

CHAPTER EIGHTEEN: DESCRIPTION OF WATER BODIES BY SUBWATERSHED



This chapter describes the five subwatersheds in the *KGI Watershed: Burley/Minter Creek, Gig Harbor, Rocky Bay, Islands, and Key Peninsula*. These subwatersheds were defined by the *Pierce County Watershed Ranking Committee* in 1988 as part of its work in ranking the watersheds to comply with WAC 400- 12. The *Committee's* Subwatersheds were further refined by the *KGI Watershed Committee* which chose to fold the *Fox Island Subwatershed* into the *Islands Subwatershed* and break the *Rocky Bay Subwatershed* out of the *Key Peninsula Subwatershed*.

Key items for understanding **nonpoint** source issues in each subwatershed are outlined for the subwatershed as a whole: location, physical description, land use, shoreline development, groundwater, marine resources, and lakes and **wetlands**. Then the largest individual water bodies in each subwatershed are described in more detail, including any water quality and habitat information available. Finally, the Chapter presents trends and conclusions for each subwatershed.

The most current information on shoreline modifications available is the **COASTAL ZONE ATLAS** published in 1979. Although additional modifications have taken place since its publication, it is referenced because it gives a general indication of the degree of shoreline modification.

ISLANDS SUBWATERSHED

Location

The *Islands Subwatershed* encompasses *Fox, Anderson, McNeil, Herron, Raft, and Ketron Islands* as well as several small islands including *Cutts, Tanglewood, Eagle, and Gertrude*. Most of the islands are reached only by ferry or other boat. Only *Raft* and *Fox Island* are connected to the mainland by bridge. All the streams in the subwatershed are very small, under one-mile in length. There are several large lakes and reservoirs. **APPENDIX "T", MAPS, ISLANDS SUBWATERSHED**, shows the boundaries of the subwatershed, which contain approximately 11,500 acres.

Physical Description

Anderson Island has an area of approximately 8.1 square miles and is approximately 4.5 miles long with 14 miles of shoreline. Relatively gentle north facing slopes and steep southern and eastern sea cliffs characterize *Anderson Island*. The island has a maximum elevation of approximately 280-feet above sea

level. *Ketron Island* has an area of approximately 0.36 square miles and is 1.5 miles long with 3.5 miles of shoreline. The southern portion of the island is relatively steep, with elevations reaching 300+ feet above sea level. *McNeil Island* is slightly smaller than *Anderson* and has rolling hills with the highest elevation approximately 320-feet above sea level. *Fox Island* is approximately 5 miles long with about 12-miles of shoreline. The south end and southwest side of *Fox Island* are characterized by high bluffs between 200- and 300-feet high. The northeast side has more gentle slopes. Small islands lay off the north side of *Fox, McNeil, and Anderson Islands*.

Short streams and springs drain the subwatershed. Two natural lakes, *Florence and Josephine*, occupy connected depressions on the northeastern part of *Anderson Island*. *Butterworth Reservoir* on *McNeil Island* is the only other large water body in the subwatershed.

Land Use

Approximately 63 % of *Anderson Island* is vacant and 19 % is residential, with 451 single-family houses, including 28 mobile homes (*Pierce County*, 1991). 4 % is agriculture, including cattle farming. There is only one small commercial activity center, at the intersection of *Eckenstam-Johnson* and *Camus Roads*, consisting of a grocery store, hair salon, real estate office, fire station, and post office. There are approximately 200-acres designated forest land and 100-acres designated open space. There are also a golf course, community swimming beaches and parks on *Anderson Island*. A private saltwater marina, open May through September, is just east of *Lake Josephine*. Over 85 % of *Ketron Island* is vacant and there are 16 homes.

McNeil Island contains a state penal institution located at the ferry dock on the southeast side of the island and has limited residential development (approximately 55 units) for employees. The *State Department of Fish and Wildlife* controls 3,119-acres of the island while the *Department of Corrections* controls 1,326-acres. Less than 100-acres have been developed for correctional facilities.

Fox Island is almost exclusively low-density residential with just one store/cafe/gas station and a small amount of agriculture (Christmas tree farming and small hobby farms). Other uses include a yacht club, a camp, the Naval *Surface Warfare Fox Island Acoustic Laboratory*, and a church (all on the shoreline) and a cemetery and a former landfill. Land cover is primarily coniferous forest and other natural cover with a small amount of mixed forest. Impervious surface is between 0 and 20 %. Under the COMPREHENSIVE PLAN, the island is designated "Rural 10" (one dwelling unit per 10 acres) with a "Rural Activity Center" located at the site of the existing store. However, many of the existing lots are smaller than 10-acres.

Hen-on Island, located in *Case Inlet* on the west side of *Key Peninsula*. The island was subdivided many years ago into small lots which for the most part contained

summer homes. Some of these summer homes have now been converted into year-round residences, increasing the permanent population on the island. Land cover in the subwatershed consists primarily of coniferous forest with significant areas of other natural cover, mainly pasture and grassland, especially on *McNeil Island*. It provides good habitat for a number of species of wildlife, including deer, raccoon, and a variety of birds.

The population of the subwatershed is approximately 6,700 permanent residents, with about 5,000 full-time residents on *Fox Island*, 400 on *Anderson Island*, 10 on *Ketron Island*, and the remainder on *McNeil Island*.

Anderson Island contains a large subdivision, the *Lake Josephine Riviera* subdivision, created in the late 1960s with 3,144 lots. *Ketron Island* contains 26 1 lots in three formal plats. The ANDERSON AND KETRON ISLANDS COMMUNITY PLAN predicted the number of housing units and households to rise gradually on *Anderson Island* to approximately 600 housing units and 350 households by the year 2010. Major changes on *Ketron Island* are not expected. On *McNeil Island*, the Department of Corrections is planning to expand their facilities to house 435 additional prisoners, but this is not expected to cause a significant change in land use. On *Fox Island*, the population is expected to increase by 2,500 residents by the year 2020. Construction of single-family homes is occurring and is expected in the future. Land use is expected to remain the same with increasing development of single-family homes.

Shorelines

On *Anderson Island*, over one-half of the shoreline is designated as unstable bluffs by the 1979 COASTAL ZONE ATLAS. Almost one-quarter of the shoreline was bulkheaded in 1979. Much of the existing housing development on the island is on the shoreline and the two large lakes, *Florence* and *Josephine*. Unstable slopes ring most of *Ketron Island*, which had only a small area of shoreline modified in 1979. Again much of the housing is on the shoreline. The COASTAL ZONE ATLAS does not map *McNeil Island*. However, very little of the shoreline itself is modified with the exception of the area around the main ferry dock and *Still Harbor*. There is a road along the shoreline of most of *McNeil Island*.

Much of the shoreline on the south end of *Fox Island* has unstable slopes, and there have been several slides recently. In 1979, less than ½ of the south side of the shoreline was bulkheaded. Only a small area on the north side of the island has unstable slopes and there is a significant amount of bulkheading. Much of the shoreline has houses along it, either at the water level or on the cliffs above the water. There are a number of docks associated with these homes, particularly in the *Hale Passage* area.

Groundwater

All drinking-water supplies are from groundwater, except on *McNeil Island*. Known areas of global seawater intrusion encompass the southwestern portion of *Anderson*

Island and the southern portion of the peninsula between *Oro Bay* and *East Oro Bay*. No other detailed information on groundwater quality is available; however, local people on *Anderson Island* report generally good water quality in wells, with the exception of the areas of seawater intrusion. *McNeil Island* has a shallow, perched groundwater table but groundwater on the island is not used for human consumption.

Fox Island was included in the **GIG HARBOR GROUNDWATER MANAGEMENT STUDY**. No widespread or consistent contamination was found, but there were sporadic occurrences of elevated metal, bacteriological, and nitrate contaminant levels (*Sweet-Edwards/EMCON*, 1992). **In the sampling performed for the GIG HARBOR GROUNDWATER MANAGEMENT STUDY, fecal coliform was only detected in one well, which was on Fox Island.** One *Fox Island* well violated state groundwater (drinking water) criteria for arsenic (This was the only heavy metal violation from within the study area). Barium, cadmium, and copper were also detected in the same well. Iron and manganese were detected in *Fox Island* wells, and the manganese violated the secondary drinking-water standard (based on aesthetic criteria).

Marine Resources

Eelgrass is found on the west side of *Ketron Island*, the south and north ends of *Fox Island*, and the east side of *Anderson Island*. *Kelp* is found off the north side of *Anderson Island*, in *Oro Bay*, and off the south end of *Fox Island*. A plant listed as a critical floral resource in the **COASTAL ZONE ATLAS, tall peppergrass (*Lepidium virginicum* L. var. *menziesii*)**, occurs on the west side of *Anderson Island*. It is a white-flowered member of the mustard family and grows on spits and in beach grasslands.

Pigeon guillemot nest at Lyle Point, on *Gertrude* and *Eagle Islands*, and in *Pitt Passage*. Bald eagles and great blue heron also nest on *Anderson* and *McNeil Islands*. Bald eagles and osprey nest on *Fox Island*. **Dall's** porpoise concentration areas are found in the southern and eastern marine waters of the subwatershed. Seal and sea lion haul-out areas are found on *Eagle* and *Gertrude Islands*, off the southwest side of *Fox Island*, and northwest of *McNeil Island*. *Minke whales* are found east of *Fox Island*.

Commercial salmon fishing occurs in *Hale Passage*. Recreational salmon fisheries exist between *McNeil* and *Anderson*, north and east of *Fox Island*, and south of *Anderson Island*. *Pacific herring* holding areas are found southwest of *Anderson Island*, north of *McNeil Island*, and in *Hale Passage*. *Pacific cod* is found in *Hale Passage*. *Demersal groundfish* are found west and south of *Anderson Island* and east of *Fox Island*. *Pandalid shrimp* are found off the southern half of *Anderson Island*. *Redrock* and *Dungeness crab* are found in *Oro Bay* and *Hale Passage*. *Sea cucumbers* are found in the areas immediately off all of the islands. *Geoducks* are found off *Anderson*, *Fox*, and *McNeil Islands* and other *clams* off *Eagle Island*, *Fox Island*, and in *Still Harbor*.

Eagle Island State Park, Cutts Island State Park, and Pitt Island County Park provide opportunities for public recreational shellfishing. There is a county park (*Towhead Island County Park*) on *Fox Island* next to the bridge that provides a public recreational shellfish beach and boat launch. A *Department of Natural Resources* (DNR) public access site is located at the south end of *Fox Island* at *Toy Point* and provides beach access with opportunities for walking and fishing. The south end of *Ketron Island* is a wildlife refuge.

Lakes and Wetlands

On *Anderson Island*, *Florence and Josephine Lakes* lie in the *Riviera Subdivision*. The lakes provide habitat for waterfowl, including eagles, geese, and heron. Both lakes are stocked with bass and trout. Fishing is popular. Milfoil is extensive in *Florence Lake*, and grass carp have recently been introduced in it as a control mechanism, because they eat milfoil.

The areas around *Josephine Lake* and the south side of *Lake Florence* are completely subdivided and the roads are in place. A number of lakefront homes have been built and new construction is underway. Both lakes have a number of docks and allow boating; waterskiing is allowed on *Lake Florence*. There is a major park on each lake, as well as seven miniparks, a campground, a golf course, and a club house. Potential sources of **nonpoint** pollution include the golf course, on-site sewage, fertilizer and pesticide run-off from lakeside homes, parks and the golf course and construction impacts. On-site may be a particular problem since the subdivision has relatively small lots. No water quality information is available.

On *McNeil Island* there are two large reservoirs, *Butterworth and Eden Creek*, created by a dam on *Eden Creek*. They are used for water supply for the island.

Both islands have a number of wetlands, including wetlands connected to the streams described below, as well as isolated wetlands. On *Anderson Island*, the PIERCE COUNTY INVENTORY identified 18 wetlands, ranging in size from ½ to 155 acres. On *Fox Island* there are a number of small freshwater and estuarine wetlands and most are associated with the shoreline.

Streams

Most of the streams are very small and do not support salmon. Landlocked *Cutthroat* trout and *Coho* have been found in *Schoolhouse Creek* on *Anderson Island*. *Schoolhouse Creek* has experienced signs of additional sediment following the loss of upstream vegetation resulting from a logging operation. A small creek running into *Heckman Cove* on *Anderson Island* has been ditched along the road and has a tendency to run muddy. There are four streams on *McNeil Island* (*Eden, Luhr, Milewa, and Bradley Creeks*) but they are short and unlikely to support anadromous fish. No water quality information is available. Streams on *Fox Island* are very small and most have been Culver-ted.

Specific Problems

At least two closed landfills exist on *McNeil Island*, one on *Fox Island*, and one on *Anderson Island*. The *Anderson Island* dump is a 25-acre site at the corner of *Steffensen* and *Camus Roads*. It operated from 1962 until 1985. The refuse consisted of household garbage, building demolition, stumps, brush, and other clearing material. No problems are anticipated and the health department continues to make periodic site visits (TPCHD, 1993).

The former *Fox Island* dump is located near the corner of *12th Ave* and *Mowitz Drive*. This 10-acre disposal site began operation in 1956 and closed on September 1, 1976. The site is currently used as a *Pierce County* gravel pit and storage area for rock and gravel but most of the site is covered with blackberry bushes. The dump was used exclusively by *Fox Island* residents and accepted waste such as car bodies, washers, dryers, and household garbage. Based on site inspections conducted by *TPCHD* in 1990 and 1992, illegal dumping was not evident (*TPCHD*, 1993). There are no monitoring wells at this facility.

Two of the old landfills on *McNeil Island* are described in the *TPCHD CLOSED LANDFILL STUDY*. Landfill # 1 is located in a ravine along the northeastern corner of the island and was used until 1970. It was operated as an open-face dump over a bluff and accepted wastes such as solvents, paints, oils, and garbage. *TPCHD* does not anticipate problems from this landfill (*TPCHD*, 1993)

Landfill #2 is located in the southwestern portion of the island in a narrow gully that extends down to *Puget Sound*. It operated from 1970 to 1989. Wastes disposed of at Landfill #2 include general household and prison garbage, industrial wood, metal waste, oil filters, and soiled rags. Significant quantities of **leachate** had been documented to be seeping into the groundwater and then discharging into the waters of *Puget Sound*. The landfill was closed in 1991 and a landfill cap installed together with improved stormwater run-off controls. These measures were anticipated to significantly reduce the amount of **leachate** produced and the amount entering *Puget Sound* (*TPCHD*, 1993). Both landfill sites on *McNeil* are being monitored by a consultant for the *Department of Corrections*. *TPCHD* receives periodic reports on the findings and have seen a significant improvement in groundwater quality following the completion of the landfill cap (*Wright*, 1997).

A short ravine leading down to *Puget Sound* on the southeast corner of *Fox Island* (at *Queets Drive*) experienced excessive erosion from a plastic drainage pipe which broke off at the top of the bluff. Stormwater from the pipe was widening and deepening the ravine at a rapid rate. In 1996, *Pierce County Surface Water Management* performed an emergency repair to prevent further erosion. The repair involved stabilizing the ravine and installing new pipe which tightlined the flow down to the beach and dissipated the energy of the flow before releasing the water to *Puget Sound*.

Landslides have occurred on the south end of Fox *Island* in areas with existing homes and recent development. At least two boat houses have been destroyed. There is a small yacht club at *Cedrona Cove* and small cattle farm immediately adjacent to the cove but neither have proven to be a source of water quality problems.

On both *Anderson and Fox Island*, poor clearing and construction practices on small lots have been noted which may be **contributing** sediment to nearby ditches and tributaries. A field visit to *Anderson Island* in 1996 found one small farm supporting a population of animals much higher than the pasture area could accommodate. The animals were standing in mud approximately 6-8 inches deep. The farm was not adjacent to any streams or wetlands but was seen as a potential problem. There were some farms closer to both salt and freshwater but most appeared to have low animal densities and were maintaining the grass cover in their pastures.

On *McNeil Island*, a large population of *Canada geese* may be contributing fecal coliform bacteria to runoff from the main prison area, but the runoff is not being discharged to an estuarine or shellfish growing area. The only other potential sources of **nonpoint** pollution on *McNeil Island* may be from the vehicles and equipment on the island since many vehicles are stored near the shoreline in convenient proximity to both the ferry landing and the main correctional facility. Agricultural practices on the island are fairly minimal and management practices appear to be quite good. In spite of past disturbances, *McNeil Island* is being managed as a wildlife preserve and may serve as the best example of a natural island and shoreline ecosystem available within Pierce *County*.

Ketron Island has experienced ongoing problems with sewage treatment. The **north-**end of the island was platted as a single development which was to be served by sewers. A sewage treatment plant was built but not maintained. As a result, the residents have had to convert to on-site systems. Soils in the area are extremely poor for septic systems so most of these systems have had to incorporate complicated, high **mainte-nance**, and fairly costly technologies. Of the 14 lots on the island which have constructed residences, three were never connected to the sewage treatment plant and have always been served by an on-site system. Of the 11 homes that were connected, 9 have installed on-site systems and two have submitted applications but have not completed their repairs but these homes are not occupied full time. In fact, there are probably five or fewer full-time residents on the island. The island is served by a "Group **B**" water system.

CONCLUSIONS AND TRENDS

Because little data are available on water quality or habitat, few definite conclusions can be drawn about this subwatershed. On *Anderson Island*, potential pollution can be expected that is typical of residential development, especially

nutrients and pesticides from the many small home lots on the lakeshores, the golf course, and parks. On-site sewage and construction impacts are probable. Geese on the lakeshores also provide a source of fecal contamination. Impacts from timber-cutting is also a potential source of pollution. Seawater intrusion is a known concern for the whole southwestern portion of the island. As the island becomes gradually more developed with homes, existing habitat will decrease.

Probably the biggest problem currently facing Fox, *Herron*, and *Raft Islands*, is poor construction practices as individual homes are built and remodeled. The landsliding occurring on the southwest side of Fox *Island* may be attributed to development of homes and the associated removal of vegetation and addition of septic systems and impervious surface run-off. Ravine erosion is another problem currently occurring in isolated areas that may increase in the future as development continues. Providing effective sewage treatment and potable water should also be considered important issues for all of the islands.

BURLEY-MINTER CREEK SUBWATERSHED

Location

The *Burley-Minter Creek Subwatershed* encompasses *Burley Lagoon* and *Minter Bay* at the end of *Henderson Bay*; *Burley*, *Minter*, and *Purdy Creeks*; and each of these waterbodies associated drainage basins. *Henderson Bay* is at the upper end of *Can-Inlet*. The subwatershed includes the unincorporated areas of *Purdy*, *Burley*, and *Glenwood*. Most of the subwatershed is in *Kitsap County*. The *Gig Harbor Subwatershed* lies to the south and the *Key Peninsula Subwatershed* lies to the west. The larger creeks are important salmon streams. **APPENDIX "T", MAPS, BURLEY-MINTER CREEK SUB-WATERSHED**, shows the boundaries of the subwatershed, which contains 20,608-acres.

Physical Description

The terrain in the subwatershed is characterized by low hills of moderate slope with heavy mixed second growth vegetation in all uncleared areas. The streams have mostly moderate gradients. Shallow soils overlay glacial till. This subwatershed has the longest **streams** in the *KGI Watershed* with the exception of *Rocky Creek*. *Horseshoe Luke* is the only large lake.

Land Use

The *Purdy* and *Burley* areas have small commercial centers with some surrounding residential development, but the majority of the subwatershed is rural in nature with small scale agricultural uses and residential tracts scattered among forested uplands. Most of the subwatershed has been divided into parcels of 5-acres or less in size. In fact, many of the parcels are 2%acres in size. Although many of the parcels are currently vacant, rapid population growth and development continue to affect the watershed. It is estimated that the subwatershed is experiencing a

population growth rate of 2 to 3 % per year (*Dickes and Patterson, 1994*). The 1994 population is estimated as 18,000.

Land cover is a mix of coniferous forest and other natural cover, primarily pasture land with areas of built-up land and mixed forest.

Future land use is expected to remain similar to current land use, that is, large lot residential and hobby farming. It is expected that currently vacant parcels will be built on over time. Most of the subwatershed is designated as one-dwelling unit per 5-acres under the **KITSAP COUNTY COMPREHENSIVE PLAN**, with an area next to *SR 16* designated one-dwelling unit per 10 acres. In *Fierce County*, most of the subwatershed is designated under the **COMPREHENSIVE PLAN** as one-dwelling unit per 10-acres or "Reserve 5" with a few areas of agriculture overlay.

Shorelines

This subwatershed has a minimal amount of shoreline in comparison to most of the other subwatersheds in the *KGI Watershed*. Most of the shoreline is along *Burley Lagoon* and *Minter Bay*. However these two bays are significant estuaries and support commercial shellfish growing. *Purdy Spit* is probably the most heavily used recreational stretch of beach in the watershed. The road along the spine of *Purdy Spit* is entirely riprapped. The shoreline of *Minter Bay* and *Burley Lagoon* are heavily developed with houses, as are the stretches of shoreline between the two bays. Both bays have sand spits sheltering their entrances so recent efforts to place bulkheads along the feeder bluffs supplying sand to these spits may starve these spits of replenishing sand and cause them to retreat.

Groundwater

As with the vast majority of the watershed, groundwater is the source of drinking water for the *Burley-Minter Creek Subwatershed*. Groundwater in the area probably moves in roughly the same direction as surface waters, from north to south. However, groundwater studies have not been done in this subwatershed. No areas of seawater intrusion have been identified.

Marine Resources

Historically, both *Burley Lagoon* and *Minter Bay* were productive commercial shellfish-growing areas. In 1981, the commercial oyster beds in *Burley Lagoon* were reclassified from "Approved" to "Restricted" (In "Restricted" areas, harvested shellfish cannot be marketed directly, but must be relayed to an "Approved" growing area for natural biological cleansing). In 1982, inner *Minter Bay* was reclassified from "Approved" to "Prohibited" (in "Prohibited" areas, shellfish cannot be harvested commercially). The reclassifications were based on water quality surveys documenting levels of fecal coliform bacteria that exceeded the "National Shellfish Sanitation Program Standards" for "Approved" commercial shellfish areas. **Nonpoint** pollution is thought to be the leading cause of water quality deterioration leading to shellfish harvest restrictions (*Dickes and Patterson, 1994*). In 1988, local

governments responded by adopting the **BURLEY-MINTER WATERSHED MANAGEMENT PLAN** as developed by area residents. In October 1993, *Burley Lagoon* was upgraded for shellfish harvesting to "Conditionally Approved" based on marine water quality data collected by the *Department of Health*. At the beginning of 1999, *Burley Lagoon* was again downgraded to "Prohibited" because fecal coliform bacteria levels were unacceptably high.

The *Minter Creek Salmon Hatchery* is an important production facility and provides annual releases of *Chinook* and *Coho* fingerlings to many of the streams of the *Kitsap Peninsula* and other *Puget Sound* river systems. As a result the bay is heavily used by both juvenile and adult salmon. *Burley Lagoon* is a *great blue heron* and *osprey* nesting area. *Clams* are found in *Burley Lagoon*. There is a county park at *Purdy Spit*, which is a recreational shellfish beach. *River otter* are found at *Minter Bay*.

Surveys performed by volunteers for *Adopt-a-Beach* found *Kingfisher*, *Ducks*, *Osprey*, *Gulls*, *Crows*, and a *Red-tailed Hawk* in the area. The bluffs in one area surveyed were about 200-feet high and showed signs of both old and new slumping, severe erosion, and a number of seeps coming through the banks. A survey done on *Minter Spit* found a number of remains of old ships. It is believed that, many years ago, ships which were no longer usable were beached on the spit and set on fire. The spit has a large *sand dollar* population and the ship remains are covered with *barnacles* and *mussels*. *Great blue heron* were sighted near the shellfish beds on *Minter Spit*.

Lakes and Wetlands

Burley Lagoon and *Minter Bay* are among the most significant estuarine wetland systems in the *KGI Watershed*. Important freshwater wetlands are associated with the creeks, in particular, at the headwaters and along the east fork of *Minter Creek*; along the main fork of *Minter*, *Huge*, and *Burley Creeks*; and in the area around *Horseshoe Lake*. There is a large wetland, known as *Mace Lake*, above *Purdy Creek*, as well as scattered smaller, isolated wetlands. *Horseshoe Lake* is the only large lake in the subwatershed and it hosts a county park and recreational fishing.

Specific Problems

Unlike the other subwatersheds in the *KGI Watershed*, the *Burley-Minter Creek Subwatershed* has been studied extensively since at least 1978. These studies include investigations of pollution sources, water quality monitoring, and development of plans, regulations and programs to curb **nonpoint** source water quality problems. They are briefly summarized below. The studies and local concerns about water quality resulted in the adoption of the **BURLEY-MINTER WATERSHED MANAGEMENT PLAN** in 1988.

The major water quality concern is bacterial contamination and its impacts on shellfish harvesting. Excessive sediment problems have also been experienced. Likely sources of contamination have been identified as agricultural, on-site septic, and stormwater run-off. The former *Purdy Landfill* was previously suspected as a source. However, more recent studies have confirmed that it is not (see below).

The *Kitsap Conservation District* has been the main entity working with agricultural sources in the watershed. The *District* has worked with small farmers in the watershed for the last 11 years. They report that in 1995, there were 73 active small farms in the *Burley Basin*. Of these, 66 are between one and 20-acres in size. Approximately 86 % of these have been contacted by the District and offered assistance. The results of this effort include miles of stream fencing to exclude livestock from wetlands and streams, gutters and piping to manage roof run-off water, and renovated and cross-fenced pastures to aid in pasture management (Garitone, 1996).

Since the **BURLEY-MINTER PLAN** was adopted, the *TPCHD* has performed one on-site septic survey in the *Minter Buy Drainage Basin* and two on-site septic surveys in the *Burley Lagoon Drainage Basin*. The **MINTER SURVEY** and the first **BURLEY SURVEY** were done in 1989 - 90, and the second **BURLEY SURVEY** was done in 1993 - 94. The **MINTER SURVEY** did not detect any failing septic systems. The first **BURLEY SURVEY** identified one failing septic system and one problem system. The second survey, which included a cursory survey of upland systems along *Purdy Creek*, identified 15 failing systems. They also identified problems with the way sewage was being handled at the commercial businesses in *Purdy*. Those businesses have since been connected to the *Gig Harbor* sewer system.

Two small stormwater investigations were done by *TPCHD*. In one, two residential developments in the *Minter Drainage Basin* were sampled during a few storm events to measure the fecal coliform concentrations to determine if residential areas may be a major source of fecal coliform bacteria. In general, the fecal coliform counts were fairly high. All the samples exceeded the fecal coliform criteria for *Washington* state "Class AA" fresh water. In the second investigation, 10 stormdrains in the *Burley Drainage Basin* and one drain in the *Minter Drainage Basin* were sampled to determine if stormwater is a significant source of fecal coliform bacteria to these systems. Eight of the drains were selected from within the town of *Purdy* in order to concentrate on the area with the greatest amount of impervious surface and the most activity. Sample results indicated that stormwater is a significant source of fecal coliform bacteria, at least to *Burley Lagoon* (*TPCHD, 1990b*).

In 1989, surface water near the *Purdy Landfill* was sampled and drainage from the landfill was traced in an effort to estimate the fecal coliform contribution from the landfill to *Burley Lagoon*. In addition, groundwater monitoring data were reviewed by *TPCHD* to determine if contaminated groundwater from the landfill could be the source of elevated fecal coliform counts noted in the ditch along *144th Street NW*. It

was found that surface water from the landfill had minimal, if any, effect on the water quality of *Burley Lagoon* and that the groundwater from the landfill did not appear to be the source of the fecal coliform in the ditch along *144th Street NW*. The landfill has since been closed and surface water drainage modified to ensure that no surface water escapes the perimeter of the landfill (TPCHD, 1990b).

Water quality studies completed in the early and mid-1980s showed freshwater tributaries to be the primary source of fecal coliform bacteria to the estuarine shellfish growing areas. After five years of watershed management and restoration efforts, the *Bremerton-Kitsap County Health Department* conducted a water quality study in the subwatershed and found that water quality in the area had not improved significantly since 1983, except for *Bear Creek*. Improvements in *Bear Creek* were attributed to intensive implementation of livestock best management practices and on-site septic system repairs.

The *Department of Ecology* conducted a water quality study in the *Burley-Minter Creek Subwatershed* and monitored fecal coliform bacteria and total suspended solids levels during the 1992-93 wet season and compared results to wet season baseline data collected in 1983 or 1988-89. This study (referred to below as the most recent *Department of Ecology* study) found violations of the "Class AA" water quality standard for fecal coliform bacteria throughout the subwatershed in 1992-93. Elevated concentrations occurred primarily during rain events. Conditions were particularly poor in the lower reaches of *Burley and Purdy Creeks* and in the upper reaches of *Minter Creek*. The mean fecal coliform bacteria levels in the lower reaches of *Purdy and Minter Creeks* were significantly greater in 1992-93 when compared to baseline wet season data (*Dickes and Patterson, 1994*). (See TABLES 18-1 AND 18-2.)

TABLES 18- 1 AND 18-2 show fecal coliform summararies for *Burley and Minter Subwater-sheds*. Data from the 1992-93 water quality monitoring study are compared to baseline data.

TABLE 18-1 BURLEY SUBWATERSHED

Site Location	Site	Year	Fecal coliform (cfu/100mL)			
			sample size	min.	max.	G. Mean
Lower Burley	B1	1983	10	18	380	76
		1993	16	40	1900	172
Lower Burley	B2	1983	8	17	380	66
		1993	16	29	1500	115
Middle Burley	B3	1988-89	5	34	180	62
		1993	9	6	1000	27

Site Location	Site	Year	Fecal coliform (cfu/ 100mL)			
			sample size	min.	max.	G. Mean
Upper Burley	B4	1988-89 1993	5	3	130	24
			9	5	210	24
Upper Burley	B5	1988-89 1993	5	6	170	20
			9	1	300	10
Lower Purdy	P1	1983 1993	11	6	230	32
			16	6	1500	24
Middle Purdy	P2	1988-89 1993	5	2	82	15
			11	2	290	12
Upper Purdy	P3	1988-89 1993	4	7	84	22
			10	1	200	6
Lower Bear	BR1	1983 1993	8	7	870	76
			16	4	1400	47
Upper Bear	BR1.8	1983 1993	7	2	51	9
			4	1	290	14
Upper Bear	BR2	1993	9	1	67	5
Middle Burley Tributary	C1	1983 1993	8<1		13	2
			9	1	24	2

TABLE 18-2 MINTER SUBWATERSHED

Site Location	Site	Year	Fecal coliform (cfu/ 100mL)			
			sample size	min.	max.	G. Mean
Lower Minter	M1	1983 1993	10	4	120	24
			14	4	240	28
Lower Minter	M2	1988-89 1993	2	5	71	19
			16	9	200	33
Middle Minter	M4	1983 1993	10	4	100	29
			8	23	400	60
Upper Minter	M5	1988-89 1993	5	13	110	38
			8	49	270	99
Upper Minter	M6	1988-89 1993	5	4	60	17
			8	1	294	12
Lower Little Minter	LM1	1983 1993	10	3	140	31
			16	4	600	20

Site Location	Site	Year	Fecal coliform (cfu/ 100mL)			
			sample size	min.	max.	G. Mean
Upper Little Minter	LM2	1983	10	2	140	19
		1993	8	5	5600	41
Lower Huge	H1	1983	10	6	70	16
		1993	16	1	660	11
Upper Huge	H2	1988-89	3	2	51	14
		1993	8	1	290	7

Water Body Description and Known Problems

The largest individual water bodies (streams over 1-mile long) and *Horseshoe Luke* are characterized below.

- **Minter Creek**

Minter Creek is 6.3 miles long, begins north of *Minter Creek Road*, and flows south to *Minter Bay*. It has two major tributaries. It has several major road crossings and flows for about one-mile of its length along *Minter-Kitsap Road (1 18th Avenue NW)*, which crosses it several times.

The fish hatchery is located a short distance from the mouth of *Minter Creek*, which is an important salmon stream, supporting runs of *Chinook*, *Coho*, and *Chum* salmon. In 1996 over 3,200 *Coho* proceeded upstream past the hatchery to spawn. In 1995, over 13,000 *Chum* made their way to their spawning grounds past the hatchery. The creek is considered critical spawning habitat for resident species (*Popochock*, 1996). There are about eight beaver dams in the area and significant wetlands are associated with the creek.

Water quality sampling performed in 1992-93 found violations of the "Class AA" fecal coliform standard at all five locations tested along the creek. Water quality declined in upper *Minter Creek* in the reach between the uppermost and next stations. Then it improved at each station downstream toward the mouth. Both parts of the water quality standard were exceeded at the second and third uppermost stations while just the second part of the "Class AA" criterion was exceeded at the other stations.

The *Kitsap County Conservation District* reports that "Best Management Practices" have been focused along *Minter Creek* between the second and third upstream stations and may be the cause for the lower concentrations at the downstream site. However, problem areas identified between the two uppermost stations have not been addressed yet by the *Conservation District*. Flow-adjusted mean fecal coliform levels were significantly higher in 1992-93 compared with

baseline data from 1983 at both the mouth site and an upper watershed site (*Dickes and Patterson, 1994*). See TABLE 18-2.

Another historic water quality problem noted in the creek is excessive sedimentation. *Denis Popochock, Manager of the Minter Creek Hatchery*, has noticed an increase in the amount of sediment in the last three years as compared with the previous 17 years. The increase has ranged from what was formerly five to 10-cubic yards of organic muck-type sediment annually accumulating in the settling ponds at the intakes to the hatchery to 25 to 30 and up to 650-cubic yards of sandy material each year currently.

The source is unclear but several sources are suspected, including, failure of an upstream gravel pit's stormwater system (since corrected), run-off from three gravel pits, increased development resulting in more stormwater erosion and more debris in stormwater, removal of streamside vegetation, stream channelization, and road development on *Huge Creek*, a major tributary (*Small, 1996b; Popochock, 1996*). The change in the type of sediment from finer **grained organics** to coarser sand may be due to the maturing of the development in the basin. 20 years ago more timber cutting and land clearing was occurring. Now there may be greater amounts of run-off due to increased impervious surface resulting in more erosion. Culverts which are impassable to migrating fish and the ditching of tributaries is decreasing available habitat.

The *Pierce County Stream Team* rated macroinvertebrates in the creek as "Moderate" in 1996, and "Excellent" in 1997. *Stoneflies* in the creek seem to be particularly robust. They rated the **stream** as "good to excellent" on the streamwalks conducted in a 200-foot site located 1/4 mile above the hatchery. Bank conditions noted were artificial modifications and silt in the stream, although silt was not in excessive amounts when the streamwalk was conducted. *Minter Creek's* gravel streambeds are excellent habitat for spawning and the riparian zone is excellent. Land uses were single-family residences and unpaved roads. A second site monitored on *11 8th Ave KPN* almost to *County Line Road* was found to be healthy also with an excellent riparian zone and good spawning gravels. Water quality parameters measured (**pH**, dissolved oxygen, temperature, and average nitrate) were reported as good. Low **pH** problems have occurred in the spring. Problems identified by *Stream Team* include unpaved roads and bank modifications. A foam or sheen has been seen on the surface of the water just upstream of *Minter Hatchery*. Mud and silt also seem to be entering the stream. Temperatures taken during a summer of 1998 survey found levels between 12 and 14°C.

Minter Creek is on the 303(D) LIST with the impaired use of aquaculture due to fecal coliform and other pathogens.

- **Little Minter Creek (East Fork of Minter)**

Little Minter Creek is 2.95 miles long, begins in the vicinity of *82nd Avenue NW* and the *Kitsap-Pierce County* line at a small pond, and flows southwesterly to *Minter Creek*. It flows in the vicinity of *Highway 302, the Gig Harbor-Longbranch Road*, in its lower reach. *Little Minter* supports runs of *Coho* and *Chum* salmon. The creek has its headwaters in significant wetlands. The creek is considered critical spawning habitat for resident species.

Water quality in the creek is not as good as that found in other area streams. Elevated levels of fecal coliform were found during rain events. The highest fecal coliform count found in the most recent DEPARTMENT OF ECOLOGY STUDY OF THE BURLEY-MINTER CREEK SUBWATERSHED was collected at the upper Little Minter Creek site. Mean bacteria levels were higher in the upper watershed than in the lower watershed, unlike other creeks in the study (*Dickes and Patterson, 1994*). This pattern on *Little Minter Creek* has also been documented in other studies, with the source of the bacteria identified as poor livestock management. Temperature readings taken during a summer of 1998 survey found levels ranging between 11.5 and 14.5°C.

The *Pierce County Stream Team* found the stream to have good riparian cover on a streamwalk in back of the *Harvestime Store* off the *Key Peninsula Highway*. Some siltation was noted but for the most part, the stream runs swift, clean, and cold. Water quality parameters measured and macroinvertebrate counts were adequate. However, nitrate levels were higher than typically found in the *Key Peninsula* area.

Rensel and Associates has been monitoring the water quality of both ground and surface waters in the area surrounding *Horseshoe Lake Golf Course* since at least 1994. A small tributary to *Little Minter* runs near the course. There appears to be a strong potential for the golf course to impact water quality in the creek through groundwater infiltration since the soils in the area are gravelly which allows rapid movement of water while providing minimal filtration. Possible pollutants include nutrients and pesticides depending on what products are used and how carefully they are applied.

Stream Team volunteers noted concerns about commercial impacts from existing businesses as well as new development. They are also concerned about proposed residential developments impacting water quality.

Little Minter Creek is on the 303(D) LIST with the impaired use of aquaculture due to fecal coliform and other pathogens.

TABLE 18-3
 POLLUTANTS AND HABITAT RATING OF WATER BODIES
 IN THE BURLEY-MINTER CREEK SUBWATERSHED

Water Bodies	Fecal Coliform	Dissolved Oxygen	Temperature	pH	Nutrients ^a	Streamwalk Rating ^b
Minter Creek	-	+	+	+	2.2 - 8.8 average nitrate	79.5 - 98.5
Little Minter Creek		NA	+	NA	13.2 average nitrate	NA
Huge Creek		+	+	+	NA	91
Burley Creek		NA	NA	NA	NA	NA
Bear Creek		NA	NA	NA	NA	NA
Purdy Creek		+ ^c	+	+	NA	75 - 88.6
Unnamed 0061 Tributary to Purdy Creek (east fork)	NA	NA	NA	NA	NA	NA
Horseshoe Lake		NA	NA	NA	Total P 12 - 24 $\mu\text{g/L}$ Total N 0.36 - 0.40 me/L	NA

^aNo state standard

^bEPA Streamwalk Rating is a qualitative rating of the substrate, riparian zone, pool/riffle ratio, and absence or presence of possible pollutant sources along a 200-foot segment of the stream. Rating was made by volunteers. Rating is as follows:

- < 25 = very poor
- 25 - 50 = poor
- 50 - 70 = medium
- 70 - 90 = good
- > 90 = excellent

^cOne violation measured by volunteers out of six samples.

Notes: NA - Not available
 - - Does not meet state standard
 + - Meets state standard

• Huge Creek

Huge Creek is 5.2 miles long, starts west of *Glenwood* at the intersection of I 18th (*Glenwood Road*) and *Hunter Street (Pine Street)* and flows easterly and then southerly to *Minter Creek*. There are several road crossings. *Coho*, *Chum*, and *Steelhead* use the creek for spawning with *Coho* being the most abundant. The creek is considered critical spawning habitat for resident species. A healthy run of *salmon* was noted in 1996 as far as the upper reach of the creek even though the fish must pass through several gravel pits (*Small*, 1996b).

Macroinvertebrates were rated by the *Pierce County Stream Team* as "Excellent". Land uses, noted during the streamwalk conducted along a 200-foot stretch where the stream passes *County Line Road*, included single-family residences and paved roads. The stream received an "Excellent" rating on the walk, with good spawning gravels and a good riparian zone cover noted. The *Stream Team* also monitored an unnamed intermittent tributary to *Huge Creek* near *160th*

Ave KPN and *126th Ave KPN*. The site had an established riparian zone and good water quality. It is also an excellent tree frog hatchery site. According to the most recent DEPARTMENT OF ECOLOGY STUDY, fecal coliform levels were low in *Huge Creek* except during rain events (*Dickes and Patterson, 1994*). Elevated fecal coliform levels in the upper watershed resulted in a standard violation.

In 1998, residents adjacent to the creek noted an increase in sediment but also mentioned unexplained surges in stream flow. Temperatures taken during a summer of 1998 survey found temperatures ranging between 13 and 19.5°C.

- **Burley Creek**

Burley Creek is 5.2 miles long and flows southerly to the head of *Burley Lagoon*. It supports runs of *Chinook*, *Coho*, and *Chum* salmon. It has one major tributary (*Bear Creek* -described below) and two minor tributaries. The creek is considered critical spawning habitat for resident species. Significant wetlands are associated with the creek. In the lower reach of the creek, both parts of the fecal coliform standard were violated in the most recent DEPARTMENT OF ECOLOGY STUDY. The report suggests that poor water quality in this reach could be due to the transition into poorer soils, lack of focused best management practices, and increased proximity to the town of Burley where septic failures may be a problem. In general, the upper watershed had low fecal coliform bacteria levels except during rain events, when the standard was violated. Livestock from small farms have been sighted in the creek. In addition to water quality improvements, the creek needs some culvert repairs in order to allow fish access to good habitat areas.

Burley Creek is on the 303(D) LIST with the impaired use of aquaculture due to fecal coliform and other pathogens.

- **Bear Creek (West Fork of Burley)**

Bear Creek is 1.9 miles long and flows northeasterly from near *Madrona and Pine Roads* and then southeasterly to join *Burley Creek* almost at the town of *Burley*. *Bear Creek* has one minor tributary. It supports *Coho* salmon and an unconfirmed run of *Chum*. The creek is considered critical spawning habitat for resident species. The water quality standard for fecal coliform was exceeded on the main stem of *Bear Creek* during the most recent DEPARTMENT OF ECOLOGY STUDY. The small tributary did not exceed the standard. During the study, routine dredging of roadside ditches by *Kitsap County* resulted in a total suspended solid concentration of 160 mg/L, and the water turned opaque brown with sediment. A total suspended solid concentration of similar magnitude was also found a month later during a rain event. This most likely resulted from the resuspension of sediment deposited during earlier dredging activities (*Dickes and Patterson, 1994*).

Bear Creek is on the 303(D) LIST with the impaired use of aquaculture due to fecal coliform and other pathogens.

- **Purdy Creek**

Purdy Creek is 3.55 miles long and flows from north of the *Burley Olalla Road* generally southerly to *Burley Lagoon*. Land use is varied and includes rural areas, *Highway 16*, a trailer park, a park and ride lot, and *Peninsula High School*. It has one major tributary (described below) and supports runs of *Coho*, *Chum*, and *Cutthroat*.

Macroinvertebrates were sampled by the *Pierce County Stream Team* on four different occasions. It received "Poor" ratings twice, a "Moderate" rating once, and an "Excellent" rating once. They rated the creek on the streamwalks conducted in the vicinity of I.5501 *62nd Ave NW* as "Good" on five different occasions and "Excellent" once. Dissolved oxygen and nitrate tests both showed healthy levels. In November 1996, large numbers of *Chum* salmon swam up the stream and spawned. Land uses noted were single-family residences, logging, paved roads, and unpaved roads. A temperature survey performed on August 19, 1998 found temperatures ranging from 11.5 to 14°C which were generally lower than many other area streams sampled on the same day. *Stream Team* water quality sampling results have generally found the creek to be in fairly good condition.

According to the **DEPARTMENT OF ECOLOGY STUDY** of 1993, fecal coliform levels were relatively low in *Purdy Creek* except during rain events, when high-[peak values led to standard violations. The upper reach did not violate the standard; however, fecal coliform bacteria levels increased during rain events. Total suspended solids were comparatively high in upper *Purdy Creek* even during low rainfall. Upper *Purdy Creek* was the only location where a significant decrease in fecal coliform levels was detected relative to earlier years. The reason is unclear, since **nonpoint** source controls have not been focused in this area. The source of the total suspended solids is unclear, although tree thinning operations had been occurring in the upper drainage basin (*Dickes and Patterson*, 1994). The *Stream Team* also noted silt in the stream in 1996.

There is a barrier to fish passage where the creek crosses *Highway 16* and a block near the estuary during low tides. Adjacent property owners have installed at least one "duck pond" near the creek and have diverted creek water. The creek runs through a fairly rural area and has good riparian cover although it needs additional conifer coverage. The creek is on the **303(D) LIST with the** impaired use of aquaculture due to fecal coliform and other pathogens.

- **Unnamed 0061 Tributary to Purdy Creek (East Fork)**

The creek is 1.2 miles long, has one minor tributary, and flows southerly and then westerly to *Purdy Creek*. It supports a run of *Coho* salmon.

- **Horseshoe Luke**

Horseshoe Luke has an area of **40.3** acres and drains northeasterly to *Bear Creek*. It's shoreline is mostly developed with residences and a county park. There is also a recreational property known as *Rainbow Ranch* which abuts the lake and a golf course nearby. There are some concerns that the amount of water being withdrawn by the golf course to water its grass may draw down the water table and lower the level of the lake.

An intermittent lake lies adjacent to the north. *Horseshoe Luke* failed to meet both parts of the Ecology "Lake Class Fecal Coliform Standard", when measured in 1995. However, more intensive sampling was conducted at public access points, i.e., swimming beaches and public fishing access areas. If sampling had been more evenly distributed, it is possible that the lake would have met the standard (*Whitford, 1995*). *Horseshoe Luke* has met the swimming beach standards since but was closed to swimming in 1998 due to high-bacteria levels.

CONCLUSIONS AND TRENDS

This subwatershed has had more than 10-years of remedial action implementation. The *Burley-Minter Subwatershed* has received the highest amount of state funding for remedial actions of the shellfish projects in *Washington*. Estimates for local and state government spending range up to \$1 million. Yet elevated levels of fecal coliform bacteria continue to result in "Class AA" water quality violations throughout the subwatershed.

The mean fecal coliform bacteria levels at the mouths of *Purdy* and *Minter Creeks* were significantly higher in 1992-93 than baseline conditions in 1983. Baseline (1988-89) fecal coliform bacteria levels in upper *Purdy Creek* were low, but this was the only location monitored where a statistically significant decrease in fecal coliform bacteria concentrations was identified (*Dickes and Patterson, 1994*). There were no significant differences in total suspended solids between 1992-93 and 1983 at any of the sites in the subwatershed.

It appears that, although the *Burley-Minter Creek Subwatershed* has a large percentage of rural acreage treated with best management practices, bacterial water quality has continued to decline in these freshwater systems. Possible sources of bacteria that may need to be investigated could include failing on-site systems, pets, stormwater, and livestock.

In 1993, the *State Department of Health* upgraded *Burley Lagoon* from "prohibited" for commercial shellfish harvesting to "conditionally approved". Unfortunately, *Burley Lagoon* was again downgraded in 1999, indicating that the water quality

improvements have not been sustained. However, *Stream Team* results for pollutants other than fecal coliform and habitat in the watershed were generally good.

GIG HARBOR SUBWATERSHED

Location

The *Gig Harbor Subwatershed* encompasses the *Gig Harbor Peninsula* beginning just south of the unincorporated community of *Purdy* and includes the *City of Gig Harbor and Raft Island*. The *Burley-Minter Subwatershed* is to the north and *Fox Island* is to the south. The *Peninsula* is connected to *Tacoma* by the *Tacoma Narrows Bridge*. The subwatershed includes several creeks that drain to *Henderson Bay, Carr Inlet, and Colvos Passage*. APPENDIX "T", MAPS, GIG HARBOR SUBWATERSHED, shows the boundaries of the subwatershed. The subwatershed contains 31,104-acres.

Physical Description

As with the rest of the *KGI Watershed*, numerous small streams with small drainage areas drain the subwatershed. *Artondale, Wollochet, McCormick, Goodenough, and Crescent Creeks* are the largest streams. *Crescent Creek* is the longest at 3.1 miles and flows into *Gig Harbor*. However, most of the independent streams are one-mile or less in length and are not discussed individually below. Terrain in the subwatershed is predominantly low hills, below 400-foot elevation, that frequently extend to the shoreline. Like the streams they drain, most valleys are small and typically have moderate or steep slopes. The exception is *Crescent Creek*, which has a broad valley and level terrain. *Crescent Lake* and *Lake Sylvia* are the largest lakes.

Land Use

Current land use is about evenly split between single-family residences (13,300-acres) and vacant land (13,000-acres) with an additional 4,300-acres of agriculture and forest lands. The remainder of the acreage (approximately 500-acres) contains the *Tacoma Narrows Airport* and significant commercial nodes, mostly along *State Highway 16* and in the *City of Gig Harbor*. Consistent with land use of vacant land and low-density residential, land cover is primarily coniferous and mixed forest with significant areas of low-density built-up land. Current population is approximately 22,000; projected population in the year 2020 is approximately 40,000.

The subwatershed has been undergoing a transition from low-density residential and agricultural development to more of a suburban residential character. Between 1/4 and 1/3 of the subwatershed is slated for urban development under **PIERCE COUNTY'S COMPREHENSIVE PLAN**. This future urban development, like the current urban development, is primarily concentrated in and around the *City of Gig Harbor* and stretches along both sides of *State Route 16*. The urban development includes commercial and pleasure boat moorage in *Gig Harbor*, low- to medium-density residential development, and commercial development. *Gig Harbor* is the

home port for an important segment of the *Puget Sound* commercial salmon fleet. Between 1/4 and 1/3 of the subwatershed immediately outside the urban growth area is designated "Reserve 5" under the COMPREHENSIVE PLAN. This area has an average density of one unit per five-acres now, but would allow for growth at urban densities if needed. The remainder of the subwatershed (approximately 1/3) is designated "Rural 10", which translates into one dwelling unit per 10-acres.

Shorelines

The *Gig Harbor Peninsula* has a large amount of shoreline. Houses line almost the whole shoreline. The northeast shore, north of *Gig Harbor* proper, is more than half unstable slopes and, according to the 1979 COASTAL ZONE ATLAS, only a small area was modified (bulkheaded). In *Gig Harbor* itself, slopes are not unstable and much of the shoreline is modified with bulkheads and docks. South of the harbor on the southeast shore, much of the shoreline is unstable and only a small area was modified in 1979. The southern shore, including *Wollochet Bay* and *Horsehead Bay*, has only a small amount of unstable slopes and significant bulkheading. Along the northwestern shore, approximately half of the shore is unstable and about three-quarters was bulkheaded in 1979. This subwatershed has the most intensive shoreline development in the *KGI Watershed*.

Groundwater

Groundwater serves as the primary drinking-water source. The "Gig Harbor Groundwater Management Program" covers the whole subwatershed. More information on the groundwater quality and quantity in the subwatershed is found in the "Water Quality" and "Physical Description" chapters. In general, the biggest current groundwater quality problem is saltwater intrusion. Areas of known saltwater intrusion in the subwatershed are the area around *Horsehead Bay* north to *Kopachuck State Park* and the southern parts of *Wollochet Bay* (*Point Fosdick* and *Cromwell* areas). **Known** high-water table problems exist in two areas: the *Peacock Hill/144th St. NW/Crescent Luke* area and *Ray Nash Drive*. Builders are running into high-water tables and are having difficulties handling stormwater installing on-site systems.

Marine Resources

Pacific pink scallops are found off the northeast shore, and there is a small area of *kelp* and a lot of *eelgrass* in that area as well. *Kelp beds* also exist on the outside of *Gig Harbor* to the north and south of *Gig Harbor*. *Octopuses* and *kelp beds* are found off the southern part of the *Peninsula* and *Pacific cod* is found in *Hale Passage*. Pockets of *eelgrass* are found in the *Wollochet Bay* to *Horsehead Bay* areas. *Eelgrass*, *Spot Shrimp*, *Longnose Skate*, *Western Grebe*, and *River Otter* are found in *Henderson Bay*.

Harbor seals are found in *Horsehead Bay*, on *Cutts Island* off the *Peninsula*, and near *Allen Point*. *Pigeon guillemots* nest near *Allen Point* and on *Cutts Island*. *Ospreys* nest on the *Peninsula*. *Bald eagles* nest on the northeastern shore, near *Gig Harbor*, and on the southeastern shore. Cliff habitat is found at *Point Evans*

where cliffs are approximately 300-feet high. A small area of old-growth habitat is found in the interior of the *Peninsula* near the *North Rosedale* exit off *Highway 16*. *Great blue herons* nest near *Horsehead Bay*. *Minke whales* concentrate in the Narrows and *gray whales* in *Henderson Bay*. Recreational and commercial fishing for salmon is common in many of the waters off the *Peninsula*. *Pelagic, demersal, and reef dwelling* are all found off the *Peninsula*; as are *Pacific herring* holding areas, *geoducks*, and *sea cucumbers*. *Redrock and Dungeness crab* are found in *Wollochet Bay* and *Hale Passage*. Public recreational shellfish beaches are located at *Sunrise County Park*, under the *Narrows Bridge*, and at *Kopachuck* and *Cutts Island State Parks*, but not all are open to harvest.

Lakes and Wetlands

Crescent, Maloney, and Sylvia are the largest natural lakes in the subwatershed. There are a number of other smaller lakes and wetlands throughout the subwatershed. Significant estuarine systems include *Gig Harbor, Wollochet Bay, Horsehead Bay, Henderson Bay*, and the area near *Raft Island*. Many of the freshwater wetlands are associated with the major creeks in the subwatershed.

Sylvia Lake, three miles west of *Gig Harbor*, has been treated repeatedly with copper compounds to control algae. A 1994 **TOXICS INVESTIGATIONS STUDY** showed that copper levels in the lake and outlet stream (which flows to *Ray Nash Creek*) exceeded water quality criteria for at least 18 days following a summer application of copper sulfate. Continued use of copper could adversely affect the hatching and rearing of *Coho* and *Chum* salmon in the ½-mile-long outlet stream. Therefore, the *Department of Ecology* has not allowed further copper treatments in *Sylvia Lake* (Carey, et al. 1996).

Streams

The largest individual streams (over one-mile long) in the *Gig Harbor Subwatershed* are characterized below.

General Description and Known Problems

The individual water bodies are characterized below:

- ***Donkey Creek (North Creek)***

Donkey Creek is 1.4 miles long, begins in the vicinity of *Highway 16*, and flows to *Gig Harbor*. It has one short tributary and several major road crossings. It flows for about one-mile of its length in the vicinity of *Burnham Hunt Road*. It flows through the urban area of *Gig Harbor*, into the heart of downtown *Gig Harbor*, and through a gravel pit near *Highway 16*. It supports *Coho, Chum, and Cutthroat* runs. Temperature readings taken in August of 1998 found temperatures between 14 and 15 °C.

A volunteer has been incubating eggs on the creek for the past 24 years (*Allen, per-s. comm.*, 1996). He currently raises one million *Chum* salmon eggs and estimates a 75 % success rate in hatching. He reports concerns with stormwater run-off and siltation, although sources are not confirmed. He also reports one culvert that creates a fish passage problem (a videotape of habitat along the entire stream length has been made by a salmon enhancement volunteer). Habitat along this stream reach is quite good for an urban creek. The drainage basin is slated for additional commercial and industrial development in the near future and extra efforts will need to be made to protect the creek from increased stormwater flows as a result of the impervious cover generally associated with this kind of development.

- **Crescent Creek**

Crescent Creek flows south from *Crescent Lake* to *Gig Harbor*. It is 3.1 miles long, has one of the largest drainage basins in the subwatershed, and supports runs of *Coho* and *Chum* salmon (a native run of *Chinook* is now gone). There are also freshwater clams and mussels in the creek. It flows for most of its length in the vicinity of *Crescent Valley Road*, and there are a number of road crossings. There are sections where the stream has been ditched and straightened along *Crescent Valley Road*. The mouth of the creek is at the *Gig Harbor City Park*. There are beaver dams at about *Stream Mile 3* and a number of wetlands associated with the creek. There is a historic gravel pit near the headwaters. Most of the valley is developed with small agricultural operations. There is a large piece of land in the drainage which is owned by a large timber company and is currently undeveloped but is being marketed for sale.

Crescent Creek has a moderate or shallow gradient throughout its length and its substrate is predominantly gravel with sandy sections. The CATALOG OF STREAMS (WDOF, 1975) reports, "Stream conditions in the lower 2.0 miles are particularly favorable for salmon production." The *Chum* run is particularly important and the lower mile is heavily utilized for spawning. The creek has received *Coho* plants from *Minter Creek Hatchery*.

A volunteer raises 70,000 *Chinook* eggs, 200,000 *Coho* eggs and 300,000 *Chum* eggs annually and has been planting eggs in the creek for the last 20 years. The *Coho* are raised in ponds for one-year. He estimates a 5 % return. He reports concerns with stormwater and construction and has videotape of most of the stream habitat (*Oathout, pers. comm.*, 1996).

Habitat deterioration occurred early on from logging and subsequent farming practices. These practices resulted in the accumulation of sandy sediment that has left portions of the creek unsuitable for salmon spawning (WDOF, 1975).

The *Pierce County Stream Team* rated the stream as "Medium" on its streamwalk near the *Gig Harbor Park*. Temperatures taken in August of 1998 ranged between 13 and 20°C (the high temperature was taken from a stagnant pool in

open sun). The culvert between Crescent *Lake* and Crescent *Creek* was plugged at that time. They noted algae floating and coating rocks, natural streamside cover degraded, banks artificially modified and collapsed/eroded, and mud/silt/sand in or entering the stream.

- **Salmonberry Creek**

Salmonberry Creek starts in the *Peacock Hill* area and runs east toward Crescent *Creek*. The Pierce County *Stream Team* tested macroinvertebrates at two sites on *Salmonberry Creek*, a small intermittent tributary to *Crescent Creek*, and found one site with an "Excellent" rating and one site with a "Moderate" rating. A lot of construction is occurring along the *Salmonberry Creek stream* corridor and the stream is experiencing siltation. The riparian zone is reported as good. An August 1998 survey found sluggish flow and temperatures ranging between 14.5 and 17.5°C.

- **Crescent Lake**

The headwaters of *Crescent Creek* (described above), *Crescent Lake* is the largest lake in the subwatershed and one of the largest lakes in the *KGI Watershed*. The shoreline has a moderate amount of development. It contains largemouth bass and rainbow trout and is stocked with additional rainbow trout. It is 46.8 acres in area. The *Department of Ecology* has listed it in the SECTION 305 (B) REPORT as supporting the beneficial use of aesthetic enjoyment. There is public boat access (*Bortleson*, 1976). The only water quality information available was collected in the 1970s. The fecal coliform standard was met. The "Lakes Standard" for the other measurements taken is "no measurable change" so additional more recent measurements would be necessary to determine compliance. *Pierce County Parks* owns land adjacent to the lake but has not yet developed it for recreational purposes.

- **Lay Creek (Nelyaly Creek)**

Lay Creek is 1.5 miles long and flows to *Lay Inlet* near *Rosedale*. *Coho* and *Chum* salmon have been planted in *Lay Creek* by volunteers for a number of years. They report a high-rate of hatching and success with fish returning (*Olsen*, pers. comm., 1996). In one-year, disease did kill a number of eggs. Tribal members have been netting fish at the mouth of the creek (*Olsen*, pers. comm., 1996). An increase in silting has been noted in the last few years as well as a decrease in flow when individuals built ponds. Volunteers have tried to restore spawning grounds by placing gravel and woody debris in the creek. No water quality sampling information is available.

- **McCormick Creek**

McCormick Creek is 1.6 miles long and flows from its headwaters (a wetland to the northwest) to *Henderson Bay*. It flows in the vicinity of the *Old Gig Harbor Highway* and there are a number of road crossings, including a crossing of *State*

Highway 16. Its major tributary is described below. There are fish passage barriers near the mouth at a county road and at *Highway 16*. A large development is proposed within this drainage so additional road crossings and stormwater are expected. A long stretch of the creek near the correctional facility is owned by the parks department and is being protected from development. This area also includes a small area with old-growth trees.

McCormick Creek supports a minor run of *Coho*, *Chum*, and *Cutthroat*. *Chum* salmon are planted by volunteers. The volunteers are currently incubating 300,000 eggs. Last year 600 fish returned. They report that the habitat below the freeway is good but report concerns about excessive flows created by stormwater run-off from the highway and other development (*Manning and Manning*, pers. comm., **1996**). A previous volunteer quit incubating eggs because a construction company's gravel pit resulted in excessive silt. The creek is recorded by the *Department of Fish and Wildlife* as important fish habitat for listed resident fish as well as anadromous fish.

Gig Harbor High School has performed numerous data collection activities on *McCormick Creek*. Thirty macroinvertebrate samples taken from the creek have resulted in an average rating of "Excellent" but results have varied. Macroinvertebrate samples taken since March 1996 have generally fallen into the "Good" to "Moderate" range. They also performed two stream walks, one resulted in a "Good" rating and another in a "Poor" rating. The high school performed 30 water quality samples on the creek between 1994 and 1996 on two different sites. The average temperature was 9.33°C, the average pH was 6, and the average dissolved oxygen level was 8.23 mg/l. The unusually low pH readings are attributed to acidity coming from wetlands associated with the creek. Nitrate levels were extremely low, with most readings not reaching detectable levels. Average discharge was 9.81 cfs but discharge ranged between 1.6 and 17.5 cfs. Temperature readings taken during August of 1998 ranged between 15 and 17°C.

- ***Goodenough Creek (Gooch Creek)***

Goodenough Creek is one-mile long, originates at the *Canterwood Subdivision* (a very large subdivision and golf course development) east of *Canterwood Drive NW*, and flows west to *Henderson Bay* in the vicinity of *Purdy*. It has one small tributary known as *Wilderness Creek* that flows south from *144th St. NW* into the main branch at *Canterwood Drive*. *Gooch Creek* is a tributary to *Goodenough*. The closed *Purdy Landfill* is in the drainage basin. Salmon use is prevented by four culverts. There are blockages where the stream crosses *Highway 302*, *Highway 16*, and two blockages are from private road culverts.

The *Pierce County Stream Team* tested for macroinvertebrates and rated the stream as "Poor" on one occasion, "Moderate" on four other dates, and

“Excellent” during two samples. They report a very healthy riparian zone, yet excessive siltation was frequently found. Residential housing construction, *Purdy Topsoil*, and the Pierce County Public *Works* shop are suspected as possible sources of sediment. Nitrate levels were higher than most of the other area streams so Pierce *County Water Programs* is investigating further. Possible sources of nitrates include *Canterwood golf course* and numerous homes. Readings taken for temperature, pH, and dissolved oxygen generally found the stream to be in good condition.

Streamwalk ratings have ranged between “Poor” and “Good” with the majority being “Good”. Among the bank conditions noted were artificial modifications, algae/scum floating or coating rocks, garbage in and adjacent to stream, stream artificially modified, and foam or sheen. Land uses represented a broad range from single-family residences to road construction. Those noted as clearly affecting water quality included single-family residences, heavy industry, residential construction, industrial construction, grazing, multi-family residences and construction, and road construction. In spite of this assessment, volunteers still found excellent cover and felt that the creek has good potential.

- **Artondale Creek**

Artondale Creek is 2.2 miles long and drains south and east to *Wollochet Bay*. It is one of the largest streams in the subwatershed, has two major tributaries (described below), and supports moderate runs of Coho, *Cutthroat*, and *Chum* salmon. Culverts and bridges on this reach are particularly good, with no notable blocking problems. Significant wetlands form the headwaters and the stream flows through a golf course, under roads, and by homes and hobby farms. The golf course has removed the riparian cover over the creek and that section is becoming choked with grass. The golf course owners want to channelize the creek through the course to control flooding. There are a number of associated wetlands along the creek and the *Peninsula Heritage Land Trust* is acquiring rights to shorelines in the estuary to provide additional protection. The drainage basin is currently experiencing a large amount of residential development. No water quality information is available except for one temperature survey taken in the summer of 1998 which found temperatures ranging between 13.4 and 14.6°C.

- **East Branch Artondale**

The *East Branch* is 1.1 miles long and has one small tributary that begins at *Luke Maloney*. It supports a run of *Coho*, *Cutthroat*, and an unconfirmed run of *Chum* salmon. Downstream of its crossing of *Hunts Street NW* there are erosion problems along the creek for approximately 1,200 feet. The *Pierce County Capital Improvement Plan* reports on two alternatives to solve the problem. One alternative would be to riprap the entire section and the other would be to use

bioengineering techniques to stabilize the channel. Either would be successful if livestock are prohibited from accessing this portion of the stream (James M. *Montgomery Consulting Engineers*, 1991). No water quality information is available.

Other tributaries to *Artondale* have been channeled into pipes and have low oxygen levels. They have also been ditched along roads and are cleaned by the county.

- **Garr Creek**

Garr Creek is 1.4 miles long and flows northwest, west, and south to *Wollochet Bay*. It has three major tributaries (described below) and two minor tributaries. There are a number of small ponds, lakes, and wetlands in the drainage basin. The creek supports a run of Coho and an unconfirmed run of *Chum* salmon.

A hydrologic/hydraulic and engineering analysis performed for the *Garr Creek/Wollochet Creek* drainage basin concluded that channel erosion, habitat drainage, and water quality do not appear to be major problems at this time. The report prepared for *Pierce County* stated, "The series of interconnected wetlands, streams, and lakes are providing an excellent level of both flood control and water quality treatment for most drainages within the watershed" (*Economic and Engineering Services*, 1995). The report states that stormwater run-off quality in the basin appears to be generally acceptable under current conditions, although no chemical testing was performed.

Garr Creek basin drains about two-thirds of the drainage basin. Land use is largely residential, with both subdivisions and higher density housing. More rural uses are located in the western areas of the basin. Commercial and multi-family uses are located along the eastern border of the basin in the vicinity of *Highway 16, Point Fosdick Road and Olympic Drive NW*. The *Garr Creek* system contains several manmade stormwater detention ponds, as well as natural depressions that provide storage.

Three areas of erosion severe enough to warrant mitigation were noted in the hydrologic report: the outlet channel below the *Quail Run* subdivision detention pond, a small portion of *Garr Creek* before it enters the bay, and a short interval of *Garr Creek* below *Park Luke* (*Economic and Engineering Services*, 1995). No water quality sampling results are available. Erosion at the location on *Garr Creek* before it enters the bay appears to have been corrected as a result of construction of a large culvert beneath *Wollochet Drive NW* and the installation of streambank erosion control measures including rock armoring. This construction was performed for the purpose of enhancing fisheries in *Bitter Creek* (*Economic and Engineering Services*, 1995).

- **Wollochet Creek (Bitter Creek)**

Wollochet Creek is 1.7 miles long and runs due south from a private pond near the area of Maloney Lake to *Garr Creek*. It is the major tributary to *Gun-Creek* and drains the western one-third of the drainage basin. There are significant wetlands located at the headwaters and some are being protected through efforts by the *Peninsula Heritage Land Trust*. A large natural pond, *Bitter Creek Pond*, is located next to the creek about halfway between the headwaters and the juncture of *Wollochet Creek with Gun-Creek*. The creek supports a run of Coho and an unconfirmed run of *Chum* salmon. A small private fish hatchery exists just above *Bitter Creek Pond*. A few culverts exist under the main roads. Otherwise much of the natural drainage system is still in place.

Land use in the basin is mostly rural, with large lot residences in a natural setting. There is also a greenhouse/nursery and a few multi-family apartments in the basin. Along the *Wollochet Creek* valley in the vicinity of *Bitter Creek Pond*, the predominant land use is natural open space and a few small farming and livestock activities. This area is a natural flat and wide valley with numerous wetlands and water filled depressions. Erosion is evident in some reaches of the **stream** channel due to increased rates of flow (*Economic and Engineering Services*, 1995). No water quality sampling information is available except for temperature readings taken in August of 1998. Temperatures fell between 14.6 and 16.8 °C. A number of private culverts conveying *Wollochet Creek* drainage are located beneath driveways adjacent to *Wollochet Drive*. These culverts create difficulties for fish passage. Homeowners are removing the buffer along the creek.

Tributaries to *Wollochet Creek* have fish in them as so do the ponds associated with the creek. However, a property owner has been doing bulldozer work in one of the creeks and some of the tributaries have been ditched.

- **Sullivan Gulch Creek**

Sullivan Gulch Creek is 1.2 miles long and flows mostly southerly to *Wollochet Bay*. The headwaters of the creek are steep and the area nearer the mouth is 'slow flowing and the bottom is silty. Its flow comes primarily from seeps and wetlands. There is a driving range and a mini-storage proposed for development near the headwaters of the creek. It contains *Cutthroat*. It has associated wetlands, one major tributary, and several road crossings. No water quality information is available. The *Puyallup Tribe* has made some efforts to improve conditions in the creek.

CONCLUSIONS AND TRENDS

The *Gig Harbor Subwatershed* has significant resources in terms of salmon production, shoreline habitat, and wildlife habitat generally. Unfortunately, very little information is available on the status of pollutants, and specifically whether

water bodies currently comply with the state standards. Monitoring has not been done by any agencies and volunteer monitoring is just beginning. Of all the subwatersheds, the *Gig Harbor Subwatershed* has the greatest diversity of sources. It also will be undergoing a great deal of change and activity in the future as the urban area expands and the rural area becomes more heavily developed. Given the variety and number of potential sources, **nonpoint** pollution problems are very likely to increase.

ROCKY BAY SUBWATERSHED

Location

The Rocky Bay *Subwatershed* is the northwesternmost portion of the Key *Peninsula-Gig Harbor-Islands (KGI) Watershed*. The subwatershed encompasses the drainages of Rocky Creek and *Fork Muck Creek*, a large tributary of *Rocky Creek*, which extend almost five miles into *Kitsap County* to the north. APPENDIX "T", MAPS - -ROCKY BAY SUBWATERSHED shows the boundaries of the subwatershed.

The major transportation route through the *Rocky Buy Subwatershed* is *State Highway 302* which runs east and west through the lower portion of the subwatershed and joins *Slate Highway 16* to the east with *Olympic Peninsula* highways to the west.

Physical Description

The *Rocky Buy Subwatershed* contains over 12,000-acres of land. Elevation in the subwatershed ranges from sea level to 450-feet. For the most part, the land cover is a mix of deciduous and coniferous forests with their associated shrub understory and groundcover (*Hazel Nut Trees, Indian Plum, Elderberry, Snowberry, Ferns, Salal, Salmonberry, Piggyback*, etc.).

The largest streams in the *Rocky Buy Subwatershed* are *Rocky Creek* and *Fork Muck Creek* at five miles and 7.5 miles respectively.

Land Use

The *Rocky Buy Subwatershed* is for the most part low density residential and rural in character, with more concentrated residential development near the shoreline.

The *Pierce County Council* passed in 1994 the **PIERCE COUNTY COMPREHENSIVE PLAN** which limited any new development in this subwatershed to one dwelling unit per 10-acres. This was done to protect the rural setting of this subwatershed and to preserve its natural resources. The *Council* passed an amendment to the **COMPREHENSIVE PLAN** in 1995 to further limit development to one dwelling unit per 20-acres, and that is under effect at the time of this writing.

The population of the *Rocky Buy Subwatershed* is approximately 500 permanent residents. The population is not expected to rise too sharply in the foreseeable future because of the development limitations of the **COMPREHENSIVE PLAN**.

Shorelines

Information about shorelines within this subwatershed is derived from beach surveys collected by volunteers for *Adopt-a-Beach*. The shorelines within this watershed are limited almost entirely to the interior of *Rocky Buy*. While not as intensely developed as most areas of the *Gig Harbor Peninsula*, most of the homes within the subwatershed are clustered around the shores of *Rocky Buy* or the subwatershed's larger lakes. Bluffs are limited to a maximum height of about 40-feet. There is a moderate amount of bulkheading.

Groundwater

As with the whole *Key Peninsula-Gig Harbor-Islands (KGI) Watershed*, groundwater supplies almost all the water for *Rocky Buy Subwatershed* residents. Only residents surrounding some of the smaller lakes in the subwatershed use lake water rather than groundwater. Most wells supply water for individual homes or for small clusters of homes.

Marine Resources

All information regarding marine resources in the *Rocky Bay Subwatershed* are derived from surveys done by volunteers for *Adopt-a-Beach*. *Eelgrass* may be found in *Rocky Bay* as may *Sea Lettuce*, *Pickleweed*, and various shore grasses. There are no signs of *Spartina*.

Bald eagle and *Great blue heron* have been sighted in the area as have a variety of *duck species* and *seagulls*. The bay supports a commercial shellfish bed although the inner bay was prohibited for shellfish harvest in 1995.

Lakes and Wetlands

There are six identified lakes in the *Rocky Buy Subwatershed*. A complete list of all the lakes in the *KGI Watershed* (except for *Lake Minterwood*) is located in **APPENDIX "O"**. Two of these water bodies have been known to dry up or are intermittent in nature (*Hidden Lake* and *Sailor Lake* south of *Fairview Lake* in *Kitsap County*). *Wye Lake's* overflow begins the main stem of *Rocky Creek*, flowing in to and out of *Lake Koeneman*. *Carney Lake* has no surface outlet and the lake level rises considerably during years with heavy rainfall.

The *Washington State Department of Fish and Wildlife* stocks *Wye*, *Koeneman*, *Camey*, and *Helena* lakes with various trout species.

There are two large marshes within this subwatershed. *Reid Marsh*, the larger of the two is about one mile east of *Wye Lake*. A smaller, unnamed marsh is just north of *Reid Marsh*. Many of the streams and tributaries to *Rocky Creek* have associated wetlands.

Streams

The *Rocky Creek* system hosts the longest creek within the watershed. It is also the most productive, supporting *Chinook*, *Coho*, *Chum*, and *Cutthroat*. The stream even hosts *Sockeye* and *Steelhead* on occasion. *Fork Muck* is a sizable tributary to *Rocky Creek* and also supports salmon. *Fork Muck Creek* currently has a salmon passage barrier at *Wright-Bliss Road* which a number of organizations are working to correct. Most of the other tributaries to *Rocky Creek* are small and seasonal.

General Description and Known Problems

The individual water bodies are characterized below:

- **Unnamed stream north of Rocky Bay (0012, northern stream)**

This stream is 1.15 miles in length and flows in a southwesterly direction to *North Bay*, northwest of *Rocky Bay*. NATIONAL WETLAND INVENTORY (NWI) and USGS TOPOGRAPHIC MAPS show this stream as being an intermittent stream. Anadromous fish use is unknown. It has one small intermittent tributary flowing in from the north. There is no available water quality data or habitat assessment, and surrounding land uses need to be confirmed.

- **Unnamed stream north of Rocky Bay (0014, southern stream)**

This stream is 1.3 miles in length, flows in a southwesterly direction to *North Bay*, and, along with the intermittent stream to the north, drains that portion of the subwatershed located in *Mason County*. Its headwaters are a large wetland in *Pierce County*. Anadromous fish use is unknown. There is no water quality data or habitat assessment, and surrounding land uses need to be confirmed.

- **Rocky Creek**

Rocky Creek is five miles long and, beginning south of *Wye Lake*, flows into *Rocky Bay*. It has two major tributaries, is the second-longest stream in the subwater-shed, and supports runs of *Chinook*, *Coho*, and *Chum* salmon. There are many wetlands associated with the creek and *Fern Lake* three miles upstream from *Rocky Bay*.

Pierce County Stream Team has been monitoring the stream at a site less than a mile upstream. Monitoring includes water quality sampling, taking flow measurements, macroinvertebrate sampling, and assessing the instream and riparian habitat along a 200-foot stretch of a stream. Categories for assessment include clarity of the water, amount of canopy cover, presence of pools and riffles, estimation of riparian width, and the amount of woody debris. Bank conditions and surrounding land uses are also noted. Points are given for each answer and totaled for an overall rating. *Rocky Creek* has received ratings ranging from 72 (good) to 94 (excellent). Volunteers have noted a large riparian width (300-400 feet), good canopy cover, and occasional woody debris. Volunteers have also noted collapsed and eroded banks along this stretch of the

creek as well as unpaved roads affecting the stream. However, every data sheet assessed the clarity of the water as clear.

Flow data for *Rocky Creek* shows a low of four cubic feet per second on June 10, 1995, to a high of 9.4 cubic feet per second on October 29, 1996. A flow survey performed by Pierce County *Water Programs* on September 12, 1997 calculated a total quantity of 9.8 cubic feet per second with a velocity of 1.58 feet per second. Macroinvertebrate samplings have resulted in ratings ranging between "moderate" and "excellent".

One sampling site is located on *Rocky Creek* and is monitored by Pierce County *Water Programs, Storm Drainage and Surface Water Management* (SWM) for the purpose of identifying sources of fecal coliform into *Rocky Bay*. Samples taken since 1995 have all found the creek well within state water quality standards.

Water quality samples taken by *Stream Team* volunteers and *Pierce County Water Programs* have generally found the stream to be in very good condition. Temperatures have ranged between 5°C and 14 °C and the average pH is 7. Dissolved oxygen readings have ranged between 7 and 14.88 mg/l.

More recently, *Stream Team* volunteers have noticed more algae in the creek and a mild reduction in clarity. Anecdotal information from adjacent property owners has noted heavy which sediment loads entering the creek after improperly performed timber harvesting practices. Poaching of salmon has been occurring near the mouth of the stream

- **Fork Muck Creek**

Fork Muck Creek, though a tributary to *Rocky Creek*, entering 1/4-mile above where *SR302* crosses *Rocky Creek*, is, at 7.5 miles, the longest creek not only in the subwatershed, but in the entire *KGI Watershed*. This fact is a little misleading since the upper waters of the creek have seasonal flows. *Fork Muck Creek*, beginning near *Lake Flora Road* in *Kitsap County*, flows in a southerly direction for most of its length before turning southwest and west 1.5 miles from the confluence with *Rocky Creek*. The many large wetlands associated with the upper reaches may explain why the creek has seasonal flows. During times of low rainfall, these wetlands help recharge groundwater and have no surface water flow.

The creek has healthy runs of *Coho*, *Chum*, and **searun** *Cutthroat*. Unfortunately, the culvert under *Wright-Bliss Road* (at river mile 1.4) completely blocks upstream migration and denies access to approximately six miles of potential habitat. Biologists have noted a number of fish just below the barrier apparently trying to move upstream. Volunteers have organized during the spawning season to net the fish and assist them over the barrier.

Stream Team has two monitoring sites on *Fork Muck Creek*; one where *Wright-Bliss KPN* crosses the creek, and one to the north where *144th KPN* crosses the creek. Only *Stream Walk* information has been taken thus far on these two sites, and only the *144th site* data is available. Two *Stream Walks* have been taken at that site, in June and December, 1995. The June assessment was "Good" but noted garbage and junk adjacent to the stream and collapsing banks as impacting the stream. The volunteers also noted unpaved roads as affecting the stream and that the natural **streamside** cover was degraded. The December assessment was "Poor". Differences in the assessments result from a dramatic reduction in the estimation of canopy, no notice of pools or riffles, and even lower ratings for bank conditions and land use. In addition to the impacts noted in June, the volunteers also noted mud/silt/sand in the stream, garbage/junk in the stream, and the degradation of the streamside cover as severely impacting the stream. Land uses clearly affecting the stream included the unpaved roads again, but also logging and recreation as well. Multi-family residences were also noted.

Fork Muck Creek has four **small** tributaries, or more accurately, two small tributaries draining into the lower reaches and two small tributaries draining into the upper wetlands feeding the creek. *Stream Team* is monitoring the second of the lower tributaries at the end of *132nd St KPN*. *Stream Walk* assessments have noted cloudy water, a dramatic reduction in the riparian width, and the absence of riffles. In addition, the banks were collapsed and eroded, unpaved roads and recreation were impacting the stream, there was degradation of the natural streamside cover, and logging was clearly affecting the **stream**. More recent reports have noted higher sediment and algae levels in the **stream** as well as loss of cover to forestry operations.

Water quality testing at the site revealed **pH** levels between 6 and 6.5 and dissolved oxygen levels ranging between 5 and 11 **mg/l**. Two out of four readings violated state standards for dissolved oxygen even though the temperature of the water was good (The colder the water, the greater its ability to contain dissolved oxygen). One flow rate has been measured at the site, in June, 1996, and the rate was less than .2 cubic feet per second. Two **macro**-invertebrate samples have been taken, in June and November, 1996. The June sampling had a moderate rating, and the November sampling rating was poor indicating that the stream does not have a strong macroinvertebrate population.

In 1998, 240-acres along the creek were transferred to the *Peninsula Park Board*. The area, now known as the "Rocky Creek Natural Area" will be protected from future development. Volunteers have been working actively to remove garbage from the stream and are planning habitat restoration projects. In addition, the *South Puget Sound Salmon Enhancement Group*, *Pierce County*, and the *Department of Fish and Wildlife* are working to remove the barrier at

Wright-Bliss Road. This would allow salmon to access that portion of the stream which runs through the “Rocky Creek Natural Area.”

- **Unnamed western tributary of Rocky Creek (0021)**

This stream is two miles long, begins just west of *Fern Luke*, and flows in a southerly direction for 1.5 miles before turning east and entering *Rocky Creek* near *144th St. KPN*. There is no water quality data or habitat assessment. Salmon and other fish use is unknown, and surrounding land uses need to be confirmed. There is a large wetland **1.5** miles upstream.

KEY PENINSULA SUBWATERSHED

Location

The *Key Peninsula Subwatershed* is the westernmost portion of the *Key Peninsula-Gig Harbor-Islands (KGI) Watershed*. The subwatershed encompasses *Key Peninsula*, located between *Case Inlet* to the west and *Carr Inlet* to the east.

APPENDIX “T”, MAPS-KEY PENINSULA SUBWATERSHED shows the boundaries of the subwatershed.

Major transportation routes to and from the *Key Peninsula Subwatershed* include the *Key Peninsula Highway*, running roughly north and south through the peninsula, and *State Highway 302* which runs east and west through the upper portion of the subwatershed and joins *State Highway 16* to the east with *Olympic Peninsula* highways to the west.

Physical Description

The *Key Peninsula Subwatershed* contains over **26,000-acres** of land including about 30 streams and tributaries. As with all of the subwatersheds in the *KGI Watershed*, most of these streams are short and **small**, draining hills of moderate to steep slopes frequently extending to the shoreline. Elevation in the subwatershed ranges from sea level to about 300-feet. For the most part the land cover is a mix of deciduous and coniferous forests with their associated shrub understory and groundcover (*Hazel Nut Trees, Indian Plum, Elderberry, Snowberry, Ferns, Salal, Salmonberry, Piggyback*, etc.).

Because the subwatershed is a peninsula, it has miles of shoreline with many coves and bays along those miles. The largest streams are 2.5-mile *Lackey Creek* which flows to *Glen Cove* (although there is some doubt that it is still that long) and 1.8-mile *Dutcher Creek* which flows to *Dutcher Cove* on the west side of *Key Peninsula*.

Land Use

The *Key Peninsula Subwatershed* is for the most part low-density residential and rural in character, with more concentrated residential development near the shoreline. There are small areas of commercial development located in the rural

communities of *Key Center*, *Home*, and *Longbrunch*. There are no large commercial agricultural operations located in the subwatershed, nor are there any large forestland holdings. However, many of the residents are small farm enthusiasts, raising a number of animals and growing crops, and there are a number of private foresters with forty acres or less located in the subwatershed.

The *Pierce County Council* passed in 1994, the **PIERCE COUNTY COMPREHENSIVE PLAN** which limited any new development in this subwatershed to one dwelling unit per ten acres. This was done to protect the rural setting of this subwatershed and to preserve its natural resources.

The population of the *Key Peninsula Subwatershed* is approximately 8,500 **permanent** residents. The population is not expected to rise too sharply in the foreseeable future because of the development limitations of the **COMPREHENSIVE PLAN**. The Plan does allow for commercial development and increased residential density in the rural centers of *Key Center*, *Home*, and *Longbrunch*.

Shorelines

Information on shorelines in this area is limited. Most of the shoreline is high bank with significant bluffs. Banks within the bays and inlets are much lower and are often surrounded by homes and cabins because the low banks allow for easier access to the beach. Many of these homes have associated bulkheads but the rate of bulkheading in this subwatershed is the lowest. There are state parks at *Penrose Point* and *Joemma Beach*.

Groundwater

As with the whole *Key Peninsula-Gig Harbor-Islands (KGI) Watershed*, groundwater supplies almost all the water for *Key Peninsula Subwatershed* businesses and residents. Only residents surrounding some of the smaller lakes in the subwatershed use lake water rather than groundwater. Most wells supply water for individual homes and businesses or small groups of the same. In recent years, most new wells are for six or fewer connections to avoid the need to apply for special water rights.

Four areas in the subwatershed are known to have problems with seawater intrusion. They are the west side of *Glen Cove*, the north side of *Whiteman Cove*, the portion of land between the north and west fingers of *Filucy Bay*, and the rounded head of land north and west of *Taylor Buy*.

Marine Resources

Eelgrass has been confirmed in *Glen Cove* and may be present in other bays but a survey has not been completed. *Filucy Buy* supports a commercial shellfish bed but the area is beginning to show signs of increased bacteria levels and may be at risk for downgrade. Recreational shellfishing may be done at *Vaughn Buy*, *Joemma*

Beach State Park, Wyckoff Shoal, and Penrose Point State Park. Vaughn Bay, Taylor Bay, the west arm of Filucy Bay, Von Geldern Cove, and Glencove have the potential to support commercial shellfish operations but are currently prohibited for harvest due to poor water quality.

Surf smelt, Sand lance, and Rock sole spawning areas may all be found in *Filucy Bay*. Volunteers performing surveys for *Adopt-A-Beach* identified the following bird species in the area: *Seagulls, Crows, Great Blue Heron, Cormorants, Bufflehead Ducks, Mallard Ducks, Widgeons, Grebes, and Kingfishers*. Volunteers also found *Shore Crabs, Limpets, Sea Slugs, Barnacles, Mussels, Worms, Oysters, Sand Fleas, Moon Snails, Clams, Ghost Shrimp, and Sand Dollars*.

Lakes and Wetlands

There are 20 identified lakes in the *Key Peninsula Subwatershed*. A complete list of all the lakes in the *KGI Watershed* (except for *Lake Minter-wood*) is located in APPENDIX "O". Some of the lakes in the subwatershed have some parameter which may cause them not to be classified as lakes. Two of these water bodies are near the shoreline and may be saltwater lakes, and as many as four of them may be large wetlands that have open water when there is enough rainfall.

Regardless of their definition, most of the lakes in the subwatershed are quite small; only *Bay Lake* is greater than 20-acres in size. All of the lakes are fairly shallow with *Jackson Lake* being the deepest at 30-feet. Fish use of many of the lakes is unknown.

The *Key Peninsula Subwatershed* has a vast number of wetlands associated with its water bodies (lakes, streams, shorelines) as well as those **occurring** by themselves, called palustrine wetlands. Wetlands are an integral part of a natural system to clean water, provide for flood control and wildlife habitat. Isolated incidents of residents changing wetlands, either by filling or draining, or changing the wetland to make a pond in their backyard, have been reported.

Streams

There are a number of small streams in the *Key Peninsula Subwatershed* but only those over one-mile in length and are characterized below.

General Description and Known Problems

The individual water bodies are characterized below:

- ***Vaughn Creek***

This one-mile-long stream flows in a southerly direction west of *Wright-Bliss KPN* and into *Vaughn Bay*. Its headwaters begin in an area that has three fairly large wetlands, two of which drain to this stream. The third wetland supplies surface water to a **stream** which passes through the community of *Vaughn* and into the

sound just outside the spit at the entrance to *Vaughn Bay*. Fish use of the unnamed stream is unknown, and there is no water quality data or habitat assessment. However, *Stream Team* volunteers have been monitoring *Vaughn Creek*, a small creek flowing into *Vaughn Bay* from the east. This information is given below.

Vaughn Creek's Streamwalk habitat assessment rating has been "Good" the last three surveys. The first rating was "Medium"; the major difference in this assessment was that pools and riffles in the stream were not noted. Bank conditions noted a severe impact from mud/silt/sand entering the stream.

Other impacts noted were artificial modifications to the banks, and algae/scum floating or coating the rocks (which may be attributed to the tides). Land uses noted were single-family residences, paved and unpaved roads, and recreation. All these notes for the most part are on each of the assessments, with the first being the only one to show the mud/silt/sand as severely impacting the stream.

Local residents and stream team volunteers have expressed concerns about one property owner in the middle of the stream reach who is creating ponds, diverting creek water, and dredging the creek. These activities are believed to be contributing to the high sediment levels and the lack of fish in the stream. Other than this one area, riparian cover over the creek is good.

Water quality data shows temperature, **pH**, and dissolved oxygen easily meeting state standards. There is no data for fecal coliform or turbidity. *Vaughn Creek's* discharge rate is low: 1.13 cubic feet per second on November 11, 1996. The stream flows from a series of wetlands, and macroinvertebrate sampling rated the site as moderate. Temperature data, taken during a summer of 1998 survey, ranged between 12.8 and 14.4°C. During the survey there was no water in the stream at the DNR road which crosses the creek. Nitrate levels, while not regulated by state standards, seem to be noticeably higher in this creek than in other creeks in the subwatershed. A sample taken on June 11, 1997 recorded a level of 12 mg/l.

Macroinvertebrate samples taken on this creek have generated one rating of "Poor", and two ratings of "Moderate".

Vaughn Bay remains closed to commercial shellfish harvesting due to high fecal coliform counts. *Vaughn Creek*, even if its fecal coliform counts were high, is most likely not the source of the pollution causing *Vaughn Bay's* closure because its discharge is so low. More data needs to be developed for the **unnamed** stream since it may have a greater flow, even though the **NWI MAP** shows it as being an **intermittant** stream. The surrounding land uses need to be confirmed.

- **Lackey Creek**

Lackey Creek flows southerly between the *Key Peninsula Highway* and *Cramer Road KPN*, emptying in to *Glen Cove*. As previously mentioned, the creek may not be 2.5 miles in length as stated in the WRIA **ATLAS**. The USGS **MAP** shows the creek being an intermittent stream beginning directly east from the top of *Lake Minterwood*. It has one intermittent tributary flowing below *Cramer Road*, and supports a run of *Chum* salmon and an unconfirmed report of *Coho*. The *Chum* run is particularly active with the stream providing about 3/4 of a mile of good spawning habitat.

Stream Team volunteers have been monitoring a site below the confluence of the streams for almost a year and report good flow even in the summer months. The discharge rate on July 7, 1996 was six-cubic feet per second, while the rate was ten-cubic feet per second on September 7, 1996, generally considered the low-flow time of year. Interestingly, a lower flow rate of 3.5-cubic feet per second was recorded on November 21, 1996.

Water quality data shows state standards being met for those tests administered except for dissolved oxygen (DO); results show levels hovering at or just below the minimum state standard for "Class A" waters of 8.0 milligrams per liter. Description of the streambed coating has ranged from greenish and yellowish to brown. An explanation for low DO levels and the coated streambed may be that the site is downstream too far and is getting interference from tidal action and saltwater (Go to the end of this chapter for an explanation of low DO levels in **Puget Sound**). Nitrates have been at undetectable levels in all samples taken.

A "Streamwalk" performed on March 16, 1996 gave the stream an "Excellent" rating. A macroinvertebrate sample was taken on June 1, 1996 and the **stream** was also rated as "Excellent". Thirteen distinct **taxa** were found totaling 181 organisms. The percentage of organisms needing higher levels of DO, ie. the **EPT** species which are mayflies, stoneflies, and caddisflies, was 92 %. Clearly, there is enough dissolved oxygen in the water for these important **macro-invertebrates**. The stream is currently in very good condition but the headwaters of the stream may be at risk for development in the near future.

- **Dutcher Creek**

Dutcher Cove, approximately halfway down the west side of *Key Peninsula*, receives the waters of 1.8-mile *Dutcher Creek*. The creek's headwaters, located near the end of *75th St. KPN* by the *Key Peninsula Highway*, are an intermittent stream flowing south-southwest until river mile one, then flowing west. A small stream having a dam and reservoir joins it just east of *Lackey Road*, and the main stem has an approximately 2.5-acre reservoir west of *Lackey Road*. *Dutcher Creek* has a *Coho* run and an unconfirmed report of a *Chum* run. There is no water quality data or habitat assessment, but a *South Puget Sound Salmon Enhancement* volunteer, rearing 10,000 *Coho* eggs annually, reports that the

habitat is very good with good canopy cover and not an inordinate amount of stormwater runoff (Manning *and Manning*, pers. comm., 1996). Surrounding land uses need to be confirmed but the creek ends near a new state park.

- **Unnamed stream south of Dutcher Cove (0028)**

This 1.2-mile stream has been modified by humans. The "Watershed Resource Inventory Area" (WRIA) and NWI_{MAPS} show a dam at the entrance to the bay where this stream empties. This may explain why this stream is unused by fish. Its headwaters, located near the intersection of *Lackey Road* and *Lackey Court KPN*, are an intermittent stream flowing southwesterly until halfway to the bay where it turns and flows westerly. At this bend there is an approximately 2.5-acre, open water wetland that has been excavated. It is not on the stream but may divert water from it. No water quality or habitat assessment data is available. Surrounding land uses need to be confirmed.

- **Unnamed stream northeast of Herron Island (0029)**

Flowing southwesterly from two fairly large wetlands near *32nd St. KPN* and *Jackson Lake Road KPN*, this 1.7-mile intermittent stream turns and flows northwesterly .4 miles before entering *Herron Bay* near where the ferry to *Her-t-on Island* lands. Fish use is unknown, and no water quality or habitat assessment data is available. In recent years, five-acre large lot residential housing has increased around the upper reaches of the stream and wetlands, but surrounding land uses need to be confirmed.

- **Schoolhouse Creek, north of Longbranch (0036)**

This creek is listed in the WRIA book as being 1.3 miles in length, but the NWI_{MAP} shows the creek stopping well before the large wetlands north of *Erickson Road KPS* which drain to this creek. Whether tied hydrologically to the wetlands above or below the surface, *Schoolhouse Creek* follows *Ericson Road KPS* where it turns south and heads toward the northwest finger of *Filucy Bay*. The point where the creek passes underneath *Ericson Road* has been the site of a restoration project funded by the *South Puget Sound Salmon Enhancement* group, in cooperation with the *Washington State Department of Fish and Wildlife*. The volunteers have built and rebuilt a series of three weirs providing pools for migrating fish to successfully navigate past the culvert under *Ericson Road*. The creek supports a run of *Coho* and an unconfirmed run of *Chum* salmon.

Stream Team may have a site upstream, but no water quality or habitat assessment data is available, and surrounding land uses need to be confirmed. *Stream Team* may also have a site on a smaller stream beginning south of *Bay Lake* and flowing into the northern end of *Filucy Bay*. This part of *Filucy Bay* is closed to commercial shellfishing because of the high fecal coliform count. It would seem worthwhile to monitor both of these streams.

Specific Problems

The *Washington State Department of Ecology* (Ecology) has three “Marine Waters Monitoring Stations” located in and around the coastal waters of the *Key Peninsula Subwatershed*. Monthly readings are taken at these stations for a period of three years and are then moved elsewhere. The three stations began collecting data in 1996 and are located between *Burley Lagoon* and *Minter Buy*, off the southern tip of *Hen-on Island*, and off *Green Point*, northwest of *Fox Island*.

Data collected from these stations put *Henderson Buy*, *Case Inlet*, and *Carr Inlet* on *Washington State’s* 1996 **SECTION 303 (D) LIST** which, in accordance with the “Clean Water Act”, lists water bodies not meeting state water quality standards. All three failed to meet state standards for fecal coliform, *Can- Inlet* and *Case Inlet* failed to meet dissolved oxygen (DO) standards, and *Case Inlet* failed to meet pH standards. The natural DO concentrations in *Puget Sound* are generally lower because its waters are upwelled *Pacific Ocean* waters which have lower DO concentrations, particularly in late summer. This may explain the failures for DO standards, but the numbers for fecal coliform may signify a wider concern. *Ecology* states the monitoring stations are typically located in the middle of the water body being monitored and away from the shoreline. “Also, the near-shore areas of many of the inlets may have fecal contamination when mid-bay monitoring stations do not, as was shown by the data from *Carr and Case Inlets*. Because of the relatively short life span of fecal coliform bacteria in saline water (*Lessard and Sieburth, 1983*), mid-bay monitoring (e.g., MWM stations) is not well-suited to detecting fecal contamination. ” (*Jan Newton and the Marine Waters Monitoring Team, Ambient Monitoring Section, 1996.*)

Streams on the 1994 **SECTION 303 (D) LIST** in this subwatershed include six small drainages sampled during the “Penrose Point Protection Project.” The *Tacoma-Pierce County Health Department* (TPCHD) is continuing to seek funds to implement the projects recommendations, and at the time of this writing, has not posted signs warning against the collection of shellfish at *Mayo Cove* or anywhere else in the subwatershed. However, *Mayo Cove* and other recreational beaches may be closed seasonally or indiscriminantly to protect the resource and to prevent overharvesting.