, Cowardin et al, 1979). McAllister/Eaton Creek basin contains 1,861.2 acres of known wetlands, according to the National Wetlands Inventory. The wetlands in the McAllister/Eaton Creek basin fall into three broad classifications: Estuarine systems (areas where salt water and fresh water mix), Palustrine systems (fresh water areas less than 20 acres), and Lacustrine systems (fresh water areas greater then 20 acres). Table 2-2 shows the specific proportions of the basin's wetlands. These wetland types have distinctly different species composition.

Table 2-2: Wetlands of McAllister/Eaton Creek Basin

CLASSIFICATION	TYPE 1[1]	TYPE 2[2]	TOTAL	%
Estuarine	183.4	151.6	335.0	18.0
Palustrine	1,238.3	53.0	1291.3	69.4
Lacustrine	13.3	221.6	234.9	12.6
TOTAL:	1435.0	426.6	1861.2	100.0

[1]Type 1 wetlands have surface vegetation.
[2]Type 2 wetlands are open water areas with only submerged vegetation.

The lowland area north of Martin Way and east of McAllister Creek contains extensive Estuarine wetlands. These wetlands have highly fertile soils, so they have been diked, drained, and used for agriculture since the turn of the century. Statewide, about 45% to 62% of Washington's salt marsh habitat has been destroyed. Sixty-nine percent of the tidally-influenced emergent wetlands (wetlands with plants that emerge above the water surface) in Puget Sound's 11 major estuaries have been lost (Bortelson et al, 1980). More than half the historic salt marshes of the McAllister/Nisqually delta have been lost to diking, dredging and filling for agricultural use (Burg, 1984).

The salt marshes of the delta are classified as Estuarine emergent wetlands, unconsolidated bottomlands, and shores. Dominant vegetation includes eelgrass on the mudflats and submerged areas, sand spurry on the low banks sloping to the mudflats, Lyngbye's sedge along the edges of sloughs and stream channels, Baltic rush behind the Lyngbye's sedge communities, and saltgrass, fleshy jaumea, and Virginia glasswort in emergent areas. Saltgrass is found in virtually all the plant communities on the salt marshes.

The diking of the Nisqually Delta for Brown's farm in 1909 converted 736 acres from Estuarine to Palustrine emergent wetlands by preventing saltwater from reaching the wetlands. Agricultural cultivation replaced many native species with introduced cereal grasses. The Nisqually National Wildlife Refuge continues to cultivate about 30 acres and hay 150 acres (Hesselbart, 1993). Introduced grasses now dominate this area to the almost total exclusion of native species. The introduced dominant species include annual and perennial rye grasses, orchard grass, timothy grass, Kentucky bluegrass, meadow foxtail, quack grass, velvet grass, and three species of clover. The only dominant native grass species are red fescue, and water foxtail in the wetter areas. The specific species mix depends on the elevation, soils and wetness of each area.

The city of Olympia owns and protects an outstanding 256-acre Palustrine shrub-scrub wetland around McAllister Springs. Red alder, willows, ash, hazel, and occasional western hemlocks and western red-cedars form the wetland's overstory. Middle and understory species include vine maple, bog birch, cascara, indian plum, and red elderberry; and ground covers include skunk cabbage, sedges, water parsley, and various ferns. Isolated stands of lodgepole pine occur in the wetland.

Other Palustrine wetlands are found in the basin's potholes and upland depressions. The largest of these contain standing water with emergent vegetation including water lilies, water parsley, duckweed, and various pondweeds. Pure sedges dominate many of the potholes without standing water. Other vegetation often found in these wetlands includes Scouler's willow, Douglas' spirea, Hooker's willow, salmonberry, and herbaceous plants such as sedges, ferns, and skunk cabbage. This vegetation varies in relation to the degree of moisture in the soil. Wetter areas have cattails and bulrushes.

Perched till layers have created numerous seeps and small wetlands throughout the basin. In forested areas, isolated communities of skunk cabbage and water parsley mark these perched wetlands, often growing adjacent to Douglas-fir, salal, and other upland species. In open areas, these wetlands often contain sedges or pure stands of spirea. In late summer when the water table subsides, the ground will often appear bone dry, though the plants and soils are clearly wetland types.

Riparian Zones The "riparian" zone is the stream corridor area where vegetation directly interacts with the stream or river. Vegetation along the stream corridors (riparian vegetation) stabilizes the stream banks, prevents erosion, reduces runoff velocity, removes pollutants from runoff and subsurface flow, provides food and habitat for fish, insects and wildlife, and provides travel corridors for wildlife. Removal of riparian vegetation degrades habitat and increases potential for erosion and sedimentation. Increased runoff velocities are more likely to transport pollutants into the streams. Riparian plants moderate stream water temperatures, which are critical for fish survival.

A stream's hydrology and the surrounding landform largely determine the natural riparian vegetation. For instance, a stream that floods frequently across a broad, level plain will have a wide riparian area consisting of plants adapted to frequent inundation and sedimentation. Conversely, a steep stream in a ravine will have a relatively narrow riparian zone comprised of plants adapted to shade and able to withstand high velocities. However, human land use has substantially altered the riparian vegetation of McAllister and Eaton Creek.

Upper McAllister Creek's riparian vegetation consists of a broad wetland with plants adapted to some salt water intrusion, including a variety of willows, red elderberry, ninebark, and indian plum, as well as bog plants such as labrador tea. Reed canary grass, a non-native grass that aggressively invades sunny stream corridors, dominates the riparian corridor of McAllister Creek's middle reach and excludes most other vegetation except for an occasional willow and a few wildflowers such as yellow monkeyflower. Dikes have isolated the floodplain from the creek and confined riparian habitat to the stream banks. The riparian zone from Steilacoom Road to Martin Way includes planted lawns and ornamentals, wetland plants such as sedges, bulrushes, water parsley and skunk cabbage, and reed canary grass. The riparian zone below Martin Way and I-5 consists of the salt marsh wetlands of the Nisqually Delta, described in the "Wetlands" section, above.

The riparian zone of Eaton Creek's headwaters consists of a broad forested wetland with skunk cabbage, vanilla leaf, indian plum, red elderberry and salmonberry beneath a canopy of mature western red-cedar, red alder and Douglas-fir. North of Evergreen Valley Road the vegetation changes to a narrow strip of willows, alder, crab apple, and non-native fruit trees with an understory of salmonberry, spiraea, and wild rose. Reed canary grass has invaded the stream banks and channel in many parts of the stream. As Eaton Creek nears Yelm Highway and flows down the ravine to Lake St. Clair, the vegetation changes to mature forest of western red-cedar, western hemlock, Douglas-fir and big leaf maple, with an understory of vine maple, red elderberry, indian plum and salmonberry. Near Lake St. Clair the riparian zone enters a shrub-scrub wetland of skunk cabbage, red elderberry, salmonberry, and water parsley; cattails line the lake at the creek's mouth.

Prairies Prairies are relatively uncommon in western Washington, and Thurston County contains some of the best examples. The prairies in this region formed in a long crescent of outwash soils along the leading edge of the last glacier, extending from Pierce County through Thurston County and into Mason County. Grassy prairies have been used for agriculture since the middle 1800s. Some areas that are no longer being farmed may be naturally changing to forest vegetation as conifers encroach on the prairie edges. Grassy prairies are located throughout the basin. Prairies are dominated by a mixture of native and introduced grasses, with scattered broad-leaf trees, and wetland vegetation in the potholes. Oregon white oak stands often occur along the edges of prairies.

The Weir Prairie of Fort Lewis, along the southern edge of Eaton Creek basin, served as an example of undisturbed prairie vegetation in a 1961 study of Thurston County prairies, which became the basic description of prairie plant communities in the widely accepted classification method of Franklin and Dyrness (1973). Weir Prairie is dominated by Idaho fescue, a native perennial bunch grass, with thick moss between the grass clumps. Nonnative grasses and Scotch broom have invaded many sections of the prairie. Native wildflowers such as shooting stars, violets, camas and balsam root dot the prairie. *Aster curtus* is a state-listed sensitive plant species which occurs frequently on Weir prairie and other prairies in the basin.

Prairies have rapidly diminished in area since settlement by Europeans, as a result of development, fire suppression, and encroachment by Douglas-fir. Neats Prairie, just south of Yelm Highway between Spurgeon Creek Road and Meridian Road, has been largely disturbed by development and the Puget Power lines. The understory in these areas consists primarily of Scotch broom, an invasive non-native shrub, as well as snowberry, kinnikinnik, and sedges and grasses.

2.1.7 Wildlife

The Nisqually Delta, the McAllister Creek corridor, Lake St. Clair, Evergreen Valley and the undisturbed forests and prairies of Fort Lewis form links in a natural wildlife corridor from Puget Sound to the Cascade mountains. Fort Lewis is the largest undeveloped area between the Cascade Mountains and Puget Sound, and offers some of the only potential northern spotted owl habitat in the Puget trough. The Nisqually National Wildlife Refuge (NNWR) is one of the premier birding areas in the western United States for both resident and migratory birds. Appendix F contains a list of known wildlife species in the basin.

The McAllister/Eaton Creek delta was designated by the U.S. Department of the Interior as a natural landmark in 1971. In 1974, the Brown Farm property was purchased for inclusion in the U.S. National Wildlife Refuge system, managed by the U.S. Fish and Wildlife Service. The NNWR now encompasses 2,818 acres north of Interstate 5, including portions of the salt marshes and upland bluffs, and is the only Federal wildlife sanctuary in Puget Sound.

One hundred and seventy-seven recorded bird species use the Nisqually Delta. Waterfowl that utilize the delta include American widgeons, pintails, mallards, and green-winged teals. Since 1918, waterfowl use of the delta has declined by an estimated 75%. Loss of estuarine habitat due to diking is probably one of many complex factors behind this decline. The 1985 report, Biologically Significant Wetlands Within Puget Sound, identified the remnant salt marshes in the refuge as one of 19 priority sites in the Sound.

In addition to waterfowl, numerous birds of prey use the delta, including peregrine falcons, osprey, northern harriers, four hawk species, American kestrels, merlins, three owl species, and bald eagles. Osprey and red-tailed hawks often hunt over McAllister Creek. A red-tailed hawk nest was discovered on the banks of McAllister Creek in 1974, by students conducting a raptor survey for The Evergreen State College. Another nest was found in the same area in 1977, with an immature hawk nearby. The peregrine falcon is a federally listed endangered species which was observed over McAllister Creek in 1992. Birds of prey feed on some of the 27 fish species and 35 mammal species which utilize the refuge. Mink and otter live in the freshwater sloughs behind the dike. In 1991, a western pond turtle, considered threatened by the state, was found near McAllister Creek, under I-5.

McAllister bluff provides habitat for one of the largest great blue heron rookeries in the south Sound area. Great blue herons are a state-monitored species because they are sensitive to human disturbances and their breeding habitat is disappearing. At least two known bald eagle nests occupy the bluff, and bald eagles have been observed during nesting season in at least two other locations within the basin since 1988. An eagle pair nesting on the bluff successfully fledged two young in 1992 and one in 1993. State and federal governments list the bald eagle as a threatened species. Recent developments along the top of the bluff have been required to maintain vegetated wildlife corridors. At the south end of the bluff, the wetland and forest around McAllister Springs, owned and protected by the city of Olympia, offers prime wood duck habitat and foraging for birds of prey.

Marbled murrelets have been recorded regularly on Nisqually Reach and occasionally on McAllister Creek. The US Fish and Wildlife Service recently designated the marbled murrelet as a threatened species, and they are candidates for state listing. The Washington Department of Wildlife lists all of Thurston County as potential marbled murrelet habitat. They feed on inland salt waters and the ocean, and nest between April 1 and September 15 in conifers in mature or old-growth forests. There are no known nests in Thurston County; however, marbled murrelets were sighted regularly between May and September during a bird census in 1977 on the Nisqually Reach. Up to 16 individuals were recorded in one day, and the census considered them "common" on the Reach, and "rare" on McAllister Creek.

Common loons have been observed regularly, feeding on McAllister Creek. These are candidate species for the state endangered, threatened, or sensitive species lists, and they require undisturbed shorelines or islands to nest successfully. Other bird species which have been observed in McAllister basin include snowy owls and great egrets. Western grey squirrels, candidates for the state threatened species list, have been observed near McAllister Creek. Band-tailed pigeons congregate at the springs along the banks of McAllister Creek.

Lake St. Clair and Evergreen Valley link Fort Lewis to McAllister Creek and Puget Sound. At least one pair of bald eagles nests at Lake St. Clair, and osprey use the lake frequently. Wood ducks, which are valued game birds, breed around the lake. Western grey squirrels have also been observed near the lake and in Evergreen Valley.

The Department of Wildlife considers all of Evergreen Valley including Raymond Ditch and the Eaton Creek headwaters to be critical waterfowl breeding habitat. Red tailed hawks have been reported nesting in Evergreen Valley. South and east of the valley, osprey nest in the Fort Lewis potholes area of the basin, which is also home to western grey squirrels and western bluebirds. Western bluebirds are listed as sensitive species by the federal government, and are candidates for state listing. Western bluebird nests with eggs and young were located in the basin in 1987 and 1988. Pileated woodpeckers, which are candidate species for the state listing of threatened species, have been observed in the basin during nesting season since 1988. Wood ducks and band-tailed pigeons use the basin for nesting. The US Forest Service is currently working with Fort Lewis and the Washington Department of Natural Resources to improve the Fort's Northern spotted owl habitat through a variety of selective thinning treatments.

2.1.8 Fish

McAllister Creek Fish Stocks Historically, McAllister Creek contained coho, chum, sockeye, winter-race steelhead, chinook and possibly a few pink salmon, as well as cutthroat trout. Remnants of all the wild runs except for chinook still find their way back to the creek. All the chinook in the creek are fall-race chinook, probably related to hatchery stock. The salmon in McAllister Creek are the latest-returning salmon runs in Puget Sound.

Spawning areas in the creek are mostly limited to the upper reaches, due to high levels of peat and muck and little gravel in the stream bed. Most salmon spawning occurs in the gravel beds adjacent to the lagoon at McAllister Springs. Spawning also occurs on gravelly hummocks in the middle reach of the stream. Medicine Creek, which is the longest tributary, currently has little use by fish due to extensive agricultural development and low gradient. It is doubtful that any spawning or rearing occurs in this tributary, which is largely blocked to fish passage by a tide gate.

The Washington Department of Fisheries has operated a fish hatchery on McAllister Creek near the Steilacoom Road crossing since 1981. The hatchery releases approximately 1 - 1.3 million fall chinook smolts into the creek each year in late May. The hatchery recaptures about 50 - 60% of the spawning adults at the hatchery upon their return. The Department of Fisheries cooperates with the Nisqually Tribe to recapture the remainder at the head of the creek, next to the McAllister Springs lagoon. The hatchery oxygenates all water entering from McAllister Creek, raising oxygen levels to about 11 - 13 ppm, because the creek has low ambient dissolved oxygen levels of about 6 - 9 ppm depending on the season. The low ambient oxygen level is probably due to salt water intrusion combined with the low velocity of the stream, and the lack of riffles and falls which oxygenate the water. Disease and parasite problems have prevented the hatchery from operating at full design capacity since it began operations. The hatchery closed in July, 1993, due to budget constraints, and its fate is currently being contested.

The commercial catch on McAllister Creek has varied widely from year to year. The table below presents commercial catch data from 1980 through 1991. The yearly fluctuations in catch reflect the cyclical nature of the salmon's life history, and the significant increase in chinook catch in the mid-1980s reflects returning fish from the new hatchery.

The Department of Fisheries has conducted salmon spawning surveys on McAllister Creek sporadically since 1965. The surveys revealed spawning sockeye, chum and chinook every year since 1970. The surveyors recorded only sporadic coho spawning, probably because the surveys were conducted in the winter to look for spawning chum, but most of the coho spawn in October and November. The surveys also identified spawning pinks in 1973, 1979, and 1985.

The Washington Department of Wildlife began releasing cutthroat into McAllister Creek in 1992, in cooperation with Trout Unlimited and a private landowner. The Department of

Wildlife holds cutthroat smolts in tanks just downstream from the WDF salmon hatchery for about a week before releasing them in batches of 1,000 - 2,000. In May of 1992, about 9,000 cutthroat were released into McAllister Creek. The goal of the program is to release 10,000 cutthroat per year into the creek, and collect the returning fish to use for wild returning brood stock. The parent stock came from Minter Creek and McLane Creek in the South Sound area.

Table 2-3: Commercial salmon catch on McAllister Creek, 1980-1991

YEAR	SPECIES		
	Chinook	Coho	Chum
1980	0	0	0
1981	1	493	11,406
1982	3	3,063	1,725
1983	1	260	158
1984	0	0	0
1985	26	102	1,627
1986	58	5	1,253
1987	1,949	1,691	777
1988	3,018	476	478
1989	1,785	349	714
1990	1,898	1,127	1,597
1991	1,036	27	1,536

Eaton Creek and Lake St. Clair Fish Stocks Eaton Creek and Lake St. Clair contain resident populations of kokanee, cutthroat, and rainbow trout, with spawning areas below Yelm Highway. Kokanee is a resident variety of sockeye salmon (*Oncorhynchus nerka*) which spawns in streams but rears exclusively in lakes. Cutthroat and rainbow trout spawn in streams and rear in both streams and lakes. Residents of Eaton Creek and Lake St. Clair report a steady decline of both cutthroat and kokanee for at least the past five years.

There are apparently no anadromous fish because the creek and lake have no surface water connection with marine waters. However, local residents report occasionally seeing salmon in the upper stream, and speculate that they came up Spurgeon Creek from the Deschutes River and washed into Eaton Creek during extreme high water events, when the headwater springs for both streams were flooded together. These reports have not been confirmed, and the sightings could have been kokanee that managed to pass through the Yelm Highway culvert. Field investigations did not reveal an open water connection between Spurgeon and Eaton creeks.

The Department of Wildlife reports planting 60,000 to 100,000 kokanee fry in Lake St. Clair each year. Kokanee normally spawn in streams, but they will also utilize lake shores if good spawning habitat is available. The Department considers the lower reach of Eaton Creek to be critical spawning habitat for kokanee. The Department of Wildlife also has occasionally stocked the creek with cutthroat, but no fish have been planted in the creek for about 10 years. They prefer to have natural, self-sustaining cutthroat populations through preserving and enhancing habitat. However, they will consider one-time plantings to restore populations. The Department of Wildlife is also considering planting warm water species such as small mouth bass in the lake

2.2 CULTURAL RESOURCES DESCRIPTION

This section describes the basin's cultural characteristics, including:

- Population
- Land use
- Zoning
- Archeological and historical resources

2.2.1 Population

Population growth in Thurston County slowed down to 30% in the 1980s after averaging 62% the 1970s, when it was one of the fastest growing counties in the nation. Most of the growth in the seventies occurred in unincorporated areas of the county, which experienced a whopping 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 eighties.

The state Growth Management Act ordered local jurisdictions to adopt and plan for twenty-year population growth scenarios by 1992. The Thurston Regional Planning Council developed population projections for the county through the year 2015, which were officially adopted by Thurston County in 1993. 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, and will serve as the basis for planning and funding the county's future capital facilities.

According to the official forecast, the total county population, including all incorporated and unincorporated areas of the county, will expand from a current population of 174,118 to 279,127 by the year 2015, a gain of about 60%. The Thurston Regional Planning Council believes the county currently has the capacity for this level of growth without expanding the North Thurston Urban Growth Management Area boundaries.

However, population is expected to grow faster in the McAllister/Eaton Creek basin, due largely to increasing personnel at nearby Fort Lewis. The forecast includes 1,300 additional military personnel by the year 1995. The McAllister/Eaton Creek basin encompasses a large portion of Hawks Prairie, which is predicted to be the fastest growing area of the county, jumping from a current population of 2,063 to 9,153 by the year 2015, a rise of 343%. That represents a growth rate almost six times higher than the projected overall county growth rate.

Agricultural zoning in Nisqually Valley, which limits large-lot subdivisions to a minimum of 20 acres per parcel, will partially offset growth in Hawks Prairie. Growth in the Nisqually area is predicted to be only 16% by 2015. Protected land in Fort Lewis and the Nisqually National Wildlife Refuge will also help to mitigate the total growth in the basin.

Nevertheless, the current basin population of 13,862 is projected to increase to 25,895 by the year 2015, for a total rise of 86%. The population is expected to jump 22% in the next two years, emphasizing the need for quick action to prevent development-related water and resource degradation. The table below presents the projected population growth in the basin by planning years.

Table 2-5: Population forecast for McAllister/Eaton Creek basin

YEAR:	1993	1995	2000	2005	2010	2015
POPULATION:	13,862	16,878	19,301	21,188	23,427	25,895

2.2.2 Land Use

McAllister/Eaton Creek basin is still largely undeveloped, with large tracts of open space preserved in Fort Lewis, the Nisqually Indian Reservation, and the Nisqually National Wildlife Refuge. Single family residential housing is the prevailing land use outside those preserved areas, followed by timber lands. Commercial land represents a small proportion of the total basin area. Map 8 in Appendix A shows the extent of developed lands.

Agricultural land use in McAllister/Eaton Creek basin, and in Thurston County generally, has changed over the past twenty years, and our traditional definition of agriculture no longer describes many of the current farming operations. The basin contains 1,765 acres of commercial agricultural land, according to the County Assessor's data, but a tour through the basin reveals more agricultural activity than this number indicates.

Small farms with horses, sheep, or a few head of stock cover much of Evergreen Valley, and specialty farms such as llama and buffalo breeders also use land in the basin. The owners and operators of these farms devote significant time and labor to their agricultural endeavors, although agriculture rarely constitutes the sole source of income. At least three major horticultural nurseries are also located in the basin. These land uses contribute to the agricultural economic base of Thurston County, and cause cumulative impacts to the natural resources similar to the effects of large commercial farms.

The table below shows the basin's land use according to type of use, based on the Thurston County Assessor's records.

Table 2-6: Land use in McAllister/Eaton Creek basin (in acres)

Vacant[1]	Open Space[2]	Timber	Single Family Residential	Duplex Residential	Multi Family Residential	Commercial	Agricultural
11,346	433	2,377	4,137	11	233	382	1,765

[1] Includes only developable vacant land
[2] Includes parks, preserves, greenbelts, and other areas protected from development

2.2.3 Zoning

The underlying zoning for most of McAllister/Eaton Creek basin is 1 residential unit per 5 acres. Some areas along the west edge inside the long term Urban Growth Management Area boundary are zoned at higher densities, and include some commercial/industrial lands. The McAllister Geologically Sensitive Area is zoned for 1 residence per 5 acres and has additional restrictions on commercial activities which pose a risk to the aquifer. Map 3 in Appendix A shows the basin's current zoning.

Nisqually Sub-area Land Use and Zoning Plan The Nisqually Sub-area Land Use and Zoning Plan was adopted as part of the Thurston County Comprehensive Plan in November, 1992, and contains policies governing most of McAllister Creek basin (but not Eaton Creek basin). The zoning regulations in the plan comprise an overlay on the pre-existing zoning, which is 1 unit per 5 acres for most of the basin. The plan divides all land uses into three categories: Natural Resource Lands; Rural Lands; and Commercial Lands.

- **Natural Resource Lands** Natural resource lands include two new designations: Nisqually Agriculture, and Mineral Resource. The plan designates 1,255 acres on the floor of McAllister Valley as Nisqually Agriculture lands. The purpose of this designation is to maintain agricultural lands for current and future use. The basic density for developing land within this designation is 1 unit per 40 acres. However, the development rights to this land may be transferred to another site at the rate of 1 unit per 5 acres, once a transfer-of-development-rights program is adopted. The plan also calls for the county to develop a program for purchasing the development rights to this land at the density of 1 unit per 5 acres. These measures are intended to compensate the land owners for any loss of value due to the reduced level of allowable development. The plan also permits clustered developments to occur at the density of 1 unit per 5 acres under the recently adopted Planned Rural Residential Development standards.

Designated Mineral Resource Lands will form an overlay which will be added to the map after a Special Use Permit has been granted for a specific parcel. All pre-existing mines or gravel pits with valid state or local permits will qualify.

- Rural Lands The Rural Lands category includes a number of new designations which formalize existing land uses, including: Public Preserve, which covers Nisqually National Wildlife Refuge; Military Reservation, which covers Fort Lewis; and McAllister Geologically Sensitive Area.

  This category also includes four separate residential designations with permitted densities of 1 unit per 5 acres (1/5), 1/2, 1/1, and 2/1. Those designations were based on the existing development densities for those areas. There are no 1/1 lands in the McAllister basin. The 1/2 lands are concentrated in the Luhr Beach area just west of the mouth of McAllister Creek. The 2/1 lands in the basin include the Nisqually Tribal Offices on the east side of Reservation Road and the Meridian Heights subdivision on the east side of Meridian Road, north of I-5. All other residential lands are zoned 1/5.

  The plan requires clustering of homes for all subdivisions of 20 or more acres. The basic requirements include preserving 75% open space, granting of a 20% density bonus for clustered developments, and minimizing impacts to critical areas and resource lands.

  The plan also creates a Nisqually Hillside Overlay district, which covers from the base of McAllister bluff west to 200 feet back from the top of the bluff, and from Old Pacific Highway north to Nisqually Head. Within this area, large buffers are required to protect the bluff and prevent property damage from landslides.

- Commercial Lands Commercial lands are limited to areas previously zoned commercial, and a new site near the Nisqually Tribal Office. Previously zoned commercial lands in the basin include the area where Martin Way crosses over McAllister Creek and the commercial corner of Old Nisqually. Billboards are prohibited in all commercial areas.

2.2.4 Archeological/Historical Resources

Nisqually Indian Tribe

The aboriginal people currently known as the Nisqually Indian Tribe inhabited the McAllister Basin lowlands and other lowlands throughout the Nisqually Basin. This group of people consisted of several small bands with few political ties but sharing similar dialects and culture. Piles of old clamshells, known as shell middens, on the west bank of McAllister Creek provide evidence of spring and summer shellfish gathering by the Nisqually Indians. The village known as She-nah-ham or She-nah-da-dob, on the west bank of McAllister Creek, contains prehistoric and historic artifacts. She-nah-nam, or Medicine Creek, was the Nisqually Indian name for McAllister Creek. Medicine Creek is the name now applied to the major tributary joining McAllister Creek from the east at river Mile 4.1.

The Treaty Trees stood across from this village site, where about 400 indians from nine south Sound tribes, including the Nisqually Indians, signed the Medicine Creek Treaty in 1854. This treaty required the Nisqually Indians to give up most of their land and move to the Nisqually Indian Reservation on the west bank of McAllister Creek. The Treaty Trees were a traditional gathering place for the Nisqually Indians. Only one of the Treaty Trees still stands. New treaties were negotiated in 1856 which granted 4,700 acres of river bottom lands on both sides of the Nisqually River to the Nisqually Indians.

Brown Farm

Brown Farm is located on the Nisqually Delta, in the Nisqually National Wildlife Refuge. The farm was settled in 1904 by Seattle attorney Alson L. Brown and his wife, Emma. The original property contained 2,350 acres west of the mouth of the Nisqually River, including about 850 acres on the bluff above McAllister Creek. Brown built a four mile dike around three sides of the property to prevent salt water from inundating the farmland. Brown kept about 300 dairy cows, 100 calves, 2,000 hogs, 4,000 laying hens, 20,000 chickens, and bees for honey. The farm processing operations included a creamery for dairy products, a meat-packing facility, and a small factory to produce shipping boxes. In addition, the farm housed the crew required to carry out farm operations, and had a small general store on the site.

Brown lost the farm to P.B. Truax, C.D. Clinton, and Robert Olden in 1919, due to financial problems. The new owners kept the name and operated the farm themselves for a short time before leasing it to other dairy farmers. They had a new, higher dike built in 1924. The farm changed hands again in 1952, and continued operations until about 1964. A long period of controversy over the area ensued, with plans for a garbage dump, a deep-water port, a marina, an industrial park, and an aluminum mill all proposed. These proposals were all rejected, largely through the efforts of citizen activists, and the U.S. government finally purchased Brown Farm in 1974 for inclusion in the National Wildlife Refuge System. The U.S. Fish and Wildlife Service converted two barns from the original farm into the Twin Barns Nature Center, and a few out-buildings still stand. The dike was repaired following a breach in 1975, and is now a popular walking trail. The Wildlife Refuge has cultivated grass for waterfowl feeding, hay, and browse since 1978.