CHAPTER 6

NONPOINT SOURCE POLLUTION ANALYSIS

INTRODUCTION

The major water bodies near the Irondale and Port Hadlock ~~DISTRICT~~ UGA are Port ~~Ludlow~~ Townsend Bay that extends from the straits of ~~Admiralty Inlet~~ Juan de Fuca to ~~the inlet of Ludlow Creek.~~ Port Hadlock and Chimacum Creek, which originates in the ridges and valleys south of the UGA and flows through the UGA and into Port Townsend Bay. The surface water features in this region play a part in its natural beauty and rich heritage. Fish and wildlife habitat, clean water, and aesthetic appeal are benefits of the surface water resources, which must be managed to wisely protect their value. Without proper stormwater management, urban runoff may degrade these surface water resources.

The National Marine Fisheries Service (NMFS) has listed a number of salmonid species that use Puget Sound and Hood Canal as part of their habitat. As mentioned in Chapter 3, the Puget Sound Chinook and Hood Canal summer Chum Salmon are listed as threatened under the Endangered Species Act (ESA). In addition, the United States Fish and Wildlife Service (USFWS) has listed the Bull Trout as threatened. Measures must be taken to comply with the regulations protecting these species. These measures include preventing further degradation of their habitat from nonpoint source pollutants such as stormwater runoff.

Stormwater is defined as the runoff from residential, commercial, and other urban areas. As rain falls and runs off of urban surfaces pollutants transported to surface waters where they may damage aquatic organisms and reduce the aesthetic value of the water body.

Nationwide, approximately 30 percent of water quality problems have been attributed to stormwater runoff. Many sources of stormwater pollution are uncontrolled. Sources of nonpoint pollution are numerous, varied and hard to detect, but their cumulative effect on water quality and habitats can be significant.

UGA WATER QUALITY SAMPLING

Jefferson County conducted water quality sampling of stormwater runoff from two locations in the UGA: the outfall of the Port Hadlock Core storm sewer system and the outfall from Moore Street in Irondale. Grab samples were taken during rain events and analyzed at an accredited laboratory. The results are presented in Table 6-1 below.

TABLE 6-1

Irondale - Moore Street Stormwater Runoff
Water Quality Sampling Results – October 20, 2003

Parameter	Site 1*	Site 2**	National Average Value***
Chromium	0.004 mg/L	0.004 mg/L	0.004 mg/L
Copper	0.009 mg/L	0.009 mg/L	0.033 mg/L
Lead	<0.004 mg/L	<0.004 mg/L	0.144 mg/L
Zinc	0.013 mg/L	0.008 mg/L	0.162 mg/L
Fecal Coliform	450 cfu/100ml	375 cfu/100ml	15,000 cfu/100ml
Oil and Grease	ND	ND	3 mg/L
TKN (Nitrogen)	<1.5 mg/L	<1.5 mg/L	2.4 mg/L
Total Phosphorus	0.22 mg/L	0.17 mg/L	0.38 mg/L

*Site 1 is the outfall of the cross culvert at the end of Moore Street.
**Site 2 is the outfall of the drainage swale, above the beach.

Port Hadlock Core Storm Sewer System Runoff
Water Quality Sampling Results – December 4, 2003

Parameter	Value	National Average Value***
Chromium	0.027 mg/L	0.004 mg/L
Copper	0.078 mg/L	0.033 mg/L
Lead	0.022 mg/L	0.144 mg/L
Zinc	0.0314 mg/L	0.162 mg/L
Fecal Coliform	500 cfu/100ml	15,000 cfu/100ml
Oil and Grease	ND; est. 3.6 mg/L	3 mg/L
TKN (Nitrogen)	2.45 mg/L	2.4 mg/L
Total Phosphorus	0.82 mg/L	0.38 mg/L
Total Suspended Solids	272 mg/L	78 mg/L

***Source: Center for Watershed Protection, 2003 and EPA, 1999

mg/L: Milligrams per liter
cfu/100ml: colony forming units per 100 milliliters
ND: Not Detected (below analytical detection; value represents an estimate)

The water quality samples collected by Jefferson County indicate that stormwater runoff being discharged to Port Townsend Bay and (in the case of the Port Hadlock Core system) to groundwater contains metals, oil and grease, fecal coliform bacteria, nitrogen,

phosphorus, and suspended solids. These are typical pollutants associated with urban runoff. The concentrations measured are well within the range of normal for stormwater.

Due to the relatively low level of development in the UGA, there is not a high volume of stormwater being discharged into Port Townsend Bay. Thus, the overall impact on water quality in the Bay associated with storm sewer outfalls appears to be limited. High fecal coliform counts have been reported in Port Townsend Bay during the summer. Based on the levels, timing, and location, they do not appear to be associated with runoff from the Port Hadlock storm sewer system or Moore Street.

Nonetheless, the pollutant concentrations are sufficiently high that runoff treatment should be provided. In order to accomplish this goal, the County should coordinate with the Washington Departments of Transportation and Fish and Wildlife and with private landowners to plan, design, fund, and construct treatment facilities at both locations.

IMPACTS TO WATER QUALITY

Pollutants discharged in stormwater are largely uncontrolled. In the Puget Sound area, stormwater has been estimated to contribute about 7 percent of the total flow from all point and nonpoint sources but about 60 percent of the total lead, 30 percent of the total zinc, and nearly all of the total fecal coliform bacteria. Research in western Washington has shown that the concentrations of many pollutants found in stormwater from residential, commercial, and industrial areas exceed water quality criteria.

The National Water Quality Inventory, 1986 Report to Congress (EPA 1986), concluded that diffuse sources of water pollution, including runoff from urban areas, are the leading cause of water quality impairment.

The Nationwide Urban Runoff Program (NURP), (EPA, 1983), included extensive field monitoring throughout the United States to characterize urban runoff flows and pollutant concentrations. Listed below are the conclusions reached in the NURP Study:

1. Heavy metals (especially copper, lead and zinc) are the most prevalent priority pollutants.[1]

[1] Due to the lack of intense agriculture in the vicinity of Irondale & Port Hadlock, runoff from the area is relatively residential in nature, with minimal biochemical oxygen demand (BOD) in most areas.[1] ~~In Port Ludlow, low to undetectable amounts of dissolved and total metals were found in the 2001 Port Ludlow Non-Point Monitoring Program Report.~~

2. The organic priority pollutants were detected less frequently and at lower concentrations than the heavy metals.

3. Coliform bacteria are present and can be expected to exceed EPA water quality criteria during and immediately after storm events.

4. Nutrients are present, but typical concentrations are not high.

5. Oxygen demanding substances are present at concentrations approximating those in secondary treatment plant discharges.[1]

6. Total suspended solids (TSS) concentrations are fairly high in comparison with treatment plant discharges.

The effects of the pollutants listed above on receiving waters are site-specific, however, the following generalities can be assumed:

- Urban runoff produces frequent exceedances of ambient water quality criteria for heavy metals on freshwater aquatic life. Metals content in Port Hadlock stormwater runoff should be significantly lower than most cities, due to the lower population and relatively low traffic volumes.

- Copper, lead, and zinc pose a significant threat to aquatic life uses in some areas of the country. Copper is suggested to be the most significant of the three.

- Organic priority pollutants typically are not a threat to freshwater aquatic life.

- Bank erosion and streambed scour can be significant causes of habitat disruption.

- Sediment contamination can be attributed wholly or in part to urban runoff.

- Coliform bacteria are typically present at high levels and may exceed EPA water quality criteria during and immediately after storm events in most rivers and streams.

- Adverse effects of urban runoff in marine waters are highly specific to the local situation. Though estuaries and embayments were studied to a very limited extent in NURP, they were not believed to be generally threatened by urban runoff. Coliform bacteria are the primary concern, causing direct impacts on shellfish harvesting and beach closures.

The conclusions reached by the NURP study indicate that sedimentation, erosion and bacterial pollution are the pollutants of most concern in stormwater runoff. The Bellevue, Washington NURP project concluded that habitat changes associated with streambed scour and sedimentation produced by urbanization were more significant than pollutant concentrations.

WATER QUALITY STANDARDS

The following discussion focuses on the criteria used to evaluate water quality contaminants, and sources most common in runoff. Documented problems in the Irondale & Port Hadlock areas are identified later in this chapter. Appropriate strategies for addressing problem areas and reducing adverse impacts are then summarized.

Stormwater runoff constitutes the primary transport mechanism for nonpoint pollution. Pollution problems associated with land use and development encompass typical pollutants such as pesticides, fertilizers, and petroleum products. A further problem stemming from residential, commercial, and industrial land uses is the higher volume of runoff because of the higher percentage of impervious area. In developed areas, certain pollutants are more prevalent that in undeveloped areas. Pollutants accumulate in surficial soils and on paved surfaces from vehicular emissions, atmospheric deposition, spills, leaks, improper waste storage/disposal practices, and fertilizer/pesticide application. They are then washed off the land surface during subsequent storm events and transported via stormwater runoff to nearby water bodies or infiltrated to shallow groundwater.

Although these types of nonpoint pollution can be attributed to an individual source, their intermittent nature makes them difficult to identify and control. For the purposes of this report, these discharges have been considered nonpoint pollution sources. Parameters that define nonpoint pollution are discussed below in terms of state standards and potential sources.

PARAMETERS OF CONCERN

There are numerous water quality parameters that are affected by stormwater runoff including sediment, nutrients, and metals; oxygen demanding and inert material; particulate and dissolved substances; chemical, biological, and physical; toxic and nontoxic; and organic and inorganic. Many specific pollutants are incorporated into one classification if their effects on receiving water are similar. Receiving water can assimilate a limited quantity of each, but there are thresholds beyond which the measured amount becomes a pollutant and results in an undesirable impact.

Human health considerations for fresh water can be monitored through the analysis of conventional water column parameters. The following section provides a brief description of contaminants, likely sources, and potential environmental effects.

Dissolved Oxygen (DO) is necessary in water to maintain aquatic life. In the oxidation of organic matter by biological activities, oxygen from water is used. Low DO problems result when the rate of oxygen-demanding material exceeds the rate of replenishment. DO levels are especially important during summer when low stream flows and high

temperatures make oxygen less available to aquatic life. Dissolved oxygen concentrations may also become critical when wastes that require oxygen for decomposition enter the water. In addition to diurnal variation, DO also varies with season and stream site. These natural variations are caused by differences in such things as light intensity, nutrient levels and hydrogeological conditions. Natural variation can also be caused by water sources. Groundwater or water draining bogs and marshes will typically have lower DO concentrations. Fish kills and reduction in aesthetic values have resulted from low-DO conditions.

pH impacts chemical and biological systems of natural waters. Similar to DO, pH responds to natural environmental factors. Changes in pH affect the degree of dissociation of weak acids and bases, which affect the toxicity, reactivity, and solubility of many compounds. Diurnal variations in pH occur as a result of changes in production and respiration rates and different water sources such as groundwater or water draining wetlands.

Temperature extremes affect stream productivity and eventually may result in loss of aquatic life. Temperature also affects stream chemistry, specifically the solubility of oxygen, carbon dioxide and metals, and varies diurnally and seasonally.

Turbidity is not a measurement of mass or concentration; it is a water quality attribute. Therefore, it can not be used as a quantitative measure to calculate loadings, but is used qualitatively to compare against a standard. Turbidity responds to physical factors such as runoff, proximity to exposed erodible soils, and stream flow.

Nutrients are chemicals that stimulate the growth of algae and water plants. Typical sources include detergents, fertilizers, septic system effluent, and manure. The primary nutrients of concern are nitrogen and phosphorous. Forms of nitrogen include ammonia, nitrite, and nitrate. The typical nutrient concentrations in stormwater runoff are often more than sufficient to stimulate the growth of algae and plant species. The increased algal activity will initially raise DO levels. Once decomposition of dead algae begins, DO levels drop, surface algal scums form, and water discoloration and odors may occur.

Nitrogen and phosphorus are the principal nutrients for algae and other plants in fresh water ecosystems including wetlands, streams, and lakes. Phosphorus is often the controlling nutrient for algae growth in fresh waters. A large input from nonpoint sources can result in algal blooms that can affect recreational use and reduce the overall quality of receiving waters. Nitrogen can affect the trophic status of receiving waters. It is also an important parameter for waters used as drinking water supplies.

Pathogens/bacteria commonly refer to fecal coliform bacteria, which are found in the intestinal tracts of warm-blooded animals, including humans. Concentrations of fecal

coliform bacteria in surface waters have historically been used as an indicator of water-borne pathogenic bacteria or viruses. Therefore, fecal coliform bacteria concentrations are used as indicators of potential public health concerns. High levels can indicate failing septic systems, poor livestock management practices, poorly operated wastewater treatment systems, poorly maintained municipal storm and sanitary sewers, and other point or nonpoint sources.

High oil and grease concentrations are associated with urban and industrial stormwater runoff. In addition to representing a water quality problem, they can also serve as indicators of a wide array of hydrocarbon compounds that can be toxic to aquatic life at low concentrations. Typically, oil and grease concentrations are low in receiving waters and are usually associated with runoff events.

Total suspended solids originate from soil erosion. Sediments washed off paved surfaces are transported by runoff and discharged to receiving waters. Land-clearing activities associated with urban development as well as poor livestock and crop management can accelerate soil erosion and increase sediment transport to receiving waters. Timber harvest and the conversion of forestland to other uses can result in sedimentation, increases impervious surfaces and accelerated stormwater runoff. As the total volume and peak rate of stormwater increases, scouring occurs in stream channels, thereby increasing the suspended solids loading in the stream.

Metals commonly found in stormwater runoff from road surfaces and parking areas that are of concern include lead, zinc, copper, chromium, arsenic, cadmium, and nickel. Other potential sources of metals originate from commercial car washes, auto repair facilities, and industrial operations. Most metals are adsorbed onto suspended solids present in the runoff and are probably not toxic to aquatic life.

Toxic organic compounds include a variety of contaminants such as pesticides, petroleum hydrocarbons, and volatile organic compounds. Potential nonpoint sources of these contaminants include urban and agricultural runoff, hazardous substance spills, improper disposal of waste products, and industrial discharges. Compounds that are most frequently found in runoff include phosphates, polyaromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and some pesticides. The availability of toxic organic compounds is difficult to determine because of their adsorption to particulate matter. Particulate-bound contaminants are usually flushed out of the receiving system during high stormwater flows.

Organic material is an integral component of topsoil. The organic content of soil is primarily produced by microorganisms during the degradation of dead plant and animal material. The microbial degradation of organic matter in aerobic systems results in the consumption of oxygen. Waters high in organic matter may experience depressed oxygen concentrations relative to concentrations at saturation.

CRITERIA

Water quality standards for surface water in Washington State are established in Chapter 173-201A WAC. Standard criteria allow for comparison of the data of interest to a safe or desired concentration or level. Management practices that violate established standards are subject to further investigation and ultimately appropriate corrective measures.

The Department of Ecology has responsibility for managing the state's water resources which are classified into five classes for surface water: Class AA (extraordinary), Class A (excellent), Class B (good), Class C (fair), and Lake. Specific surface water bodies are classified under WAC 173-201A-130 or 173-201A-140. All unclassified surface waters that are tributaries to Class AA waters are classified Class AA. All other unclassified surface waters within the state are classified Class A. The water quality standards for Class AA and Class A and Lake Class waters are shown in Table 6-2, 6-3 and 6-4.

The State of Washington classifies Chimacum Creek as Class A fresh water. ~~s.~~ Port Townsend Bay is classified as Class AA Marine water. ~~According to~~

In addition to the water quality parameters listed in Table 6-2, concentrations of toxic substances, such as organic compounds and metals, must not exceed standards specified in WAC 173-201A-040. These standards are based in the U.S. Environmental Protection Agency (EPA) Quality Criteria for Water (1986), which are derived from federal water quality criteria based on aquatic toxicology.

The WAC defines both acute and chronic criteria for toxic substances. Acute toxicity criteria are based on death percentages of test organisms within 24 hours. Chronic toxicity criteria are defined as the concentration that causes long-term adverse effects on an organism's functions.

Water quality criteria for nutrients are not defined in federal or state regulations for surface water. However, because of their influence on algal growth in surface waters, nitrogen and phosphorus are the nutrients of greatest interest in stormwater runoff. Phosphorous is often the limiting nutrient for growth of plants in freshwater systems. Phosphorous enrichment can, therefore, result in the excessive algal blooms and associated nuisance conditions in streams and lakes. The general threshold for eutrophic conditions in lakes is 20 ug/l total phosphorous. Criteria for defining eutrophic thresholds in streams do not exist. However, soluble phosphorous in the range of 15 to 25 ug/l promotes nuisance conditions in streams.

TABLE 6-2

Water Quality Criteria for Class A Waters (WAC 173-201A-030(2))

Parameter	Criteria
Fecal coliform	Freshwater - fecal coliform organisms shall not exceed a geometric mean value of 100 organisms/100mL, with not more than 10 percent of samples exceeding 200 organisms 100/mL.
Dissolved oxygen	Freshwater - dissolved oxygen shall exceed 8.0 mg/L.
Total dissolved gas	Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.
Temperature	Temperature shall not exceed 18.0 degrees C (freshwater) due to human activities.
pH	pH shall be within the range of 6.5 to 8.5 (freshwater) with a man-caused variation within a range of less than 0.2 units.
Turbidity	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Toxic, radioactive, or deleterious material	Toxic, radioactive, or deleterious material concentrations shall be below those that may adversely affect characteristic water uses, cause acute or chronic conditions to the aquatic biota, or adversely affect public health.
Aesthetic values	Aesthetic values shall be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

TABLE 6-3

Water Quality Criteria for Class AA Waters (WAC 173-201A-030(1))

Parameter	Criteria
Fecal coliform organisms	Freshwater - fecal coliform organisms shall not exceed a geometric mean value of 50 organisms/100 mL, with not more than 10 percent of samples exceeding 100 organisms/100 mL.
Dissolved oxygen	Freshwater - dissolved oxygen shall exceed 9.5 mg/L.
Total dissolved gas	Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.
Temperature	Temperature shall not exceed 16.0 degrees C (freshwater) due to human activities.
pH	pH shall be within the range of 6.5 to 8.5 (freshwater) with a man-caused variation within a range of less than 0.2 units.
Turbidity	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.
Toxic, radioactive, or deleterious	Toxic, radioactive, or deleterious material concentrations shall be below those, which may affect material concentrations adversely, affect characteristic water uses, cause acute or chronic conditions to the aquatic biota, or adversely affect public health.
Aesthetic values	Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Groundwater standards in the state of Washington are listed in Chapter 173-200 WAC. The standards establish criteria for maximum contaminant concentrations in terms of primary and secondary contaminants and radionuclides based on human health-based criteria. Special protection area can be designated because of wellheads and recharge areas that are vulnerable to pollution because of hydrogeologic characteristics and sole source aquifer status by federal designation. The Jefferson County Public Utility District has a well-head protection area for its well located at SR 19 and Kennedy Road in the UGA.

The general impacts of non-point sources on beneficial uses that are likely to be of concern to water bodies in or adjacent to the UGA are indicated in Table 6-4.

TABLE 6-4

General Impact of Nonpoint Sources Likely to be of Concern to the Irondale & Port Hadlock UGA

Body	Key Pollutants	Affect on Water	Affected Uses
Streams	Sediment/suspended solids	Turbidity deposition in stream pools and wetlands	Loss of flood control capacity, degraded fish habitat, loss of wetland cleaning ability, visual pollution
	Hydraulic erosion	Streambank loss sediment deposit downstream	Damage of private and public property and fish habitat
	Bacteria/viruses	Contamination	Swimming
Groundwater	Nitrates	Loss of use as a drinking water supply	
	Toxic organics	Cancer, related diseases	
	Bacteria/viruses	Contamination	

EXISTING BACKGROUND WATER QUALITY SURVEYS

The Department of Ecology is required to perform a total maximum daily load (TMDL) evaluation, and complete either or both a waste load allocation (WLA) for point sources and a load allocation (LA) for nonpoint sources in water quality-limited areas. The basic goal of the TMDL/WLA procedure is to bring water bodies back into standards compliance by limiting pollutant loading based on the characteristics of the water bodies, rather than by the limits capable from the usual source treatment processes. Irondale and Port Hadlock are included in the 400,000 acre Water Resource Inventory Area (WRIA) No. 17 as designated by the EPA. In general, water quality problems in this WRIA include summer high temperatures, low dissolved oxygen levels and high fecal coliform counts in streams and lakes.

SOURCES OF NONPOINT POLLUTANTS

The major types of nonpoint pollution sources in the Irondale & Port Hadlock UGA area are related to urban development and transportation-related activities. Other important sources of nonpoint pollution may include illicit connections to the storm drain system, on-site sewage systems, and improper waste storage and disposal practices.

URBAN DEVELOPMENT

Commercial development in the UGA includes numerous small and medium-sized businesses. Potential sources of pollution from these developments include oil and grease, suspended solids and metals from the parking lots, bacterial loads and garbage from improper waste storage and disposal practices at the grocery stores and restaurants, oil and grease and petroleum hydrocarbons from boat yards and fertilizers, pesticides and herbicides from landscaping activities.

The runoff from commercial development is most likely contributing metals, such as cadmium and lead, to stormwater runoff. These contaminants are produced by dryfall from vehicle emissions, vehicle wear and tear, and chemical products. Other contaminants that may be associated with the commercial establishments in the UGA include toxic organic compounds such as pesticides and polyaromatic hydrocarbons (PAH). Volatile organic compounds such as solvents may also be present in urban runoff and are typically associated with spills and improper waste disposal activities. Improper chemical storage and waste disposal practices are common sources of contaminates migrating off-site from commercial and industrial establishments. The improper use of garbage dumpsters, such as exposing the contents to rain or depositing garbage on the ground rather than in the dumpster, are potential sources of stormwater pollution.

Throughout the UGA, undeveloped land is being converted to residential and commercial use. The construction-related activities of land clearing and site preparation are potential sources of stormwater pollution. Areas that have been cleared of vegetation are more prone to erosion and can significantly increase sediment loading to nearby water bodies. Sediments can be deposited in natural and constructed channels, thereby reducing the hydraulic capacity. The efficiency and capacity of associated stormwater control structures such as culverts, pipes, and detention facilities will also be affected by the deposition of sediment.

The amount of stormwater runoff usually increases during construction activities as vegetative cover is removed. Leaf interception and infiltration provide a natural detention benefit while plant roots generally improve a soil's water holding capacity. When vegetation is removed from an area, the total runoff volume and peak runoff rate increases, which can erode streambanks and accelerate channel scouring. This in turn can damage property, destroy riparian habitat and degrade water quality.

In addition to soil erosion, other pollutants can also be generated by building activities. Pesticides, fertilizers, petroleum products, cleaning solvents, paints, asphalt by-products, acids, and salts as well as solid wastes are potential sources of stormwater pollution if improperly handled on a construction site. The pouring and finishing of concrete on a construction site can also adversely affect water quality by potentially increasing the pH of the water to toxic levels, which may threaten aquatic life.

The impact of increased development on stormwater pollution does not stop after construction. The volume of stormwater runoff and peak discharge rate increases as a direct result of the increase in the amount of impervious area. Higher flow rates accelerate bank erosion and scour in the receiving systems, which result in an increase in sediment deposition further downstream. Higher flow rates can also cause localized flooding where the carrying capacity of natural streams and piped conveyance systems is exceeded. The pollutant load of stormwater in residential areas also increases as development increases. The potential pollutant sources in residential areas include fertilizers, pesticides and herbicides from landscaping activities, biological loads from pet wastes, waste oil disposal from vehicle maintenance activities, improper disposal of household and yard wastes and illegal connections of sanitary sewers to the storm sewer system.

Urban development can severely impact wetlands in several ways. Development often includes the filling in of wetlands. When increased stormwater flows due to development are directed to a wetland area the hydrologic regime of the wetland may be altered which may lead to the destruction of the wetland. Nutrient pollution from urban development may impact wetlands by promoting the growth of nuisance plants and pesticide, herbicide or fertilizer pollution from urban development may destroy wetland plants. Organic pollution from urban development may increase the oxygen demand in wetlands that may lead to destruction of existing ecosystems.

HIGHWAYS

Stormwater runoff from State highways, as well as County collectors and residential streets can contain elevated concentrations of metals, suspended solids, and organic compounds such as petroleum hydrocarbons. Studies have shown that pollutant loading is directly related to the amount of vehicle traffic during the storm (Horner and Mar, 1982). Major highways with high vehicle use can be significant sources of nonpoint pollutant loading. Sanding in the winter further contributes sediment to the drainage system. Major thoroughfares in the UGA include State Highway 19 and 116, Chimacum Road, and Irondale Road.

DOMESTIC ACTIVITIES

Nonpoint pollution from domestic activities in the UGA consists primarily of pet waste and runoff from residential gardens and landscaping. Pet wastes are likely the most significant source of nonpoint pollution from residential activities. Runoff laden with animal wastes, fertilizers, pesticides, or herbicides can contribute to non-point pollution.

OTHER ISSUES

In addition to the ~~known~~ pollutant sources discussed above, the following sources may are occur:

- Lack of preventive maintenance of stormwater facilities.
- Pollutant wash-off from car and truck parking areas.
- Dumping of used motor oil into the UGA's storm drainage system or on the ground.
- Nutrient loading due to excessive fertilizer usage.
- Bacterial contamination from pet wastes that are not "scooped."