

PORT LUDLOW DRAINAGE DISTRICT

JEFFERSON COUNTY, WASHINGTON

COMPREHENSIVE STORMWATER MANAGEMENT PLAN



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CHAPTER 1

INTRODUCTION

For many years stormwater management has meant controlling water quantity and the inundating effects of large storm events. However, more recently, the cumulative effects of smaller storms have been recognized as a major contributor to water quality degradation.

Stormwater runoff carries excessive amounts of sediment from exposed construction sites and pollutants from residential, commercial, and industrial developments. Pollutants in stormwater runoff include metals such as lead, cadmium, and copper; oil and grease; pesticides and fertilizers; and harmful bacteria. In addition, the high rates of urbanization have increased the amount of impervious surfaces such as rooftops, streets, and parking areas. Impervious surfaces directly relate to an increase in runoff volumes and peak rate flows. The pollutant loads and increased volumes of stormwater runoff results in negative impacts to downstream properties, downstream water bodies such as local streams and Puget Sound, and reduced infiltration to groundwater. Due to regulations required under the Clean Water Act as well as the current and potential future listing of anadromous (salmon, trout, char) species under the Endangered Species Act, it has become increasingly more important for municipalities to implement stormwater control measures.

PURPOSE

The purpose of the Port Ludlow Drainage District's Comprehensive Stormwater Plan is to provide the District with a stormwater planning document that includes Jefferson County ordinances and programs necessary to fulfill the requirements of a comprehensive stormwater program. The plan will additionally identify specific structural and non-structural solutions to known flooding and water quality problems that currently exist within the District. Structural solutions include detention ponds, pipe, ditch maintenance, etc. Non-structural solutions include encouraging low impact development, catch basin stenciling, and education. The Comprehensive Stormwater Plan will meet local, state, and federal stormwater requirements; identify water quality and quantity problems associated with surface water runoff that may endanger the environment and community; and provide recommendations for improvements including a cost analysis and an implementation schedule.

This plan will meet the stormwater provisions recommended by the Washington State Department of Ecology (Ecology). Other important elements of a stormwater program include operation and maintenance ordinances and a technical manual for structural and non-structural control measures. To meet the technical manual requirement, the Port Ludlow Drainage District formally has adopted the latest version of Ecology's

Stormwater Management Manual for Western Washington (August 2001) and all subsequent updates relating to this manual. The District will request Jefferson County to formally adopt the Port Ludlow Drainage District Stormwater Comprehensive Plan. This will provide the District and the County a means of reviewing projects within the District to ensure compliance with stormwater regulations.

The District may include additional measures to control stormwater runoff for projects that fall below the threshold outlined in the manual. Included in this comprehensive plan are best management practices (BMP) for the addition of impervious area less than 5,000 square feet. These measures are included in Appendix B.

WATER QUALITY AND QUANTITY GOALS

The primary goal of the District's Stormwater Comprehensive Plan is to preserve and protect water quality and the hydraulic regime within the District's drainage basins and the receiving waters of Port Ludlow Bay.

The Port Ludlow Drainage District currently experiences flooding during moderate to large storm events. During the wet season, the District generally experiences nuisance flooding in yards, streets, and residences. The main reason for the flooding is due to poorly maintained or undersized conveyance system and development of lots that do not properly consider stormwater runoff. In addition, in certain large areas of the District the underlying soils have very low permeability, thus preventing infiltration of surface water. As additional development occurs within the District limits, the amount of impervious surfaces will increase which will ultimately increase peak surface-water runoff rates.

To this end, the District intends to manage stormwater to minimize contact with contaminants, mitigate the impacts of increased runoff due to major build-out and development within the District's drainage areas, provide management of runoff from large and small construction sites, and to preserve wildlife habitat. These efforts would meet District goals to protect the health, safety, and welfare of the local citizenry and to preserve surface water resources within the Port Ludlow Drainage District. The District will work with Jefferson County to provide planning.

PLANNING PERIOD

The planning period for this document has a ten-year planning horizon, which runs from 2003 through 2013. However modeling of runoff is completed for completely built-out conditions within the District.

SCOPE OF WORK

Gray & Osborne, Inc. (Engineer) will develop a Comprehensive Stormwater Plan that meets the State’s recommendations and guidelines for stormwater practices as developed in the Department of Ecology’s “*Stormwater Management Manual.*” The scope of work for this plan includes the following agreed-upon tasks:

PORT LUDLOW DRAINAGE DISTRICT COMPREHENSIVE STORMWATER PLAN

Task 1 – Identify System Components (Chapter 4)	
a)	Use existing maps and as built plans to identify the drainage network and flow direction of stormwater. Verify and augment the data with field survey.
b)	Generate a stormwater base map showing all publicly owned facilities.
Task 2 – Delineate Drainage Basins and Land Use (Chapter 5)	
a)	Using land use and topographic maps, soils surveys, geologic information, and field surveys, define the drainage sub-basins in the District basins and the location of each in relation to the drainage network. Identify land use.
b)	Transfer the above data onto the stormwater base map to be used in the analysis of the system.
Task 3 - Determine the Existing Level of Maintenance (Chapter 4)	
a)	Perform field surveys to gather information on the level of maintenance currently being provided by the Jefferson County and developer. Assess the level of maintenance being performed by private owners of stormwater facilities.
b)	Discuss with maintenance personnel the schedule and activities performed for stormwater maintenance. Assess areas of need. Discuss with District staff a desired level of maintenance.
c)	Develop a maintenance schedule, procedure and costs for performing facilities maintenance.
Task 4 - Model Stormwater Flows (Chapter 5)	
a)	Using the information gathered above, model the existing system for the design storms defined in the Stormwater Management Manual for Western Washington, August 2001.
b)	Using information from the Jefferson County’s planning documents, determine runoff for future conditions. Model the system for future conditions.
c)	Evaluate the impact of the runoff flows on the existing system.
d)	Install a rain gauge and flow meters during dry and wet weather to obtain flow data.
e)	Using actual flow data, calibrate the model and make adjustments as necessary.
f)	Evaluate the conveyance performance of the system.

Task 5 - Identification of Water Quality Problems (Chapter 6)	
a)	Perform field surveys to identify areas that are possible sources of pollution. Specifically evaluate erosion control practices, thoroughfares, development, and commercial activities. Distinguish point and non-point sources of pollution.
b)	Identify water quality problems in runoff and receiving waters.
Task 6 - Identify Conveyance Problems (Chapter 5)	
a)	Using data from the model, and information from field surveys and interviews, identify portions of the drainage network that are not capable of conveying the design storm. Evaluate possible flood damage to life and property.
b)	Evaluate the probability of water quality related problems such as erosion, sedimentation and pollutant transport due to conveyance system deficiencies.
Task 7 - Identify Possible Solutions (Chapter 5)	
a)	Develop design standards and policies to be implemented for water quality. Use information from other jurisdictions, agencies, and academic and research organizations to institute the appropriate Best Management Practices.
b)	Propose facilities improvements for conveyance problems, including costs.
c)	Propose facilities improvements for water quality problems, including costs.
d)	Develop a public involvement plan that may involve water quality monitoring, volunteer projects for trash cleanup, storm drain stenciling and education field activities.
e)	Develop a stormwater ordinance to be presented to District and County Commissioners for adoption. The stormwater ordinance will address erosion control practices, water quality control and water quantity control measures.
Task 8 – Capital Improvement Plan (Chapter 8)	
a)	Based on the improvements recommended in Task 7 propose a schedule of capital improvements for the six-year and ten-year planning horizon. Provide funding options, rate adjustments and priorities for improvements.
Task 10 – Presentation to District Commission, Jefferson County Commission and Public	
a)	Present the Stormwater Comprehensive Plan. Describe the methodology used to model the system. Describe the improvements necessary, how they were prioritized and the alternatives for scheduling improvements. Discuss funding for each project.
b)	Prepare a SEPA checklist
c)	Conduct two (2) public workshops. Revise plan as necessary based on public comment.

Task 11 - Stormwater Management Plan	
a)	Prepare final version of plan based on public comment and District Commission direction.
b)	Present to District Board of Commissioners for adoption.

LIST OF PREVIOUS REPORTS

The following documents were used to provide background information for the development of the Port Ludlow Drainage District's Stormwater Comprehensive Plan:

2001 Annual Report on the Port Ludlow Area Groundwater Monitoring Program, for Port Ludlow Associates, LLC by Robinson & Noble, Inc., February 2002.

Jefferson County Comprehensive Plan, Jefferson County, 1998.

Port Ludlow Non-Point Monitoring Program 2001 Report, Aquatic Research, Inc., February 25, 2002.

Port Ludlow North Bay Drainage Analysis, prepared for Olympic Resource Management by Gardner Consultants, November 1999.

Stormwater Management Manual for the Puget Sound Basin, Washington State Department of Ecology, February 1992.

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

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CHAPTER 2

REGULATORY CONSIDERATIONS

INTRODUCTION

Stormwater drainage planning and construction has historically been provided for the purposes of keeping stormwater away from structures and property so that the property can be drained and protected from damage due to stormwater runoff. Local and state governments have installed the majority of existing stormwater facilities to drain roadways. Private property owners have installed facilities to drain their property, which discharge into the public drainage system that immediately or ultimately connect with the roadway drainage system. However, over the last thirty years many new regulations have come forth to protect the natural environment from the increasing flows and pollution contained in stormwater runoff. Chapter 6 describes many of the water quality and quantity problems associated with today's urban stormwater runoff.

Through the Clean Water Act and other legislation, the federal government has delegated to Washington State the authority to implement rules and regulations within the state that meet the goals of this legislation. Subsequently, the State has delegated some of this authority to the local agencies (city, county). Local agencies, in turn, enact development regulations to enforce the rules sent down by the state. Local agencies are free to enact and enforce rules and policies that are more stringent than those of the state, but cannot enact any that are less stringent. Permits may be issued by all three levels of government depending on the type of project and the impacts it may have on the natural drainage systems, which may include streams (intermittent or year-around flows), wetlands, lakes, ponds, rivers, estuaries, marine waters, and groundwater.

The role of federal, state, and local stormwater regulations is to provide minimum standards for the drainage and discharge of stormwater runoff. Specifically, the goal of these regulations is to reduce the damaging effects of increased runoff volumes to the natural environment as the type of cover on the land surface changes and to prevent pollutants from getting into runoff and remove the pollutants that become entrained in the runoff.

Because of changing administrations, conditions, and technology, all of these policies, rules, and regulations are subject to significant change through time.

FEDERAL REGULATIONS

The federal government regulates stormwater through several different programs. Responsibility for implementing the policies of these programs is often delegated to the state and local agencies through various rules, regulations, and permitting policies. The

federal government does, however, maintain some of the responsibilities for those activities that are of national interest.

FEDERAL WATER POLLUTION CONTROL ACT (CLEAN WATER ACT)

The Clean Water Act (CWA) is a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States. The law gave the Environmental Protection Agency (EPA) the authority to set effluent standards on an industry basis (technology-based) and continued the requirements of the original act to set water quality standards for all contaminants in surface waters. The CWA makes it unlawful for any person to discharge any pollutant from a point source into waters of the United States unless a Nationwide Pollutant Discharge Elimination System (NPDES) permit is obtained under the Act.

The CWA provisions for the delegation by EPA of many permitting, administrative, and enforcement aspects of the law to state governments. In states with the authority to implement CWA programs, EPA still retains oversight responsibilities.

Provisions of the CWA directly apply to the purpose and creation of the non-point source management program. Under the CWA, stormwater control was established as part of the NPDES permit program (Section 402 of CWA).

Phase I NPDES Stormwater Permits

In 1990, the United States Environmental Protection Agency (EPA) set out regulations for Phase I stormwater permits for large and medium municipalities as well as industries and construction sites. Section 402 of the Clean Water Act, establishes this regulatory program for point sources of pollution but exempts most agricultural activities. The NPDES permit program draws its power from this section and was originally designed to reduce pollution from point sources such as domestic and industrial wastewater discharges. The program now includes certain runoff discharges from specific industrial activities, including construction sites that disturb more than five acres of land, and runoff discharges operated by local governments with a population over 100,000. To obtain a NPDES permit, a plan must be developed and implemented to reduce the discharge of pollutants to the "Maximum Extent Practicable," protect water quality, and satisfy the appropriate water quality requirements of the Clean Water Act.

Phase II NPDES Stormwater Permits

The United States Environmental Protection Agency (EPA) issued draft regulations for Phase II NPDES stormwater permits in January 1998 and issued final Phase II regulations on December 8, 1999. The EPA proposes to cover all urban areas, not initially covered by Phase I regulations under a general Phase II permit. The regulations call for the development of the following stormwater management measures:

- Public Education and Outreach Program,
- Public Involvement and Participation Program,
- Elicit Discharge Detection and Elimination Program,
- Erosion and Sediment Control Program for Construction,
- New Development and Redevelopment Runoff Program, and
- Pollution Prevention (Good Housekeeping) Program, and
- Record Keeping, and
- Recording.

The above stormwater management measures must include quantitative goals and a description of how these goals will be met. Therefore, monitoring will be an important part of the Elicit Discharge Detection and Elimination Program. Elicit discharges to storm drains are any discharges that are not considered stormwater. Examples include spills, illegal dumping and cross connections with the sanitary sewer. Spill control is required under the Elicit Discharge Detection and Elimination Program.

The regulations specify minimum requirements for the stormwater programs developed to comply with the Phase II permits. One of those requirements is the adoption of a program for “post-construction stormwater management in new development and redevelopment.” Another is a program for “construction site stormwater runoff control.”

The EPA will issue a “menu of Best Management Practices (BMPs)” that will serve as the basis for the stormwater program measures listed above. In the State of Washington, the Department of Ecology is the delegated authority to issue and administer NPDES permits to municipal and industrial point and non-point source discharges. An initial estimate is that 102 municipalities will be subject to the requirements and 10 additional municipalities may be subject to the requirements, depending upon an analysis that Ecology must perform. Additional Cities and counties may be added by petition. The Phase II communities must submit their stormwater programs to comply and obtain permit coverage by March 2003. The state intends to require that those jurisdictions requiring a Phase II NPDES permit adopt either Ecology’s manual or an equivalent manual. The statewide general permit issued by Ecology will likely emulate the Comprehensive Program for stormwater as outlined in Ecology’s Technical Manual. A decision has not been made whether the permit will be included as a requirement that Ecology’s technical manual or an equivalent one will be required to be adopted by the permit.

In the State of Washington, the Department of Ecology is the delegated authority to issue and administer NPDES permits to municipal and industrial point and non-point source discharges. The state published a final Technical Manual in August 2001 to address aspects included in Phase II. For western Washington, they are published as five volumes titled *Stormwater Management Manual for Western Washington*.

Endangered Species Act

The purpose of the 1972 Endangered Species Act (ESA) is to “provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved....” In pursuit of this goal, the ESA authorizes the U.S. Fish and Wildlife Service and the National Marine Fisheries Service to list species as endangered or threatened, and to identify and protect the critical habitat of listed species. USFWS has jurisdiction over terrestrial and freshwater plants and animals such as bull trout, while NMFS is responsible for protection of marine species including anadromous salmon. Under the ESA, endangered status is conferred upon “any species which is in danger of extinction throughout all or a significant portion of its range...,” while threatened status is conferred upon “any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” The ESA defines critical habitat as the “geographical area containing physical and biological features essential to the conservation of the species.”

Once a species is listed as endangered or threatened, the ESA makes it illegal for the government or individuals to “take” a listed species. "Take" is defined in Section 9 of the act and includes killing, hunting, trapping, or otherwise "harming" the listed species or habitat the species depends upon. “Take” has been interpreted by the federal courts to include “significant modification or degradation of critical habitat” that impairs essential behavior patterns. For species listed as endangered, the blanket prohibitions against “take” are immediate.

The ESA Section 9 “take” prohibition applies to all “persons” including local public entities. State and local governments may face twin exposures through their direct conduct and through the exercise of the regulatory authorities over activities, which “take” may occur.

However, threatened species may be protected through a more flexible Section 4(d) rule describing specific activities that are likely to result in a “take.” The draft of the Section 4(d) rule prepared by NMFS was published in the Federal Register on January 3, 2000 (Federal Register, Vol. 65, No. 1). The final 4(d) rule was published in June, 2000 and became effective January 8, 2001.

The National Marine Fisheries Service

Under the ESA, NMFS is responsible for the protection of marine life, including anadromous salmon such as the Columbia River, Coastal, and Puget Sound Chinook and Steelhead. Although NMFS may choose to invoke the blanket prohibitions of Section 9, the “threatened” status of the Puget Sound Chinook and Hood Canal Chum salmon allows more flexibility to establish regulations designed to protect these species. These regulations, known collectively as a Section 4(d) rule, outline activities exempted from the “take” prohibitions of Section 9.

United States Fish and Wildlife Service

Under the ESA, USFWS is responsible for the protection of all non-marine life such as bull trout. The bull trout was proposed for ESA protection and was listed as “threatened” during the summer of 1999. Unlike the NMFS, the USFWS does not differentiate between “threatened” and “endangered” species, so a Section 4(d) rule will not contain exceptions to the Section 9 prohibition on “take.”

The 4(d) rules may exempt certain activities from “take” liabilities and thereby offer an alternative mechanism by which to secure relief from potential “take” liability. The 4(d) rule approves some specific existing state and local programs, and creates a means for NMFS to approve additional programs if they meet certain standards set out in the rule. NMFS published “A Citizen’s Guide to the 4(d) Rule for Threatened Salmon and Steelhead on the West Coast” in June, 2000. A copy of the guide is included in Appendix A. The guide introduces and explains the rule. The following discussion summarizes this guide.

Section 4(d) requires NMFS to issue regulations deemed “necessary and admissible to provide for the conservation to the species.” NMFS must establish protective rules for all species now listed as threatened under the ESA. The rules need not prohibit all take. There may be an “exception” from the prohibitions on take so long as the take occurs as the result of a program that adequately protects the listed species and its habitat. The 4(d) rule can “limit” the situations to which the take prohibitions apply. By providing limitation from take liability, NMFS encourages governments and private citizens to adjust their programs and activities to be “salmon safe.”

One of the limitations on the take prohibitions contained in the 4(d) rule is Limit No. 12 – Municipal, Residential, Commercial and Industrial development and redevelopment (MRCI). The 4(d) rule recognizes that MRCI development and redevelopment have a significant potential to degrade habitat and injure or kill salmon and steelhead in a variety of ways. The 4(d) guide states that with appropriate safeguards, MRCI development can be specifically tailored to minimize impacts on listed fish to the extent that additional Federal protections would not be needed to conserve the listed ESU. The guide further states that NMFS would individually apply the following 12 evaluation considerations when determining whether MRCI development ordinances or plans adequately conserve listed fish.

1. An MRCI development ordinance or plan ensure that development will avoid inappropriate areas such as unstable slopes, wetlands, areas of high habitat value, and similarly constrained sites.
2. An MRCI development ordinance or plan adequately prevents stormwater discharge impacts on water quality and quantity and stream flow patterns in the watershed – including peak and base flows in perennial streams.

3. An MRCI development ordinance or plan protects riparian areas well enough to attain or maintain Proper Functioning Condition (PFC), habitat that provided for the biological requirements of the fish, around all rivers, estuaries, streams, lakes, deepwater habitats, and intermittent streams.
4. An MRCI development ordinance or plan avoids stream crossings – whether by roads, utilities, or other linear development – wherever possible and, where crossings must be provided, minimize impacts.
5. An MRCI development ordinance or plan adequately protects historic stream meander patterns and channel migration zones and avoids hardening stream banks and shorelines.
6. An MRCI development ordinance or plan adequately protects wetlands, wetland buffers and wetland function – including isolated wetlands.
7. An MRCI development ordinance adequately preserves permanent and intermittent streams’ ability to pass peak flows.
8. An MRCI development ordinance or plan stresses landscaping with native vegetation to reduce the need to water and apply herbicides, pesticides, and fertilizer.
9. An MRCI development ordinance or plan contains provisions to prevent erosion and sediment run-off during (and after) construction and thus prevent sediment and pollutant discharge to streams, wetlands and other water bodies that support listed fish.
10. An MRCI development ordinance or plan ensures that demands on the water supply can be met without affecting either directly or through groundwater withdrawals – the flows salmon need.
11. An MRCI development ordinance or plans provides mechanisms for monitoring, enforcing, funding, reporting, and implementing its program.
12. An MRCI development ordinance or plan complies with all other state and Federal environmental and natural resource laws and permits.

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. The Puget Sound Chinook and Hood Canal Chum Salmon are listed as “threatened” under the Endangered Species Act (ESA). In addition, the United States Fish and Wildlife Service (USFWS) listed the Bull Trout as “threatened” during the summer of 1999. ESA listings are expected to significantly impact activities that affect salmon and trout habitat, such as water use, land use, construction activities, and wastewater disposal. Impacts to the District may include

longer timelines for permit applications, and more stringent regulation of construction impacts and activities in riparian corridors.

In response to existing and proposed ESA listings of salmon, steelhead, and trout species throughout Washington State, Governor Locke established the Office of Salmon Recovery in 1997 to direct the State's salmon recovery efforts. The Office of Salmon Recovery is also supported by the Joint Natural Resources Council (composed of representatives of state natural resource agencies) in the preparation of the Statewide Strategy to Recover Salmon, entitled "Extinction is Not an Option" (January, 1999). The goal of the Statewide Strategy is to restore wild salmon, steelhead, and trout populations to harvestable levels. Rather than attempting to avert additional ESA listings, the Statewide Strategy intends to provide local input into, and hopefully maintain some local control over the salmon recovery regulatory processes that will inevitably effect the majority of Washington State. The Statewide Strategy was submitted to NMFS in 1999 for possible inclusion in the Section 4(d) rule. The draft of the Section 4(d) rule was published in the Federal Register on January 3, 2000 (Federal Register, Vol. 65, No. 1). The final 4(d) rule was published in June 2000 and became effective January 8, 2001. The Statewide Strategy to Recover Salmon was not included in the 4(d) rule.

In order to minimize liability under the ESA, local governments will need to demonstrate that their land use regulations will not result in a prohibited "take" of a listed species, including adverse modification of critical habitat. Possible regulatory impacts may include the following:

- Adopt model critical areas ordinances designed to protect critical habitat.
- Amend critical areas ordinances to include riparian buffers, vegetation retention, soil retention, maximum road density within a watershed, maximum impervious surface in a watershed, and limits on road crossings of streams.
- Amend GMA comprehensive plans to require an "environmental protection element."
- Adopt stormwater operation and maintenance ordinances requiring regular, frequent maintenance of stormwater facilities.
- Increase inspection and enforcement of stormwater best management practices.
- Require monitoring of best management practices.
- Provide adequate funding of stormwater infrastructure, which may include implementation of stormwater utilities.
- Amend Shoreline Master Programs to encourage greater use of conservancy and natural designations, and limit conversion of agricultural and forest land.

STATE STORMWATER REGULATIONS

The principal state programs already in existence that relates to stormwater include the *Puget Sound Water Quality Management Plan*, municipal NPDES stormwater permits,

the Growth Management Act, the Shorelines Management Act, and Hydraulic Project Approvals.

Governor Locke issued a *Draft Salmon Recovery Strategy* plan on September 25, 1998 in response to the listing of Puget Sound Chinook salmon as “threatened” and the potential for other listings. Once the *Final Salmon Recovery Plan* is implemented throughout the State of Washington, further stormwater flow controls will likely be required. The *Draft Recovery Plan* stormwater strategy emphasizes preservation of existing high quality habitat and restricting new development. Retrofitting of existing development is recommended only in priority habitat areas due to the high cost and limited potential for successful rehabilitation. The *Draft Recovery Plan* relies on voluntary measures and greater enforcement and monitoring of existing regulations.

Puget Sound Water Quality Management Plan

In December of 2000, the Puget Sound Water Quality Action Team adopted the 2000 *Puget Sound Water Quality Management Plan*. The plan establishes the framework for managing and protecting the Puget Sound and coordinating the roles and responsibilities of federal, state, tribal and local governments. As part of this plan, a *Water Quality Work Plan* is established every two years to identify actions in order to maintain or improve water quality in the region. The Plan is separated into 21 programs including:

- Estuary Management and Plan Implementation
- Puget Sound/Georgia Basin Shared Waters
- Aquatic Nuisance Species
- Contaminated Sediments and Dredging
- Marine and Freshwater Habitat Protection
- Municipal and Industrial Discharges
- Nonpoint Source Pollution
- Agricultural Practices
- Forest Practices
- Household Hazardous Waste
- Local Watershed Action
- Marinas and Recreational Boating
- On-Site Sewage Systems
- Pest Management
- Shellfish Protection
- Spill Prevention and Response
- Stormwater and Combined Sewer Overflows
- Education and Public Involvement
- Laboratory Support
- Monitoring
- Research

Per RCW 90.71.070, local governments are required to implement local elements of the work plan subject to the availability of appropriated funds or other funding sources. the *Puget Sound Water Quality Management Plan*, the Plan provides valuable guidance regarding implementation of suggested actions in areas where water quality is a concern. The *Puget Sound Water Quality Management Plan* (Puget Sound Plan) consists of elements calling for counties and cities to develop and implement local stormwater management programs.

The Puget Sound Plan directed Ecology to develop stormwater guidance for local programs, including a technical manual (SW-2) and model ordinances (SW-3.2) for stormwater management, operation and maintenance. Ecology recently released its latest version of a technical manual entitled, *Stormwater Management Manual for Western Washington*. The 2000 Puget Sound Plan also calls for jurisdictions to adopt a comprehensive stormwater program (SW-1). Densely populated urbanized areas, in accordance with EPA regulations, must also meet the requirements of municipal stormwater NPDES permits (SW-2.5). This 2000 Plan also suggests Ecology develop criteria for determining whether small municipalities outside of urban areas will need an NPDES phase II permit. This criteria includes evaluation of the potential to degrade water quality through discharge to sensitive waters, high growth or growth potential, high population density, and the evaluation of the effectiveness of water quality programs currently in place. Based on these criteria, some smaller communities may be required to obtain NPDES phase II permits.

The Port Ludlow Drainage District should be committed to meeting the comprehensive stormwater requirements. In the unlikely event the District is ever selected as a federally designated urbanized area, it will be required to meet Phase II NPDES stormwater regulations. By fulfilling the requirements of a comprehensive stormwater program, the District may well be in compliance with the Phase II NPDES requirements.

Local Government Planning and Stormwater Programs (SW-1)

The following are excerpts from the Puget Sound Plan regarding recommended components for local government planning and stormwater programs. The plan calls on local governments to use the tools listed here in order to protect water quality of surrounding waters.

Growth Management Planning: Every city and county required to plan under the Growth Management Act (GMA) shall review and revise, as necessary, countywide planning policies, local comprehensive plans and development regulations to ensure that development does not degrade water quality, aquatic species and habitat, and natural hydrology and processes. This review shall be completed according to GMA amendment timelines using best available science and shall include:

- a. Designating urban growth management areas with appropriate densities and sufficient capital facilities to reduce sprawl;
- b. Providing sufficient vegetative buffers and development setbacks in critical areas ordinances to protect riparian zones, shorelines, wetlands and other sensitive areas;
- c. Assessing how full build-out according to the comprehensive plan will alter natural hydrology, water quality and aquatic species; and
- d. Incorporating measures to retain natural hydrology and processes, such as establishing goals for limiting effective impervious surfaces and preserving open spaces and forests.

Comprehensive Stormwater Programs: Every city and county shall develop and implement a comprehensive stormwater management program. Cities and counties are encouraged to form intergovernmental cooperative agreements in order to pool resources and carry out program activities most efficiently. Programs shall include:

- a. **Stormwater Controls for New Development and Redevelopment –** Adopt ordinances that require the use of best management practices (BMPs) to control stormwater flow, provide treatment, and prevent erosion and sedimentation from all new development and redevelopment projects. Adopt and require the use of the Department of Ecology's stormwater technical manual (or an alternative manual developed under SW-1.3) to meet these objectives. All new development in the basin, particularly new development sited outside of urban growth areas, shall seek to achieve no net detrimental change in non-natural surface runoff and infiltration.

- b. **Stormwater Site Plan Review** – Review new development and redevelopment projects to ensure that stormwater control measures are adequate and consistent with local requirements.
- c. **Inspection of Construction Sites** – Regularly inspect construction sites and maintain temporary BMPs according to guidance developed under SW-2 and 3. Adopt ordinances to ensure clear authority to inspect construction sites, to require maintenance of BMPs and to enforce violations. Provide local inspectors with training under SW-3 on erosion and sediment control practices.
- d. **Maintenance of Permanent Facilities** – Adopt ordinances that require that all permanent stormwater facilities be regularly maintained according to guidance developed under SW-2 and 3 to ensure performance. Develop provisions as necessary, such as agreements or maintenance contracts, to ensure that facilities on private land (e.g., residential subdivisions and commercial complexes) are maintained. Provide training under SW-3 for professionals who maintain stormwater facilities.
- e. **Source Control** – Develop and implement a program to control sources of pollutants from new development and redevelopment projects and from existing developed lands, using BMPs from Ecology’s stormwater technical manual. Source control activities shall include pollution from roadways and landscaping activities. Integrated pest management practices shall be used to manage roadside vegetation.
- f. **Illicit Discharges and Water Quality Response** – Adopt ordinances to prohibit dumping and illicit discharges. Carry out activities to detect, eliminate and prevent illicit discharges, and respond to spills and water quality violations.
- g. **Identification and Ranking of Problems** – Identify and rank existing problems that degrade water quality, aquatic species and habitat, and natural hydrologic processes. Local governments may choose to achieve this through watershed or basin planning (SW-1.2.j) or another process. Conduct a hydrologic analysis and map stormwater drainages, outfalls and impervious surfaces by watershed. Develop plans and schedules and identify funding to fix the problems.
- h. **Public Education and Involvement** – Educate and involve citizens, businesses, elected officials, site designers, developers, builders and other members of the community to build awareness and understanding of stormwater and water quality issues. Provide practical alternatives to

actions that degrade water quality and biological resources.

- i. **Low Impact Development Practices** – Adopt ordinances that allow and encourage low impact development practices. These are practices that infiltrate stormwater (using proper safeguards to protect groundwater) on-site rather than collecting, conveying and discharging stormwater off site. The goals of low impact development practices are to enhance overall habitat functions, reduce runoff, recharge aquifers, maintain historic in-stream flows and reduce maintenance costs. Low impact development provides a variety of benefits, including cost savings and added market appeal, additional green space for recreational uses and greater esthetic appeal than traditional facilities. Low impact development practices may not be appropriate for all sites. Low impact principles include:
 - i. Maintain the pre-developed, undisturbed stormwater flows and water quality;
 - ii. Retain native vegetation and soils to intercept, evaporate and transpire stormwater on the site (rather than using traditional ponds and conveyances);
 - iii. Emphasize a higher standard of soil quality in disturbed soils (by using compost and other methods) to improve infiltration, reduce runoff and protect water quality;
 - iv. Cluster development and roads on the site and retain natural features that promote infiltration; and
 - v. Reduce impervious surface area and use permeable surfaces instead.
- j. **Watershed or Basin Planning** – Participate in watershed or basin planning processes, such as planning under Chapter 400-12 WAC or Chapter 90.82 RCW, in order to coordinate efforts, pool resources, ensure consistent methodologies and standards, maintain and restore watershed health, and protect and enhance natural hydrology and processes, including natural surface runoff, infiltration and evapotranspiration. Progress in achieving this goal shall include biological monitoring. Cities and counties may choose watershed or basin planning processes to identify and rank existing stormwater problems, develop a plan and schedule to fix the problems, and set goals for limiting effective impervious surfaces and preserving open spaces and forests. Basin planning should use continuous runoff modeling to simulate existing and potential impacts of land use and water management on natural hydrology. Basin plans shall address water quality, aquatic habitat, groundwater recharge and water re-use. Basin plans may prescribe stronger stormwater

management measures to protect sensitive resources in a certain basin or sub-basin. Stormwater management measures in all basins shall at least meet the minimum requirements of ecology's technical manual. Cities and counties shall incorporate recommendations from watershed or basin plans and specific requirements from Total Maximum Daily Load (TMDL) Water Cleanup Plan processes into their stormwater programs, land use comprehensive plans and site development ordinances.

- k. **Funding** – Create local funding capacity, such as a utility, to ensure adequate, ongoing funding for program activities and to provide funding to contribute to regional stormwater projects.
- l. **Monitoring** – Monitor program implementation and environmental conditions and trends over time (according to guidance developed under SW-2 and 3) to measure the effectiveness of program activities. Periodically share monitoring results with local and state agencies, citizens and others.
- m. **Schedule for Implementation** – Develop an implementation schedule with specific target dates and funding sources to help plan program activities.

Stormwater Technical Manual (SW-2)

The Puget Sound Plan states that Ecology shall maintain a stormwater technical manual for new development and redevelopment with overall goals of protecting and restoring aquatic species and habitat, water quality and natural hydrology and processes, including achieving no net detrimental change in natural infiltration and surface runoff, particularly for new development sited outside of urban growth areas.

Jefferson County has adopted the August 2001 Department of Ecology's *Stormwater Management Manual for Western Washington*. Port Ludlow Drainage District is under the regulatory requirements of Jefferson County. The *Stormwater Management Manual for Western Washington* establishes the minimum requirements for stormwater control and site development requirements for all new development and redevelopment. This manual outlines water quantity design criteria, water quality controls, erosion and sediment control practices, and site development.

The intent and purpose of the manual is to provide for the following elements:

- Establish criteria for review and analysis of all development,
- Manage stormwater to minimize contact with contaminants,
- Mitigate the impacts of increased runoff due to urbanization,
- Manage runoff from developed property and that being developed, and
- Protect the health, safety, and welfare of the public.

STATE OF WASHINGTON SHORELINE MANAGEMENT ACT

On November 29, 2000, the Department of Ecology adopted new shoreline master program guidelines (Chapter 173-26 WAC), ending a five-year effort to review and update the state regulations and the first time since 1972 the regulations had been updated. However, a coalition of business groups and local governments challenged the guidelines, and the Shoreline Hearings Board subsequently invalidated them. In an effort to avoid years of legal appeals, the Department of Ecology director asked the governor and attorney general to sponsor mediation talks aimed at reaching a legal settlement.

The outcome of the negotiations is new draft shoreline management guidelines that Ecology will propose through formal rule-making. In addition, all parties to the mediation will jointly propose legislation in 2003 to change implementation deadlines contained in the underlying Shoreline Management Act, and to seek state funding, beginning with \$2 million over the next two years, to help local governments update their local shoreline master programs.

Jefferson County is currently completing an update of its Shoreline Master Program. All development within the designated shoreline areas must comply with the County's Shoreline Master Program.

JEFFERSON COUNTY STORMWATER MANAGEMENT PROGRAM

Local jurisdictions are typically responsible for implementing and enforcing regulations passed down from the State and Federal governments and for enacting additional policies, procedures and regulations based on local conditions and desires of the citizens.

The District currently follows the requirements of Chapter 15.78 of the Unified Development Ordinance (UDO) and the Jefferson County Conditions and Standards for Utility and Roadway Construction when designing or reviewing storm drainage projects. The UDO regulates the following aspects of storm drainage for new and redevelopment within the District:

- Maintenance of existing drainage patterns,
- Proper drainage of all developments,
- Prevention of discharge of storm water into the sanitary sewer,

development is beneath the impervious threshold set by the Ecology manual). All projects which fall under the requirements of the manual should be required to be designed by a licensed professional engineer or by a licensed on-site designer who can show that results will be met, and will be subject to approval by the county. Reference to the county's Critical Areas Ordinance, Shoreline Master Program, and SEPA would provide the county with the ability to impose more stringent runoff controls, if needed, in order to best serve the public's interest.

The Port Ludlow Development Agreement, recorded August 4, 2000, is a 20-year contract between Pope/OPG/ORM and their Assigns (PLA) with Jefferson County in compliance with the State GMA. Appendix C – Jefferson County Stormwater Management Ordinance #10-1107-96 (Effective Date 2/2/97) adopts the 1991 Puget Sound Water Quality Management Plan (revised May 1994) and the Washington State Department of Ecology Stormwater Management Manual (the current edition at the date being the 2/92 Edition).

JURISDICTIONAL COORDINATION

The main purpose of stormwater management is to preserve or improve surface water quality, prevent or control flooding, and control the flow regime of the natural drainage systems. This purpose will be accomplished through the adoption and implementation of the capital improvements and maintenance and operations program contained in this document. In addition, the county's stormwater ordinance should be comprehensive in nature and consistent with the ordinances of surrounding jurisdictions.

The Port Ludlow Drainage District has jointly prepared this planning document. The county owns and maintains the storm drainage facilities on county right-of-ways and much of the stormwater from the county drains through the private property. This plan recommends that the District obtain easements from the private property owners for the storm drainage facilities on private property so that the District can assist in maintenance of the facilities. The District is responsible for training, implementation and maintenance of pollution prevention measures for the businesses within the District. The County is responsible for training, implementation and maintenance for pollution prevention measures regarding County facilities (within the County rights-of-way).

The District has entered into an interlocal agreement with the Ludlow Maintenance Commission to review and provide comment on drainage plans submitted to the architectural committee.

CHAPTER 3

SERVICE AREA CHARACTERISTICS

LOCATION

The Port Ludlow Drainage District is located in Jefferson County in northwest Washington State near the entrance of Hood Canal. The community is in unincorporated Jefferson County and is primarily residential with some areas of commercial development. The commercial developments within the District include a resort, marina, hotel complex in the southeast area; and retail, office, and general commercial in the southwest.

SERVICE AREA AND URBAN GROWTH AREA

The service area for the District's Stormwater Comprehensive Plan will essentially consist of the District's corporate limits. However, the stormwater drainage basins reviewed and developed in this report extend beyond the borders to the north into the unincorporated areas of Jefferson County.

Figure 3-1 shows the Port Ludlow Drainage District boundary. The District includes approximately 700 acres in the northern portion of Port Ludlow. Port Ludlow is a Master Planned Report. The urban growth area (UGA) shown in the Jefferson County 1998 *Comprehensive Plan* encompasses approximately 2,300 acres for the Master Planned Report and consists of residential, commercial, and resort zoning areas as shown in Figure 3-2. The UGA was established to contain the population growth within the District up to the year 2020.

LAND USE AND ZONING

Land use within the Port Ludlow Drainage District has generally developed in a non-aggressive manner. Throughout this development, drainage has been accomplished along the streets through a number of open ditches, culverts, small-sized pipes, and natural drainage ways.

Growth and land use decisions are incorporated in to the document entitled *Jefferson County Comprehensive Plan*, adopted by the Jefferson County Board of Commissioners, August 28, 1998 (1998 Plan). Among the land use goals presented in the 1998 Plan, are as follows:

- Encourage development in urban areas where adequate public facilities and services exist or can be provided in an efficient manner.

- Include greenbelts and open space areas within Urban Growth Areas
- Adopt a stormwater management program designed to minimize the risk of flooding and avoid degradation of Port Ludlow Bay, Ludlow Creek, and other water bodies with polluted stormwater.

The 1998 Plan addresses the problems associated with residential and recreational subdivisions and the ability to maintain a rural lifestyle that is valued by District residents. A rural lifestyle is characterized by a variety of low-density neighborhoods and developments, concentrations of residential buildings surrounded by open space, as in planned unit developments, and commercial development, which is generally, limited to growth areas and convenience centers. With this objective in mind, land use for the Port Ludlow was implemented through the Master Planned Resort. The Port Ludlow Drainage District is the northern portion of the Port Ludlow Master Planned Resort. The Drainage District comprises just under a third of the area of the Master Planned Resort (MPR). The Land Use for the Port Ludlow Drainage District (see Figure 3-2) was separated into the classifications shown in Table 3-1:

TABLE 3-1

Port Ludlow Land Use Classifications

Land Use Category	Port Ludlow Drainage District
Single Family Residential, MPR-SF 4:1	565 acres
Single Family Residential, MPR-SFT 1:2.5	78 acres
Single Family Residential, RR 1:5	0 acres
Multi Family Residential, MPR-MF 10:1	20 acres
Resort Complex/Community Facilities, MPR-RC/CF 10:1	55 acres
Village Commercial Center, MPR-VC	17 acres
Recreation Areas, MPR-RA	0 acres
Open Space Reserve, MPR-OSR	0 acres
TOTAL	735 acres

The intent of the 1998 Plan was to focus growth. Innovative land development techniques such as planned unit developments, or clustering of units, will be encouraged where possible to more efficiently utilize land resources and public services. These techniques will also be used to preserve unique or sensitive areas as open space, for this is an important aspect to preserving water quality within the area. It should be noted that the County’s 1998 Comprehensive Plan echoes these land use objectives and will enforce them in the years to come.

EXISTING POPULATION

SCALE
1"=1000'

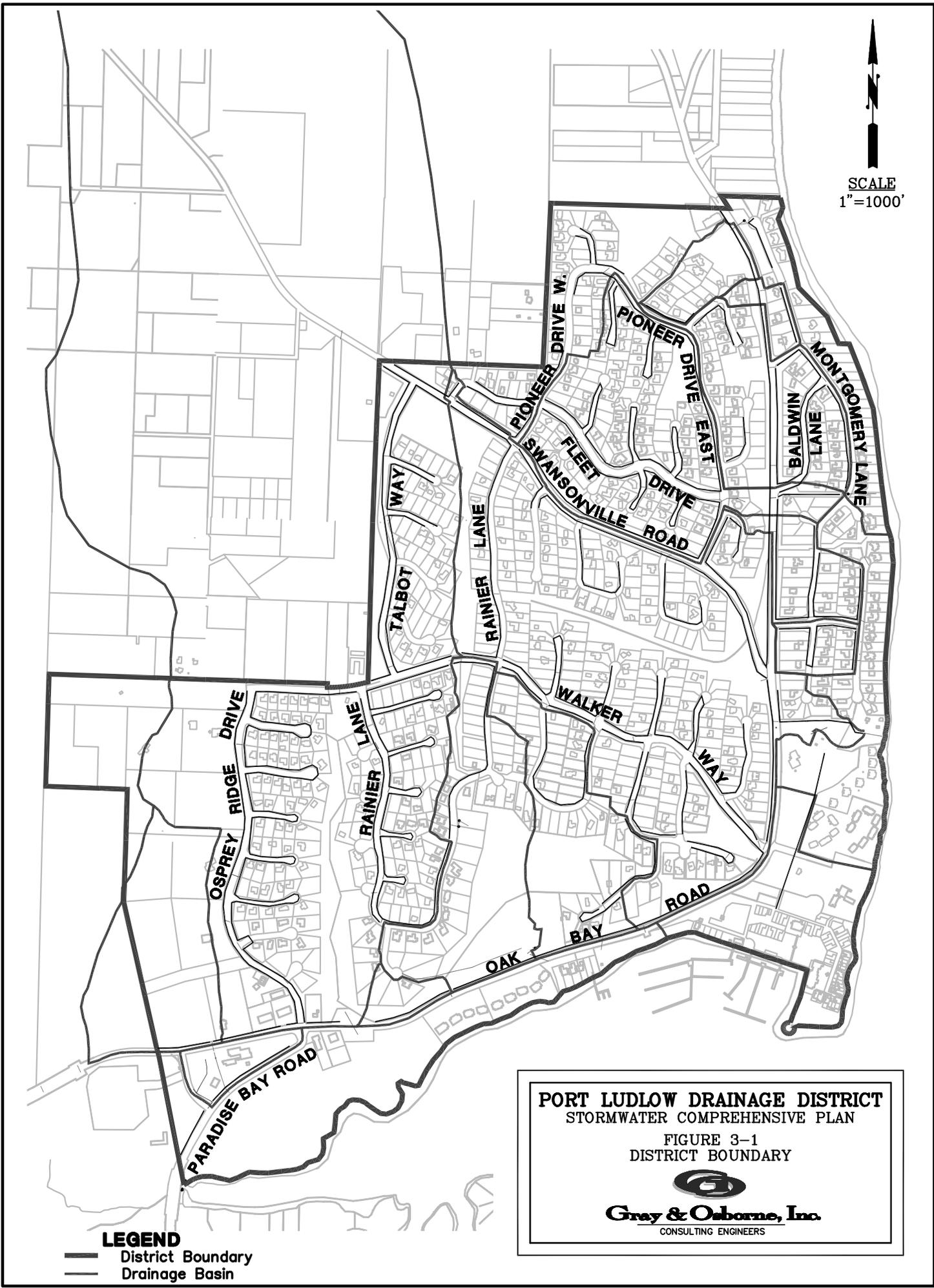


LEGEND
— District Boundary
— Drainage Basin

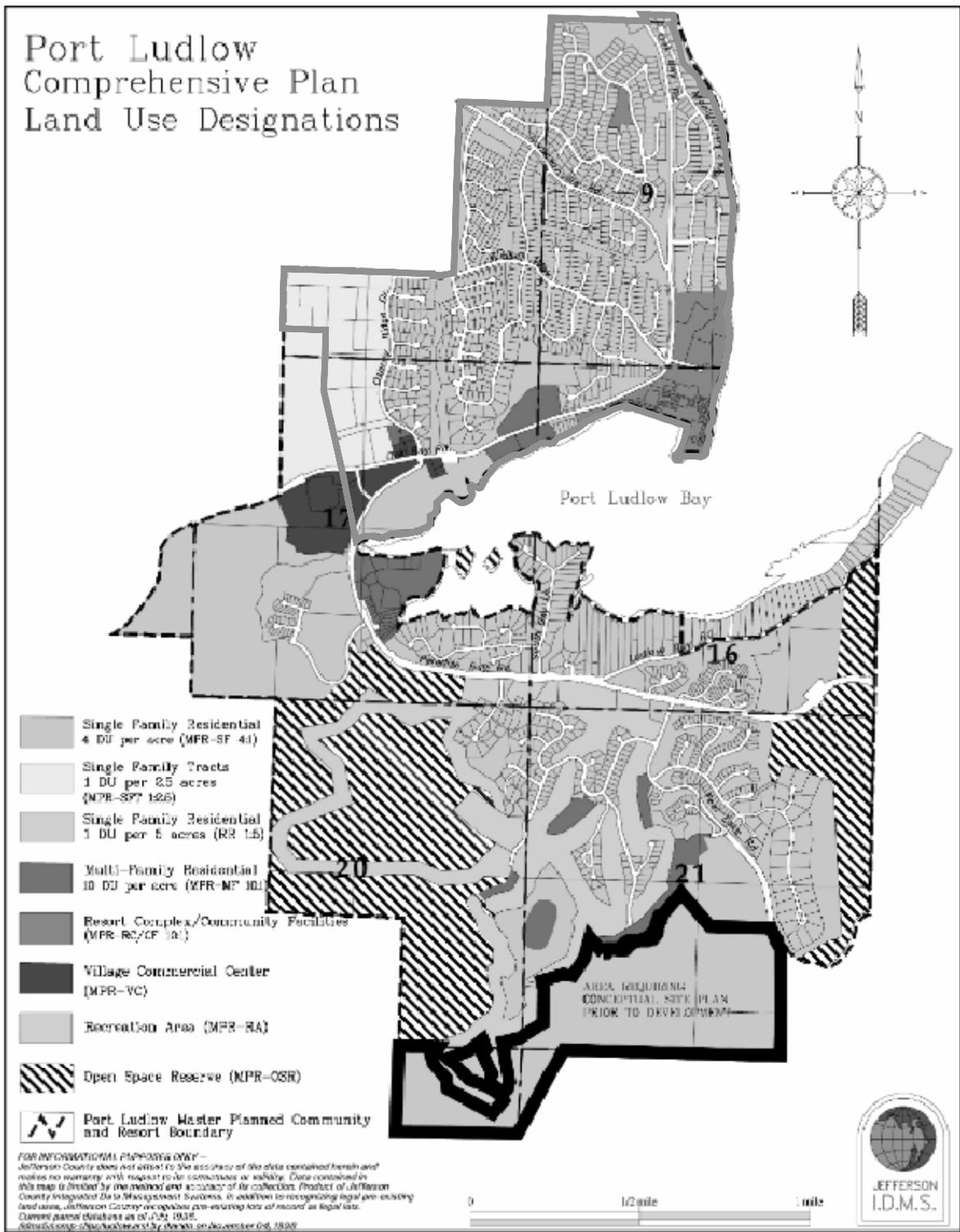
PORT LUDLOW DRAINAGE DISTRICT
STORMWATER COMPREHENSIVE PLAN
 FIGURE 3-1
 DISTRICT BOUNDARY



Gray & Osborne, Inc.
 CONSULTING ENGINEERS



Port Ludlow Comprehensive Plan Land Use Designations



Source: Jefferson County Integrated Data Management Systems, 1998

PORT LUDLOW DRAINAGE DISTRICT BOUNDARY

DU - DWELLING UNIT
MPR - MASTER PLANNED RESORT

PORT LUDLOW DRAINAGE DISTRICT
COMPREHENSIVE STORMWATER
MANAGEMENT PLAN
FIGURE 3-2
LAND USE

Gray & Osborne, Inc.
CONSULTING ENGINEERS

The Washington State Office of Financial Management (OFM) is the state agency that develops official state population figures. Table 3-2 lists the Port Ludlow Drainage District’s population for the years 1990 through 1999 as listed from OFM’s Forecasting Division and the population estimate for 2000 from the U.S. Census Bureau.

TABLE 3-2

Port Ludlow Drainage District Population 1990 through 2001

Year	Port Ludlow Drainage District
1990	838 ⁽¹⁾
1991	856
1992	880
1993	890
1994	870
1995	875
1996	864
1997	874
1998	876
1999	860
2000	950 ⁽²⁾
2001	950 ⁽³⁾

- (1) Special Count
- (2) 2000 Federal Census Count
- (3) OFM 2001 Estimate

FUTURE POPULATION

The planning period for this document has a ten-year planning horizon from 2000 through 2010. As determined from Table 3-3, the average annual growth rate from 1990-2000 was 1.3 percent. The July 1991 OFM Forecasting Report predicted a population increase of 2.88 percent from 2000 to 2005 and 2.96 percent for every five years thereafter. The population will be limited to the available development. The majority of the District is platted. There are currently 613 single-family residences, 123 condominium units, and 395 vacant residential lots in the District. The relatively small number of resident per house is due to the nature of the population. Many residents are part-time and/or retired. In Table 3-3, the District’s future population was estimated using the OFM predicted growth rates in five-year increments to the year 2020.

TABLE 3-3

Port Ludlow Drainage District Projected Population to the Year 2020 OFM

Year	Port Ludlow Drainage District	Growth Rate
2000	950	--
2005	977	2.88%
2010	1,006	2.96%
2015	1,035	2.96%
2020	1,065	2.96%

The Jefferson County 1998 Comprehensive Plan forecasts population through 2015 with an annual growth rate of 2 percent. The numbers resulting from this prediction is listed below in Table 3-4.

TABLE 3-4

Port Ludlow Drainage District Projected Population to the Year 2015 Jefferson County Comprehensive Plan

	2000	2005	2010	2015
District Population	1,047	1,167	1,286	1,406

EQUIVALENT RESIDENTIAL UNITS

The use of Equivalent Residential Units (ERUs) is necessary for calculating the District’s stormwater assessment and for the financial analysis in Chapter 9 of this report. An ERU was determined by averaging the impervious surface measured among fifty single-family lots within the District. The resulting unit was rounded to 3,000 square feet per single-family lot. Therefore, one ERU is equivalent to 3,000 square feet of impervious surface. Commercial ERUs are determined by dividing the amount of impervious surface located on that particular lot by the 3,000 square feet per ERU number. It was calculated that there are a total of 986 ERUs currently within the District, with 613 ERUs attributed to single family homes, 123 to multi-family housing, and 250 ERUs attributed to commercial sites.

PHYSICAL DESCRIPTION

TOPOGRAPHY

The topography of the Port Ludlow Drainage District is generally moderately sloped toward Ludlow Bay with a mean elevation of 212 feet above sea level. The outlying area of the District encompasses some very hilly terrain with elevations ranging from sea-

level in the south and eastern portion of the District and up to 400 feet in the north and west portion.

SOILS

The soils characteristics for the Port Ludlow area were obtained from the Soil Survey of Jefferson County Area, Washington, August 1975, provided by the USDA Natural Resource Conservation Service (formerly known as the Soil Conservation Service). The specific soil series within the area of Port Ludlow include Swantown gravelly loam and gravelly sandy loam (SuB and StB), Indianola loamy sand (InC), Alderwood gravelly sandy loam (AIC and AID), Cossolary sandy loam (CfD), Cossolary-Everett complex (ChC), Everett gravelly sandy loam (EvC), coastal beaches (Co), and cut and fill land (Cu). The characteristics of these soils are further described below and exhibited on Figure 3-3.

Alderwood Gravelly Sandy Loam (AIC and AID)

Alderwood gravelly sandy loam series AIC is found on glacial terraces with slopes from 0 to 25 percent. AID soils are moderately steep soils (15 to 30 percent) found in places of rolling glacial upland terraces that converge toward ravines and steep drainage paths. The Alderwood Series is moderately well drained and has a very slow permeable cement layer at a depth of 20 to 40 inches. The Alderwood Series formed in glacial till under a mixes of coniferous and broad-leaf forest species. A thin layer of organic matter typically covers the surface, with the first inch a very dark grayish-brown gravelly fine sandy loam. The next 12 inches consists of dark yellowish-brown gravelly sandy loam, and continuing to a depth of 30 inches is gravelly sandy loam that is brown in the upper strata but dark grayish brown with prominent mottling in the lower strata. The Alderwood soils are used for tree production, wildlife habitat, and recreation areas.

Cossolary Sandy Loam (CfD)

The Cossolary sandy loam series is found on terraces along the breaks of ravines or marine bluffs. Collolary soils are well drained, with moderately slow permeability. Roots can extend to a depth of 60 inches. This soil can hold 7 to 9 inches of water for plants. Water runoff is moderate and erosion hazard is slight to moderate. Cossolary soils are used for production of trees, wildlife habitat, and recreation. A small portion is used for permanent pasture, hay, and home gardens. Cossolary sandy loam soils have slopes from 15 to 30 percent.

Cossolary-Everett Complex (ChC)

This soil is approximately 60 percent Cossolary sandy loam and 40 percent Everett gravelly sand loam, with slopes from 0 to 15 percent. Cossolary soils slope gently and the Everett soils are rolling. This series has small areas that have 30 percent slopes.

Coastal Beaches (Co)

This soil is found at the base of coastal bluffs, and consist of sandy and gravelly sloping beaches in long, narrow strips. Coastal beaches are void of vegetation and a subject to constant wave action. This series is used for the production of clams and oysters, and for recreation and wildlife habitat.

Cut and Fill Land (Cu)

Cut and fill lands were filled due to their low, wet, and swampy characteristics. Since the soils were imported for fill materials, cut and fill land consists of a mixture of soil types. The marina and Resort at Ludlow Bay are all located on of cut and fill soils.

Everett Gravelly Sandy Loam (EvC)

This soils series is nearly level to rolling and is found on glacial outwash terraces. Most sites have 4 to 10 percent slopes. The Everett gravelly sandy loam is somewhat excessively drained with rapid permeability. Roots can extend as deep as 60 inches. This soil holds about 3 to 4 inches of water for plants, has slow runoff, with slight to moderate water erosion. This soils is used primarily for tree production, wildlife habitat, and recreation. About 20 percent has been cleared of vegetation, and is used for permanent pasture, hay, and garden crops.

Indianola Loamy Sand (InC)

This soil is found on glacial outwash plains with nearly level to steep slopes (0 to 15 percent). The soil is found in combination with Alderwood, Kitsap, and Quilcene soils. It drains somewhat excessively and permeability is rapid, but can hold about 3 to 5 inches of water for plants. Roots can penetrate to 60 inches. The Indianola series is used for growing trees and supporting wildlife habitat, but about 20 percent has been cleared for growing permanent pasture, hay, and home gardens.

Swantown Gravelly Loam (SuB)

The Swantown gravelly loam has 0 to 8 percent slopes and is used mostly for the production of trees, support for wildlife habitat, and recreation areas. The soil typically supports wooded areas but approximately half has been cleared for summer recreational home sites. The surface layer is very dark gray and very dark grayish-brown gravelly loam to 10 to 14 inches. The subsoil is dark-gray to dark grayish-brown gravelly loam



Source: Soil Survey of Jefferson County Area, Washington. United States Dept. of Agriculture, August 1975

 PORT LUDLOW DRAINAGE DISTRICT BOUNDARY

- AIC - ALDERWOOD GRAVELLY SANDY LOAM (GLACIAL TERRACE)
- AID - ALDERWOOD GRAVELLY SANDY LOAM (STEEP SLOPE)
- CFD - COSSOLARY SANDY LOAM
- ChC - COSSOLARY EVERETT COMPLEX
- Co - COASTAL BEACHES
- Cu - CUT AND FILL LAND
- Evc - EVERETT GRAVELLY SANDY LOAM
- Inc - INDIANOLA LOAMY SAND
- StB - SWANTOWN GRAVELLY SANDY LOAM
- SuB - SWANTOWN GRAVELLY LOAM

**PORT LUDLOW DRAINAGE DISTRICT
COMPREHENSIVE STORMWATER
MANAGEMENT PLAN
FIGURE 3-3
SOILS**



that has grayish-brown mottles. Below this layer is a cemented layer. The soil has medium to slight acidity. The soils above the cemented layer are moderately permeable.

Swantown Gravelly Sandy Loam (StB)

Swantown gravelly sandy loam is characterized by level to gently sloping areas in lowland areas abutting the toeslopes of moderately steep hilly glacial terraces. The soil is used mostly for the production of trees, support for wildlife habitat, and recreation areas. The soil is similar to Swantown Gravelly Loam in many ways, with the exception that the soil tends to hold water near above a cemented layer less than 2 feet below the ground surface, making a low water erosion hazard. This soil is located outside of the District in Swansonville, but within a drainage basin tributary to the District.

SURFACE WATER

Port Ludlow is located on the eastern boundary of the Olympic Peninsula and lies at the junction of Hood Canal and Admiralty Inlet. Port Ludlow Bay is a major water body extending from the straits of Admiralty Inlet to the inlet of Ludlow Creek. Port Ludlow is home to a large resort with a 300-slip marina. The inlet of Ludlow Creek is a mud flat with unstable slopes on the north bank. Ludlow Falls is located on the creek. (See Figure 3-4, Surface Waters.) Port Ludlow is located within Water Resource Inventory Area 17 (WRIA 17, Quilcene Snow).

GROUND WATER AND AQUIFER RECHARGE

Port Ludlow Associates own both a water and wastewater system. The water system relies on five groundwater wells with an annual capacity of 80 million gallons. The majority of the Drainage District is served by sanitary sewer. Some portions of the District have septic systems.

CLIMATE

Port Ludlow is located adjacent to the Olympic Mountains and lies partially within a “rain shadow,” which is a natural barrier to storms flowing inland from the Pacific Ocean. The air temperature is influenced by the surrounding water temperatures and remains fairly constant year round, cool during the summer days and warmer in winter months. In general, rainfall averages between 28 and 34 inches, snowfall averages 3 to 12 inches, and there are 200 days of sunshine per year. Summer temperatures range from 50 degrees at night to 70 degrees during the day, and winter temperatures range from 35 degrees at night to 45 degrees during daytime.

Climate data for Port Townsend is included since it is the closest National Oceanic and Atmospheric Administration station. Port Ludlow Associates also has a manual rain gauge at their north and south well site. Data from both sources is presented below.

TABLE 3-5

Port Townsend Climatological Data, 1967 – 1999

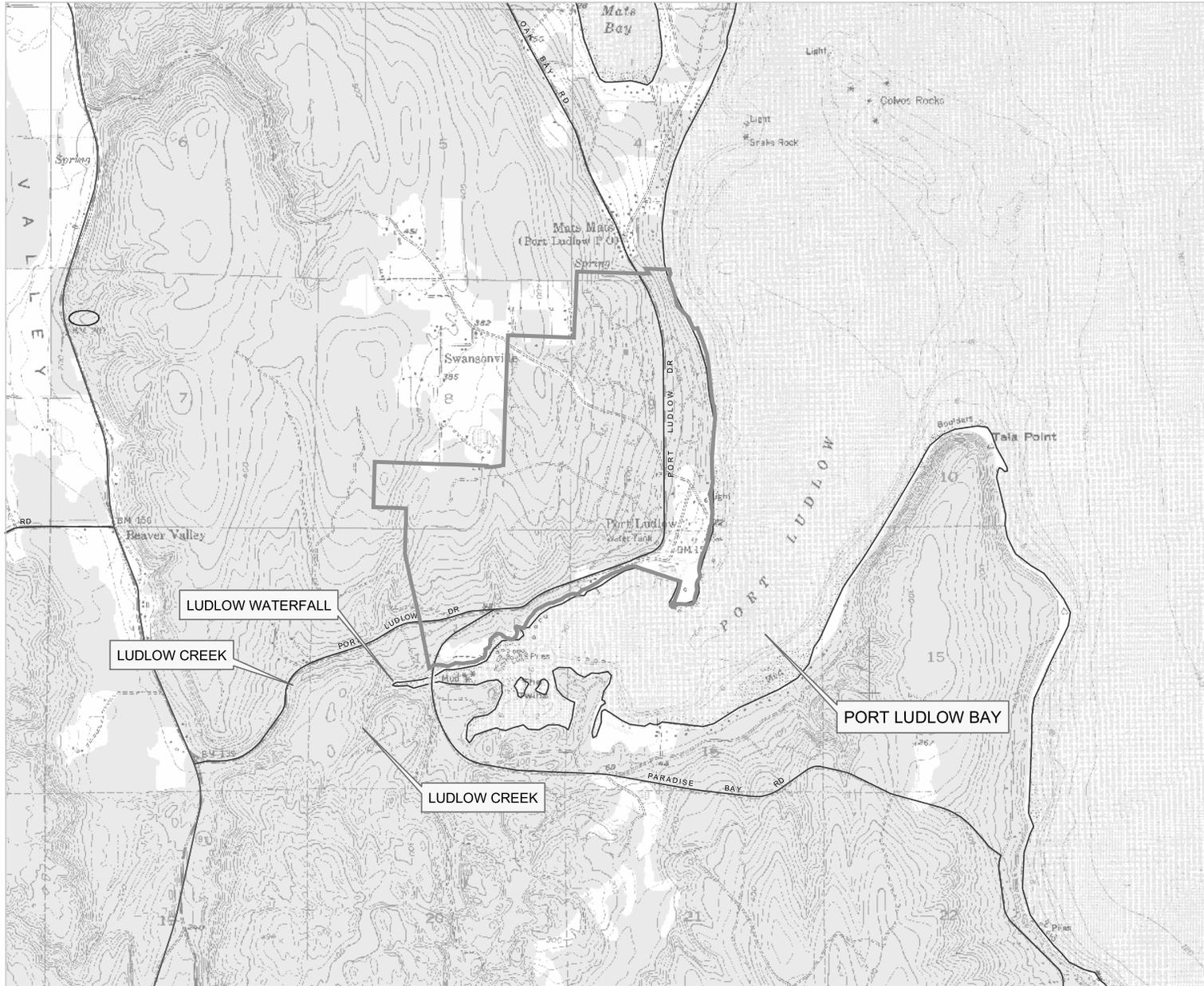
Month	Average Temperature (F°) (Port Townsend)	Average Precipitation (Inches) (Port Townsend)	Average Precipitation – Port Ludlow 1992- 2002 (Inches)
January	41	2.41	5.4
February	44	1.63	3.1
March	46	1.92	3.4
April	49	1.69	3.1
May	54	1.61	1.8
June	59	1.33	1.4
July	62	0.88	1.3
August	62	0.90	1.0
September	59	1.23	1.5
October	52	1.53	3.0
November	46	2.65	3.5
December	42	3.24	6.3
Average	51		
Total (annual average)		21.02	31.7

The average annual rainfall within the region for a 32-year period is 21.02 inches. Data regarding the 2-year, 25-year, and 100-year storms with a 24-hour duration were obtained from isopluvial maps in Ecology’s *Stormwater Management Manual for the Puget Sound Basin*. These values were used throughout the model described further in this plan. The 2-year, 25-year, and 100-year storms equated to 1.5-inches, 3.0-inches, and 3.5-inches, respectively.

GEOLOGIC HAZARD AREAS

Geologically hazardous areas are areas that because of their susceptibility to erosion, sliding, earthquakes, or other geological events are not suited to siting commercial, residential, or industrial development consistent with public health or safety concerns. The hilly portions of the Port Ludlow Drainage District contain steep slopes, which are prone to erosion and landslides.

The Department of Ecology’s website provides “Slope Stability Maps” for Jefferson County based on the Coastal Zone Atlas. Steep bluffs line the outside shoreline between Port Ludlow and Admiralty Inlet for about one mile north and are considered “unstable recent slide” (Urs) areas. An area upland of Port Ludlow Bay is designated as “unstable” (U), as well on the north bank along the inlet to Ludlow Creek. The point where the Resort at Port Ludlow is located is named “modified” (M), in addition to a few



SCALE 1" = 2000'

LEGEND

 PORT LUDLOW DRAINAGE DISTRICT BOUNDARY

PORT LUDLOW DRAINAGE DISTRICT
 COMPREHENSIVE STORMWATER
 MANAGEMENT PLAN
 FIGURE 3-4
 SURFACE WATERS



smaller areas close to the inlet of Ludlow Creek. (See Figure 3-5, Landslide Areas.) Modified denotes significant alteration and fill due to the industrial activities during the use of Port Ludlow Mill

FLOOD HAZARD AREAS

The 100-year flood plain is shown in Figure 3-6. These boundaries are in accordance with the Federal Emergency Management Agency (FEMA). The boundaries of the 100-year flood essentially encompass Port Ludlow Bay, the shorelines of the Port Ludlow community, and the inlet of Ludlow Creek. FEMA highly recommends against the placement of any structure in the 100-year flood plain. Any structure built within the flood plain's boundaries must provide for adequate protection against the 100-year flood (i.e. structures within the floodplain are constructed at a minimum of one foot above the flood plain elevation).

The 100-year flood plain does not cover all areas subject to localized flooding. Conveyance and detention facilities may be undersized or not maintained leading to flooding problems. These areas are the primary focus of the Port Ludlow Drainage District.

WETLANDS

Wetlands are defined as those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

The National Wetlands Inventory (NWI) documents several wetland areas in and around the Port Ludlow community. Figure 3-7 illustrates the wetlands identified by the National Wetlands Inventory. There is one wetland at the mouth of Ludlow Creek, which is identified as an Estuarine, intertidal, unconsolidated shore, and regularly flooded (E2USN). Another wetland is located at the Resort on Ludlow Bay. This wetland was created as a holding pond for past industrial activity, and is designated as Palustrine, open water, permanently flooded, excavated (POWHX). The upland wetlands near Swansonville are classified as Palustrine wetlands of varying subsystems. There are four (4) Palustrine, emergent, seasonally flooded; two (2) Palustrine, forested, temporarily flooded; one (1) Palustrine, scrub-shrub, seasonally flooded; and one (1) Palustrine, emergent, seasonally flooded, partially drained/ditched.

The United States Fish and Wildlife Service (USFWS) produced a document titled "Classification of Wetlands and Deepwater Habitats of the United States," dated December 1979. This document provides a description of the Classification System and Hierarchical Structure of the wetland subgroups listed above. The definitions of these wetland systems are summarized below:

Estuarine System

The Estuarine system “consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to open ocean, and in which ocean water is at least occasionally diluted by fresh water runoff from the land.”

Palustrine System

The Palustrine system includes a vegetated group of wetlands called “marsh, swamp, bog, fen, or prairie.” This system also includes the “small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments, or on slopes.”

Emergent Wetland

“The Emergent Wetland Class is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years.” The Emergent wetland is “in areas with stable climatic conditions” and “are known by many names, including marsh, meadow, fen, prairie pothole, and slough”. “All water regimes are included except subtidal and irregularly exposed.”

Marine System/Open Water Wetland

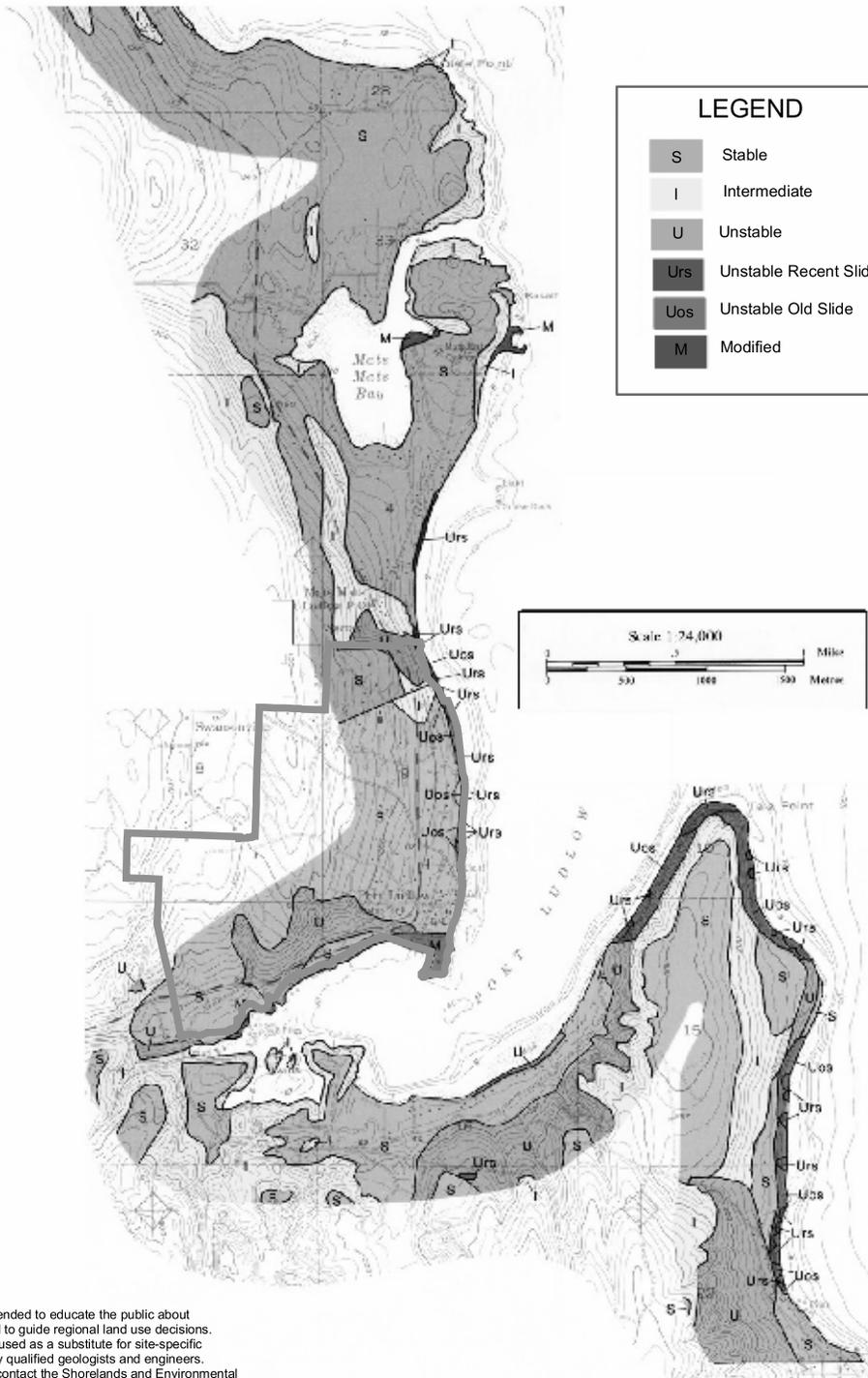
The Open Water wetland is also known as the Marine System and “consists of open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the water regimes are determined primarily by the ebb and flow the ocean tides.”

Scrub-Shrub Wetland

“The Class Scrub-Shrub Wetland includes areas dominated by wood vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. These wetlands may be successional to Forested wetlands or remain somewhat stable in its growth. Scrub-shrub wetlands occur only in Estuarine or Palustrine systems. These wetlands have been commonly referred to as shrub swamp, shrub carr, bog, and pocasin.”

Forested Wetland

The Forested wetland consists of woody vegetation that is 20 feet or taller. These wetlands are most common in the eastern United States but exist in the West where moisture is abundant such as along river and in mountains. Forested wetlands occur only



NOTE: These maps are intended to educate the public about Washington's shoreline and to guide regional land use decisions. These maps should not be used as a substitute for site-specific investigations carried out by qualified geologists and engineers. For additional information, contact the Shorelands and Environmental Assistance Program, Washington State Department of Ecology.

Source: Department of Ecology, Slope Stability Maps - Coastal Zone Atlas - Jefferson County

Legend

 PORT LUDLOW DRAINAGE DISTRICT BOUNDARY

PORT LUDLOW DRAINAGE DISTRICT
 COMPREHENSIVE STORMWATER
 MANAGEMENT PLAN
 FIGURE 3-5
 LANDSLIDE AREAS

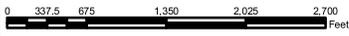




SOURCE: FEMA Q3 FLOOD DATA, DISK 24, WASHINGTON

LEGEND

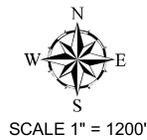
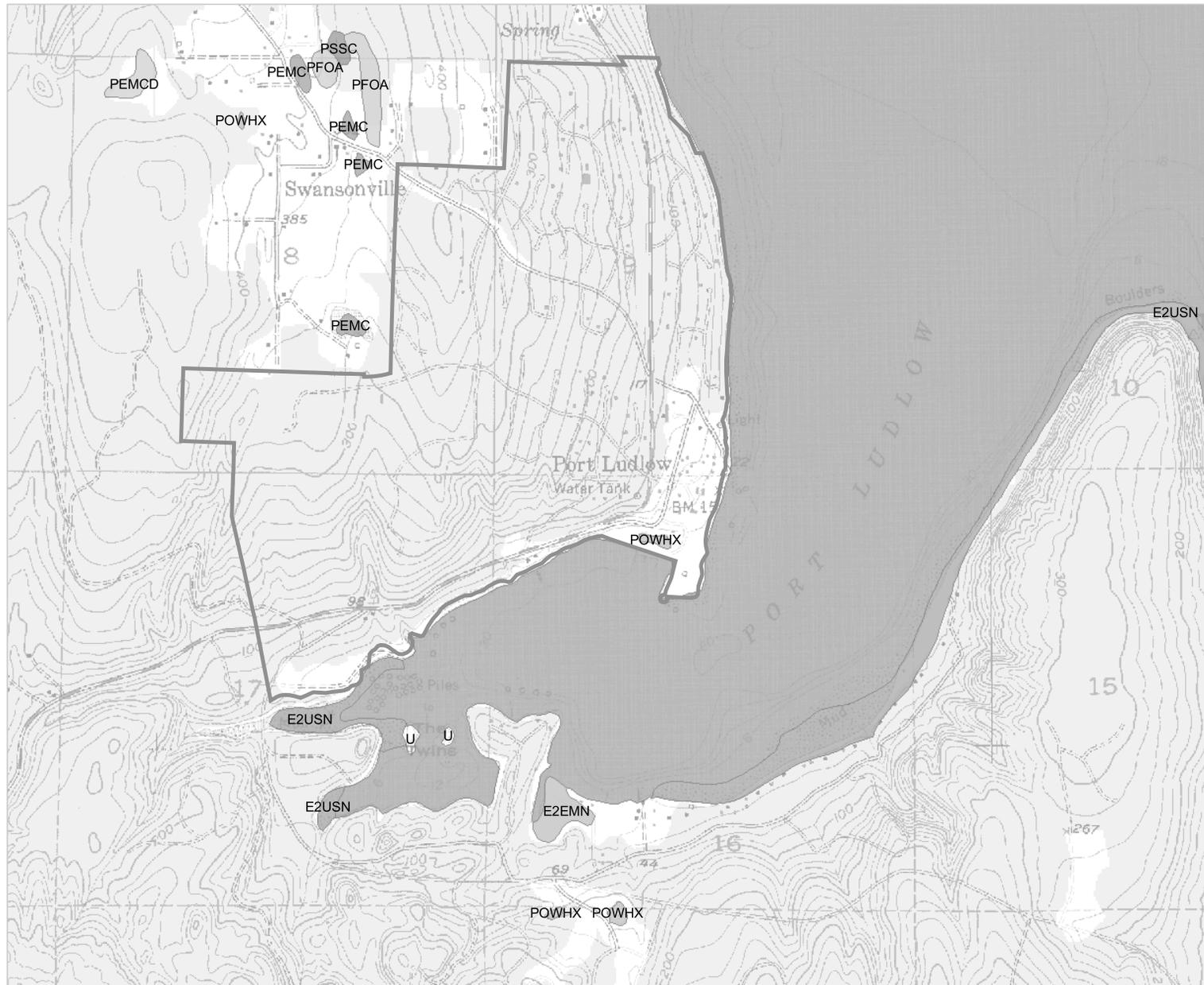
-  Area within 100-Year Floodplain as described by FEMA
-  PORT LUDLOW DRAINAGE DISTRICT BOUNDARY



PORT LUDLOW DRAINAGE DISTRICT
COMPREHENSIVE STORMWATER
MANAGEMENT PLAN
FIGURE 3-6
FLOODPLAIN MAP


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BPARK D:\CLIENTDATA\PORTLUDLOW\0246.01\WETLANDS.MXD



LEGEND

NWI CLASSIFICATION

- E10WL Estuarine, Subtidal, Open Water, Subtidal
- E2EMN Estuarine, Intertidal, Emergent, Regularly Flooded
- E2USN Estuarine, Intertidal, Unconsolidated Shore, Regularly Flooded
- PEMC Palustrine, Emergent, Seasonally Flooded
- PEMCD Palustrine, Emergent, Seasonally Flooded, Partially drained/ditched
- PFOA Palustrine, Forested, Temporarily Flooded
- POWHX Palustrine, Open Water, Permanently Flooded, Excavated
- PSSC Palustrine, Scrub/Shrub, Seasonally Flooded

SOURCE: U.S. DEPT. OF FISH AND WILDLIFE,
NATIONAL WETLANDS INVENTORY

PORT LUDLOW DRAINAGE DISTRICT BOUNDARY

PORT LUDLOW DRAINAGE DISTRICT
COMPREHENSIVE STORMWATER
MANAGEMENT PLAN
FIGURE 3-7
WETLANDS



in Estuarine and Palustrine systems and all water regimes except for subtidal. They typically possess an overstory of trees, an understory of young trees or shrubs, and a herbaceous layer.

Tidal Water Regimes

Water regimes are largely determined by ocean tides. Subtidal is substrate that is permanently flooded with tidal water. Intertidal is substrate exposed and flooded by tides, including splash zones. These water regimes are subsystems to the Marine, Estuarine, and Palustrine systems.

Nontidal Water Regimes

Though not influenced by oceanic tides, nontidal water regimes may be affected by wind or seiches in lakes, and are defined by modifying terms included “permanently flooded, regularly flooded, seasonally flooded, and temporarily flooded.”

Special Modifiers

The USFWS defines special modifiers to be used in wetlands systems or deepwater habitats. The specific modifiers that are used in the classification systems above are “excavated and partially drained/ditched”. The excavated modifier means the basin or channel was excavated by man. Partially drained/ditched is where the water level has been artificially lowered or drained. However, the area is still classified as a wetland because the soils moisture still supports hydric plants.

UTILITY SERVICES

The Puget Sound Energy (PSE) is the electrical power provider that serves the Port Ludlow Drainage District. The PSE’s goals and future objectives include providing sufficient electrical capacity to meet existing demand for both the incorporated District limits as well as the surrounding area.

Qwest Communications International provides the majority of conventional telephone service in Jefferson County and provides the local service for the Port Ludlow area. Cellular telephone service is provided by AT&T Wireless Services and Verizon Wireless. Cable television service is provided by Millennium Digital Media. Millennium Digital Media provides local and cable channels and internet connection.

The Port Ludlow Associates provide water and sanitary sewer systems as a private utility company. Jefferson County is responsible for drainage facilities within the County rights-of-way and the Port Ludlow Drainage District is responsible for drainage outside the rights-of-way.

CHAPTER 4

EXISTING STORMWATER DRAINAGE SYSTEM

INTRODUCTION

The analysis of stormwater runoff system performance requires knowledge of the components that make up the stormwater system. Port Ludlow Drainage District's storm drainage collection and conveyance system, which ultimately conveys stormwater to the Puget Sound, consists of typical components such as catch basins, piping, open roadside ditches, other ditches, and natural streams. This chapter presents a physical description of the current stormwater systems within the District.

EXISTING STORMWATER DRAINAGE INVENTORY

The evaluation of the District's drainage facilities begins with the establishment of an inventory of the existing system's components. Information included in the inventory for selected areas is pipe diameter, length and slope invert, elevations of catch basins and configuration of open channels. Jefferson County provided a database of culverts within the rights-of-way and District personnel assisted with locations of other drainage features out of the rights-of-way. An inventory of the existing stormwater drainage system was compiled from field inspection data, aerial surveying, and existing as-built maps. A summary of the results is shown in Table 4-1.

TABLE 4-1

Stormwater System Inventory

Structure	Quantity ⁽¹⁾ (Linear Feet)
Catch Basins (Each)	60
Open Ditch/Channel	80,000
Driveway Tiles	9,300 ⁽²⁾
12-inch Pipe	2,800
15-inch Pipe	40
18-inch Pipe	3,700
21-inch Pipe	50
24-inch Pipe	630
30-inch Pipe	300
36-inch Pipe	390
42-inch Pipe	150

(1) Rounded

(2) Estimate based on 2003 assessment and aerial survey

Information from the system inventory was used to numerically model the flow of stormwater through the drainage system. From the information generated by the hydraulic model, conveyance systems can be planned to accommodate storm runoff for any specific design storm. The model can also identify current system deficiencies from which a capital improvement plan can be developed. The improvements may be installed as part of the District Capital Improvement Program, by Jefferson County, or as part of developer improvements. The model results indicate the proper size of the storm pipe to be installed to allow for conveyance of stormwater runoff. For example, the model may indicate that a system component such as a pipe may be satisfactory for the conveyance of runoff from a 2-year storm event, but may not be able to convey runoff from a 10-year storm event. At such time that the District has funding available, or as part of mitigation for a new development, a design can then be completed based upon the model results and the improvement constructed.

A base map provides a tool for District staff to use in planning for future extensions and for tracking facilities maintenance and repair and replacement (Appendix F). The District may wish to expand upon the inventory developed for this project and maintain a detailed set of surface water drainage maps for use by staff as a basic component of the District inventory.

BASIN DESCRIPTIONS

Most of the Port Ludlow Drainage District is on moderate to steep slopes draining general south and east. Grades within the District are at times steep enough to cause significant erosion due to high velocity of runoff. Infiltration in the area is limited due to the high groundwater table and the poorly drained soils, which dominate the region. Though no catastrophic floods have occurred in recent history, there have been a few instances of water entering residences. The District generally experiences nuisance ponding and flooding during wet weather months. Wet crawl spaces under homes are also prevalent throughout the District during the wet season.

The District has a number of outfalls for flow from the upland areas. Basins discharging to specific outfalls are named for the primary road in the area and shown in Figure 4-1. For the purpose of isolating and identifying potential deficiencies within the conveyance system, the Port Ludlow Drainage District was divided into 38 separate drainage basins as shown in Figure 4-2 and as described in Table 4-2.

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BY: MW

SCALE
1"=1000'



SWANSONVILLE

C1

C2

E

BALDWIN

MONTGOMERY LANE

PIONEER

DRIVE

DRIVE

EAST

PIONEER

DRIVE

DRIVE

ROAD

SWANSONVILLE

DRIVE

BOUNDARY

DRAINAGE DISTRICT

OSPREY

RIDGE

DRIVE

OSPREY

RIDGE

DRIVE

RAINIER LANE

TALBOT

WAY

DETENTION
POND

WALKER

WAY

OAK

BAY

ROAD

RESORT

1B

PARADISE BAY ROAD

PORT LUDLOW DRAINAGE DISTRICT
STORMWATER COMPREHENSIVE PLAN

FIGURE 4-1
DRAINAGE BASIN MAP



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CONSULTING ENGINEERS

LEGEND
— District Boundary
— Drainage Basin

TABLE 4-2

Drainage Basin Descriptions

	Location
Basin A	West Swansonville & portion of District west of Osprey Ridge Dr. → M1
Basin B	East Swansonville to Walker Way west of Rainier Ln → M1
Basin C1	North of Pioneer Dr. West & Foster Ln → Spring Creek → Puget Sound
Basin C2	Between Foster Ln, Jackson Ln, & Oak Bay Rd → Puget Sound
Basin D	Between McCurdy Ln, Harms Ln, & Pioneer Dr. E. → H
Basin E1	Between Jackson Ln & Oak Bay Rd → Oak Bay Rd (E2)
Basin E2	Montgomery Ln north of Baldwin Ln → Puget Sound
Basin F	East of Talbot Way → B
Basin G1	East of Camano Ln incl. Resolute Ln & Goliah Ln → Oak Bay Rd (G2)
Basin G2	Between Resort Maintenance Complex parking lot & south tip of Montgomery Ln → Puget Sound
Basin H	Between Pioneer Dr. & Fleet Dr. → J
Basin I1	Jackson Ln & north of Wheeler Ln → Oak Bay Rd (I3)
Basin I2	Wheeler Ln → Oak Bay Rd (I3)
Basin I3	Baldwin Ln & west of Montgomery Ln → Puget Sound
Basin J	Between Fleet Dr., Swansonville Rd, & Pioneer Dr. → K
Basin K	Between Pioneer Dr. & Montgomery Ln & across Oak Bay Rd, west of Baldwin Ln, east of Grove Ct → Puget Sound
Basin L1	West of Osprey Ridge Dr. (Basin A), north of Oak Bay Rd → L2
Basin L2	Between Oak Bay Rd, Paradise Bay Rd, & Breaker Ln → Puget Sound
Basin M1	Between Osprey Ridge Dr. & Rainier Ln, south of Walker Way, north of Oak Bay Rd → Puget Sound
Basin M2	Bound to west, south, & east by Rainier Ln, north by Basin N → M1
Basin N	Rainier Ln south of Walker Way (Schooner Ln to Topsail Ln) → M1
Basin O	Northwest of Walker Way & Rainier Ln intersection → Q1
Basin P	West of Olympic Ln → Q1
Basin Q1	Rainier Ln and Walker Way, south of Swansonville Rd, west of Camano Ln, not incl. Basins O, P, or S1, east of Puget Loop → Q3
Basin Q2	Between Cressey Ln & Cascade Ln → Q3
Basin Q3	Lower Walker Way → Oak Bay Rd (Z)
Basin R	Between Gamble Ln & Oak Bay Rd → Oak Bay Rd (Z)
Basin S1	Southwest of Rainier Ln & Swansonville Rd intersection → S2
Basin S2	Swansonville Rd & Keller Ln → Oak Bay Rd (G1)
Basin T	Between Oak Bay Rd & Condon Ln, north of Pope Way → Puget Sound
Basin U	Between Northwood Ct cul-de-sac bulb & Oak Bay Rd → Oak Bay Rd, Port Ludlow Condos
Basin V	Eastern Rainier Ln → Port Ludlow No. 7 detention pond → Puget Sound
Basin W	Machias Loop → Y

TABLE 4-2 – (continued)

Drainage Basin Descriptions

	Location
Basin X	Between Machias Loop & Oak Bay Rd → Puget Sound
Basin Y	Between Machias Loop, Puget Loop, & Drew Ln → X
Basin Z	Puget Loop & Phinney Ln → Oak Bay Rd → Puget Sound
Basin 1A	Between Oak Bay Rd & Condon Ln, south of Pope Way → T
Basin 1B	Condos north of Ludlow Bay Village → Puget Sound
Basin 1C	Ludlow Bay Village & Marina → Puget Sound

The specific soil series within the area of Port Ludlow include Swantown gravelly loam and sandy loam (SuB and StB), Indianola loamy sand (InC), Alderwood gravelly sandy loam (AIC and AID), Cossolary sandy loam (CfD), Cossolary-Everett complex (ChC), Everett gravelly sandy loam (EvC), coastal beaches (Co), and cut and fill land (Cu). The characteristics of these soils are described in more detail in Chapter 3.

DRAINAGE BASIN A – DRAINS TO BASIN M1

Basin A includes a long, narrow stretch of land between Swansonville and the District. The land use varies from quarter-acre residential lots commercial. The terrain is varied, with mild to steep slopes. Drainage is primarily overland flow upstream of Osprey Ridge Drive, where roadside ditches and culverts convey runoff south. The soil in the north half of the basin is Alderwood Gravelly Sandy Loam (AIC) whereas the south half consists primarily of Cossolary-Everett Complex (ChC) soils, which are poorly drained soils. The entire drainage area for Basin A is approximately 135 acres.

DRAINAGE BASIN B – DRAINS TO BASIN M1 VIA WALKER WAY

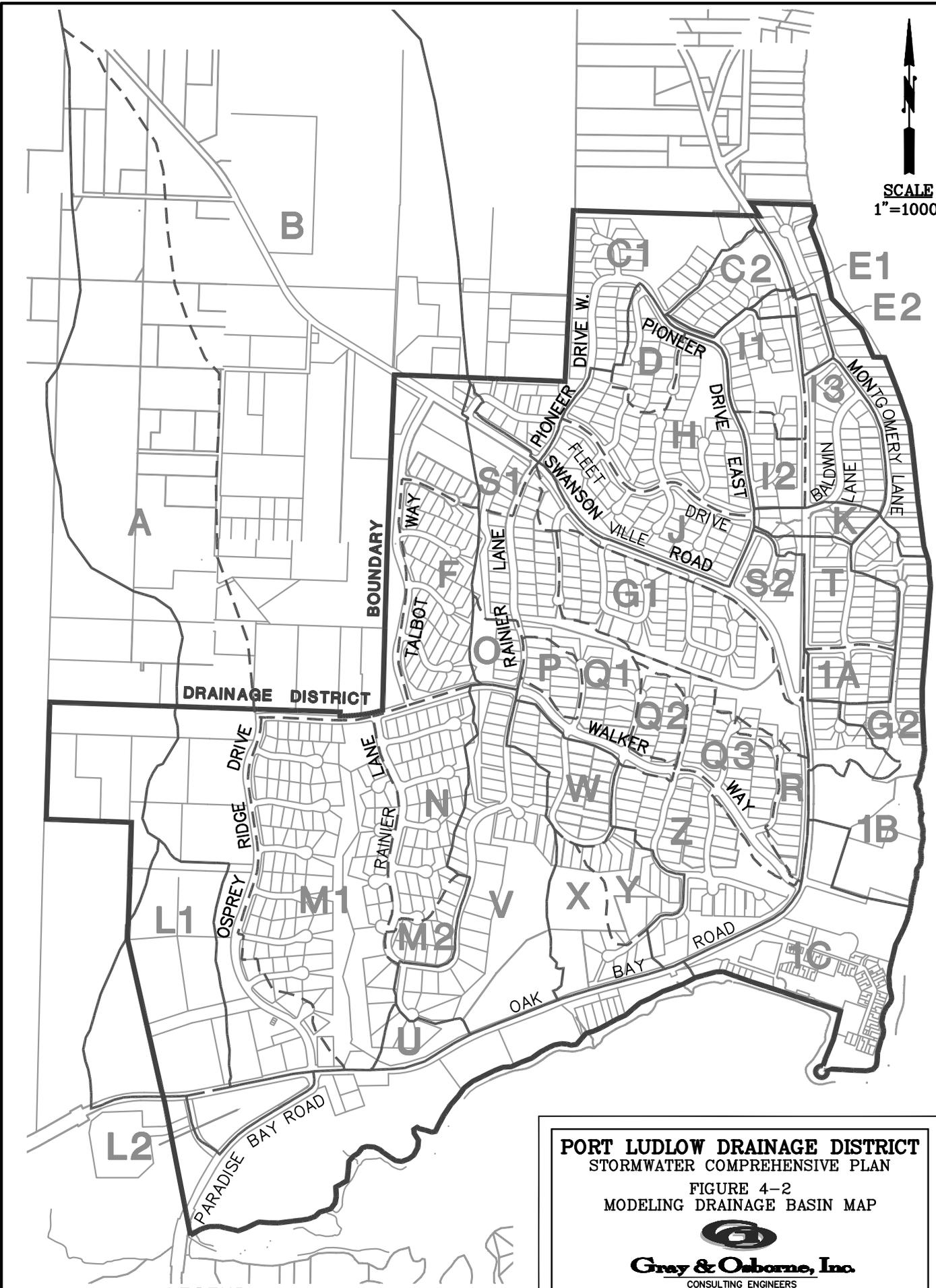
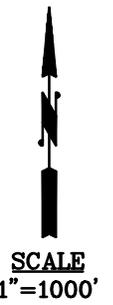
Basin B is by far the largest of all drainage basins, covering a large portion of Swansonville, a small portion of the District west of Talbot Way, and draining south into the District across Walker Way. Land uses are a mix of heavy forest, undeveloped areas, and residential. The terrain is varied, with primarily mild slopes outside of the District. Soils in this basin are dominated by Alderwood Gravelly Sandy Loam (AIC), though a narrow north-south section of Swantown Gravelly Sandy Loam (StB) is located in the middle of the basin. The entire drainage area for Basin B is approximately 264 acres.

DRAINAGE BASIN C1 – DRAINS ACROSS OAK BAY RD TO PUGET SOUND

Basin C1 is generally located north of Pioneer Drive West and Foster Way at the north edge of the District. A portion of the runoff collected along Jefferson Avenue is conveyed in a roadside ditch or sheet flows to Pioneer Drive West. From there, runoff is conveyed northeasterly towards a culvert under Pioneer Drive East near McCurdy Lane. Then, a steep, wooded ravine located between Pioneer Drive West and Oak Bay Road

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BY: MW



LEGEND

-  District Boundary
-  Drainage Sub-Basin
-  Drainage Basin

PORT LUDLOW DRAINAGE DISTRICT
 STORMWATER COMPREHENSIVE PLAN
 FIGURE 4-2
 MODELING DRAINAGE BASIN MAP



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acts as a natural drainage course for stormwater conveyed through the culvert. The ravine spills into a culvert under Oak Bay Road (outside of the District) on route to Spring Creek and the Puget Sound. Soils in this basin are generally Alderwood Gravelly Sandy Loam (AIC). The drainage area within the District for Basin C1 is approximately 32 acres.

DRAINAGE BASIN C2 – DRAINS ACROSS OAK BAY RD TO PUGET SOUND

Basin C2 is located near the north margin of the District and in the vicinity of Foster Lane and Jackson Lane. Land use consists of residential lots and undeveloped open space primarily composed of a ravine. The terrain is steep, especially those slopes off the rear of the residential lots and into the ravine. Drainage consists of roadside ditches and driveway tiles in the residential area prior to entering the ravine. A culvert crossing Oak Bay Road drains the basin towards the northern tip of Montgomery Lane prior to discharge into Puget Sound via a residential drainage system. Soils in this basin are Cossolary Sandy Loam (CfD). The entire drainage area for Basin C2 is approximately 9 acres.

DRAINAGE BASIN D – DRAINS TO BASIN H

Basin D is located in the vicinity of McCurdy Lane and Harms Lane. Land use residential, of which, a majority is developed. The terrain is mild, relative to the rest of the District, with an average slope of approximately 5 percent. Drainage is primarily roadside ditches and driveway tiles. Runoff is conveyed out of the basin in a culvert located in Pioneer Drive. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin D is approximately 8 acres.

DRAINAGE BASIN E1 – DRAINS TO BASIN E2 VIA OAK BAY ROAD

Basin E1 is the smallest basin in the District located in between Jackson Lane and Oak Bay Road. The basin consists of a few residential lots and a heavily forested area west of Oak Bay Road. The forested terrain is relatively steep, with an average slope of approximately 10 percent. Drainage is primarily sheet flow upstream of a culvert crossing Oak Bay Road. Soils in the basin are Cossolary Sandy Loam (CfD). The entire drainage area for Basin E1 is approximately 1 acre.

DRAINAGE BASIN E2 – DRAINS TO PUGET SOUND

Basin E2 is located near the north end of Montgomery Lane. The basin is entirely residential, with three existing residences. Drainage is routed in roadside ditches and driveway tiles to an outfall to Puget Sound. Drainage is conveyed through roadside ditches and driveway tiles prior to discharging into Puget Sound. Soils in the basin are Cossolary Sandy Loam (CfD). The entire drainage area for Basin E2 is approximately 3 acres.

DRAINAGE BASIN F – DRAINS TO BASIN B VIA TALBOT ROAD

Basin F is located east of Talbot Way. Drainage consists of sheet flow to roadside ditches on cul-de-sacs where it is then routed to Talbot Way and further into a culvert crossing Walker Way. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin F is approximately 20 acres.

DRAINAGE BASIN G1 – DRAINS TO BASIN G2 VIA OAK BAY ROAD

Basin G1 is a residential basin located in the vicinity of Resolute Lane and Goliath Lane. Drainage consists of roadside ditches and driveway tiles prior to discharge to a reserve area, which discharges into a culvert in Oak Bay Road. During large storm events and/or a blockage of the culvert underneath Oak Bay Road, runoff in excess of the carrying capacity of the culvert is routed in the ditch alongside Oak Bay Road towards Basin R and further on towards Basin Z and a separate outfall into Puget Sound. Soils in this basin are Alderwood Gravelly Sandy Loam. The upper portion of the basin is generally steeper than the lower portion, which is consistent with further classification of the soils in the basin. The upper portion of the basin is comprised primarily of AID soils (15-30 percent slopes) and the lower portion is generally AIC soils (0-25 percent slopes). The entire drainage area for Basin G1 is approximately 30 acres.

DRAINAGE BASIN G2 – DRAINS TO PUGET SOUND VIA 42-INCH CULVERT

Basin G2 is located upstream of the wastewater treatment plant in an undeveloped portion of land north of the resort parking lot. Drainage is contained within ditches and culverts. Soils in this basin are Swantown Gravelly Loam (SuB). The entire drainage area for Basin G2 is approximately 6 acres.

DRAINAGE BASIN H – DRAINS TO BASIN J VIA PIONEER DRIVE EAST

Basin H is a relatively large basin comprising most of the land between Fleet Drive and Pioneer Drive East. Drainage is a mix of sheet and tightlined flow. A majority of roads within the basin are lined with ditches and driveway tiles. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin H is approximately 25 acres.

DRAINAGE BASIN I1 – DRAINS TO BASIN I3 VIA OAK BAY ROAD

Basin I1 is a mix of residential development and reserve area located in the vicinity of Jackson Lane and north of Wheeler Lane. Drainage is conveyed to the reserve area in the middle of the basin on route to Oak Bay Road. Soil in the north half of this basin is Cossolary Sandy Loam (CfD) whereas the south half of the basin is Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin I1 is approximately 12 acres.

DRAINAGE BASIN I2 – DRAINS TO BASIN I3 VIA OAK BAY ROAD

Similar to Basin I1, Basin I2 is a mix of residential development and reserve area. The basin is located in the vicinity of Wheeler Lane. Drainage is conveyed a culvert located within Wheeler Lane, across undeveloped residential land on route to Oak Bay Road. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin I2 is approximately 7 acres.

DRAINAGE BASIN I3 – (BALDWIN LANE) DRAINS TO PUGET SOUND

Basin I3 is located in the vicinity of Baldwin Lane and is comprised of residential lots. Drainage along Baldwin Lane is contained within roadside ditches and driveway tiles. The basin ultimately discharges Puget Sound via a culvert in Montgomery Lane. The western edge of this basin alongside Oak Bay Road is comprised of Alderwood Gravelly Sandy Loam (AIC) soils whereas the soil in the remainder of the basin is Swantown Gravelly Loam (SuB). The entire drainage area for Basin I3 is approximately 14 acres.

DRAINAGE BASIN J – DRAINS TO BASIN K VIA OAK BAY ROAD

Basin J is bound by Fleet Drive and Swansonville Road and is comprised of residential lots. Drainage is contained within roadside ditches and driveway tiles prior to discharge into a culvert in Pioneer Drive East on route to Oak Bay Road. Puget Sound via a culvert in Montgomery Lane. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin J is approximately 20 acres.

DRAINAGE BASIN K – DRAINS TO PUGET SOUND

Basin K consists primarily of a reserve area and an incised drainage course. Development within the District has caused significant erosion within this drainage course. The basin discharges into Puget Sound via a culvert in Montgomery Lane. Oak Bay Road approximately divides soil types in the basin, with Alderwood Gravelly Sandy Loam (AIC) west of and in the near vicinity of the road and Swantown Gravelly Loam (SuB) to the east. The entire drainage area for Basin K is approximately 5 acres.

DRAINAGE BASIN L1 – DRAINS TO BASIN L2 VIA OAK BAY ROAD

Basin L1 is mostly undeveloped and is covered by both forested and open grassy areas. The basin discharges into an underground conveyance system in Basin L2 via a culvert in Oak Bay Road. Soils in the basin are a mix of Alderwood Gravelly Sandy Loam (AIC), and Cossolary-Everett Complex (ChC). The entire drainage area for Basin L1 is approximately 36 acres.

DRAINAGE BASIN L2 – DRAINS TO PARADISE BAY ROAD

Basin L2 includes commercially zoned land and is bound by Oak Bay Road and Paradise Bay Road. Drainage in the interior of the basin is contained within a manmade underground conveyance system while roadside ditches line the edges of the basin. Soils in this basin are primarily Alderwood Gravelly Sandy Loam (AIC), with a small pocket of Everett Gravelly Sandy Loam (EvC) in the southwest corner. The entire drainage area for Basin L2 is approximately 7 acres.

DRAINAGE BASIN M1 – DRAINS TO PUGET SOUND VIA OAK BAY ROAD

Basin M1 covers a large area of land between Walker Way and Oak Bay Road, bound by Osprey Ridge Drive and Rainier Lane. The center of the basin is a moderately sloped, forested drainage-way located within a reserve area. The lower portion of the basin transitions into a steep ravine. Tributary flows are from residential lots and Basins B, F, M2, and N. The majority of this basin is underlain by Cossolary-Everett Complex (ChC) soils. The steep, lower section of the basin is underlain by Alderwood Gravelly Sandy Loam (AID) soils. The entire drainage area for Basin M1 is approximately 59 acres.

DRAINAGE BASIN M2 – DRAINS TO BASIN M1 VIA RAINIER LANE

Basin M2 is a small basin located at the south end of Rainier Lane. The basin is made up of residential lots all draining into Basin M1 via roadside ditches and a culvert under Rainier Lane. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin M2 is approximately 5 acres.

DRAINAGE BASIN N – DRAINS TO BASIN M1 VIA RAINIER LANE

Basin N is located in the vicinity of Rainier Lane. Drainage from streets tributary to Rainier Lane is conveyed in roadside ditches and driveway tiles. The land use is exclusively residential. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin N is approximately 22 acres.

DRAINAGE BASIN O – DRAINS TO BASIN Q1 VIA RAINIER LANE

Basin O is located immediately northwest of the intersection of Walker Way and Rainier Lane. The relatively small drainage area is comprised of residential lots and reserve area. A culvert in Rainier Lane drains the basin east towards Walker Way and Basin Q1. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin O is approximately 5 acres.

DRAINAGE BASIN P – DRAINS TO BASIN Q1 VIA WALKER WAY

Basin P is located uphill from Olympic Lane. The basin is exclusively residential zoning, though approximately half of the basin is undeveloped. Reserve area along Walker Way and a roadside ditch along Olympic Lane convey flow to a culvert in Walker Way. Soils in this basin are Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin P is approximately 5 acres.

DRAINAGE BASIN Q1 – DRAINS TO BASIN Q3

Basin Q1 is primarily located along Walker Way, though it extends north along Rainier Lane to Swansonville Road. The terrain is varied, with mild to moderate slopes along Rainier Lane and moderate to steep slopes in residential areas and Walker Way. Drainage from streets tributary to Walker way is contained within roadside ditches and driveway tiles. A roadside ditch is also located on both sides of Walker Way, as runoff is conveyed east towards Basin Q3. Soils in this basin are Alderwood Gravelly Sandy Loam. The portion of the basin in the vicinity of Rainier Lane has generally milder slopes than the lower portion, which is consistent with further classification of the soils in the basin. The upper portion of the basin is comprised primarily of AIC soils (0-25 percent slopes), with the lower portion generally AID soils (15-30 percent slopes). The entire drainage area for Basin Q3 is approximately 27 acres.

DRAINAGE BASIN Q2

Basin Q2 collects a small area uphill from Walker Way between Cressey Lane and Cascade Lane. Surface runoff from residential lots drains to roadside ditches and driveway tiles on route to Walker Way. Soils in this basin are Alderwood Gravelly Sandy Loam (AID). The entire drainage area for Basin Q2 is approximately 6 acres.

DRAINAGE BASIN Q3 – DRAINS TO BASIN Z VIA OAK BAY ROAD

The lower portion of Walker Way and the area between Gamble Lane and Cressey Lane makes up Basin Q3. Roadside ditches convey runoff to Walker Way where the flow is directed east towards Oak Bay Road. Soils in this basin are Alderwood Gravelly Sandy Loam (AID). The entire drainage area for Basin Q3 is approximately 15 acres.

DRAINAGE BASIN R – DRAINS TO BASIN Z VIA OAK BAY ROAD

Basin R is located between Oak Bay Road and Gamble Lane. Drainage from residential lots east of Gamble Lane sheet flows east towards a roadside ditch in Oak Bay Road. Soil in this basin is mild to moderate sloped Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin R is approximately 6 acres.

DRAINAGE BASIN S1 – DRAINS TO BASIN S2

Basin S1 is located immediately southwest of the intersection of Swansonville Road and Rainier Lane. Land use is a mix of residential and reserve area used as a vehicle parking lot. Roadside ditches convey stormwater to a culvert under Rainier Lane on route to Basin S2. The domestic water reservoir located in this basin also drains to the ditch in Swansonville Road. Soil in this basin is mild to moderate sloped Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin S1 is approximately 6 acres.

DRAINAGE BASIN S2 – SWANSONVILLE ROAD BASIN

Basin S2 is a long narrow basin centered about Swansonville Road and including a small area in the vicinity of Keller Lane. A majority of the basin runoff comes from Swansonville Road and is conveyed in roadside ditches and culverts before discharging to a culvert west of Oak Bay Road and into Basin G1. Soil in this basin is mild to moderate sloped Alderwood Gravelly Sandy Loam (AIC). The entire drainage area for Basin S2 is approximately 15 acres.

DRAINAGE BASIN T – DRAINS TO PUGET SOUND

Basin T is located between Oak Bay Road and Condon Lane north of Pope Way. The basin consists entirely of residential lots and has mild slopes relative to the rest of the District. Drainage is conveyed in roadside ditches and culverts on route to a culvert under Condon Lane and further on to Puget Sound. Soil in the vicinity of Oak Bay Road Alderwood Gravelly Sandy Loam (AIC). East of Oak Bay Road, the basin consists of Swantown Gravelly Loam (SuB). The entire drainage area for Basin T is approximately 15 acres.

DRAINAGE BASIN U – DRAINS TO PORT LUDLOW CONDOMINIUMS VIA OAK BAY ROAD

Basin U is located between Northwood Court and Oak Bay Road. The basin consists of three residential lots lining the southern end of Northwood Court and a steep, wooded reserve area next to Oak Bay Road. Soil in this basin is moderate to steep sloped Alderwood Gravelly Sandy Loam (AID). The entire drainage area for Basin U is approximately 5 acres.

DRAINAGE BASIN V – DRAINS TO PORT LUDLOW NO. 7 POND

The upper portion of Basin V is located along Rainier Lane south of Walker Way and extends south towards the Port Ludlow No. 7 detention pond. The lower portion of the basin consists of a large, steep reserve area covered in dense trees and undergrowth. Stormwater from the detention pond outfall is conveyed in a deep culvert located underneath Oak Bay Road on route to a ravine south of the road and further on into a culvert that discharges into Puget Sound. Soil in this basin is moderate to steep sloped

Alderwood Gravelly Sandy Loam (AID). The entire drainage area for Basin V is approximately 42 acres.

DRAINAGE BASIN W – DRAINS TO BASIN Y

Basin W is located in the vicinity of Machias Loop and entirely south of Basin Q1 (Walker Way). Drainage is collected in roadside ditches and conveyed in ditches and driveway tiles to a culvert underneath the southeast portion of Machias Loop. Soil in this basin is moderate to steep sloped Alderwood Gravelly Sandy Loam (AID). The entire drainage area for Basin W is approximately 10 acres.

DRAINAGE BASIN X – DRAINS TO PUGET SOUND VIA OAK BAY ROAD

The land use of Basin X is almost entirely reserve area, as the land is very steep with heavy tree cover. The upper corner of the basin contains a few residential lots that drain into the reserve area. Drew Lane also extends into the basin. Runoff from the residential lots on that street drains to roadside ditches or sheet flows into the reserve area. Drainage for the basin is generally overland flow, likely with minor channels developing in places. Soil in this basin is moderate to steep sloped Alderwood Gravelly Sandy Loam (AID). The entire drainage area for Basin X is approximately 13 acres.

DRAINAGE BASIN Y – DRAINS TO BASIN X

Basin Y is located immediately east of Basin X and is bound to the south by Drew Lane. Steep slopes transverse the residential lots located within the basin along Puget Loop, Machias Loop, and Drew Lane. Runoff from these lots primarily sheet flows into the reserve area, though a majority of the lots north of Drew Lane drain into a roadside ditch. This runoff is then conveyed in the ditch via driveway tiles to a culvert under Drew Lane on route to a culvert underneath Oak Bay Road further on to Puget Sound. Soil in this basin is moderate to steep sloped Alderwood Gravelly Sandy Loam (AID). The entire drainage area for Basin Y is approximately 9 acres.

DRAINAGE BASIN Z – DRAINS TO PUGET SOUND VIA OAK BAY ROAD

Basin Z contains Puget Loop and Phinney Lane and is located between Walker Way, Oak Bay Road, and Basins W and Y. Drainage from the basin is collected in roadside ditches and is conveyed via driveway tiles and culverts to a reserve area located south of and alongside Walker Way. From that point, stormwater is conveyed in an asphalt lined ditch along north margin of Oak Bay Road to a culvert underneath Oak Bay Road, which empties into a small vault prior to discharging into Puget Sound. The asphalt ditch also collects stormwater from the Walker Way drainage basins (O, P, Q, and R) and from Basins S1 and G1 during large storm events. Soil in this basin is moderate to steep sloped Alderwood Gravelly Sandy Loam (AID). The entire drainage area for Basin Y is approximately 26 acres.

DRAINAGE BASIN 1A – DRAINS TO PUGET SOUND VIA BASIN T

Basin 1A is located between Oak Bay Road and Condon Lane south of Pope Way. Drainage from this mildly sloped basin is conveyed in roadside ditches and driveway tiles to a culvert underneath Pope Way on route towards the outfall of Basin T. Soils in this basin are Swantown Gravelly Loam (SuB). The entire drainage area for Basin 1A is approximately 6 acres.

DRAINAGE BASIN 1B – DRAINS TO PUGET SOUND

Basin 1B is located in the vicinity of the Ludlow Bay Village Condominiums and between Oak Bay Road and Puget Sound. The upper portion of the basin is mild to moderately sloped and consists of mostly grassy fields and a parking lot. The condominiums are located in the lower portion of the basin where the basin transitions to moderate slopes. Drainage within the upper portion of the basin is primarily overland sheet flow. Runoff from the condominiums is collected in a storm drainage system (catch basins and pipes) and eventually discharges into Puget Sound. Soils in this basin are Swantown Gravelly Loam (SuB). The entire drainage area for Basin 1B is approximately 16 acres.

DRAINAGE BASIN 1C – DRAINS TO PUGET SOUND

Ludlow Bay Village and the Marina make up Basin 1C. This basin is built-out with commercial and residential land uses and serves as one of the main centers of the District. A manmade pond located near the east side of the basin collects runoff from the west and north portions of the basin. Other portions of this basin outfall directly to Puget Sound. Soils in this basin are a mix of Swantown Gravelly Loam (SuB), Indianola Loamy Sand (InC), Coastal Beaches (Co) and Cut and Fill Land (Cu). The entire drainage area for Basin 1C is approximately 30 acres.

KNOWN DRAINAGE PROBLEMS

It was determined during various site visits, and through discussion with District Commissioners, that a number of projects should be undertaken which would substantially reduce the locations and frequencies of nuisance ponding within the District. Possible solutions for these problems may be found in Chapter 8. Other drainage problems are identified through the modeling of the District. These problems are identified in Chapter 5.

CHAPTER 5

HYDROLOGIC MODELING

Hydrologic and hydraulic analysis of the Port Ludlow Drainage District stormwater system was performed using the EPA's Surface Water Management Model (SWMM). This computer program is capable of numerically modeling existing basin conditions as well as future land use conditions to reflect future anticipated stormwater runoff. The hydrologic/hydraulic model for the Drainage District was developed to assess the capacity of the current stormwater system under these conditions and to provide a basis for the development of improvements to the system.

MODELING BACKGROUND

Hydrologic analysis addresses the movement of rainfall to the conveyance system. The purpose of a hydrologic model is to predict the flow of stormwater runoff into the conveyance system. The input parameters to the model assume that within each hydrologic basin or collection area there are discrete locations at which runoff enters the conveyance system, such as catch basins, culverts, and channels. In actuality, runoff enters a conveyance system at numerous locations, for example, any point along the entire length of a ditch. For these situations it was assumed that the runoff enters the system at a known point downstream and time of concentration¹ values were adjusted accordingly. The information generated in the hydrologic model is presented in the form of a hydrograph, a standard plot of runoff (cubic feet per second, cfs) versus time (hours) for a given location and design storm event.

Hydrologic modeling methods require input parameters that describe physical drainage basin characteristics. Together with the distribution of rainfall over time, these parameters determine the shape of the resulting hydrograph generated by the model. Key parameters are the area of pervious and impervious surfaces, the interconnectivity of the impervious areas, topography, and infiltration characteristics of the soil. As part of the hydraulic modeling, all stormwater conveyance information was obtained through the review of existing as-builts for the District, an aerial survey of the District developed as a part of this comprehensive plan, Jefferson County records, discussions with District Commissioners and residents, public questionnaires, and data collected during field visits. A topographic survey of a portion of the Oak Bay Road storm drainage system was also completed.

The basic steps in the development of the hydrologic or runoff model include:

¹ Time of concentration is the amount of time from the onset of the precipitation event it takes water to travel from the farthest point of the basin to the discharge node. This is calculated using equations for overland flow, sheet flow, shallow concentrated flow, and channelized flow.

- Development of rainfall intensity over time.
- Delineation of the drainage basins and sub-basins.
- Identification of land use and estimation of the amount of pervious and impervious area.
- Identification of soil types and estimation of the infiltration parameters.
- Identification of topographic characteristics and estimation of flow parameters including average slope, roughness coefficients, and depression storage.

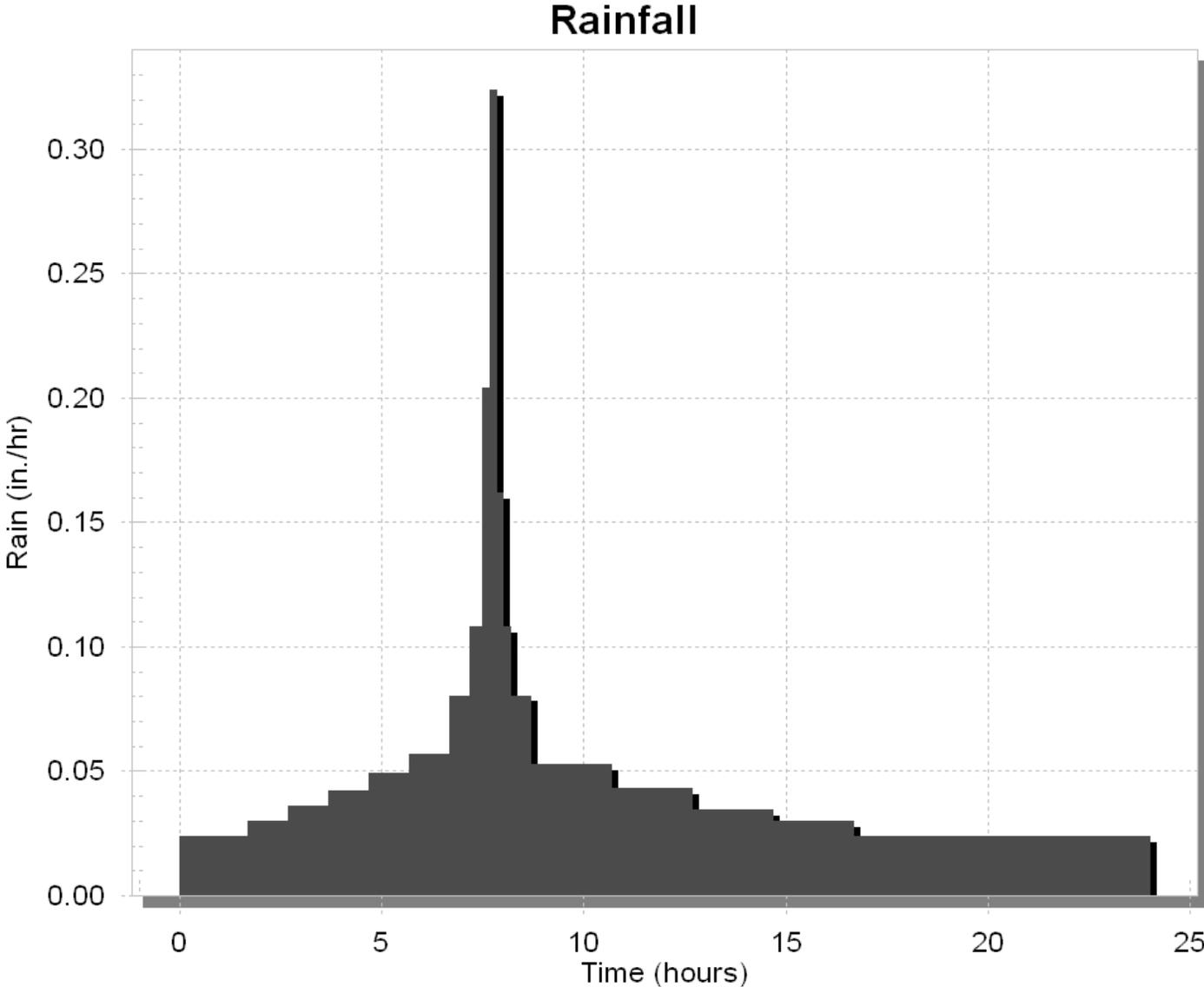
Based upon these parameters, the model estimates the resulting runoff from each sub-basin. The resulting runoff hydrographs are added together within the conveyance system to provide inflow volumes. Hydraulic analysis is then used to determine the flow rates over the time of the design storm, including the peak flow rate for the event. The water surface elevations is determined over time throughout the conveyance system for a given storm event. Hydraulic analysis is based on the physical characteristics of the conveyance system, such as cross-sectional area, slope, and roughness.

It should be especially noted that missing information relating to the conveyance system was supplemented with worst case assumptions. These assumptions include the estimation of pipe invert levels at approximately 3 feet below the ground and a slope corresponding to the natural topography above the pipe. Since no on the ground field survey was conducted for the majority of the District, any recommended capital improvement project areas resulting from this plan need to be surveyed to ensure the most accurate and effective design for the project. All recommended pipe sizes in this chapter assume that the existing slope will be utilized in the future. However, the most optimum slope should be analyzed in order to provide maximum capacity while also allowing sand and other sediment to transport through the pipe. **Prior to the implementation of any design projects recommended throughout this plan, the slope should be carefully analyzed to ensure that the maximum pipe capacity is attainable while allowing the minimum sized pipe to be installed.**

CALIBRATION

The model was compiled using data collected from continuous flow meters that were installed as part of this project. Flows were measured at three separate locations. The flow meters were in place for a 7-week period between February 7 and March 27, 2002. The first location was in a 36-inch culvert located underneath Montgomery Lane near Libby Court. The second location was in an 18-inch pipe within a catch basin on Montgomery Lane, located approximately 250 feet north of Libby Court. The third location was in a 36-inch pipe located within a vault on Oak Bay Road west of the marina. Rainfall data was collected with a tipping gauge bucket located at the RV storage area in the north-central part of the District. Measured flows were compared to flows generated by the model using daily rainfall data for Port Ludlow obtained from the rain gauge. This rainfall was distributed using the SCS Type 1A storm shown in Figure 5-1. It should be noted that model development based on this form of rainfall distribution

FIGURE 5-1
Unit Storm Rainfall Distribution



can sometimes be inaccurate due to the distribution of rain that actually occurred throughout the modeling period.

Calibration of the model was performed by adjusting the input parameters until the observed flows from selected storm events compared favorably to the modeled runoff from the same period. However, there were no significant rainfall events during the flow-metering period. Hydraulic models can be calibrated more accurately with large storm events that more closely mimic SCS Type 1A rainfall distribution. The largest rainfall event during the flow-metering period was 1.3 inches of rain over a two-day period or approximately 0.65 inches of rain in a one-day period, which is only two-thirds of the rainfall accumulated during a 2-year, 24-hour design storm event for the District. Figure 5-2 shows flow generated by the model compared with those obtained from the 36-inch pipe flow meter in Montgomery Lane. Figure 5-3 shows flow generated by the model compared with those obtained from the 18-inch pipe flow meter in Montgomery Lane. Figure 5-4 shows flow generated by the model compared with those obtained from the 36-inch pipe flow meter in Oak Bay Road.

Only a portion of the District is tributary to the three flow meters discussed in this plan. The model parameters that were modified during calibration of the drainage basins tributary to flow meters were applied to the non-metered basins. Characteristics of each drainage basin were accounted for when applying assumptions across the District.

DESIGN STORM

All storm event models, such as SWMM, require the input of data describing rainfall intensity over time. Design storms are defined in terms of:

- Return frequency – the statistically estimated length of time between which storms with a given total amount of rainfall will occur
- Total rainfall (depth in inches)
- Storm duration and rainfall distribution over time

Design storms are hypothetical storms based upon a statistical analysis of historical storm events. For western Washington, design storm rainfall, both intensity at a given time and the total volume, are described in the Washington Department of Ecology *Stormwater Management Manual for the Puget Sound Basin*. The 100-year design storm was used to size the conveyance system. This design storm results in a total precipitation of 3.5 inches over a 24-hour period. Design Storm rainfall totals based on NOAA maps are shown in Table 5-1.

TABLE 5-1

Design Storm Rainfall Totals

Event	Precipitation
2 year - 24 hour	1.5-inches
10 year – 24-hour	2.5-inches
100 year – 24 hour	3.5-inches

The design storm dictates the rainfall intensity at a given time and the total rainfall depth in inches. This creates a volume and distribution of rainfall over a given period of time. Figure 5-1 shows the recommended hyetograph (rainfall distribution) used for modeling rainfall events in western Washington. The hyetograph shown is the standard SCS Type 1A rainfall distribution, modified for western Washington.

In order to complete the model, the Port Ludlow Drainage District was divided into 13 separate drainage networks using a 2-foot contour map. The basins are shown in Figure 4-1. These networks were in turn, divided into smaller sub-drainage basins, and parameters for each of these smaller basins were input into the model. A total of 38 sub-basins were used for the modeling. The sub-drainage basin are shown in Figure 4-2.

The pipe sizes, slopes and general ditch elevations for the storm drainage networks were obtained from the field survey and the Jefferson County database. The ditch bottom elevations were assumed to be approximately two to three feet below the surrounding ground elevation with the constraint that the slope of the ditch was consistent to the general topographic slope parallel to, and in the vicinity of, the ditch. All ditches were assumed to be grass lined with a Manning’s “n” coefficient of 0.0026.² All pipes were assigned a Manning’s “n” coefficient value of 0.022.³ Basin characteristics were established through field observation, Soil Conservation Service Soil Surveys, and topographical information provided from the aerial survey map.

The outfall for these conveyance systems was modeled under the assumption that all outfalls within the District are free outfalls, unobstructed by tidal fluctuations or other physical constraints.

A majority of the drainage basins within the District limits are near to build-out conditions. As discussed later in this chapter, each portion of the drainage model was tested for sensitivity to changes in impervious area and pipe and ditch conditions. Future development of single family homes or any short plats within the District will require the developer to provide detention and treatment per the Washington State Department of

² Roberson, John A. et.al. *Hydraulic Engineering*, Houghton Mifflin Co., Boston, 1988, p.169.

³ Lindeburg, Michael R., *Civil Engineering Reference Manual* 6th Ed., Professional Publications, Belmont, CA, 1992, p 5-23.

FIGURE 5-2
Modeled Flow for 100-year Storm Event
Libby Court / Montgomery Lane 36-inch Diameter Outfall Pipe

Conduit 64

[Max Flow = 31.0][Max Velocity = 15.6]

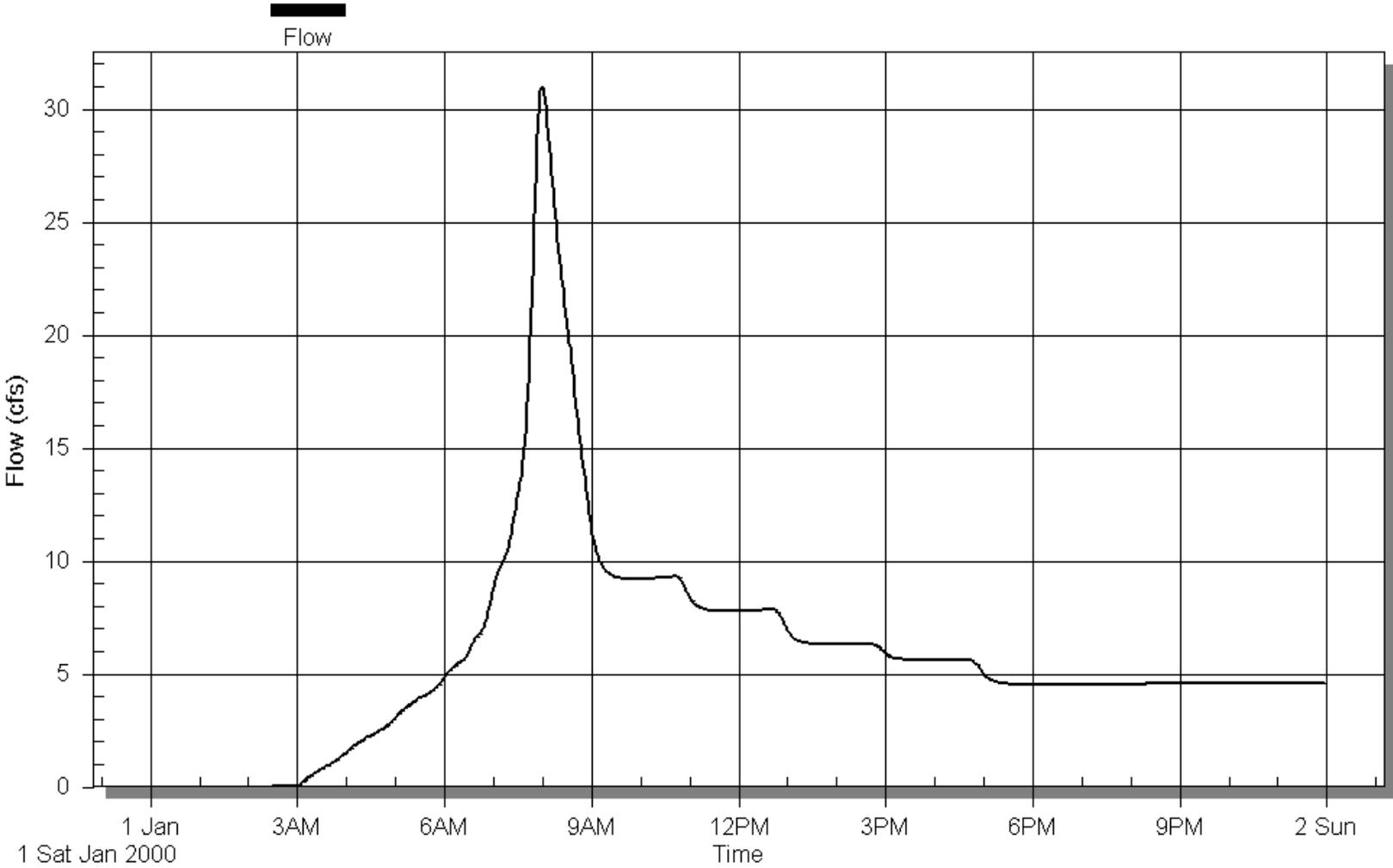


FIGURE 5-3
18-inch Diameter Culvert Under Montgomery Lane

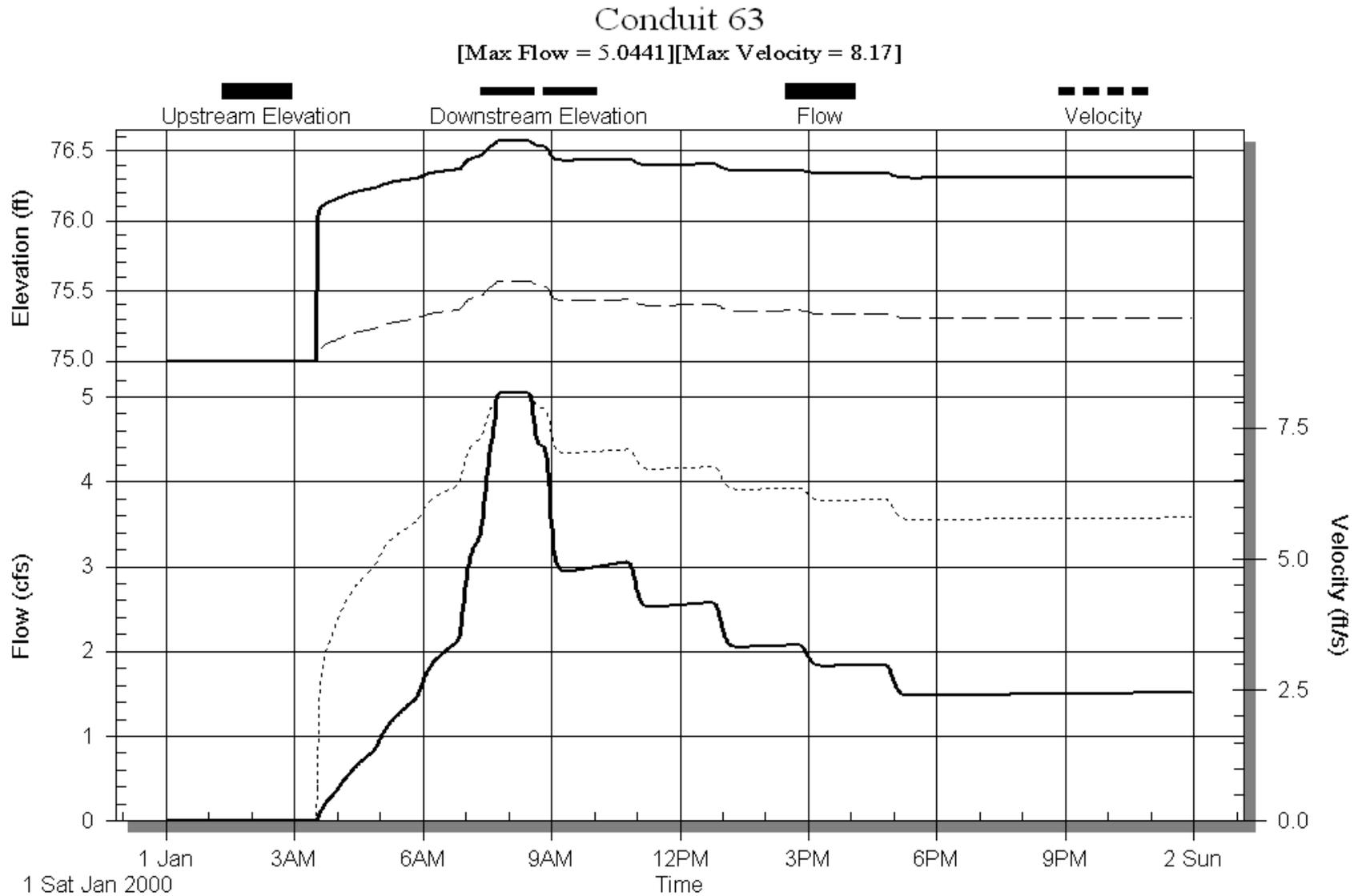
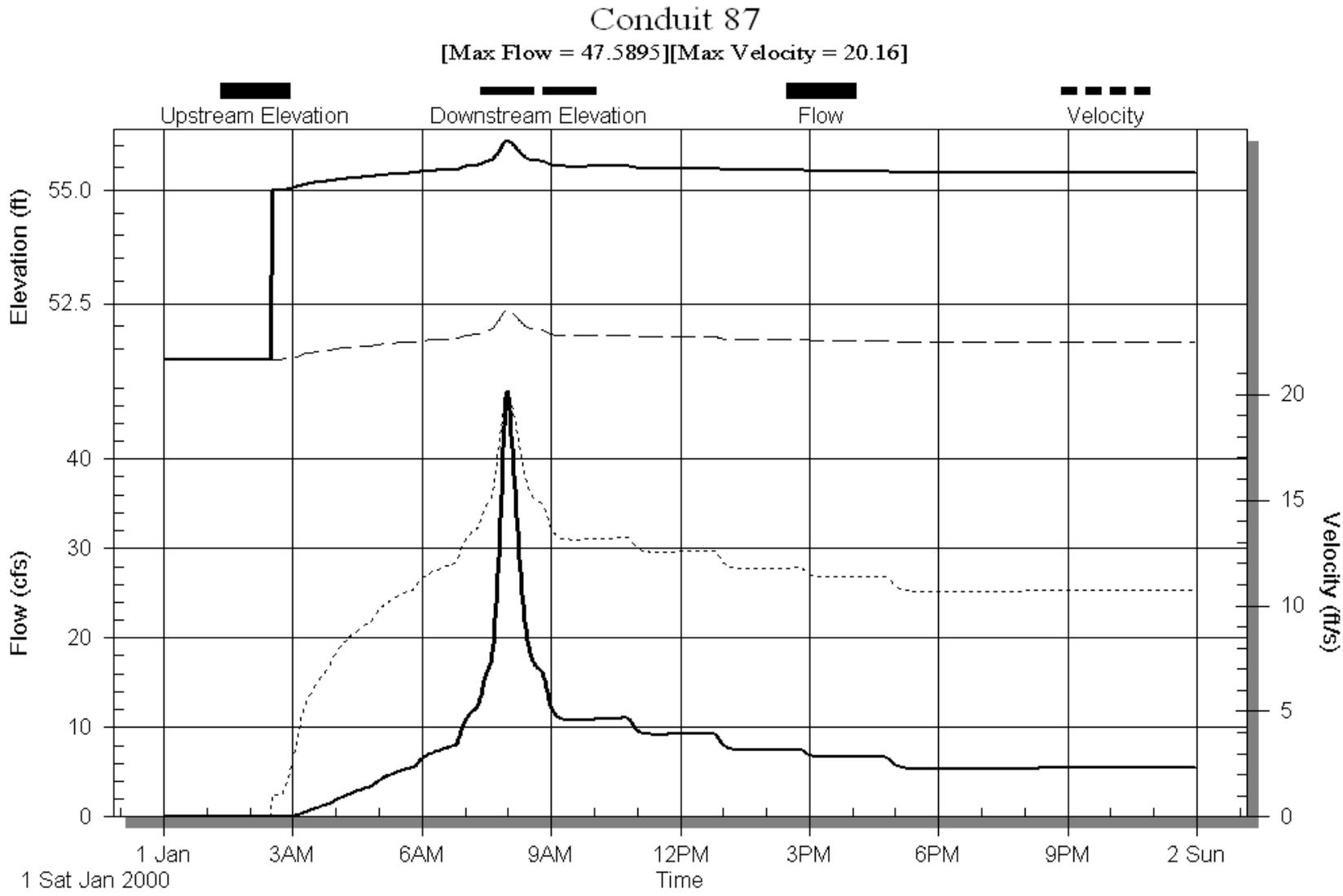


FIGURE 5-4
36-inch Diameter Culvert to Marina Outfall



Ecology's *Stormwater Technical Manual* standards and to assess those portions of the storm drainage system fronting their property. Assuming detention facilities are installed and maintained, development should not significantly increase the peak flows experienced by the public conveyance systems. The model however, assumed the worst case scenario where detention systems were not required. Generally, the amount of impervious area expected under build-out conditions is not significantly greater than the amount of existing impervious area (a difference of approximately 0-10 percent of the total basin area). The 25-year storm event modeled under expected build-out conditions produced nearly the same results as for the 25-year model under existing conditions.

MODEL RESULTS

The following paragraphs describe the model results. A sample SWMM output file is included in Appendix C. Each culvert that was included in the modeling is provided in the table whether it has an identified capacity or condition problem or no identified problem. Those culverts and ditches that are damaged, have capacity deficiencies, or require any other revision are listed in bold print, with the recommended action in the final column. Those culverts and ditches that are recommended for revisions are also summarized in Table 5-1. A sensitivity analysis was conducted and is discussed following Table 5-1 and is summarized in Table 5-2. The results of all pipes in the system are summarized in Table 5-3 at the end of this chapter.

TABLE 5-2

Recommended Improvements

Culvert/ Ditch No.	Location	Exist. Pipe / Ditch Size (in.)	Rec. Pipe / Ditch Size (in.)	County / District Priority	Additional Comments
89	Oak Bay Rd d/s of Det. Pond	30	24	1 C	Slipline with 24" HDPE pipe
64	Montgomery Ln near Libby Ct	36	30	2 D	Slipline with 30" HDPE pipe
12	Osprey Ridge Dr / Oak Bay Rd	12	30	3 C	Revise inlet configuration
West Ditch	Osprey Ridge Dr	0 to 12	18	3 C	History of flooding
West Ditch	Osprey Ridge Dr driveway culverts	12	24	3 C	History of flooding
Ditch K3-K4	Incised ditch b/n 84 & 64	18	18	4 D	Install rock check dams
74	Montgomery Ln / Baldwin Ln	18	30	5 C	Insufficient capacity
Ditch I8-I9	Roadside ditch b/n 63 & 74	12	18	5 C	History of ditch flooding
Pipe 63-74	B/n 63 & 74 (Driveway tiles)	12	30	5 C	Insufficient capacity
63	Montgomery Ln 280' N of Libby Ct	18	30	5 C	Revise inlet configuration
-	Jackson Ln	None	18	6 C	No exist. culvert/History of flooding
41	Talbot Way / Ames Ln	18	18	7 C	Ditch maintenance recommended
North Ditch	Pioneer Drive East near Jackson Ln	0 to 6	12	8 C	History of flooding onto res. prop.
9	Walker Way west of Cascade Ln	18	24	C	Insufficient capacity
18	Machias Loop/Walker Way (E)	18	24	C	Insufficient capacity
2	Helm Ln/Walker Way	18	24	C	Enlarge Walker Way ditch
95	Gamble Ln/Walker Way	18	24	C	Enlarge Walker Way ditch
7	Walker Way/Oak Bay Rd (W)	18	24	C	Enlarge Walker Way ditch
35	Rainier Ln/Clipper Ln	12	15	C	Insufficient capacity
34	Rainier Ln/Barque Ln	12	15	C	Insufficient capacity
28	Rainier Ln/Mainsail Ln	12	15	C	Insufficient capacity
27	Rainier Ln/Topsail Ln	12	15	C	Insufficient capacity
33	Rainier Ln/Cutter Ln	18	24	C	Insufficient capacity
52	Fleet Dr/Pioneer Dr East	18	24	C	Ditch maintenance recommended
88	Oak Bay Rd south of Drew Ln	12	18	C	Insufficient capacity

SENSITIVITY ANALYSIS

The impervious area for each sub-basin was calculated by measuring existing impervious area (i.e. roofs, driveways, roads, trails, etc.) from the storm drainage basemap. The total impervious area was then increased to account for a “build-out” condition within the District, meaning all developable lots have been developed with a maximum impervious area per lot of 4,000 square feet. The storm drainage model was run using different impervious areas for each sub-basin, as each sub-basin has a different percentage of impervious cover. The typical range of impervious coverage is 15-35 percent. To test the sensitivity of the model based on the amount of impervious area, each drainage model was rerun with all sub-basins having an impervious cover of less than and above average impervious coverage. Approximately 10 percent of impervious area was added to or subtracted from the impervious area used in the original model. These sensitivity tests do not reflect projected impervious area for build-out conditions since the build-out impervious area is already added into the “Initial Impervious Area” scenario. The scenario that has a reduced impervious area more closely models existing conditions only, without build-out conditions added. Table 5-2 provides a sampling of those culverts and ditches whose sizing would be affected by this sensitivity testing.

TABLE 5-3

Impervious Area Sensitivity Testing

Culvert No.	Flow Rate w/ Decreased Impervious Area (cfs)	Flow Rate w/Initial Impervious Area (cfs)	Flow Rate w/ Increased Impervious Area (cfs)
2	26.4 ⁽¹⁾	28.6 ⁽²⁾	29.8 ⁽²⁾
12	38.0 ⁽³⁾	39.5 ⁽³⁾	42.7 ⁽³⁾
28	11.3 ⁽⁴⁾	11.4 ⁽⁴⁾	12.1 ⁽⁴⁾
86	24.8 ⁽²⁾	26.0 ⁽²⁾	27.0 ⁽⁵⁾
91	165.0 ⁽²⁾	167.1 ⁽²⁾	186.6 ⁽⁶⁾

- (1) Pipe has adequate capacity. No change required.
- (2) Requires upsizing pipe from 18- to 24-inch diameter as shown above. Additionally, culverts 7 and 95 will need to be upsized.
- (3) Requires upsizing pipe from 12- to 30-inch diameter.
- (4) Requires upsizing pipe from 15- to 18-inch diameter in Culvert No. 28 as shown above. Additionally, culverts 27 and 33 will also need to be upsized.
- (5) Increased impervious area causes flow to submerge culvert and overflow in ditch to west.
- (6) Requires upsizing pipe from 36- to 42-inch diameter or modification to inlet or outlet of pipe.

When using a lower impervious area, some culverts that appear to be undersized under the initial models are no longer undersized. Similarly, some culverts that are adequately sized under the original models are undersized when using a higher impervious area. Based on the results of the sensitivity testing for the District, an average range of deviation away from the flow rate that is based on measured conditions is ±4 cfs for pipes

with large flow rates and ± 1 cfs for pipes with small flow rates. Sub-basin outfalls are the most susceptible to fluctuation in impervious area since the flow reaching those culverts is a culmination of flows from the entire basin. This is apparent for Culvert No. 64 located in Montgomery Lane north of Libby Court and Culvert No. 91 located in Oak Bay Road east of Osprey Ridge Drive.

The condition of a pipe or ditch also affects the sensitivity of the model. Without a detailed inventory of the condition of each pipe and ditch, only the characteristics of those pipes and ditches with known problems (i.e. damaged inlet/outlet or pipe material, poorly maintained ditches) are input into the model. All culverts and ditches that are near full capacity are sensitive to minor changes in the model. This is apparent for Culvert No. 8, which crosses Walker Way at its intersection with Cressey Lane. The model shows this culvert's capacity to be 83 percent full during the 100-year storm. With a projected increase of flows to this culvert stemming from the recommended upsizing of Culvert Nos. 9 and 18 upstream at the intersection of Walker Way and Cascade Lane, any added constriction to the flow capacity of this pipe could cause flooding.

A characteristic of the model that impacts the recommendations for upsizing certain pipes or ditches is that a change to one culvert or ditch may impact a downstream portion of the system. For example, the culverts along the east edge of Rainier Lane between Clipper Lane and Cutter Lane are impacted by the recommendation to upsize Culvert No. 35 at Mainsail Lane. Once Culvert No. 35 is upsized from 12- to 15-inch, all downstream culverts and ditches must be revised to accommodate additional flows. This means that Culvert Nos. 27, 28, and 34 should be upsized from 12- to 15-inch pipe and Culvert No. 33 upsized from 18- to 24-inch pipe. Similarly, the model shows that there is flooding upstream of Culvert No. 9 at the northwest corner of the intersection of Walker Way and Cascade Lane. To alleviate the flooding, Culvert No. 9 must be upsized from 18- to 24-inch diameter pipe. Subsequently, Culvert No. 18, located immediately downstream, must also be upsized to 24-inch diameter pipe.

There are also areas within the District that are known to have a history of flooding or are in need of revisions and repairs. These areas are listed below and are ranked in order of priority. It is also noted whether the project would be a District or County project. The recommended improvements shown in Table 5-1 include the following list of projects.

1. Port Ludlow No. 7 detention pond outfall underneath Oak Bay Road (Culvert No. 89). Settlement of the pavement was observed over the top of the pipe and the bottom of the 30-inch pipe has rusted and eroded away. Slip-lining of the existing pipe with a smaller diameter pipe is recommended. A 24-inch diameter pipe is adequate to convey the 100-year storm flows. **(COUNTY)**
2. North Bay Condominiums currently have heavy surface sheet flows over the existing driveway and parking area. Immediately upstream of the location of the flooding, a 12-inch culvert crosses Oak Bay Road and

discharges onto the asphalt pathway south of Oak Bay Road. These concentrated flows disperse somewhat in the greenbelt south of Oak Bay Road and the North Bay Condominiums. However, down gradient of the greenbelt is the parking area and driveway. The flows then concentrate again causing some flooding and flow control problems near the entrance to the two of the buildings. The 12-inch culvert is adequately sized for the modeled flow. A closed pipe connection between the existing culvert on Oak Bay Road and the downstream culvert between the buildings would eliminate the problem. Downstream impacts must be addressed to assure the system can handle the flow. **(Condominium Owners and DISTRICT)**

3. The detention pond and bioswale leading to the pond have been neglected for years. Significant vegetation has developed in both the pond and the swale. The facility needs to have vegetation removed, sediment removed, and regraded to the original design. **(DISTRICT)**
4. The outfall pipe downstream of Montgomery Lane near Libby Court appears to have a rusted and eroded pipe bottom. A historical television inspection was inconclusive on the overall condition of the pipe due to flow in the pipe at the time of the taping. Slip-lining of this pipe is recommended if possible. A 30-inch diameter pipe is adequate to convey 100-year flows. **(DISTRICT)**
5. The inlet to Culvert No. 12 located at the intersection of Oak Bay Road and Osprey Ridge Drive is poorly configured and the culvert is undersized. The inlet configuration should be revised and culvert diameter increased from 12- to 30-inches. The drainage system upstream of this culvert should also be enlarged. That modification includes upsizing of the driveway tiles for the commercial businesses along Osprey Ridge Drive from 12- to 24-inch diameter pipes and enlargement/installation of a roadside ditch between the northernmost driveway tile and Culvert No. 12. **(COUNTY – Culvert No. 12 and roadside ditches; BUSINESS OWNERS and/or DISTRICT – driveway tiles)**
6. The channel located in the reserve area between Culvert No. 84 in Oak Bay Road and Culvert No. 64 in Montgomery Lane near Libby Court is heavily incised. Regrading, erosion protection and rock check dams should be installed to reduce the flow velocity and stabilize the ongoing erosion in this channel. **(DISTRICT)**
7. Culvert No. 74 located at the intersection of Montgomery Lane and Baldwin Lane is undersized. The culvert diameter should be increased from 18- to 30-inches. Subsequently, the downstream ditch between

Culvert Nos. 74 and 63 should be enlarged, Culvert No. 63 should be enlarged to 30-inch diameter pipe, and driveway tiles also increased to 30-inch diameter pipes. Culvert No. 63 is located within Montgomery Lane approximately 280 feet north of Libby Court and is the outfall for Basin I. The inlet to Culvert No. 63 should be reconfigured to accept flow more efficiently. A house on the east side of Montgomery Lane has had water from the ditch overtop the roadway and enter into the house. **(COUNTY – R/W culverts and ditches; HOMEOWNERS and/or DISTRICT– driveway tiles)**

8. Flooding across the road has been observed on Jackson Lane downstream of Culvert No. 53. There is no culvert to convey flows under the road at this location. An 18-inch diameter pipe and catch basin should be installed to eliminate the flooding. The discharge of the culvert should extend to the greenbelt area immediately to the south **(COUNTY)**
9. Flooding observed near Culvert No. 41 at the intersection of Talbot Way and Ames Lane. Field investigation found the upstream ditch in need of maintenance. **(COUNTY)**
10. Flooding onto residential property at northwest corner of the intersection of Pioneer Drive East and Jackson Lane caused by flows originating within right-of-way. The ditch on the north edge of Pioneer Drive East should be enlarged and maintained. **(COUNTY)**
11. Green belt detention west of Oak Bay Road at Montgomery Lane. Flows from upland areas discharge to the roadside ditch of Oak Bay Road. A detention pond and conveyance pipe to the north could reduce runoff getting into the Montgomery Lane system. A detention system would need to be sized and pipe to convey to the north **(DISTRICT)**
12. Field investigation found the water reservoir located south of Swansonville Road between Talbot Way and Rainier Lane discharged to the ditch upstream of the intersection of Swansonville Road and Rainier Lane. The culvert crossing under Rainier Lane at this intersection appears to be adequately sized to convey the 100-year storm event but the capacity is reduced by the capacity of the ditch downstream of the culvert, causing the conveyance capacity of the outlet of the pipe to be reduced. If the water reservoir discharges a large quantity of water at the same time as a storm event, flooding could occur at this intersection. This intersection should be monitored during larger storm events. **(DISTRICT)**
13. Areas north of Cascade Lane have surface and subsurface flow that collect from the greenbelt behind homeowners at the end of Cascade Lane. Runoff is collected in a ditch and conveyed to Cascade Lane. Cascade

Way Lane had ditches on both the east and west side. Currently the east side ditch is filled and two driveways cross where the ditch once was. The solution could be to install driveway tiles and reconstruct the ditch or to install a single culvert from the north end of Cascade Lane to the downstream ditch on the east side. This would require cutting through the bulb of the cul-d-sac. Alternatively, the greenbelt behind (north) of Cascade could have improvements to the conveyance system through improved channels. This would reduce the flow migrating out of the greenbelt area. **(Homeowners, COUNTY, DISTRICT)**

14. Greenbelt between Walker Way and Swansonville Road. The greenbelt collects water from a number of sources including homeowners and roadway ditches. Some areas of the greenbelt have a defined channel and other areas disperse flows. The area just upstream from Oak Bay Road area could provide detention to reduce flows downstream. A detention system would need to be sized and conveyance of flows directed to the system. **(DISTRICT)**

15. Greenbelt between Walker Way and Phinney Lane. The greenbelt collects water from a number of sources including homeowners and roadway ditches. Some areas of the greenbelt have a defined area and other areas disperse flows. The area just upstream from Oak Bay Road channel could provide detention to reduce flows downstream. A detention system would need to be sized and conveyance of flows directed to the system. **(DISTRICT)**

TABLE 5-4

SWMM Modeling Results/Recommended Improvements

Basin ⁽¹⁾	Culvert No. ⁽²⁾	Location	Culvert Size (in.) ⁽³⁾	Exist. Flow Capacity (cfs)	Rec. Culvert Size (in.) ⁽⁴⁾	100-yr Flow, Modeled (cfs) ⁽⁵⁾	% Full Pipe ⁽⁶⁾	New Flow Capacity (cfs) ⁽⁷⁾	Additional Comments ⁽⁸⁾
A	12	Osprey Ridge Dr./Oak Bay Rd	12	3.9	30	39.5	1009%	45.1	Upsize pipe to 30"/Increase slope
A	D/Way ⁽³⁾	Osprey Ridge Dr. West side of road	12	11.5	24 (3)	36.8	319%	73.1	Upsize pipes to ⁽³⁾ 24"
A	Ditches	Osprey Ridge Dr. West side of road	12	17.8	18	36.8	207%	37.7	Enlarge ditch
B	11	Walker Way west of Rainier Ln	30	130.6	30	117.1	90%	130.6	No change rec.
C	80	Oak Bay Rd	24	76.4	24	5.5	7%	76.4	No change rec.
D	60	Pioneer Dr / McCurdy Ln	18	18.2	18	0.9	5%	18.2	No change rec.
D	61	Pioneer Dr / Harms Ln	18	22.3	18	4.2	19%	22.3	No change rec.
E1	81	Oak Bay Rd / N of Montgomery Ln	18	17.3	18	1.0	6%	17.3	No change rec.
E2	P-81-78	Culvert b/n Culv. 81 & 78	18	51.9	18	1.3	3%	51.9	No change rec.
E2	78	N cul-de-sac of Montgomery Ln	24	86.7	24	3.4	4%	86.7	No change rec.
F	38	Talbot Way / Evans Ln	18	17.6	18	14.0	79%	17.6	No change rec.
F	39	Talbot Way / Tyee Ln	18	13.7	18	9.3	68%	13.7	No change rec.
F	40	Talbot Way / Sayward Ln	18	15.6	18	4.7	30%	15.6	No change rec.
F	41	Talbot Way / Ames Ln	18	14.1	18	6.7	47%	14.1	No change rec.
F	42	Talbot Way near Walker Way	21	34.8	20	17.1	49%	30.6	No change rec.
G1	23	Goliah Ln	18	17.6	18	2.2	12%	17.6	No change rec.
G1	25	Resolute Ln	18	21.1	18	2.3	11%	21.1	No change rec.
G1	P-G6-G3	SW of Swansonville Rd/Oak Bay Rd	18	28.5	18	4.1	14%	28.5	No change rec.
G2	86	Oak Bay Rd / towards WWTP	18	26.6	18	26.0	98%	26.6	No change rec.
G2	P-G11-G12	East of Culvert 86/under walkway	30	41.1	30	27.7	67%	41.1	No change rec.
G2	P-G13-G14	Parking Lot b/n Oak Bay Rd & WWTP	12	4.8	12	1.0	21%	4.8	No change rec.
G2	P-G15-G16	Culvert u/s of WWTP access road	18	40.1	18	21.6	54%	40.1	No change rec./some ponding in area
G2	P-G17-G18	Underneath WWTP access road	42	307.6	42	17.1	6%	307.6	No change rec.

TABLE 5-4 – (continued)

SWMM Modeling Results/Recommended Improvements

Basin ⁽¹⁾	Culvert No. ⁽²⁾	Location	Culvert Size (in.) ⁽³⁾	Exist. Flow Capacity (cfs)	Rec. Culvert Size (in.) ⁽⁴⁾	100-yr Flow, Modeled (cfs) ⁽⁵⁾	% Full Pipe ⁽⁶⁾	New Flow Capacity (cfs) ⁽⁷⁾	Additional Comments ⁽⁸⁾
H	52	Fleet Dr / Pioneer Dr East	18	12.5	24	15.6	125%	26.8	Upsize pipe to 24" / Ditch Maint. Rec.
H	70	Fleet Dr / Explorer Ln	18	14.1	18	3.3	23%	14.1	No change rec.
H	71	Fleet Dr / Pathfinder Ln	18	10.5	18	7.0	66%	10.5	No change rec.
H	72	Fleet Dr / Adventurer Ln	18	15.6	18	7.7	49%	15.6	No change rec.
I1	53	Jackson Ln	18	35.4	18	0.6	2%	35.4	No change rec.
I1	54	Jackson Ln @ end of cul-de-sac	12	4.8	12	1.1	23%	4.8	No change rec.
I1	82	Oak Bay Rd near Montgomery Ln	18	19.4	18	8.6	44%	19.4	No change rec.
I2	83	Oak Bay Rd 180 ft E of Baldwin Ln	18	16.3	18	5.2	32%	16.3	No change rec.
I3	74	Montgomery Ln / Baldwin Ln	18	16.7	30	18.6	112%	65.0	Upsize pipe to 30" / Revise inlet config.
I3	D-I8-I9	Ditch b/n Culverts 74 & 63	12	7.9	18	21.7	276%	16.7	Enlarge ditch
I3	P-63-74	Driveway tiles b/n Culverts 74 & 63	12	7.9	30	21.7	276%	65.0	Culvert 74 u/s upsized to 30"
I3	63	Montgomery Ln / 280 ft W of Libby Ct	18	21.6	30	21.6	100%	48.7	Culvert 74, driveway tiles u/s upsized to 30"
J	47	Pioneer Dr East / Fleet Dr	36	149.5	36	28.8	19%	149.5	No change rec.
J	62	Fleet Dr / Navigator Ln	18	14.9	18	8.4	56%	14.9	No change rec.
J	67	Seafarer Ln	18	14.5	18	6.2	43%	14.5	No change rec.
J	68	Fleet Dr / Trader Ln	18	14.9	18	4.0	27%	14.9	No change rec.
J	69	Fleet Dr / Forester Ln	18	24.5	18	2.6	11%	24.5	No change rec.
K	64	Montgomery Ln near Libby Ct	36	74.2	36	36.6	49%	74.2	No change rec.
K	64 ⁽⁹⁾	Downstream of Culvert 64	36	74.2	24	36.6	49%	46.5	Pipe in poor cond. / Slipline w/ 24" HDPE pipe
K	D-K3-K4	Ditch b/n Culverts 84 & 64	18	100.6	18	29.6	29%	100.6	Channel incised / Rock check dams rec.
K	84	Oak Bay Rd near Baldwin Ln	30	65.0	30	29.6	46%	65.0	No change rec.
L	92	Oak Bay Rd / Port Ludlow Div. 7	24	62.1	24	11.9	19%	62.1	No change rec.
M	32	Rainier Ln near Northwood Ct	15	6.5	15	3.7	57%	6.5	No change rec.
M	91	Oak Bay Rd east of Osprey Ridge Dr	36	173.2	36	167.1	96%	173.2	No change rec.

TABLE 5-4 – (continued)

SWMM Modeling Results/Recommended Improvements

Basin ⁽¹⁾	Culvert No. ⁽²⁾	Location	Culvert Size (in.) ⁽³⁾	Exist. Flow Capacity (cfs)	Rec. Culvert Size (in.) ⁽⁴⁾	100-yr Flow, Modeled (cfs) ⁽⁵⁾	% Full Pipe ⁽⁶⁾	New Flow Capacity (cfs) ⁽⁷⁾	Additional Comments ⁽⁸⁾
N	27	Rainier Ln / Topsail Ln	12	7.4	15	9.1	123%	13.4	Upsize pipe to 15"
N	28	Rainier Ln / Mainsail Ln	12	6.4	15	8.1	127%	11.6	Upsize pipe to 15"
N	33	Rainier Ln / Cutter Ln	18	10.5	24	10.4	99%	22.7	Upsize pipe to 24" / Impacted by u/s changes
N	34	Rainier Ln / Barque Ln	12	8.3	15	9.3	112%	15.1	Upsize pipe to 15"
N	35	Rainier Ln / Clipper Ln	12	6.9	15	6.9	100%	12.5	Upsize pipe to 15"
N	36	Rainier Ln / Yawl Ln	12						No change rec.
N	37	Rainier Ln / Schooner Ln	12	4.2	12	3.0	71%	4.2	No change rec.
O	30	Rainier Ln / Walker Way	18	20.5	18	4.2	20%	20.5	No change rec.
P	21	Olympic Ln	18	18.5	18	3.6	19%	18.5	No change rec.
Q1	8	Walker Way west of Cressey Ln	18	25.6	18	21.3	83%	25.6	No change rec.
Q1	9	Walker Way west of Cascade Ln	18	13.7	24	17.8	130%	29.6	Upsize pipe to 24"
Q1	10	Walker Way / Olympic Ln	18	29.0	18	4.8	17%	29.0	No change rec.
Q1	16	Cressey Ln / Walker Way (South)	18	31.6	18	21.7	69%	31.6	No change rec.
Q1	18	Machias Loop (East) / Walker Way	18	20.0	24	20.7	104%	43.0	Upsize pipe to 24"
Q1	20	Machias Loop (West) / Walker Way	18	32.8	18	0.6	2%	32.8	No change rec.
Q1	29	Rainier Ln north of Walker Way	18	18.8	18	3.5	19%	18.8	No change rec.
Q1	30	Rainier Ln @ Walker Way	18	21.1	18	4.2	20%	21.1	No change rec.
Q2	17	Cressey Ln / Walker Way (North)	18	12.5	18	4.1	33%	12.5	No change rec.
Q3	2	Helm Ln / Walker Way	18	29.2	24	28.6	98%	71.3	Upsize pipe to 24" / enlarge ditch
Q3	7	Walker Way / Oak Bay Rd (West)	18	29.0	24	30.4	105%	50.0	Upsize pipe to 24" / enlarge ditch
Q3	95	Gamble Ln / Walker Way	18	14.5	24	30.3	209%	52.5	Upsize pipe to 24" / enlarge ditch
R	6	Walker Way / Oak Bay Rd (East)	18	11.5	18	4.1	36%	11.5	No change rec.
S1	50	Fleet Dr / Swansonville Rd	18	23.3	18	0.4	2%	23.3	No change rec.
S1	P-S13-S14	Swansonville Rd west of Rainier Ln	12	27.8	12	1.0	4%	27.8	No change rec.
S1	P-S15-S16	Rainier Ln / Swansonville Rd	12	27.8	12	4.6	17%	27.8	No change rec.
S2	22	Goliah Ln / Swansonville Rd	18	32.6	18	7.3	22%	32.6	No change rec.
S2	24	Resolute Ln / Swansonville Rd	18	29.4	18	6.3	21%	29.4	No change rec.
S2	26	Camano Ln / Swansonville Rd	18	28.5	18	5.6	20%	28.5	No change rec.
S2	45	Swansonville Rd / Oak Bay Rd	18	13.3	18	8.2	62%	13.3	No change rec.
S2	48	Keller Ln	18	15.3	18	1.7	11%	15.3	No change rec.

TABLE 5-4 – (continued)

SWMM Modeling Results/Recommended Improvements

Basin ⁽¹⁾	Culvert No. ⁽²⁾	Location	Culvert Size (in.) ⁽³⁾	Exist. Flow Capacity (cfs)	Rec. Culvert Size (in.) ⁽⁴⁾	100-yr Flow, Modeled (cfs) ⁽⁵⁾	% Full Pipe ⁽⁶⁾	New Flow Capacity (cfs) ⁽⁷⁾	Additional Comments ⁽⁸⁾
T	65	Pope Way / Montgomery Ln	18	19.1	18	6.3	33%	19.1	No change rec.
T	85	Oak Bay Rd	18	25.1	18	0.8	3%	25.1	No change rec.
T	P-AA3-T5	Pope Way @ Condon Ln	18	9.4	18	4.8	51%	9.4	No change rec.
T	P-T5-T6	Condon Ln @ Pope Way	24	72.8	24	14.6	20%	72.8	Revise outfall configuration
U	90	Oak Bay Rd/outfall to PL Condo No. 2	12	7.5	12	2.1	28%	7.5	No change rec.
V	31	Rainier Ln south of Rainier Ct	24	182.2	24	3.3	2%	182.2	No change rec.
V	P-V2-V3	D/s of Culvert 31	24	181.2	24	3.3	2%	181.2	No change rec.
V	P-V3-V4	D/s of Culvert P-V2-V3 / Outfall to ravine	24	42.6	24	3.3	8%	42.6	No change rec.
V	P-V6-V7	Between Northwood Ct & Detention Pond	18	32.9	18	4.6	14%	32.9	No change rec.
V	Pond Out	Outfall of Detention Pond	18	14.9	18	8.9	60%	14.9	No change rec.
V	89	Oak Bay Rd beyond Pond Outfall	30	119.2	24	9.2	8%	65.7	Pipe in poor cond. / Slipline w/ 24" HDPE pipe
W	19	Machias Loop (SE corner)	18	19.1	18	7.6	40%	19.1	No change rec.
X	88	Oak Bay Rd S of Drew Ln/W of Culv. 87	12	12.5	18	13.7	109%	36.9	Upsize pipe to 18"
Y	3	Drew Ln	18	38.3	18	13.8	36%	38.3	No change rec.
Z	4	Puget Loop (East)	18	16.7	18	9	54%	16.7	No change rec.
Z	5	Puget Loop (West)	18	23.8	18	3.8	16%	23.8	No change rec.
Z	87	Oak Bay Rd near cemetery	36	165.2	36	55.7	34%	165.2	No change rec.
AA	66	Montgomery Ln South of Pope Way	18	17.0	18	2.2	13%	17.0	No change rec.

- (1) Basins are shown on the storm drainage basemap revised 8/12/02.
- (2) Culvert numbers assigned by Gray & Osborne. Culvert numbers resembling "P-V6-V7" or "P-81-78" denote culverts not identified by Jefferson County database. Culvert numbers resembling "D-K3-K4" denote ditches.
- (3) The column labeled "Culvert Size (in.)" represents the bottom width for ditches.
- (4) Pipe or ditch sizes listed in the "Rec. Culvert Size (in.)" column are adequate to convey the 100-yr flow.
- (5) The column labeled "100-yr Flow, Modeled (cfs)" shows flows in the pipe under build-out conditions.
- (6) The column labeled "% Full Pipe" shows the percentage of capacity used under build-out conditions.
- (7) The column labeled "New Flow Capacity (cfs)" shows flows in the proposed pipe.
- (8) Comments summarized in accompanying text.
- (9) This culvert is located east of Montgomery Ln and discharges to Port Ludlow Bay.

CHAPTER 6

NONPOINT SOURCE POLLUTION ANALYSIS

INTRODUCTION

As indicated earlier, the major water body near the District is Port Ludlow Bay, which extends from the straits of Admiralty Inlet to the inlet of Ludlow Creek. 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 management, urban runoff may cause the degradation of 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 Chum Salmon are listed as “threatened” under the Endangered Species Act (ESA). In addition, the United States Fish and Wildlife Service (USFWS) listed the Bull Trout as “threatened” during the summer of 1999. Measures must be taken to comply with the regulations protecting these species. Such measures include focusing on preventing further degradation of these species’ habitat from nonpoint sources.

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

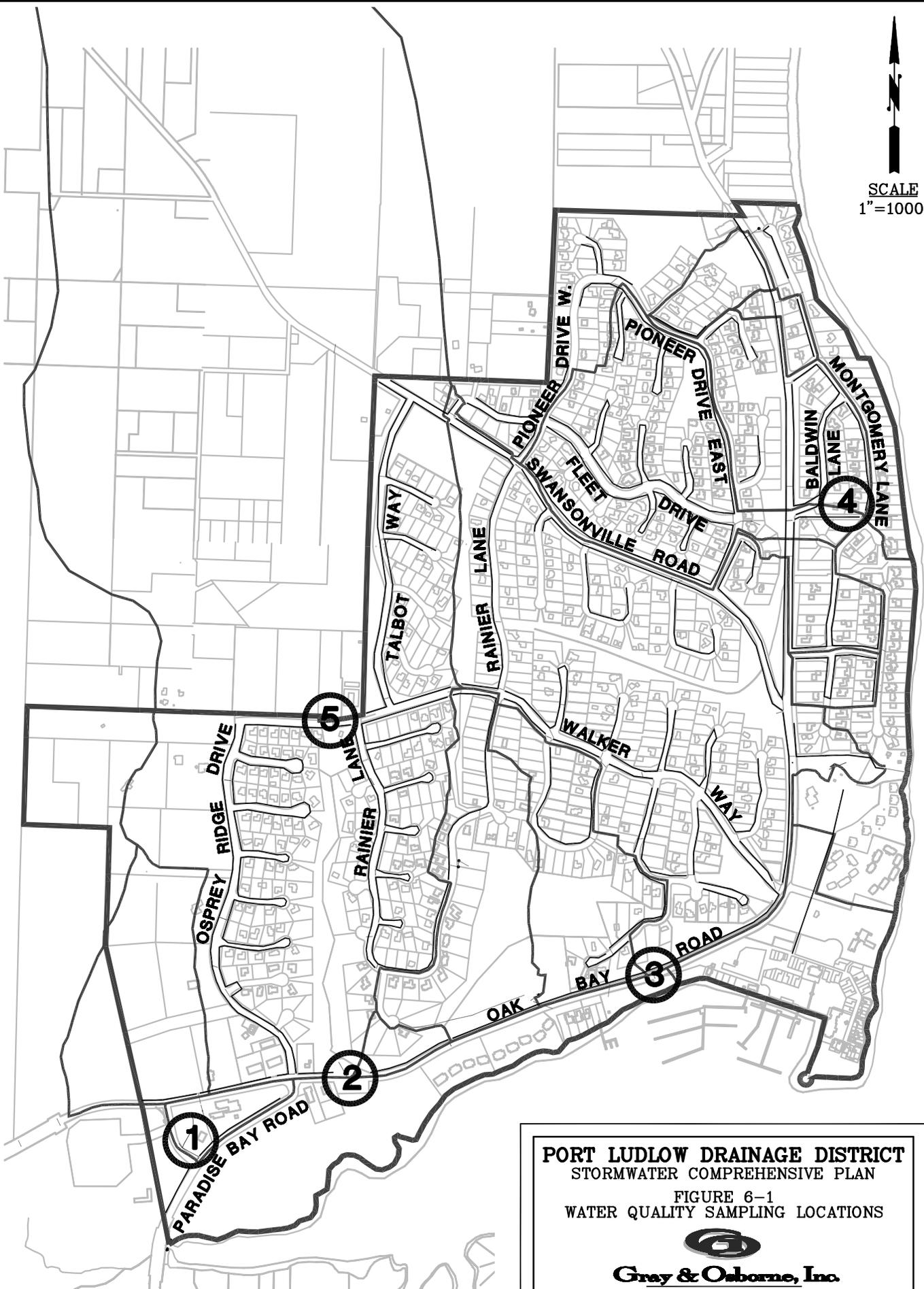
Nationwide, approximately 30 percent of water quality problems have been attributed to stormwater runoff. Many sources of stormwater pollution are uncontrolled. Sources of nonpoint pollution are numerous, varied and hard to detect, but their cumulative effect on water quality and habitats can be significant. Similar to most communities nationwide, the District is relatively developed which indicates that stormwater may likely carry concentrations of metals and polyaromatic hydrocarbons (PAHs) normally associated with urban runoff. However, due to the somewhat rural nature upstream of the District, bacterial concentrations may be similar if not higher than in other highly urbanized areas.

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. Water quality monitoring data collected by Gray & Osborne indicated that stormwater runoff to Port Ludlow carried numerous fecal coliform bacteria during heavy storms. During the heavy storm, the high ranges of fecal coliform counts were out of compliance with State standards (WAC 173-201A-045(1) (See tables 6-1 and 6-2) however, with only light rain, all streams and outfalls were found to be in compliance with the state standards.

Water quality monitoring conducted by Gray & Osborne was sampled in the locations shown in Figure 6-1 in March 2003 and April 2003. The results of this monitoring (see Table 6-1) indicate that as expected, large storms result in high turbidity and greater amounts of fecal coliform. Large amounts of fecal coliform during heavy rains may be attached to the larger amounts of sediment being transported through the streams. The presence of fecal coliform may be due to a number of reasons including failing septic systems and an abundance of wild and domestic animals such as deer, cows and dogs. Besides the high turbidity and fecal coliform counts during large storms, the remaining parameters were generally normal and were located within the expected range for these streams. The lower dissolved oxygen levels at Site 6 are believed to have resulted from a lack of significantly flowing water in this area at the time of testing. For the most part, the dissolved oxygen levels were quite high, indicating a healthy stream for aquatic life. The pH values ranging from 6.55 to 7.87 also makes for a healthy environment for fish and other aquatic life. Values outside the range of 6 to 8 can begin to pose a threat to organisms within the stream. Specific conductivity ranged from 60 to 127 $\mu\text{mS/cm}$. Conductivity is a measure of the ability of a solution to conduct a current due to the ions in the solution. Conductivity typically increases with the rise in urbanization and is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate and phosphate anions. It is difficult to tell from only two samples as to whether or not the streams are being affected by urbanization in terms of conductivity. Further conductivity and associated data is needed to establish a true trend for the water quality of runoff in Port Ludlow. We recommend the District monitor these streams and outfalls a minimum of three times a year. The monitoring schedule should include one period during the beginning of the wet weather season when flow in the area has been established (i.e. November-December), one at the end of the wet season (i.e. April) and one storm event which preferably equates to a 6 month storm (0.96 in. within a 24 hour period) or greater.



LEGEND
— District Boundary
— Drainage Basin
① = Sampling Locations

PORT LUDLOW DRAINAGE DISTRICT
 STORMWATER COMPREHENSIVE PLAN
 FIGURE 6-1
 WATER QUALITY SAMPLING LOCATIONS



Gray & Osborne, Inc.
 CONSULTING ENGINEERS

TABLE 6-1

Water Quality Results for March and April 2003

Site	Turbidity (NTUs)	Temp (Deg F)	Specific Conductivity (umS/cm)	D.O. (mg/L)	D.O. Sat. (%)	pH	Fecal Coliform (per 100/mls)
1: Lower Paradise Bay Rd.							
March 13, 2003 (Hard Rain)	22	48.0	67	10.84	95.3	6.98	127
April 24, 2003 (Light Rain)	2	49.1	127	11.0	96.9	7.87	0
2: Lower Oak Bay Rd.							
March 13, 2003 (Hard Rain)	59	48.0	60	11.00	98.2	6.98	183
April 24, 2003 (Light Rain)	3	46.4	122	9.82	83.5	7.58	0
3: Upper Oak Bay Rd.							
March 13, 2003 (Hard Rain)	56	48.5	60	10.83	95.6	6.65	798
April 24, 2003 (Light Rain)	4	48.3	60	11.42	98.9	7.72	71
4: Montgomery Lane							
March 13, 2003 (Hard Rain)	71	49.5	70	10.94	98.2	6.80	1,110
April 24, 2003 (Light Rain)	3	46.8	127	10.88	92.9	7.57	1
5: Rainier Lane							
March 13, 2003 (Hard Rain)	10	48.3	59	10.37	89.6	6.84	113
April 24, 2003 (Light Rain)	1	46.7	37	2.69	22.8	6.62	0
6: Rainier Lane (Duplicate)							
March 13, 2003 (Hard Rain)	6	48.3	59	10.78	89.1	6.65	115
April 24, 2003 (Light Rain)	2	46.7	71	2.85	24.4	6.55	0

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 pollutant constituents found in urban runoff. End-of-pipe concentrations exceed EPA ambient water quality criteria and drinking water standards in many instances. Some of the metals are present often enough and in high enough concentrations, to be potential threats to beneficial uses.¹
2. The organic priority pollutants were detected less frequently and at lower concentrations than the heavy metals.
3. Coliform bacteria are present at high levels in urban runoff and can be expected to exceed EPA water quality criteria during and immediately after storm events in many surface waters, even those providing high degrees of dilution.
4. Nutrients are generally present in urban runoff, but with a few individual site exceptions, concentrations do not appear to be high in comparison with other possible discharges to receiving water bodies.
5. Oxygen demanding substances are present in urban runoff at concentrations approximating those in secondary treatment plant discharges.²
6. Total suspended solids (TSS) concentrations in urban runoff are fairly high in comparison with treatment plant discharges. Urban runoff control is strongly indicated where water quality problems associated with TSS, including build-up of contaminated sediments, exist.³

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 Due to the lack of intense agriculture in the vicinity of Port Ludlow, runoff from the area is relatively residential in nature, with minimal biochemical oxygen demand (BOD) in most areas.

³ Stormwater runoff from areas under construction around Port Ludlow has the potential to contribute significantly to TSS levels. Construction Best Management Practices for sediment and runoff control should be required for all projects with the potential for discharging runoff from the site.

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 Ludlow stormwater should be significantly lower than most cities, due to the lower population and relatively low traffic volumes.
- Although a significant number of problem situations could result from heavy metals in urban runoff, levels of freshwater aquatic life use impairment (suggested by the magnitude and frequency of ambient criteria exceedances) were not observed.
- Copper, lead and zinc appear to 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 in urban runoff generally do not pose a general threat to freshwater aquatic life.
- The physical aspects of urban runoff, e.g., erosion and scour, can be significant causes of habitat disruption and can affect the type of fishery present.
- Sediment contamination due to the build-up of priority pollutants can be attributed wholly or in part by urban runoff.
- Coliform bacteria may be present at high levels in urban runoff and may be expected to exceed EPA water quality criteria during and immediately after storm events in most rivers and streams. Coliform bacteria discharges in urban runoff have a significant negative impact on the recreational uses of lakes.
- Domestic water supply systems with intakes located on streams in close proximity to urban runoff discharges are encouraged to check for priority pollutants which have been detected in urban runoff, particularly those in the organic category.
- Nutrients in urban runoff may accelerate eutrophication problems and severely limit recreational uses, especially in lakes. However, NURP's

lake projects indicate that the degree of beneficial use impairment varies widely, as does the significance of the urban runoff component.

- 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 present in urban runoff are the primary pollutants of concern, causing direct impacts on shellfish harvesting and beach closures.
- Groundwater aquifers that received deliberate recharge of urban runoff do not appear to be imminently threatened by this practice at the two locations where they were investigated.

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. This conclusion may be an important factor in the non-developed areas of the Port Ludlow Drainage District.

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 Port Ludlow area 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 utilization and development encompass the common use of potential pollutants such as pesticides, fertilizers, petroleum products, and numerous others. 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 than 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

Water quality parameters affecting stormwater comprise a long list and are classified in many ways. Typical categories include sediment, nutrients, and metals; oxygen demanding and inert material; particulate and dissolved; 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, nutrients, and oil and grease. The following section provides a brief description of contaminants, likely sources, and potential environmental effects.

Dissolved Oxygen (DO) is necessary in water to maintain 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, manure, etc. The primary nutrients of concern are **nitrogen** and **phosphorous**. Forms of nitrogen include ammonia, nitrite, and nitrate, which are components of fertilizers, septic system effluent, and manure. 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, and 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, 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 erosion of urban and agricultural soils. 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. The conversion of land from forest to urban increases impervious surfaces and accelerates stormwater runoff. The total volume and peak rate of stormwater is increased and can cause scouring 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.

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.

TABLE 6-4

Water Quality Criteria for Lake Class Waters (WAC 173-201A-030(5))

Parameter	Criteria
Fecal coliform	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 - no measurable decrease from natural conditions.
Total dissolved gas	Total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.
Temperature	No measurable change from natural conditions.
pH	No measurable change from natural conditions.
Turbidity	Turbidity shall not exceed 5 NTU over background.
Toxic, radioactive, or deleterious	Toxic, radioactive, or deleterious material concentrations shall be below those that may 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. Currently, no special protection areas are recognized within the study area.

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 Port Ludlow Drainage District are indicated in Table 6-5.

TABLE 6-5

General Impact of Nonpoint Sources Likely to be of Concern to the Port Ludlow Drainage District

Body	Key Pollutants	Affect on Water	Affected Uses
Streams	Sediment/suspended solids	Turbidity deposition in stream pools and wetlands	Loss of flood control capacity, fishing, loss of wetland cleaning ability, visual pollution
	Hydraulic erosion	Streambank loss sediment deposit downstream	Damage of private and public property
	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. Port Ludlow is 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. However, after review of the Department of Ecology’s Clean Water Act Section 303 (d) List, it is apparent that the surface waters in the immediate vicinity of Port Ludlow are not listed through the State as being impaired with these or any other water quality problems.

Water Quality Specific to the Port Ludlow Drainage District:

Ludlow Creek is classified as Class A fresh waters whereas Port Ludlow is designated Class AA Marine water. Water quality monitoring data for these areas was collected over the last ten years by HLA/Harper-Owes and Vasse Engineering and was analyzed by Aquatic Research Inc. in the 2001 “Port Ludlow Non-Point Monitoring Program Report.” According to this report, state water quality standards are being maintained throughout

the Port Ludlow region with the possible exceptions of turbidity and fecal coliform in the immediate vicinity of a few tributary outfalls during storm events.

Due to the relatively light level of development in Port Ludlow, impacts on water quality in the bay associated with storm sewer outfalls are limited. Dissolved oxygen and coliform bacteria levels may not always conform to Ecology Standards, however, flushing in the bay from tidal action limits any adverse impacts on aquatic organisms in Port Ludlow.

Few studies have been conducted on water quality within the Drainage District's borders. As mentioned earlier, the 2001 "Port Ludlow Non-Point Monitoring Program Report" analyzed the water quality of the streams within the region. The intent of the report was to establish baseline water quality conditions, evaluate the impacts of development activities and related non-point sources, evaluate the effectiveness of non-point source controls, and monitor long-term trends of bay water quality. The conclusions of this report indicated that the water quality within the area is meeting state standards and that no alarming upward or downward trends exist. Another study entitled "2001 Annual Report on the Port Ludlow Area Groundwater Monitoring Program for Port Ludlow Associates, LLC" by Robinson & Noble, Inc. found conductivity levels within monitoring wells for groundwater to be stable and within state standards. On a local basis, according to the Department of Ecology, the Port Ludlow Log Yard, the Marina and the Beaver Valley General Store were all involved in independent remedial actions as part of the Toxics Cleanup program, most of which were voluntary.

SOURCES OF NONPOINT POLLUTANTS

The major types of nonpoint pollution sources in the Port Ludlow 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 District includes full-service restaurants, a resort, and miscellaneous smaller business. 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 the commercial establishments listed above 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 Port Ludlow 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 contaminants 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 District, 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 highways, as well as city arterials 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 District include Oak Bay Road.

DOMESTIC ACTIVITIES

Nonpoint pollution from domestic activities in the District consists primarily of pet waste and domestic gardens. 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.

In addition to the water pollution/quality issues listed above, the following water quality issues are suspected:

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

CHAPTER 7

NONPOINT SOURCE POLLUTION CONTROL

The following sections discuss general considerations for the control of stormwater pollution from the sources identified in Chapter 6 and present some specific recommendations for the Port Ludlow Drainage District.

GENERAL CONSIDERATIONS IN URBAN STORMWATER QUANTITY AND QUALITY CONTROL

Each issue discussed in the previous chapter for stormwater quantity and quality problems represents a classic stormwater quantity or quality management problem. Stormwater management solutions to alleviate the stormwater problem areas must be found from an engineering viewpoint. They must also comply with the current and proposed state and federal regulations as discussed in Chapter 2.

As the consequences of uncontrolled urban runoff have become more widely recognized and better understood, and as the alternatives available for control have increased, the complexity of stormwater management has grown. Several general considerations may be identified which provide a framework for consideration of issues that affect the method in which the Port Ludlow Drainage District handles their stormwater management program. The considerations are briefly discussed in the following paragraphs and include:

- Stormwater quality versus quantity control
- Construction phase versus long-term site operation phase
- Structural versus nonstructural controls
- Source control versus downstream treatment
- Control in new versus existing development
- Special sensitive area considerations

STORMWATER QUALITY VERSUS QUANTITY CONTROL

Stormwater management has traditionally been concerned with control of runoff quantities for the purpose of preventing flooding. Accordingly, most regulations and engineering design procedures represent this concern. Recently, runoff water quality control has become an added concern as it has been recognized that water quality goals often cannot be realized through control of point sources of water pollution alone.

Efforts at quantity and quality control are confronted with the same basic task: predict the amount of runoff resulting under various conditions and provide sufficient storage capacity to achieve control objectives. In the case of quantity control, the objective is to

release storm runoff at a rate that does not exceed stream channel capacity (which may not be the same as matching pre-development hydrologic conditions for a given site). For quality control the objective is to provide sufficient holding time for the effective operation of gravity settling or biochemical removal of pollutants. Because storage may benefit both quantity and quality, some of the same storage strategies, if correctly applied, can advance both goals. This discussion will emphasize the achievement of dual water quantity and quality control goals wherever possible.

CONSTRUCTION PHASE VERSUS LONG-TERM SITE OPERATION PHASE

In general, the types of potential water quality problems differ sufficiently between construction and the operation of a developed site. Therefore, these periods should be treated separately in stormwater management planning. At the same time, there should be awareness that some measures installed for the construction phase can be converted to permanent service.

STRUCTURAL VERSUS NONSTRUCTURAL CONTROLS

Control of water pollution from industrial and municipal discharges relies to a large extent on structural treatment devices. Grass swales, oil/water separators, and wet ponds could all be considered structural stormwater treatment devices. Much greater opportunities may exist for nonstructural stormwater quality controls. Nonstructural approaches may include enhanced maintenance programs, regulations, public involvement, land use controls, and other measures. The most effective stormwater quality programs use a mix of structural and nonstructural alternatives.

SOURCE CONTROL VERSUS DOWNSTREAM TREATMENT

While the distinction is not perfect, a source control generally prevents pollutants from coming into contact with stormwater and is located at the site of pollutant generation, whereas downstream treatment is removed somewhat from the source. Source control measures (such as enclosing or covering a pollutant source) are usually applied at multiple locations, while a downstream treatment measure (such as an artificial wetland) often receives drainage from more than one individual source. In the extreme case, a single downstream treatment structure (such as a regional detention pond) can serve a relatively large area.

CONTROL IN NEW VERSUS EXISTING DEVELOPMENTS

New developments offer greater opportunities to apply stormwater management techniques than do existing developments. In particular, retroactively fitting structural techniques is generally difficult and expensive, if possible at all, in existing developments. These measures often take substantial land, which may not be available in built-out areas. However, existing development areas are frequently amenable to a variety of nonstructural approaches (such as modified maintenance practices or public education).

CONTROL OF ACUTE VERSUS CHRONIC IMPACTS

If antifreeze were poured into a catch basin near a creek, a fish kill might result; this would be an example of an acute impact to water quality associated with the storm drainage system. Conversely, over time, more devastating impacts to a creek could result from loss of fish habitat associated with erosion and siltation. This would be termed a chronic impact. Reducing acute and chronic impacts requires distinct strategies in the overall stormwater quality management program.

SPECIAL SENSITIVE AREA CONSIDERATIONS

Areas sensitive to the potential impacts of urban stormwater include stream corridors, especially those with valuable fish habitat; flood plains; wetlands; steep slopes and groundwater aquifers. Some special considerations in stormwater management apply to these areas. These considerations will be brought into the discussion as appropriate.

STORMWATER QUANTITY AND QUALITY CONTROL: STRUCTURAL ALTERNATIVES

Stormwater management alternatives for the control of the quantity of stormwater runoff and the quality of the runoff are not mutually exclusive. The outdated method of designing stormwater conveyance systems that relied on curb and gutters to transport stormwater directly into pipes which discharged the stormwater directly into a stream, river or lake provided little in the way of stormwater quantity control and nothing in the way of stormwater quality control. As citizens, municipalities and designers are becoming more aware of the damaging effects of stormwater quantity and quality, the line between stormwater management alternatives which are strictly concerned with quantity issues and those concerned strictly with quality issues is becoming blurred. In the remainder of this Chapter stormwater management alternatives, which will serve to limit the quantity of stormwater runoff and improve the quality of the runoff, will be discussed.

The quantity of stormwater runoff can be controlled by storage and regulated release of stormwater or by site controls. Storage and regulated release of stormwater includes systems such as detention vaults or ponds with stormwater release orifices.

Site controls can minimize the quantity of stormwater released as well as provide water quality benefits. Site controls are generally those controls that attempt to reduce runoff rate and volume at or near the point where the rainfall hits the ground surface. The following types of site controls are common:

- Low Impact Development
- Minimization of directly connected impervious area
- Swales and filter strips
- Porous pavement and parking blocks
- Infiltration devices, such as trenches and basins.

LOW IMPACT DEVELOPMENT

Low impact development is one method for controlling stormwater on a site. The primary goal of low impact development methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff. Use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. The *Puget Sound Water Quality Management Plan* mentioned in Chapter 2 recommends that low impact development include the following:

- Maintain the pre-developed, undisturbed stormwater flows and water quality;
- Retain native vegetation and soils to intercept, evaporate and transpire stormwater on the site (rather than using traditional ponds and conveyances);
- Emphasize a higher standard of soil quality in disturbed soils (by using compost and other methods) to improve infiltration, reduce runoff and protect water quality;
- Cluster development and roads on the site and retain natural features that promote infiltration; and
- Reduce impervious surface area and use permeable surfaces instead.

Management practices used to accomplish low impact development goals include bioretention facilities, dry wells, filter/buffer strips, grass swales, rain barrels, cisterns, and/or infiltration trenches. Low impact development is an efficient method at decreasing the amount of runoff associated with developing a site. However, as with many practices, maintenance in low impact developments is a concern and should be addressed prior to implementation.

STORAGE AND REGULATED RELEASE

Storage and regulated release of stormwater is not fully practiced throughout the Port Ludlow Drainage District, although detention does occur in the form of ponding in yards, vacant lots, and ditches. Storage and regulated release of stormwater requires the installation of detention systems to insure that the rate of stormwater runoff leaving the site for the design storm event during the post-development condition is no greater than the pre-development rate for the same design storm event. This method of stormwater control minimizes downstream impact on the existing conveyance system.

Detention systems can be either wet or dry systems. Detention systems are widely used for runoff quantity control. However, if wet detention systems are properly sized they can act as effective runoff quality control devices as well.

A wet detention basin consists of 1) a permanent water pool, 2) an overlying zone with capacity to temporarily store the design runoff volume for release at the allowed peak discharge rate, and 3) a shallow littoral zone (the biological filter), which serves to treat the permanent volume between storm events. The permanent water pool volume and the vegetated littoral zone are of utmost importance for water quality enhancement. Wet detention ponds are often used in series with swale interconnectors. If properly designed and maintained, wet detention ponds can provide not only effective flood and water quality protection, but also ancillary benefits, such as enhanced aesthetics and wildlife habitat.

The removal of stormwater pollutants in a wet detention system is accomplished by a number of physical, chemical, and biological processes. Gravity settling removes particles through the physical process of sedimentation. Chemical flocculation occurs when heavier sediment particles overtake and coalesce with smaller, lighter particles to form still larger particles. Biological removal of dissolved stormwater pollutants includes uptake by aquatic plants and metabolism by phytoplankton and microorganisms that inhabit the bottom sediments.

Dry detention basins are the most common type of detention basin used around the country for peak-flow attenuation. Dry detention systems perform very poorly as treatment devices for runoff. This is primarily due to short residence time and the fact that these basins do not remove any dissolved pollutants.

Design, sizing, and maintenance criteria for detention facilities can be found in Chapter 3 of the DOE *Stormwater Management Manual for Western Washington*.

DIRECTLY CONNECTED IMPERVIOUS AREA

Directly connected impervious area (DCIA) is defined as the impermeable area that drains directly to the improved drainage system, *i.e.*, paved gutter, improved ditch, or pipe. The minimization of DCIA is an effective method of runoff quantity and quality control because it delays the concentration of flows into the improved drainage system and maximizes the opportunity for rainfall to infiltrate at or near the point at which it falls. Figure 7-1 illustrates the difference between an area where the DCIA is extensive and one where DCIA has been minimized. The residential lot on the north side of the street has all impervious areas on the lot draining directly to the gutter. This drainage plan allows no opportunity for water falling on the impervious surfaces to infiltrate into the ground; in fact, the system is laid out so that the rain falling on the impervious areas is quickly concentrated and drained to the gutter. The result is a greatly increased peak runoff rate and runoff volume compared to the pre-development condition. The pollutants contained in the runoff from the rooftop, driveway, sidewalk and street are simply collected in the gutter and must be dealt with at some location further down in the drainage system.

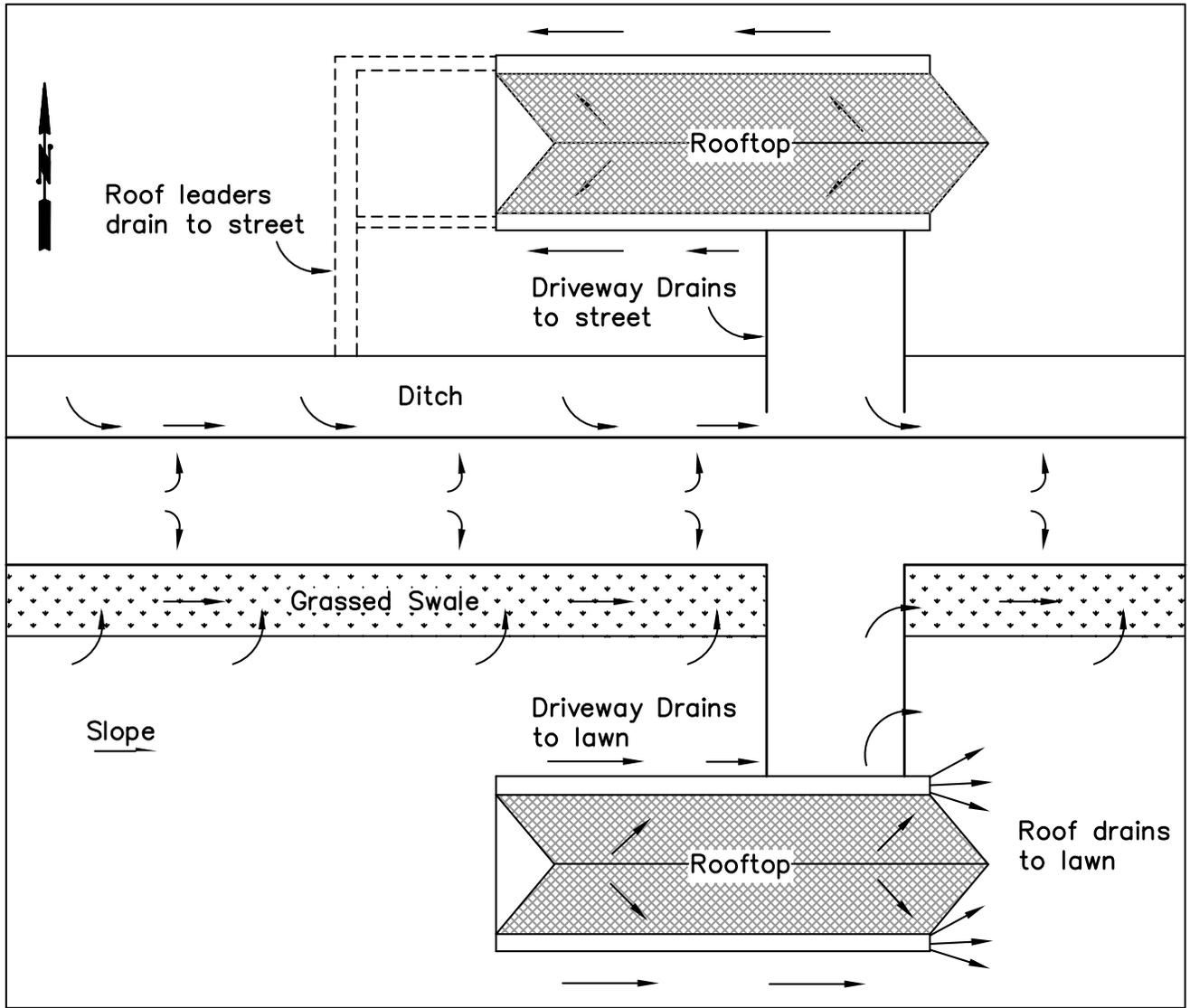
In contrast, the drainage layout for the lot on the south side of the street has been designed to minimize DCIA. All impervious areas drain to a pervious area before they reach the grassed swale that serves as the primary conveyance facility for runoff from the lot. The roof runoff drains to the lawn and sheet-flows across it, the driveway is sloped to drain to the lawn instead of the street, and the sidewalk and the street sheet-flow across a grass filter strip before reaching the water in the grassed swale. All of these techniques combine to provide maximum opportunity for infiltration and for retardation of the runoff rate. This approach to drainage system layout, which emphasizes peak-flow reduction and pollutant capture, is called stormwater management, in contrast with the north lot design, which is simply a drainage plan.

The majority of residences in Port Ludlow, particularly the older homes, have been constructed with minimal DCIA. Commercial development and more recent multiple housing tends to exhibit greater DCIA. In the future, development within the Port Ludlow area should address this issue.

SWALES AND FILTER STRIPS

Swales, or grassed waterways, and filter strips are among the oldest stormwater control measures, having been used alongside streets and highways, as well as by the farmer, for many years. A swale is a shallow trench that has the following characteristics:

- Side slopes flatter than three feet horizontally to one foot vertically.
- Contiguous areas of standing or flowing water only following rainfall.
- Planted with or containing vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake.



EXAMPLES OF MAXIMIZING (North Lot AND MINIMIZING (South Lot) DIRECTLY CONNECTED IMPERVIOUS AREAS

PORT LUDLOW DRAINAGE DISTRICT
 STORMWATER COMPREHENSIVE PLAN
 FIGURE 7-1
 Connected Impervious Areas

Gray & Osborne, Inc.
 CONSULTING ENGINEERS

A filter strip is simply a strip of land across which stormwater from a street, parking lot, rooftop, etc., sheet-flows over before entering adjacent receiving waters.

For small storms, both swales and filter strips remove pollutants from stormwater by 1) slowing the water and settling or filtering out solids as the water travels over the grassed area and 2) allowing infiltration into the underlying soil. Heavy metals are typically trapped in the upper regions of the soil column. In addition, the vegetation tends to function as fixed media to support growth of microorganisms, which can break down dilute concentrations of organics such as oil residues. In general, the higher the flow rate, the lower the efficiency. Thus, low velocity and shallow depth are key design criteria. A swale designed with a low bottom slope and check dams will perform much more efficiently than one without check dams. Raised driveway culverts can be effective as swale check dams. For maximum efficiency of pollutant removal during small storms, a trapezoidal swale with as large a bottom width as can be fitted into the site plan is desirable, since this will maximize the amount of runoff in contact with the vegetation and soil.

Design equations for swales and filter strips can be found in Chapter 3 of the DOE *Stormwater Management Manual for Western Washington*. Maintenance of both of these devices is an important consideration, for reasons of both aesthetics and hydraulic efficiency. In the case of the swale, care must be taken to insure that flows through a swale used for drainage purposes during large storms are not impeded by an overgrowth of vegetation. To prevent this, the vegetation planted in the channel should be suitable for mowing, and the channel designed so that mowing machines can be easily and efficiently operated along the swale. The swale should be mowed on a regular basis. For filter strips that are not part of the drainageway during large storms, maintenance is purely an aesthetic matter. These strips can be planted in grass and mowed, or natural vegetation can be used. Ground cover must be sufficiently dense to keep the overland flow from channeling and eroding rivulets through the filter strip.

PARKING BLOCKS

Parking blocks are a very effective site-control device. Parking blocks are hollow concrete blocks similar to but smaller than those used in construction. In commercial parking lots, the use of parking blocks in the less frequently used areas will give them an attractive appearance and will considerably reduce runoff quantity, flow rates, and pollution. This is also true for private driveways and parking areas where more than half of the area is used less than 20 percent of the time.

Parking blocks are put in place in rows, with soil surrounding each one. Soil areas are planted with appropriate vegetation. Runoff quantity reduction occurs as infiltration takes place in the planted areas. Greater flow resistance of the grassed areas retards the runoff rate, especially during small storms. Finally, the quality of the runoff is much enhanced over that from a normal parking lot because the pollutants, restrained by the

vegetation matrix, will be more difficult to wash off than if they were simply lying on asphalt or concrete. Entrapped heavy metals are typically contained in the upper soil column, while microorganisms attached to the vegetation can act to break down low concentrations of organic pollutants.

In designing a parking block area, the block manufacturer should be consulted to determine the most suitable sub-base to use. Also, only the actual parking spaces should be paved with the blocks, since they do not hold up well under traffic. The traffic lanes through the lot should be paved in the normal fashion.

INFILTRATION DEVICES

Infiltration devices are those stormwater quality control measures that completely capture runoff from the design storm and allow it to infiltrate into the ground. The DOE *Stormwater Management Manual for Western Washington* provides design and sizing guidance in Chapter 7 of Volume V (Runoff Treatment BMPs). Infiltration systems provide groundwater recharge and pollutant removal, can be integrated into a site's landscaped and open areas, and if designed properly, can serve larger developments. Infiltration devices should be used only in situations where the captured volume of water can infiltrate into the ground before the next storm and where soils, slope, and cover will not promote sloughing and mass wasting (landslides). Infiltration systems in the Port Ludlow area may only be used if tests reveal that sufficient permeability exists within the soil.

Infiltration devices can be classified into one of two categories: above-ground infiltration basins and buried infiltration trenches.

An infiltration basin is made by constructing an embankment or by excavating in or down to relatively permeable soils. The basin will temporarily store stormwater until it infiltrates through the bottom and sides of the system. The infiltration "basin" can actually be a landscaped depression within open areas or even a recreational area such as a soccer field. Infiltration basins generally serve areas ranging from a front yard to a 50-acre area.

Infiltration basins can be constructed on-line or off-line with respect to the normal drainage path. When a basin is located on-line, it will capture the water quality design storm entirely. When a larger storm occurs, runoff overflows the basin, which then serves as a detention pond for those larger events.

Off-line infiltration basins are designed to divert the more polluted first flush of stormwater out of the normal path and hold it for later water quality treatment. When the infiltration basin reaches capacity, the flow path for any additional stormwater returns to normal and is managed for drainage and flood control. The diverted first flush is not discharged to surface water. It is stored and gradually removed by infiltration, evaporation, and evapotranspiration. This is the most effective practice for enhancing the

quality of stormwater. It also helps to reduce stormwater volume and to recharge groundwater.

Infiltration trenches, which can be located on the surface of the ground or buried beneath the surface, are usually designed to serve areas ranging up to five to ten acres in size and are especially appropriate in an urban area, where land costs are very high. An infiltration trench generally consists of a long, narrow excavation, ranging from three to twelve feet in depth, which is backfilled with stone aggregate, allowing for the temporary storage of the first-flush stormwater in the voids between the aggregate material. Stored runoff then infiltrates into the surrounding soil through either the trench bottom or the sides, depending on the elevation of the water table and soil properties. Soil type is also a consideration, since coarse soils overlying a shallow aquifer may provide a direct route for pollutants to contaminate groundwater.

There are two major types of trenches, surface trenches, and underground trenches. The major differences between the two involve the amount of stormwater that can be handled and the ease of maintenance.

Surface trenches receive sheet-flow runoff directly from adjacent areas after a grass buffer has filtered the runoff. They are typically used in residential areas where relatively small loads of sediment and oil can be trapped in grass filter strips at least 20 feet wide. Sediments can clog infiltration devices. Once these devices are clogged, rehabilitation of the infiltrative surfaces requires significant effort.

Underground trenches can be used in many development situations, although discretion must be exercised in their application. While underground trenches can accept runoff from storm sewers, they require installation of special inlets to prevent coarse sediment and oils and greases from clogging the stone reservoir. These inlets should include trash racks, catch basins, and baffles to reduce blockage by sediment, leaves, debris, and oils and greases. In addition, pretreatment by routing the flow over grassed filter strips or vegetated swales is essential to protect the infiltration trench.

If properly constructed, with pretreatment practices in place to prevent heavy sediment loading, infiltration trenches can provide stormwater benefits without tremendous maintenance requirements. Since trenches are usually "out of sight, out of mind," getting property owners to maintain them can be difficult. Accordingly, a public commitment for regular inspection of privately owned trenches is essential, as are legally binding maintenance agreements and education of owners about the function and maintenance needs of trenches.

Inspection of trenches should occur frequently within the first few months of operation and once per year thereafter. Such inspections should be done after large storms, in order to check for water-ponding. Water levels in the observation wells should be recorded over several days to check drawdown. In addition, grass buffer strips should maintain a dense, vigorous growth of vegetation, which should receive regular mowing (with

bagging of grass clippings) as needed. Finally, pretreatment devices should be checked periodically and cleaned when the sediment reduces available capacity by more than 10%.

Structural Alternatives

The incorporation of runoff quality controls into urban landscape design is more an art than a science. However, if the design is developed with the following concepts in mind, a good water quality management system will result.

- Design runoff quality controls to capture small storms.
- Design to maximize sediment removal, and removal of other pollutants will generally be good.
- The most effective method for reducing urban runoff pollution is to minimize directly connected impervious area (DCIA).
- Infiltration devices are most efficient but are most difficult to maintain, and may not be used on sites with poor soil conditions.
- Dry detention is easiest to design and operate, but efficiency can be low.
- Wet detention is more difficult to design but more efficient than dry detention, and often more aesthetic.

With thoughtful planning and careful design, cost-effective runoff quality controls can be integrated into urban development plans to achieve the required level of pollutant reduction with minimal negative impact on aesthetics. The aesthetic character of a development site can often be enhanced by properly integrating runoff quality controls into the site plan.

STORMWATER QUANTITY AND QUALITY CONTROL: NON-STRUCTURAL ALTERNATIVES

Management of a stormwater system can be improved by strengthening various areas of District administration. The administrative issues, also termed non-structural issues, embrace a wide variety of measures, which include source controls.

Non-structural stormwater management alternatives include:

- Maintenance programs
- Staff Training
- Changes to the municipal codes or regulations
- Enforcement actions for non-compliance with stormwater regulations
- Public education
- Stormwater Best Management Practices

Source control measures are designed to minimize or eliminate contact of pollutants with stormwater at the site of origin. Regulation of development, such as requiring the enclosure of a pollutant source, physically segregating the pollutant source to prevent run-on of uncontaminated water and connecting directly to sanitary sewers are forms of source control. A requirement for erosion and sedimentation control during construction is a source control method for reducing pollutant load to receiving waters. Source control methods also include education of the public to prevent disposal of yard wastes, household chemicals, and motor oil into drainage facilities. Source control measures that District staff can implement include the BMPs discussed in Volume IV Chapter 2 of the *Stormwater Management Manual for Western Washington* for landscaping and lawn/vegetation management; maintenance and repair of vehicles and equipment; maintenance of public and private utilities; and maintenance of roadside ditches and urban streets.

FACILITIES MAINTENANCE

The objective of a stormwater maintenance program is to assure the reliability and dependability of the stormwater system. A complete maintenance program includes more than the physical tasks of cleaning catch basins, pipes and open ditches; maintenance of vegetation in biological treatment structures; and proper disposal of debris from the maintenance activities. Maintenance programs also involve management items such as completing and maintaining a facilities inventory, maintenance scheduling, assessing costs for contract maintenance versus staff maintenance, and record keeping.

In order to perform maintenance at the appropriate time, a budget, staff, and priority schedule needs to be established. Certain types of maintenance are more important than others. It is important that catch basins and conveyance facilities be inspected before the wet season to assure that debris has not blocked a channel or taken up capacity in a manhole. Street sweeping in the fall is important because leaves block catch basin grates, which could result in overland flow across private property or flooding of roadways. Loss of vegetative cover in treatment swales and filter strips during summer drought conditions can result in reduced effectiveness during the “first flush” of autumn storms.

Reports and record keeping are important feedback mechanisms that enable management to compare actual versus planned costs, production, and efficiency. Reports provide a database for improved budgeting and resource allocation. Records and reports should include man-hours, equipment hours, materials used, and the unit of work completed.

Maintenance control establishes accountability for specific results within a specific time frame and budget. The maintenance program needs a control hierarchy to establish a chain of command to complete the work.

Appendix D identifies the requirements and guidelines for maintaining stormwater facilities. This appendix includes a table that describes potential problems and the necessary corrective actions for typical stormwater treatment, detention, and conveyance

facilities. The table also identifies a recommended period of time between routine inspections and routine maintenance activities. Of course, as these facilities are maintained the need may arise for maintenance at a level more (or less) than these typical values. It should also be noted that at the time of facility installation, the District should request a manual describing specific maintenance necessary for the facility. This, coupled with a routine schedule, will help ensure proper maintenance of the facility. One item of critical importance is the District's diligence in inspecting privately owned and maintained facilities. Some jurisdictions provide stormwater utility credits or refunds for those private facilities that are properly and routinely maintained. The Port Ludlow Drainage District does not currently provide for this. Therefore, with no financial incentive, it is even more critical that the District performs these inspections and issue notices of inspections to those private parties who are not maintaining their facilities. Because the proper operation and maintenance of stormwater facilities benefits the public as a whole, the District should utilize innovative solutions to accomplish the goals of stormwater management in those cases where a private entity will not, or cannot, maintain their facility, rather than enacting civil penalties for the sake of punishment. It is highly recommended that the District seek easements for those portions of the system that lie outside of the right-of-way.

The various stormwater facilities that require maintenance are described below.

1) Street Sweeping

Streets with concrete curb and gutter or thickened edges are part of the stormwater conveyance system. All streets accumulate vehicular emission particles, silt, and, leaves and other debris and pollutants that could enter the stormwater conveyance system. Street sweeping (not washing) is an important maintenance item to reduce pollution in the receiving waters and to reduce the potential for blocking of the conveyance system. High efficiency street sweepers are recommended due to the fact that they have evolved into a useful technique for picking up small particulates, which accumulate pollutants along District streets. Street sweeping is recommended at least once per year in the fall, after the leaves have fallen.

2) Catch Basin Cleaning

Catch basins in the District include types with and without sumps. Sumps are important features that allow deposition of particulate matter carried in the stormwater. When sumps become filled to 60 percent of their volume, the efficiency of silt removal diminishes significantly. All catch basins should be inspected at least twice per year. Once a maintenance program is in place, the District will be able to develop a history on particular areas to determine which basins require more frequent attention. Catch basins are normally cleaned with a vactor truck that removes the sediment from the basin. This sediment must be disposed of properly into an appropriate disposal site. Jefferson County Public

Works currently uses the Port Hadlock maintenance facility (approximately 10 miles away). For the purposes of this plan, catch basin cleaning is estimated to be required an average of twice a year.

3) Pipe Cleaning

Pipes in the District vary in size from 8-inch to 36-inch diameter. Pipe types include concrete, corrugated metal and HDPE. All pipes should be inspected annually and cleaned, at a minimum, every third year. A vacuum system is recommended for cleaning. If pipe flushing is used, adequate downstream siltation control must be in place.

4) Open Ditch Cleaning

Some roads in the Port Ludlow Drainage District are drained by means of roadside ditches. Ditches and swales can provide biofiltration, if vegetation is allowed to remain within the channel and on the sides. The primary pollutant removal mechanism of a bioswale (or ditch) involves filtration by grass blades, which enhance sedimentation, as well as trapping and adhesion of pollutants to the grass and thatch. To be most effective, the vegetation within the ditch should be cut down to a height between 2 and 6 inches. Swales can be cleaned by the use of a horizontal auger. Ditches should be cleaned twice a year, preferably during the summer months to allow vegetation to grow back before the rainy season. The edges of the ditches should be mowed four times a year.

5) Detention System Cleaning

Upon installation of a detention system the District should request a manual regarding specific maintenance requirements for facilities such as detention ponds. At a minimum, when detention systems are installed in the District, they should be monitored annually for sediment accumulation. Removal of accumulated sediment is anticipated to be required once every five years.

6) Future Oil/Water Separators

Oil/water separators must be maintained in order to be effective. If deposited material is not removed on a periodic basis; it may be flushed downstream by winter storms. Inspection of oil/water separators should be scheduled bimonthly and maintenance cleaning scheduled at least annually and more frequently if required.

All components of the stormwater system should be inspected at least twice per year. Additional inspections may be warranted in problem areas and also in areas where land development is occurring, due to the potential for erosion and sedimentation. Routine maintenance should be performed on all components based on these inspections. In

general, most jurisdictions do not provide an appropriate level of maintenance for all portions of their system. Maintenance is often reactive, rather than proactive.

Several benefits can be realized by maintaining all portions of the stormwater system. With a well maintained system better treatment and flow control is accomplished, the public recognizes a well run maintenance program, it becomes easier to identify problems and resolve complaints, and problems such as flooding, icing of roadways, and damage to the system are minimized.

STAFF TRAINING

A fundamental part of the stormwater program includes training for District personnel on how to address stormwater issues. The District should ensure that the District staff is well trained on how to inspect and maintain best management stormwater practices as outlined in Section 4.6 of the *Stormwater Management Manual for Western Washington*. At a minimum, staff should be educated on how to maintain catch basins, detention ponds and control structures, bioswales/ditches, Stormfilter vaults, and any other best management practices implemented within the District. Staff shall also be knowledgeable in identifying pollutant sources and in understanding pollutant control measures, spill response procedures, and environmentally acceptable material handling practices. Ecology's "Stormwater Pollution Prevention Planning for Industrial Facilities" (WQ-R-93-015, 9/93) may be used as a training reference. The utilities supervisor may be designated as responsible for setting up training for new employees regarding these issues. Renewal training for all employees on a biannual basis is recommended as well.

Personnel must also be well trained on sediment and erosion control issues so they can properly investigate and advise contractors regarding problem areas during construction. Staff members should be certified through the "Construction Site Erosion and Sediment Control Certification Course" offered thought the year by the Associated General Contractors of Washington Education Foundation or an approved equivalent. Equivalent certificates include:

- WSDOT certification in Construction Site Erosion and Sediment Control.
- Certified Professional in Erosion and Sediment Control (CPESC) offered by the International Erosion Control Association (IECA).

Erosion and sediment control certification for staff members should be renewed every three years.

CHANGES TO MUNICIPAL CODES AND REGULATIONS

The federal, state, and local rules, regulations, and guidelines that govern stormwater have been discussed in Chapter 2 of this document. The Jefferson County Stormwater Requirements should be used as support for implementing erosion and sedimentation

control facilities on development sites, allow establishment of best management practices (BMPs), and provide design criteria for structural stormwater management facilities.

ENFORCEMENT

District staffing levels must be sufficient to monitor construction activity, respond to surface water complaints, and provide periodic inspection of private stormwater treatment facilities such as oil/water separators and detention facilities. Existing staff should document the hours spent on site inspections, together with the frequency of inspection of construction sites and private stormwater facilities. From these records and the records of time spent responding to complaints, an understanding of the adequacy of the current staffing level can be gained.

PUBLIC INVOLVEMENT AND EDUCATION

An important element of a stormwater management plan is public involvement and education. The involvement of the public is necessary to insure the overall success of the stormwater management plan. For the public to be motivated to participate in stormwater management it must first be made aware of the existing surface water problems, what role the public has in causing surface water problems and what can be done about them.

The general public must be made aware of how their normal activities affect stormwater quality and quantity. Most citizens believe that stormwater management is someone else's problem. In order to educate the public it is necessary to identify those subjects that have local relevance and then design a program that addresses those issues. Public education programs in the Port Ludlow area should focus on the following issues:

- Voluntary ditch maintenance
- Catch basin stenciling
- Citizen hotline
- Oil recycling center
- Newsletter articles
- Signs at stream crossings
- Neighborhood compost bin

1) Voluntary Ditch Maintenance

A voluntary drainage ditch maintenance program should be established that encourages property owners to mow and otherwise maintain the drainage ditches adjacent to their properties. Local groups, clubs, and service organizations can be recruited to provide maintenance for drainage features, which have a more community-wide significance. The efforts will need to be coordinated by the District, which must also provide a clearinghouse where information can be stored and distributed. The goal of the program is to insure that drainage ditches

are maintained in a condition, which insures that ditches will be able to carry the full design capacity of stormwater when needed. The District may wish to encourage the County to adopt an ordinance that requires property owners to maintain the ditches adjacent to their property. Such an ordinance would be similar to sidewalk maintenance ordinances used by other cities.

2) Catch Basin Stenciling

A program that encourages citizens and local service groups to stencil catch basins is needed to discourage the dumping of oil or other harmful substances and to inform citizens that materials dumped in the catch basins end up in waterbodies. The goal of this program is to have 100% coverage of catch basin stenciling.

Many if not most, people are unaware that storm drains usually discharge into nearby surface waters. By stenciling all catch basins within the District with an appropriate warning, citizens will be made aware that anything dumped into a catch basin will soon enter the Ludlow Bay.

3) Oil Recycling Center

This program will encourage a local business to become a drop-off point for waste oil to be recycled. The general public must be made aware of the location and hours for the local recycling station and the procedures for disposing of waste oil at the station.

The goal of this program will be to provide a suitable destination for waste oil. This will serve to provide alternatives to other practices that have been used in the past, such as dumping of waste oil down storm drains. An effort should be made to coordinate the establishment of the waste oil-recycling center with other nearby jurisdictions.

4) Newsletter

A community newsletter that addresses stormwater issues should be published. The newsletter can include articles containing relevant information of local interest to help citizens eliminate or minimize stormwater quantity or quality problems.

The goal of this program will be to place issues concerning activities affecting the watershed before citizens in a timely manner. Issues to be addressed include:

- Composting
- Fertilization practices

- Hazard household waste disposal
- Waste oil recycling
- Pesticide use
- Ditch maintenance
- Sensitive area protection
- Waterfowl feeding (adverse effects)
- Wetlands protection/maintenance
- Citizen hotline

An expected impact of this portion of the plan is to provide residents timely reminders of the role they play and the effect they have on water quality in the watershed.

5) Citizen Hotline

This portion of the program will establish and publish a phone number for use by citizens to report activities that could cause water quality problems. It would also be used for reporting surface water quality problems.

The goal of this program is to reduce the amount and types of external loading on local streams and water bodies. The impact of this program will be to reduce stormwater impacts and to assure that appropriate education of enforcement actions are undertaken.

6) Signs at Drainage Channel Crossings

This program will provide signs at the locations where roadways cross drainage channels. These signs are intended to mark the location of stormwater drainage features to provide an ongoing reminder to citizens of the community's efforts to improve and control surface water pollution. The goal of this program is to increase the public awareness of and familiarity with surface water resources.

7) Neighborhood Compost Bin

This program will survey available sites with the intent of establishing a community compost bin. The compost bin, when established, will provide a site for disposal of yard wastes for residents without sufficient space for a residential compost bin or for those whose properties are unsuitable for such use. The District will maintain and manage the compost bin and use the resulting compost in the District parks and public places.

The goal of this program is to insure that all yard wastes are disposed of in an environmentally sound manner. Side benefits of this program include the

reduction of the quantity of yard wastes sent to landfills and provision of a source of landscaping material for the District.

BEST MANAGEMENT PRACTICES

In most communities a major source of stormwater contamination comes from sources that are lumped together and called non-point pollution. Non-point pollution sources can generally be defined as “pollution that does not have a single point of discharge.” Non-point pollution discharges can be divided into commercial and residential categories.

The treatment of stormwater runoff prior to discharge to surface water or prevention of non-point pollution in stormwater should be accomplished by using Best Management Practices (BMPs). Best Management Practices are defined as physical, structural, and/or managerial practices, which when used singly or in combination, prevent or reduce pollution of water.

The DOE *Stormwater Management Manual for Western Washington* contains BMPs for urban land uses. Best Management Practices can be placed into two general groups: source control BMPs, and runoff treatment BMPs. The former group includes those BMPs, which keep a pollutant from ever coming in contact with stormwater; the latter group consists of various methods of treating stormwater. Source control BMPs are preferred as they are generally less expensive and frequently are very effective in eliminating the source of pollution prior to its entry into runoff.

The DOE *Stormwater Management Manual for Western Washington* lists many types of BMPs, and provides some general strategies for their use. The strategies are listed below in order of preference:

Alter the activity: The preferred option is to alter any practice that may contaminate surface water or groundwater by either not producing the pollutant to begin with or by controlling it in such a way as to keep it out of the environment. An example would be recycling used oil rather than dumping it down a storm drain.

Illicit or unintentional connection of indoor drains to the storm drain, rather than to the sanitary or process sewer is a significant source of stormwater contamination. It is important that these connections are identified and corrected.

Enclose the activity: If the practice cannot be altered, it should be enclosed in a building. Enclosure accomplishes two things. It keeps rain from coming into contact with the activity, and since drains inside a building must discharge to sanitary or process wastewater sewers or a dead-end sump, any contamination of runoff is avoided.

Cover the activity: Placing the activity inside a building may be infeasible or prohibitively expensive. A less expensive structure with only a roof may be effective although it may not keep out all precipitation. Internal drains must be connected to the

sanitary sewer to collect water used to wash down the area as well as any rain that may enter along the perimeter.

Segregate the activity: Segregating an activity that generates more pollutants than other activities may lower the cost of enclosure or covering to a reasonable level.

If the segregated activity cannot be covered, it may be possible in certain situations to connect the area to the public sanitary sewer, subject to approval. Drains may also be connected to a businesses' own process wastewater system if the business operates independently of the local authority.

Discharge stormwater to the process wastewater treatment system: Many industries have their own process wastewater treatment system with final disposal directly to the receiving water. In these cases, stormwater from areas of significant pollution sources can be plumbed to the process treatment system as long as its capacity is not exceeded.

Discharge small, high frequency storms to public sanitary sewer: This BMP would be limited to those few outside activities that contribute unusually high concentrations of pollutants and/or pollutants of unusual concern. Limited entry of these few special cases may not overtax the public sanitary sewer.

The entry of stormwater to the sanitary or combined sewer can be limited to the small high-frequency storms that carry off the majority of pollutants over time. Storm flows in excess of the hydraulic capacity of the sanitary or combined sewer would be discharged to the storm drain.

Discharge small, high frequency storms to a dead-end sump: This BMP would be limited to those few activities that contribute unusually high concentrations of pollutants and/or pollutants of unusual concern. This option would be used when discharge into a sanitary sewer or process wastewater treatment is not available or feasible. This option requires the capacity to pump out the sump regularly and to dispose of the pumpage in an appropriate manner.

Treat the stormwater with a stormwater treatment BMP: The treatment of stormwater is the least-preferred option for several reasons. Source control BMPs keep the pollutants completely away from stormwater. In contrast, stormwater treatment devices are not 100 percent effective. In fact, a highly effective BMP is considered successful if 80 percent of the pollutants are removed. Even after treatment, freshwater criteria may not be met for commercial areas.

Given the above strategies for use of BMPs, DOE has developed mandatory BMPs for many different business groups. Section 2.2 and Appendix IV-A of Volume IV in the DOE *Stormwater Management Manual for Western Washington* lists each group of business in the following way:

- Title of business group
- Standard Industrial Code (SIC)
- Description of business activities
- Potential pollution generating sources
- Pollutant Control Approach
- Applicable Operation BMPs
- Applicable Structural Control BMPs

The source control BMPs are found in Volume IV, in numerical order, in the DOE *Stormwater Management Manual for Western Washington*. Descriptions of regulations that are specifically referenced can be found in Appendix IV-D, and any stormwater treatment BMPs required can be found in Volume V, Runoff Treatment BMPs. Ecology has recently recommended implementing oil control measures for “high use areas.” These areas include:

- An area of a commercial or industrial site subject to an expected average daily traffic count equal to or greater than 100 vehicles per 1,000 square feet of gross building area,
- An area of a commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, not including routinely delivered heating oil,
- An area of a commercial or industrial site subject to parking, storage or maintenance of 25 or more vehicles that are over 10 tons gross weight,
- A road intersection with a measured average daily traffic count of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersection roadway, excluding projects proposing primarily pedestrian or bicycle use improvements.

Providing treatment under the oil control menu is just one of four treatment menus that Ecology has provided in Chapter 3 of the Stormwater Manual. The other three include a basic, enhanced, and phosphorus treatment menu. However, as noted earlier, source control BMPs are preferred over treatment BMPs, if feasible.

CHAPTER 8

CAPITAL IMPROVEMENT PLAN

INTRODUCTION

The Capital Improvement Program (CIP) is based on a number of criteria. First, all known storm drainage problems identified by the District staff and the general public were investigated. Capital improvements or other measures are recommended for these problems. In addition, the hydrologic/hydraulic modeling effort identified that some storm drainage facilities are inadequately sized to convey the runoff generated by the 25-year and/or 100-year design storm event based on future land use conditions.

It is important to keep in mind that whenever an inadequate pipe or channel is replaced or reconstructed, the improvement may transfer the problem downstream. It is therefore **strongly** recommended that all improvements include consideration for on-site detention and water quality treatment, as described in the Washington State Department of Ecology's *Stormwater Management Manual for Western Washington*, especially in the steep, currently forested areas.

The cost estimates provided herein are conservative in nature and should be considered adequate for planning purposes. Also, as stated in Chapter 5, since no on ground field survey was conducted throughout the compilation of this plan, any recommended capital improvement projects resulting from this plan need to include surveys to ensure the most accurate and effective design for the project. All recommended projects assume that the existing pipe slope will be utilized in the future. However, the most optimum slope should be analyzed in order to provide maximum pipe capacity. Table 8-1 summarizes all of the recommended capital improvements (See Figure 8-1). Costs estimates are detailed in Appendix E. Projects within the County rights-of-way are identified but cost estimates have not been generated for all projects.

The projects presented here are those identified from computer numeric modeling, District input and public comments. These projects are ranked based on the severity of the problem as outlined in Chapter 5. Other drainage problems may arise in the future and will need to be addressed at that time. The Comprehensive Plan will need to be updated as development and regulatory requirements change.

TABLE 8-1

Recommended District Capital Improvements

Priority⁽¹⁾	Project	Priority Year	Estimated Total Project Cost⁽²⁾
2.	Port Ludlow No. 2 Condo Conveyance System	2003	\$ 15,000
3.	Area 7 Detention Pond/Bioswale rehabilitation	2003	\$ 5,000
4.	Montgomery Lane Outfall Repair/Replacement	2004	\$117,000
6.	Incised Drainage Ditch Repair	2004	\$ 11,000
7.	Oak Bay Road / Montgomery Lane Detention and Redirection of flows (ditch grading)	2005	\$ 90,000
13.	Cascade Lane Conveyance/Greenbelt Channel	2006	\$ 12,000
15.	Walker Way/Phinney Lane Detention System	2007	\$ 49,000

(1) A complete listing of projects is found in Table 5-3. The priority projects are discussed below.

(2) 2003 Dollars. Total cost includes engineering, administrative, legal, permitting and construction costs

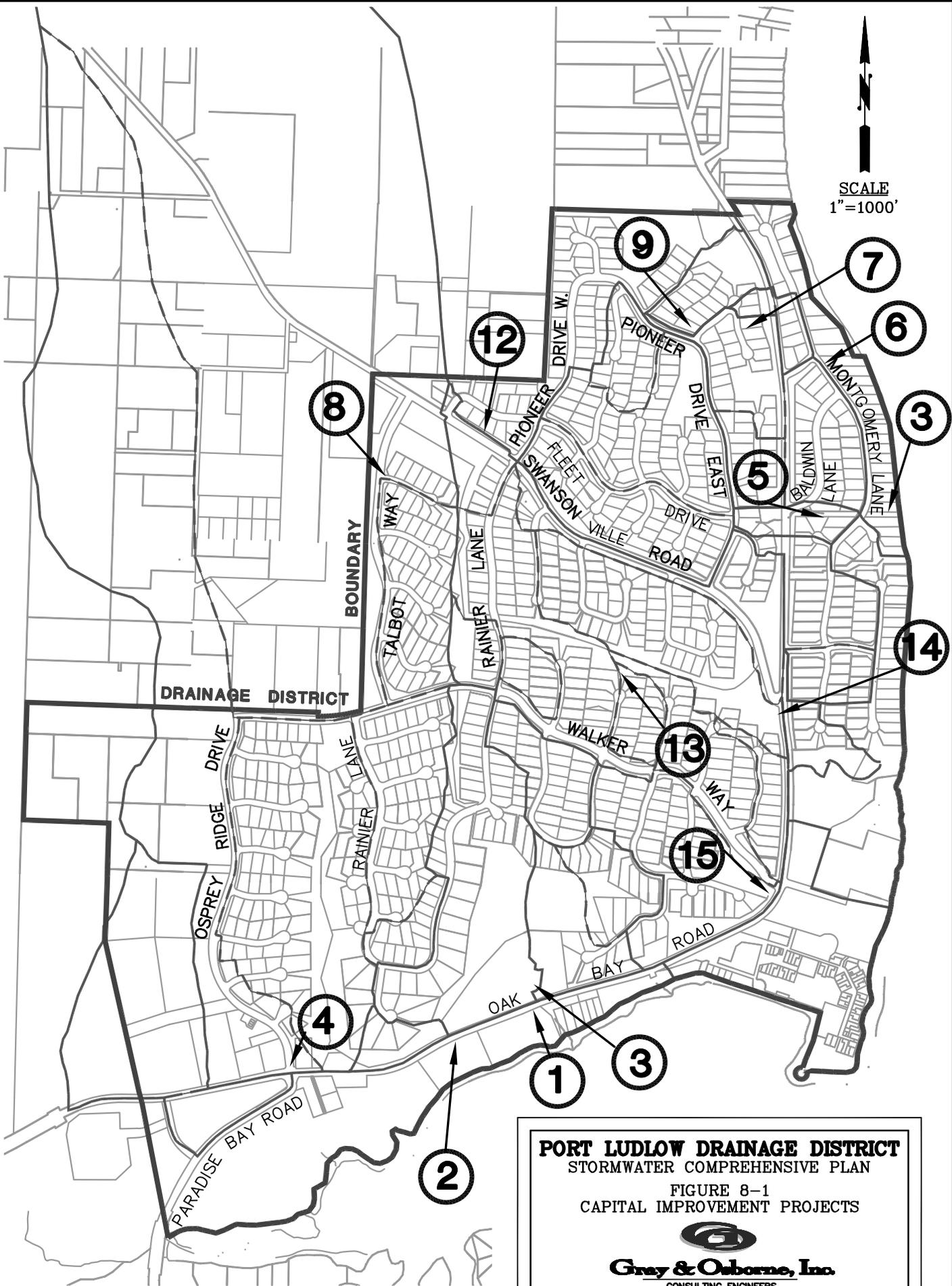
SIX YEAR CAPITAL IMPROVEMENT PLAN

DITCH REHABILITATION

Maintenance of ditches belonging to both the District and the County is critical in reducing flooding. All ditches should be inspected and maintained as described in the maintenance program in Appendix D. To facilitate this maintenance on a regular basis, it is highly recommended that the District obtain easements for all stormwater systems (including pipes and ditches) lying within private property. Maintenance of these systems involves clearing ditches of trash and debris, removing sediment that exceeds 20 percent of the ditch’s depth, and ensuring that existing vegetation allows free movement of water throughout the ditch. Side slopes shall also be checked for erosion hazards and repaired on an as-needed basis. Since the first cleaning will be more involved than future ones, the estimated cost of the first phase of this project is greater than the on-going annual maintenance costs.

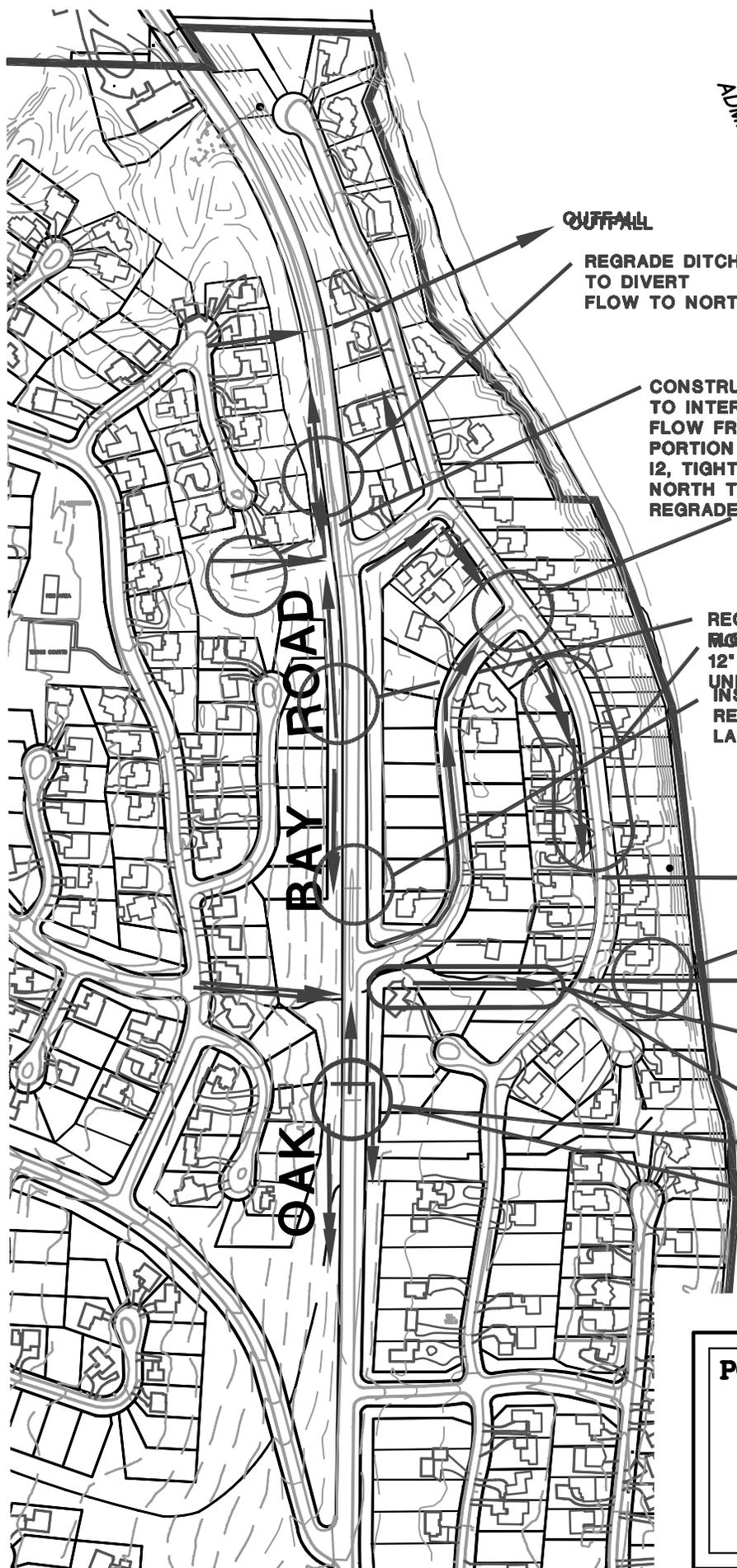
1. Port Ludlow No. 7 detention pond outfall underneath Oak Bay Road (Culvert No. 89). Settlement of the pavement was observed over the top of the pipe and the bottom of the 30-inch pipe has rusted and eroded away. Slip-lining of the existing pipe with a smaller diameter pipe is recommended. A 24-inch diameter pipe is adequate to convey the 100-year storm flows. **(COUNTY)**

SCALE
1"=1000'



2. North Bay Condominiums currently have heavy surface sheet flows over the existing driveway and parking area. Immediately upstream of the location of the flooding, a 12-inch culvert crosses Oak Bay Road and discharges onto the asphalt pathway south of Oak Bay Road. These concentrated flows disperse somewhat in the greenbelt south of Oak Bay Road and the North Bay Condominiums. However, down gradient of the greenbelt is the parking area and driveway. The flows then concentrate again causing some flooding and flow control problems near the entrance to the two of the buildings. The 12-inch culvert is adequately sized for the modeled flow. A closed pipe connection between the existing culvert on Oak Bay Road and the downstream culvert between the buildings would eliminate the problem. Downstream impacts must be addressed to assure the system can handle the flow. **(Condominium Owners and DISTRICT)**
3. The detention pond and bioswale leading to the pond have been neglected for years. Significant vegetation has developed in both the pond and the swale. The facility needs to have vegetation removed, sediment removed, and regraded to the original design. **(DISTRICT)**
4. The outfall pipe downstream of Montgomery Lane near Libby Court appears to have a rusted and eroded pipe bottom. A historical television inspection was inconclusive on the overall condition of the pipe due to flow in the pipe at the time of the taping. Slip-lining of this pipe is recommended if possible. A 30-inch diameter pipe is adequate to convey 100-year flows. **(DISTRICT)**
5. The inlet to Culvert No. 12 located at the intersection of Oak Bay Road and Osprey Ridge Drive is poorly configured and the culvert is undersized. The inlet configuration should be revised and culvert diameter increased from 12- to 30-inches. The drainage system upstream of this culvert should also be enlarged. That modification includes upsizing of the driveway tiles for the commercial businesses along Osprey Ridge Drive from 12- to 24-inch diameter pipes and enlargement/installation of a roadside ditch between the northernmost driveway tile and Culvert No. 12. **(COUNTY – Culvert No. 12 and roadside ditches; BUSINESS OWNERS and/or DISTRICT – driveway tiles)**
6. The channel located in the reserve area between Culvert No. 84 in Oak Bay Road and Culvert No. 64 in Montgomery Lane near Libby Court is heavily incised. Regrading, erosion protection and rock check dams should be installed to reduce the flow velocity and stabilize the ongoing erosion in this channel. **(DISTRICT)**

7. Culvert No. 74 located at the intersection of Montgomery Lane and Baldwin Lane is undersized. The culvert diameter should be increased from 18- to 30-inches. Subsequently, the downstream ditch between Culvert Nos. 74 and 63 should be enlarged, Culvert No. 63 should be enlarged to 30-inch diameter pipe, and driveway tiles also increased to 30-inch diameter pipes. Culvert No. 63 is located within Montgomery Lane approximately 280 feet north of Libby Court and is the outfall for Basin I. The inlet to Culvert No. 63 should be reconfigured to accept flow more efficiently. A house on the east side of Montgomery Lane has had water from the ditch overtop the roadway and enter into the house. An alternative to replacing culverts and drainage tiles is to redirect flows from west of Oak Bay Road south to the Montgomery Lane/Libby Court Outlet. Figures 8-2 through 8-5 show the existing and alternative approaches. It is imperative that improvements described in items 3 and 5 above are completed before any redirection of flows occurs. The detention pond shown in Figure 8-5 would also need to be completed prior to redirection of flows. More detailed design work will be required to determine the preferred alternative for this problem. **(COUNTY – R/W culverts and ditches; HOMEOWNERS and/or DISTRICT– driveway tiles)**
8. Flooding across the road has been observed on Jackson Lane downstream of Culvert No. 53. There is no culvert to convey flows under the road at this location. An 18-inch diameter pipe and catch basin should be installed to eliminate the flooding. The discharge of the culvert should extend to the greenbelt area immediately to the south**(COUNTY)**
9. Flooding observed near Culvert No. 41 at the intersection of Talbot Way and Ames Lane. Field investigation found the upstream ditch in need of maintenance. **(COUNTY)**
10. Flooding onto residential property at northwest corner of the intersection of Pioneer Drive East and Jackson Lane caused by flows originating within right-of-way. The ditch on the north edge of Pioneer Drive East should be enlarged and maintained. **(COUNTY)**
11. Green belt detention west of Oak Bay Road at Montgomery Lane. Flows from upland areas discharge to the roadside ditch of Oak Bay Road. A detention pond and conveyance pipe to the north could reduce runoff getting into the Montgomery Lane system. A detention system would need to be sized and pipe to convey to the north **(DISTRICT)**
12. Field investigation found the water reservoir located south of Swansonville Road between Talbot Way and Rainier Lane discharged to the ditch upstream of the intersection of Swansonville Road and Rainier Lane. The culvert crossing under Rainier Lane at this intersection appears

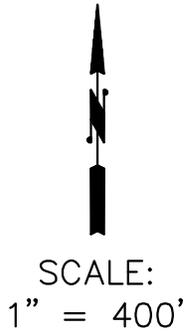


ADMIRALTY

OUTFALL

REGRADER DITCH
TO DIVERT
FLOW TO NORTH

INLET



CONSTRUCT DETENTION POND
TO INTERCEPT AND REDUCE
FLOW FROM BASIN D, NORTHERN
PORTION OF BASIN H, AND BASIN
I2, TIGHTLINE FLOW EAST THEN
NORTH TO OAK BAY ROAD
REGRADER DITCH
CULVERT
UNDERSIZED

REGRADER DITCH TO DIVERT
FLOW TO BALDWIN LANE
12" DIA. DRIVEWAY CULVERTS
UNDERSIZED AND FLOODING
INSTALL CATCH BASIN,
RESTRICT FLOW TO BALDWIN
LANE, DIVERT FLOW TO SOUTH

OUTFALL

REHABILITATE
CULVERT

OUTFALL

INCISED
CHANNEL

REHABILITATE
CHANNEL

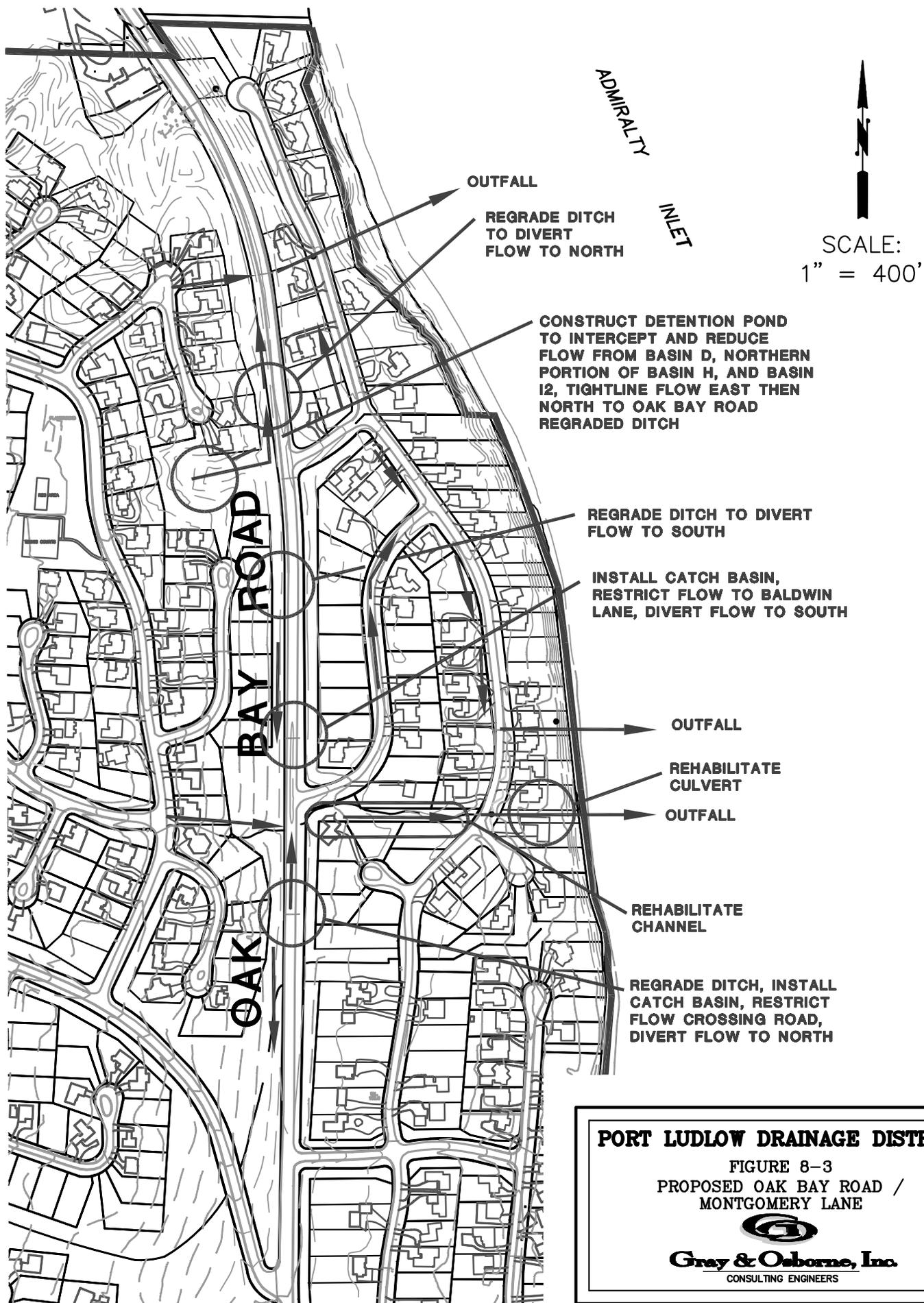
18" DIA.
CULVERT

REGRADER DITCH
UNDERSIZED
INSTALL
CATCH BASIN, RESTRICT
FLOW CROSSING ROAD,
DIVERT FLOW TO NORTH

PORT LUDLOW DRAINAGE DISTRICT

FIGURE 8-2
EXISTING OAK BAY ROAD /
MONTGOMERY LANE

Gray & Osborne, Inc.
CONSULTING ENGINEERS



ADMIRALTY



SCALE:
1" = 400'

OUTFALL

REGRADING DITCH TO DIVERT FLOW TO NORTH

INLET

CONSTRUCT DETENTION POND TO INTERCEPT AND REDUCE FLOW FROM BASIN D, NORTHERN PORTION OF BASIN H, AND BASIN I2, TIGHTLINE FLOW EAST THEN NORTH TO OAK BAY ROAD REGRADED DITCH

REGRADING DITCH TO DIVERT FLOW TO SOUTH

INSTALL CATCH BASIN, RESTRICT FLOW TO BALDWIN LANE, DIVERT FLOW TO SOUTH

OUTFALL

REHABILITATE CULVERT

OUTFALL

REHABILITATE CHANNEL

REGRADING DITCH, INSTALL CATCH BASIN, RESTRICT FLOW CROSSING ROAD, DIVERT FLOW TO NORTH

OAK BAY ROAD

OAK

PORT LUDLOW DRAINAGE DISTRICT

FIGURE 8-3
PROPOSED OAK BAY ROAD /
MONTGOMERY LANE



Gray & Osborne, Inc.
CONSULTING ENGINEERS

Figure 8-4 – Existing Oak Bay Road Profile

Pp

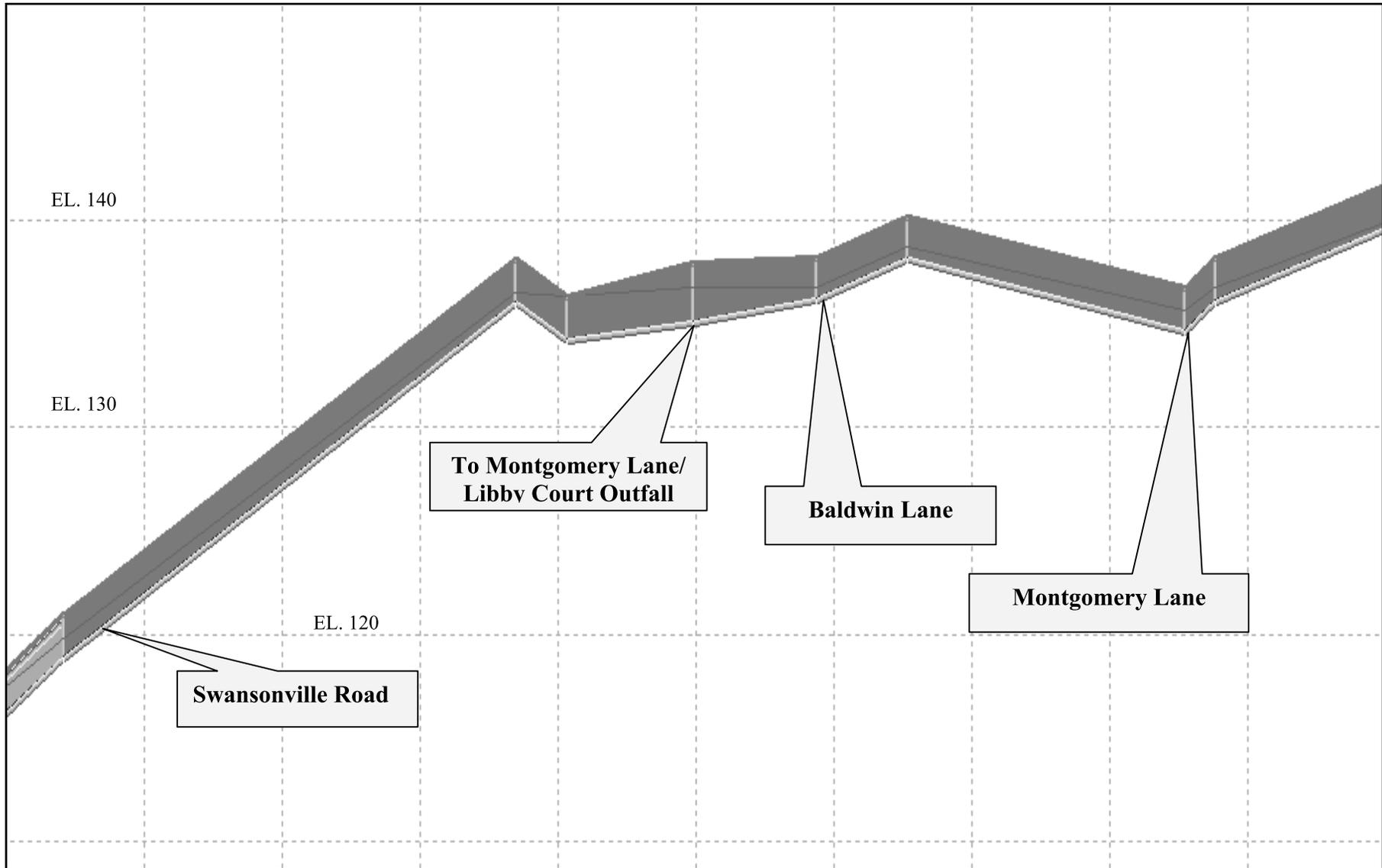
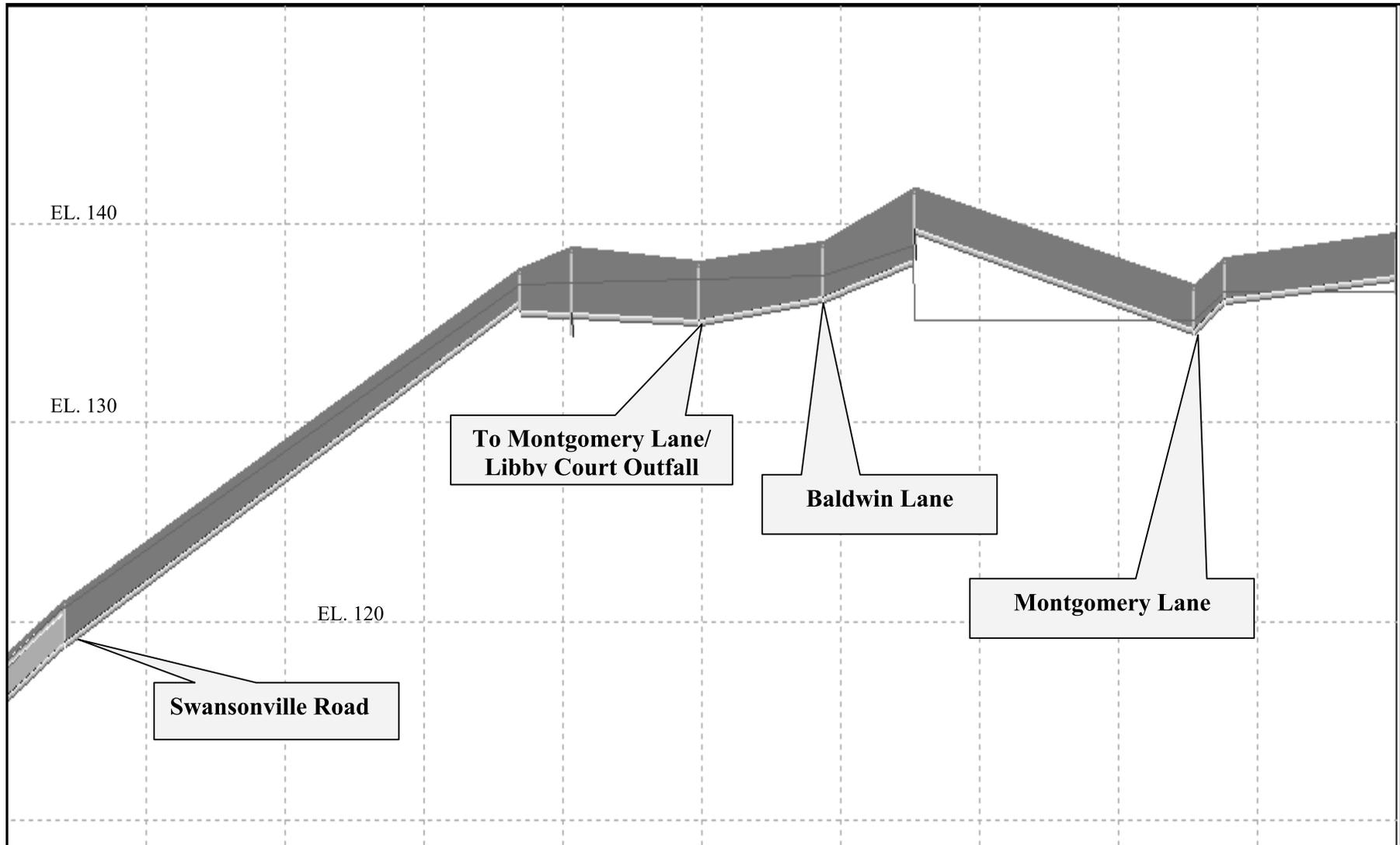


Figure 8-5 – Alternative Oak Bay Road Profile



to be adequately sized to convey the 100-year storm event but the capacity is reduced by the capacity of the ditch downstream of the culvert, causing the conveyance capacity of the outlet of the pipe to be reduced. If the water reservoir discharges a large quantity of water at the same time as a storm event, flooding could occur at this intersection. This intersection should be monitored during larger storm events. **(DISTRICT)**

13. Areas north of Cascade Lane have surface and subsurface flow that collect from the greenbelt behind homeowners at the end of Cascade Lane. Runoff is collected in a ditch and conveyed to Cascade Lane. Cascade Lane had ditches on both the east and west side. Currently the east side ditch is filled and two driveways cross where the ditch once was. The solution could be to install driveway tiles and reconstruct the ditch or to install a single culvert from the north end of Cascade Lane to the downstream ditch on the east side. This would require cutting through the bulb of the cul-d-sac. Alternatively, the greenbelt behind (north) of Cascade could have improvements to the conveyance system through improved channels. This would reduce the flow migrating out of the greenbelt area. **(Homeowners, COUNTY, DISTRICT)**
14. Greenbelt between Walker Way and Swansonville Road. The greenbelt collects water from a number of sources including homeowners and roadway ditches. Some areas of the greenbelt have a defined channel and other areas disperse flows. The area just upstream from Oak Bay Road area could provide detention to reduce flows downstream. A detention system would need to be sized and conveyance of flows directed to the system. **(DISTRICT)**
15. Greenbelt between Walker Way and Phinney Lane. The greenbelt collects water from a number of sources including homeowners and roadway ditches. Some areas of the greenbelt have a defined area and other areas disperse flows. The area just upstream from Oak Bay Road channel could provide detention to reduce flows downstream. A detention system would need to be sized and conveyance of flows directed to the system. **(DISTRICT)**

OTHER RECOMMENDED PROJECTS

Development Standards

The District is recommended to adopt the development standards included in Appendix B as a part of this Comprehensive Plan. The development standards provide stormwater management for development that fall below the current thresholds of the 2001 DOE Stormwater Management Manual for Western Washington. Because Port Ludlow is a platted area with little or no open land that can be subdivided, development of existing

lots and infill are the primary forms of future development. These developments often fall below the thresholds outlined in the 2001 DOE manual but will contribute significantly to additional stormwater runoff. The District may request Jefferson County to include these requirements as part of the Unified Development Code.

GENERAL RECOMMENDATIONS

The District is recommended to continue to update the stormwater system base map and inventory, and that this base map be updated at least once per year.

The District is recommended to enact a complete maintenance program that includes not only the physical task of cleaning catch basins, pipes, and open ditches, but also involves items such as completing and maintaining a system inventory, maintenance scheduling, assessing costs for contract maintenance versus staff maintenance, and record keeping. In order to ensure that maintenance will be provided on a regular basis throughout the entire City, it is highly recommended that the District obtain easements for those portions of the stormwater system that exist on private property.

Gray & Osborne recommends that during the course of review of development proposals, the District and the County strictly enforce the development codes with respect to steep slope buffers, stormwater flow control, erosion hazards buffers, and habitat assessments.

Gray & Osborne also recommends that during the course of review of development proposals, the District enforce the provisions in the Washington State Department of Ecology Manual with respect to downstream analysis. If the analysis identifies conveyance problems, the District should require additional mitigation as a condition of approval.

CHAPTER 9

FINANCING ANALYSIS

INTRODUCTION

This chapter discusses methods of providing financing for the stormwater system operation and maintenance program and capital improvement projects that were recommended in Chapter 8, Capital Improvement Plan.

Funding for the capital improvements listed in Chapter 8 is an essential requirement for the implementation of the recommendations. The financial resources available to the District for the implementation of stormwater capital improvement projects, other than the general District assessment, include grant and loan funds, debt financing, and improvement districts. All financial resources are discussed below.

ASSESSMENT

In 2001, Jefferson County Board of Commissioners established an assessment methodology for the Port Ludlow Drainage District. This assessment methodology is based on a gross area assessment and an impervious area assessment. Jefferson County established a system where 90 percent of the total District budget is based on impervious area and 10 percent of the total District budget is based on gross area. In addition, the Jefferson County Board of Commissioners established a three-zone system. Parcels in Zones 0 and 2 pay 25 percent of the standard gross area assessment. Zone 0 is for parks and dedicated open space and Zone 2 are for parcels west of Osprey Ridge Drive. The stated reason for the reductions was cited as reduced runoff or runoff that flowed out of the District. Aerial surveys, unavailable at the time to the assessment methodology, show that only two parcels in the extreme western portion of the District drain out of the District. All other parcels drain to greenbelt drainage easements or Jefferson County public rights-of-way within the District boundary.

In August 2003, the Port Ludlow Drainage District commissioners requested Jefferson County revise the assessment methodology. Following a public hearing the Jefferson County Board of County Commissioners adopted resolution 07-825-03 amending the assessment system.

The Assessment System is based on a combination of two assessments. The first is an assessment on the parcel's acreage in proportion to the total acreage within the District. The second is an assessment on the parcel's impervious surface area in proportion to the total impervious surface area within the District. The assessment has 35 percent of the total assessment based on gross area acreage and 65 percent of the total assessment based on impervious area.

35 percent of the assessment is assigned to the land area within the District. The gross area acreage system of assessments for the District shall consist of a five-zone classification system (Zone 0, Zone 1, Zone 2, Zone 3, and Zone 4). Zone 0 are the areas permanently held in reserve or greenbelt areas that cannot be developed. Zone 1 are areas that can be developed, other than those in the succeeding zones, and comprise the majority of the District. Zone 2 are parcels in Port Ludlow No. 6 five-acre residential lots that completely drain into the District. Zone 3 are parcels in Port Ludlow No. 6 that partially drain into the District. Zone 4 are parcels in Port Ludlow No. 6 that completely drain out of the District. Zone 0 will pay 5 percent of the standard gross acreage assessment. Zone 1 will pay 100 percent of the standard gross acreage assessment. Zone 2 will pay 15 percent of the gross acreage assessment. Zone 3 will pay 10 percent of the gross area assessment. Zone 4 will pay 5 percent of the gross area assessment.

The assessment methodology must be reviewed by the county engineer and finalized by the county legislative authority at least once every four years and can be updated more frequently. The county must finalize the system of assessments no later than the first of September for the year it is finalized. RCW 85.38.160 provides detailed information on the system of assessment.

The assessment is currently the primary means of funding ongoing maintenance programs, repair or replacement of existing systems, and administration of the stormwater utility district. In addition, assessment revenue can be used to repay debt service for loan or bond indebtedness for the District.

FUTURE STORMWATER UTILITY OPERATING EXPENSES

Future stormwater utility operation and maintenance expenses are estimated using input from staff, the current budget, and current sub-contracting rates. The majority of the estimated stormwater utility O&M expenses are due to administrative and maintenance labor costs.

Jefferson County is responsible for all drainage maintenance, operations, and capital improvements within the public rights-of-way. Jefferson County does not pay into the District assessment. The District is responsible for drainage maintenance, operations, and capital improvements for areas outside of the public rights-of-way. Many of the maintenance issues are due to the age of the infrastructure. The area was first platted in the 1960s and drainage systems installed at that time. Much of the corrugated metal pipe installed at that time has rusted and/or been severely degraded. Facilities to maintain drainage of individual developed and undeveloped lots are not the responsibility of the District.

Developing costs for maintenance and operations will be primarily cleaning and maintaining ditches, swales, the Port Ludlow No. 7 detention pond, and any new facility constructed by the Port Ludlow Drainage District.

In addition to these services, the District is recommended to conduct annual maintenance on ditches located within the District. A “spider” (or walking backhoe) may be needed to clean and reshape major ditches. The rental cost approximated for this machinery is \$300/day. Assuming it takes three days to clean the ditches on an annual basis with a three-person crew, the annual cost is estimated at approximately \$4,000.

Under miscellaneous expenses are the annual cost of stormwater utility supplies and equipment. Currently budgeted for stormwater supplies and equipment is \$5,000 per year and for rate analysis, the cost is adjusted at 4% per year for inflation (see Table 9-2). A \$5,000 administration expense was also added to the total stormwater utility operation and maintenance costs.

Table 9-1 shows the budget projection the District including for annual stormwater operation and maintenance expenses for the years 2001 through 2008.

TABLE 9-1
2003 Budget and 6 year Projection

EXPENSES								
Item	2001	2002	2003	2004	2005	2006	2007	2008
Personnel Services	\$ 4,000	\$ 12,000	\$ 10,100	\$ 15,000	\$ 15,000	\$ 15,000	\$ 15,000	\$ 15,000
Field Expenses	\$ 3,000	\$ 4,000	\$ 3,700	\$ 4,000	\$ 4,000	\$ 4,000	\$ 4,000	\$ 4,000
General District Engineering	\$13,000	\$ 13,000	\$ 10,500	\$ 8,000	\$ 8,000	\$ 8,000	\$ 8,000	\$ 8,000
Commissioner Meetings, Mileage, & Travel Expenses	\$ 4,000	\$ 4,000	\$ 10,800	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000
Miscellaneous District Office Expenses	\$ 9,000	\$ 5,000	\$ 8,700	\$ 8,500	\$ 8,500	\$ 8,500	\$ 8,500	\$ 8,500
Assessment, Taxes, County Fees & Election Costs	\$ 9,500	\$ 8,000	\$ 1,300	\$ 8,000	\$ 2,000	\$ 8,000	\$ 2,000	\$ 2,000
Comprehensive Plan		\$ 90,000	\$ 20,000					
PWTF Loan Repayment			\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	
SRF Loan Repayment			\$ 12,300	\$ 12,200	\$ 12,200	\$ 12,200	\$ 12,200	
County Loan Repayment (based on revised schedule)		\$ 4,405	\$ 12,200	\$ 11,893	\$ 11,637	\$ 11,381		
Estimated Loan interest								
Professional Services		\$ 6,000	\$ 9,600	\$ 6,000	\$ 6,000	\$ 6,000	\$ 6,000	\$ 6,000
Capital Facilities incl. Engineering & Permits	\$ 2,000	\$ 16,595	\$ 70,000	\$ 60,000	\$ 70,000	\$ 60,000	\$ 70,000	\$100,000
Revenue Bond Counsel		\$ 2,000	\$ 0					
Contingency		\$ 28,277	\$ 9,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000
Total	\$44,500	\$193,276	\$188,200	\$158,593	\$162,337	\$158,081	\$150,700	\$158,500
INCOME								
PWTF Planning Loan Funds		\$ 50,000	\$ 5,000					
CCWF-SRF Loan Funds		\$ 40,000	\$ 20,000					
Jefferson County Loan	\$44,500							
Carryover from previous year			\$ 30,000					
Assessment required to fund projected Budget	\$ 0	\$103,276	\$133,200	\$158,593	\$162,337	\$158,081	\$150,700	\$158,500

- (1) Personnel services: Part-time administrative for \$4,000 and part-time field of \$6000 in 2002 and \$11,000 thereafter
- (2) Field Expenses: Equipment purchase and rental, day labor, and disposal costs
- (3) General District Engineering: All Misc. Engineering excluding Comprehensive Planning and major facilities design and construction management
- (4) Commissioner Meetings, Mileage & Travel Expenses: Commissioners expenses.
- (5) Miscellaneous: Rent, storage, insurance & office expenses
- (6) Assessment, Taxes, County Fees & Election Costs: Assessment preparation limited to 1% of assessment levy, election cost every other year
- (7) Professional Services: Legal and Accounting
- (8) Capital Facilities Incl. Engineering and Permits

Maintenance operations within the District boundary including right-of-way areas and District drainage are estimated below. Jefferson County is responsible for maintenance and operations of drainage within the rights-of-way. Table 9-2 provides an estimate of the cost for stormwater drainage maintenance operations within the District.

TABLE 9-2

Future Stormwater Utility Operation & Maintenance Expenses

Activity	Quantity	Rate (per day)	Frequency (per year)	Crew (# persons)	Estimated Annual Cost
Catch Basins	60	14	2	2	\$5,200
Clean/Jet Pipes	3,700 LF ⁽¹⁾	1,500 LF	1	3	\$2,500
Maintain Ditches	10,000 LF ⁽¹⁾	4,000 LF	1	3	\$2,800
Drainage Supplies	---				\$3,000
Administration	---				\$2,000
Total (Rounded):					\$15,500

(1) See Chapter 4 for information on total pipe and ditch lengths within the District. The majority of drainage facilities are located in the County rights-of-way.

FUTURE STORMWATER REVENUES

District revenue is based on an annual assessment for property owners within the boundary. Each year, the District Commissioners establish a budget and submit it to Jefferson County. The budget includes all revenue sources including the annual assessment. The assessment amount submitted to Jefferson County is then divided up based on the assessment methodology approved by the Jefferson County Board of Commissioners. Assessments are sent out as part of the property tax statement and collected by the County. The budget projections in Table 9-1 show the estimate of the assessment over the next six years.

CAPITAL IMPROVEMENT FINANCING

The recommended capital improvements for the District are detailed in Chapter 8. The budget shown in Table 9-1 includes a planned amount for capital improvements. The list of projects, recommended schedule for implementation, and their costs in year 2003 dollars, are shown in Table 9-3.

TABLE 9-3

Recommended Capital Improvements

	Project	Priority Start Year	Estimated Total Project Cost (2003 Dollars)
2.	North Bay Condos No. 2 Conveyance System	2003	\$ 15,000
3.	Area 7 Detention Pond/Bioswale rehabilitation	2003	\$ 5,000
4.	Montgomery Lane Outfall Repair/Replacement	2004	\$117,000
5.	Incised Drainage Ditch Repair	2004	\$ 11,000
7.	Oak Bay Road / Montgomery Lane Detention and Redirection of flows (ditch grading)	2005	\$ 90,000
13.	Cascade Lane Conveyance/Greenbelt Channel	2006	\$ 12,000
15.	Walker Way/Phinney Lane Detention System	2007	\$ 49,000

As was shown in Table 9-1, the budget includes sufficient annual net revenues to pay for the capital improvement projects listed in the six-year plan from the annual assessment. However some years may require more funds than will be collected through the assessment. Table 9-4 shows the cash flow over the next five years and the cost of the projects in the recommended year.

TABLE 9-4

Port Ludlow Drainage District Capital Improvements and Budget

Year	Project	Estimated Project Costs	Budget for Capital Projects)
2003	Area 7 Detention Pond/Bioswale rehabilitation Ludlow No. 2 Condo Conveyance System Subtotal YEAR TOTAL – SURPLUS/DEFICIT	\$ 5,000 \$15,000 \$20,000	\$70,000 \$50,000
2004	Montgomery Lane Outfall Repair/Replacement Port Incised Drainage Ditch Repair Subtotal YEAR TOTAL – SURPLUS/DEFICIT	\$117,000 \$ 11,000 \$128,000	\$60,000 (\$18,000)
2005	Oak Bay Road/Montgomery Lane Detention and Redirection of flow Subtotal YEAR TOTAL – SURPLUS/DEFICIT	\$90,000 \$90,000	\$70,000 (\$38,000)

TABLE 9-4 – (continued)

Port Ludlow Drainage District Capital Improvements and Budget

Year	Project	Estimated Project Costs	Budget for Capital Projects)
2006	Cascade Way Conveyance/Greenbelt Channel	\$12,000	\$60,000
	Subtotal	\$12,000	
	YEAR TOTAL – SURPLUS/DEFICIT		\$10,000
2007	Walker Way/Phinney Lane Detention System	\$49,000	\$70,000
	Subtotal	\$49,000	
	YEAR TOTAL – SURPLUS/DEFICIT		\$31,000

Both the State and Federal Government offer low interest rate loans and grant funds. Use of these low cost loans may be financially favorable to self-financing as long as the interest costs of the loans are less than the interest that can be earned from reserve funds. In addition, commercial bank loans can also provide short-term funding. These programs are discussed in detail in the next section.

ALTERNATIVE CAPITAL FINANCING SOURCES

GRANT AND LOAN FUNDS

Within the State of Washington there are several grant and loan funds available for capital improvements. Among these are the Public Works Trust Fund (PWTF), Centennial Clean Water Fund (CCWF), and the State Revolving Fund (SRF). There are other state and federal agencies that offer funding for wetlands protection and flood control. These include the Flood Control Assistance Account Program (FCAAP) through the Department of Ecology and the Aquatic Lands Enhancement Account (ALEA) through the Department of Natural Resources. None of these programs can be counted on to consistently provide revenue for stormwater improvements and therefore, should be considered secondary avenues of funding. In addition, grant funding is extremely limited. Therefore, loans are the more likely source for outside funding.

PUBLIC WORKS TRUST FUND

The Public Works Trust Fund (PWTF) is a revolving loan fund designed to help local governments finance needed public works projects through low-interest loans and technical assistance. The PWTF, established in 1985 by legislative action, offers loans substantially below market rates, payable over periods ranging up to 20 years.

Interest rates are 0.5 percent, 1.0 percent, or 2.0 percent, with the lower interest rates providing an incentive for a higher financial share. The local community, to qualify for a 2.0 percent loan, must provide a minimum of 5 percent local matching funds of the project's costs. A 10 percent local share qualifies the applicant for a 1.0 percent interest rate and a 15 percent local share qualifies for a 0.5 percent loan. The useful life of the project determines the loan term, with a maximum term of 20 years.

To be eligible, an applicant must be a local government such as a city, town, county, or special purpose utility district, and have a long-term plan for financing its public work needs. If the applicant is a town, city, or county, it must adopt the 1/4-percent real estate excise tax dedicated to capital purposes. Eligible public works systems include streets and roads, bridges, storm sewers, sanitary sewers, and domestic water. Loans are presently offered only for purposes of repair, replacement, rehabilitation, reconstruction or improvement of existing service users. A recent change has now made projects intended to meet reasonable growth (as detailed in a twenty-year growth management plan) eligible for PWTF funding.

CENTENNIAL CLEAN WATER FUND

The Centennial Clean Water Fund (CCWF) is administered by the Department of Ecology and provides loans and grants for projects that enhance water quality. Eligible stormwater projects include water quality treatment facilities and projects or facilities that address non-point pollution problems. Projects which only address flood control or wetlands purchase are not eligible under CCWF. Under its grant program, water quality facilities construction projects may receive 50% of the eligible cost. The design and construction of water quality facilities are also eligible for 100% loans. Recent loan terms have been 4.5 to 5% interest rate for 20 years. Eligibility for grants is based on a rating system that includes such factors as seriousness of the water quality problem, public health impacts, and beneficial impact of the project on water quality.

STATE REVOLVING FUND

The State Revolving Fund (SRF) program will provide loans for stormwater related projects. The Department of Ecology administers the SRF program. Projects that are eligible for funding under this program must have a component that contributes to the improvement of water quality. Flood control projects are not eligible. Loan terms vary depending on the payback period. Recent loan terms are 1.5% interest on loans for 20 years, 0.5% interest on loans paid back in 5 years. Loans can cover 100% of the project cost.

FLEXLINE

Flexline is a low cost cooperative program offered by the Association of Washington Cities (AWC) and Washington State Association of Counties (WSAC) in cooperation with U.S. Bank of Washington. Cities, Towns and Counties may pool debt of up to \$500,000 per jurisdiction per issuance into one larger certificate of participation (COPs). The cooperation financing alternative may be used to purchase equipment, real property, or other debt-financed projects.

The COPs have the appearance of a bond or note and are tax exempt. Typically, Flexline debt is non-voted or non-utility backed revenue debt. To receive Flexline financing a municipality needs to submit an application, and pass an ordinance or resolution for financing. Funding is usually provided after the ordinance or resolution becomes effective. Interest rates are determined in the open market.

FLOOD CONTROL ASSISTANCE ACCOUNT PROGRAM

The Flood Control Assistance Account Program (FCAAP) was established by the state of Washington in 1984 to assist local jurisdictions with comprehensive flood planning and maintenance efforts to reduce flood damages. The program is administered through the Department of Ecology in association with the Department of Fish and Wildlife and County engineers. Funding for the program is approximately \$4.0 million each biennium. Operations, maintenance, and capital improvement projects are all eligible for grant assistance as long as the public entity has a certified comprehensive flood control management plan in place. The FCAAP are generally written through the County. This means that the all projects within the County are ranked and compete for the portion of the total FCAAP funds available to the County.

AQUATIC LANDS ENHANCEMENT ACCOUNT

The Aquatic Lands Enhancement Account (ALEA) was established in 1994 to provide grants to cities, towns, counties, and port districts for preservation or improvement of wetlands, natural systems, waterfront redevelopment plus some aquatic-land related planning. The maximum grant is \$100,000 and the project must be associated with state-owned aquatic lands. A storm project that redirects or treats runoff and thus improves state-owned aquatic lands would be an eligible project under this program.

DEBT FINANCING

Two forms of debt financing are available for capital improvements including general obligation (G.O.) bonds and revenue bonds. General obligation bonds are backed by the “full faith and credit of the District” and are paid for through property tax levies. These bonds require voter approval before they can be implemented. A less common means of financing capital improvements associated with stormwater projects is through the use of revenue bonds. The District, like other municipalities, is capable of issuing tax-exempt

bonds. The principal and interest of such bonds are repaid from revenue generated from a water, sewer, or stormwater utility. This type of funding may be offered without voter approval. However, in order to qualify to sell revenue bonds, the District must establish that its net operating income, gross income less expenses, is equal to or greater than its debt coverage factor (typically 1.3-1.4) times the annual principal and interest due for all outstanding bonded indebtedness. Essentially, utility rates have to be set high enough to ensure revenue bond repayment.

DEVELOPER FEES

The District may require improvements for service to a property within new plats or commercial improvements to be financed by the developer. The developer, for example, is usually required to construct detention facilities in accordance with District standards or pay into a fund for construction of an off-site facility to service multiple properties. The alternative approach allows the District to develop facilities in a planned and cost effective manner. However, several developments are generally required before the District has available funds to construct a regional facility. The District has little control over the scheduling of such facilities unless alternative funding sources such as service charge revenues are utilized on a short-term basis to fund initial construction and are then repaid as developer fees are collected.

IMPROVEMENT DISTRICTS AND SPECIAL ASSESSMENTS

Levying of special assessments on benefited properties has been used throughout the state for stormwater improvements. Projects funded through special assessments must have an identifiable benefit to the properties included in the assessment area, and charges for each parcel must be consistent with the relative benefit to each property. In Washington, municipalities can establish a local improvement district (LID) or utility local improvement district (ULID). These approaches require an assessment against benefited property owners within the district boundaries. In order to establish the district and implement this approach, a minimum percentage of property owners within the proposed district must vote their approval.

The use of LIDs to fund stormwater projects is complicated by the difficulty in quantifying benefits for individual property owners. For water and sewer improvements, for example, the benefits are generally easy to identify. With drainage improvements, however, upstream or hillside properties, which could contribute significantly to runoff, may actually benefit little from improvements because of their protected location. One result may be to narrowly establish the boundaries of the LID, which may be counterproductive to comprehensive stormwater management. Another problem with LIDs is that they place heavy administrative burdens on District staff to maintain and manage the improvement projects in the district.

The District may also present a modified methodology to the Jefferson County Board of Commissioners and include various zones to allow assessment based on projects within

the drainage basins. This approach will require a cost benefit analysis for each of the zones and the related capital improvement projects.

RECOMMENDATIONS

- Whenever possible, utilize low cost alternative (State or Federal) fund sources for financing major capital improvements. Currently the Public Works Trust Fund provides funding for public agencies at very low rates. These programs are becoming more competitive but the District should pursue this funding if available.
- Loan applications are typically on an annual basis. The Public Works Trust Fund has an annual cycle that closes the first of May.
- Re-evaluate the six-year budget as actual operation and maintenance expenses become available.