STORM AND SURFACE WATER PLAN

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City of Black Diamond

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CITY OF BLACK DIAMOND

STORM AND SURFACE WATER PLAN

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Storm and Surface Water Plan
City of Black Diamond, WA

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ENGINEER'S CERTIFICATION

I hereby certify that this Storm and Surface Water Plan for the City of Black Diamond, Washington has been prepared under the supervision and direction of the undersigned, whose seals as Licensed Professional Engineers of the State of Washington are affixed below.

L. Brandon Smith, PE

Christine J. Smith, PE

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EXECUTIVE SUMMARY

The City of Black Diamond Storm and Surface Water Plan (SSWP) provides a long-term outlook for the City's stormwater system. It has been developed consistent with the City-wide Comprehensive Plan and other long range planning documents. This plan has also been developed to outline strategies and recommendations to support the City's compliance with their NPDES Phase II permit requirements.

The study area for the Black Diamond Storm and Surface Water Plan consists of ten stormwater runoff basins ranging in size from 45 acres to almost 2,400 acres. Within these basins, the majority of the City drains to Lake Sawyer, either directly or through one of three major streams -- Rock Creek, Ginder Creek, or Ravensdale Creek.

The City of Black Diamond's stormwater system consists of a mixture of enclosed pipes, as well as open channels and ditches. A snapshot look at the stormwater system indicates: 572 catch basins; 12.1 miles of streams; 6 lakes; and over 49,000 feet of pipe ranging in size from 8-inch to 72-inch.

Capital improvement projects were developed as a result of hydrologic and hydraulic analyses that were conducted. Additional projects were identified by staff in areas where drainage and/or maintenance problems have been identified. In total, twenty five projects were identified for the stormwater system with an assigned priority of high, medium, or low.

The City established a stormwater utility in November 2008 and began imposing rate charges to its customers in February 2009. Since that time, the City has adopted a reduced stormwater rate in order to minimize the impact on customers who have also been financially affected by the national economic recession and an emergency long-term closure of the Green River Bridge. Due to the reduction in revenue in the stormwater utility, it is recommended that no capital improvement projects be completed until the utility is operating without a budget deficit and capital reserves are established as per City goals.

The City of Black Diamond Storm and Surface Water Plan (SSWP) also includes recommendations for the City's illicit discharge detection and elimination program and the public education and outreach component of the NPDES Phase II permit requirements. The final chapter of the Storm and Surface Water Plan includes recommended standards for Low Impact Development.

The City of Black Diamond is anticipating substantial growth in population over the next several decades. This plan provides a means for ensuring that the City storm system is able to accommodate current and future customers.

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ACRONYMS & DEFINITIONS

Allowable Discharge	The rate at which runoff may be released from a project.
Basin	An area in which surface runoff is concentrated, usually to a single point, such as the mouth of a stream.
BMP	Best Management Practice
Best Management Practice	Structures, conservation practices and/or regulations that improve runoff quality or reduce the impact of development on runoff quantity
Biofilter	A plane, vegetated surface over which runoff traverses at a uniform depth and velocity.
Buffer	A zone which is an integral part of a stream or wetland ecosystem and which protects aquatic resources by providing: 1) protection of slope stability; 2) attenuation of runoff; 3) reduction of landslide hazards; 4) shading, input or organic debris and coarse sediments to streams; 5) room for variation in stream or wetland boundaries; and 6) habitat for wildlife and protection from harmful intrusion.
Bypass	The diversion of stormwater from any portion of a stormwater treatment facility.
cfs	Cubic Feet per Second
Check Structure	A rock, earthen, or log dam used in channels to reduce water velocities, promote sediment deposition and/or enhance infiltration.
CIP	Capital Improvement Plan
City	City of Black Diamond
Clean Impervious Surface	An impervious surface on which the frequency or probability of contamination from motor vehicles or from the routine handling of hazardous materials is minimal. Such surfaces may include, but are not limited to: rooftops, sidewalks, dedicated play areas, and emergency fire lanes.
Closed Basin	A basin for which there is no surface water outlet.

Connection Charge	The fee charged by the stormwater utility to property which is developed which reflects a proportionate share of the utility's capital costs attributable to the newly developed property.
Conveyance	A mechanism or device for transporting water including but not limited to, pipes, natural and/or manmade channels, culverts, gutters, and manholes.
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
Dead Storage	The volume of storage in a facility below an outlet which does not drain after a storm event.
Design Event	An amount of rainfall in a specified period of time and occurring in specified volume increments over time which is used in the design of facilities.
Detention Facilities	A facility such as a pond, vault, or pipe in which surface and stormwater is temporarily stored.
DOE	Washington State Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GMA	Growth Management Act
Ground Water	Water in a saturated zone or stratum beneath the surface of the land or below a surface water body.
Illicit Connection	Any man-made conveyance that is connected to a municipal separate storm sewer without a permit, excluding roof drains and other similar type connections.
Illicit Discharge	Any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire fighting activities.
JARPA	Joint Aquatic Resources Permit Application

KCSWDM	King County Surface Water Design Manual
LID	Low Impact Development
Low Impact Development	A stormwater management and land development strategy applied at the parcel and subdivision scale that emphasizes conservation and use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely mimic pre-development hydrologic functions.
MS4	Municipal Separate Storm Sewer System
Municipal Separate Storm Sewer System	A conveyance, or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) that is (1) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State Law) having jurisdiction over disposal of wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States; (2) designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and (4) which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.
National Pollutant Discharge Elimination System	The national program for issuing, modifying, revoking, and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Federal Clean Water Act, for the discharge of pollutants to surface waters of the state from point sources. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington Department of Ecology.
Natural Channel	A stream, creek, river, lake, wetland, estuary, gully, swale, ravine or any open conduit in which water concentrates and flows intermittently or continuously.
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
Outfall	Point source as defined by 40 CFR 122.2 at the point where a municipal separate storm sewer discharges to waters of the State and does not include open conveyances connecting two municipal separate storm sewer systems, or pipes, tunnels, or other conveyances which connect segments of the same stream or other waters of the State and are used to convey waters of the State.

PGIS	Pollutant Generating Impervious Surfaces
Pollutant Generating Impervious Surfaces	Surfaces considered to be significant sources of pollutants in stormwater runoff. Such surfaces include those that are subject to vehicular use, industrial activities, or storage of erodible or leachable materials that receive direct rainfall or run-on or blow-in of rainfall. Metal roofs are considered to be PGIS unless coated with an inert, non-leachable material. A surface, whether paved or not, shall be considered PGIS if it is regularly used by motor vehicles. The following are considered regularly-used surfaces: roads, un-vegetated road shoulders, bike lanes within the traveled lane of a roadway, driveways, parking lots, unfenced fire lanes, vehicular equipment storage yards, and airport runways.
Pothole	A closed basin.
RCW	Revised Code of Washington
Receiving Waters	Waters of the United States including but not limited to wetlands, lakes, intermittent streams, and natural swales and gullies.
Retention Facility	A facility with no outlet to surface water and which is intended to discharge accumulated stormwater to groundwater
Runoff	Water that travels across the land surface and discharges to water bodies either directly or through a collection and conveyance system.
SEPA	State Environmental Policy Act
SMA	Shoreline Management Act
SSWP	Storm and Surface Water Plan
Stormwater	Runoff during and following precipitation and snowmelt events, including surface runoff and drainage.
Sub-basin	A drainage area which drains to a point contained within a larger basin.
SWMMWW	Stormwater Management Manual for Western Washington
SWMP	Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load

Total Maximum Daily Load	A water cleanup plan. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the water body can be used for the purposes the state has designated. The calculation must also account for seasonable variation in water quality. Water quality standards are set by states, territories, and tribes. They identify the uses for each water body, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use. The Clean Water Act, section 303, established the water quality standards and TMDL programs.
WAC	Washington Administrative Code
Water Quality Standards	Surface Water Quality Standards, Chapter 173-201A WAC, Ground Water Quality Standards, Chapter 173-200 WAC, and Sediment Management Standards, Chapter 173-204 WAC.
WRIA	Water Resource Inventory Area
40 CFR	Title 40 of the Code of Federal Regulations, which is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the federal government.

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1.0 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

This "Storm and Surface Water Plan" provides information on the City's existing stormwater management program and recommends a comprehensive stormwater management plan for the City. This plan presents capital facilities needed to accommodate existing and future growth, and proposes strategies to address compliance with Federal and State stormwater requirements.

The following are some of the primary topics covered within this plan:

- Stormwater System Inventory and Basin Identification
- Stormwater Model of Existing Conditions
- Stormwater Model of Future Conditions
- Identification of System Deficiencies and Recommendation of Capital Improvements
- Operations and Maintenance Program
- Illicit Discharge Detection and Elimination Program Recommendations
- Public Education and Outreach Program Recommendations
- Low Impact Development Guidelines

1.2 FEDERAL REGULATIONS & PROGRAMS

CLEAN WATER ACT[1]

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1977. Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry. They have also set water quality standards for all contaminants in surface waters.

The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. EPA's National Pollutant Discharge Elimination System (NPDES) permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters

[1] Environmental Protection Agency, "Summary of the Clean Water Act", Nov. 11, 2008, <http://www.epa.gov/regulations/laws/cwa.html>.

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States. (The Act does not deal directly with ground water or with water quantity issues.) The statute employs a variety of regulatory and non-regulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

For many years following the passage of CWA in 1972, EPA, states, and Indian tribes focused mainly on the chemical aspects of the "integrity" goal. During the last decade, however, more attention has been given to physical and biological integrity. Also, in the early decades of the Act's implementation, efforts focused on regulating discharges from traditional "point source" facilities, such as municipal sewage plants and industrial facilities, with little attention paid to runoff from streets, construction sites, farms, and other "wet-weather" sources. Starting in the late 1980s, efforts to address polluted runoff have increased significantly. For "nonpoint" runoff, voluntary programs, including cost-sharing with landowners are the key tool. For "wet weather point sources" like urban storm sewer systems and construction sites, a regulatory approach is being employed.

Evolution of CWA programs over the last decade has also included something of a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining state water quality and other environmental goals is another hallmark of this approach.

NPDES PERMITS[2]

Water pollution degrades surface waters making them unsafe for drinking, fishing, swimming, and other activities. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. In Washington State, the NPDES permit program is administered by the Washington Department of Ecology. Since its introduction in 1972, the NPDES permit program is responsible for significant improvements to our Nation's water quality.

[2] Environmental Protection Agency, "National Pollutant Discharge Elimination System (NPDES) Overview", Nov. 11, 2008, <http://cfpub.epa.gov/npdes/>.

ENDANGERED SPECIES ACT[3]

When the Endangered Species Act (ESA) was passed in 1973, it represented America's concern about the decline of many wildlife species around the world. It is regarded as one of the most comprehensive wildlife conservation laws in the world. The purpose of the ESA is to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species. Under the law, species may be listed as either "endangered" or "threatened". Endangered means a species is in danger of extinction throughout all or a significant portion of its range. Threatened means a species is likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened.

The species listed include U.S. and foreign species and covers mammals, birds, reptiles, amphibians, fishes, snails, clams/ mussels, crustaceans, insects, arachnids, and plants.

The law is administered by the Interior Department's U.S. Fish and Wildlife Service (FWS) and the Commerce Department's National Marine Fisheries Service. The FWS has primary responsibility for terrestrial and freshwater organisms, while the National Marine Fisheries Service's responsibilities are mainly for marine species such as salmon and whales.

Appropriate use and development impacting the creeks, streams, rivers, lakes within the City of Black Diamond is important to ensure protection of the habitat for species included on the federal Endangered Species list. A listing of endangered species can be found on the U.S. Fish and Wildlife Service website at www.fws.gov/endangered.

1.4 STATE REGULATIONS & PROGRAMS

PUGET SOUND WATER QUALITY MANAGEMENT PLAN[4]

The Puget Sound Water Quality Management Plan is Washington State's long-term strategy for protecting and restoring Puget Sound. The management plan provides the framework for managing and protecting the Sound and coordinating the roles and responsibilities of federal, state, tribal and local governments. To coordinate government actions for protecting and restoring the Sound, the 1996 legislature established the Puget Sound Water Quality Action Team, the Puget Sound Council and a governor-appointed chair who manages both of these. Together, the Action Team and Council periodically review and update the management plan to reflect changing issues, advances in technology, public expectations, and political and budgetary concerns.

The management plan also serves as the federally approved Comprehensive Conservation and Management Plan (CCMP) for Puget Sound under Section 320 of the federal Clean Water Act, which established the National Estuary Program.

The goal of the Puget Sound Management Plan is to restore and protect the biological health and diversity of Puget Sound by:

[3] US Fish and Wildlife, "ESA Basics", Nov. 12, 2008, <http://www.fws.gov/endangered/>
[4] "Puget Sound Water Quality Management Plan", Puget Sound Water Quality Action Team, Dec. 14, 2000.

• preserving and restoring wetlands and aquatic habitats and the natural processes and functions that created them;
• preventing increases in the introduction of pollutants to the Sound and its watersheds; and
• reducing and ultimately eliminating harm from the entry of pollutants to the waters, sediments and shorelines of Puget Sound.

The management plan's emphasis on prevention recognizes that it will cost us far more to clean up pollution later than to prevent it now. The management plan recognizes that we all share responsibility for the Puget Sound region and that fish, wildlife, water and pollutants cross jurisdictional lines. It establishes a framework based on a partnership among levels of government, each having a defined set of responsibilities in different program areas. And it recognizes and includes actions of federal, state, local and tribal governments, the private sector and citizens.

MUNICIPAL NPDES STORMWATER PERMITS

The City of Black Diamond is covered under the Western Washington Phase II Municipal Stormwater Permit, National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Discharges from Small Municipal Separate Storm Sewers in Western Washington (effective date February 15, 2007). The City is required to comply with all conditions of this permit identified for primary permittees.

One of the requirements of the NPDES Phase II Permit is that the City develop a Stormwater Management Program (SWMP). Required components of this program include:

- Public Education and Outreach
- Public Involvement and Participation
- Illicit Discharge Detection and Elimination
- Controlling Runoff from New Development, Redevelopment, and Construction Sites
- Pollution Prevention and Operation and Maintenance for Municipal Operations

Additional requirements of the NPDES Phase II Permit include: Compliance with Total Maximum Daily Load (TMDL) requirements, as well as monitoring and reporting responsibilities.

One of the intents of this Storm and Surface Water Plan is to provide a documented plan of action and guidance for the City to support conformance with NPDES Phase II requirements.

GROWTH MANAGEMENT ACT[5]

The Washington State Growth Management Act was adopted because the Washington State Legislature found that uncoordinated and unplanned growth posed a threat to the environment, sustainable economic development and the quality of life in Washington.

[5] "The Growth Management Act", Washington State Department of Community, Trade, and Economic Development, Nov. 11, 2008, <http://cted.wa.gov/site/375/default.aspx>.

Known as the GMA, the Act (Chapter 36.70A RCW) was adopted by the Legislature in 1990. In 1991 the GMA was amended to create the Growth Management Hearings Boards to hear and determine allegations of non-compliance with the GMA.

The GMA has been amended several times since, including 1996, when the boards' jurisdiction was expanded to include allegations of non-compliance with certain provisions of the Shoreline Management Act (SMA, Chapter 90.58 RCW).

The GMA requires state and local governments to manage Washington's growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans and implementing them through capital investments and development regulations. This approach to growth management is unique among states. Rather than centralize planning and decision-making at the state level, the GMA built on Washington's strong traditions of local government control and regional diversity. The GMA established state goals, set deadlines for compliance, offered direction on how to prepare local comprehensive plans and regulations and set forth requirements for early and continuous public participation. Within the framework provided by the mandates of the Act, local governments have many choices regarding the specific content of comprehensive plans and implementing development regulations.

Additionally, the Growth Management Act requires that the City include a Capital Facilities Element as a component of the Comprehensive Plan. The Capital Facilities element is required to consist of the following:

1. An inventory of existing capital facilities owned by the City, showing the locations and capacities of the facilities;
2. A forecast of the future needs for the above capital facilities;
3. The proposed locations and capacities of expanded or new capital facilities;
4. At least a six-year plan to finance capital facilities within projected funding capacities, which plan clearly identifies sources of public money for such purposes;
5. A requirement to reassess the land use element if probable funding falls short of meeting existing needs and to ensure that the land use element, capital facilities plan element and financing plan within the capital facilities plan element are coordinated and consistent.

TOTAL MAXIMUM DAILY LOAD (TMDL) PROGRAM[6]

The Total Maximum Daily Load (TMDL) or Water Quality Improvement Project process was established by Section 303(d) of the Clean Water Act (CWA). Federal law requires states to identify sources of pollution in waters that fail to meet state water quality standards, and to develop Water Quality Improvement Reports to address those pollutants. The Water Quality Improvement Project establishes limits on pollutants that can be discharged to a body of water and still allow state standards to be met.
In January 1998, the Washington Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), Northwest Environmental Advocates, and Northwest Environmental Defense Center agreed to a clean up schedule directing how Washington

[6] "TMDL – Overview", Washington State Department of Ecology, Nov. 11, 2008, <http://www.ecy.wa.gov/programs/wq/tmdl/overview.html>.

state will improve the health of nearly 700 water segments. Ecology's Memorandum of Agreement (MOA) outlines a plan and schedule to improve polluted waters while expanding public involvement in Water Quality Improvement Reports.

Lake Sawyer within the City of Black Diamond has experienced water quality issues for several decades. In the 1970's, the lake's water quality declined as a result of failing septic systems in the watershed. The City constructed a wastewater treatment plant that began operating in 1981. This plant was designed to discharge to a natural wetland next to Rock Creek, ultimately draining to Lake Sawyer. This resulted in excessive nutrient loading to Lake Sawyer. In response, in 1991 the Department of Ecology developed a Total Maximum Daily Load (TMDL) with a total phosphorus target concentration for Lake Sawyer at 16 µg/L. In 1992 all wastewater from the treatment plant was diverted to the King County treatment plant located in Renton.

Since diverting the City's wastewater flows away from Lake Sawyer, there has been a consistent decline in phosphorus, although the levels are still too high. The Department of Ecology developed the "Lake Sawyer Total Phosphorus Total Maximum Daily Load – Water Quality Implementation Plan" in June 2009. This plan provides for corrective actions to address sources of phosphorus pollution in Lake Sawyer and the surrounding watershed. A copy of this plan can be found in ***APPENDIX A – Lake Sawyer Total Phosphorus TMDL***.

1.5 LOCAL REGULATIONS & PROGRAMS

CITY OF BLACK DIAMOND COMPREHENSIVE PLAN[7]

The City of Black Diamond adopted an updated City Comprehensive Plan in June of 2009. The City anticipates a significant increase in population in the near future as a result of several potential master planned developments. The Comprehensive Plan helps to provide guidance for the City as it grows to accommodate new growth.

The City of Black Diamond Comprehensive Plan is based upon the premise that sustainable development is based upon a trinity of ecology, sociology and economics. The plan embodies a holistic approach to treatment of nature and the human spirit. The extensive natural beauty and intricate ecosystem that comprise the planning area have been considered in determining lands that are appropriate for development at different intensities.

Planning for natural resources and open space are the cornerstone of the City of Black Diamond Comprehensive Plan. The plan supports recognition and protection of quality habitat including: the protection of key riparian corridors, wetlands and the design of green spaces between habitats; water quality protection measures and support for an environmental education area and program to build a strong community commitment to conservation and habitat improvement. Stewardship of the environment is supported by the plan.

[7] "Comprehensive Plan Features", City of Black Diamond Draft Comprehensive Plan, Sept. 2008

The City's developed areas will be compact, preserving 35% to 40% of the entire City as open space. Interspersed among the built areas will be large connected areas of open space that act as a green necklace. Creeks, wetlands and significant animal habitat will be protected as part of the open space network. Trails, parks, community facilities will also define the open space network.

STORMWATER TECHNICAL MANUAL[8]

The City of Black Diamond has adopted the "Stormwater Management Manual for Western Washington", as published by the Department of Ecology and as modified by the "Black Diamond Development Standards". These standards establish the minimum requirements for stormwater control and site development requirements for all new development and redevelopment. The manuals outline water quantity design criteria, water quality controls, erosion and sediment control practices, and site development.

SEPA

The City of Black Diamond's Environmental Policies and Procedures have been adopted as Chapter 19.094 of the Black Diamond Municipal Code. This section of the code was developed in conformance with the State Environmental Policy Act (SEPA) and applicable State regulations.

SHORELINE MASTER PROGRAM

The City of Black Diamond's Shoreline Master Program has been adopted as Chapter 19.08 of the Black Diamond Municipal Code. The Shoreline Master Program was developed pursuant to the Shoreline Management Act of 1971 and applicable State regulations. It is in the process of being updated as required.

SENSITIVE AREAS ORDINANCE[9]

The City of Black Diamond has recently adopted a Sensitive Areas Ordinance. This ordinance identifies protection measures for the City's wetlands, streams, wildlife habitat, and other ecological systems. Development must adhere to these protection and mitigation guidelines.

The City of Black Diamond's approach to Sensitive Areas is to provide the highest level of protection for the natural systems that contribute the highest ecological functions. This is accompanied by a lower level of protection for resources that provide less critical function. This method is unique to the specific environmental characteristics of the City, and allows for a balance of natural systems protection and urban and economic development.

[8] The recently updated "Black Diamond Development Standards" identify the Department of Ecology's 2005 "Stormwater Management Manual for Western Washington" as the City's standard with minor modifications as included in the City's Development Standards. The "Black Diamond Development Standards" are in draft format as of April 2009. References included herein may refer to the Standards as an adopted document as it is reasonably assumed that adoption of this document will occur prior to adoption of this "Storm and Surface Water Plan".

[9] "Draft BAS Report and Sensitive Areas Summary", City of Black Diamond, August 2008.

STORMWATER REGULATIONS

Title 14 of the Black Diamond Municipal Code is entitled Stormwater Regulations and covers such topics as Stormwater Management and Drainage Design, as well as the City's Stormwater Utility.

SWMP

The City of Black Diamond has developed a Stormwater Management Program (SWMP) as required by the conditions of the Western Washington Phase II Municipal Stormwater Permit (NPDES Phase II Permit). This document details the actions that the City of Black Diamond has taken or will take to maintain compliance with the conditions in the permit. A copy of the City's Stormwater Management Program has been included in ***APPENDIX B – Stormwater Management Program (SWMP)***.

2.0 DRAINAGE AREA CHARACTERISTICS

2.1 LOCATION

The City of Black Diamond is located approximately 30 miles southeast of Seattle, Washington. Black Diamond was established in 1880 and developed as a coal mining town over the next fifty years. The City is located along Highway 169 (also known as Maple Valley-Black Diamond Road), just west of the Cascade Mountains. ***Figure 2.1 Vicinity Map (Washington State)*** illustrates the location of Black Diamond in the State of Washington. ***Figure 2.2 Vicinity Map (King County)*** illustrates the location of Black Diamond within King County.

Figure 2.1 Vicinity Map (Washington State)

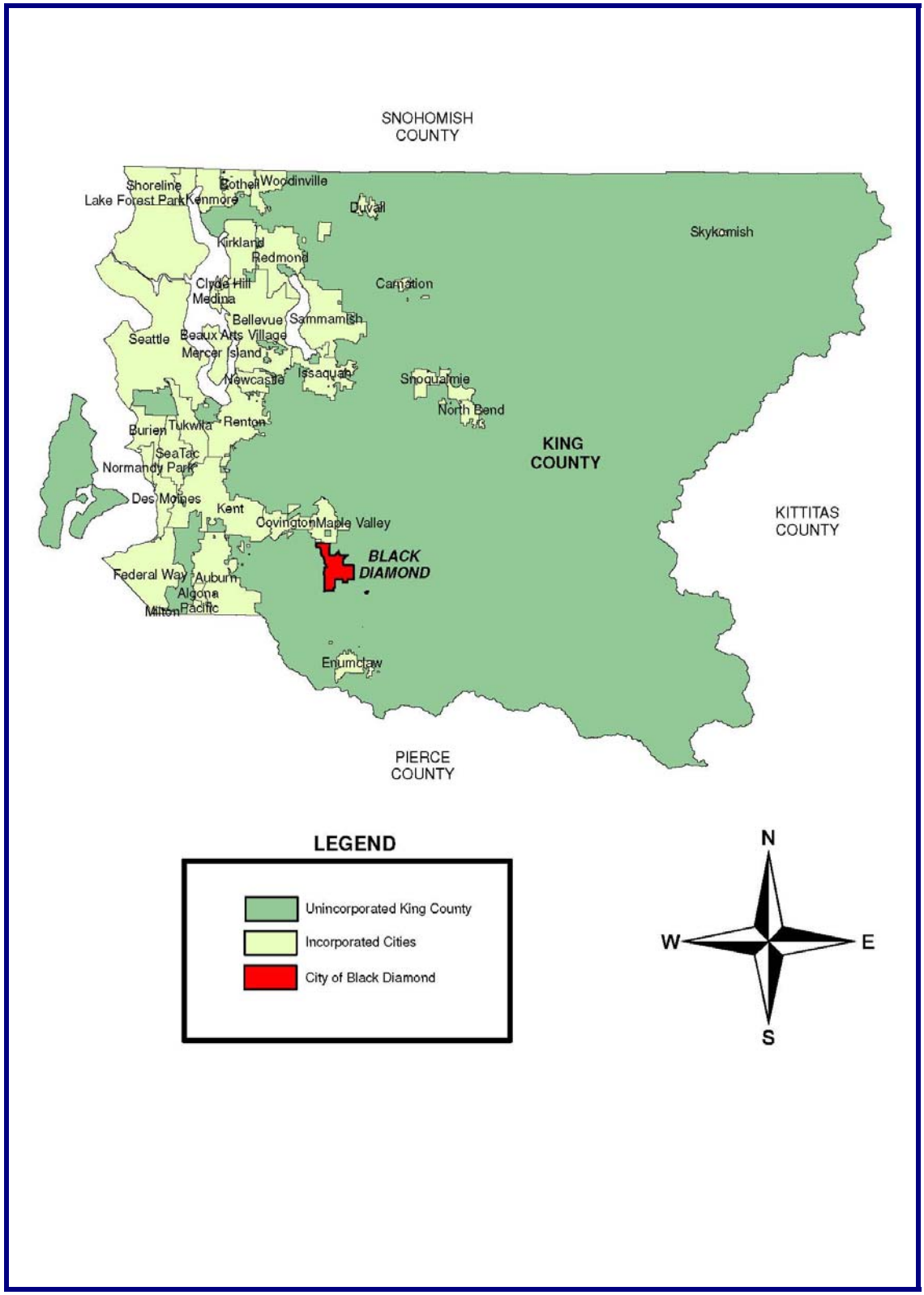


Figure 2.2 Vicinity Map (King County)

The City of Black Diamond is located entirely within the Water Resource Inventory Area (WRIA) 9 – Duwamish-Green as shown in ***Figure 2.3 Water Resource Inventory Areas (King County)***.

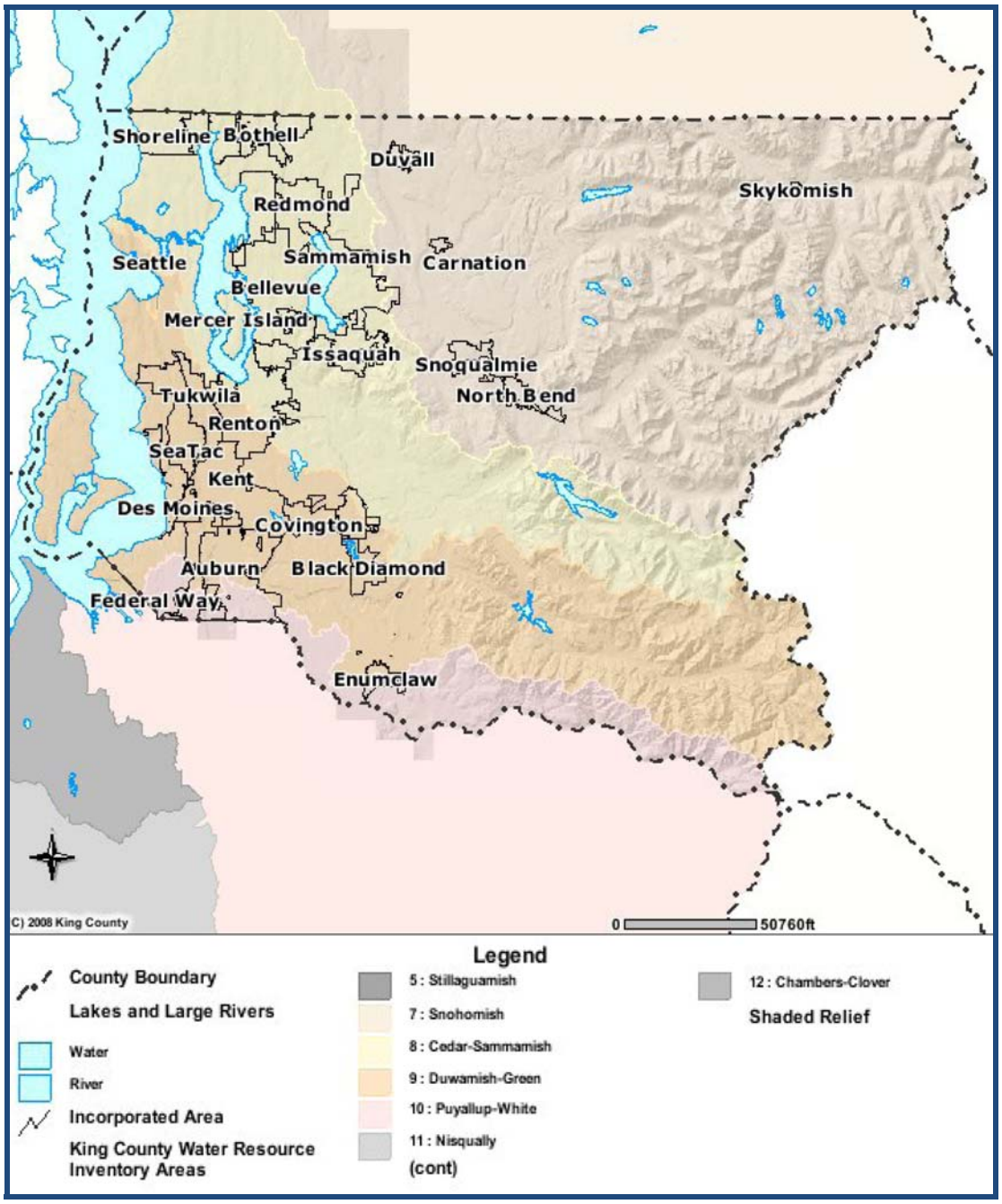


Figure 2.3 Water Resource Inventory Areas (King County)

2.2 PHYSICAL ENVIRONMENT[10]

Planning for the future storm drainage system requires a basic understanding of the physical environment of the area. A working knowledge is useful in identifying any constraints which may affect the development of the storm system. Physical characteristics which influence planning and design include topography, geology and soils, surface water, groundwater, and climate. Descriptions of these characteristics, as well as a summary of environmentally sensitive areas in the City are as follows:

TOPOGRAPHY

The City is situated on an upland plateau bounded on the south and southeast by the Green River and on the northeast by the Cascade Range. Depressions and hummocks characterize the rolling glacial terrain.

The plateau is dotted with lakes and cut by numerous streams which drain to the Green River. The plateau is deeply incised by the Green River gorge located approximately two miles south of the City. The descent to the River is steep with a maximum slope of approximately 55%.

Elevations within the existing City limits vary between approximately 500 feet at Morganville to 1,000 feet at the eastern perimeter. Most of the existing buildings within the City are located at lower elevations, between approximately 500 and 700 feet.

Elevations within the study area range from approximately 300 feet in the southwestern corner of the study area near the banks of the Green River, to over 1,200 feet in the eastern part of the study area outside the City limits. Elevations of at least 1,000 feet are also found in the northeast corner of the study area, northeast of Lake No. 12.

GEOLOGY AND SOILS

The surficial geology and landforms in the Black Diamond area, located on the Covington Drift Plain, are the result of the most recent regional glaciation, the Vashon Stade of the Fraser glaciation. The Vashon ice sheet completely melted from the Black Diamond area approximately 10,000 years ago. During the maximum extent of the Vashon Stade, the planning area was covered with up to 2,000 feet of ice.

Since the last glaciation, urbanization, rural development, logging, gravel mining activities, erosion, and sedimentation have modified the land surface. Weathering and erosion of native soils has resulted in the development of topsoil and colluvium at the ground surface. The topsoil in undeveloped areas consists of a few inches of silt and sand with decayed roots and leaves. The weathered soils underlying the topsoil consists of silty sand and gravel with roots, generally extending 2 to 6 feet. Topographic depressions and low gradient stream channels have accumulated soft organic silt and peat. In general, the areas underlain by organic silt and peat are within wetland areas.

[10] City of Black Diamond, City of Black Diamond Water System Plan, 2008.

Vashon recessional outwash mantels the west portion of the City. The soil consists of sand and gravel with variable amounts of silt and cobbles deposited by the rivers emanating from the melting front of the Vashon ice sheet. This soil is considered a valuable gravel resource in this area depending on its thickness and silt content.

Vashon till is at the ground surface in some areas of the east portion of the City. Till consists of unstratified silt, sand, gravel and cobbles that are in a very dense condition because of being overridden by the glacial ice. Till is usually 20 to 40 feet thick and probably underlies the recessional outwash but may be absent where eroded during deglaciation meltwater runoff episodes.

Pre-Vashon glacial and interglacial sediments underlie the Vashon till in the west portion of the City area where bedrock is deep. The pre-Vashon glacial and interglacial sediments consist of inter-bedded and/or stratified silt, gravel and till. These soils are not exposed at the ground surface in the City, but are exposed in the upper walls of the Green River gorge, south of the City, and are penetrated by water wells in the west portion of the area.

Bedrock of the Puget Group underlies the City and surrounding area. The bedrock is locally exposed at the surface in the east portion of the area and in the walls of the Green River gorge. The bedrock consists of sedimentary sandstone, mudstone, shale and coal. Based on elevations of surface exposures and the interpretation of well water logs by Icicle Creek Engineering, Inc., bedrock underlies the property at a depth of 200 feet or more in the west portion of the City.

A map depicting soil types within the City of Black Diamond has been included as ***Figure 2.4a Soils*** and ***Figure 2.4b Soils***.

SURFACE WATERS

A map showing the surface water features within and surrounding the City of Black Diamond has been included in ***Figure 2.5 Surface Waters***. How these features interact as they relate to the City's drainage system is discussed in ***Chapter 3.0 Existing Storm Drainage System.***

Rivers

The Green River originates in the western Cascade range approximately 30 linear miles east of the City. Flows in the river result largely from rainfall runoff and snowmelt. Flows are regulated approximately 20 miles upstream of the City by a flood control structure operated by the Corps of Engineers known as the Howard Hanson Dam. Approximately three miles downstream from the dam, the City of Tacoma operates a water intake structure capable of diverting water to the McMillin Reservoir near Tacoma.

Streams

There are eight creeks located in the planning area—Covington Creek, Rock Creek, Jones Lake Creek, Ginder Creek, Lawson Creek, Mud Lake Creek, an unnamed tributary to Black Diamond Lake, and Ravensdale Creek.

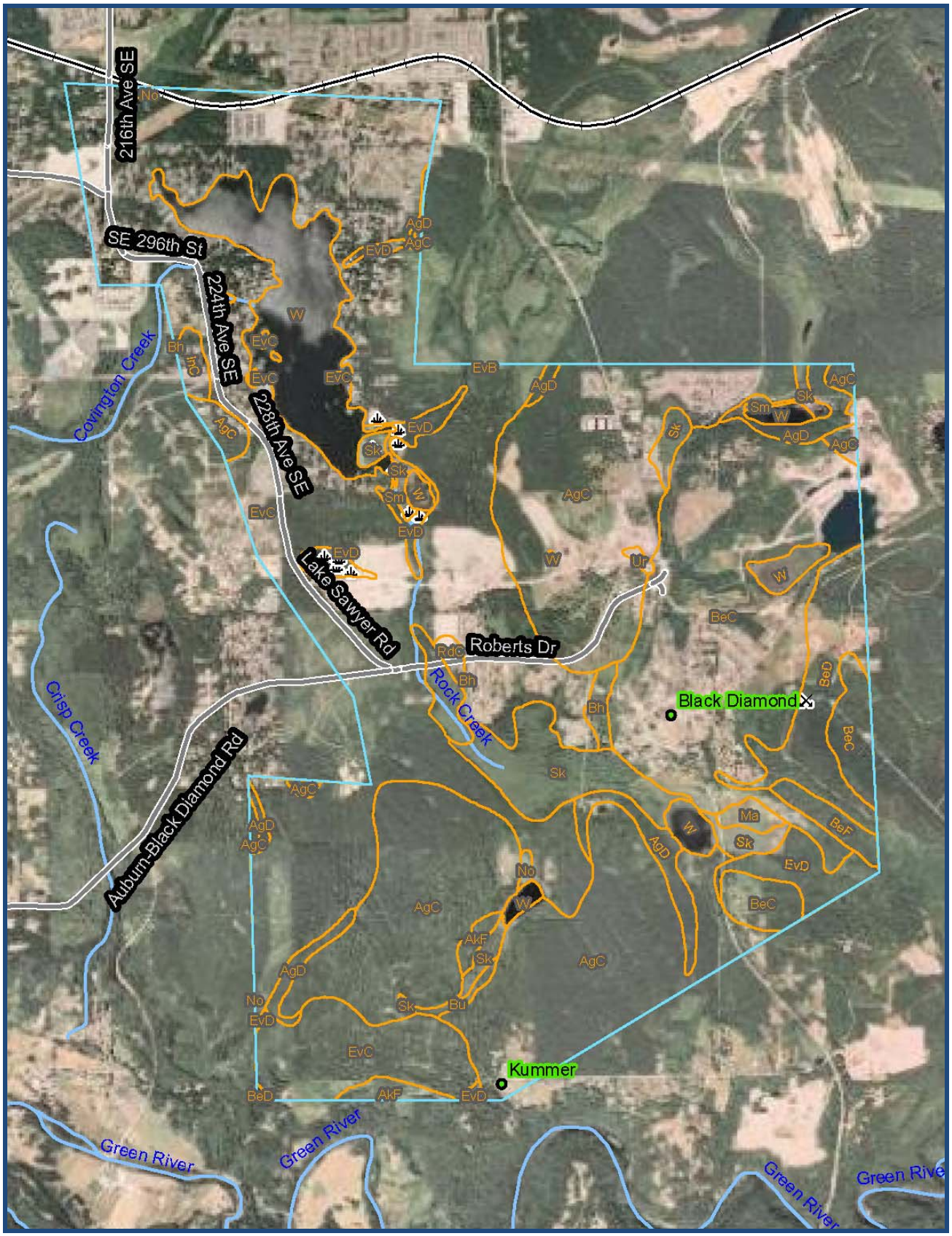


Figure 2.4a Soils
(Source: Natural Resources Conservation Service)

Map Unit Legend

King County Area, Washington (WA633)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AgC	Alderwood gravelly sandy loam, 6 to 15 percent slopes	1,393.1	25.4%
AgD	Alderwood gravelly sandy loam, 15 to 30 percent slopes	120.8	2.2%
AkF	Alderwood and Kitsap soils, very steep	31.3	0.6%
BeC	Beausite gravelly sandy loam, 6 to 15 percent slopes	803.1	14.7%
BeD	Beausite gravelly sandy loam, 15 to 30 percent slopes	157.9	2.9%
BeF	Beausite gravelly sandy loam, 40 to 75 percent slopes	32.1	0.6%
Bh	Bellingham silt loam	48.3	0.9%
Bu	Buckley silt loam	8.9	0.2%
EvB	Everett gravelly sandy loam, 0 to 5 percent slopes	0.6	0.0%
EvC	Everett gravelly sandy loam, 5 to 15 percent slopes	2,118.2	38.7%
EvD	Everett gravelly sandy loam, 15 to 30 percent slopes	124.2	2.3%
InC	Indianola loamy fine sand, 4 to 15 percent slopes	19.5	0.4%
Ma	Mixed alluvial land	16.2	0.3%
No	Norma sandy loam	6.9	0.1%
RdC	Ragnar-Indianola association, sloping	9.9	0.2%
Sk	Seattle muck	209.0	3.8%
Sm	Shalcar muck	8.4	0.2%
Ur	Urban land	4.6	0.1%
W	Water	366.1	6.7%
Totals for Area of Interest		**5,479.1**	**100.0%**

Figure 2.4b Soils
(Source: Natural Resources Conservation Service)

Covington Creek is classified as a Shoreline of the State, subject to the Shoreline Management Act (SMA). There is only a small segment of Covington Creek where it exits Lake Sawyer within the existing city limits.

Lakes
There are eight existing lakes within the planning area — Lake Sawyer, Frog Lake, Lake Marjorie, Black Diamond Lake, Jones Lake, Ginder Lake, Mud Lake, and Lake Number 12.

Lake Sawyer is the fourth largest natural lake in King County at 286 acres. Lake Sawyer is considered a "shoreline of the state" and is subject to the SMA and the City's Shoreline Master Program. The lake is fed by Rock Creek and Ravensdale Creek. Lake Sawyer's outlet is Covington Creek which flows west into the Soos Creek Drainage System. Lake Sawyer has experienced water quality problems from various sources, including discharge of inadequately treated sewage from the decommissioned City of Black Diamond sewage treatment plant. A lake management plan for Lake Sawyer was completed by King County in 2000. The City and King County have conducted stormwater monitoring in the lake's watershed to help identify sources of phosphorus. Data collected by volunteer lake

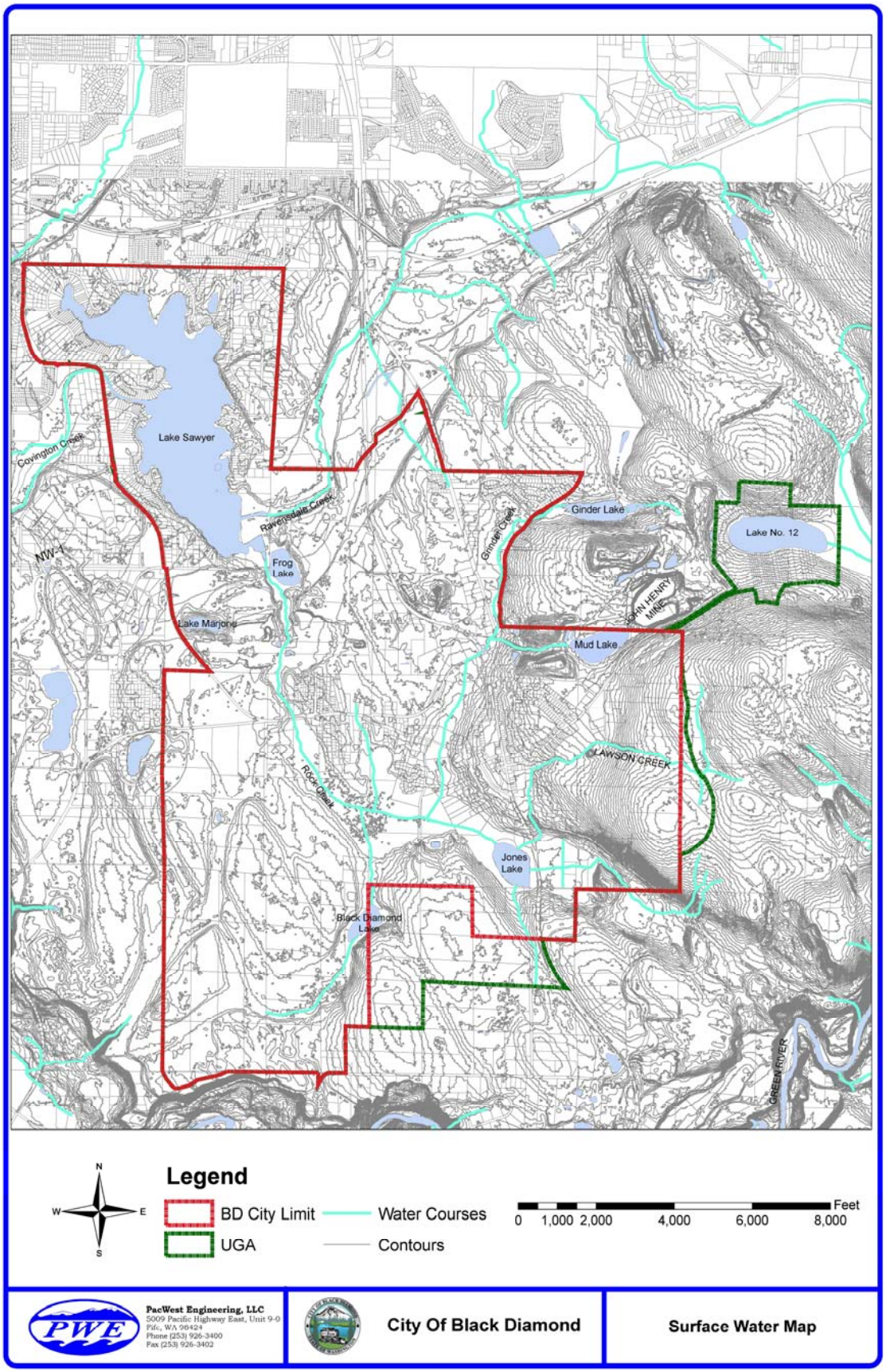


Figure 2.5 Surface Waters

monitors indicate that Lake Sawyer is low to moderate in primary productivity with very good water quality. Lake Sawyer is an important migration corridor for a late run of Coho salmon that pass upstream shortly after Christmas. The fish spawn in upper Ravensdale Creek. Lake Sawyer also provides year-round recreational fishing for stocked rainbow trout and warm water fish. The lake is also used extensively for boating, water-skiing, and other recreation. Public access is provided at a boat launch on the northwest side of the lake. An undeveloped 168 acre park is located along the southern part of the lake.

Frog Lake is located in the northwestern part of the planning area at the southeastern portion of Lake Sawyer. Frog Lake is approximately 25 acres in size. It is largely a forested wetland with an open water area. As a wetland related to Lake Sawyer, Frog Lake is considered a shoreline of the state regulated by the SMA.

Lake Marjorie is approximately 5 acres in size. It is described as a groundwater depression or pothole.

Black Diamond Lake is approximately 11 acres in size with an average depth of 6 feet and a maximum depth of 8 feet and is fed by surface water and groundwater. Black Diamond Lake has recreational fishing values provided by bass and other warm water fish. The lake was stocked with rainbow trout by the Washington Department of Fish and Wildlife in 1958, 1963, and 1965. There is a high quality peat wetland area located upstream from the open water lake. Black Diamond Lake and its associated world-class bog have been extensively researched by the Nature Conservancy and represent a valuable natural asset for the City.

Jones Lake is 23 acres in size. It is fed by Lawson Creek and two other unnamed tributaries, but is a highly groundwater-dependent lake that displays a seasonal fluctuation in water level. Jones Lake is classified as a dystrophic lake, which means that it has too low an accumulation of dissolved nutrients to support abundant plant life. Dystrophic lakes often have highly acidic, brownish waters filled with undecayed plant materials, and eventually develop into a peat bog or marsh.

Jones Lake is characterized by relatively high concentrations of acidic organic materials in solution. These chemical conditions can reduce the rate or prevent the processes of bacterial breakdown that would otherwise recycle nutrients from dead organic material at the bottom. The bottom deposits of Jones Lake consist largely of unrated organic material which accumulates as peat. The area of Jones Lake is identified as a peat deposit in the Tahoma Raven Heights Community Plan. Jones Lake and the surrounding land have been identified and partially acquired by the City using funds from the King County Open Space Bond Fund. Jones Lake has recreational fishing values. Stocking records available for Jones Lake (previously known as Lake 14) show the following plantings: 1915 - yellow perch; 1922, 1926, 1928, 1929 and 1930 - eastern brook trout; 1932 - kokanee; 1950 - rainbow trout; and 1956 - rainbow trout. Bass, crappie and brown bullheads have also been introduced into this system. Warm water species such as yellow perch, bass, crappie, and bullheads can spawn in lakes and establish self-reproducing populations.

Ginder Lake is approximately 14 acres in size. It is located northwest of Mud Lake and Lake Number 12.

Mud Lake is largely a wetland with no open water. This lake is located in an area designated as mineral resource land. It was once part of a mining plan. However, disturbance of the lake is no longer proposed.

Lake Number 12 covers 44 acres and is fed by surface runoff and shallow groundwater flow over a less permeable substrate layer. The lake is known to have an aquatic weed growth problem associated with high phosphorus concentrations. Lake 12 is considered a "shoreline of the state" and is regulated by King County's Shoreline Master Program. Lake 12 is in the City's Urban Growth Area (UGA) northeast of the current city limits.

GROUNDWATER

Groundwater occurs in three aquifer systems beneath the City. These aquifer systems include (1) a seasonal shallow, or "perched", unconfined aquifer in the weathered soil and recessional outwash overlying till of bedrock, (2) an intermediate depth, regional, unconfined and confined aquifer system within the pre-Vashon glacial and interglacial sediments, and (3) a confined regional aquifer system within the bedrock.
The shallow aquifer system is the primary water resource penetrated by most of the domestic wells in the service area. The intermediate depth aquifer has potential for development as a water resource based on limited available information regarding this aquifer. The deep bedrock aquifer is controlled by fractures in the bedrock. Several domestic wells penetrate the bedrock aquifer in the east portion of the area, but are typically very low in yield.

Groundwater Quality

The shallow aquifer is particularly vulnerable to contamination from the surface and may dry out seasonally in some areas. The intermediate depth aquifer is recharged over a very large area and is generally protected from contamination from the surface. The bedrock aquifer often contains water with elevated levels of minerals, such as iron and sulfur, that may affect water quality.

Groundwater Flow Patterns

Groundwater flow patterns have both horizontal and vertical components. In the Black Diamond area, the primary vertical component of flow is downward percolation from the shallow aquifer, through the underlying till or fractures in the bedrock, and into the intermediate or deep bedrock aquifer. Horizontal groundwater flow in the shallow aquifer discharges to surface water features Rock Creek, Ravensdale Creek and Crisp Creek.

Groundwater Recharge

Groundwater recharge to the shallow aquifer is primarily from precipitation or infiltration of surface water runoff from adjacent areas. As precipitation falls on the ground surface, a portion infiltrates the soil. Precipitation that does not infiltrate remains on the surface, filling small depressions or moving down slope as surface runoff. Some shallow infiltrated water is used by plants and returns to the atmosphere by evapotranspiration. When the soil moisture content is high, such as occurs after a long period of rainfall, some water

within the soil migrates downward. Downward percolation of water is impeded by relatively impermeable till or bedrock that underlies most of the area. Where water is concentrated within topographic low areas such as wetland or streams, there is generally more recharge than in topographic high area, where the surficial aquifer is dry much of the time.

The intermediate depth and deep bedrock aquifer systems are recharged by infiltrating water over an area much larger than the City area.

Information regarding groundwater wells in the area was collected for the Brown and Caldwell hydrogeology report of the Black Diamond Springs (1989) and well log information collected by Robinson & Noble, Inc. (1990) regarding well development in the southeastern corner of the City limits.

CLIMATE

The Pacific Ocean and Puget Sound moderate temperature extremes in the region while the Cascade Mountains influence the area's precipitation. Precipitation in the area occurs primarily due to cooling of moisture-laden air masses as they flow and rise over the Cascade Mountains.

Annual precipitation ranges from 45 to 70 inches, averaging approximately 55 inches. More than 80% of the precipitation occurs October through May and 50% from November through February. Total evaporation averages approximately 25 inches per year with approximately 75% occurring during the months of May through August. Precipitation and evaporation were measured at the Landsburg weather station located approximately 5 miles north northeast of the City of Black Diamond.

Available temperature data is also from the Landsburg weather station. Low temperatures in December and January average 30° to 33° F and the highs range from 41° to 46° F. In July and August the average low temperature is approximately 50° F and the high 75° F. The lowest recorded temperature from 1976 to 1993 was 0° F in February 1989 and the highest recorded temperature was 102° F in August 1981 and May 1983.

Prevailing wind direction is from the south to the southwest during the rainy season and from the west or northwest in summer. Average wind velocity is less than 10 mph.

MINING ACTIVITY

Abandoned coal mines underlie at least 50,000 acres in western and central Washington. Many of the abandoned, underground mines present in the Black Diamond area have been documented by the State. Applicants for building permits in abandoned coal mine areas are required to demonstrate the safety of the proposed project. Mitigation of a mine may be required, and a horizontal buffer of 500 feet from the vertical projection of the mine is required, regardless of depth, unless otherwise recommended by a geotechnical report by a professional engineer with expertise in geotechnical engineering. High hazard areas are typically those areas underlain by mine workings shallower than 200 feet or fifteen times the knees of the coal seam for gently dipping seams. Moderate hazard areas are areas where more workings are deeper than 200 feet or deeper than fifteen times the knees of the seam or workings for gently dipping seams. The study by professional

engineers should detail the presence of surface openings, potential sinkholes, depth of working, and a detailed examination of historic mine maps and records.

The John Henry Mine, as shown on ***Figure 2.5 Surface Waters***, is currently permitted for active mining, although no mining is currently occurring. The John Henry Mine is not allowed to discharge pumping to Mud Lake. The John Henry Mine must be actively mined by January 2010 or it must be reclaimed.

ENVIRONMENTALLY SENSITIVE AREAS

The Black Diamond Municipal Code Chapter 19.12 establishes regulations for development in environmentally sensitive areas. These regulations were developed in order to prevent action undertaken by any person or entity resulting in a substantial environmental alteration. Specific information on the location and extent of sensitive areas within the City can be obtained from the City while sensitive area information for other areas is available from King County.

Environmentally sensitive areas include wetlands, fish and wildlife habitat conservation areas and geologically hazardous areas. Geologically hazardous areas include areas that are not suitable to development due to their susceptibility to erosion, sliding, earthquake or other geological events. A geotechnical report prepared by a licensed professional engineer is required prior to any development in these areas.

Fish and wildlife conservation areas within the City include Rock Creek and Ginder Creek corridors, open water ponds, lakes and riparian forests. Geologically hazardous areas include steep slopes (greater than 25%) and past coal mine working areas. Development around wetland areas requires buffer zones in order to reduce or mitigate any adverse impact. Permitted activities within the buffer zones include passive recreation, parks, pedestrian and bicycle trails and road and utility facilities when necessary.

2.3 LAND USE & ZONING

Land use and zoning play an important role in determining growth patterns, and therefore future storm drainage patterns and requirements. Future land use, variations in use, and changing population densities, as determined by applicable zoning ordinances, can significantly impact the City of Black Diamond's future storm drainage patterns and needs.

Figure 2.6 Black Diamond Future Land Use is the proposed land use for the City as included in the City of Black Diamond Comprehensive Plan. This figure shows designated land use within incorporated Black Diamond and the portions of unincorporated King County that are planned for master developments and may be annexed into the City in the future. Current land uses are primarily residential uses, with some light industrial and commercial areas.

Figure 2.7 Black Diamond Zoning includes the City's zoning as included in the City of Black Diamond Comprehensive Plan.

Figure 2.8 King County Land Use includes the designated land uses for the area of unincorporated King County surrounding Black Diamond.

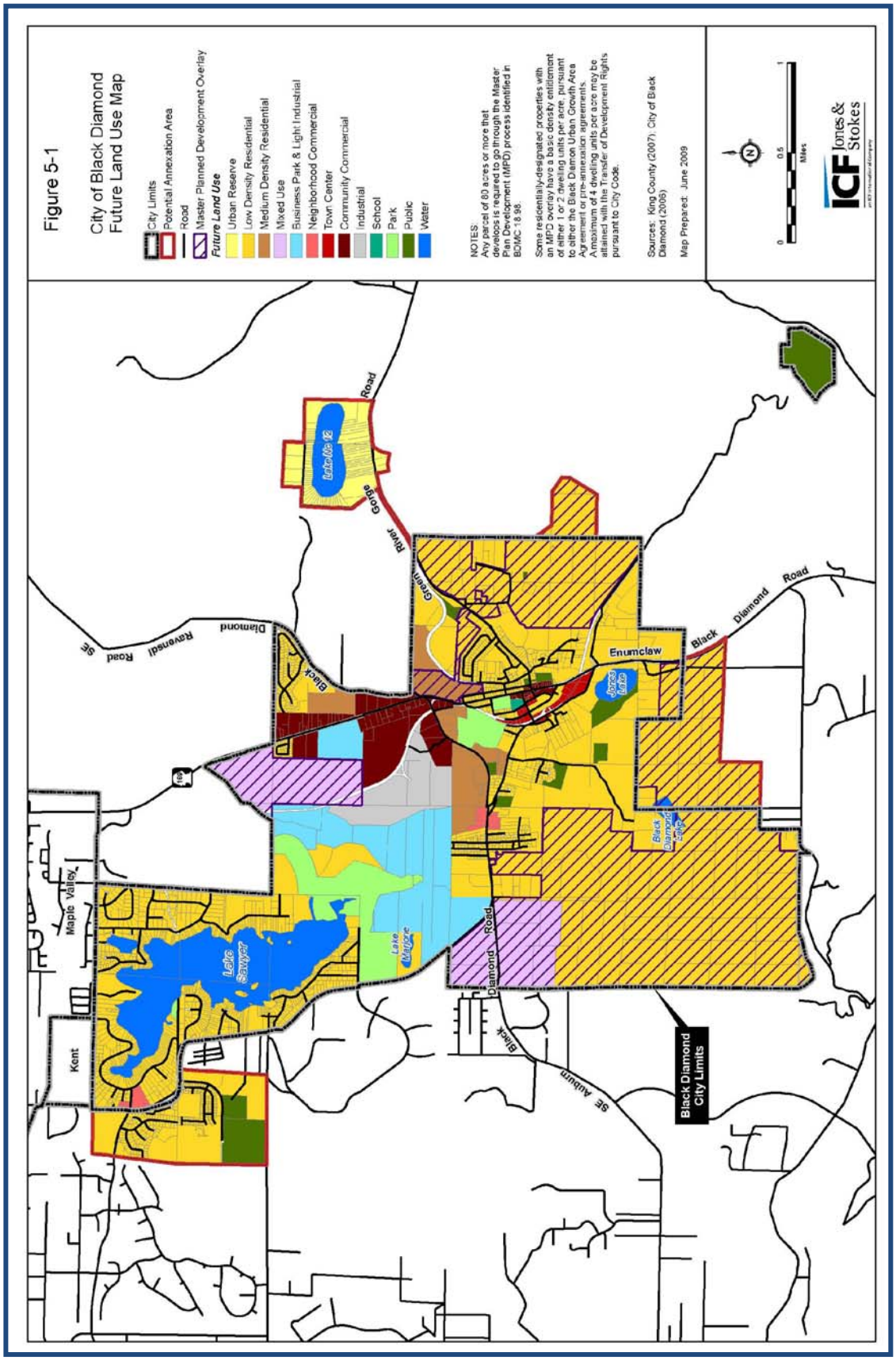


Figure 2.6 Black Diamond Future Land Use

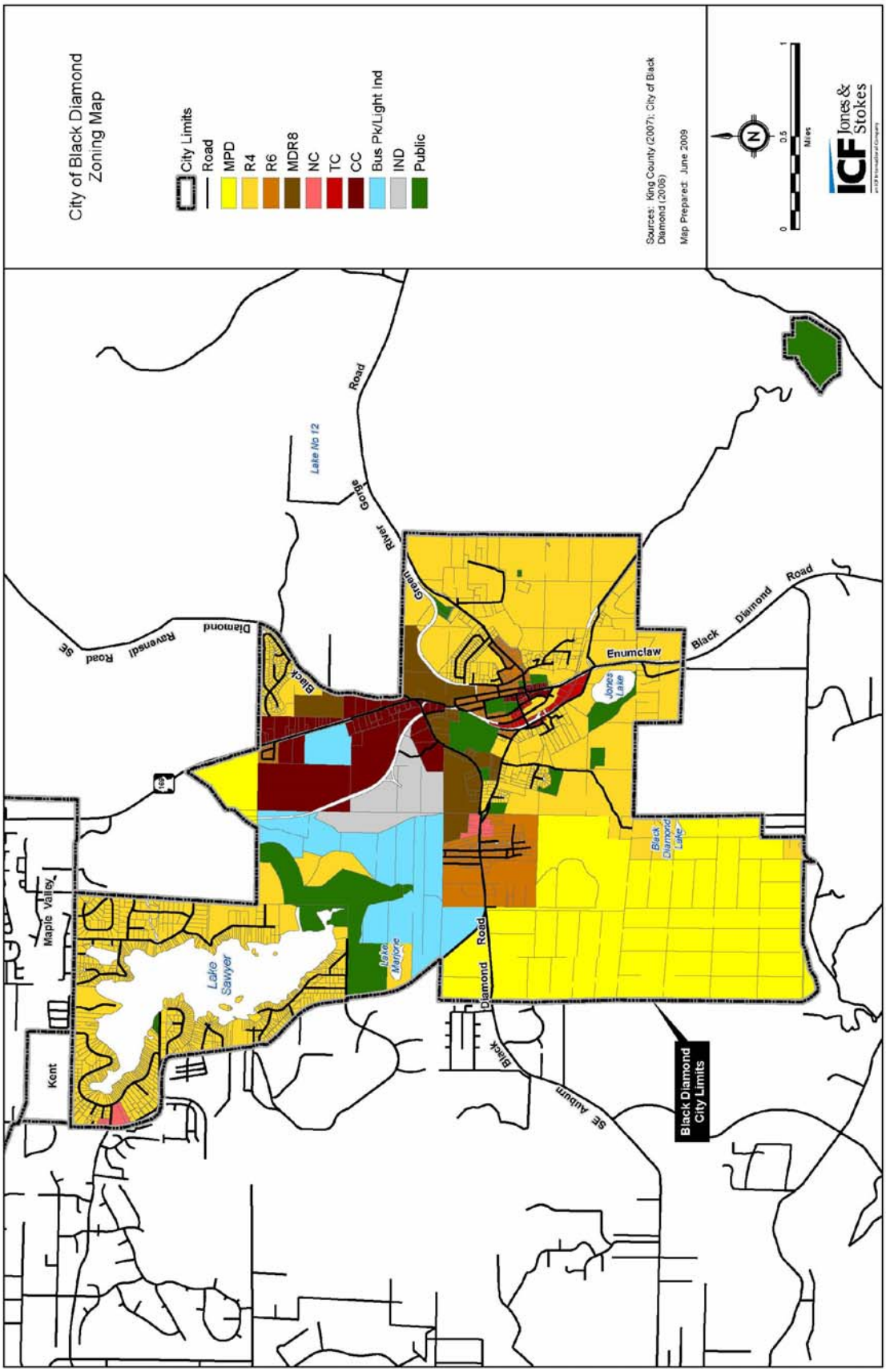


Figure 2.7 Black Diamond Zoning

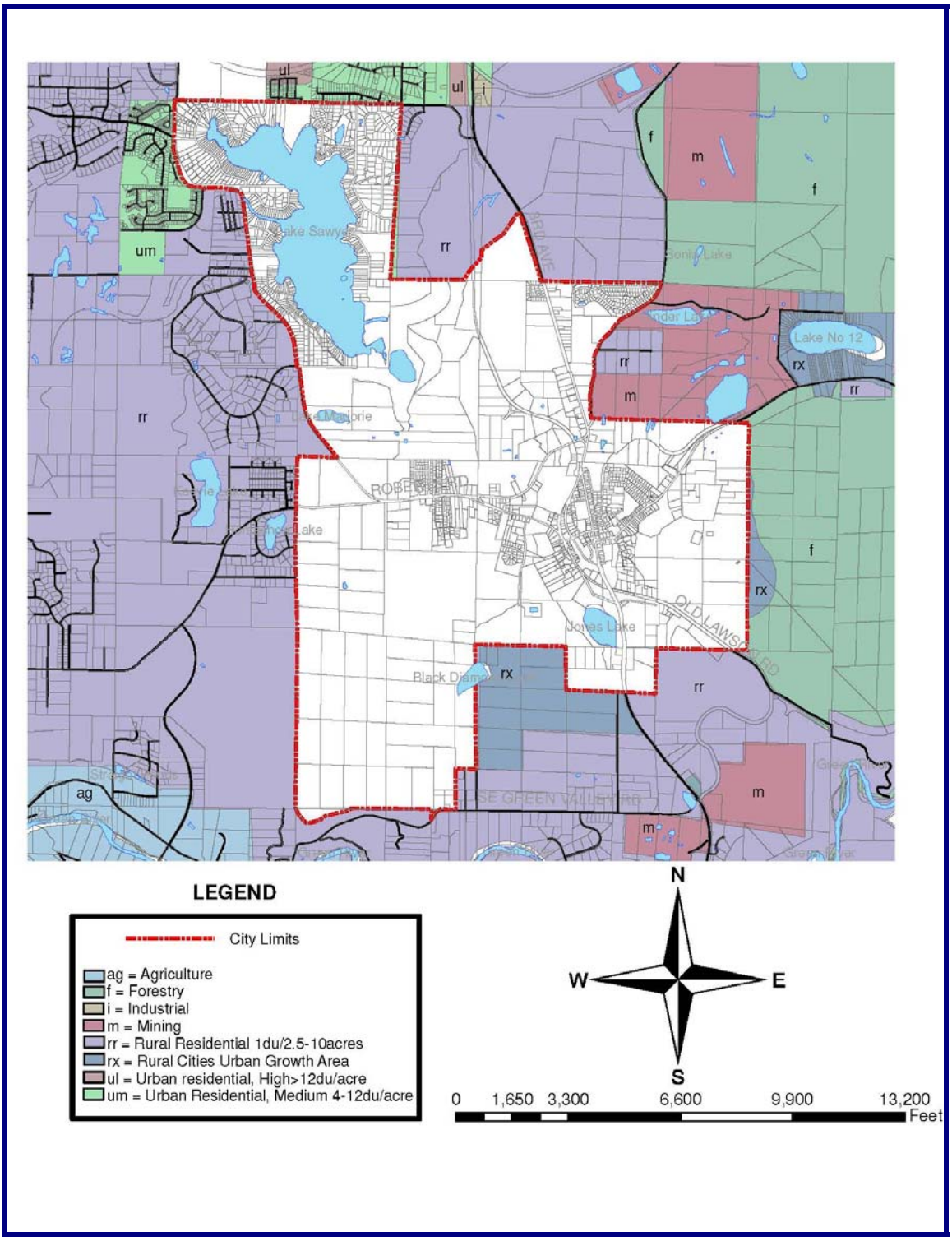


Figure 2.8 King County Land Use

Figure 2.9 ***King County Zoning*** includes the zoning designations as defined by King County for the area of unincorporated King County surrounding Black Diamond.

2.4 POPULATION

EXISTING POPULATION & STORMWATER UTILITY CUSTOMERS

The 2008 population within the City of Black Diamond was 4,155 per the Washington State Office of Financial Management (OFM). The City has found that developed properties contribute to an increase in surface and stormwater runoff to the surface and stormwater management system. A stormwater utility was adopted by the City of Black Diamond in November 2008. There are presently 1,478 developed parcels that are assessed the monthly stormwater utility rate. Developed properties are subject to the rates and charges of the surface water management utility based on their contribution to increased runoff based on the amount of impervious surface areas.

Properties remaining in an undeveloped condition are deemed not to make use of the services of the utility or of the facilities of the system beyond that used by such property in the natural state. Therefore, no service charge is imposed upon undeveloped real property. City, County, and/or State roadway right-of-ways are exempt from service charges and general facility charges.

EQUIVALENT RESIDENTIAL UNITS

The City calculates the impervious ground cover of each parcel of developed real property within the boundaries of the utility to determine the number of equivalent residential units contained therein. 3,000 square feet of impervious ground cover equals one equivalent residential unit. All detached single-family residences and mobile homes are deemed to contain one equivalent residential unit; all duplexes are deemed to contain two equivalent residential units; all triplexes are deemed to contain three equivalent residential units. For all other developed real properties within the utility boundaries, the City determines the number of equivalent residential units contained thereon by dividing the number of square feet of impervious ground cover on each property by 3,000 square feet/ERU; the total thus obtained will be rounded to the nearest half representing the equivalent residential units contained on such property. Each developed parcel of property is deemed to contain a minimum of one equivalent residential unit.

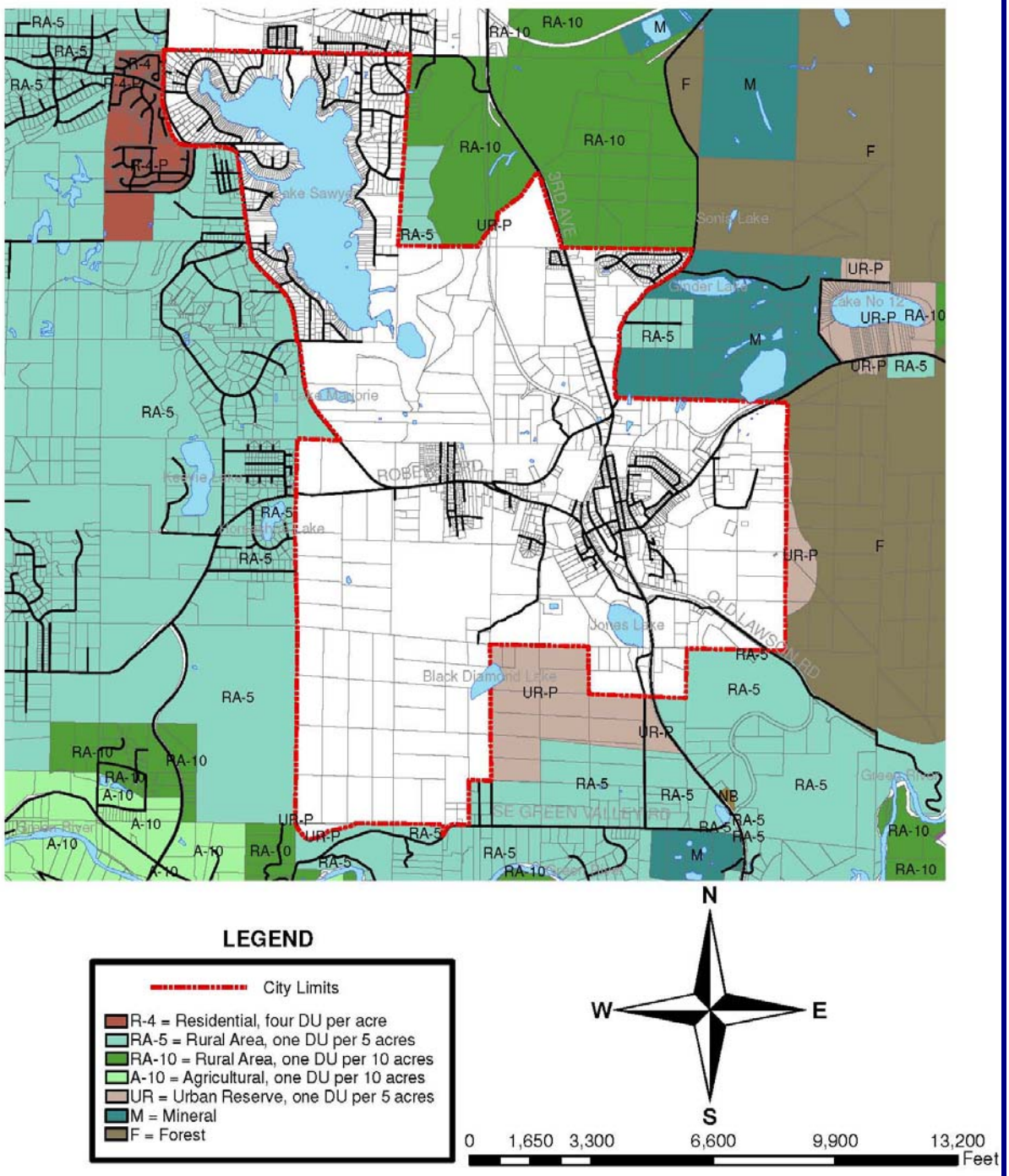


Figure 2.9 King County Zoning

PROJECTED POPULATION & LAND USE

Population projections for the twenty-year planning horizon were in support of the update to the City's Comprehensive Plan. Growth projections reflect anticipated growth associated with large-scale planned developments.

The City has been under a development moratorium for several years which is expected to be removed in 2009. The City is anticipating that several large master-planned communities will submit development applications in the near future. The City is preparing to experience substantial growth. Projected land uses are based on the City of Black Diamond Land Use map as shown in the City's Comprehensive Plan and has been included previously in this Plan as ***Figure 2.6 Black Diamond Future Land Use.***

Assumptions included in this Plan for these large-scale developments are based on conversations with the proposed development company and are subject to change based on the actual rate development occurs. The projections utilized in this Storm and Surface Water system analysis are the same projections utilized in the City's Comprehensive Plan and other planning documents.

The Lawson Hills Development is assumed to consist of 1,200 residential units at build-out. The Villages at Black Diamond development is assumed to consist of 4,800 residential units at build-out. It should be noted that the 6,000 proposed new residential units described above are build-out figures. Based on projected growth rates, it is anticipated that 5,000 of the proposed residential units will be constructed during the 20-year planning period of this plan.

3.0 EXISTING STORM DRAINAGE SYSTEM

3.1 INVENTORY OF EXISTING FACILITIES

The evaluation of the City's drainage facilities begins with the establishment of an inventory of the system's components. An intensive field-survey effort was undertaken to identify the extent and nature of the storm water system. This inventory concentrated on collecting the physical characteristics of the storm water management system, including sizes of pipes, materials, and their general condition. The inventory included some surface channels carrying storm water in addition to the underground pipe systems. The inventory also helped define the layout of the storm drainage system.

Since Black Diamond is a well established community, the underlying storm water infrastructure has been developed under many different programs and philosophies. As the City has undergone development and redevelopment, its storm water systems have been modified and some of the original connections were changed over time.

Figure 3.1 Existing Storm Drainage System, Pg 1 and ***Figure 3.2 Existing Storm Drainage System, Pg 2*** show the location of the City's existing stormwater facilities. Large size copies of these maps have been included in ***APPENDIX C – Existing Storm System Map***. A summary of major components of the City's stormwater system is summarized in ***Table 3.01 Stormwater System Inventory***.

Table 3.01 Stormwater System Inventory

Facility	Quantity
Catch Basins	572
Stream Channel	12.1 miles
City-owned Ponds	9
Major Wetland Areas	7
Lakes	6
8-inch Pipe	918 Ft
12-inch Pipe	38,761 Ft
15-inch Pipe	3,123 Ft
18-inch Pipe	4,251 Ft
24-inch Pipe	1,024 Ft
36-inch Pipe	632 Ft
48-inch Pipe	268 Ft
54-inch Pipe	168 Ft
72-inch Pipe	213 Ft
Total Pipe (8-inch to 72-inch)	49,358 Ft

The field collected inventory of stormwater facilities was developed into a Geographic Information System Database (GIS) to create an electronic inventory. The City will be

updating this inventory as development continues to ensure that a current record of the system is maintained.

A "Stormwater Inventory Map Book" has been developed in association with the field-inventory efforts and has been produced as a stand-alone document. This set of drawings include all data included in the GIS system in an easy to read reference set for use by the City staff, it's residents, and anyone else needing as-built information on the City's storm drain system.

3.2 BASIN DESCRIPTIONS

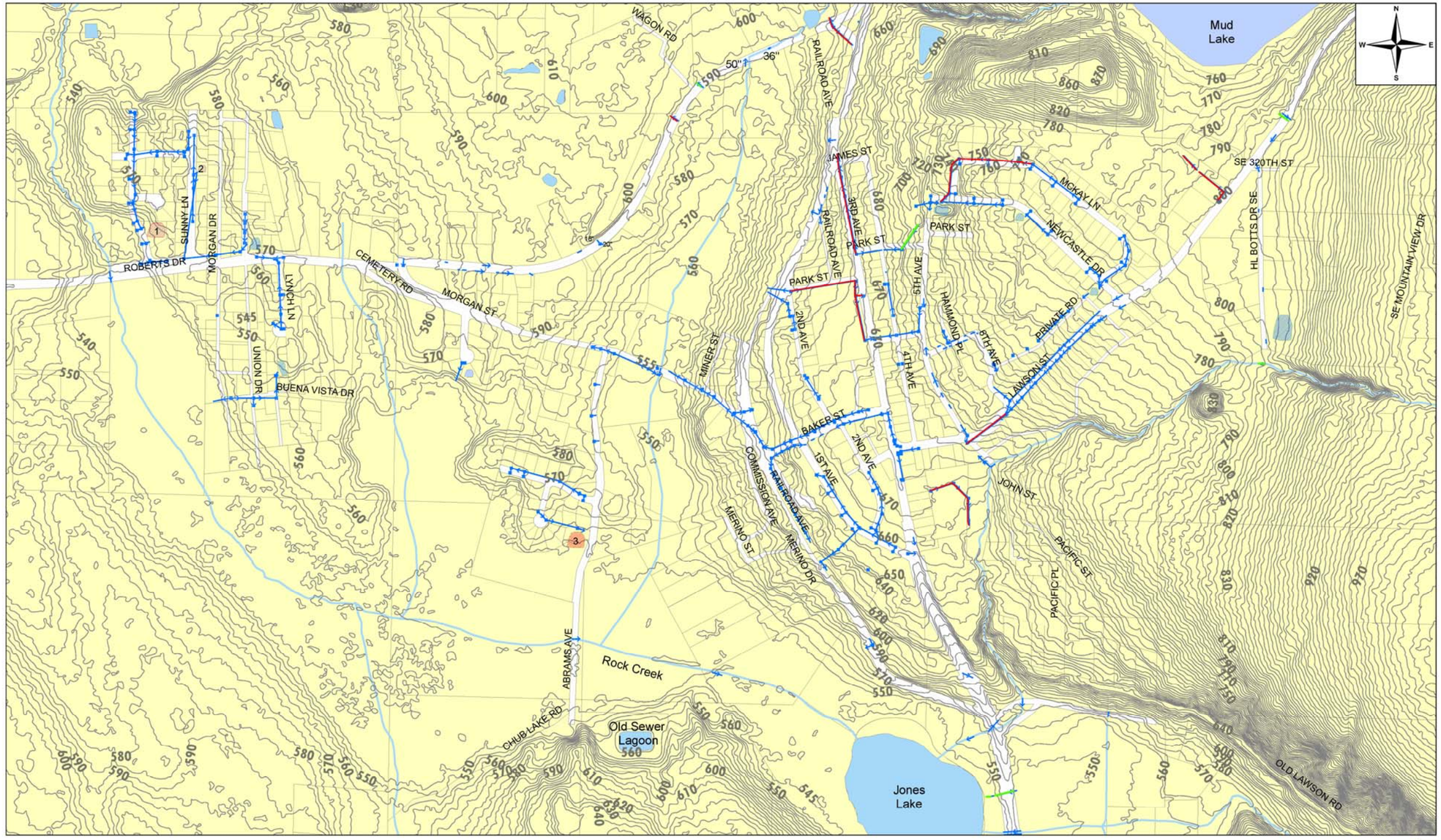
The study area for the City of Black Diamond Storm and Surface Water Plan consists of the incorporated area of the City of Black Diamond, its Urban Growth Area (UGA), and a limited analysis of areas outside of the City's UGA that contribute stormwater runoff to the City and it's system. The majority of the City drains to Lake Sawyer either directly or through one of three major streams: Rock Creek, Ginder Creek (a tributary of Rock Creek), or Ravensdale Creek. Black Diamond is bounded by areas of unincorporated King County to the east, west, and south, and abuts portions of the Cities of Kent and Maple Valley to the north.

The study area for the Black Diamond Storm and Surface Water Plan consists of ten stormwater runoff basins as illustrated in ***Figure 3.3 Basin Index Map***. A large scale copy of this map has been included in ***APPENDIX D – Basin Index Map***. Each of these basins can be further defined by one to five sub-basins depending on tributary water course and existing topography. Individual basin maps are included as ***Figure 3.4 Lake Sawyer Basin***, ***Figure 3.5 Rock Creek Basin***, ***Figure 3.6 Ginder Creek Basin***, ***Figure 3.7 Ravensdale Basin***, ***Figure 3.8 Jones Lake Basin***, ***Figure 3.9 Lake Marjorie & Lake No. 12 Basin***, ***Figure 3.10 Southern Basin***, and ***Figure 3.11 Northwest & Southwest Basin***.

Table 3.02 Stormwater Basins

Basin	Size (acres)
Lake Sawyer Basin	1,360
Rock Creek Basin	1,400
Ginder Creek Basin	1,378
Ravensdale Basin	2,365
Jones Lake Basin	1,137
Lake 12 Basin	354
Lake Marjorie Basin	106
Southern Basin	45
Northwest Basin	143
Southwest Basin	622
TOTAL	**8,910**

Large areas outside of the City and its UGA contribute stormwater runoff to the City and the surface waters contained with in it. The Black Diamond Watershed described in this plan is entirely within the King County WRIA (Watershed Resource Inventory Area)



Sheet 1

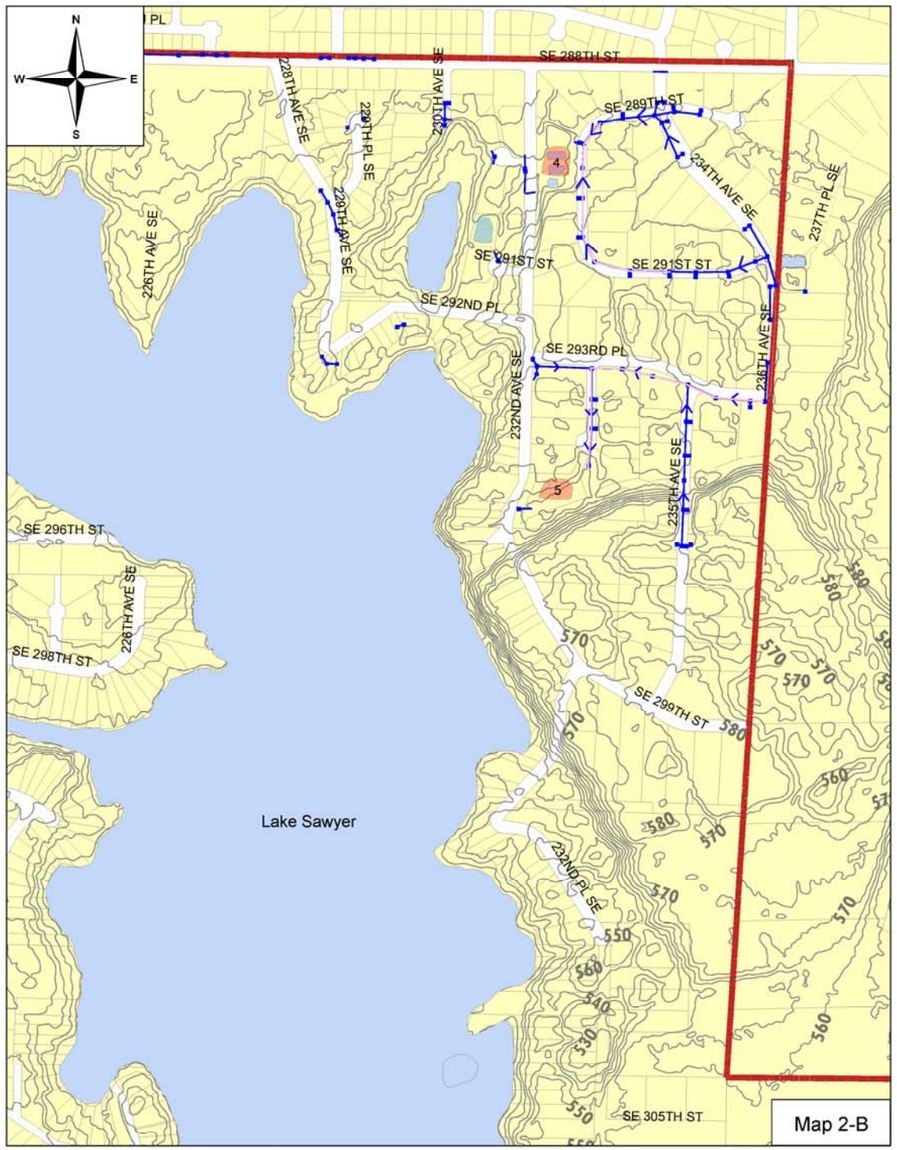
PacWest Engineering, LLC
5009 Pacific Highway East, Unit 9-0
Fife, WA 98424
Phone (253) 926-3400
Fax (253) 926-3402

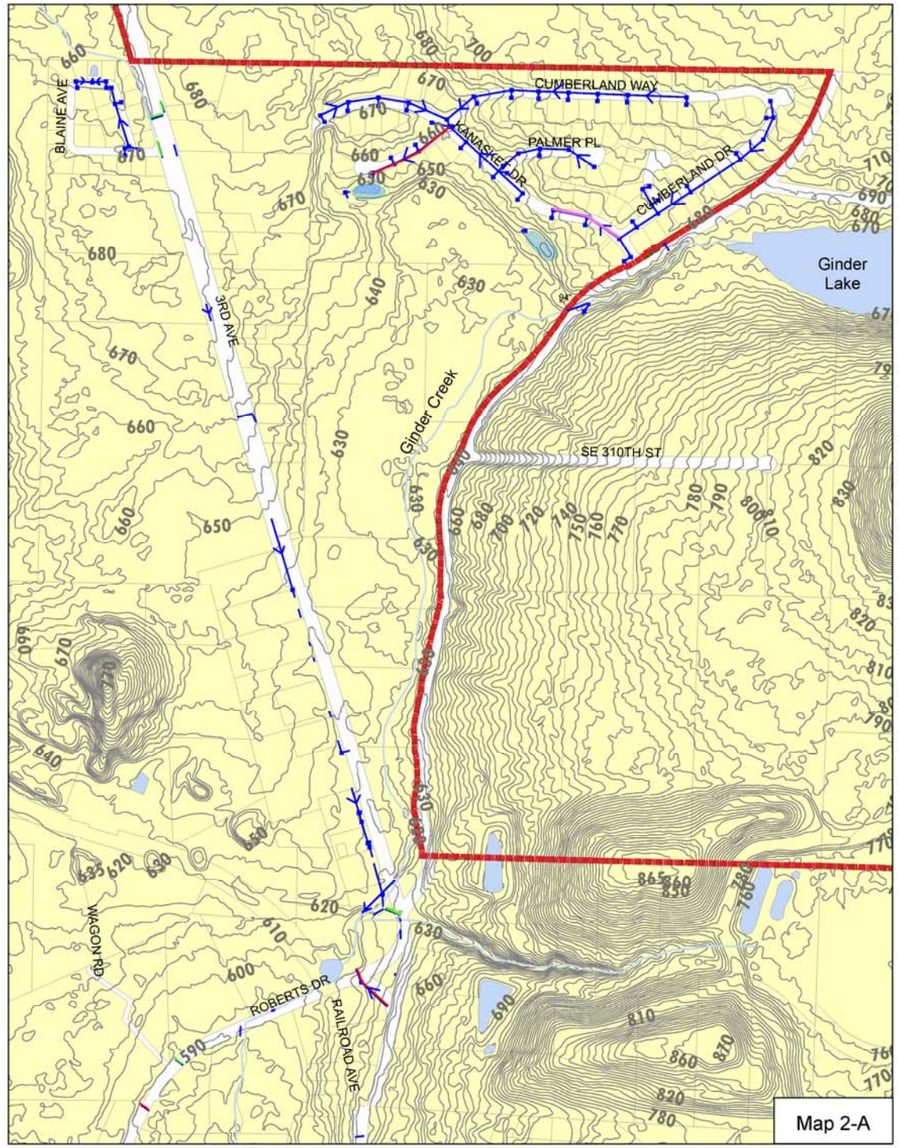
City Of Black Diamond

Legend
Public Pond
Private Pond
BD City Limit
Contours
15" Pipes
UGA
Catch Basin
18" Pipes
Water Courses
6" - 12" Pipes
24" Pipes

0 300 600 1,200 Feet

Existing Storm Drainage System





Sheet 2

PacWest Engineering, LLC
5009 Pacific Highway East, Unit 9-0
Fife, WA 98424
Phone (253) 926-3400
Fax (253) 926-3402

City Of Black Diamond

Legend
BD City Limit
UGA
Contours
Public Pond
Water Courses
Catch Basin
6" - 12" Pipes
Private Pond
15" Pipes
18" Pipes
24" Pipes

0 300 600 1,200 Feet

Existing Storm Drainage System

Figure 3.2 Existing Storm Drainage System, Pg 2

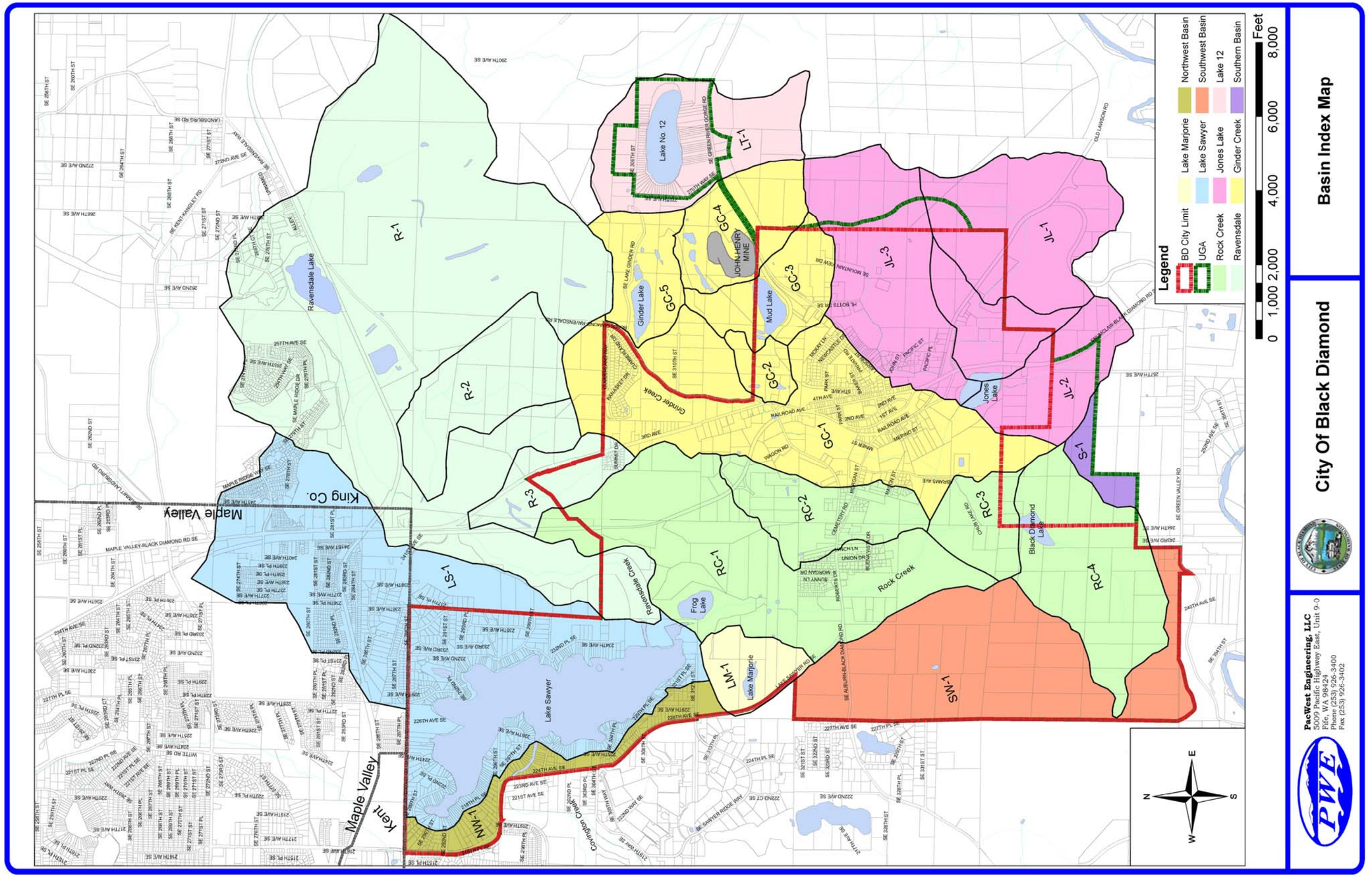


Figure 3.3 Basin Index Map

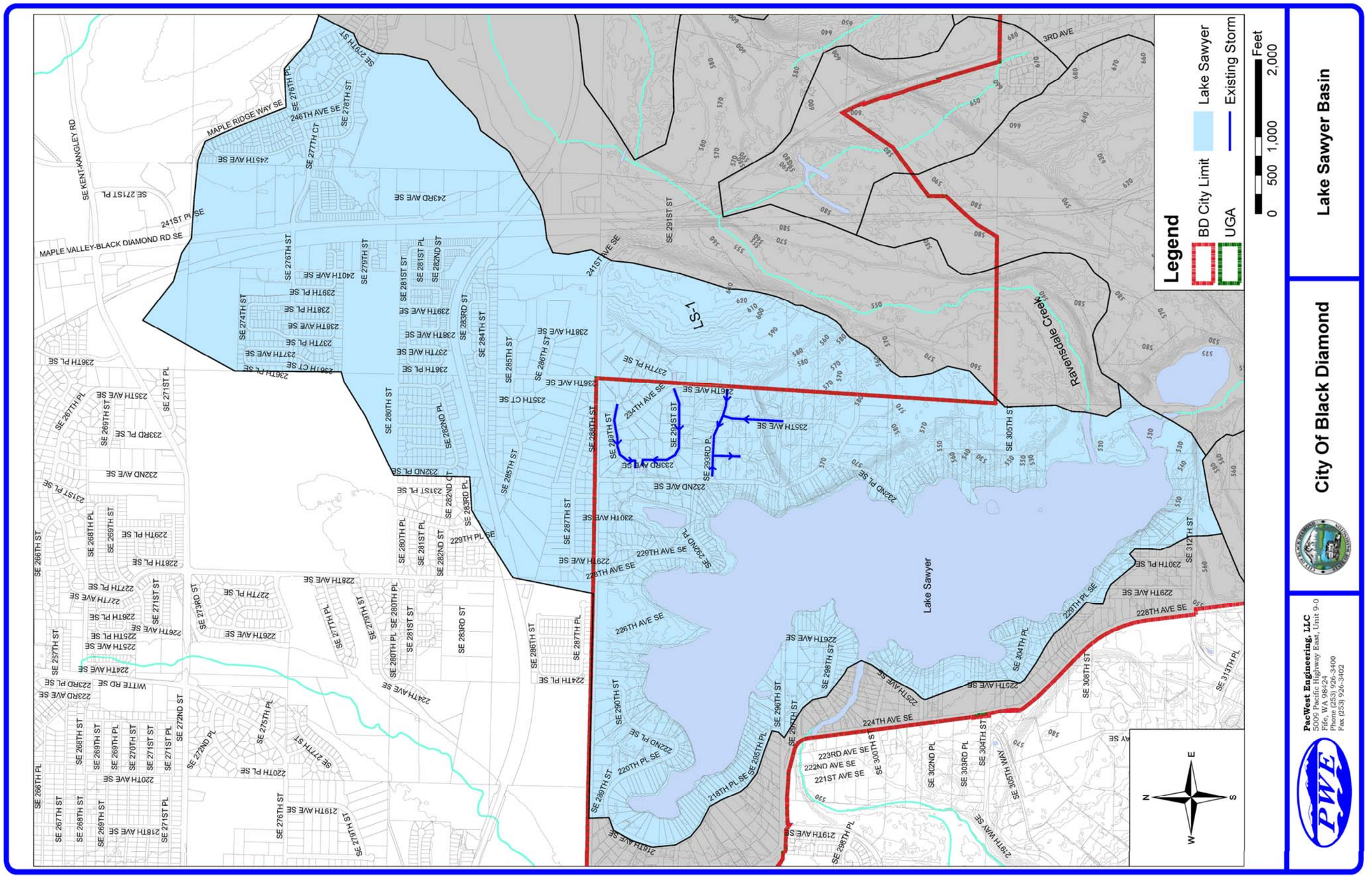


Figure 3.4 Lake Sawyer Basin

PACWEST ENGINEERING LLC

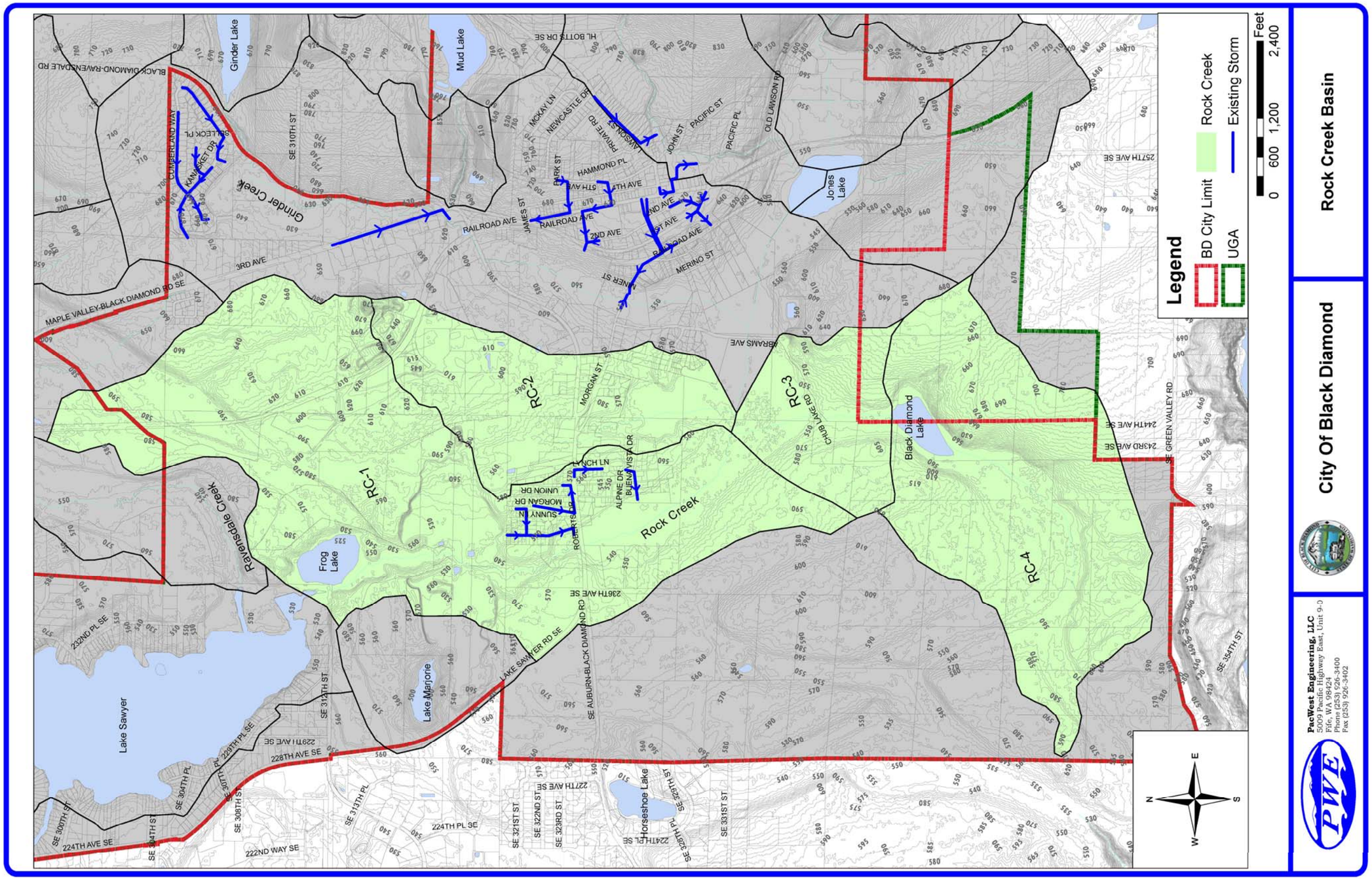


Figure 3.5 Rock Creek Basin

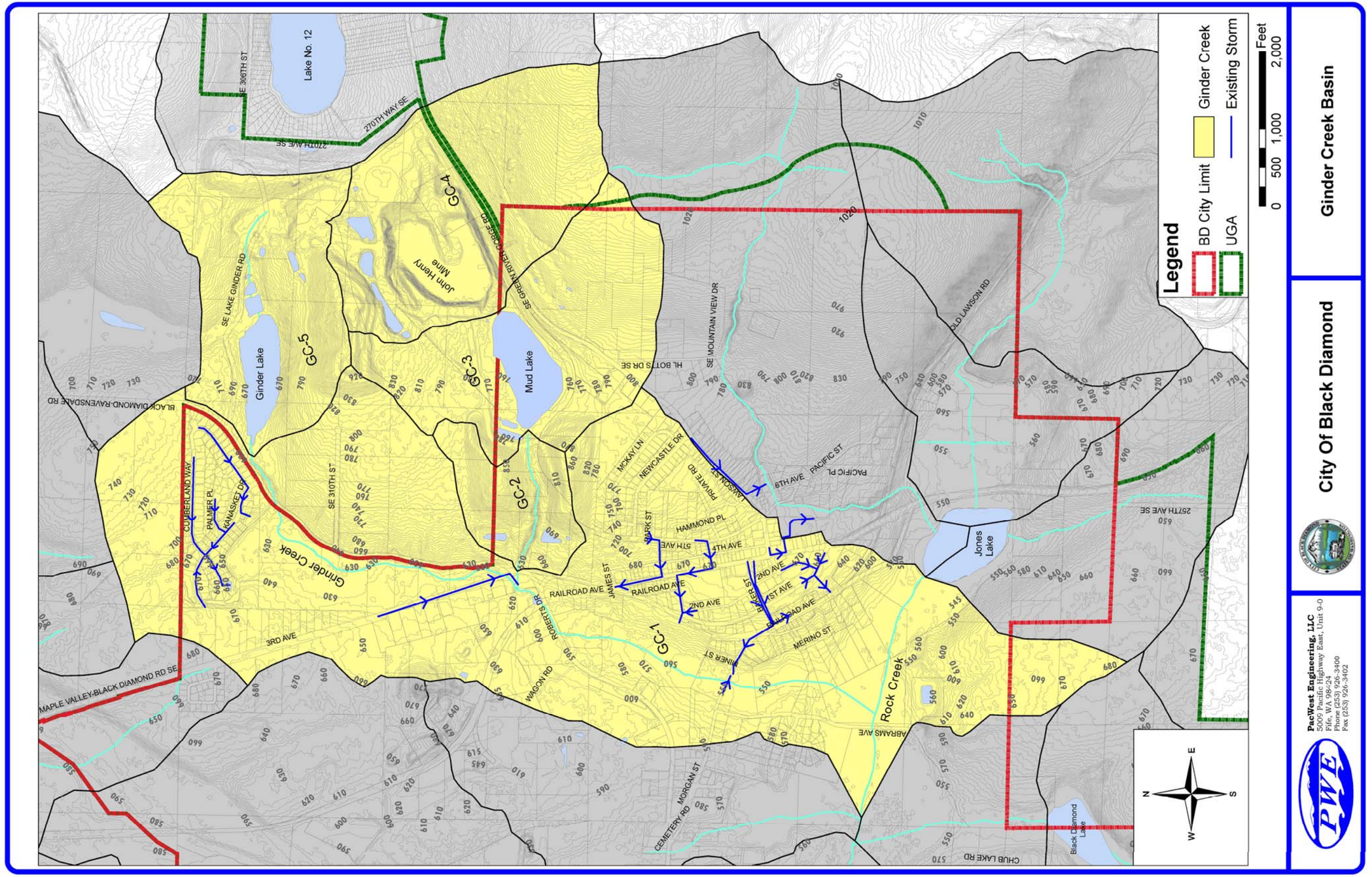


Figure 3.6 Ginder Creek Basin

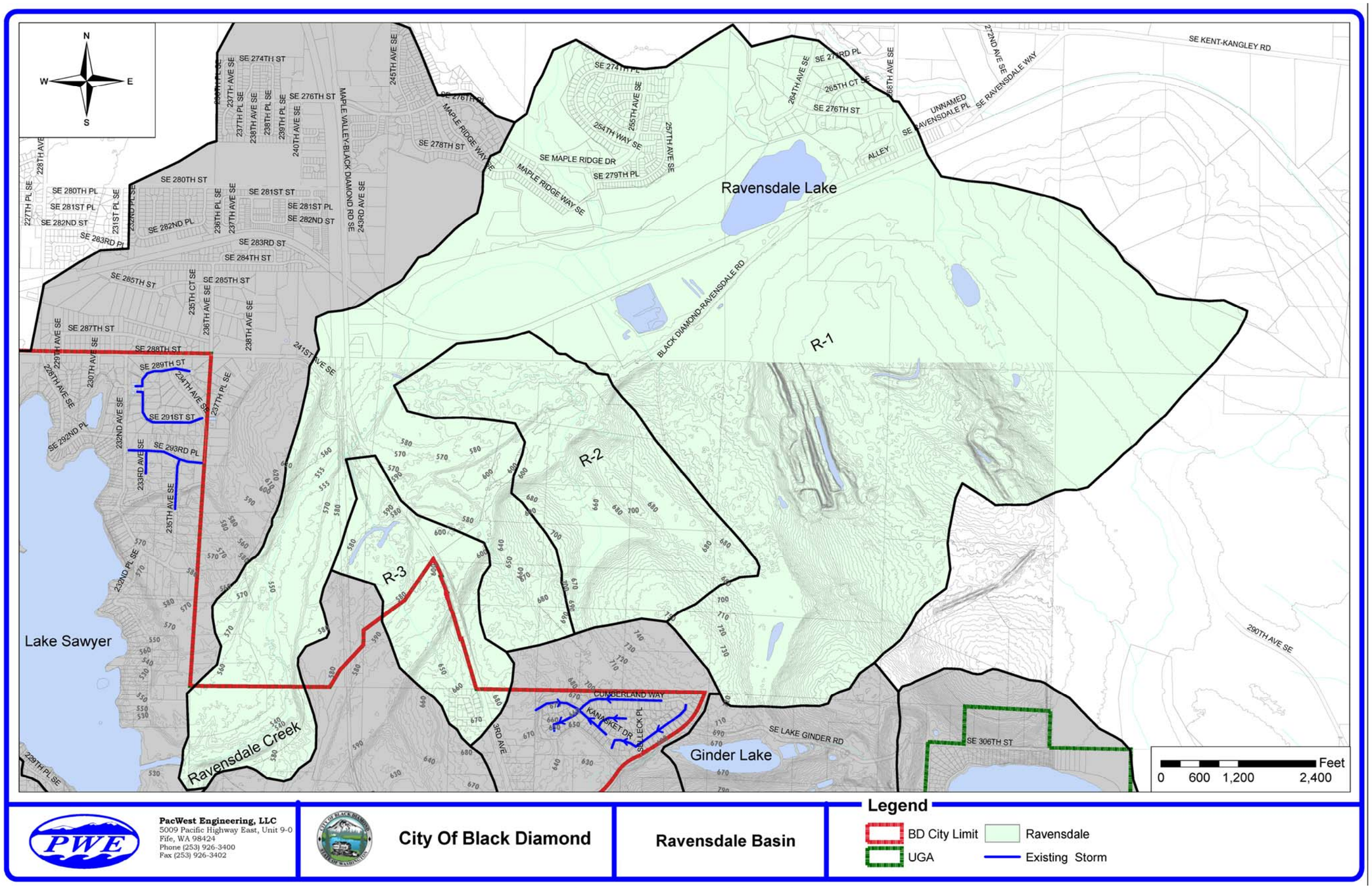


Figure 3.7 Ravensdale Basin

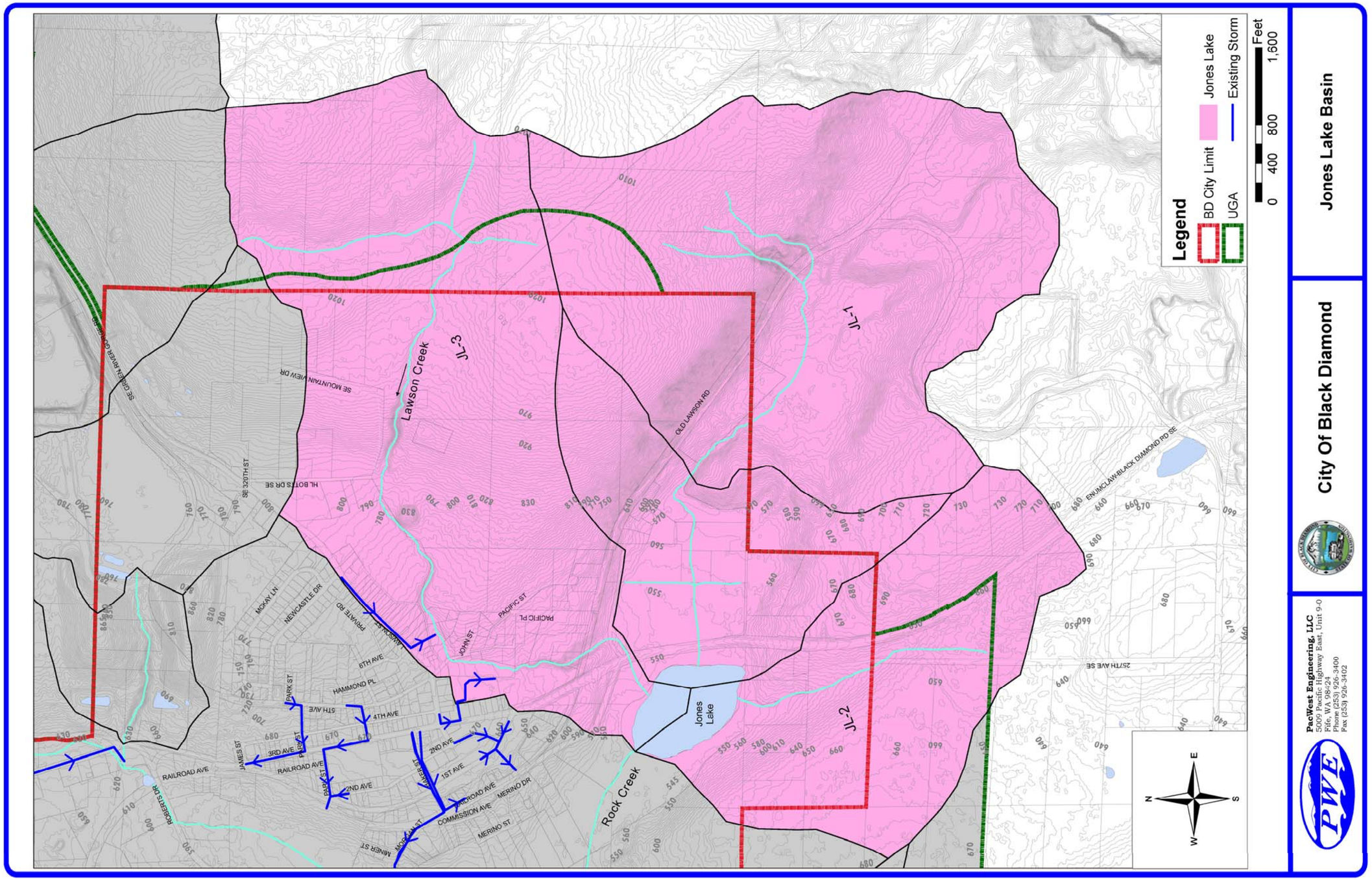


Figure 3.8 Jones Lake Basin

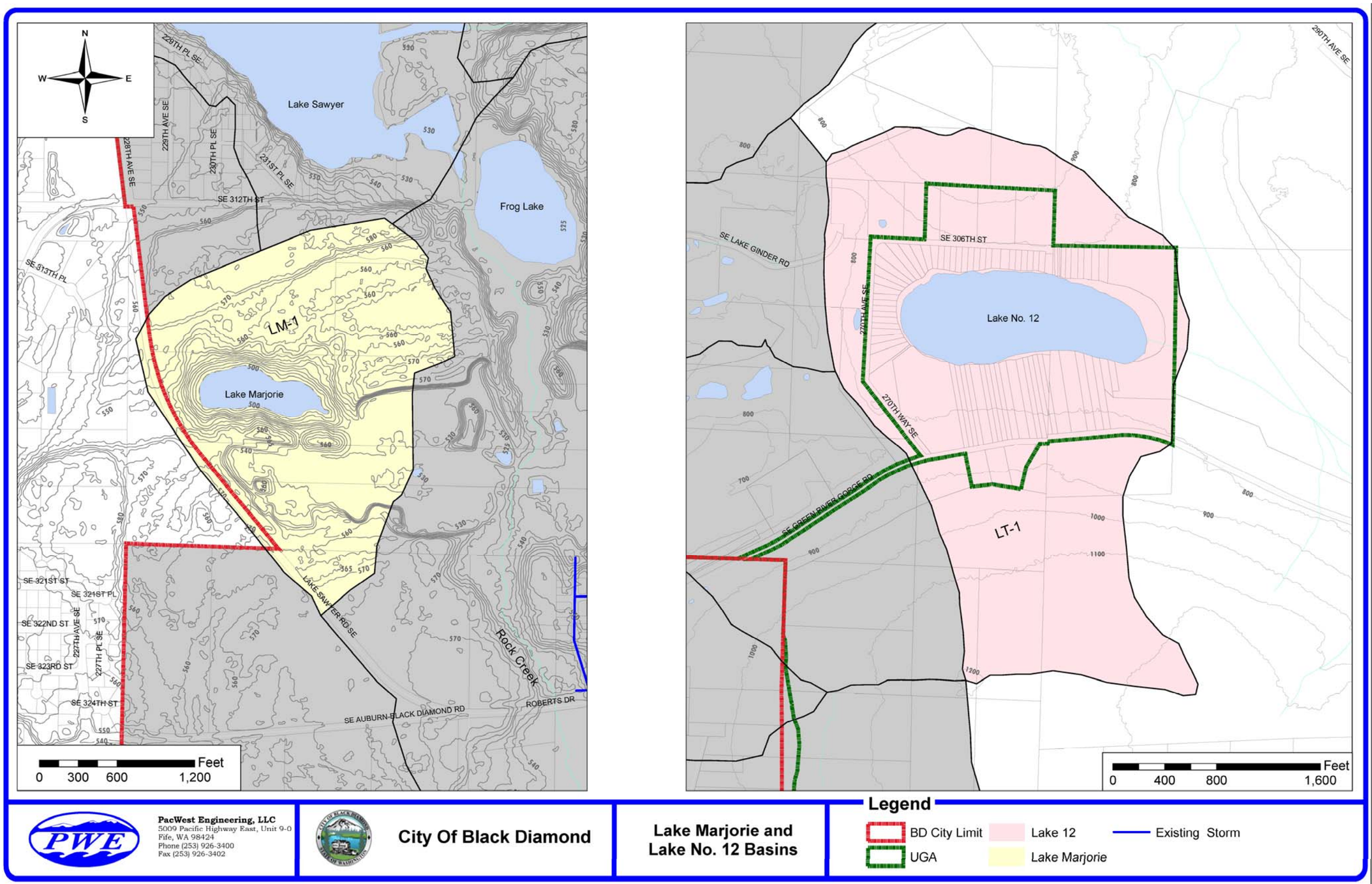


Figure 3.9 Lake Marjorie & Lake No. 12 Basins

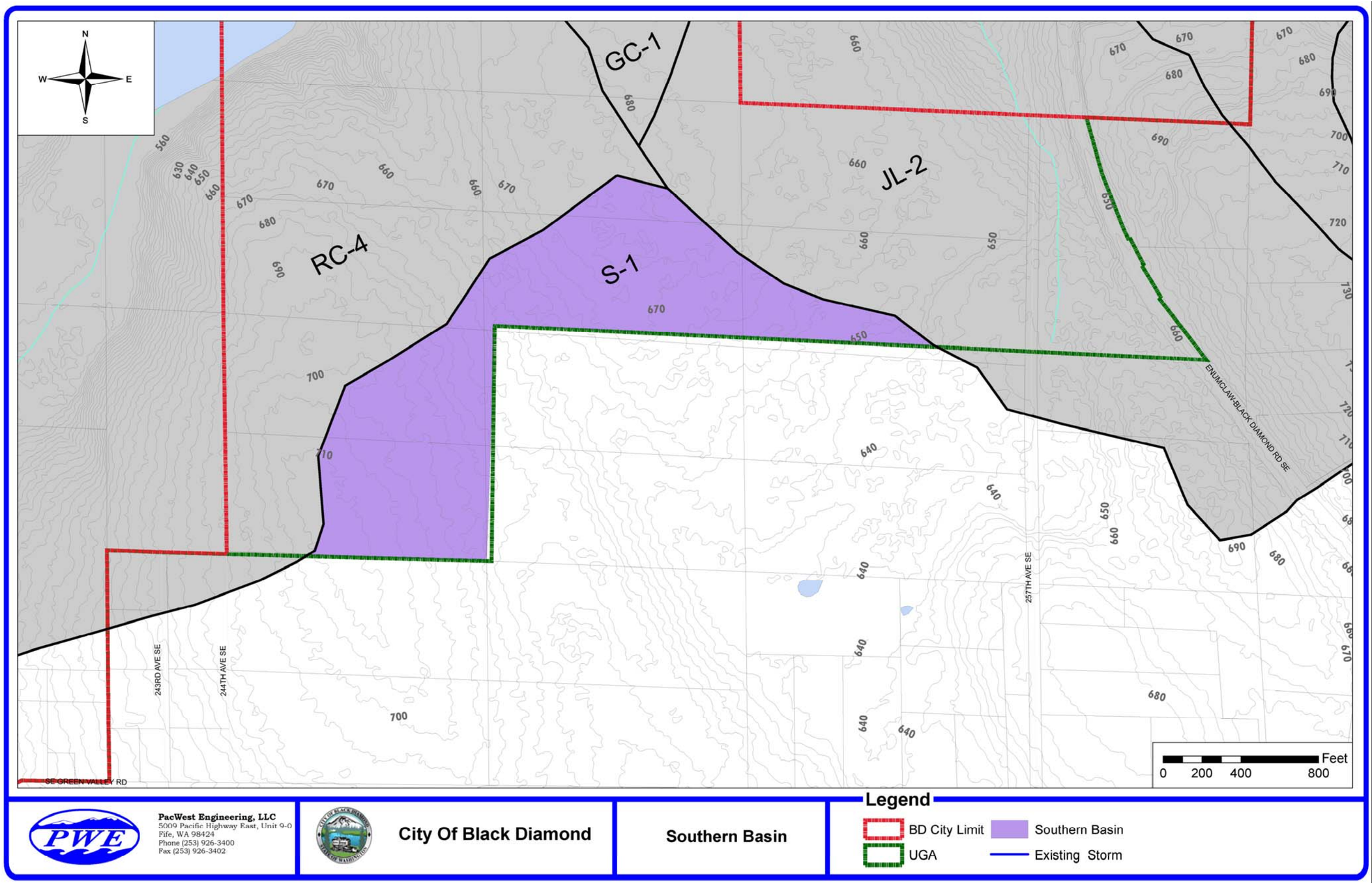
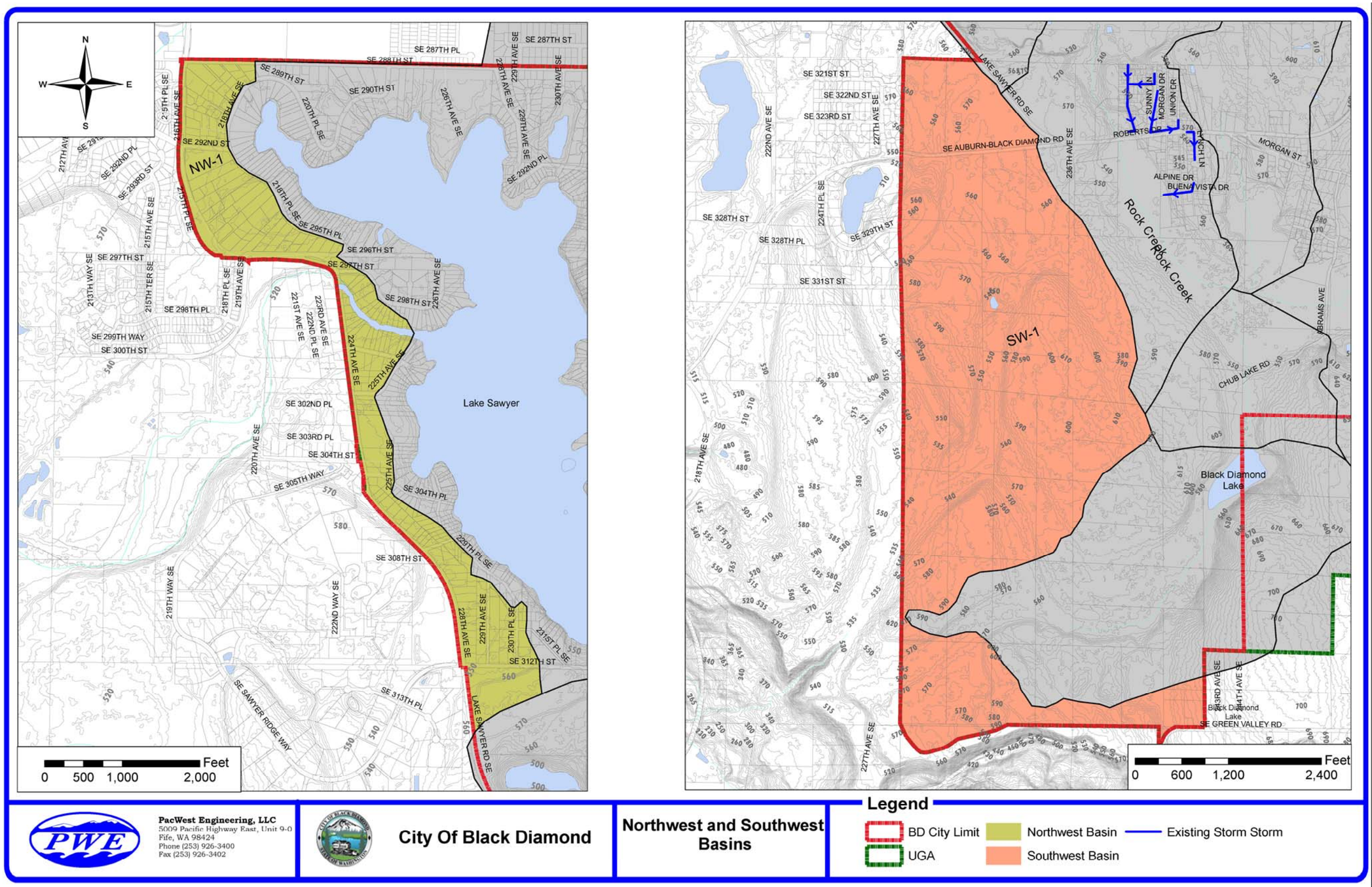


Figure 3.10 Southern Basin



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City Of Black Diamond

Northwest and Southwest Basins

Legend

- BD City Limit
- UGA
- Northwest Basin
- Southwest Basin
- Existing Storm Storm

Figure 3.11 Northwest & Southwest Basins

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Number 9, the Duwamish-Green Area. The subset King County Drainage Basin within WRIA 9 is the Covington Creek Basin. The only exception to this is the City's Lake No. 12 basin. This basin falls within WRIA Number 8, the Cedar-Sammamish and the King County Basin known as the Lower Cedar River Basin.

LAKE SAWYER BASIN (LS)

The Lake Sawyer Basin is comprised mostly of residential areas both within the City limits and in neighboring King County and Maple Valley to the north. For purposes of this study this basin was not further broken into sub-basins due to the general overland runoff and highly infiltrative soils throughout most of the basin. The basin is approximately 1,361 acres with 705 acres within the City limits of Black Diamond and the remainder in unincorporated King County and in the City of Maple Valley. The receiving body of water for this basin is Lake Sawyer.

Soils in the Lake Sawyer Basin are generally sandy and considered outwash soils. Some till soils are present in the low lying wetland areas and some of the undeveloped areas in unincorporated King County. These wetlands are located near the shores of Lake Sawyer and in the southern areas of the basin where Rock Creek and Ravensdale Creek enter Lake Sawyer.

There are a variety of zoning designations within the Lake Sawyer Basin. Zoning within the City of Black Diamond is primarily low density residential with an average density of four dwelling units per acre. Additionally there are 18 acres owned by the City which are located within the City of Black Diamond and zoned as a Park. These lands include the Lake Sawyer Regional Park at the southern end of the lake, as well as Lake Sawyer Park at the east end of SE 296th Street which includes a public boat launch site. Zoning within the City of Maple Valley is predominately low density residential with a small amount of commercial use. The portion of the Lake Sawyer Basin located in unincorporated King County is rural and mostly undeveloped.

Most of the developed areas of the Lake Sawyer basin within the City limits have little or no piped conveyance systems. Roadside ditches and driveway culverts serve the majority of the homesites around Lake Sawyer. A small portion of these ditches convey runoff directly to Lake Sawyer, but many of them retain water until it can infiltrate into groundwater. Due to the majority of this basin being in outwash soils, infiltration of this type is a successful means of dealing with the existing runoff. Some of the newer developments (such as Greenbriar Estates located northeast of Lake Sawyer) within the Lake Sawyer Basin also employ retention (infiltration) ponds to manage runoff from their curb and gutter street sections.

ROCK CREEK BASIN (RC)

The Rock Creek Basin is comprised largely of undeveloped land and large areas of wetlands. The receiving body of water for this basin is Rock Creek which flows into Lake Sawyer at its southernmost point. The developed area within the basin is an area of Black

Diamond known as Morganville. Morganville consists of a residential neighborhood located off of Roberts Drive and Morgan Street west of downtown Black Diamond.

The Rock Creek Basin is comprised of four sub-basins as listed in ***Table 3.03 Rock Creek Basin***. RC-1 is a basin area contributing directly to Rock Creek and Frog Lake immediately upstream of Lake Sawyer. RC-2 contributes to an unnamed stream flowing south into Rock Creek through the Morganville area of the City. This stream crosses Roberts Drive just west of the intersection of Roberts Drive and Morgan Street. RC-3 drains to a tributary connecting Black Diamond Lake to Rock Creek and RC-4 drains to Black Diamond Lake and its tributary stream south of Lake Sawyer.

Table 3.03 Rock Creek Basin

Sub-Basin	Size (acres)
RC-1	685.2
RC-2	205.0
RC-3	122.3
RC-4	388.5
TOTAL	**1,401**

The majority of Rock Creek Basin is located within the City limits and the Urban Growth Area. Two relatively small areas are located in unincorporated King County. One is an area south of the City Limits near 243rd Ave SE (approximately 5.4 acres). The other is at the north tip of sub-basin RC-1 east of Ravensdale Creek (approximately 29.2 acres).

The tributary water for this basin is Rock Creek. Two lakes, Black Diamond Lake & Frog Lake, are located in the Rock Creek Basin as well. Black Diamond Lake, in sub-basin RC-4, is a small lake in the southwestern area of the City limits. Black Diamond Lake releases to a tributary stream of Rock Creek. Frog Lake in sub-basin RC-1 is a body of water associated with the wetlands at the south end of Lake Sawyer. Rock Creek empties into these wetlands and enters Lake Sawyer through a pipe arch at the southern tip of the lake.

Both outwash and till soils are present in the Rock Creek Basin. Outwash soils are generally located in the higher regions of the basin away from Rock Creek, and in the northwest portion of the basin near Lake Sawyer. Outwash soils are of the Everett soil series per the Natural Resources Conservation Service (NRCS) and the till soils are of several types including the following series: Alderwood, Bellingham, Buckley, Norma, Seattle Muck, and Shalcar Muck. These till soils are located around Rock Creek, the lakes and wetlands as well as undeveloped areas in the south and northeast portions of the basin.

Many different types of zoning are represented within the Rock Creek Basin. A large portion of the basin is zoned MPD and is in the preliminary stages of a master planned development called The Villages. This development has been proposed by a private developer although at this time formal applications have not yet been submitted to the City. Other zoning within the basin includes Residential (R4, R6, and MDR8), Business Park / Light Industrial, Commercial, and Public lands.

Much of the Rock Creek Basin is undeveloped. The developed regions of the basin are mainly residential and are centrally located in the Morganville area west of downtown. The Morganville area of the City is primarily served by piped conveyance systems and roadside ditches that convey runoff to a number of stormwater control ponds within individual developments. Street sections where road runoff is piped are typically asphalt raised edge section, but some of the newer developments in this basin have concrete curb and gutter sections. The soils in the Morganville area are generally outwash and therefore many of the ponds in these neighborhoods are infiltration ponds.

GINDER CREEK BASIN (GC)

The Ginder Creek Basin is the tributary area for the majority of downtown Black Diamond. This includes most of the existing commercial lands for the City as well as much of the residential areas. The receiving waters for this basin are Ginder Lake, Ginder Creek, and the upper reach of Rock Creek downstream of Jones Lake.

Ginder Creek Basin is approximately 1,378 acres with approximately 912 acres within the City limits of Black Diamond and the remainder in unincorporated King County. The area outside of the City limits is the northeast portion of the basin including Ginder Lake and the John Henry Mine.

Ginder Creek Basin is comprised of five sub-basins as listed in ***Table 3.04 Ginder Creek Basin***. GC-1 is the largest sub-basin and contains nearly all of the developed area within the Ginder Creek Basin. This sub-basin collects the downtown commercial and residential areas as well as the commercial corridor north of the downtown area along 3rd Avenue. GC-2 is a relatively small catchment collecting flows contributing to Mud Lake Creek immediately east of the 3rd Ave/Roberts Dr. intersection. Mud Lake Creek connects to Ginder Creek on the west side of 3rd Ave at this intersection. The GC-3 sub-basin collects flows contributing directly to Mud Lake. The GC-4 sub-basin is the area tributary to the John Henry Mine. A portion of sub-basins GC 2 through GC-4 lie outside of the Black Diamond Urban Growth Boundary. The GC-5 sub-basin lies entirely outside of the City and its Urban Growth Boundary. This sub-basin includes areas directly tributary to Ginder Lake.

Table 3.04 Ginder Creek Basin

Sub-Basin	Size (acres)
GC-1	806.9
GC-2	53.1
GC-3	169.8
GC-4	200.1
GC-5	148.2
TOTAL	**1,378**

The Ginder Creek Basin is characterized primarily by till soils; however, some outwash Everett series soils are present in the far southwest portion of the basin. The till soils are of several types including the following series: Alderwood, Beausite, Bellingham, Seattle

Muck, and Shalcar Muck. These till soils are located throughout the basin in both the developed and undeveloped areas.

Zoning within the Ginder Creek Basin includes most types of zoning included in the City's Comprehensive Plan. The only two zones not represented are Business Park/Light Industrial and the Master Planed Development zone. Although MPD zoning is not included, a large development known as Lawson Hills is planned for portions of the basin, the majority of which lies east of the downtown area.

The Ginder Creek Basin includes areas served by both piped conveyance systems and roadside ditches. The newer outlying developments, with curb and gutter street sections, pipe runoff to ponds serving those individual developments. The downtown area within this basin is collected in a piped conveyance system which directs flows to Ginder Creek, west of downtown.

RAVENSDALE BASIN (R)

The Ravensdale Basin is located almost entirely outside of the Black Diamond City Limits and Urban Growth Area. The receiving waters for this basin are Ravensdale Creek.

The Ravensdale Basin is comprised of three sub-basins as listed in ***Table 3.05 Ravensdale Basin***. The total basin area is approximately 2,365 acres. Two relatively small areas are located within the City limits. One is a portion of the area known as the North Triangle, west of 3rd Ave. The other is an area near the mouth of Ravensdale Creek. These two areas within the Ravensdale Creek basin are approximately 52.8 and 62.8 acres respectively.

Table 3.05 Ravensdale Basin

Sub-Basin	Size (acres)
R-1	1,965
R-2	264
R-3	136
TOTAL	**2,365**

The Ravensdale Basin is included in this plan due to its large area and runoff contribution to Lake Sawyer. Specific analysis for this basin was completed on a limited basis.

Soils in the Ravensdale Basin, per the NCRS, generally consist of a mix of both till and outwash soils. The soils within the city limits in the North Triangle are approximately 70% till soils and 30% outwash; the outwash soils lying near the western border of the triangle. The soils at the mouth of Ravensdale Creek within the city limits are primarily outwash soils. Per the NCRS, outwash soils described for this basin are of the Everett series while till soils are of the Alderwood series.

City zoning within the Ravensdale Basin is MPD within the North Triangle and R6 within an existing development off of 3rd Ave. Zoning at the basin area near the mouth of

Ravensdale Creek is R4 Residential and Public as a part of the Black Diamond Regional Park.

JONES LAKE BASIN (JL)

The Jones Lake Basin is comprised largely of undeveloped land. The receiving body of water for this basin is Jones Lake which serves as the headwaters for Rock Creek. The most heavily developed area within the basin is a portion of the downtown area south of Lawson Street. This area is a moderately dense single family neighborhood. The remaining development within the basin consists of single family homes, mostly on large parcels at very low densities. This portion of the basin also includes the City Shop.

The total acreage of the Jones Lake Basin is approximately 1,137 acres. Approximately 637 acres of the basin lie inside the City's Urban Growth Area and approximately 500 acres lie in unincorporated King County.

The Jones Lake Basin is comprised of three sub-basins as listed in ***Table 3.06 Jones Lake Basin***. JL-1 drains to an unnamed stream and wetland system west of Jones Lake. This sub-basin includes most of Old Lawson Road and its associated parcels. JL-2 contributes to an unnamed stream flowing north into Jones Lake. This stream follows 257th Ave SE and connects to Jones Lake from the south. JL-3 is the northern most sub-basin and drains Lawson Creek. Lawson Creek flows west from outside the Urban Growth Area into the City where it turns south, crosses under 3rd Ave and enters the north side of Jones Lake. JL-3 is where the most concentrated development currently exists within the Jones Lake Basin.

Table 3.06 Jones Lake Basin

Sub-Basin	Size (acres)
JL-1	523.7
JL-2	199.3
JL-3	414.0
TOTAL	**1,137**

Per NCRS the majority of the Jones Lake Basin has till soils, however a small area of outwash soils are shown to be present south of Old Lawson Rd. Outwash soils are of the Everett soil series per the NRCS and the till soils are of several types including the following series: Alderwood, Beausite, and Seattle Muck.

Zoning within the Jones Lake Basin is mainly Residential R4, R6, and Urban Reserve. Small areas of Public and Town Center zoning also exist within the basin. Although MPD zoning is not included, a large development known as Lawson Hills is planned for portions of the basin, the majority of which lies east of the downtown area.

Much of the Jones Lake Basin is yet undeveloped. The developed regions of the basin are mainly residential and are centrally located in the downtown area. These areas of the City are served by piped conveyance systems and roadside ditches that convey runoff to the

streams within the basin or directly to Jones Lake. Street sections where road runoff is piped are typically an asphalt raised edge section.

LAKE NO. 12 BASIN (LT)

The Lake No. 12 Basin is an area of both City Urban Growth Area and unincorporated King County tributary to Lake No. 12. It is located northeast of downtown Black Diamond and abuts the previously described Ginder Creek Basin. The dividing line between these basins is also shared by the King County WRIA (Water Resource Inventory Area) Basins 8 and 9. The Lake No. 12 Basin is not tributary to Lake Sawyer as is most of the City, but lies in King County WRIA 8 and is tributary to the Lower Cedar River which feeds Lake Washington in Seattle. It was analyzed on a limited basis and included in this plan due to its inclusion in the City UGA.

The total basin area is approximately 354 acres, 168 of which are inside the City UGA. The area inside the UGA is zoned Urban Reserve and is developed with single family homes mostly on lots abutting Lake No. 12.

The NCRS describes soils in the Lake No. 12 Basin as consisting of both till and outwash soils. Approximately 30% of the basin is outwash soils which are found on the north, west, and south sides of the lake where the majority of the homes within the basin are located. The remaining 70% of the basin is made up of till soils. The NCRS describes the outwash soils in this basin as Everett series soils and the till soils are Alderwood, Beausite, and Seattle Muck series.

LAKE MARJORIE BASIN (LM)

The Lake Marjorie Basin is located in the western boundary of the Black Diamond City Limits. The basin is located along the east side of Lake Sawyer Rd, south of SE 312th St and west of Rock Creek. The basin is a closed depression or “pothole” with no natural surface discharge.

The total basin area is approximately 106 acres and is entirely located within the City limits of Black Diamond. The zoning in the basin is Public (Lake Sawyer Regional Park), Residential R4, and Business Park/Light Industrial.

The NCRS describes soils in the Lake Marjorie Basin as outwash soils of the Everett soil series.

SOUTHERN BASIN (S)

The Southern Basin is located along the southern boundary of the City’s urban growth boundary. The basin is approximately 45 acres and is zoned urban reserve (1 unit per 5 acres).

The Southern basin as defined by this plan is tributary to a closed depression or “pothole” with no natural surface discharge.

NORTHWEST BASIN (NW)

The Northwest Basin is located along the western boundary of the City, west of the Lake Sawyer Basin. The Northwest Basin is not tributary to the Lake Sawyer system as most of the rest of the City is. The Northwest Basin is tributary to Covington Creek downstream of Lake Sawyer. Covington Creek is part of the Covington Basin within the Soos Creek Basin Plan for unincorporated King County. The boundaries for the Northwest Basin were defined by the City limits for purposes of this study.

The Northwest Basin consists of Type A & Type B soils which are supportive of infiltration. It is assumed that this basin is currently infiltrating and has minimal impact on the overall Covington Basin within unincorporated King County. Due to the small size of this basin in comparison to the entire Covington Basin, a limited analysis is included in this plan.

SOUTHWEST BASIN (SW)

The Southwest Basin is located along the western boundary of the City, west of the Rock Creek Basin. The Southwest Basin is part of the Middle Green River King County drainage basin within WRIA 9. The receiving water for this basin is the Green River. The boundary was defined by the City limits for purposes of this study. A limited analysis of this basin is included in this plan.

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4.0 HYDROLOGIC & HYDRAULIC ANALYSIS

4.1 EXISTING BASIN ANALYSES

Hydrologic and hydraulic analyses were conducted to analyze the drainage planning area Stormwater runoff potential and to evaluate the capacity of the city's existing drainage infrastructure to deliver runoff to receiving waters. This was completed using two different methods; a continuous model for large scale sub-basin runoff calculations, and a single-event model for specific closed conveyance analysis within the more developed areas of the City.

The large scale sub-basin analysis is the basis for the culvert hydraulic analysis and is also intended to serve as a base flow generation for future stream modeling projects. The single-event model was used to analyze the capacity of specific trunk drainage lines within the City system.

4.2 DRAINAGE SUB-BASIN HYDROLOGY & CULVERT HYDRAULICS

Sub-basin hydrologic modeling was used to evaluate stormwater runoff potential and to generate recurrence interval peak discharge estimates within the entire City planning area based on drainage sub-basin delineation and characterization. The highlights of the analysis approach, methods, and assumptions are included below along with a summary of the results. Modeling software data output of this assessment is contained in ***APPENDIX E – Drainage Sub-basin Hydrology and Culvert Hydraulics.***

MODELING APPROACH

The approach to hydrologic analysis for the drainage basins and sub-basin areas that are tributary to the City's culvert and stream systems was focused around conducting analysis using a continuous simulation analysis approach consistent with City and Department of Ecology requirements for development and redevelopment projects. The MGS Flood computer software modeling program was selected for use due to its ability to meet the requirements, efficiencies in evaluation of system improvement effects and benefits, and its relative simplicity in use. MGS Flood is a continuous rainfall-runoff computer model developed for stormwater facility design in Western Washington. The program meets the requirements of the 2005 Ecology SWMMWW.

MGS Flood uses computational algorithms to compute a continuous time series of runoff for the calculated basins and computes flood magnitude-frequency statistics. The program includes the ability to simulate runoff hydrographs from a number of sub-basins and perform routing through stream channels and stormwater ponds if so desired. The program contains extended precipitation time series developed for stormwater analysis in western Washington. The data has a time step of 15 minutes, is 158 years in length, and represents the rainfall characteristics of the City SWMP planning area. The extended precipitation time series allows for accurate calculation of the runoff potential from floods of interest for stormwater management planning. The extended length allows for

interpolation to compute 100-year recurrence interval flood flows rather than extrapolation, which is required with the use of shorter precipitation time series.

The MGS Flood model was used to compute runoff hydrographs and peak discharge magnitude frequency statistics for the sub-basin drainage areas within the drainage planning area. The MGS Flood program was ideal for this purpose because it is easy to use, provides accurate results, and allows for quick analysis of stormwater improvement options.

ASSUMPTIONS

Key assumptions for the hydrologic analysis used to develop planning level estimates of sub-basin recurrence interval flood flows are as follows:

- Existing land cover (impervious area) and pervious area soils conditions were used; future land use was not evaluated for hydrologic analysis of local drainage systems because new development and redevelopment requires mitigation of peak flow effects through adequately sized detention storage facilities meeting current City standards.
- Analyses did not include any detention storage systems. Many of these systems were built to lower design standards and their performance and net effect is diminished for larger events where overflows may occur. Also, many of these on-site detention systems are private with maintenance not directly provided under the City's O&M program.
- All impervious areas were assumed fully effective in generating stormwater runoff tributary to trunk drainage systems. Losses to runoff in pervious areas were based on use of regional parameters included within the MGS Flood model considering the hydrologic soils characteristics of those pervious areas.
- Peak flows for combined sub-basin flows at points of analysis within local drainage systems were additive without need for hydrologic routing analysis within those drainage systems.

RESULTS

The results of the MGS Flood hydrologic analysis conducted for the sub-basin drainage systems to generate peak flood flow estimates are reported in ***Table 4.01 Sub-Basin Hydrologic Analysis***. Peak recurrence interval flood flow estimates represent the predicted flood flows at sub-basin outfalls to their respective receiving waters as noted in the basin descriptions. Corresponding sub-basin tributary areas and existing impervious land cover percentages are also reported.

The following recommendations should be noted:

- Recommend further analysis with the down stream analysis for any new development
- Recommend model calibration for any proposed culvert improvement projects

The results of the hydraulic analysis of City culverts are shown in ***Table 4.02 Culvert Hydraulic Analysis***. Modeling software outputs are included in ***APPENDIX E – Drainage Sub-basin Hydrology and Culvert Hydraulics***.

Table 4.01 Sub-Basin Hydrologic Analysis

Sub-Basin	Area at Outfall (acres)	Impervious Area (%)	Simulated Runoff Peak Flows (Q) at Outfall (cfs)					
			Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
Lake Sawyer Basin								
LS-1	1351.0	25.4	43.4	64.8	80.5	102.2	119.7	138.4
Rock Creek Basin								
RC-1	685.2	2.8	19.8	29.1	36.6	47.9	58.0	69.5
RC-2	205.0	6.0	5.8	9.1	11.8	16.0	19.8	24.3
RC-3	122.3	1.5	4.5	6.7	8.5	11.1	13.3	15.9
RC-4	388.5	2.8	15.4	22.6	28.3	36.9	44.4	52.9
Ginder Creek Basin								
GC-1	806.9	8.1	47.7	68.7	86.1	113.4	138.1	167.3
GC-2	53.1	2.1	1.9	2.8	3.5	4.6	5.6	6.7
GC-3	169.8	2.8	6.5	9.6	12.1	15.8	19.0	22.7
GC-4	200.1	17.5	8.6	13.1	16.4	21.1	25.0	29.2
GC-5	148.2	11.4	6.8	10.3	13.0	17.0	20.5	24.5
Ravensdale Basin *(Ravensdale Sub-basins were not individually analyzed)*								
R-1, R-2, & R-3	2365.4	12.5	94.2	142.9	180.5	235.4	282.1	334.2
Jones Lake Basin								
JL-1	523.0	1.5	10.0	15.0	19.1	25.5	31.2	38.0
JL-2	190.4	1.9	7.4	11.0	13.9	18.3	22.1	26.4
JL-3	413.5	1.5	16.9	25.3	32.2	42.5	51.7	62.3
Lake No. 12 Basin								
LT-1	347.3	16.5	16.1	24.2	30.5	39.5	47.1	55.5
Lake Marjorie Basin								
LM-1	106.0	9.4	1.6	2.3	2.8	3.7	4.6	5.6

Table 4.02 Culvert Hydraulic Analysis

Pipe No.	Culvert Location	Material	Diam. (in.)	Length (ft)	Anticipated Flow – 100 yr event) (cfs)	Modeled Capacity (cfs)
373	Crossing 3rd Ave @ Old Lawson Rd	Concrete	36	108	62.3	70
434	Crossing Roberts Dr ~ 850' southwest of 3rd Ave	CMP	54	51	77.9	140
471	Crossing 5th Ave ~ 250' southeast of Lawson St	Concrete	36	36	62.3	120
528	Crossing 3rd Ave @ Black Diamond-Ravensdale Rd	Concrete	36	232	72.2	80

537	Crossing 224th Ave @ Outlet from Lake Sawyer	CMP	72	71	* Not Modeled	160
538	Crossing 224th Ave @ Outlet from Lake Sawyer	CMP	72	71	* Not Modeled	160
539	Crossing 224th Ave @ Outlet from Lake Sawyer	CMP	72	71	* Not Modeled	160
542	Ravensdale Creek Inlet to Lake Sawyer (City Park)	CMP	48	52	** Not Modeled	90
543	Ravensdale Creek Inlet to Lake Sawyer (City Park)	HDPE	48	52	69.5	90
544	Inlet to Lake Sawyer from Frog Lake (City Park)	CMP	48	55	69.5	70
545	Inlet to Lake Sawyer from Rock Creek (City Park)	CMP	48	50	69.5	70
546	Box culvert (bridge) crossing Roberts Dr ~ 250' west of Bruckners Way	Concrete	16' x 6'		69.5	280
556	Crossing Morgan St ~ 400' east of Abrams Ave	Concrete	54	50	117.4	160
584	Crossing Old Lawson Rd, east of 3rd Ave	CMP	36	67	62.3	70
586	Crossing 3rd Ave (Enumclaw-BD Rd) @ Jones Lake	Concrete	36	80	38.0	60
587	Crossing 3rd Ave (Enumclaw-BD Rd) @ Jones Lake	Concrete	36	80	38.0	60
588	Crossing 3rd Ave (Enumclaw-BD Rd) @ Jones Lake	Concrete	24	90	38.0	40
597	Crossing Black Diamond-Ravensdale Rd ~ 400' southwest of Kanasket Dr	CMP	4'x8' Pipe Arch	70	24.5	140

* Lake Sawyer outlet will require flow monitoring to predict flows to Covington Creek. Flow monitoring was not done as a part of this Comprehensive Plan.
** The majority of this basin producing these flows is outside the City limits and was not studied in detail for the Comprehensive Plan.

4.3 TRUNK DRAINAGE SYSTEM HYDROLOGIC & HYDRAULIC ANALYSIS

Small scale basin hydrologic modeling analysis was used to evaluate stormwater runoff directly relating to the City's limited trunk line drainage systems based on small drainage subareas delineation and characterization. This was done using the Santa Barbara Urban Hydrograph (SBUH) within the StormShed 2G modeling software. The highlights of the analysis approach, methods, and assumptions are included below along with a summary

of the results of that analysis. Modeling software data output of this assessment is contained in ***APPENDIX F – Trunk-line Drainage Hydrology and Hydraulics***.

MODELING APPROACH

The approach to hydrologic analysis to evaluate the areas that are tributary to the City's trunk-line piped conveyance systems was focused around conducting analysis using an instantaneous model (SBUH) for specific hydrologic modeling. The modeling done at the sub-basin level was found to be too large a scale to accurately route flows through most of the City's drainage system. Individual investigation areas were analyzed at each point of entrance into the trunk system.

The Santa Barbara Urban Hydrograph model and StormShed 2G software were selected for use due to their accuracy and efficiency in estimating stormwater runoff flows at relatively small intervals and cumulatively routing these flows through a conveyance system. With the routing of runoff, StormShed 2G also provides a backwater analysis of the modeled system providing an accurate accounting of the cumulative flows modeled in the system.

ASSUMPTIONS

Key assumptions from the hydrologic analysis used to develop planning level estimates of trunk drainage system recurrence interval flood flows are as follows:

- Existing land cover (impervious area) and pervious area soils conditions were used; future land use was not evaluated for hydrologic analysis of local drainage systems because new development and redevelopment requires mitigation of peak flow effects through adequately sized detention storage facilities meeting current City standards. However, the developed model will be useful in determining the effects of future development flows on the City system.
- Analyses were performed at a 10 minute simulation time-step to allow capture of appropriate peak flows considering the relatively small drainage sub-catchment areas being analyzed.
- Analyses did not include any detention storage systems. Many of these systems were built to lower design standards, and their performance and net effect is diminished for larger events where overflows may occur. Also, many of these on-site detention systems are private with maintenance not directly provided under the City's O&M program.
- All impervious areas are assumed fully effective in generating stormwater runoff tributary to trunk drainage systems; losses to runoff in pervious areas are based on use of CN values associated with the Santa Barbara Urban Hydrograph model considering the hydrologic soils characteristics of those pervious areas.

RESULTS

The results of the hydrologic and hydraulic analysis conducted for the trunk-line drainage systems are included in ***APPENDIX F – Trunk-line Drainage Hydrology and Hydraulics.***

This analysis was conducted at the catchment level of drainage area. Peak recurrence interval flood flow estimates reported here represent the predicted flood flows within the City's trunk line drainage systems and estimate outfalls to their respective receiving

waters. Corresponding tributary areas and existing impervious land cover percentages are also reported.

4.4 EXISTING SYSTEM DEFICIENCIES

The stormwater hydraulic modeling identified existing drainage problem areas throughout the system. Three areas were identified where stormwater conveyance is constricted by the existing piped storm drainage system and are included in ***Table 4.03 Deficiencies Identified by Hydraulic Modeling***.

Table 4.03 Deficiencies Identified by Hydraulic Modeling

Location	Description
5th Avenue (Baker St to Lawson St)	Modeling indicates overtopping of shallow roadside ditches with a 25 year storm event
Railroad Avenue (Baker St to Merino St)	Modeling indicates overtopping of storm drain system with a 10 year storm event
1st Avenue (Southeast of Baker St)	Modeling indicates catch basin overtopping with a 25 year storm event

Additional projects are included in the Capital Improvement Program in ***Chapter 6.0 Capital Improvement Plan***. These additional projects are located in areas where drainage and/or maintenance problems have been identified by the City.

4.5 SYSTEM RECOMMENDATIONS

Proposed capital improvement projects are discussed in ***Chapter 6.0 Capital Improvement Plan.*** Additional recommendations concerning the City's storm drainage system are listed below.

CULVERT PASSAGE

Culverts analyzed at the basin flow level appear to be adequate for stormwater conveyance as reflected in ***Table 4.02 Culvert Hydraulic Analysis*** and ***APPENDIX E – Drainage Sub-basin Hydrology and Culvert Hydraulics***. However, further analysis on the needs for fish passage, habitat accommodations, and/or structural integrity on these culverts is recommended.

FLOOD MONITORING

No flooding has been recorded by the City in the areas identified in ***Table 4.03 Deficiencies Identified by Hydraulic Modeling***. However, it is recommended that these areas be monitored and observed during heavy storms. If surcharging does occur at these locations, further analysis is recommended to develop proposed solutions.

STORMWATER QUALITY

A study was conducted by AC Kindig and Associates which recommends that all future stormwater mitigations released to the Lake Sawyer system (including Ginder Creek, Rock Creek, and all other tributaries) provide treatment for phosphorus. A copy of this study has been included in ***APPENDIX G – Water Quality Technical Report***. The phosphorous

problems for Lake Sawyer are attributed to the once-failed sewage treatment plant and not to existing runoff conditions.

Phosphorous levels as of the date of this study appear to be relatively normal and stable, but given the history of Lake Sawyer, the amount of phosphorous contributed to the system should be minimized as much as possible. In order to not worsen the problem, phosphorous control standards per DOE should be enforced for future development. This is especially true given the large amount of growth anticipated for Black Diamond in the near future.

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5.0 FUTURE STORM DRAINAGE SYSTEM

5.1 FUTURE DEVELOPMENT ANALYSIS

The City of Black Diamond is expected to experience substantial growth in the near future due to the large-scale developments that are anticipated to submit formal development applications once the development moratorium currently in place is lifted. There are two master planned developments, "Lawson Hills" and "The Villages at Black Diamond" that have undergone significant studies and analyses.

An analysis of future development potential in regards to stormwater has been analyzed on a sub-basin level. In addition, a review of the preliminary storm drainage proposals that have been prepared by the master planned developments have been reviewed and are included in ***APPENDIX H – "The Villages" Stormwater Management*** and ***APPENDIX I – "Lawson Hills" Stormwater Management***. A map which shows the location of the Master Planned Development stormwater zones in relations to the City's drainage basins has been included as ***Figure 5.1 Future Development Stormwater Mgmnt. Zones***.

LAKE SAWYER BASIN

The Lake Sawyer Basin consists of developed low residential density properties within the City of Black Diamond, along with the Lake Sawyer Regional Park property. The portion of the Lake Sawyer Basin that is located within the City of Maple Valley has also been developed as predominately low density residential with a small amount of commercial use. The portion of the Lake Sawyer Basin located in unincorporated King County is rural and partially undeveloped.

The Lake Sawyer Basin consists of infiltrative soils throughout most of the basin. Any future development located in areas of Type A or Type B soils are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage.

However, the soils within the undeveloped portion of King County are type C & D soils which are less conducive to infiltration. Prior to development occurring in these areas, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge. Lower density developments may be appropriate.

The large Master Planned Communities (The Villages and Lawson Hills) do not have any anticipated development within the Lake Sawyer Basin, however both MPDS's are contributory to the Lake Sawyer Basin.

ROCK CREEK BASIN

The Rock Creek Basin is comprised largely of undeveloped land and large areas of wetlands. The receiving body of water for this basin is Rock Creek which flows into Lake Sawyer at its southernmost point. The Morganville area within the City of Black Diamond is located in the Rock Creek Basin.

RC-1: The Rock Creek RC-1 sub-basin consists primarily of undeveloped lands, with the exception of the Morganville area. The zoning within the sub-basin consists of a variety of uses including, master planned development, residential, industrial, business park/light industrial and public lands.

The soils within the Rock Creek RC-1 sub-basin are a variety of soil types ranging from Type A & B soils which are appropriate for infiltration to Type C & D soils which are less conducive to infiltration.

Future development located in areas of Type A & B soils are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

A portion of the "Lawson Hills" Master Planned Development is located within the Rock Creek RC-1 sub-basin. The area in the Rock Creek RC-1 sub-basin is the western half of the area known as the Lawson Hills North Triangle Basin. The preliminary storm drainage proposal for the North Triangle Basin indicates that "in the developed condition, stormwater runoff from the North Triangle development will be infiltrated in the lower portion of the site along with runoff from offsite that currently infiltrates on the lower portion of the North Triangle."

It is recommended that a detailed soils analysis be required of the developer to confirm on-site soil characteristics. Based on the NCRS soil maps, it is not anticipated that infiltration will be appropriate for this area. Additionally, an infiltration pond has been proposed by the developer in the southwest corner of the "North Triangle Basin". The "North Triangle Basin" is located within both the Ravensdale R-3 sub-basin, as well as the Rock Creek RC-1 sub-basin. The development proposal indicates that water within Ravensdale R-3 sub-basin will be directed to the infiltration pond located in the Rock Creek RC-1 sub-basin. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

The Villages Stormwater Management Zone 1B is also partially located within the Rock Creek RC-1 sub-basin. The preliminary storm drainage proposal for Zone 1B indicates that "clean" stormwater will be used to recharge wetlands or infiltrated to the shallow aquifer. Stormwater from pollution generating surfaces will be treated and infiltrated. Based on a review of NCRS soil maps, it appears that infiltration would be appropriate for the area of overlap of Zone 1B along the western boundary of the Rock Creek RC-1 sub-

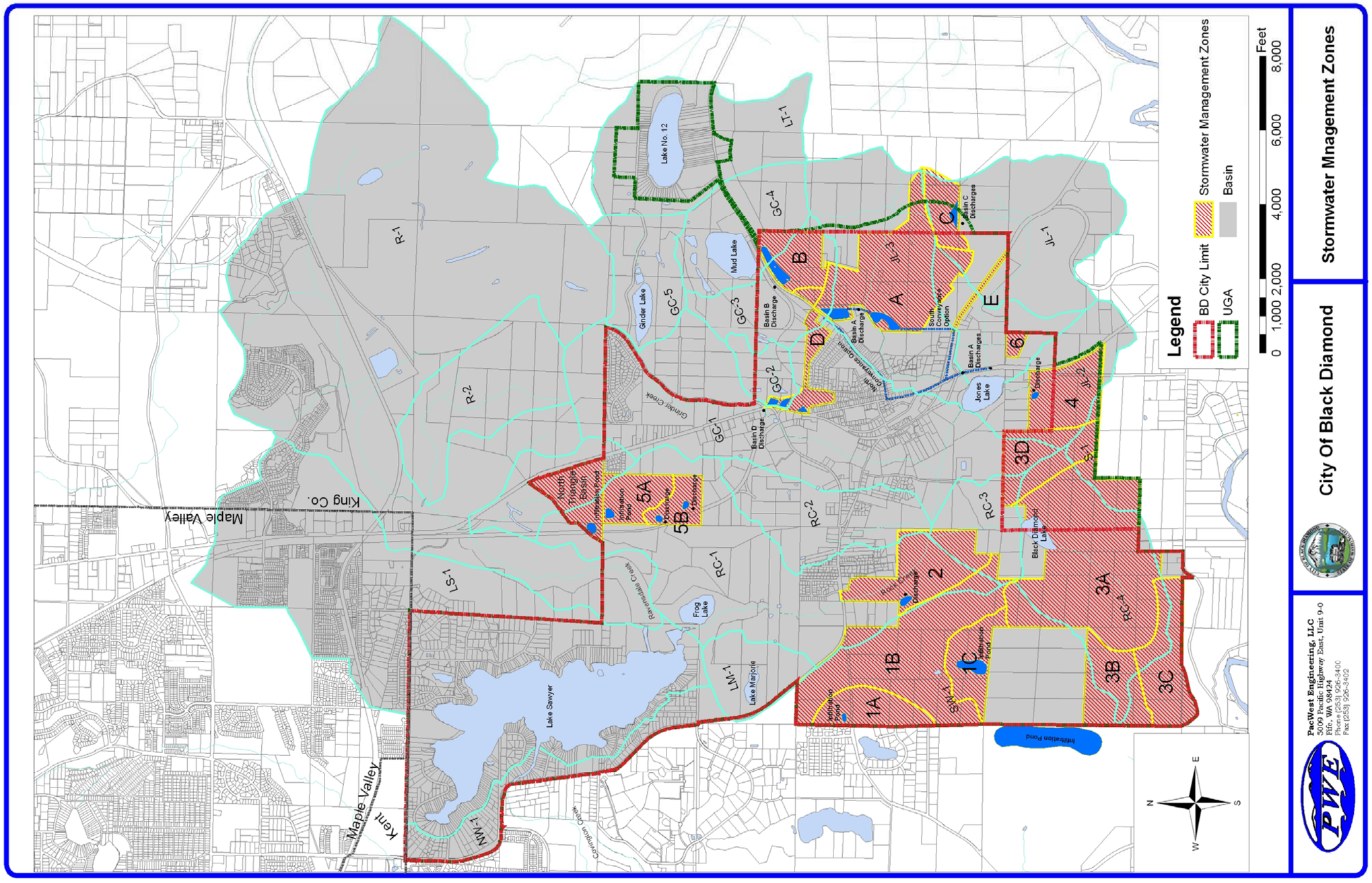

Figure 5.1 Future Development Stormwater Mgmnt. Zones

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basin, however not for the southern-most portion of the Rock Creek RC-1 sub-basin. Furthermore, Zone 1B is partially located within Rock Creek RC-1 sub-basin, and primarily located within the Southwest Basin. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

The Villages Stormwater Management Zone 2 is located in the southern tip of the Rock Creek RC-1 sub-basin. The preliminary storm drainage proposal for Zone 2 indicates that "a detention/water quality pond will be used to manage stormwater for this zone.". Based on the NCRS soil maps and the required phosphorous treatment, it appears that the proposed storm drainage proposal would appropriately handle the stormwater needs for this zone.

The Stormwater Management Zones 5A and 5B are located in the northern portion of the Rock Creek RC-1 sub-basin. The preliminary storm drainage proposal for Stormwater Management Zone 5 indicates that "stormwater runoff from the northern portion of Stormwater management Zone 5 drains to the north and northwest overland and through a series of wetlands and a stream to the outwash soils in the northwest corner where it infiltrates. The infiltrated stormwater flows towards Ravensdale Creek".

It is recommended that a detailed soils analysis be completed by the developer to confirm on-site soil characteristics. Based on the NCRS soil maps, it is not anticipated that infiltration will be appropriate for this area. The boundaries of Stormwater Management Zone 5 fall within both the Rock Creek RC-1 sub-basin, as well as a small portion is located within the Ravensdale R-3 sub-basin. Stormwater should be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

RC-2: The Rock Creek RC-2 sub-basin consists of some developed properties in the Morganville area, but primarily consists of undeveloped lands. These lands are zoned for residential use, master planned development, neighborhood commercial, industrial, and business park/light industrial.

The soils within the Rock Creek RC-2 sub-basin are Type A/B soils through the central part of the sub-basin, while the soils located in the northern-most portion and southern-most portions of the sub-basin are Type C & D soils. Type A/B soils are appropriate for infiltration. Any future development located in these areas are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage.

Any future development located in the areas of Type C & D soils are recommended to conduct a detailed soils analysis. Based on the lesser infiltration capacities of these soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

There is a small portion of The Villages Stormwater Management Zone 2 that falls within the Rock Creek RC-2 sub-basin. The preliminary storm drainage proposal for this zone indicates that "a detention/water quality pond will be used to manage stormwater for this zone". Based on the NCRS soil maps and the required phosphorous treatment, it appears

that the proposed storm drainage proposal would appropriately handle the stormwater needs for this zone.

RC-3: The Rock Creek RC-3 sub-basin consists primarily of undeveloped lands. It is zoned residential (4 units per acre) and Master Planned development. The soils within the Rock Creek RC-3 sub-basin are a variety of soil types ranging from Type A/B soils which are appropriate for infiltration to Type C & D soils which are less conducive to infiltration.

Future development located in areas of Type A & B soils are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

Small portions of The Villages Stormwater Management Zones 1B, 2, and 3D all fall within the Rock Creek RC-3 sub-basin. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

RC-4: The Rock Creek RC-4 sub-basin consists of undeveloped lands. Black Diamond Lake is also located within its boundaries. Just to the east of Black Diamond Lake is a concentration of Type A/B soils. The remainder of the sub-basin's soils are Type C & Type D.

Future development located in areas of Type A & B soils are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

Rock Creek RC-4 sub-basin contains portions of The Villages Stormwater Management Zones 3A, 3B, 3C and 3D. The preliminary storm drainage proposal for The Villages Stormwater Management Zone 3 indicates that rooftop runoff will be used to recharge Black Diamond Lake. Wetlands will be recharged, as well as infiltration through the use of a regional water quality and infiltration facility.

It is recommended that a detailed soils analysis be completed by the developer to confirm on-site soil characteristics. Based on the NCRS soil maps, it is not anticipated that infiltration will be appropriate for this area. Furthermore, the Stormwater Management Zones overlap basin boundaries and the regional infiltration pond is located outside of the Rock Creek Basin boundaries. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

GINDER CREEK BASIN

The Ginder Creek Basin is the tributary area for the majority of downtown Black Diamond. This includes most of the existing commercial lands for the City as well as much of the residential areas.

GC-1: The Ginder Creek GC-1 sub-basin consists primarily of developed properties. The soils within the Ginder Creek GC-1 sub-basin are Type C & D soils which are less conducive to infiltration. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

The Ginder Creek GC-1 sub-basin contains a portion of The Villages Stormwater Management Zone 3D. This stormwater management zone also extends into the Rock Creek Basin, the Jones Lake Basin, and the Southern Basin. The preliminary storm drainage proposal for the Villages indicates that runoff will be used to maintain pre-developed conditions for Black Diamond Lake and nearby wetlands. Excess water will be routed to the regional pond located west of the Southwest Basin. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

The Ginder Creek GC-1 sub-basin also contains a portion of the Lawson Hills Stormwater Basin D. The preliminary storm drainage proposal for Basin D indicates that “in the developed condition, stormwater runoff will be routed to detention and water quality facilities.” Based on the soils in this area per NCRS this appears to be an acceptable method of handling stormwater runoff.

GC-2: The Ginder Creek GC-2 sub-basin consists of undeveloped properties. The land is zoned for medium-density residential use (4 to 8 units per acre) in the area within City limits and as mineral lands for the area within unincorporated King County.

The soils within the Ginder Creek GC-2 sub-basin are Type C & D soils which are less conducive to infiltration. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

The Ginder Creek GC-1 sub-basin contains a small portion of the Lawson Hills Stormwater Basin D. The preliminary storm drainage proposal for Basin D indicates that “in the developed condition, stormwater runoff will be routed to detention and water quality facilities.” The aforementioned ponds are located within the Ginder Creek GC-2 sub-basin. Based on the soils in this area per NCRS, this appears to be an acceptable method of handling stormwater runoff.

GC-3: The Ginder Creek GC-3 sub-basin consists primarily of undeveloped lands which are zoned for residential (4 units per acre) within the City limits and as mineral lands within unincorporated King County.

The soils within the Ginder Creek GC-3 sub-basin are Type C & D soils which are less conducive to infiltration. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

The Lawson Hills Stormwater Basin B is primarily located within the Ginder Creek GC-3 sub-basin. A small portion of Basin D is also located in the southern portion of the GInder Creek GC-3 sub-basin. Additionally, Lawson Hills Basin A has a small region located along the southern border of the GC-3 sub-basin. Basin A is primarily located within the Jones Lake Basin. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

According to the preliminary storm drainage proposal for Lawson Hills, "in the developed condition, stormwater runoff from Basin B will be routed to a detention pond combined with a large wetpond to provide phosphorous removal and water quality treatment. A portion of Basin B may be too low in elevation to drain to this pond and will be routed to the Basin D stormwater facilities. Basin B & D are both located with the Ginder Creek basin.

GC-4: The Ginder Creek GC-4 sub-basin consists of undeveloped lands which are zoned for residential (4 units per acre) within the City limits and as mineral lands with unincorporated King County.

The soils within the Ginder Creek GC-4 sub-basin are Type C & D soils which are less conducive to infiltration. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

A portion of Lawson Hills Stormwater Basin D is located in the Ginder Creek GC-4 sub-basin. The preliminary storm drainage proposal for Basin D indicates that "in the developed condition, stormwater runoff will be routed to detention and water quality facilities." The aforementioned ponds are located within the Ginder Creek GC-2 sub-basin. Based on the soils in this area per NCRS, this appears to be an acceptable method of handling stormwater runoff.

GC-5: The Ginder Creek GC-5 sub-basin consists of undeveloped lands within unincorporated King County that are zoned as mineral lands. Ginder Lake is also located within the Ginder Creek GC-5 sub-basin.

The soils within the Ginder Creek GC-5 sub-basin are Type C & D soils which are less conducive to infiltration. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

The large Master Planned Communities (The Villages and Lawson Hills) do not have any anticipated development within the Ginder Creek GC-5 sub-basin.

RAVENSDALE BASIN

The Ravensdale Basin is almost entirely outside of the Black Diamond City Limits and Urban Growth Area. This basin is mostly undeveloped lands that are tributary to Ravensdale Creek and eventually Lake Sawyer. The lands are zoned for low-density residential (1 unit per 10 acres), forest land, and mining land.

R-1: The Ravensdale R-1 sub-basin consists primarily of undeveloped properties. The land is zoned for low-density residential (1 unit per 10 acres), as well as forest lands and mining lands. The soils within the Ravensdale R-1 are a variety of soil types ranging from Type A & B soils which are appropriate for infiltration to Type C & D soils which are less conducive to infiltration.

Future development located in areas of Type A & B soils are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage. For future development located in areas of Type C & D soils, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

The large Master Planned Communities (The Villages and Lawson Hills) do not have any anticipated development within the Ravensdale R-1 sub-basin.

R-2: The Ravensdale R-2 sub-basin consists of undeveloped properties. The land is zoned for low-density residential (1 unit per 10 acres). The soils within the Ravensdale R-2 sub-basin are Type C & D soils in the southern portion of the basin which are less conducive to infiltration. It is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge. The soils within the northern portion of the Ravensdale R-2 sub-basin are Type A & B soils which are appropriate for infiltration. Any future development in the northern portion of the sub-basin are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage.

The large Master Planned Communities (The Villages and Lawson Hills) do not have any anticipated development within the Ravensdale R-2 sub-basin.

R-3: The Ravensdale R-3 sub-basin consists primarily of undeveloped properties with the exception of one small residential subdivision in the southern portion of the sub-basin. The undeveloped portions of the sub-basin within the City limits are zoned for master planned development, while the undeveloped portions of the sub-basin within unincorporated King County are zoned for low-density residential use (1 unit per 10 acres).

The soils within the portion of the Ravensdale R-3 sub-basin that are located in unincorporated King County are Type A & B soils which are appropriate for infiltration. Any

future development in the unincorporated King County portion of the sub-basin are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage.

The soils within the portion of the Ravensdale R-3 sub-basin located within City limits are Type C soils which are less conducive to infiltration. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline points of proposed discharge.

A portion of the "Lawson Hills" Master Planned Development is located within the Ravensdale R-3 sub-basin in the portion located within the City limits. The area included in the Ravensdale R-3 sub-basin is the eastern half of the area known as the Lawson Hills North Triangle Basin. The preliminary storm drainage proposal for the North Triangle Basin indicates that "in the developed condition, stormwater runoff from the North Triangle development will be infiltrated in the lower portion of the site along with runoff from offsite that currently infiltrates on the lower portion of the North Triangle."

It is recommended that a detailed soils analysis be required of the developer to confirm on-site soil characteristics. Based on the NCRS soil maps, it is not anticipated that infiltration will be appropriate for this area. Additionally, an infiltration pond has been proposed by the developer in the southwest corner of the "North Triangle Basin". The "North Triangle Basin" is located within both the Ravensdale R-3 sub-basin, as well as the Rock Creek RC-1 sub-basin. The development proposal indicates that water within Ravensdale R-3 sub-basin will be directed to the infiltration pond located in the Rock Creek RC-1 sub-basin. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

Additionally, a small corner of The Villages Stormwater Management Zone 5A is located within Ravensdale R-3 sub-basin. Again, it is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

JONES LAKE BASIN

The Jones Lake Basin is located within the City limits, the Urban Growth area, and unincorporated King County. Portions of the Jones Lake Basin are developed areas east of downtown Black Diamond. The majority of the Basin consists of undeveloped lands.

JL-1: The Jones Lake JL-1 sub-basin consists primarily of undeveloped lands. The lands within the City of Black Diamond are zoned for residential (4 units per acre) with a small portion of Urban Reserve. The lands within unicorporated King County are zoned RA-5 (rural area, one dwelling unit per 5 acres), UR (urban reserve, one dwelling unit per 5 acres), and Forest lands.

The soils within the Jones Lake JL-1 sub-basin are a combination of soils types. The areas of Type C & D soils are less appropriate for infiltration. Prior to development occurring in these areas, it is recommended that a detailed soils analysis be conducted.

Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge. Lower density developments may be appropriate.

The areas containing Type A & B soils are more appropriate for infiltration. Any future developments in these portions of the sub-basin are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage.

The Villages Master Planned Development includes Stormwater Management Zone 6. The preliminary storm drainage development proposal indicates that "Stormwater Management Zone 6 will remain the same in both the existing and developed conditions". This statement indicates that no construction or modification of the land and/or its natural drainage patterns will occur in this area.

The Lawson Hills Master Planned Development includes Stormwater Management Zones E, C, and a small portion of A which are located within the Jones Lake JL-1 sub-basin.

The Lawson Hills Master Planned Development includes Stormwater Basin E. The preliminary storm drainage development proposal indicates that "Stormwater Basin E consists of a strip of the railroad grade south of the main Lawson Hills project site. Basin E will be left unchanged in the developed condition." This statement indicates that no construction or modification of the land and/or its natural drainage patterns will occur in this area.

Basin C is located in a region of the Jones Lake JL-1 sub-basin where the soils are less conducive to infiltration. The preliminary storm drainage proposal for the Lawson Hills development indicates that "in the predeveloped condition, all drainage from Basin C flows to the unnamed creek to the south of the project site and ultimately to Jones Lake". The eastern portion of Basin C will be routed to a detention pond within Basin C. The development indicates that stormwater from the west and central sub-basins of Basin C will be routed to the stormwater facilities in Basin A. A portion of this water directed to Basin A will then be conveyed directly to Jones Lake in a pipeline. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

JL-2: The Jones Lake JL-2 sub-basin consists of undeveloped lands that are zoned for residential development (1 unit per 4 acres within the City limits and 1 unit per 5 acres within unincorporated King County). The soils within this sub-basin are primarily Type C & D soils which are less appropriate for infiltration. Prior to development occurring in these areas, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge. Moderate slopes, fine soils, and some clay content present high erosion and sediment transport risks. Lower density developments may be appropriate.

There is an area in the southern portion of the Jones Lake JL-2 sub-basin which includes Type A & B soils. These soils are more conducive to infiltration and any future

developments in these portions of the sub-basin are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage.

The Villages Master Planned Development includes Stormwater Management Zone 4 which is primarily located within the Jones Lake JL-2 sub-basin . Additionally, the eastern portion of Stormwater Management Zone 3D extends into the Jones Lake JL-2 sub-basin. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

The preliminary storm drainage proposal for Stormwater Management Zone 4 indicates that all stormwater in this zone will be conveyed to a detention/water quality pond. Given the soils types, it appears that this is an appropriate method for handling the storm drainage in this area.

The preliminary storm drainage proposal for Stormwater management Zone 3D indicates that stormwater will be directed as necessary to maintain predevelopment conditions for Black Diamond Lake, as well as wetland recharge. Additional stormwater flows will be conveyed to the regional stormwater pond located west of the City limits. Again, it is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

JL-3: The Jones Lake JL-3 sub-basin includes developed properties located south of Lawson Road. It also includes undeveloped properties that are zoned for residential use (1 unit per 4 acres) within the city limits and zoned urban reserve (1 unit per 5 acres) and forest lands within unincorporated King County.

The soils within the Jones Lake JL-3 sub-basin are Type C & D soils which are less appropriate for infiltration. Prior to development occurring in these areas, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge. Lower density developments may be appropriate.

The Lawson Hills Master Planned Development includes Stormwater Management Zone A which is primarily located within the Jones Lake JL-3 sub-basin, although it extends into the Jones Lake JL-1 sub-basin as well as the Ginder Creek GC-3 sub-basin. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

According to the preliminary stormwater management plan for Lawson Hills, two detention ponds will be utilized for stormwater management for Stormwater Basin A. Additionally, “to minimize the erosion impact from the Lawson Hills project, one of the Basin A ponds (approximately half of the stormwater) will be conveyed directly to Jones Lake in a pipeline, bypassing Lawson Creek. The other pond will discharge to Lawson Creek to maintain flows.” The developer will need to provide additional information including detailed storm drainage calculations for it to be determined whether this proposal is in accordance with City standards.

LAKE NO. 12 BASIN

The Lake No. 12 Basin is located within the City's Urban Growth Area and unincorporated King County. The lots surrounding Lake No. 12 have been developed with single family homes. There is a small portion of the basin within unincorporated King County that have been zoned for low-density residential uses (1 unit per 5 acres). The remaining undeveloped portion of the basin is zoned as forest land.

The soils surrounding Lake No. 12 in the areas already developed are a combination of soils types, primarily those which are appropriate for infiltration. The undeveloped lands within this basin are Type C & Type D soils which are less appropriate for infiltration. Prior to development occurring in these areas, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge. Lower density developments may be appropriate.

The large Master Planned Communities (The Villages and Lawson Hills) do not have any anticipated development within the Lake No. 12 Basin.

LAKE MARJORIE BASIN

The Lake Marjorie Basin is a closed depression or "pothole" with no natural surface discharge. The basin consists of Lake Sawyer Regional Park, along with residential land and land zoned as business park/light industrial.

The soils within Lake Marjorie Basin are Type A & B soils which are conducive to infiltration. It is recommended that any future development provide stormwater quality treatment and infiltration. The use of Low Impact Development or traditional infiltration techniques would be appropriate and are encouraged.

The large Master Planned Communities (The Villages and Lawson Hills) do not have any anticipated development within the Lake Marjorie Basin.

SOUTHERN BASIN

The Southern Basin is located along the southern boundary of the City's urban growth boundary. It consists of undeveloped properties and is currently zoned urban reserve (1 unit per 5 acres). The Southern Basin is tributary to a "pothole".

The soils within the Southern Basin are Type C soils which are less conducive for infiltration. Prior to development occurring in these areas, it is recommended that a detailed soils analysis be conducted. Based on the lesser infiltration capacities of the soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge. Lower density developments may be appropriate.

The Southern Basin consists of properties located within the Villages Stormwater Management Zones 3A, 3D, and 4. This is a very small basin and the majority of these zones are located in other basins. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

NORTHWEST BASIN

The Northwest Basin is located along the western boundary of the City, west of the Lake Sawyer Basin. This basin is not tributary to Lake Sawyer, but rather flows to the west to Covington Creek and the Soos Creek Basin within unincorporated King County. The Northwest Basin is almost fully developed within the City of Black Diamond.

The soils within the Northwest Basin are Type A & B soils which are conducive to infiltration. It is recommended that any future development would provide stormwater quality treatment and infiltration. The use of Low Impact Development or traditional infiltration techniques would be appropriate and are encouraged.

The large Master Planned Communities (The Villages and Lawson Hills) do not have any anticipated development within the Northwest Basin.

SOUTHWEST BASIN

The Southwest Basin is located along the western boundary of the City, west of the Rock Creek Basin. It consists of undeveloped properties and is currently zoned for Master Planned Development. The Southwest Basin is part of the Middle Green River King County drainage basin within WRIA 9. The receiving water for this basin is the Green River.

The soils within the Southwest Basin are Type A/B soils through most of the basin, however the soils located in the mid and southern portions of the basin are Type C & D soils. Type A/B soils are appropriate for infiltration. Any future development located in these areas are recommended to utilize low impact development or traditional infiltration techniques to accommodate storm drainage.

Any future development located in the areas of Type C & D soils are recommended to conduct a detailed soils analysis. Based on the lesser infiltration capacities of these soils, it is recommended that any development proposals within this area develop a detailed storm drainage plan and outline proposed points of discharge.

The Villages Master Planned Development includes Stormwater Management Zones 1A, 1B, 1C, 3A, 3B, & 3C that are completely or partially located within the Southwest Basin. It is important to note that it is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

Additionally, a proposed regional infiltration pond is located west of the Southwest Basin outside of the Black Diamond city limits. The location of this pond leads to questions in

who would be responsible for ownership and maintenance. The preliminary storm drainage plan proposed by the developer indicates that all stormwater facilities are proposed to be owned and maintained by the City of Black Diamond. However, the proposed location of the pond is not within the City's current city limits.

The preliminary stormwater proposal for Stormwater Management Zone 3 indicates that stormwater will be used to match predevelopment levels of Black Diamond Lake and wetlands. Excess stormwater flows will be directed to the regional water quality and infiltration pond located west of the Southwest Basin. Stormwater Management Zone 3 is primarily located within the Rock Creek Basin which is tributary to Black Diamond Lake which flows to Lake Sawyer via Rock Creek. The regional infiltration pond is proposed to be located in a separate drainage basin that is tributary to the Green River. It is normally advisable for stormwater to be managed within its own basin and not travel to a neighboring basin for quantity and/or quality control.

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6.0 CAPITAL IMPROVEMENT PLAN

6.1 PROJECT IDENTIFICATION

The City's Storm and Surface water capital improvement program consists of a series of projects that were identified by: 1) system deficiencies identified by hydraulic modeling; 2) system deficiencies and/or maintenance concerns identified by City staff; and 3) future development projects as identified by representatives of the anticipated development.

Project costs have been developed based on the assumption that storm drainage improvements are the only improvements being completed. Therefore, the entire cost for various items such as roadway restoration, traffic control, mobilization, etc would be funded by the stormwater utility. In some cases, the stormwater improvements may be completed in conjunction with other roadway or utility projects which may result in cost sharing.

6.2 SUMMARY OF RECOMMENDED PROJECTS

A map illustrating the recommended capital improvement projects has been included as ***Figure 6.1 Capital Improvement Projects***. A large scale copy of the map has also been included as ***APPENDIX J – CIP Map***.

Table 6.01 Capital Improvement Projects

Project ID	Project Name	Project Type	Sub-Basin	Est. Cost
1	224th St Covington Creek Culvert Replacement	Culvert Replacement	NW-1	$300,000
2	Roberts Drive – Ginder Creek Culvert Replacement	Culvert Replacement	GC-1	$85,000
3	Lake Sawyer Park Culvert Replacements	Culvert Replacement	LS-1	$75,000
4	3rd Ave (SR-169) – Ginder Creek Culvert Replacement	Culvert Replacement	GC-1	$125,000
5	3rd Ave (SR-169) – Mud Lake Culvert Replacement	Culvert Replacement	GC-1	$145,000
6	3rd Ave (SR-169) Culvert Replacement at Old Lawson Road	Culvert Replacement	JL-4	$75,000
7	Ginder Creek Culvert Replacement at Morgan Street	Culvert Replacement	GC-1	$75,000

8	Rock creek Wetlands Study	Study	GC-1, RC-1	$100,000
9	North Downtown / Ginder Creek Stormwater Facility	Treatment / Detention	GC-1	$300,000
10	South Downtown / Jones Lake Stormwater Facility Study	Study	JL	$50,000
11	5th Ave Storm Drain Improvements	Conveyance	GC-1	$28,000
12	Railroad Ave Storm Drainage Improvements	Conveyance	GC-1	$100,000
13	1st Ave Storm Drainage Improvements	Conveyance	GC-1	$60,000
14	Lawson Hills Pond A North	Developer	JL-4	TBD (Developer Funded)
15	Lawson Hills Pond A South	Developer	JL-4	TBD (Developer Funded)
16	Lawson Hills Pond B	Developer	GC-4	TBD (Developer Funded)
17	Lawson Hills Pond C	Developer	JL-4	TBD (Developer Funded)
18	Lawson Hills North Triangle Pond	Developer	R-3 / RC-1	TBD (Developer Funded)
19	Lawson Hills Basin D Drainage Facilities	Developer	GC-1	TBD (Developer Funded)
20	The Villages Zone 1 Pond	Developer	SW-1	TBD (Developer Funded)
21	The Villages Zone 2 Pond	Developer	RC-1	TBD (Developer Funded)
22	The Villages Regional Pond	Developer		TBD (Developer Funded)
23	The Villages Zone 2 Pond	Developer	JL – 2	TBD (Developer Funded)
24	The Villages Zone 5 Drainage Facilities	Developer	RC-1	TBD (Developer Funded)
25	Pipeline Road Regional Facility	Developer	RC-1	TBD (Developer Funded)
26	Storm Pond Maintenance	Maintenance	Various	$5,000
27	Public Works Shop Upgrades	Maintenance	GC-1	$25,000

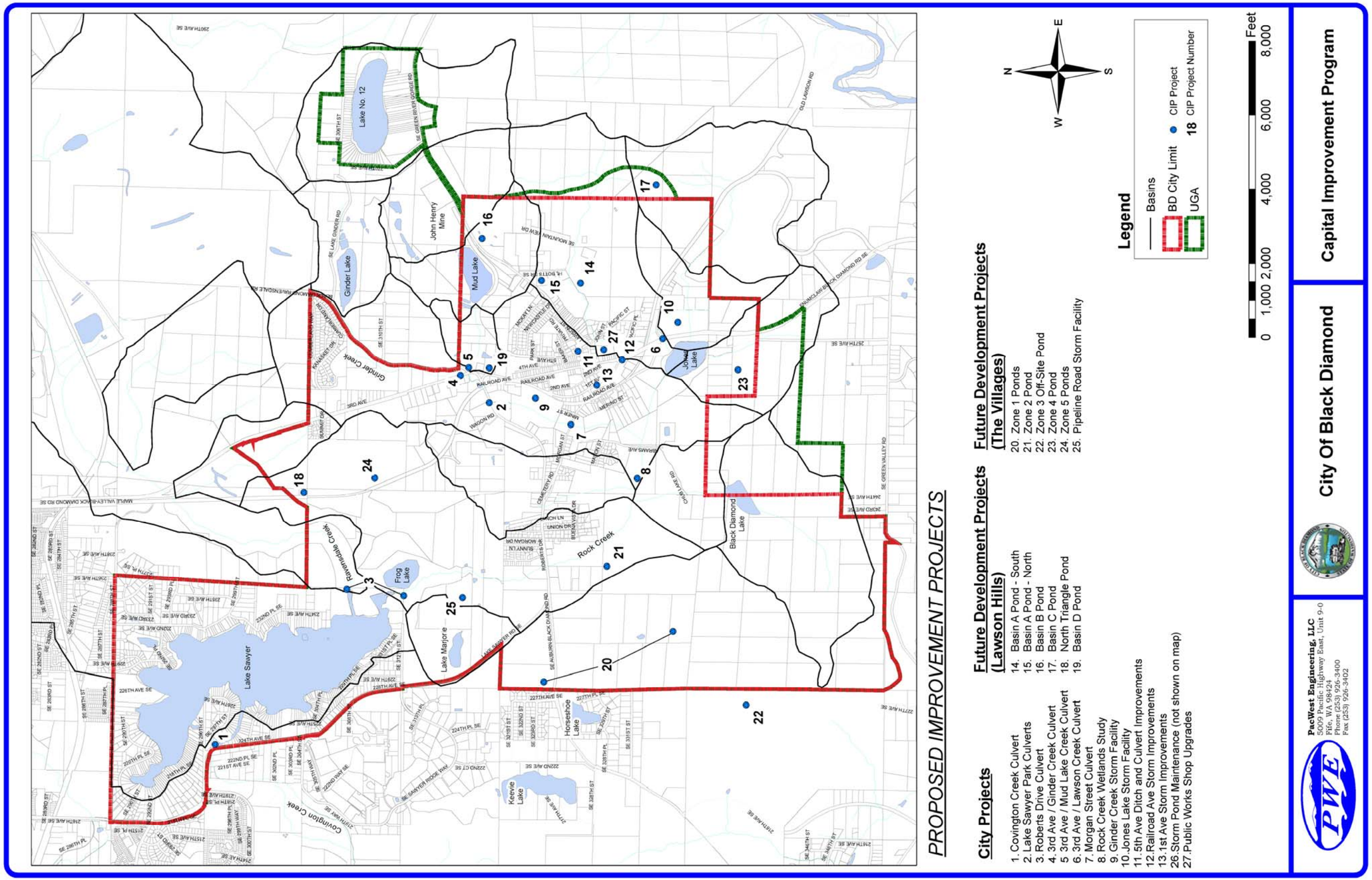

Figure 6.1 Capital Improvement Projects

PacWest Engineering LLC

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6.3 DETAILED PROJECT DESCRIPTIONS

Each of the identified projects is further detailed below. Detailed breakdowns of estimated project costs have been included in ***APPENDIX K – Project Cost Estimates***.

Table 6.02 224th St Covington Ck Culvert Replacements

PROJECT ID #1

224TH STREET COVINGTON CREEK CULVERT REPLACEMENTS

Description:	This project includes the removal and replacement of three 72-inch culverts under 224th Street SE at the outlet of Lake Sawyer into Covington Creek and associated roadway restoration. Each of the three existing culverts is approximately 75-feet long and constructed of corrugated metal pipe. The project could replace the culverts either individually or with a single conveyance mechanism. Wildlife and fish passage for Covington Creek and Lake Sawyer will be considered in the design of this project.
Location:	224th Ave SE, south of SE 297th St
Sub-Basin:	NW-1
Receiving Water:	Covington Creek
Priority:	Medium
Estimated Cost:	$300,000

Table 6.03 Roberts Dr – Ginder Ck Culvert Replacement

PROJECT ID #2

ROBERTS DRIVE – GINDER CREEK CULVERT REPLACEMENT

Description:	This project includes the removal and replacement of a 54-inch culvert under Roberts Drive and associated roadway restoration. This culvert conveys Ginder Creek north to south under Roberts Drive and is located approximately 800-feet southwest of the intersection of 3rd Ave (SR-169) and Roberts Drive. The existing culvert is constructed of corrugated metal and is approximately 60-feet in length. Wildlife and fish passage for Ginder Creek will be considered in the design of this project.
Location:	Roberts Dr. ~ 800' west of 3rd Ave
Sub-Basin:	GL-1
Receiving Water:	Ginder Creek / Jones Lake
Priority:	Medium
Estimated Cost:	$85,000

Table 6.04 Lake Sawyer Park Culvert Replacement

PROJECT ID #3

LAKE SAWYER PARK CULVERT REPLACEMENTS

Description: There are four existing culverts conveying Rock Creek and Ravensdale Creek into Lake Sawyer at the Lake Sawyer Regional Park. All four culverts are programmed to be replaced as a part of the maintenance projects for the CIP. The southern most culvert is a 48-inch corrugated metal pipe approximately 50 feet in length that conveys flows from Rock Creek and the associated Frog Lake wetland system into Lake Sawyer at the southern tip of the lake. The second culvert also conveys Rock Creek flows from Frog Lake into Lake Sawyer and is located approximately 350-feet north of the tip of lake. This culvert is also constructed of corrugated metal and is 48-inches in diameter. Both of these culverts cross under the walking trail/maintenance access road for the park.

Approximately 1000-feet north of the Rock Creek culverts lay a pair of 48" culverts conveying flows from Ravensdale Creek into Lake Sawyer. These culverts are side by side, one corrugated metal and the other high-density polyethylene. Both culverts are approximately 55 feet in length.

The replacements for all of these culverts will include restoration of the walking trail / maintenance road and considerations for fish and wildlife. This project has a low priority, but will need to be considered sometime in the future.

Location: Lake Sawyer Park

Sub-Basin: LS-1

Receiving Water: Lake Sawyer

Priority: Low

Estimated Cost: $75,000

Table 6.05 3rd Ave – Ginder Ck Culvert Replacement

PROJECT ID #4

3RD AVE (SR-169) – GINDER CREEK CULVERT REPLACEMENT

Description:	This project includes removal, replacement and associated roadway restoration of the existing 36-inch culvert crossing under 3rd Ave (SR-169) at the intersection of Black Diamond-Ravensdale Road and 3rd Ave. This culvert system includes a 36-inch concrete culvert connecting to an existing concrete box culvert buried under 3rd Ave (SR-169). Connected to the box culvert is an additional stretch of 36-inch concrete culvert pipe which discharges upstream of the pond north of Roberts Drive. The total length of this culvert system is approximately 250-feet. This system conveys Ginder Creek flows across 3rd Ave. Wildlife and fish passage for Ginder Creek will be considered in the design of this project. This project may be a City and/or State funded project.
Location:	Intersection of Black Diamond / Ravensdale Road and 3rd Ave (SR-169)
Sub-Basin:	GL-1
Receiving Water:	Ginder Creek / Jones Lake
Priority:	Medium
Estimated Cost:	$125,000

Table 6.06 3rd Ave – Mud Lake Ck Culvert Replacement

PROJECT ID #5

3RD AVE (SR-169) – MUD LAKE CREEK CULVERT REPLACEMENT

Description:	This project includes removal, replacement and associated roadway restoration of the existing 24-inch and 48-inch culverts crossing under 3rd Ave (SR-169) at the intersection of Black Diamond-Ravensdale Road and 3rd Ave. This culvert system includes a two side by side 24-inch culverts, one corrugated metal and one concrete, crossing under 3rd Ave and discharging to a landscaped intersection island in the intersection. Each culvert is approximately 75-feet in length. From there flows are conveyed to a 48-inch corrugated metal culvert, 60-feet in length, flowing to the pond north of Roberts Drive. This system conveys Mud Lake Creek flows across 3rd Ave. Wildlife and fish passage for Mud Lake Creek will be considered in the design of this project. This project may be a City and/or State funded project.
Location:	Intersection of Black Diamond / Ravensdale Road and 3rd Ave (SR-169)
Sub-Basin:	GL-1
Receiving Water:	Ginder Creek / Jones Lake
Priority:	Medium
Estimated Cost:	$145,000

Table 6.07 3rd Ave Culv. Replacement at Old Lawson Rd

PROJECT ID #6

3RD AVE (SR-169) CULVERT REPLACEMENT AT OLD LAWSON ROAD

Description: This project includes the removal and replacement of a 36-inch culvert under 3rd Ave (SR-169) and associated roadway restoration. This culvert conveys Lawson Creek under 3rd Ave towards Jones Lake and is located at the intersection of 3rd Ave (SR-169) and Old Lawson Road. The existing culvert is concrete and is approximately 110-feet in length. Wildlife and fish passage for Lawson Creek and Jones Lake will be considered in the design of this project. This project may be a City and/or State funded project.

Location: Intersection of 3rd Ave (SR- 169) and Old Lawson Road

Sub-Basin: JL-4

Receiving Water: Jones Lake

Priority: Low

Estimated Cost: $75,000

Table 6.08 Ginder Ck Culvert Replacement at Morgan St

PROJECT ID #7

GINDER CREEK CULVERT REPLACEMENT AT MORGAN STREET

Description:	This project includes the removal and replacement of a 36-inch culvert under 3rd Ave (SR-169) and associated roadway restoration. This culvert conveys Lawson Creek under 3rd Ave towards Jones Lake and is located at the intersection of 3rd Ave (SR-169) and Old Lawson Road. The existing culvert is concrete and is approximately 110-feet in length. Wildlife and fish passage for Lawson Creek and Jones Lake will be considered in the design of this project. This project may be a City and/or State funded project.
Location:	Intersection of 3rd Ave (SR- 169) and Old Lawson Road
Sub-Basin:	JL-4
Receiving Water:	Jones Lake
Priority:	Low
Estimated Cost:	$75,000

Table 6.09 Rock Creek Wetlands Study

PROJECT ID #8

ROCK CREEK WETLANDS STUDY

Description:	The Rock Creek wetland is a large wetland system that encompasses various wetlands between Jones Lake and Lake Sawyer. The purpose of this study is to understand the hydrology and ecological function of this wetland to better protect and utilize the Rock Creek corridor and the wetland system as an asset to the City of Black Diamond. The maintenance, operations and any changes to the overall management for storm water attenuation, stream flows, and water quality needs to be addressed.
Location:	Rock Creek Wetlands System between Jones Lake and Lake Sawyer
Sub-Basin:	GL-1, RC-1
Receiving Water:	Lake Sawyer
Priority:	High
Estimated Cost:	$100,000

Table 6.10 N. Downtown / Ginder Ck Storm Facility

PROJECT ID #9

NORTH DOWNTOWN / GINDER CREEK STORMWATER FACILITY

Description:	This project proposes to construct a stormwater facility serving a portion of the downtown Black Diamond Area. Flows from Park Drive, 3rd Ave, and the northern downtown area are proposed to be routed to the facility for detention and treatment prior to release to Ginder Creek. Funding for this project may include private developer funds, City funding, and/or State participation.
Location:	City owned Ginder Creek parcel or alternative location to be determined.
Sub-Basin:	GL-1
Receiving Water:	Ginder Creek / Rock Creek
Priority:	Medium
Estimated Cost:	$300,000

Table 6.11 S. Downtown / Jones Lk Storm Facility Study

PROJECT ID #10

SOUTH DOWNTOWN / JONES LAKE STORMWATER FACILITY STUDY

Description:	This study will identify a feasible location or locations for stormwater facilities serving the south downtown Black Diamond area. Most of the south downtown area, also know as "Old Downtown" releases stormwater runoff uncontrolled and untreated to Ginder Creek and Jones Lake. This project's goal would be to site a facility either on City owned property or identify potential properties for acquisition based on the suitability of the site topographically a preliminary sizing done as a part of the study. Funding may come from infill development of the downtown area.
Sub-Basin:	JL
Receiving Water:	Jones Lake / Rock Creek
Priority:	Medium
Estimated Cost:	$50,000

Table 6.12 5th Ave Storm Drain Improvements

PROJECT ID #11

5TH AVE STORM DRAIN IMPROVEMENTS

Description:	Based on stormwater modeling completed for the comprehensive plan update, shallow roadside ditches in 5th Ave have the potential for overtopping with a 25 year storm event. This project will improve the street side ditches and upsize driveway culverts from 12-inches to 15-inches in 5th Ave between Baker Street and Lawson Street to allow for conveyance of the 25-year event.
Location:	5th Ave from Baker Street to Lawson Street
Sub-Basin:	GC-1
Receiving Water:	Jones Lake
Priority:	Medium
Estimated Cost:	$28,000

Table 6.13 Railroad Ave Storm Drain Improvements

PROJECT ID #12

RAILROAD AVENUE STORM DRAINAGE IMPROVEMENTS

Description:	Approximately 750-feet of storm drain in Railroad Ave south of Baker St have the potential for overtopping with a 10 year storm event due to flat grades on the pipes and street. This project will upsize those pipes from 12-inch to 18-inch to provide conveyance without overtopping catch basins in Railroad Ave to convey large storm events without overtopping catch basins. It is anticipated that these repairs will be completed in conjunction with the roadway improvements to Railroad Avenue scheduled for construction in 2010.
Location:	Railroad Ave from Baker Street to Merino Street
Sub-Basin:	GC-1
Receiving Water:	Jones Lake
Priority:	Medium
Estimated Cost:	$100,000

Table 6.14 1st Ave Storm Drainage Improvements

PROJECT ID #13

1ST AVE STORM DRAINAGE IMPROVEMENTS

Description:	This project proposes to upsize approximately 500-feet of storm drain in 1st Ave southeast of Baker Street to a point where the system conveys flows south west to Railroad Ave. Flat pipe grades and impervious area runoff from the adjacent mobile home park contribute to a potential for catch basin overtopping in 1st Ave with a 25-year storm event. Upsizing from 12-inch lines to 15-inch lines is proposed.
Location:	1st Ave southeast of Baker Street
Sub-Basin:	GC-1
Receiving Water:	Jones Lake
Priority:	Medium
Estimated Cost:	$60,000

Table 6.15 Lawson Hills Pond A North

PROJECT ID #14

LAWSON HILLS POND A NORTH

Description:	This project consists of a combined wet pond and detention pond to serve a portion of Basin A of the Lawson Hills Master Planned Development (MPD) proposed in the City. The proposed pond location is along the east side of Lawson Street, north of Lawson Creek. The natural discharge location for this basin is to Lawson Creek, however this project may provide a bypass outlet directly to Jones Lake to minimize erosion in Lawson Creek.
Location:	Future Development (Lawson Hills) outfall to Lawson Creek (Basin A – South)
Sub-Basin:	JL-4
Receiving Water:	Lawson Creek / Jones Lake
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.16 Lawson Hills Pond A South

PROJECT ID #15

LAWSON HILLS POND A SOUTH

Description:	This project consists of a combined large wet pond and detention pond to serve a portion of Basin A of the Lawson Hills Master Planned Development (MPD) proposed in the City. The proposed pond location is south of Lawson Creek near the south end of HL Botts Drive SE. The natural discharge location for this basin is to Lawson Creek, however this project may provide a bypass outlet directly to Jones Lake to minimize erosion in Lawson Creek.
Location:	West boundary of Lawson Hills MPD (Basin A – North)
Sub-Basin:	JL-4
Receiving Water:	Lawson Creek / Jones Lake
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.17 Lawson Hills Pond B

PROJECT ID #16

LAWSON HILLS POND B

Description:	This project consists of a combined large wet pond and detention pond to serve a portion of Basin B of the Lawson Hills MPD. The proposed location for this facility is east of Lawson Road, opposite Mud Lake. Mud Lake is the proposed discharge point for this pond however due to topographic constraints a portion of Basin B may be routed to the Basin D facility described in Project #19.
Location:	South side of Lawson St near Mud Lake (Basin B)
Sub-Basin:	GL-4
Receiving Water:	Mud Lake
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.18 Lawson Hills Pond C

PROJECT ID #17

LAWSON HILLS POND C

Description:	This project consists of a combined large wet pond and detention pond to serve Basin C of the Lawson Hills MPD. The proposed location for this facility is at the south boundary of the proposed Lawson Hills Basin C at the east edge of the existing City Urban Growth Area. The proposed discharge point for this pond is an unnamed drainage channel tributary to Jones Lake.
Location:	South boundary of Lawson Hills MPD (Basin C)
Sub-Basin:	JL-4
Receiving Water:	Jones Lake
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.19 Lawson Hills North Triangle Pond

PROJECT ID #18

LAWSON HILLS NORTH TRIANGLE POND

Description:	This project consists of a retention pond to serve the North Triangle Basin of the Lawson Hills MPD. The proposed location for this facility is at the southwest corner of the proposed Lawson Hills North Triangle Basin approximately 1/3 of a mile west of 3rd Ave (SR-169). The proposed discharge for this facility is groundwater due to the infiltrative soils in this area of the City. No treatment is proposed for this facility; therefore new development tributary to this pond would need to provide private treatment on site.
Location:	Southwest corner of North Triangle in the Lawson Hills MPD
Sub-Basin:	R-3 / RC-1
Receiving Water:	Groundwater
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.20 Lawson Hills Basin D Drainage Facilities

PROJECT ID #19

LAWSON HILLS BASIN D DRAINAGE FACILITIES

Description:	This project consists of a series of treatment and detention facilities near the 3rd Ave (SR-169) and Roberts Drive intersection as needed to serve Basin D of the Lawson Hills MPD. Facilities may consist of detention ponds, detention vaults, wetponds, wetvaults, and sand filters depending on water quality needs for the proposed land uses in the basin. The proposed discharge point for these pond facilities is Ginder Creek.
Location:	East side of 3rd Ave (SR-169) south of Roberts Dr (Basin D)
Sub-Basin:	GC-1
Receiving Water:	Ginder Creek
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.21 The Villages Zone 1 Pond

PROJECT ID #20

THE VILLAGES ZONE 1 POND

Description:	This project consists of a retention pond to serve the Zone 1 of The Villages MPD. The proposed location for this facility is at the south boundary of The Villages Zone 1 Basin approximately 2/3 of a mile southeast Horseshoe Lake. The proposed discharge for this facility is groundwater due to the infiltrative soils in this area of the City. No treatment is proposed for this facility; therefore new development tributary to this pond would need to provide private treatment on site.
Location:	The Villages MPD – Zone 1
Sub-Basin:	SW-1
Receiving Water:	Groundwater / Horseshoe Lake
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.22 The Villages Zone 2 Pond

PROJECT ID #21

THE VILLAGES ZONE 2 POND

Description:	This project consists of a combined large wet pond and detention pond to serve a portion of Zone 2 of The Villages MPD. The proposed location for this facility is approximately 1/3 of a mile south of the Roberts Drive – Bruckners Way intersection west of Rock Creek. This pond is proposed to discharge to Rock Creek.
Location:	The Villages MPD – Zone 2
Sub-Basin:	RC-1
Receiving Water:	Rock Creek
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.23 The Villages Regional Pond

PROJECT ID #22

THE VILLAGES REGIONAL POND

Description:	The Villages MPD proposes to construct a large off-site infiltration pond west of the current City limits and approximately ½ mile south of Horseshoe Lake. This facility is not yet clearly defined, but will assist with aquifer recharge and water balance needs created by the proposed MPD
Location:	West of the Villages MPD – Zone 3 and south of Horseshoe Lake. Currently outside of the City limits.
Sub-Basin:	RC-4 / SW-1
Receiving Water:	Black Diamond Lake / Groundwater
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.24 The Villages Zone 2 Pond

PROJECT ID #23

THE VILLAGES ZONE 2 POND

Description:	This project consists of a combined large wet pond and detention pond to serve Zone 4 of The Villages MPD. The proposed location for this facility is approximately 1000-feet south of Jones Lake west of an unnamed tributary stream to Jones Lake. The proposed discharge point for this pond is the unnamed drainage stream tributary to Jones Lake.
Location:	The Villages MPD – Zone 4
Sub-Basin:	JL-2
Receiving Water:	Jones Lake
Estimated Cost:	Developer Funded

Table 6.25 The Villages Zone 5 Drainage Facilities

PROJECT ID #24

THE VILLAGES ZONE 5 DRAINAGE FACILITIES

Description: This project consists of a series of treatment, retention, and detention facilities serving Zone 5 of The Villages MPD on King County Tax Parcel #1121069006. At this time 3 pond facilities are proposed to serve this zone.

The northwest corner of the site is located on outwash soils and is proposed to contain an infiltration pond. Treatment for flows conveyed to this pond will need to be addressed on a site-by-site basis as these soils are not sufficient for treatment through infiltration. Stormwater from the northern portions of Zone 5 will be conveyed to this facility.

The southern portion of this zone will be served by two ponds providing a large wet pond and detention for stormwater runoff mitigation.

Location: The Villages – Zone 5

Priority: As Needed for Development

Estimated Cost: Developer Funded

Table 6.26 Pipeline Road Regional Facility

PROJECT ID #25

PIPELINE ROAD REGIONAL FACILITY

Description:	This project is proposed to serve the stormwater needs of the future Pipeline Road connecting Lake Sawyer Drive SE and 3rd Ave (SR-169) and future development in the area. Its location is yet undetermined, but may likely lie somewhere between Lake Marjorie and Rock Creek with an outfall to Rock Creek.
Location:	Along Future Pipeline Rd, east of Rock Creek
Sub-Basin:	RC-1
Receiving Water:	Rock Creek
Priority:	As Needed for Development
Estimated Cost:	Developer Funded

Table 6.27 Storm Pond Maintenance

PROJECT ID #26

STORM POND MAINTENANCE

Description: This is proposed to be an ongoing maintenance program with one of the current nine City-owned detention ponds receiving any necessary improvements every six years.

Location: City-owned ponds

Sub-Basin: various

Priority: Medium

Estimated Cost: $5,000

Table 6.28 Public Works Shop Upgrades

PROJECT ID #27

PUBLIC WORKS SHOP UPGRADES

Description:	This project is proposed to upgrade the City shop area to meet NPDES Phase II permit requirements. This may include such improvements as a wash rack, improved materials storage, etc. The improvements may be phased in order to address the immediate need of a wash rack to reduce polluted runoff.
Location:	City shops located on Lawson Street
Sub-Basin:	GC-1
Receiving Water:	Ginder Creek
Priority:	High
Estimated Cost:	$25,000

6.4 STORM UTILITY RATES

City of Black Diamond recently adopted Ordinance No. 08-872 with an effective date of November 16, 2008. This ordinance created a stormwater utility and established rates. The service charge rate is imposed on each parcel of real property within the City served by or which is available for service by the stormwater and surface water management utility. The adopted rate was $13.00 per Equivalent Residential Unit per month.

Subsequently, the City adopted Ordinance No. 09-901 with an effective date of May 3, 2009. This ordinance recognized that the City's recently-instituted Stormwater Utility fee went into effect at the same time that a severe economic recession affected the incomes and financial resources of the city's residents and businesses. The ordinance further recognized that although the City's Stormwater Utility fee was rationally-derived from an analysis of the cost of creating the stormwater system, the number of utility customers, and the funding sources available to the city; the original funding formula resulted in fee amounts that significantly impacted local businesses at the same time that an emergency long-term closure of the Green River Bridge and the severe economic recession has placed many local businesses under unprecedented financial strain.

Thus, Ordinance 09-901 amended the utility service charge rate for 2009 from $13.00 to $10.00 per ERU per month, effective April 1, 2009; provided, customers will receive a credit from the city for the difference in cost for the months of January, February, and March 2009 between the original rate and the new rate. A rate of $11.50 per ERU per month was adopted for 2010 and a rate of $13.00 per ERU per month for 2011.

Furthermore, a general facility charge has not been adopted for the stormwater utility. A general facility charge is a traditional source used to fund capital improvement projects.

6.5 PROJECT PRIORITIES, SCHEDULES, AND FUNDING

The projects necessary to accommodate future proposed development will be completed by and funded by Development. The remaining projects (Project No. 1 through Project No. 13) have been identified with project priorities of low, medium, or high. High priority projects are those that are recommended for completion within a short-term timeframe, whereas low priority projects are recommended for completion within a long-term timeframe.

Because the City has made a conscious decision to reduce rates and not fully fund the storm utility at this time, it is not recommended that any capital improvement projects be completed until the utility is running without a budget deficit. Once the utility rates have been adjusted to a level that fully funds the storm and surface water utility and/or the City adopts a general facility charge, it would be appropriate for the City to more closely examine the timing of the program.

It is recommended that the City pursue outside funding sources in order to not burden the stormwater utility with high capital improvement costs. Grant funding availability has reduced in recent years, however low-interest loans may be an option for the City to pursue. The City may also wish to investigate additional possible funding sources such as general facility charges, debt financing, or improvement districts.

7.0 OPERATIONS & MAINTENANCE

7.1 NPDES PHASE II REQUIREMENTS

Section S5.C.5 of the NPDES Phase II Permit outlines specific requirements for the City to establish within an Operations and Maintenance Program. The NPDES Phase II Permit requires the City to develop and implement an operations and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations. The O&M Program shall be in place by February 2010.

Major components of the O&M Program, as required by the NPDES Phase II Permit are:

- Establish maintenance standards at least as protective of facility function as those included in DOE's 2005 SWMMWW. The purpose of the maintenance standard is to determine if maintenance is required and to provide a protocol for scheduling maintenance-related activities.
- Conduct annual inspections of City owned or operated permanent stormwater facilities (other than catch basins).
- Conduct spot checks of potentially damaged permanent stormwater treatment and flow control facilities (other than catch basins) after major storm events.
- Inspect all catch basins and inlets owned or operated by the City at least once by February 2012.
- Provide cleaning and or maintenance if the above inspections indicate it is needed to comply with maintenance standards.
- Design O&M inspection program to achieve inspection of 95% of all sites.
- Implement practices to reduce stormwater impacts associated with runoff from streets, parking lots, roads, and highways owned and/or maintained by the City.
- Implement policies and procedures to reduce pollutants in discharges from lands owned or maintained by the City.
- Implement an on-going training program for City employees whose construction, operations, or maintenance job functions may impact stormwater quality.
- Implement a SWPPP for all heavy equipment maintenance or storage yards, and material storage facilities owned or operated by the City.
- Maintain records of inspections and maintenance or repair activities conducted by the City.

7.2 O&M PROGRAM RECOMMENDATIONS

Table 7.01 O&M Program Review and Recommendations contains a detailed listing of O&M Program requirements as outlined in Section S5.C.5 of the NPDES Phase II Permit. The City's O&M Program should be adjusted as necessary to ensure that these

minimum requirements are being met. The City is currently utilizing the O&M Standards as published in DOE's 2005 SWMMWW and as included in ***APPENDIX L – Maintenance Standards*** of this document.

Table 7.01 O&M Program Review and Recommendations

NPDES Phase II Municipal Stormwater Permit Requirements
Establish maintenance standards that are as protective, or more protective as those in Chapter 4, Volume 5 of the 2005 SWMMWW *NPDES S5.C.5.a*
Unless there are circumstances beyond the City's control, when an inspection identifies an exceedence of the maintenance standard, maintenance shall be performed: - Within 1 year for wet pool facilities and retention / detention ponds - Within 6 months for typical maintenance - Within 9 months for maintenance requiring re-vegetation - Within 2 years for maintenance that requires capital construction of less than $25,000 *NPDES S5.C.5.a.ii*
Annual inspection of all municipally owned or operated permanent stormwater treatment and flow control facilities, other than catch basins, and taking appropriate maintenance actions in accordance with the adopted maintenance standards. Reducing the inspection frequency shall be based on maintenance records of double the length of time of the proposed inspection frequency. In the absence of maintenance records, the City may substitute written statements to document a specific less frequent inspection schedule. Written statements shall be based on actual inspection and maintenance experience and shall be certified in accordance with permit requirements. *NPDES S5.C.5.b*
Spot checks of potentially damaged permanent treatment and flow control facilities (other than catch basins) after major (greater than 24-hour 10-year recurrence interval rainfall) storm events. If spot checks indicate widespread damage / maintenance needs, inspect all stormwater treatment and flow control facilities that may be affected. Conduct repairs or take appropriate measures in accordance with maintenance standards. *NPDES S5.C.5.c*

Inspection of all catch basins and inlets owned or operated by the City at least once by Feb. 15, 2012. Clean catch basins if the inspection indicates cleaning is needed to comply with maintenance standards established in the 2005 SWMMWW.

Inspections may be conducted on a "circuit basis" whereby a sampling of catch basins and inlets within each circuit is inspected to identify maintenance needs. Include in the sampling an inspection of the catch basin immediately upstream of any system outfall. Clean all catch basins within a given circuit at one time if the inspection sampling indicates cleaning is needed to comply with maintenance standards.
NPDES S5.C.5.d

Decant water shall be disposed of in accordance with the following:

General Procedures:

- Street waste collection should emphasize retention of solids in preference to liquids.
- Street waste liquids require treatment before their discharge.
- Discharges to sanitary sewer and storm sewer systems must be approved by the entity responsible for O&M of the system

The following order of preference, for disposal of catch basin decant liquid and water removed from stormwater treatment facilities is required:

1. Discharge of catch basin decant liquids to a municipal sanitary sewer connected to a Public Owned Treatment Works (POTW) is the preferred disposal option.
2. Discharge of catch basin decant liquids may be allowed into a Basic or Enhanced Stormwater Treatment BMP, if Option 1 is not available.
3. Water removed from stormwater ponds, vaults and oversized catch basins may be returned to the storm sewer system.

NPDES S5.C.5.d & Appendix 6

Established inspection program designed to inspect all sites and achieve inspection of 95% of all sites.
NPDES S5.C.5.e

Establishment and implementation of practices to reduce stormwater impacts associated with runoff from streets, parking lots, roads or highways owned or maintained by the City, and road maintenance activities conducted by the City. The following shall be addressed:

- Pipe cleaning
- Cleaning of culverts that convey stormwater in ditch systems
- Ditch maintenance
- Street cleaning
- Road repair and resurfacing, including pavement grinding
- Snow and ice control
- Utility installation
- Pavement striping maintenance
- Maintaining roadside areas, including vegetation management
- Dust control

NPDES S5.C.5.f

Establishment and implementation of policies and procedures to reduce pollutants in discharges from all lands owned or maintained by the City and subject to the NPDES Phase II permit, including but not limited to: parks, open space, road right-of-way, maintenance yards, and stormwater treatment and flow control facilities. These policies and procedures shall address, but are not limited to:

- Application of fertilizer, pesticides, and herbicides including the development of nutrient management and integrated pest management plans.
- Sediment and erosion control
- Landscape maintenance and vegetation disposal.
- Trash management
- Building exterior cleaning and maintenance.

NPDES S5.C.5.g

Develop and implement an on-going training program for employees of the City whose construction, operations or maintenance job functions may impact stormwater quality. The training program shall address the importance of protecting water quality, the requirements of the NPDES Phase II permit, operation and maintenance standards, inspection procedures, selecting appropriate BMPs, ways to perform their job activities to prevent or minimize impacts to water quality, and procedures for reporting water quality concerns, including potential illicit discharges.
Follow-up training shall be provided as needed to address changes in procedures, techniques or requirements.

The City shall document and maintain records of training provided.
NPDES S5.C.5.h

Development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) for all heavy equipment maintenance or storage yards, and material storage facilities owned or operated by the City in areas subject to the NPDES Phase II permit that are not required to have coverage under the Industrial Stormwater General Permit.

Implementation of non-structural BMPs shall begin immediately after the pollution prevention plan is developed. A schedule for implementation of structural BMPs shall be included in the SWPPP. Generic SWPPPs that can be applied at multiple sites may be used to comply with this requirement. The SWPPP shall include period visual observation of discharges from the facility to evaluate the effectiveness of the BMP. *NPDES S5.C.5.i*

Records of inspections and maintenance or repair activities conducted by the City shall be maintained in accordance with NPDES Phase II Permit Reporting Requirements.

All records shall be kept for at least five years.

All records shall be available to the public at reasonable times during business hours.

Records shall be incorporated into the Annual report.

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8.0 ILLICIT DISCHARGE DETECTION & ELIMINATION PROGRAM

8.1 NPDES PHASE II PERMIT REQUIREMENTS

Section S5.C.3 of the NPDES Phase II Permit requires the City of Black Diamond to implement an ongoing illicit discharge detection and elimination program. The program must be implemented by August 2011. The City's program is outlined in this chapter.

8.2 DEFINITION

The NPDES Phase II Permit contains the following definition:

> **"Illicit discharge** means any discharge to a municipal separate storm sewer that is not composed entirely of stormwater except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire fighting activities."

The "Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments" provides the following four-part definition:

1. Illicit discharges are defined as a storm drain that has measurable flow during dry weather containing pollutants and/or pathogens. A storm drain with measurable flow but containing no pollutants is simply considered a discharge;
2. Each illicit discharge has a unique frequency, composition and mode of entry in the storm drain system;
3. Illicit discharges are frequently caused when the sewage disposal system interacts with the storm drain system. A variety of monitoring techniques is used to locate and eliminate illegal sewage connections. These techniques trace sewage flows from the stream or outfall, and go back up the pipes or conveyances to reach the problem connection;
4. Illicit discharges of other pollutants are produced from specific source areas and operations known as "generating sites." Knowledge about these generating sites can be helpful to locate and prevent non-sewage illicit discharges. Depending on the regulatory status of specific "generating sites," education, enforcement and other pollution prevention techniques can be used to manage this class of illicit discharges.

8.3 ILLICIT DISCHARGES PER BDMC[11]

The City of Black Diamond Municipal Code details substances which are prohibited to be discharged into the City stormwater system. This section of the code lists specific items of concern, as well as references "Dangerous and Toxic wastes" as identified by WAC 173-

[11] "Chapter 14.04.390 Waste Discharge into Drainage Systems", Black Diamond Municipal Code.

303. The municipal code states that it shall be a violation to "cause or permit a discharge into a drainage system or waters of the United States of a material that would cause the water quality of the receiving water to degrade below the state of Washington water quality standard for that water body."

The current code appears to meet the minimum requirements of the NPDES Phase II Permit requirements for prohibited discharges. However, it is recommended that this section of the BDMC be amended with the following prohibited items in order to provide additional clarity to citizens:

- Discharges from potable water sources, including waterline flushing, hyperchlorinated waterline flushing, fire hydrant system flushing, and pipeline hydrostatic test water. Planned discharges shall be dechlorinated to a concentration of 0.1 ppm or less, pH-adjusted, if necessary, and volumetrically and velocity controlled to prevent re-suspension of sediments.
- Discharges from lawn watering and other irrigation runoff. These shall be minimized through, at a minimum public education activities and water conservation efforts.
- Dechlorinated swimming pool discharges. The discharges shall be dechlorinated to a concentration of 0.1 ppm or less, pH-adjusted and reoxygenized if necessary, volumetrically and velocity controlled to prevent re-suspension of sediments. Swimming pool cleaning wastewater and filter backwash shall not be discharged.
- Street and sidewalk wash water, water used to control dust, and routine external building wash down that does not use detergents. These discharges shall be reduced through, at a minimum, public education activities and/or water conservation efforts. At active construction sites, street sweeping must be performed prior to washing the street.
- Other non-stormwater discharges.

8.4 DISCHARGE FLOW TYPES[12]

Dry weather discharges are composed of one or more possible flow types:

- **Sewage and septage** flows are produced from sewer pipes and septic systems.
- **Washwater** flows are generated from a wide variety of activities and operations. Examples include discharges of gray water (laundry) from homes, commercial carwash wastewater, fleet washing, commercial laundry wastewater, and floor washing to shop drains.
- **Liquid wastes** refers to a wide variety of flows, such as oil, paint, and process water (radiator flushing water, plating bath wastewater, etc.) that enter the storm drain system.

[12] "Discharge Flow Types", Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments, Center for Watershed Protection, October 2004.

- **Tap water** flows are derived from leaks and losses that occur during the distribution of drinking water in the water supply system. Tap water discharges in the storm drain system may be more prevalent in communities with high loss rates in their potable water distribution system.
- **Landscape irrigation** flows occur when excess potable water used for residential or commercial irrigation ends up in the storm drain system.
- **Groundwater and spring water** flows occur when the local water table rises above the bottom elevation of the storm drain (known as the invert) and enters the storm drain either through cracks and joints, or where open channels or pipes may intercept seeps and springs.

Water quality testing is used to conclusively identify flow types found in storm drains. Testing can distinguish illicit flow types (sewage/septage, washwater and liquid wastes) from cleaner discharges (tap water, landscape irrigation and ground water). In practice, many storm drain discharges represent a blend of several flow types, particularly at larger outfalls that drain larger catchments. For example, groundwater flows often dilute sewage thereby masking its presence. Illicit discharges are also masked by high volumes of storm water runoff making it difficult and frequently impossible to detect them during wet weather periods.

8.5 DISCHARGE MODE OF ENTRY[13]

Illicit discharges can be further classified based on how they enter the storm drain system. The mode of entry can either be direct or indirect.

DIRECT ENTRY

Direct entry means that the discharge is directly connected to the storm drain pipe through a sewage pipe, shop drain, or other kind of pipe. Direct entry usually produces discharges that are continuous or intermittent. Direct entry usually occurs when two different kinds of "plumbing" are improperly connected. The three main situations where this occurs are:

Sewage cross-connections: A sewer pipe that is improperly connected to the storm drain system produces a continuous discharge of raw sewage to the pipe. Sewage cross-connections can occur in catchments where combined sewers or septic systems are converted to a separate sewer system, and a few pipes get "crossed."

Straight pipe: This term refers to relatively small diameter pipes that intentionally bypass the sanitary connection or septic drain fields, producing a direct discharge into open channels or streams.

Industrial and commercial cross-connections: These occur when a drain pipe is improperly connected to the storm drain system producing a discharge of wash water, process water or other inappropriate flows into the storm drain pipe. Older industrial areas tend to have a higher potential for illicit cross-connections.

[13] "Discharge Flow Types", Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments, Center for Watershed Protection, October 2004.

INDIRECT ENTRY

Indirect entry means that flows generated outside the storm drain system enter through storm drain inlets or by infiltrating through the joints of the pipe. Generally, indirect modes of entry produce intermittent or transitory discharges, with the exception of groundwater seepage. The five main modes of indirect entry for discharges include:

Groundwater seepage into the storm drain pipe: Seepage frequently occurs in storm drains after long periods of above average rainfall. Seepage discharges can be either continuous or intermittent, depending on the depth of the water table and the season. Groundwater seepage usually consists of relatively clean water that is not an illicit discharge by itself, but can mask other illicit discharges. If storm drains are located close to sanitary sewers, groundwater seepage may intermingle with diluted sewage.

Spills that enter the storm drain system at an inlet: These transitory discharges occur when a spill travels across an impervious surface and enters a storm drain inlet. Spills can occur at many industrial, commercial and transport-related sites. A very common example is an oil or gas spill from an accident that then travels across the road and into the storm drain system.

Dumping a liquid into a storm drain inlet: This type of transitory discharge is created when liquid wastes such as oil, grease, paint, solvents, and various automotive fluids are dumped into the storm drain. Liquid dumping occurs intermittently at sites that improperly dispose of rinse water and wash water during maintenance and cleanup operations. A common example is cleaning deep fryers in the parking lot of fast food operations.

Outdoor washing activities that create flow to a storm drain inlet: Outdoor washing may or may not be an illicit discharge, depending on the nature of the generating site that produces the wash water. For example, hosing off individual sidewalks and driveways may not generate significant flows or pollutant loads. On the other hand, routine washing of fueling areas, outdoor storage areas, and parking lots (power washing), and construction equipment cleanouts may result in unacceptable pollutant loads.

Non-target irrigation from landscaping or lawns that reaches the storm drain system: Irrigation can produce intermittent discharges from over-watering or misdirected sprinklers that send tap water over impervious areas. In some instances, non-target irrigation can produce unacceptable loads of nutrients, organic matter or pesticides. The most common example is a discharge from commercial landscaping areas adjacent to parking lots connected to the storm drain system.

8.6 LAND USE AND POTENTIAL GENERATING SITES[14]

Land use can predict the potential for indirect discharges, which are often intermittent or transitory. Many indirect discharges can be identified and prevented using the concept of "generating sites," which are sites where common operations can generate indirect

[14] "Discharge Flow Types", Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments, Center for Watershed Protection, October 2004.

discharges in a community. Both research and program experience indicates that a small subset of generating sites within a broader land use category can produce most of the indirect discharges. Consequently, the density of potential generating sites within a sub-watershed may be a good indicator of the severity of local illicit discharge problems. Some common generating sites within major land use categories described below:

RESIDENTIAL GENERATING SITES

Failing septic systems are the most common residential discharge. In addition, indirect residential discharges, which consist of oil dumping, irrigation overflows, swimming pool discharges, and car washing, are also frequently detected. Many indirect discharges are caused by common residential behaviors and may not be classified as "illicit" even though they can contribute to water quality problems. With the exception of failing septic systems and oil dumping, most communities have chosen education rather than enforcement as the primary tool to prevent illicit discharges from residential areas.

COMMERCIAL GENERATING SITES

Typical commercial discharge generators included operations such as outdoor washing; disposal of food wastes; car fueling, repair, and washing; parking lot power washing; and poor dumpster management. Recreational areas, such as marinas and campgrounds, are a notable source of sewage discharges. It is important to note that not all businesses within a generating category actually produce illicit discharges. Generally only a relatively small fraction of businesses produce these discharges. Consequently, on-site inspections of individual businesses are needed to confirm whether a property is actually a generating site.

INDUSTRIAL GENERATING SITES

Industrial sites produce a wide range of flows that can cause illicit discharges. The most common continuous discharges are operations involving the disposal of rinse water, process water, wash water and contaminated, noncontact cooling water. Spills and leaks, ruptured pipes, and leaking underground storage tanks are also a source of indirect discharges.

INSTITUTIONAL GENERATING SITES

Institutions such as hospitals, corporate campuses, colleges, churches, and cemeteries can be generating sites if routine maintenance practices/operations create discharges from parking lots and other areas. Many large institutional sites have their own areas for fleet maintenance, fueling, outdoor storage, and loading/unloading that can produce indirect discharges.

MUNICIPAL GENERATING SITES

Municipal generating sites include operations that handle solid waste, water, wastewater, street and storm drain maintenance, fleet washing, and yard waste disposal. Transport-related areas such as streets and highways, airports, rail yards, and ports can also generate indirect discharges from spills, accidents and dumping.

8.7 IMPACTS TO WATER QUALITY[15]

Water quality can be significantly impacted if pollutants enter into the stormwater system. Some of the more common stormwater pollutants, as well as the potential impacts associated with them are listed below:

TOTAL SUSPENDED SOLIDS

Particulate solids such as eroded soil, heavy metal precipitates, and biological solids (all considered as conventional pollutants), can cause sedimentation in streams and turbidity in receiving surface waters. These sediments can destroy the desired habitat for fish and can impact drinking water supplies. The sediment may be carried to streams, lakes, or Puget Sound where they may be toxic to aquatic life and make dredging necessary.

OIL AND GREASE

Oil and grease can be toxic to aquatic life. Concentrations in stormwater from commercial and industrial areas often exceed the Washington Department of Ecology (Ecology) guidelines of: 10 mg/l maximum daily average, 15 mg/L maximum at any time, and no ongoing or frequently recurring visible sheen.

NUTRIENTS

Phosphorus and nitrogen compounds can cause excessive growth of aquatic vegetation in lakes and marine waters.

BOD

This represents organic, nitrogenous and other materials that are consumed by bacteria present in receiving waters. Oxygen may be depleted in the process, threatening higher organisms such as fish.

HEAVY METALS

Stormwater can contain heavy metals such as lead, zinc, cadmium, and copper at concentrations that often exceed water quality criteria and that can be toxic to fish and other aquatic life. Research in Puget Sound has shown that metals and toxic organics concentrate in sediments and at the water surface (micro-layer) where they interfere with the reproductive cycle of many biotic species as well as cause tumors and lesions in fish.

PH

This is a measure of the alkalinity or acidity and can be toxic to fish if it varies appreciably from neutral pH, which is 7.0.

BACTERIA AND VIRUSES

Stormwater can contain disease-causing bacteria and viruses, although not at concentrations found in sanitary sewage. Shellfish subjected to stormwater discharges near urban areas are usually unsafe for human consumption.

[15] "Stormwater Pollutants and Their Adverse Impact", Appendix B, Stormwater Management Manual for Western Washington, Volume IV Source Control BMPs.

8.8 ILLICIT DISCHARGE DETECTION

Detection and removal/repair of illicit discharges throughout the system is accomplished through a three step process: (1) An assessment of illicit discharge potential; (2) Field investigation of illicit discharge problem areas; and (3) Isolation of individual discharges.

ASSESSMENT OF ILLICIT DISCHARGE POTENTIAL

The assessment of illicit discharge potential is typically conducted in the office and helps to provide guidance on where best to concentrate field investigations. ***Table 8.01 Illicit Discharge Potential Factors*** lists factors to consider in completion of the assessment. Each of the sub-basins within the City's drainage area should be evaluated for potential discharges. The discharge potential factors should be evaluated and a score assigned. Note that City staff may elect to assign more weight/importance to some factors over others in the overall assessment.

Table 8.01 Illicit Discharge Potential Factors

Factor	Description
Complaints	Frequency of complaints, phone calls, hotline reports, and/or spill responses.
Poor Dry Weather Water Quality	Frequency that individual samples exceed benchmark values for bacteria, nutrients, conductivity, or other predetermined indicators.
Generating Sites	Sub-basins with a high density of "generating sites" (or industrial NPDES permitted sites) indicates a high illicit discharge potential.
Storm Outfall Density	Sub-basins with a higher density of storm outfalls (measured in number per stream/creek mile) typically have a higher illicit discharge potential.
Development Age	An average age of development within the sub-basins shall be determined. A higher illicit discharge potential is typically associated with developments older than 50 years.
Sewer Conversion	Areas that were previously served by septic systems or a combined storm-sewer system, but have been connected to the sanitary sewer system have higher illicit discharge potential.
Older Industrial Facilities	Areas with more than 5% of its area in industrial sites that are more than 40 years old will typically have a higher illicit discharge potential.
Old / Failing Sewer System	High illicit discharge potential is present when the age of the sanitary sewer system exceeds its design life or when there is a presence of pipe breaks, spills,
Aging Septic Systems	Areas with a high density of older septic drain fields typically have high illicit discharge potential.

FIELD INVESTIGATION OF ILLICIT DISCHARGE PROBLEM AREAS

A field investigation of illicit discharge problem areas typically begins with those that had a high ranking based on the results of the potential assessment. The primary tool used to locate drainage problems in the field is an Outfall Reconnaissance Inventory (ORI). Completion of an ORI can result in the discovery of obvious illicit discharges to the storm drainage system. Completion of an ORI is a required activity for NPDES Phase II permit holders.

An ORI is a stream walk to inventory and measure storm drainage outfalls. A thorough ORI will record basic characteristics of outfalls, evaluate suspect outfalls, and assess severity of illicit discharge problems. Spring and fall are typically the best seasons to conduct an outfall reconnaissance inventory. The investigations should be completed at least 48 hours after the last runoff-producing rain event.

Outfalls should be evaluated and basic sensory and physical data recorded such as odor, color, presence of floaters, and turbidity. Water flow and quality data should also be collected. Test strips and a quick and convenient method for testing indicators such as temperature, pH, and ammonia.

A sample form that can be used to record the results of the Outfall Reconnaissance Inventory has been included in ***Figure 8.1 Outfall Reconnaissance Inventory Form (Pg 1)*** and ***Figure 8.2 Outfall Reconnaissance Inventory Form (Pg 2)***.

ISOLATION OF INDIVIDUAL DISCHARGES

If the Outfall Reconnaissance Inventory identifies a suspected illicit discharge, the next step is to trace the illicit discharge problem back up the pipe to isolate the specific source or improper connection that generates the discharge. Finding and repairing sources of illicit discharges is the core goal of any IDDE (Illicit Discharge Detection and Elimination) Program.

There are typically four types of investigations that are conducted in order to isolate discharges: (1) storm drain network investigations; (2) drainage area investigations; (3) on-site investigations; and (4) septic system investigations.

Storm Drain Network Investigations are completed to try to find and isolate the problem to a single pipe segment of the storm system. Common methods to isolate the problem area include: visual inspection at manholes; sandbagging or damming trunklines; dye testing; smoke testing; and/or video testing. Once the pipe segment has been identified, on-site investigations are used to find the specific discharge or improper connection.

Drainage Area Investigations are essentially land use investigations. They typically begin with an office assessment of potential problem areas that require field follow-up. Drainage area investigations may be conducted with a drive-by review of suspected sites. They may also include a more detailed investigation of GIS data to identify the source of a discharge. On-site investigations are often still necessary to identify the specific plumbing or connection generating the discharge.

OUTFALL RECONNAISSANCE INVENTORY/ SAMPLE COLLECTION FIELD SHEET

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours:	Last 48 hours:	
Latitude:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	

Land Use in Drainage Area (Check all that apply):

☐ Industrial ☐ Open Space

☐ Ultra-Urban Residential ☐ Institutional

☐ Suburban Residential Other: _____

☐ Commercial Known Industries: _____

Notes (e.g., origin of outfall, if known):

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ Closed Pipe	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: _____	☐ Circular ☐ Eliptical ☐ Box ☐ Other: ____	☐ Single ☐ Double ☐ Triple ☐ Other: ____	Diameter/Dimensions: _____	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ Open drainage	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: ____	☐ Trapezoid ☐ Parabolic ☐ Other: ____		Depth: ____ Top Width: ____ Bottom Width: ____	
☐ In-Stream	(applicable when collecting samples)				
Flow Present?	☐ Yes ☐ No *If No, Skip to Section 5*				
Flow Description (If present)	☐ Trickle ☐ Moderate ☐ Substantial				

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		RESULT	UNIT	EQUIPMENT
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	____' ____"	Ft, In	Tape measure
	Measured length	____' ____"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Illicit Discharge Detection and Elimination: Technical Appendices D-3

Figure 8.1 Outfall Reconnaissance Inventory Form (Pg 1)

Outfall Reconnaissance Inventory Field Sheet

Section 4: Physical Indicators for Flowing Outfalls Only

Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ Clear ☐ Brown ☐ Gray ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls

Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐ Oily ☐ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

Section 6: Overall Outfall Characterization

☐ Unlikely ☐ Potential (presence of two or more indicators) ☐ Suspect (one or more indicators with a severity of 3) ☐ Obvious

Section 7: Data Collection

1.	Sample for the lab?	☐ Yes	☐ No	
2.	If yes, collected from:	☐ Flow	☐ Pool	
3.	Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐ OBM ☐ Caulk dam

Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

D-4 *Illicit Discharge Detection and Elimination: Technical Appendices*

Figure 8.2 Outfall Reconnaissance Inventory Form (Pg 2)

On-Site Investigations are used to pinpoint the exact connection or source producing a discharge and are often completed by smoke testing, dye testing, or video testing. Dye testing the plumbing system of households and buildings is a relatively simple method of identifying and verifying illicit connections. If the dye is present in the storm drainage system, rather than the sanitary sewer system, an illicit connection is present. Video testing and smoke testing are also common methods of isolating the source points of illicit discharges.

Septic System Investigations are completed in communities with septic systems that are currently or have previously been in use. Illicit discharges may enter the storm drainage system as indirect discharges to streams, or through straight pipe discharges from bypassed septic systems. On-site septic investigations and infrared investigations are typically used to evaluate septic system performance. On-site investigations may include a survey of the homeowner, as well as a visual inspection of the site. Indicators of potential problems may include: foul odors in the yard; wet, spongy ground; algae blooms

or excessive weed growth in adjacent ditches, ponds, and streams; cars, boats, or other heavy objects located over the field that could crush lateral pipes; and/or visible liquid on the surface of the drain field (i.e. surface breakouts). Infrared investigations can also be utilized to identify thermal irregularities in drainage flows.

8.9 REPAIR, MONITORING, AND ENFORCEMENT

It is important that repairs be made to remove illicit discharges in a timely manner. Internal plumbing issues are typically the responsibility of the property owner, while repairs to the city-wide storm and/or sewer system are typically the responsibility of the City. Service laterals are typically the responsibility of the property owner as well, however the City may elect to offer assistance due to the higher cost for these type of repairs.

"Illicit Discharge Detection and Elimination: A Guidance Manual" recommends that discharges should be stopped within 7 days of notification by the City and that illicit connections should be repaired within 30 days.

The City of Black Diamond's Municipal Code currently states that individuals are subject to a fine of one thousand dollars per day, or a jail term of up to 90 days (per day of offense), or both. It is recommended that the City modify this portion of the code to include clear timeframes which allow for the opportunity for property owner repair without penalty. Escalating levels of enforcement are also recommended such as: (1) letter of notice; (2) termination of water/sewer service; (3) fine; and (4) jail time. The City's code shall also be clear as to when the City may elect to make the repairs and back-charge the property owner.

In all instances, it is important that follow-up monitoring is conducted for all sites where illicit discharges have identified in order to verify that corrections have been made.

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9.0 PUBLIC EDUCATION & OUTREACH

9.1 PUBLIC EDUCATION AND OUTREACH PROGRAM GOALS

The City of Black Diamond's goal in developing and implementing their Stormwater Public Education and Outreach Program is to reduce or eliminate behaviors and practices that cause or contribute to stormwater pollution.

9.2 NPDES PHASE II PERMIT REQUIREMENTS

Section S5.C.1 of the NPDES Phase II Permit requires that the City of Black Diamond develops a public education and outreach program by February 2009. The City has quite a bit of flexibility in determining how they want to develop and implement their public education and outreach program. The NPDES Phase II Permit outlines prioritized, target audiences and topics. The Permit also requires the City to track and maintain records of public education and outreach activities. The City must measure the understanding and adoption of the targeted behaviors in order to more effectively direct their education and outreach efforts as may be necessary.

9.3 TARGET AUDIENCES AND SUBJECT AREAS

The City's Public Education and Outreach Program should be prioritized to target the following audiences and subject areas:

1. General Public
    - General impacts of stormwater flows into surface water
    - Impacts from impervious surfaces
    - Source control BMPs and environmental stewardship actions and opportunities in the areas of pet waste, vehicle maintenance, landscaping and buffers
2. General Public, businesses, including home-based and mobile businesses
    - BMPs for use and storage of automotive chemicals, hazardous cleaning supplies, carwash soaps and other hazardous materials.
    - Impacts of illicit discharges and how to report them
3. Homeowners, landscapers and property managers
    - Yard care techniques protective of water quality
    - BMPs for use and storage of pesticides and fertilizers
    - BMPs for carpet cleaning and auto repair and maintenance
    - Low Impact Development techniques, including site design, pervious paving, retention of forests and mature trees.
    - Stormwater pond maintenance
4. Engineers, contractors, developers, review staff, and land use planners
    - Technical standards for stormwater site and erosion control plans
    - Low Impact Development techniques, including site design, pervious paving, retention of forests and mature trees
    - Stormwater treatment and flow control BMPs

9.4 PUBLIC REPORTING / SPILL HOTLINE

Section S5.C.3.d.ii of the NPDES Phase II Permit requires that the City of Black Diamond publicly list and publicize a hotline or other local telephone number for public reporting of spills and other illicit discharges which may impact the stormwater system. Spills within the City of Black Diamond should be reported to City Hall at (360) 886-2560.

The City should include this number on utility billing inserts, the City's website, and/or the City newsletter in order to publicize this number for members of the community.

The City is required to maintain a record of calls received and include this information in the annual report to the DOE regarding the NPDES implementation progress. Forms for tracking calls received and follow-up completed are included in ***Figure 9.1 Illicit Discharge / Spill Tracking Form (Pg 1)*** and ***Figure 9.2 Illicit Discharge / Spill Tracking Form (Pg 2)***.

9.5 COLLABORATION

The City of Black Diamond encourages and supports collaboration efforts with other jurisdictions and agencies in educating the public on stormwater topics. The City of Black Diamond will look for opportunities to partner with neighboring jurisdictions, community organizations, or other groups. The benefits of collaborating with others to educate the public include consistent messages, as well as reduced costs for the City.

9.6 PROGRAM CUSTOMIZATION[16]

The City of Black Diamond's Public Education and Outreach Program should be customized to serve the City's population. The City can identify audiences for stormwater education in the community by using existing information, such as:

- Demographic information, such as age, income, or education
- Economic information, such as types of commercial or development activities
- Land-use data, pet licenses, population density, and home ownership statistics

The Washington State Department of Ecology recommends: "To identify behaviors to target, focus on specific local pollution problems. For example, if a stream flowing through your community has a bacteria pollution problem, you may choose to focus on encouraging pet owners to pick up their pet waste. For commercially zoned land areas and paved parking lots, you may target your efforts on reducing automotive fluid leaks on paved surfaces. In residential neighborhoods, education messages may emphasize natural yard care techniques."

9.7 DISTRIBUTION

There are various methods to disseminate the information to the City's target audiences. Examples that the City may wish to pursue may be:

- Publication in the City's regular City-wide newsletter
- Posting on the City's website

[16] "Focus on Stormwater Public Education and Outreach", Washington State Department of Ecology, 07-10-092, Oct. 2007.

Illicit Discharge Hotline Incident Tracking Sheet				
Incident ID:				
Responder Information				
Call taken by:			Call date:	
Call time:			Precipitation (inches) in past 24-48 hrs:	
Reporter Information				
Incident time:			Incident date:	
Caller contact information (*optional*):				
Incident Location *(complete one or more below)*				
Latitude and longitude:				
Stream address or outfall #:				
Closest street address:				
Nearby landmark:				
Primary Location Description	**Secondary Location Description:**			
☐ Stream corridor *(In or adjacent to stream)*	☐ Outfall	☐ In-stream flow	☐ Along banks	
☐ Upland area *(Land not adjacent to stream)*	☐ Near storm drain	☐ Near other water source (storm water pond, wetland, etc.):		
Narrative description of location:				
Upland Problem Indicator Description				
☐ Dumping	☐ Oil/solvents/chemicals	☐ Sewage		
☐ Wash water, suds, etc.	☐ Other: _____			
Stream Corridor Problem Indicator Description				
Odor	☐ None	☐ Sewage	☐ Rancid/Sour	☐ Petroleum (gas)
	☐ Sulfide (rotten eggs); natural gas	☐ Other: Describe in "Narrative" section		
Appearance	☐ "Normal"	☐ Oil sheen	☐ Cloudy	☐ Suds
	☐ Other: Describe in "Narrative" section			
Floatables	☐ None:	☐ Sewage (toilet paper, etc)	☐ Algae	☐ Dead fish
	☐ Other: Describe in "Narrative" section			
Narrative description of problem indicators:				
Suspected Violator (name, personal or vehicle description, license plate #, etc.):				

Figure 9.1 Illicit Discharge / Spill Tracking Form (Pg 1)

Investigation Notes	
Initial investigation date:	Investigators:
☐ No investigation made	Reason:
☐ Referred to different department/agency:	Department/Agency:
☐ Investigated: No action necessary	
☐ Investigated: Requires action	Description of actions:
Hours between call and investigation:	Hours to close incident:
Date case closed:	
Notes:	

Figure 9.2 Illicit Discharge / Spill Tracking Form (Pg 2)[17]

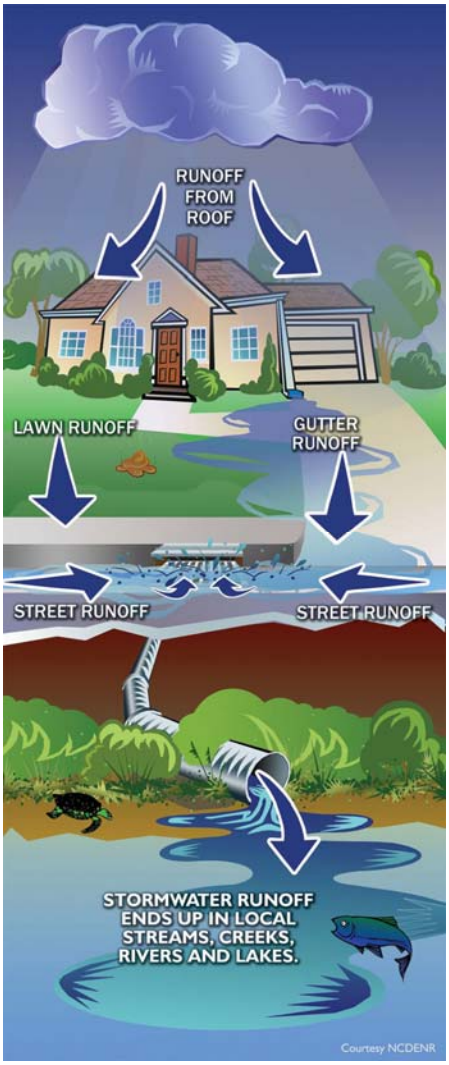
[17] "Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments", Appendix D, Center for Watershed Protection, October 2004.

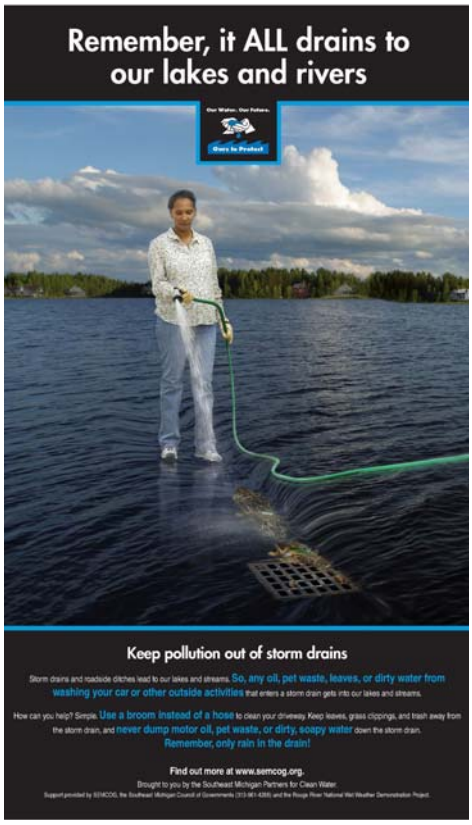
- Distribution of materials in conjunction with utility billings
- Handouts available at community meetings and / or community fairs
- Age-appropriate materials and training through the local schools
- Work with community groups such as Boy Scouts or Girl Scouts to develop programs for stenciling catch basins
- Materials available at the City Hall
- Targeted mailing to commercial business owners
- Community workshops focusing on stormwater topics
- Coordinate hazardous waste collection days throughout the year

9.8 SAMPLE PROGRAM MATERIALS[18]

The United States Environmental Protection Agency has a variety of materials available on their website to assist cities in developing their Public Education and Outreach programs. Many of these include copyright releases, or details on how to contact the creating agencies in order to obtain rights for use. In order to minimize initial program costs, it is recommended that the City utilize such materials. ***Figure 9.3 Public Education Samples – Stormwater***, ***Figure 9.4 Public Education Samples – Pet Care***, ***Figure 9.5 Public Education Samples – Vehicle Maintenance***, and ***Figure 9.6 Public Education Samples – Yard Care*** contain examples of the types of materials the City may wish to consider.

[18] "Nonpoint Source Outreach Toolbox", United States Environmental Protection Agency, Nov. 13, 2008, <http://www.epa.gov/nps/toolbox/>.





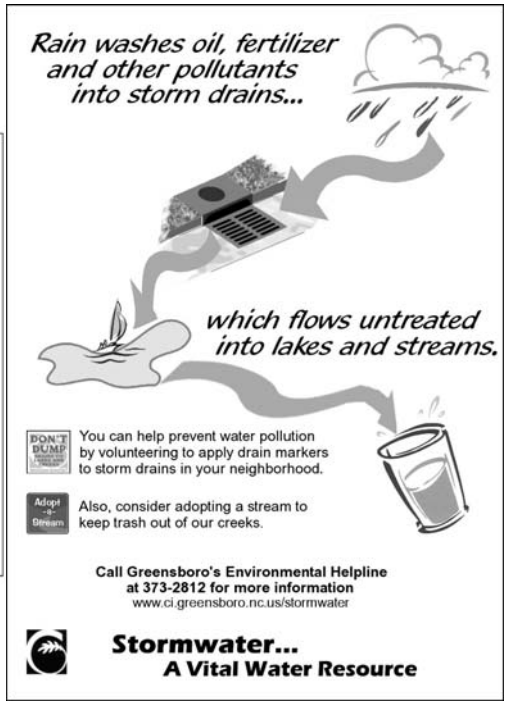


Figure 9.3 Public Education Samples – Stormwater

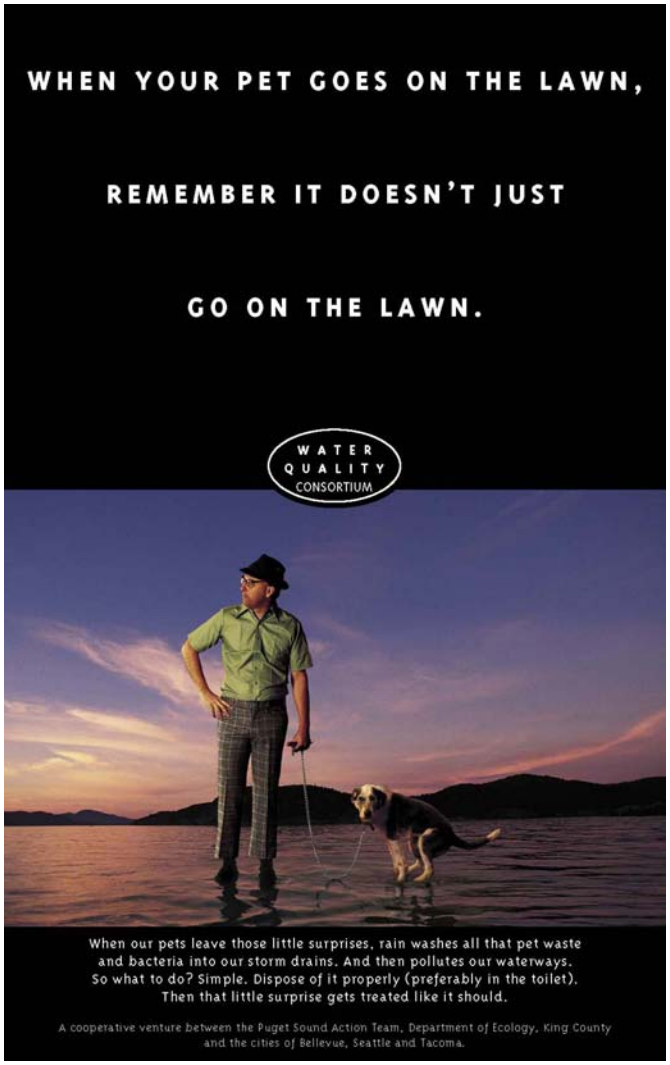
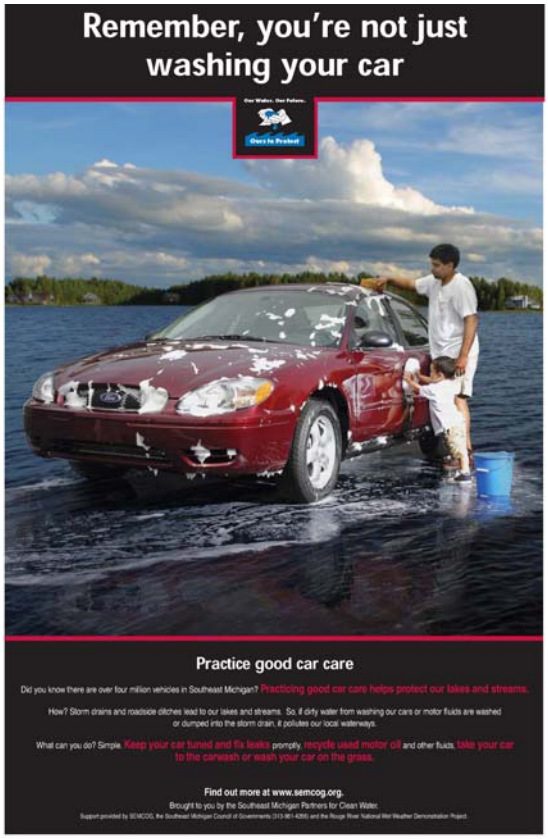


Figure 9.4 Public Education Samples – Pet Care



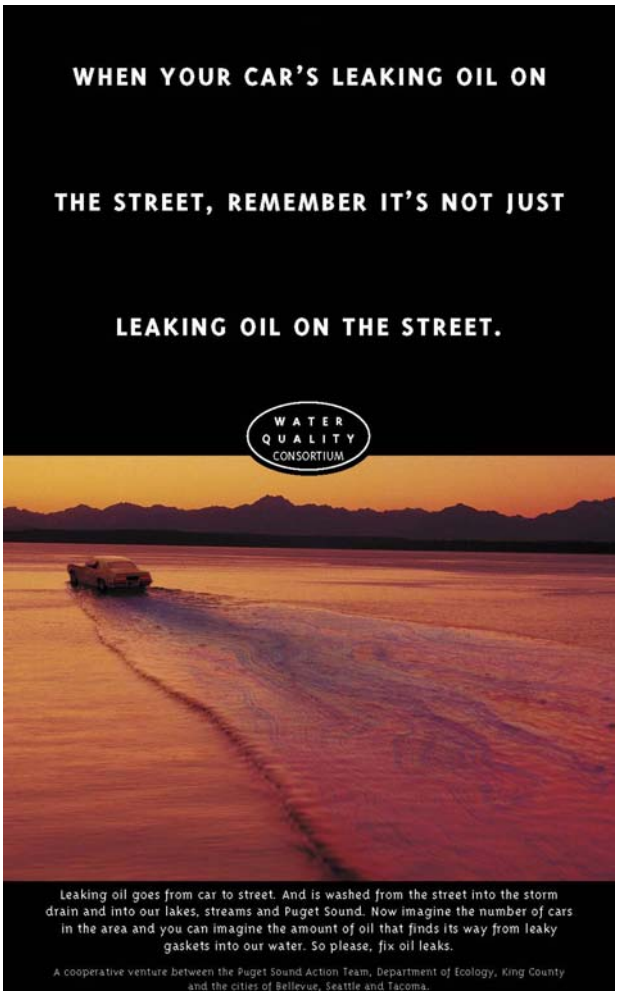
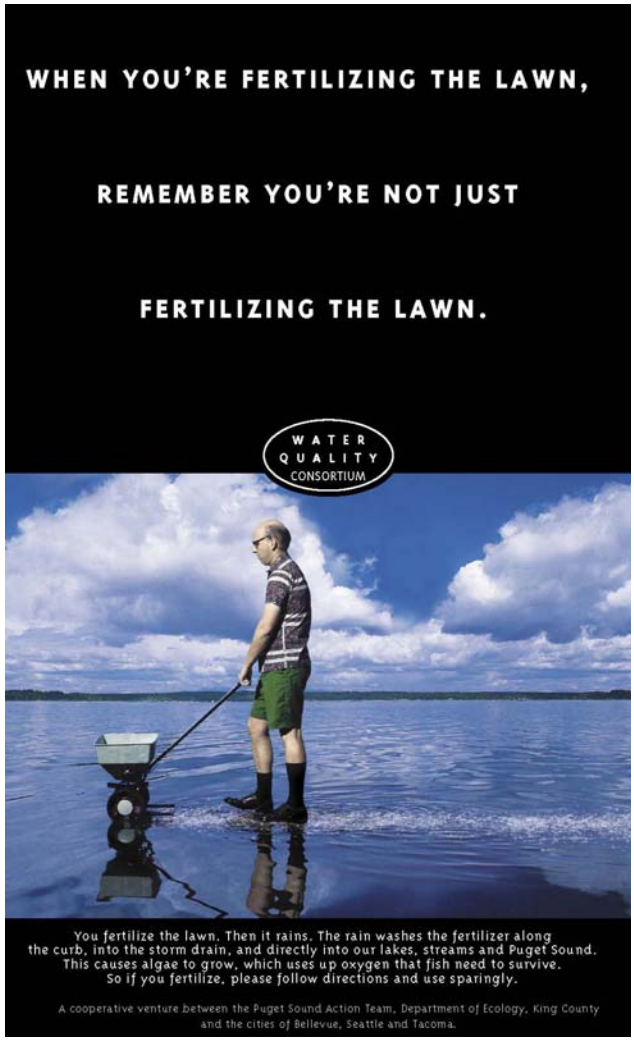


Figure 9.5 Public Education Samples – Vehicle Maintenance

PACWEST ENGINEERING LLC



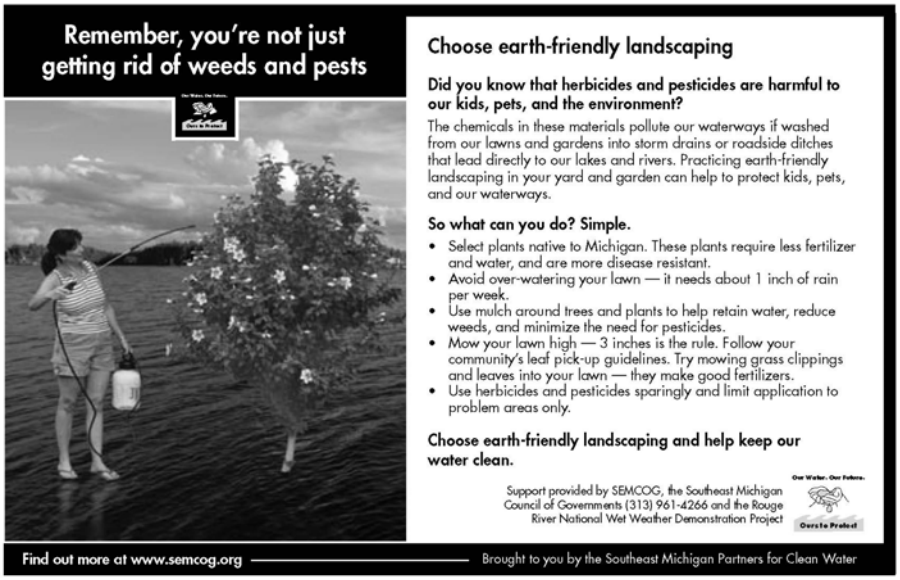


Figure 9.6 Public Education Samples – Yard Care

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10.0 LOW IMPACT DEVELOPMENT

10.1 INTRODUCTION TO LOW IMPACT DEVELOPMENT

Low impact development (LID) is a stormwater management and land development strategy applied at the parcel and subdivision scale that emphasizes conservation and use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely mimic predevelopment hydrologic functions. Most LID techniques infiltrate, filter, store, evaporate, and/or detain runoff as close to its original source as possible. The use of Low Impact Development techniques benefits the local creeks, streams, rivers, lakes, as well as ultimately the Puget Sound. The use of Low Impact Development may be in addition to, or in lieu of traditional stormwater management solutions.

Conventional stormwater management techniques typically address increases in peak flows from large, infrequent events, but not the increase in annual volume or the increase in peak flows from smaller, more frequent events. Studies have shown that Low Impact Development can infiltrate and treat 95 percent or more of the annual volume. Low Impact Development techniques are conducive to implementation into both new projects as well as redevelopment projects.

10.2 BENEFITS AND GOALS OF LOW IMPACT DEVELOPMENT

The City of Black Diamond encourages the use of LID techniques for stormwater management. Among other benefits, the use of LID techniques support a better-protected watershed hydrology which results in an enhanced aquatic habitat for many species.

The City recognizes the following benefits and goals of Low Impact Development:

- Maintain or restore the pre-developed condition surface water flow volumes, durations and frequencies
- Retain or restore native forest cover to capture, infiltrate and evaporate all or a portion of the rainfall on the site
- Cluster development and minimize land disturbance
- Preserve or restore the health and water-holding capacity of soils
- Incorporate natural site features that promote infiltration of stormwater
- Minimize total impervious surfaces and effective impervious surfaces
- Reduce or eliminate piped stormwater conveyance and conventional detention ponds
- Manage stormwater through infiltration, bioretention, and dispersion
- Manage stormwater runoff as close to its origin as possible

Low Impact Development often results in lower stormwater management costs. Initial construction costs are typically less for Low Impact Development due to the reduced size of the stormwater facilities and fewer control structures. Additionally, long term

maintenance and operation costs are typically less than those for traditional stormwater facilities.

10.3 LOCATIONS CONDUCIVE TO LID TECHNIQUES

The use of LID techniques is more appropriate in some locations rather than others. Low Impact Development should specifically be considered for the following:

- Sites located in a pothole sub-basin (i.e., draining to a closed depression)
- Sites that contain or are located adjacent to wetlands, riparian areas (such as rivers, streams, creeks, or swales), fish or wildlife habitat areas, or sub-basins tributary to these areas if changes in the land use will result in any negative impacts caused by the increase in volume or rate of surface water leaving or arriving to these areas
- Sites that are underlain by a critical aquifer recharge area
- Sites located within a designated open space area
- Sub-basins where preservation of trees is recommended by the City.

Furthermore, a map showing areas within the City that may be appropriate for Low Impact Development is shown in ***Figure 10.1 Low Impact Development***. A large scale copy of the map has also been included in ***APPENDIX M – LID Map***.

10.4 LID BMP'S

Some of the more common Best Management Practices (BMP's) for consideration are:

Bioretention – Construct landscaped areas with a special soil and plant mix that is conducive to filtering and storing runoff and is aesthetically attractive.

Disconnectivity – Direct runoff from impervious areas to landscaped and vegetated areas to reduce the volume of runoff, encourage groundwater recharge, and filter runoff.

Open Swales – Provide grass or other vegetated areas at the edges of roadways, parking lots, or other runoff-producing areas to slow and filter the runoff, promote infiltration, and remove pollutants.

Permeable Pavements – Install porous concrete, porous asphalt, geo-grid, or pavement blocks that allow water to flow to an underground gravel area where water can infiltrate and/or be slowly released.

Soil Amendment – Amending soils is a method of regaining some of the absorption and infiltration capability of the soil, and increasing the ability to retain runoff and filter pollutants.

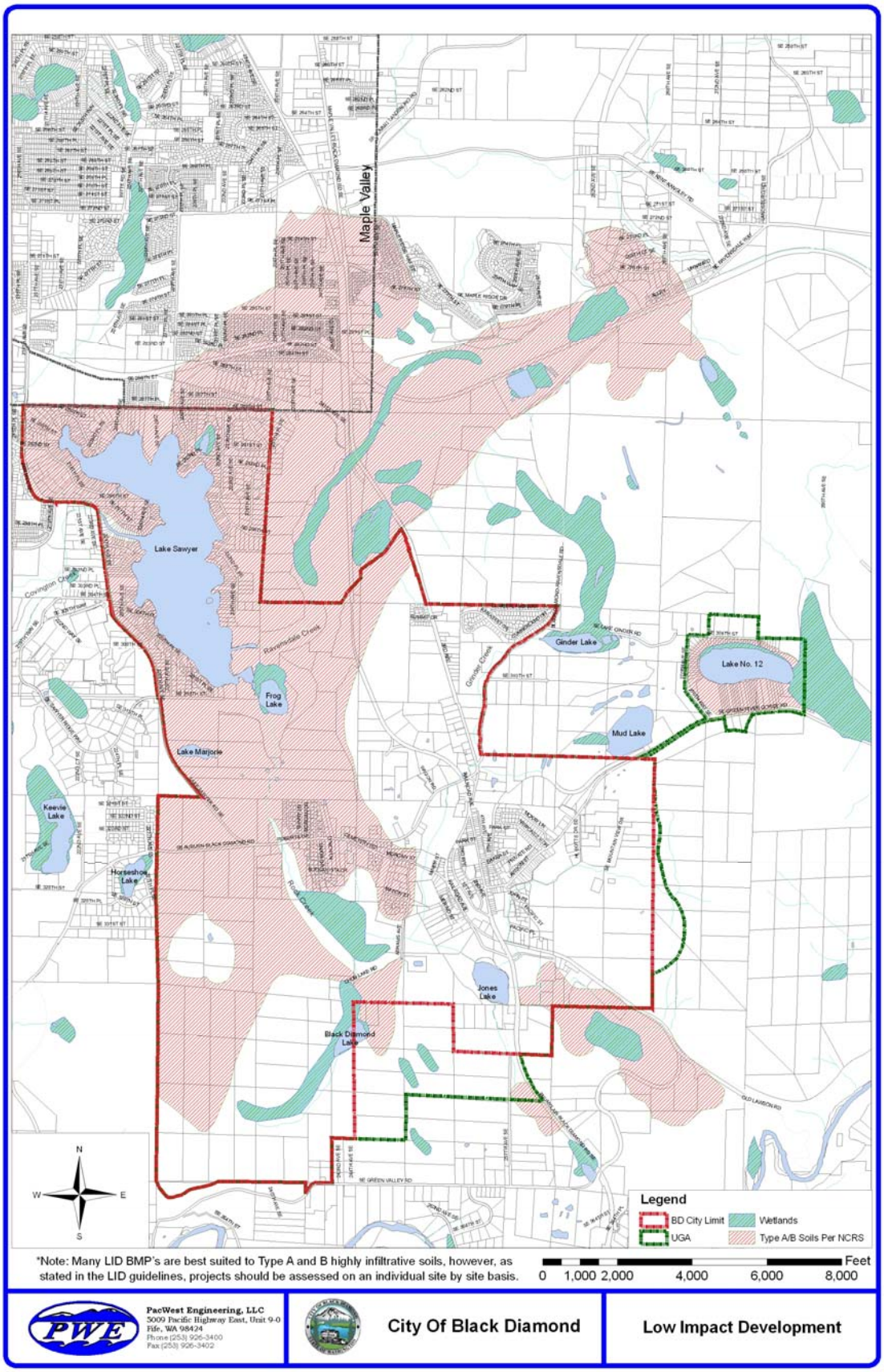

Figure 10.1 Low Impact Development

10.5 IMPLEMENTING LOW IMPACT DEVELOPMENT

It is recommended that the City of Black Diamond adopt LID Guidelines. A set of guidelines has been prepared and is included in ***APPENDIX N – LID Standards*** for consideration by the City. These guidelines will provide direction to land owners and developers.

APPENDIX A – Lake Sawyer Total Phosphorus TMDL

APPENDIX B – Stormwater Management Program (SWMP)

APPENDIX C – Existing Storm System Map

APPENDIX D – Basin Index Map

APPENDIX E – Drainage Sub-basin Hydrology and Culvert Hydraulics

APPENDIX F – Trunk-line Drainage Hydrology and Hydraulics

APPENDIX G – Water Quality Technical Report

APPENDIX H – "The Villages" Stormwater Management

APPENDIX I – "Lawson Hills" Stormwater Management

APPENDIX J – CIP Map

APPENDIX K – Project Cost Estimates

APPENDIX L – Maintenance Standards

APPENDIX M – LID Map

APPENDIX N – LID Standards

APPENDIX A – Lake Sawyer Total Phosphorus TMDL

Lake Sawyer
Total Phosphorus
Total Maximum Daily Load

Water Quality Implementation Plan

June 2009
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DEPARTMENT OF
ECOLOGY
State of Washington

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o	Eastern Regional Office, Spokane	509-329-3400

To ask about the availability of this document in a format for the visually impaired, call the Water Quality Program at 360-407-6404. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

* Cover Photo of Lake Sawyer by Mark Davis.

Lake Sawyer
Total Phosphorus
Total Maximum Daily Load

Water Quality Implementation Plan

by
Tricia Shoblom

Water Quality Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

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Executive Summary

Lake Sawyer has exceeded state standards for total phosphorus since the late 1980s. The Department of Ecology (Ecology) developed a total maximum daily load (TMDL) for phosphorus in Lake Sawyer in 1991, which set a target total phosphorus concentration for the lake at 16 μg/L. Lake Sawyer's water quality has generally improved since the TMDL was approved in 1993. Significant urban growth is scheduled to occur in the watershed over the next few years, which could have a negative impact on water quality. Ecology produced a technical memo titled *Effectiveness Monitoring for Total Phosphorus Total Maximum Daily Loads for Fenwick and Sawyer Lakes* in 2002 (Onwumere 2002). Ecology's Lake Sawyer Effectiveness Monitoring report concluded that the lake is meeting its long-term goal of reducing phosphorus, but further actions are still needed to control nutrient input from the watershed in order for the lake to maintain water quality standards into the future.

This *Lake Sawyer Total Phosphorus Total Maximum Daily Load Water Quality Implementation Plan* is the follow-up document to the *Lake Sawyer Total Phosphorus TMDL*. It provides a framework for corrective actions to address ongoing and future sources of phosphorus pollution in Lake Sawyer and the surrounding watershed. This implementation plan also incorporates recommendations from King County's Lake Sawyer Management Plan and other documents developed for Lake Sawyer.

Organizations involved in water quality improvement and TMDL implementation at Lake Sawyer include Lake Sawyer Community Club, King Conservation District, Lake Sawyer Steering Committee, King County Stormwater Division, King County Lake Stewardship Program (KCLSP), city of Black Diamond, Black Diamond City Council, city of Maple Valley, and Ecology. The Lake Sawyer Community Club will meet at least annually to discuss projects and may post implementation projects and updates on their webpage. King Conservation District will continue to advise and assist in situations involving small farms and livestock. The Lake Sawyer Steering Committee will serve as sounding board for implementation projects, monitoring updates, and adaptive management.

Municipal stormwater permit holders Black Diamond, Maple Valley, and King County will develop stormwater management programs and implement requirements of their respective permits. Permit holders will include actions to reduce phosphorus in stormwater to meet Lake Sawyer TMDL requirements. The phosphorus stormwater treatment menu will be applied to stormwater conveyed to Lake Sawyer by surface flow, as well as to stormwater infiltrated to unsuitable soils within one-quarter mile of the lake in accordance with the lake's *sensitive lake* designation.

The city of Black Diamond has been proactive in preparing for expected growth in the city, and updated several key components within the city's infrastructure. The city recently hired a Watershed Steward Director whose primary focus will be to coordinate with the residents in the Lake Sawyer Watershed and continue to actively seek out and implement new best management practices. Black Diamond contracts with King County's Lake Stewardship Program to continue monitoring phosphorus in Lake Sawyer to track trends and enable adaptive management.

Ecology will administer permits and manage TMDL implementation activities in the Lake Sawyer watershed with special attention to phosphorus. The Ecology Northwest Region Water Quality Lake Specialist will continue to coordinate TMDL-related activities and provide technical assistance for the Lake Sawyer Phosphorus TMDL. Ecology will conduct a minimum of three sampling surveys, at approximately six or more sampling sites in Lake Sawyer watershed, to help further define pollution sources and promote source correction. Ecology Northwest Region Municipal Stormwater Specialists will assist with municipal stormwater permit compliance. Ecology Northwest Region Grant Project Managers will assist grant applicants in developing stream restoration, lake restoration, and other water quality improvement projects.

All these watershed groups and agencies will have an active role in helping manage activities in the watershed in order to protect Lake Sawyer water quality. The Lake Sawyer Total Phosphorus Total Maximum Daily Load Water Quality Implementation Plan serves as an evolving document that will help guide the Lake Sawyer Steering Committee, as well as other interested parties, to track water quality trends and update best management practices suitable for implementation in the watershed. This implementation plan provides a timeline for when recommended projects will be completed, lists local government agencies and other entities that plan to implement projects, describes various funding opportunities, and promotes public involvement. Phosphorus TMDL reductions are expected to be achieved by 2014, and adaptive management measures are in place to help ensure this schedule will be met.

Introduction

Lake Sawyer is located in the city of Black Diamond, and is a significant regional recreational resource for the area. Lake Sawyer is 280 acres in size and its watershed encompasses approximately 8,300 acres. The watershed is divided into three sub-basins: Rock Creek, Ravensdale Creek, and the nearshore area of Lake Sawyer. Lake Sawyer serves as a pathway for late winter Coho salmon, which travel through the lake on their way to spawning grounds in Ravensdale and Rock Creek systems. Resident Rainbow Trout, Cutthroat Trout, Kokanee, and various warm water fish species are also present in Lake Sawyer (King County 2000).

In the 1970s, evidence of failing onsite septic systems in the Lake Sawyer watershed resulted in the decline of water quality of Rock Creek, Ginder Creek, and Lake Sawyer. To address this concern, the city of Black Diamond acquired funding from the Environmental Protection Agency's (EPA) Innovative and Alternative Grants Program to build a wastewater treatment plant. The treatment plant began operating in 1981 and was designed to discharge to a natural wetland next to Rock Creek, ultimately draining to Lake Sawyer. The innovative project soon failed, resulting in excessive nutrient loading to Lake Sawyer, prompting Ecology to set stricter effluent limits for the city of Black Diamond. In 1992, all wastewater from the treatment plant was diverted to Renton via King County's (Metro) sewer line.

In 1991, Ecology developed a total maximum daily load (TMDL), more commonly referred to as a water cleanup plan, for Lake Sawyer. A water cleanup plan is a numerical description of the amount of pollutant that a water body can accept and still meet state Water Quality Standards (Washington Administrative Code 173-201A). The *Lake Sawyer Total Phosphorus TMDL* set the total phosphorus concentration for Lake Sawyer at 16 µg/L. EPA approved the TMDL in 1993. Supporting documents for the *Lake Sawyer Total Phosphorus TMDL* include the *Lake Sawyer-Black Diamond Waste Load Allocation* (1989), *Diagnostic Study of Lake Sawyer* (1991), and the *Lake Sawyer Management Plan* (2000). These documents identify pollution sources to Lake Sawyer as well as in the surrounding watershed.

An Ecology technical memo titled *Effectiveness Monitoring for Total Phosphorus Total Maximum Daily Loads for Fenwick and Sawyer Lakes* (Onwumere 2002) determined that Lake Sawyer was not consistently meeting its TMDL goal of 16 µg/L, but may be meeting its long-term water quality goal. The report states that diverting Black Diamond's wastewater discharge from the natural wetland above Lake Sawyer to a sewer line reduced the majority of nutrient input to the lake and significantly helped the lake to recover. All aforementioned studies conclude that further actions still need to be taken to control nutrient input from the watershed in order for Lake Sawyer to meet and maintain water quality standards.

The Lake Sawyer management plan (LSMP) thoroughly examined both internal and external sources of phosphorus loading and identified the primary external sources of phosphorus in the watershed. Primary sources of total phosphorus include the sub-basins that drain to Lake Sawyer, (which include Rock Creek sub-basin, Ravensdale Creek sub basin, and the nearshore of Lake Sawyer sub-basin), nearshore septic systems, and rainfall contributions to the lake (King County 2000).

Internal sources of phosphorus were identified as aquatic plant decay, with the majority occurring in the fall, and through phosphorus-rich sediments being re-suspended into the water column during annual lake turnover, making the phosphorus-rich nutrients available to blue-green algae.

The LSMP describes best management practices (BMPs) for Lake Sawyer and its watershed that address sources of total phosphorus. The majority of the BMPs listed in the plan however, have not been implemented due to lack of funding. The LSMP made recommendations and set management goals to control excessive phosphorus loading to Lake Sawyer and its watershed.

This report, the *Lake Sawyer Total Phosphorus Total Maximum Daily Load Water Quality Implementation Plan* is the follow-up document to the *Lake Sawyer Total Phosphorus TMDL*. It provides a framework for corrective actions to address ongoing and future sources of phosphorus pollution in Lake Sawyer and the surrounding watershed. This implementation plan also incorporates recommendations from the LSMP and other documents developed for Lake Sawyer.

To effectively develop this water quality implementation plan, a committee of interested parties contributed to the development of the plan. The Lake Sawyer Steering Committee consists of representatives from Ecology; city of Black Diamond; King County; King Conservation District; Washington Department of Fish and Wildlife; the Muckleshoot Indian Tribe; and local watershed residents. The committee developed a plan of action that is in concert with meeting water quality goals for Lake Sawyer and maintaining a healthy ecosystem in preparation of expansive growth within the watershed in the near future.

The *Lake Sawyer Total Phosphorus Total Maximum Daily Load Water Quality Implementation Plan* provides a timeline for when recommended projects will be completed, lists local government agencies and other entities that plan to implement projects, provides various funding opportunities, and promotes public involvement.

In the following pages, we will discuss:

- The water cleanup process and why Lake Sawyer needs help.
- The Lake Sawyer Watershed and phosphorus pollution sources.
- Addressing the sources of phosphorus pollution in Lake Sawyer and its surrounding watershed.
- The participating parties involved in helping Lake Sawyer achieve clean water.
- Funding opportunities that may be available for implementation activities.

What is a Total Maximum Daily Load (TMDL)

Federal Clean Water Act requirements

The Clean Water Act (CWA) established a process to identify and clean up polluted waters. It requires each state to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of designated uses for protection, such as cold-water biota and drinking water supply, as well as criteria, usually numeric criteria, to achieve those uses.

To learn more about Washington State's Water Quality Standards, please visit Ecology's website link at http://www.ecy.wa.gov/programs/wq/swqs/index.html.

Every two years, states are required to prepare a list of water bodies – lakes, rivers, streams, or marine waters – that do not meet water quality standards. This list is called the 303(d) list of impaired water bodies. To develop the list, Ecology compiles its own water quality data along with data submitted by local state and federal governments, tribes, industries, and citizen monitoring groups. All data are reviewed to ensure that they were collected using appropriate scientific methods before the data are used to develop the 303(d) list. The 303(d) list is part of the state's larger Water Quality Assessment.

The Water Quality Assessment is a list that tells a complete story about the condition of Washington's water. This list divides water bodies into five categories:

Category 1 – Meets standards for parameter(s) for which it has been tested.

Category 2 – Waters of concern.

Category 3 – Waters with no data available.

Category 4 – Polluted waters that do not require a TMDL because:

- 4a. – Has a TMDL approved and it is being implemented.
- 4b. – Has a pollution control program in place that should solve the problem.
- 4c. – Is impaired by a non-pollutant such as low water flow, dams, culverts.

Category 5 – Polluted waters that require a TMDL – the 303d list.

TMDL process overview

The Clean Water Act requires a total maximum daily load (TMDL) be developed for each of the water bodies on the 303(d) list. The TMDL identifies pollution problems in the watershed and specifies how much pollution needs to be reduced or eliminated to achieve clean water. Then Ecology works with the local community to develop an overall approach to control the pollution, called the implementation strategy, and a monitoring plan to assess effectiveness of the water quality improvement activities. Once EPA approves the TMDL, a *Water Quality Implementation Plan* must be developed. This plan identifies specific tasks, responsible parties, and timelines for achieving clean water in Lake Sawyer.

Elements required in a TMDL

The goal of a TMDL is to ensure that impaired water will attain water quality standards. A TMDL includes a written, quantitative assessment of water quality problems and of the pollutant sources that cause the problem. The TMDL determines the amount of loading from a given pollutant that can be discharged to the water body and still meet water quality standards (the loading capacity) and allocates that capacity among the various sources.

If the pollutant comes from a discrete source (referred to as a point source), such as a municipal or industrial facility's discharge pipe, that facility's share of the loading capacity is called a wasteload allocation. If it comes from a set of diffuse sources (referred to as nonpoint sources), such as general urban, residential, or farm runoff, the cumulative share is called a load allocation.

The TMDL must also consider seasonal variations and include a margin of safety that takes into account any lack of knowledge about the causes of the water quality problem or its loading capacity. A reserve capacity for future loads from growth pressures is sometimes included in the TMDL. The sum of the wasteload and load allocations, the margin of safety, and any reserve capacity must be equal to or less than the loading capacity of the receiving water body.

Identification of the contaminant loading capacity for a water body is an important step in developing a TMDL. EPA defines the loading capacity as "the greatest amount of loading that a water body can receive without violating water quality standards" (EPA, 2001). The loading capacity provides a reference for calculating the amount of pollution reduction needed to bring a water body into compliance with water quality standards. The portion of the receiving water's loading capacity assigned to a particular source is a load or wasteload allocation. By definition, a TMDL is the sum of the allocations and other factors, which must not exceed the loading capacity.

TMDL = Loading Capacity = sum of all Wasteload Allocations + sum of all Load Allocations + Margin of Safety

What part of the process are we in?

Lake Sawyer's TMDL study was approved in 1993 by the Environmental Protection Agency (EPA). This *Lake Sawyer Total Phosphorus Total Maximum Daily Load Water Quality Implementation Plan* is the follow-up document to the *Lake Sawyer Total Phosphorus TMDL* (Ecology, 1993). It provides a framework for corrective and preventative actions to address ongoing and future sources of phosphorus pollution in Lake Sawyer and the surrounding watershed.

Why Ecology is Conducting an Implementation Plan in this Watershed

In the 1970s, evidence of failing septic systems in the watershed resulted in the decline of water quality for Rock Creek, Ginder Creek, and Lake Sawyer. To address this concern, the city of Black Diamond acquired funding from EPA's Innovative and Alternative Grants Program to build a wastewater treatment plant. The wastewater treatment plant began operating in 1981 and was designed to discharge to a natural wetland that discharged to Rock Creek, which in turn flows into Lake Sawyer. The wetland portion of the treatment plant soon failed, resulting in increased loading of phosphorus to Lake Sawyer.

In 1989, Ecology developed a TMDL wasteload allocation (WLA) for the Black Diamond wastewater treatment plant and concluded that a complete diversion of the wastewater treatment plant discharge from the Rock Creek drainage was necessary to protect the water quality of Lake Sawyer. It was also predicted that the lake would be eutrophic by the year 2010 if the diversion were not implemented. In 1991, all wastewater from the treatment plant was diverted to Renton via King County's (Metro) sewer line. The phosphorus WLA from the Black Diamond treatment plant to Lake Sawyer was set at zero. Furthermore, Ecology set an in-lake total phosphorus criterion of 16 μg/L to protect the lake's water quality. In 1993, EPA approved the Lake Sawyer TMDL study. In 2000, King County developed a lake management plan for Lake Sawyer that recommended best management practices to address sources of total phosphorus.

Since the diversion of the Black Diamond wastewater discharge, very little in the way of implementation has been performed in the Lake Sawyer watershed. Ecology produced a technical memo titled *Effectiveness Monitoring for Total Phosphorus Total Maximum Daily Loads for Fenwick and Sawyer Lakes*, which determined that Lake Sawyer was not consistently meeting its TMDL goal of 16 μg/L (Onwumere 2002). The report concluded that diversion of the city's wastewater to a Metro sewer line reduced the majority of nutrient input to the lake and significantly helped the lake to recover. However, the report further states that cumulative loading from internal phosphorus and increased fall and winter stormwater runoff will continue to elevate total phosphorus concentrations, even though some external sources of phosphorus to the lake have been eliminated. In addition, significant urban growth is planned in the Lake Sawyer watershed in coming years, which is expected to have a negative impact on water quality. The report concludes that the total phosphorus target concentration of 16 μg/L cannot be met or maintained without targeting further reductions of internal and external sources of total phosphorus.

This report, the *Lake Sawyer Total Phosphorus Total Maximum Daily Load Water Quality Implementation Plan* is the follow up document to the *Lake Sawyer Total Phosphorus TMDL* and provides a framework for corrective actions to address sources of phosphorus pollution in Lake Sawyer and the surrounding watershed. This implementation plan also incorporates recommendations from the LSMP and other documents developed for Lake Sawyer.

A committee of interested parties contributed significant recommendations to the development of this water quality implementation plan. The Lake Sawyer TMDL Steering Committee consists

of representatives from Ecology, city of Black Diamond, King County, King Conservation District, Washington Department of Fish and Wildlife, the Muckleshoot Indian Tribe and local watershed residents. Washington Department of Fish and Wildlife and the Muckleshoot Indian Tribe also provided technical assistance to the TMDL steering committee. The committee developed a plan of action that is in concert with meeting water quality goals for Lake Sawyer and maintaining a healthy ecosystem in anticipation of extensive future development within the watershed.

Why is phosphorus a problem?

Phosphorus is a basic element found in nature, and is also a primary nutrient that all living organisms need to survive. Lakes typically build up phosphorus levels as they age, and ultimately fill in with vegetation and sediment, a process that usually takes thousands of years. This process is called **eutrophication**. Increased amounts of phosphorus due to human activity can accelerate eutrophication and be detrimental to a lake's water quality and its beneficial uses (Figure 1). Higher levels of phosphorus from sediment, fertilizers, waste, and other sources can cause excessive plant and algae growth, which in turn may have unfavorable impacts to water clarity, aquatic habitat, fish survival, swimming, boating, and aesthetic enjoyment (Murphy et al. 2002). Human activities, such as home building, road construction, and deforestation, can drastically speed up a lake's aging process and adversely affect lake uses.

In lakes of the Puget Sound Lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus (Abella, 2009). Thus, for lakes such as Lake Sawyer, phosphorus is usually the main nutrient that drives the eutrophication process. Though other nutrients, such as potassium and nitrogen, can affect surface water quality, the amount of phosphorus being transported through various sources and pathways, such as human and animal waste, fertilizers, and stormwater in the watershed, often limits the amount of algal growth and aquatic plants (Minnesota Department of Agriculture, 2004). Nutrient levels generally determine a lake's level of biological activity or *trophic state*.

Figure 1. ***Blue-green algae bloom***. *Blue-green algae, as seen in this picture, thrive on excessive nutrients in water. When conditions are favorable, an algae bloom can cover the entire surface of a lake. Some species of blue-green algae can produce toxins, which can be harmful to humans and kill pets and wildlife. Photo by Eric Scollard.*

Lakes with low levels of biological activity are classified as *oligotrophic*. Those with moderate biological activity are *mesotrophic*. When lakes get older, or when they are polluted with excessive levels of nutrients and have high biological activity, they are considered *eutrophic*. Lakes with lower levels of biological activity have better water clarity and are more desirable for swimming and boating activities.

Lake Sawyer, like many lakes, experiences *thermal stratification*. This process generally occurs from June to mid-November and separates the lake into several distinct layers according to water temperature. The upper level of the lake, where water is relatively warm and continues to circulate is called the *epilimnion*. The deeper portion of the lake, that is much colder and denser, is called the *hypolimnion*. As phosphorus enters Lake Sawyer via tributaries, the nearshore area of the lake, and from the release of phosphorus from lake-bottom sediments, it can mix across the lake layers and effect the amount and timing of plant growth and algae blooms (Dion 1978) (Figure 2).

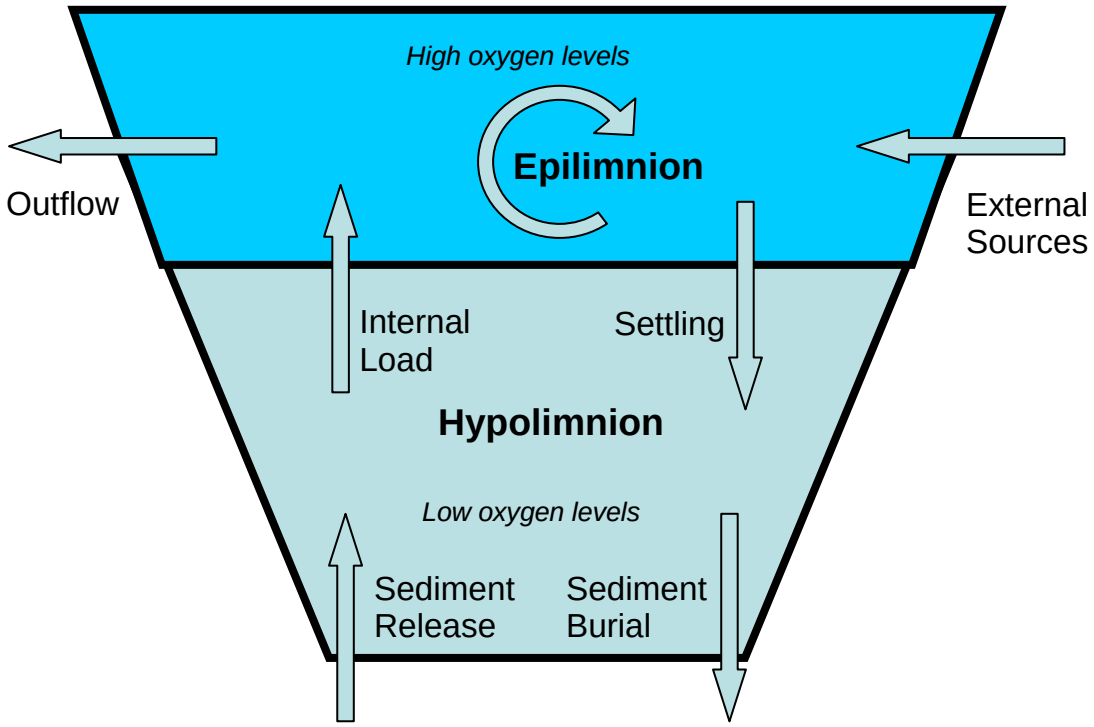

Figure 2. Phosphorus dynamics in Lake Sawyer. *Phosphorus is constantly cycling through the water column in Lake Sawyer. The amount of phosphorus available to algae in the epilimnion is dependent on phosphorus levels in external sources, the amount leaving the lake, and mixing with the hypolimnion.*

Washington State water quality criteria for phosphorus

In Washington State, a water body is considered polluted when it exceeds the thresholds set forth in the Washington State Water Quality Standards (WAC 173-201A). Unlike most pollutant parameters, the water quality standards do not have specific numeric criteria for total phosphorus, thus lake phosphorus capacity needs to be determined for each individual lake. A *loading capacity***,** or maximum amount of total phosphorus that can be introduced to Lake Sawyer, must be established (Figure 3) in order to protect the beneficial uses of the lake. A *target concentration* is developed to achieve the necessary reductions of total phosphorus loading to the lake epilimnion. Target concentration relates to the specific numeric concentration of phosphorus derived from modeling calculations.

Ecology's total phosphorus target concentrations vary by eco-region. Eco-regions are divided into Pacific Coast range, Puget Sound Lowlands, and Northern Rockies. Lake Sawyer lies within the Puget Sound Lowlands eco-region. More information about Washington State water quality criteria for lakes can be found in Appendix B of this document.

Lake Sawyer's inclusion on the state 303(d) list

Although the state of Washington does not have specific numeric criteria for phosphorus, the amount of total phosphorus entering a water body is used to determine a lake's trophic state. Lake Sawyer was not listed on Ecology's 1996, 1998, and 2002/2004 303(d) for total phosphorus, even though water quality data submitted to Ecology showed that the lake was still occasionally exceeding its total phosphorus limit of 16 μg/L (Figure 5). However, more recent data shows the lake is currently achieving its target limit, but short-term violations persist. The lake was placed in Category 4a on Ecology's 2008 water quality assessment, which means that the water is impaired but has an approved TMDL.

Components of a TMDL

1) **Wasteload allocations (WLA)**: Represents the contribution of discrete "point" sources of pollutants (e.g., municipal, industrial, and construction stormwater discharges);

2) **Load allocations (LA)**: Represent "nonpoint" sources of a pollutant, (natural sources, most agricultural activities, and other sources that are not regulated by an Ecology permit); and

3) **Margin of safety (MOS):** Allows for uncertainty in the estimation of, and ability to achieve, the previous two allocations.

Thus, the TMDL equation is as follows:

TMDL = WLA + LA + MOS

The sum of these three components may not exceed the **Loading Capacity**.

Figure 3. Components of a TMDL. *These three parts of a TMDL may not exceed the maximum amount of a pollutant that a water body can receive before it is considered polluted.*

Table 1. Loading Capacity Distribution. *Lake Sawyer's total phosphorus load capacity distribution from the 1993 TMDL study.*

Total Phosphorus (P) target in-lake average = 16 μg/L	
Total Phosphorus Source	**Loading capacity distribution (kg/June-August)**
Lake Sawyer	1.9 kg per day or (715 kg/yr)
Wasteload Allocation	0 kg per day for Black Diamond wastewater treatment plant
Tributaries Ravensdale Creek and Rock Creek	1.4 kg per day includes a 0.08 kg per day allocation for uncertainty
Internal Recycling	0.54 kg per day includes a 0.34 kg per day for uncertainty

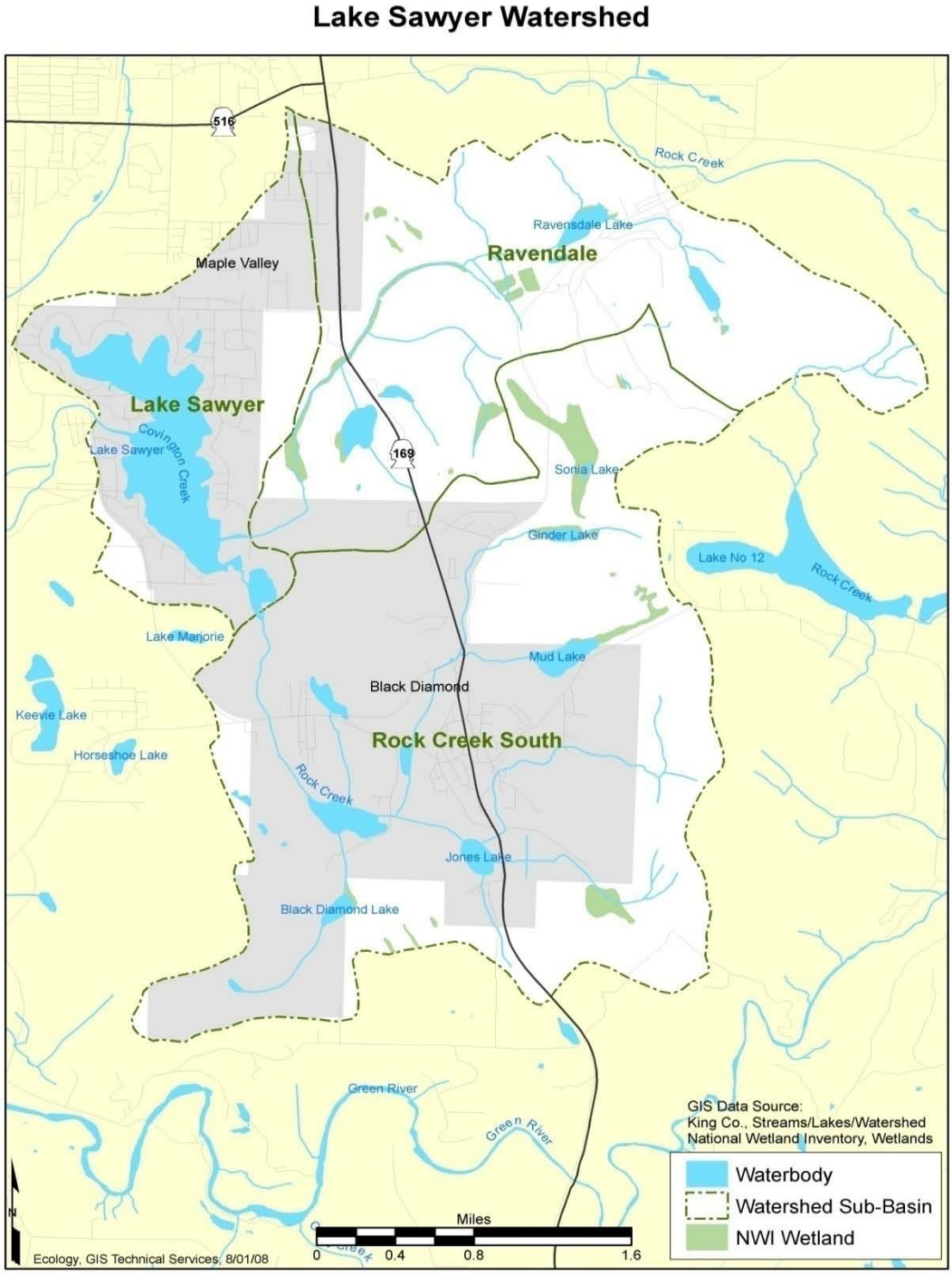

Figure 4. Map of Lake Sawyer Watershed. *The watershed includes the city of Black Diamond and a portion of the city of Maple Valley. Map provided by King County Lake Stewardship Program*.

Watershed Description

Lake Sawyer is located in the city of Black Diamond, and is a significant recreational resource for the area. Lake Sawyer is 280 acres in size and its watershed encompasses approximately 8,300 acres. The watershed is divided into three sub-basins: Rock Creek sub-basin is 4,454 acres (54%); Ravensdale Creek sub-basin is 2,532 acres (30%); and Nearshore area of Lake Sawyer is 1324 acres (16%) (Figure 4). As the fourth largest lake in King County, Lake Sawyer is a primary recreation area for swimming, boating, fishing, and aesthetic enjoyment (King County, 2000). As part of the Big Soos Creek Basin of the Green River Watershed, Lake Sawyer serves as a pathway for late winter Coho salmon that travel through Lake Sawyer on their way to spawning grounds in Ravensdale and Rock Creek systems. Resident Rainbow Trout, Cutthroat Trout, Kokanee, along with various warm water fish species are also present in the lake (King County, 2000).

Water quality in the Lake Sawyer watershed

Water quality in Lake Sawyer was relatively stable over the last decade, based on monitoring by King County Lake Stewardship Program (KCLSP) (Abella, 2009). Lake water temperature followed a pattern similar to other lakes in the region, with cool temperatures in winter and spring, and summer maximum temperatures occurring in July and August. Lake Sawyer temperatures ranged from 14 to 23 degrees Celsius during the May through October 2008 sampling season, with an average of 19 degrees. Compared to other lakes monitored in 2008 through the KCLSP, Lake Sawyer is generally in the lower range of summer temperatures.

Secchi transparency is a common method used to assess and compare water clarity. It is a measure of the water depth at which a black and white disk disappears from view when lowered from the water surface. Lake Sawyer Secchi transparency ranged from 3.0 m to 4.5 meters from May through October 2008, averaging 3.7 meters.

The ratio of nitrogen (N) to phosphorus (P) can be used to determine if conditions are favorable for the growth of cyanobacteria (bluegreen algae) that can impact beneficial uses of the lake. Total phosphorus and total nitrogen remained in relatively constant proportion to each other in Lake Sawyer through the 2008 sampling period, ranging from 21.5 to 61.2 with an average of 36.7. Since N:P ratios below 20 favor growth of cyanobacteria, conditions in Lake Sawyer were generally unfavorable for nuisance bluegreen algae growth in 2008 (Abella, 2009).

Long-term water quality sampling performed by King County's Lake Stewardship volunteer monitoring program led to Lake Sawyer's inclusion on the state's water quality assessment lists for 1996, 1998, and 2002/2004. Lake Sawyer has been monitored by King County Lake Stewardship Program and local volunteers since the early 1980s (King County 2000). Fecal coliform levels in Lake Sawyer and its tributaries are also noted as a public health concern, but the most recent monitoring data provided by King County shows that the lake is within water quality standards for bacteria.

Data from King County's Lake Stewardship Program show Lake Sawyer generally meeting its TMDL target of 16 µg/L phosphorus in recent years (Figure 5). The 16 µg/L phosphorus target has been met in the Lake Sawyer epilimnion since 1998, according to KCLSP measurements. However, more long-term monitoring of Lake Sawyer and its tributaries is needed before it can be determined that the lake is consistently meeting its phosphorus TMDL target.

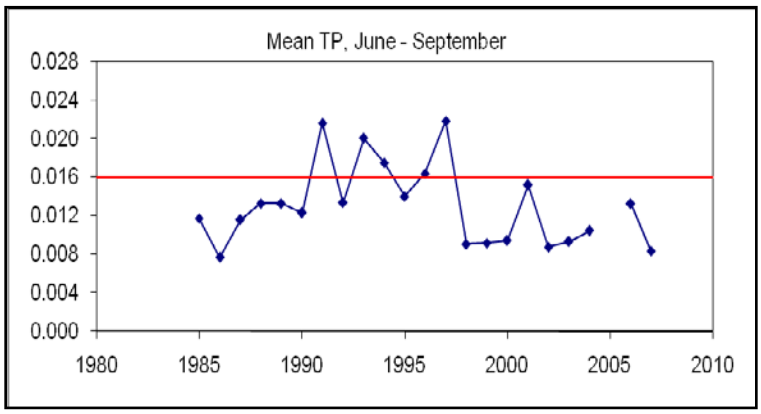

Figure 5. Average summer phosphorus in Lake Sawyer 1985-2007.
King County data shows Lake Sawyer meeting and exceeding its TMDL phosphorus target concentration of 16 µg/L.

In 1996, King County Surface Water Management developed the draft Lake Sawyer Management Plan with assistance from an Ecology Centennial Clean Water Fund grant (King County, 2000). The plan identified sources of phosphorus in the Lake Sawyer Watershed and made recommendations to reduce total phosphorus input to the lake (Figure 6). Specifically, the plan outlines 14 recommendations to address specific internal and external sources of pollution that contribute to phosphorus loading to Lake Sawyer. To date, the majority of the recommendations have not been implemented due to lack of funding. Management measures from the plan include stormwater controls, watershed measures, regional stormwater and phosphorus control, aquatic plant management and water quality monitoring activities.

Sources of phosphorus

Sources of phosphorus to Lake Sawyer can be categorized in various ways. In the Lake Sawyer Management Plan, phosphorus sources were classified by sub-basin and several general source pathways as shown in Figure 6 (King County, 2000). The majority of annual phosphorus loading to Lake Sawyer from external sources occurs in winter, during the period of highest stormwater runoff. Internal phosphorus loading from lake bottom sediments increases during late summer, often contributing to lake algal blooms in fall and early winter.

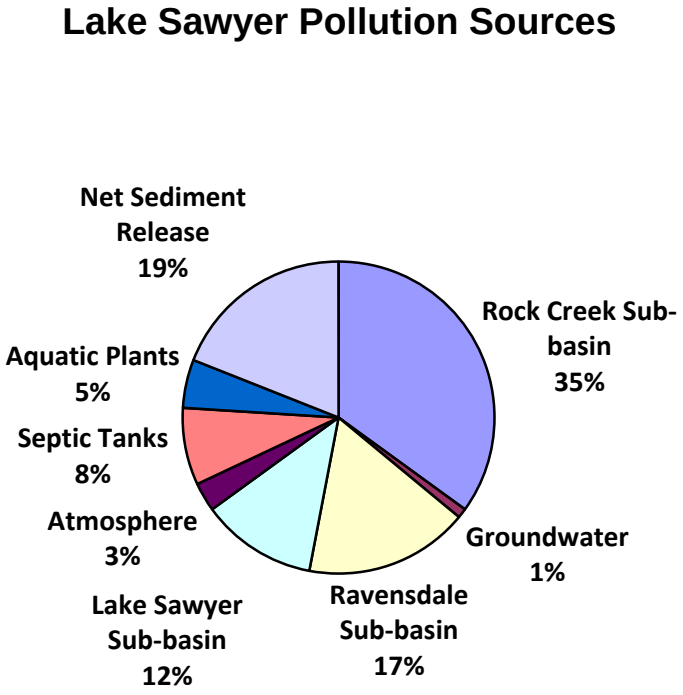

Figure 6. Pollution Loading Sources. *The Lake Sawyer Management Plan (2000) identifies eight pathways of phosphorus loading. The Pie graph shows relative loading from each source to Lake Sawyer.*

For the purposes of this implementation plan, sources of phosphorus are generally examined by type of land use activity, so that corrective actions can be more easily identified for them. These general sources of phosphorus include stormwater; construction activity; sediments; agriculture and hobby farms; home and automotive maintenance activities; onsite septic systems; loss of riparian habitat; wildlife; and aquatic plants. Most (approximately 76%) of the phosphorus loading comes from external sources to the lake (King County, 2000) (Figure 6). The majority of this phosphorus will not leave the lake, but rather will bind with lake sediments and recycle internally for years after being introduced. Therefore, it is important to address external pollution sources and control them to the greatest extent possible.

Table 2. Potential Phosphorus Pollution Sources. *The sources listed below are some of the most common activities associated with contributing pollutants to local water bodies (i.e., Lake Sawyer, Ravensdale and Rock Creeks) particularly excessive amounts of phosphorus.*

Potential Sources	Explanation
Stormwater • Municipal Stormwater • Construction Stormwater • Industrial Stormwater	Stormwater can transport: Small farm and residential pet waste, illegal sewer connections to storm drainage systems, nutrient runoff from excessive lawn and garden fertilization, sewage from failing onsite septic systems, car wash wastewater, and runoff from composting facilities.
Sediment	Often carries high levels of phosphorus because the rock material consists of phosphorus-containing minerals and phosphorus adsorbs to sediments.
Agriculture and Hobby Farms	Bacteria, nutrients, and surface runoff from improper grazing or manure management practices. Excessive use of fertilizers. Removal of riparian vegetation. Certain ditch maintenance practices.
Home and Automotive Maintenance	Improper use and disposal of soaps, fertilizers, pesticides, vehicle fluids, and other home-generated waste products.
Onsite Septic Systems	Malfunctioning septic systems could be caused by: Improper soil, lack of maintenance, construction, or improper use.
Loss of Riparian Habitat	Lack of shoreline vegetation to filter contaminants. Lack of buffer affects temperature, dissolved oxygen levels, and nutrients entering the Lake. Removal of shoreline vegetation can also contribute to the amount of untreated stormwater that can enter a water body.
Wildlife	Usually considered part of natural background levels. Exceptions are when a pollution source is created by man-made alterations of the environment, or when wildlife is being fed by humans rather than acquiring food on their own.
Aquatic Plants	Use phosphorus and other nutrients during growth period, but release phosphorus back into the water body during plant die-off.

Stormwater

In a watershed that is covered with natural vegetation and trees, water from rainfall or snowmelt is easily absorbed into the ground. Where natural vegetation has been altered, more water flows off the land to local streams. This water is commonly referred to as *stormwater* (Table 2). In lakeside and rural areas, lawns and animal pastures are good examples of where stormwater may carry phosphorus and other pollutants to Lake Sawyer. In more developed areas, stormwater is generated primarily by road surfaces, rooftops, driveways and other impervious surfaces, or by building activities (Ecology, 2005).

As stormwater moves through the watershed, it picks up all types of pollutants, including sediment; fertilizers; pet and wildlife waste; pesticides; vehicle fluids; and household product waste (Figure 7). As suburban areas grow, the amount of impervious surface increases and stormwater impacts become more prevalent. The loss in naturally vegetated area due to development is directly correlated with the amount of stormwater present in a watershed (Ecology, 2007a).

Figure 7. Stormwater Pollution. *Stormwater can carry a variety of pollutants including sediment, household products, metals, fertilizers, bacteria, and phosphorus. Some of these pollutants enter Rock and Ravensdale Creeks and eventually enter Lake Sawyer.*

Stormwater is the most significant source of pollution affecting Washington State waterways. It can carry bacteria from pet waste, runoff from failing onsite septic systems; sediment runoff; excess nutrients from lawns and gardens; and pollutants associated with activities such as construction and road building. The transport of pollutants via stormwater increases lake eutrophication, sedimentation, reduces water clarity; causes swim beach and shellfish closures and contaminate water wells (Ecology, 2007a).

As urban growth increases in the Lake Sawyer watershed, stormwater becomes more of a concern. To control stormwater and prevent it from further impacting Lake Sawyer, *best*

management practices (BMPs) must be implemented throughout the watershed. BMPs are tools and techniques that help to prevent environmental damage and are developed specifically to address a particular source of pollution. BMPs consist of physical structures such as stormwater treatment devices, activities like education and outreach to local residents, or practices such as chemical containment and street sweeping to prevent pollution.

Municipal Stormwater: Municipal stormwater refers to stormwater runoff from cities or other municipalities that enters their conveyance or system of conveyances (including roads with drainage systems; municipal streets; catch basins; curbs; gutters; ditches; manmade channels; or storm drains). Municipal stormwater conveyance systems are known as municipal separate stormwater sewer systems (or MS4s). Federal and state regulations address municipal stormwater through Ecology's Phase I and Phase II Municipal Stormwater Permit programs. The municipal stormwater permit allows permit holders to discharge stormwater to waters of state of Washington through municipal storm sewers. The Municipal Stormwater Permits require municipal permit holders to establish ordinances that prohibit non-stormwater discharges from entering stormwater systems, and apply controls to reduce the discharge of pollutants to maximum extent practicable (Ecology, 2007a).

In 1995, Ecology issued the first Phase I Municipal Stormwater Permit. The permit regulates discharges from MS4s owned or operated by King, Pierce, Clark, Snohomish Counties, as well as the cities of Seattle and Tacoma. The Phase I Municipal Stormwater Permit was re-issued in January 2007. Ecology also developed a Phase II Municipal Stormwater Permit for Western Washington that incorporates 80 cities and 5 counties, including Black Diamond and Maple Valley. The Phase II Municipal Stormwater Permit went into effect February 2007.

Both permits require the development of a *Stormwater Management Program* (SWMP) to reduce pollutant discharges and protect water quality in areas served by the MS4. All SWMPs must include public education; public participation; illicit discharge detection and elimination; construction runoff control; post construction runoff control; and pollution prevention and good housekeeping for municipal operations. The majority of the Lake Sawyer Watershed is located within the city of Black Diamond's jurisdiction; however a small portion of the watershed is in the city of Maple Valley, and the remainder is in the jurisdiction of King County. Therefore, the Lake Sawyer watershed is covered by both Phase I and Phase II Municipal Stormwater Permits.

Construction Stormwater: Construction activity can pollute water when phosphorus-rich disturbed soil is washed off a site and easily transported to water bodies. Ecology requires that a permit be obtained for all soil-disturbing activities (including grading, stump removal, demolition) where one (1) or more acres will be disturbed and stormwater will be discharged to a receiving water directly (e.g., wetlands, creeks, unnamed creeks, rivers, marine waters, ditches, estuaries), or to storm drains that discharge to a receiving water. If all stormwater is retained on site and cannot enter surface waters of the state under any condition, permit coverage is not required. Construction site operators must apply for a permit 60 days prior to discharging stormwater.

Industrial Stormwater: There is one Individual Industrial Stormwater permit in the Lake Sawyer Watershed, issued to Pacific Coast Coal Company (PCCC). Their coal mine site is located west of Lake Sawyer, and is also known as John Henry Coal Mine. PCCC is currently not actively mining, but accepting fill materials from various places, including filter cake from sand and gravel operations. PCCC expects to resume mining in the near future. PCCC discharges from four outfalls to three different receiving waters. The applicable receiving water quality standards are those adopted Ecology in WAC chapters 173-201A, 173-200. Outfall 001 discharges to Ginder Lake that flows along the western perimeter of the mine site prior to joining Mud Lake Creek just above the culvert underneath State Highway 169.

Ecology issued a Notice of Penalty (NOP No. 4162) to PCCC for violations of effluent limits for phosphate/total phosphorus between January 2005 and November 2006. PCCC has received both formal and informal enforcement actions since the company began operating in 1986. PCCC's individual permit (WA-003083-0) was re-issued by Ecology in early 2008 and the company has been in compliance with permit conditions since that time. Ecology set phosphorous limits for the mine as low as can be achieved using reasonable treatment methods.

In addition to the John Henry mine, there is a ~220-acre sand and gravel mine located near the south end of Lake Sawyer operated by the Palmer Coking Coal Company. Stormwater and process water discharges from the Palmer sand and gravel mine are covered under the Sand and Gravel General Permit (No. WAG 503007). Turbidity from the Palmer pit is limited by the permit to 50 nephelometric turbidity units (NTUs), which should help minimize phosphorus contributions from the mine site to Lake Sawyer. There are also wetlands located between Lake Sawyer and the mine site, which should help further treat runoff from the mine.

Sediment

Since phosphorus tends to adhere to sediment particles, sediment is a primary source of phosphorus. As sediment is transported through the Lake Sawyer Watershed, it will eventually make its way into Lake Sawyer. The amount of sedimentation received by Lake Sawyer has a direct effect on its trophic status. Although lakes naturally fill in over time, the process can be dramatically increased by human activities such as construction, agricultural practices, land development, and the removal of natural vegetation.

For smaller projects by homeowners near streams or ditches flowing to Lake Sawyer either directly or through one of its tributaries, preventing soil from running off site is perhaps the most economical and time-saving step. This plan recommends the following BMPs, which are proven to be effective in controlling sediment erosion:

1. Protect existing vegetation.
2. Install filter fences.
3. Lay down matting.
4. Re-seed exposed areas prior to performing any project, (i.e., construction, landscaping, or other disturbance) and consider possible effects to water quality.

Agriculture and hobby farms

The majority of land dedicated to caring for horses and other livestock is associated with homeowners and their personal stables (Figure 8). The range of land types used for residential livestock facilities is very diverse. For budgetary and other reasons, residential livestock owners frequently have limited area for grazing and exercise. Thus, many times horses and other livestock live in wooded conditions or are confined to small outdoor paddocks where grass and vegetation is quickly consumed or destroyed. Phosphorus-rich manure deposited by animals frequently finds its way into natural drainage corridors and becomes a source of water pollution.

Figure 8. Horse Facilities. *The average horse generates 50 pounds of manure per day (that's 8 tons per year not counting soiled bedding). This owner uses gravel, rubber mats, wood pellet bedding, interceptor drains, and frequent use of the dumping fork to prevent water pollution and improve compost quality. Composting manure is covered to prevent rain from carrying waste to surface water.*

Corrective/preventative actions: Like commercial facilities, horse and other livestock owners need to carefully manage their pastures and the manure produced by their animals. All small farms in proximity of a drainage conveyance should contact the King Conservation District to develop a farm plan and should implement the plan.

Home and automotive maintenance activities

Many of our everyday activities in and around our homes can have dramatic consequences for local water bodies. For example, storm sewer drains that remove excess water from our streets do not take the water to our local sewage treatment plant as one might believe. More likely, it is ultimately discharged to a local stream or lake. Car wash wastewater going to the nearest water body is a common problem (Figure 9). Whether we use biodegradable soap or some other type of soap, sudsy wash water from driveways and streets often ends up in a lake or

stream. Most people wouldn't dream of emptying dirty soapy water into the stream but that is often what happens.

Similarly, if water runs off a fertilized lawn, the same thing can happen. Although there are no suds to indicate the pollution, the phosphorus in the fertilizer can be washed away to the storm sewer. Pesticides and herbicides we put on our lawns are also found in urban creeks. These compounds act the same way in the water as they do on your lawn, and may kill off beneficial aquatic life. Common garden chemicals are now widespread throughout Puget Sound, and are damaging local waters.

Figure 9. What's wrong with this picture? *Although you can't drive your car onto a lake as shown in this picture, the ultimate destination of car wash wastewater can be Lake Sawyer if owners are not careful.*

Corrective/preventative actions: Consider alternatives to concrete or asphalt surfaces. Gravel, wood chips, and various types of porous pavers allow water to infiltrate through the ground much faster. These types of surfaces also allow pollutants such as oil, fertilizers and sediment to be contained while water is allowed to seep back into the ground. Ecology encourages a balanced approach between the natural landscape and individual property needs. Here are some other simple steps that homeowners can take to avoid polluting nearby water bodies.

- Reduce or use no chemical fertilizers on your lawn. Excessive use of fertilizers will only "feed" Lake Sawyer's nutrient problem, resulting in other problems such as frequent algal blooms and excessive plant growth.
- Use household products sparingly. Items such as cleansers, detergents, and auto fluids used around houses that are improperly disposed of can also be transported to the lake.
- Clean up hazardous material spills according to label directions.

- Maintain native plant vegetation to help stabilize the shoreline and filter pollutants.
- Avoid feeding wildlife.
- Wipe up spills with an absorbent material. Store all household and automotive products in tightly sealed, leak-proof containers. Using water to rinse away material can transport chemicals and contaminants to streams and lakes.
- Mulch grass clippings and leaves to naturally fertilize your lawn. Mulch/plant exposed soil as soon as possible after disturbing soil and use sediment barriers when necessary.
- Wash your car on your lawn or take it to a salmon-friendly car wash. Car washing water, excess fertilizer, pet waste, and anything else that can dissolve in water will travel in stormwater runoff and eventually pollute local water bodies.

For more information on household product disposal and alternatives to using such products, contact:

King County at 206-296-4692 or 1-888-TOXIC-ED or
http://www.govlink.org/hazwaste/house/index.cfm

King County's Water and Land Resources Division provides several different alternatives to car washing. To get a car wash kit from King County log on to: http://dnr.metrokc.gov/wlr/pi/carwash_res.htm.

Onsite septic systems

Onsite septic systems (OSS), both community-based and individual systems, are not a problem when designed, sited, and operated properly (Figure 10). A properly functioning OSS uses the soil surrounding the drainfield to remove bacteria and some nutrients from the wastewater. However, soil compaction, clogging of the soil with solids, and hydraulic overload can all cause a failure of the system to adequately treat wastewater to meet quality standards for bacteria.

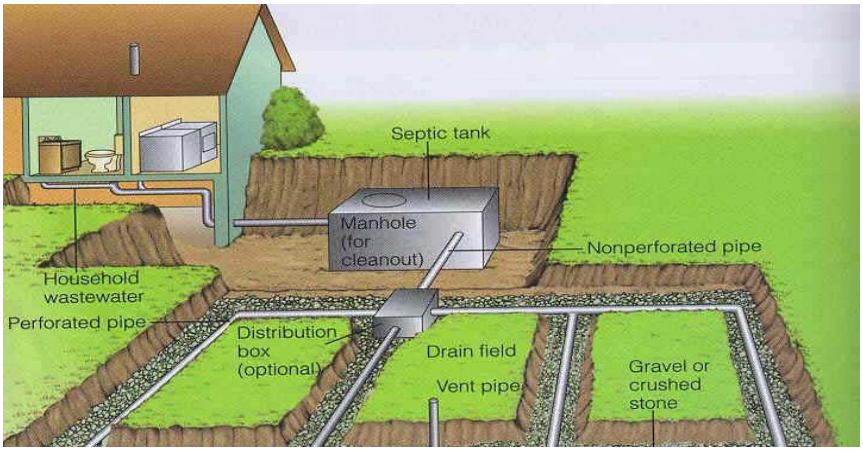

Figure 10. Onsite Septic Systems. *Onsite Septic Systems require servicing. If you have a septic system, and the ground is wet and smells bad, you should have your system inspected.*

Signs of OSS failure include:

- Odors, surfacing sewage, wet spots, or lush vegetation in the drainfield area.
- Plumbing or septic tank backups.
- Slow draining fixtures, and gurgling sounds in the plumbing system.

If wastewater surfaces as described, it is possible that wastewater could go directly to a nearby stream or ditch and contribute phosphorus to Lake Sawyer. Connecting septic systems to stormwater sewers or piping them directly to surface waters is occasionally discovered and is illegal. Another problem observed in some older septic systems is the subsurface movement of wastewater through extremely porous soils.

Corrective/preventative actions: To assist the 100,000 King County households with septic onsite sewage systems, Public Health's new Operation and Maintenance Program offers tips to improve the longevity of onsite systems and protect the community's health. For more information about the King County Wastewater Program go to: http://www.metrokc.gov/health/wastewater/ or call 206-296-4932. This program also applies to Black Diamond residents.

House Bill 2322 was recently passed into law, which restricts the amount of phosphorus in dishwashing detergent. The new law complements a 1993 law banning phosphates in laundry detergent, and prohibits distribution of any dishwashing detergent that contains more than 0.5 percent of phosphorus by weight. Washington State is the first state in the Union to restrict the amount of phosphorus for dishwashing detergent. The law will be effective statewide by 2010. For more information see Ecology's Reducing Phosphorus website: http://www.ecy.wa.gov/programs/wq/nonpoint/phosphorus/PhosphorusBan.html

Loss of riparian habitat

Riparian zones are defined as the transition zone between land and water environments. This particular area of the lake plays a valuable role in improving and protecting water quality. Riparian zones can be made up of grasses, shrubs, trees, roots, and submersed aquatic plants. Adequately sized and healthy riparian buffers help filter out a variety of pollutants, stabilize shorelines, reduce flooding, and provide food and shelter for wildlife.

Healthy riparian habitat benefits local waters in many ways such as:

Filtering runoff: Excess water runoff from yards and driveways, which carry sediment and other pollutants are filtered and removed by riparian plants.

Bank stabilization: Native plant buffers extending from down the water's edge can be the most efficient way to stabilize a bank and prevent erosion.

Preservation of aquatic habitat: Riparian areas can provide habitat for fish, protection from predators, and provide nesting areas for sensitive species of birds or amphibians.

Aesthetics: Though land owners may have varying ideas of what is aesthetically-pleasing, most agree that viewing wildlife in a somewhat natural setting is important. Leaving a natural riparian buffer in place provides natural habitat, noise reduction, and privacy to homeowners as well (Pennsylvania Association of Conservation Districts).

Corrective/preventative actions: Vegetated buffers should be placed (or left in place) between the lake and shoreline. This plan encourages all affected landowners and developers to maximize buffer widths consistent with reasonable land use expectations and meeting the goal of providing shade and maintaining natural stream and lake landscapes. Lake-side homes should explore natural landscape practices rather than having green, fertilized lawns up to the water's edge. Buffer sizes and plant communities should be designed to filter runoff, stabilize stream banks, and preserve aquatic habitat.

Wildlife

Wildlife is a natural and healthy part of our environment. Problems can arise when in certain situations animals are being fed by humans by way of improper storing of garbage or by intentionally leaving food out. This can lead to prolific reproduction or an interruption in animal behavior such as the seasonal migration of certain bird species. In order to avoid drastic measures, such as euthanizing animals that have been deemed as nuisances, it best to not feed wildlife and allow to them forage for food and to maintain their natural instincts and behaviors.

Aquatic plants

Excessive aquatic plant growth can be an indication of too much phosphorus loading in a lake. A comprehensive list of aquatic plant species in Lake Sawyer is listed in Table 3. Most of these plants are both native and beneficial to the lake and provide habitat and food for local wildlife. However, *White waterlily*, *Yellow flag iris*, and *Eurasian watermilfoil* are examples of invasive, noxious aquatic weeds found in abundance in Lake Sawyer (Figure 11). Their excessive growth leads eventually to plant die-off and decay in lake sediments, adding an additional source of internal phosphorus loading. Excessive amounts of aquatic noxious weeds can interfere with native fish populations, out-compete native aquatic plants, and restrict recreational opportunities.

White waterlily

Yellow flag iris

Eurasian watermilfoil

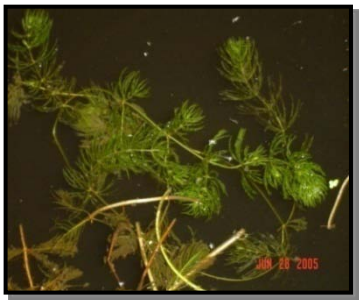

Figure 11. Noxious aquatic weed species found in Lake Sawyer.
Eurasion Watermilfoil photo by Margaret Hill. Other photo sources unknown.

Every effort should be made to eradicate or control noxious and invasive weeds. There are a variety of mechanical, manual, or chemical options available. To learn more about aquatic plant control visit Ecology's website:

http://www.ecy.wa.gov/programs/wq/links/plants.html

A complete list of aquatic plant species found in Lake Sawyer is shown in Table 3.

Table 3. Lake Sawyer Aquatic Plant List.

Scientific Name	**common name**
Ceratophyllum demersum	Coontail; hornwort
Chara sp.	muskwort
Elodea canadensis	common elodea
Hydrocotyle ranunculoides	water-pennywort
Iris pseudacorus	yellow flag iris
Juncus sp. or Eleocharis sp.	small grass-like plants
Lemna minor	duckweed
Ludwigia palustris	water-purslane
Lysimachia nummularia *Megalodonta beckii*	creeping loosestrife
Megalodonta beckii	water marigold
Myosotis sp.	forget-me-not
Myriophyllum sibiricum	northern watermilfoil
Myriophyllum spicatum	Eurasian watermilfoil
Najas flexilis	common naiad
Nitella sp.	stonewort
Nuphar polysepala	spatter-dock, yellow waterlily
Nymphaea odorata	fragrant white waterlily
Polygonum amphibium	water smartweed
Potamogeton gramineus	grass-leaved pondweed
Potamogeton illinoensis	Illinois pondweed
Potamogeton praelongus	whitestem pondweed
Potamogeton pusillus	slender pondweed
Potamogeton robbinsii	fern leaf pondweed
Potamogeton sp (thin leaved)	thin leaved pondweed
Potamogeton sp.	pondweed
Potamogeton zosteriformis	eel-grass pondweed
Scirpus sp.	bulrush
Sparganium sp.	bur-reed
Stuckenia pectinata	sago pondweed
Typha angustifolia	lesser cat-tail
Typha latifolia	common cat-tail
unknown plant	unknown
Utricularia sp.	bladderwort
Utricularia vulgaris	common bladderwort
Wolffia sp.	water-meal

Washington State Department of Ecology

What Will be Done

Implementation strategy

This water quality implementation plan outlines specific projects that are either planned or recommended for the Lake Sawyer watershed in order for the lake to continue to attain its water quality goal of 16 μg/L total phosphorus. Ecology recognizes the many projects that have already occurred in the watershed due to the efforts of the watershed community and local government, and acknowledges current progress toward improved water quality in Lake Sawyer. The maintenance of acceptable total phosphorus levels in Lake Sawyer will continue to take effort on the part of all stakeholders. Improving Lake Sawyer phosphorus levels is expected to be a slow process, especially because of internal loading, and may take several years to see measurable results.

Ecology is the primary agency charged with developing an implementation plan addressing both current and future impacts to water quality. But this plan cannot be accomplished without the combined effort and support of local agencies and watershed residents. Below is a brief summary of implementation actions that have occurred to date as well as current actions that have been developed by the Lake Sawyer Water Quality Implementation Steering Committee.

1. From 1983 to 1992, Black Diamond operated an innovative wastewater treatment plant that discharged all of the city's wastewater to a natural wetland, part of the Rock Creek drainage.
2. In1989, Ecology conducted a Phase I lake study concluding that the wetland portion of the wastewater treatment system had failed and was significantly increasing nutrient loading to lake. Excessive blue-green algae blooms were also present.
3. In 1992, the wastewater treatment plant was shut down, and all wastewater from the plant was re-routed to King County's Metro sewer line in Renton.
4. In 1998, Lake Sawyer was designated as a phosphorus-sensitive lake under King County's Surface Water Design Manual. This is the first year a sensitive lake treatment menu is included in the manual.
5. The Lake Sawyer Management Plan was finalized in 2000, in cooperation with EPA and Ecology. Many of the activities in the plan were not executed due to lack of funding.

Ecology's 2002 effectiveness monitoring report reviewed available water quality data collected by King County. The report concluded that Lake Sawyer is meeting its long-term goal of reducing phosphorus, but further actions are still needed to control nutrient input from the watershed in order for the lake to meet and maintain water quality standards into the future.

Organizations involved in cleanup efforts

1) Lake Sawyer Community Club
2) King Conservation District
3) Lake Sawyer Steering Committee
4) King County Stormwater Division
5) King County Lake Stewardship Program (KCLSP)
6) City of Black Diamond

7) Black Diamond City Council
8) City of Maple Valley
9) Washington Department of Ecology

Lake Sawyer Community Club (LSCC)

The Lake Sawyer Community Club is a non-profit organization. *"The purpose of the LSCC is to bring together all Members in good standing to inform and discuss mutual problems, concerns and interests affecting our community, the Lake, and our surrounding environment."* LSCC Bylaws (Article II). For more information about current events and updates, see LSCC website: http://www.lakesawyer.org/.

TMDL expectations: LSCC should continue to meet at least annually to discuss implementation projects that are occurring and propose new projects that will help address water quality problems in the watershed. The LSCC should post all current implementation projects and updates on their webpage, which can serve as an excellent information tool to educate citizens about best management practices for the Lake Sawyer watershed and provide current general information about lake water quality. LSCC is an important entity and should make every effort to stay informed on water quality issues. As noted in the Lake Sawyer Management Plan, LSCC should continue to build partnerships with shoreline residents, local government, and other stakeholders in the watershed.

King Conservation District

King Conservation District is a natural resource agency that provides education and technical assistance to landowners, schools, and consultants**.** All landowners within the district boundaries are entitled to free information and technical assistance for water quality protection, wildlife habitat enhancement, farm management plans, soil, and slope stability information. The district also provides native plant products, manure exchange information, volunteer opportunities, stream restoration/enhancement assistance, and information on many other natural resource topics. http://www.kingcd.org/aboutkcd.htm.

TMDL expectations: KCD should continue to provide guidance and technical assistance to residents within the watershed. KCD should continue to work with small farms, equestrian facilities, and any landowners that seek support in developing strategies for water quality protection, manure management, farm plan development, and stream rehabilitation. Ecology is interested in working with KCD on projects that help reduce phosphorus loading to Lake Sawyer.

Lake Sawyer Steering Committee

The Lake Sawyer Steering Committee (LSSC) consists of representatives from Ecology, King County Lake Stewardship Program, Lake Sawyer Community Club, King Conservation District**,** Washington Department of Fish and Wildlife; the Muckleshoot Indian Tribe and the city of Black Diamond.

TMDL expectations: LSSC should continue to meet at least annually to discuss

implementation projects that are occurring, assess the effectiveness of those projects, and propose new projects that advance TMDL goals within the watershed. The committee is an important entity for watershed improvement and should continue to make every effort to stay informed on water quality issues.

King County Stormwater Division

A portion of the Lake Sawyer Watershed is under the jurisdiction of King County. King County is responsible for implementing its Phase I Municipal Stormwater Permit in all areas under its jurisdiction. Under the permit, King County is required to develop a stormwater management program (SWMP) which applies to their municipal separate storm sewers (MS4s), and areas served by their MS4s. To the extent allowable under state and federal law, all SWMP components are mandatory and are discussed below.

1. **Legal authority**
   No later than the effective date of the permit, each permit holder must demonstrate that they can operate pursuant to legal authority which authorizes or enables the permit holder to control discharges to and from their MS4s.
2. **Municipal separate storm sewer system mapping and documentation**
   The SWMP includes an ongoing program for mapping and documenting the MS4.
3. **Coordination**
   The SWMP includes coordination mechanisms among departments within each jurisdiction to eliminate barriers to compliance with the terms of the permit. The SWMP also includes coordination mechanisms among entities covered under a municipal stormwater NPDES permit to encourage coordinated stormwater-related policies, programs, and projects within a watershed.
4. **Public involvement and participation**
   The SWMP provides ongoing opportunities for public involvement in the permit holder's stormwater management program and implementation priorities.
5. **Controlling runoff from new development, redevelopment, and construction sites**
   The SWMP includes a program to prevent and control the impacts of runoff from new development, redevelopment, and construction activities. The program applies to private and public development, including roads.
6. **Structural stormwater controls**
   SWMPs include a program to construct structural stormwater controls to prevent or reduce impacts to waters of the state caused by discharges from the MS4. Impacts addressed include disturbances to watershed hydrology and stormwater pollutant discharges. The program considers impacts caused by stormwater discharges from areas of existing development, including runoff from highways, streets, and roads, and areas of new development, where impacts are anticipated as development proceeds. The program addresses impacts that are not adequately controlled by other required actions of the SWMP, and provides proposed projects and an implementation schedule.

7. **Source control program for existing development**
   The SWMP includes a program to reduce pollutants in runoff from areas that discharge to the Permit holder's MS4.
8. **Illicit connections and illicit discharges detection and elimination**
   The SWMP includes an ongoing program to detect, remove and prevent illicit connections and illicit discharges, including spills, into the Permit holder's MS4.
9. **Operation and maintenance program**
   The SWMP includes a program to regulate and conduct maintenance activities by the Permit holder that prevent or reduce stormwater impacts.
10. **Education and outreach program**
    SWMPs include an education program aimed at residents, businesses, industries, elected officials, policy makers, planning staff, and other employees of the Permit holder. The goal of the education program is to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts. An education program may be developed locally or regionally.

Lake Sawyer was designated as a sensitive lake by King County in 1998, when the county adopted their Surface Water Design Manual. The county's sensitive lake designation means that King County's manual will be applied to all areas within the Lake Sawyer Watershed under jurisdiction of the county. King County's manual is consistent with Ecology's 2005 Stormwater Management Manual for Western Washington and contains standards and requirements for surface and stormwater management systems in King County. The Manual includes a Sensitive Lake Protection Menu which applies to all stormwater conveyed to the lake by surface flow as well as stormwater infiltrated within one-quarter mile of Lake Sawyer in soils with high infiltration rates. The Sensitive Lake Protection Menu section of the manual is designed to achieve a goal of 50 percent total phosphorus (TP) removal.

TMDL expectations: King County is expected to fully implement all requirements of their Phase I Stormwater Permit, which includes public education and outreach, public involvement, illicit discharge detection and elimination, construction site stormwater, post-construction stormwater, and pollution prevention for municipal operations. King County must continue to require removal of phosphorus as provided in Section 6.1.3 of the King County Surface Water Design Manual. With the additional TMDL expectations noted in this paragraph, compliance with the permit constitutes compliance with the TMDL. To learn more about King County's Phase I Municipal Stormwater Permit, log onto the following website:
http://www.ecy.wa.gov/programs/wq/stormwater/municipal/phaseIpermit/phipermit.html

King County Lake stewardship program

The King County Lakes Stewardship Program (KCSLP) is a division of King County Department of Natural Resources and Parks, Water and Land Resources Division. KCLSP "empowers citizens to act as stewards of their lakes and watersheds through education and technical assistance." KCSLP documents trends in water quality, encourages citizen lake stewardship, and provides educational outreach and technical support to lake residents. You can learn more about the KCSLP by visiting their website at:
http://dnr.metrokc.gov/wlr/waterres/smlakes/.

TMDL expectations**:** This plan recommends that KCLSP continue to work with residents of Black Diamond and Maple Valley to document lake water quality trends and encourage lake stewardship. Ecology also recommends that KCLSP participate actively in the adaptive management of this TMDL and continue to provide leadership in the development of a water quality sampling program for Lake Sawyer and its tributaries in order identify and control phosphorus inputs to Lake Sawyer.

City of Black Diamond

The city has a critical role in protecting the water quality of Lake Sawyer and its watershed. The city is responsible for implementing its Western Washington Phase II Municipal Stormwater Permit, providing technical assistance, education and outreach opportunities to residents, and seeking out funding opportunities for implementation.

The city of Black Diamond is covered under Ecology's Western Washington Phase II Municipal Stormwater Permit, which authorizes discharge of stormwater to their MS4. The Phase II Municipal Stormwater Permit prohibits non-stormwater discharges into storm sewers that discharge to surface water, and applies controls to reduce the discharge of pollutants to the maximum extent practicable. Permit holders are required to develop a stormwater management program (SWMP), including a set of actions and/or activities to meet the requirements of applicable TMDLs. The city of Black Diamond's SWMP shall be designed to reduce the discharge of pollutants, including phosphorus from MS4s to the maximum extent practicable, meet the state's all known, available, and reasonable methods of treatment (AKART) requirements, and protect water quality. The SWMP shall contain the following components:

1. **Public education and outreach**
   SWMPs include an education program aimed at residents, businesses, industries, elected officials, policy makers, planning staff and other employees of the permit holder. The goal of the education program is to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts.
2. **Public involvement and participation**
   SWMPs include ongoing opportunities for public involvement through advisory councils, watershed committees, participation in developing rate-structures, stewardship programs, environmental activities or other similar activities.
3. **Illicit discharge detection and elimination**
   The SWMP includes an ongoing program to detect and remove illicit connections, discharges as defined in 40 CFR 122.26(b)(2), and improper disposal, including any spills not under the purview of another responding authority, into the MS4. Permit holders must fully implement an ongoing illicit discharge detection and elimination program no later than 180 days prior to the expiration date of the permit.
4. **Controlling runoff from new development, redevelopment and construction sites**
   Permit holders must develop, implement, and enforce a program to reduce pollutants in stormwater runoff to a regulated MS4 from new development, redevelopment, and construction sites. This program is applied to all sites that disturb a land area one acre or greater, including projects less than one acre that are part of a larger common plan of

the development or sale. The program applies to private and public development, including roads.

5. **Pollution prevention and operation and maintenance for municipal operations** Within three years of the effective date of the permit, each permit holder must develop and implement an operations and maintenance (O&M) program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations.

The majority of the Lake Sawyer Watershed is located within the city of Black Diamond's jurisdiction; however, a small portion of the watershed is in the jurisdictions of Maple Valley and unincorporated King County. Therefore, both the Phase I Municipal Stormwater NPDES Permit and Western Washington Phase II Municipal Stormwater Permit will be implemented within the watershed.

Black Diamond will adopt Ecology's 2005 Stormwater Management Manual for Western Washington by August 2009, which requires the following phosphorus treatment menu be implemented for water bodies with TMDLs.

Phosphorus treatment menu: This menu applies to stormwater conveyed to Lake Sawyer by surface flow, as well as to stormwater infiltrated within one-quarter mile of the lake in soils that do not meet the soil suitability criteria in Chapter 3 of Volume III of the manual. The menu applies to projects within watersheds that have been determined by local governments, Ecology, or the USEPA to be *sensitive* to phosphorus, such as Lake Sawyer, and that are being managed to control phosphorus inputs from stormwater.

Performance goal: The phosphorus treatment menu facility choices are intended to achieve a goal of 50% phosphorus removal for a range of influent concentrations of 0.1 – 0.5 mg/l total phosphorus. In addition, the choices are intended to achieve the basic treatment performance goal which applies to the water quality design storm volume or flow rate, whichever is applicable, on an annual average basis. The incremental portion of runoff in excess of the water quality design flow rate or volume can be routed around the facility (off-line treatment facilities), or can be passed through the facility (on-line treatment facilities) provided a net pollutant reduction is maintained. Ecology encourages design and operation of treatment facilities that engage a bypass at flow rates higher than the water quality design flow rate. This is acceptable, provided that the overall reduction in phosphorus loading (treated plus bypassed) is at least equal to that achieved with initiating bypass at the water quality design flow rate.

Water quality monitoring: Black Diamond currently contracts with the King County Lake Stewardship Program to coordinate a volunteer water quality monitoring program for Lake Sawyer. King County staff trained several lake residents to collect accurate water quality data.

Community development
Black Diamond is strongly encouraged to aggressively implement low impact development (LID) on a construction sites. Projects that maintain, restore or improve natural hydrologic processes should be given significant consideration in the prioritization of capital improvement and public land acquisition projects.

Critical areas ordinance
Black Diamond is currently updating its critical areas ordinance. The ordinance will require a 225 foot setback from core wetlands as identified by the city. Black Diamond purchased a GIS system and plotter to help identify and map the city's stormwater system and outfalls.

Onsite septic system maintenance
The city is strongly encouraged to develop a city-wide septic system maintenance program, similar to King County's on-site maintenance program. The city should also institute an inspection component to its program in order to identify and correct malfunctioning systems.

Pet waste stations
The city should identify public common areas where pets are frequently present. These identified areas should be installed with pet waste dispensers and educational stations. Public areas include, but are not limited to parks, trails, walkways, and any other places the city deems appropriate.

Local partnerships
The city of Black Diamond recently hired a Watershed Steward Director whose primary duties will be to provide technical assistance to watershed residents, coordinate with state and local governments, develop watershed implementation projects, and provide education and outreach opportunities to local watershed residents.

Citizens of Lake Sawyer developed a collaborative partnership (a sub-committee of the Lake Sawyer Water Quality Implementation Steering Committee) with Black Diamond's Watershed Steward Director. The newly-formed committee will initially begin focusing on the following education and outreach projects:

- Develop a newsletter about information on upcoming events and general environmental education and good steward practices.
- Network with other lake groups and cities in neighboring watersheds to exchange ideas and experiences in watershed management.
- Develop a natural yard care series for local residents.
- Explore the possibility of forming a lake management district.

TMDL expectations: Black Diamond must continue to require removal of phosphorus as provided in Volume V, Section 3.3 of the 2005 Ecology Western Washington Stormwater Manual. The city is strongly encouraged to continue implementing a water quality monitoring program in coordination with implementation projects within the watershed so that improvement or decline in water quality can accurately be determined. *Source detection*

monitoring is also an invaluable tool that can help identify and address sources of pollution quickly. With the additional TMDL expectations noted in this paragraph, compliance with the permit constitutes compliance with the TMDL.

Black Diamond City Council

The city operates "under a strong mayor form of government with five elected members serving four year terms. The council acts as the legislative body for Black Diamond and when the city's population reaches 5,000 residents, the council will expand to seven-members." The council regulates expenditures, incurs debt, and approves the final operating cost and budget for the city.

TMDL expectations**:** The council should continue to support water quality protection standards, implementation projects as they are developed by staff, and carry out permit requirements as detailed under the city's Phase II Stormwater Permit.

City of Maple Valley

A small portion of the city of Maple Valley is located in the upper northwest corner of the Lake Sawyer Watershed. Maple Valley is a permit holder under Ecology's Western Washington Phase II Municipal Stormwater Permit. The permit authorizes discharge of stormwater to Maple Valley's MS4. The Phase II Municipal Stormwater Permit prohibits non-stormwater discharges to storm sewers that discharge to surface water, and applies controls to reduce the discharge of pollutants to the maximum extent practicable. Permit holders are required to develop a stormwater management program (SWMP) including actions and/or activities to meet the requirements of applicable TMDLs. The Maple Valley SWMP shall be designed to reduce the discharge of pollutants including phosphorus from MS4s to the maximum extent practicable, meet state AKART (all known, available, and reasonable methods of treatment) requirements, and protect water quality. The SWMP shall contain the following components:

1. **Public education and outreach**
   The SWMP includes an education program aimed at residents, businesses, industries, elected officials, policy makers, planning staff, and other employees of the city. The goal of the education program is to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts.
2. **Public involvement and participation**
   The SWMP includes ongoing opportunities for public involvement through advisory councils, watershed committees, participation in developing rate-structures, stewardship programs, environmental activities, or other similar activities.
3. **Illicit discharge detection and elimination**
   SWMPs include an ongoing program to detect and remove illicit connections, discharges as defined in 40 CFR 122.26(b)(2), and improper disposal, including any spills not under the purview of another responding authority, into the MS4. Permit holders must fully implement an ongoing illicit discharge detection and elimination program no later than 180 days prior to the expiration date of the permit.

4. **Controlling runoff from new development, redevelopment, and construction sites** The permit holder must develop, implement, and enforce a program to reduce pollutants in stormwater runoff to the MS4 from new development, redevelopment, and construction sites. This program applies to all sites that disturb one acre or more of land area, including projects less than one acre that are part of a larger common plan of the development or sale. The program applies to private and public development, including roads.
5. **Pollution prevention and operation and maintenance for municipal operations** Within three years of the effective date of the permit, each permit holder shall develop and implement an operations and maintenance (O&M) program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations.

Maple Valley has also officially adopted the 2005 Stormwater Management Manual for Western Washington. The following requirements from the 2005 Stormwater Manual are particularly relevant for the Lake Sawyer TMDL.

Phosphorus Treatment Menu: This menu applies to stormwater conveyed to Lake Sawyer by surface flow as well as to stormwater infiltrated within one-quarter mile of the lake in soils that do not meet the soil suitability criteria in Chapter 3 of Volume III of manual. The menu applies to projects within watersheds that have been determined by local governments, Ecology, or the USEPA to be *sensitive* to phosphorus, such as Lake Sawyer, and that are being managed to control phosphorus inputs from stormwater. The phosphorus menu facility choices are intended to achieve a goal of 50% phosphorus removal for a range of influent concentrations of 0.1 – 0.5 mg/l total phosphorus.

Some of Maple Valley's current education and outreach activities for citizens include:

- Natural yard care workshops.
- Articles on water quality issues aimed at the general public published in a quarterly newsletter.
- Storm drain stenciling program.
- Adopt a road litter pickup.
- Signage on proper pet waste disposal posted.

Water quality monitoring: City of Maple Valley is familiar with lake protection and lake monitoring as they are currently contracting with King County Lake Stewardship Program to coordinate a volunteer water quality monitoring program for Lake Wilderness. King County staff trained several lake residents to collect accurate water quality data. The city agreed to apply their knowledge and experience to the portion of their jurisdiction which is in the Lake Sawyer watershed.

TMDL expectations: Maple Valley must continue to require removal of phosphorus as provided in Volume V, Section 3.3 of the 2005 Ecology Western Washington Stormwater Manual. The city should also continue to investigate and require new technologies for phosphorus removal as they become available and are both reasonable and achievable to implement. Maple Valley is strongly encouraged to continue implementing a water quality

monitoring program and to include drainages within the Lake Sawyer watershed if available. Monitoring should be in coordination with implementation projects within the watershed so that improvement or decline in water quality can accurately be determined. *Source detection monitoring* is also a useful tool that can help identify and address sources of pollution quickly. To learn more about the city's stormwater management plan, log onto the following website:

http://www.ci.maple-valley.wa.us/pw/pw.asp

With the additional TMDL expectations noted in this paragraph, compliance with the permit constitutes compliance with the TMDL.

Washington State Department of Ecology

Ecology has been delegated authority by the EPA to implement many aspects of the federal Clean Water Act. This includes National Pollution Discharge Elimination System (NPDES) permitting and the total maximum daily load (TMDL) program. The Lake Sawyer watershed is under the jurisdiction of Ecology's Northwest Regional Office (NWRO). To address the municipal permitting needs of this TMDL, the NWRO has municipal stormwater specialists who provide technical assistance and auditing activities for the Phase I and Phase II municipal stormwater permits across the region.

Ecology's NWRO also has a team of inspectors that oversee compliance with stormwater permits issued to the Washington State Department of Transportation (WSDOT) and nonpublic entities. When technical assistance is not effective or is inappropriate, the NWRO also has two staff responsible for preparing enforcement actions for this team to ensure compliance with NPDES permits.

Ecology's lake specialist is assigned to develop and help implement the Lake Sawyer Total Phosphorus TMDL, and will assist all parties in coordinating TMDL-related activities. Ecology's Northwest Regional Office also has environmental specialists who are available to provide assistance with ambient monitoring and source identification monitoring projects. Ecology's Environmental Assessment Program may assist in conducting additional effectiveness monitoring in approximately five years to determine if Lake Sawyer is meeting water quality goals.

Ecology also helps local governments with funding for water quality facilities and activities through the Centennial Clean Water Fund, 319 Fund, and State Revolving Loan Fund. The full range of Ecology funding opportunities is listed under the section "Funding Opportunities." Ecology's Grant Managers assist local government to develop stream restoration and water quality improvement projects. Ecology is responsible for organizing meetings of the Lake Sawyer Steering Committee, no less than annually, and will lead or be present at additional meetings as requested by the committee.

TMDL expectations**:** Ecology should continue providing the current level of support for implementing this plan and assisting with compliance with the municipal stormwater permits. It is essential to the success of this TMDL that Ecology continue to coordinate TMDL activities within the Lake Sawyer Watershed and continue to provide grant funding opportunities to assist in funding TMDL-related activities.

Adaptive management

Adaptive management is the process by which strategies can be changed if it is determined that the implementation approach currently in place is not being implemented or Lake Sawyer water quality goals set forth in the Lake Sawyer TMDL are not being met. The Lake Sawyer Implementation Plan's first three years will focus on the successful implementation of BMPs, monitoring, and stormwater management actions associated with the municipal and construction stormwater permits. As the permitting programs are put into place and BMPs and other implementation activities are completed, evaluation of their success will be assessed through effectiveness monitoring.

Historical flow data for Ravensdale and Rock Creeks is not sufficient to determine if the creeks are exceeding the loading capacity of 1.4 kg/L. Currently, Lake Sawyer data demonstrate the lake is meeting its target of 16 μg/L. However, if lake water quality does not continue to meet water quality goals, it will be necessary to reassess the pathways and further identify the sources of phosphorus. If new sources of phosphorus loading are identified, they will be corrected through the proper entity. TMDL reductions should be achieved by 2013. Partners will work together to monitor progress towards these goals, evaluate successes, obstacles, and changing needs, and make adjustments to the cleanup strategy as needed.

It is ultimately Ecology's responsibility to assure that cleanup is being actively pursued and water standards are achieved.

Table 4. Implementation Summary Table

Organization	Recommended Action	Sc		
		2009	2010	
Lake Sawyer Community Club	Education and outreach activities accomplished through its website and newsletter.			
	Continue to work with Black Diamond's Watershed Steward and the Lake Sawyer Steering Committee.			
	Recruit volunteers to perform rehabilitation projects around the lake and its tributaries, perform water quality monitoring, and encourage local residents to implement best management practices on their own properties.			
King Conservation District	Provide guidance and technical assistance to residents within the watershed.			
	Continue to assist local farms in developing and implementing farm plans that minimize polluted runoff.			
Lake Sawyer Steering Committee	Meet at least annually to discuss implementation projects occurring in the watershed.			
	Assess water quality improvement and identify trends.			
City of Black Diamond	Implement the Phase II Stormwater Permit and additional actions in this plan.			
City of Maple Valley	Implement the Phase II Stormwater Permit and additional actions in this plan.			
King County Stormwater Division	Implement the Phase I Stormwater Permit and additional actions in this plan.			
King County Lake Stewardship Program	Provide technical assistance to the city and local residents.			
	Continue to implement a water quality monitoring program for Lake Sawyer along with volunteers from the watershed.			
City of Black Diamond Watershed Steward Director	Coordinate with Lake Sawyer Watershed residents and actively seek out new best management practices. Continue to work closely with Ecology's municipal stormwater and construction permit managers to develop a Stormwater Management Plan (SWMP) and to ensure compliance with the city's permit. Participate as an active member of the Lake Sawyer steering committee. Seek funding for implementation projects.			
Black Diamond City Council	Continue to support implementation efforts in the Lake Sawyer Watershed. Provide necessary funding to help support efforts. Continue to support water quality protection efforts and finalize the updated Black Diamond Critical Areas Ordinance.			
Black Diamond Parks	Develop park plans that help protect and enhance water quality and natural areas. Install pet waste stations in all applicable areas in order to control phosphorus and bacterial pollution from reaching any waterbody or stormwater conveyance system.			
Washington	Provide the current level of support for implementing this lake phosphorus improvement plan and the municipal stormwater permits.			

Organization	Recommended Action	Sc		
		2009	2010	
Department of Ecology	Continue to coordinate TMDL activities within the Lake Sawyer Watershed and provide grant funding opportunities to assist lake phosphorus improvement activities.			

Measuring Progress toward Goals

Progress of the Lake Sawyer Phosphorus Implementation Plan will be measured by 1) assessing the implementation projects completed and 2) direct measurement of water quality. The primary goal in accomplishing these strategies will be to meet and maintain the state's water quality criteria for the lake characteristic use. Implementation projects (Table 4) currently identified in the plan are education and outreach, restoration, monitoring, and assessment. Ecology will track implementation projects annually, and review construction and municipal stormwater permit coverage with the aid of Ecology inspectors and permit managers.

Measurement of water quality will be performed by volunteer monitors trained by King County Lake Stewardship Program (KCLSP). Twice a month from May to September, volunteers sample Lake Sawyer to measure total phosphorus, chlorophyll *a*, total nitrogen, and phytoplankton. Temperature, Secchi depth, precipitation, and lake level are also collected by volunteers weekly throughout the year. This direct measurement of lake water quality will help document whether implementation efforts have been successful and may indicate what other actions are needed in the watershed.

Monitoring

Successful identification of phosphorus sources, source control, adaptive management, and evaluation of TMDL implementation will continue to rely on current and future sampling for phosphorus in the Lake Sawyer watershed. The city of Black Diamond and King County have conducted periodic water quality monitoring in Lake Sawyer since 1976, and propose to continue water quality monitoring into the foreseeable future (Table 5).

Table 5. Summary of Water Quality Monitoring in Lake Sawyer Watershed.

Monitoring Program	Responsible Parties	Schedule
Stormwater phosphorus	City of Black Diamond City of Maple Valley King County	As needed for IDDE
Average in-lake phosphorus	King County Lake Stewardship Program	~12 sites ~8 times per year; 2009 - 2014
Phosphorus sampling surveys	Ecology Water Quality	~6 sites ~2 times per year; 2009 - 2014
Construction site phosphorus monitoring	City of Black Diamond Public Works Engineering	As required under construction stormwater permit

EPA (1991) guidance calls for a monitoring plan for TMDLs where implementation will be phased in over time. Monitoring is conducted to provide assurance that pollution control measures achieve the expected phosphorus reductions and water bodies will reach water quality standards. Over the next three years, Black Diamond, Maple Valley, King County, and Ecology will periodically monitor water quality in the Lake Sawyer watershed. Compliance monitoring will be needed when water quality standards are believed to be achieved.

Stormwater phosphorus monitoring

In the first year following issuance of the water quality implementation plan, city of Black Diamond, city of Maple Valley, and King County will develop and implement their respective monitoring programs designed to further identify the principal sources of phosphorus loads to their MS4s. This monitoring will be done as part of municipal stormwater management Illicit Discharge Detection and Elimination (IDDE) programs. Stormwater permittees will be responsible for meeting the requirements of their permits.

King County Lake stewardship monitoring

King County Department of Natural Resources and Parks, Water and Land Resources Division coordinates the King County Lake Stewardship Program. The program organizes citizen lake stewardship groups which participate in volunteer sampling to help document and track trends in lake quality. The county Lake Sawyer Stewardship Program coordinates with volunteers from Lake Sawyer to perform what is titled Level II Data Collection. Sampling occurs twice a month, from April to October, on a pre-determined schedule. Samples are taken at one meter depth for every sampling date. Deeper samples are taken twice during the season, usually at mid-depth and at one meter from the bottom. Samples are generally taken at the deepest point in the lake. Both Secchi and temperature are taken at one meter depth. Total phosphorus, total nitrogen, chlorophyll *a* and phytoplankton are measured depending on the depth of the sample (King County, 2004).

Ecology monitoring

Ecology will conduct a minimum of two sampling surveys annually at approximately six or more sampling sites in the Lake Sawyer watershed to help further define pollution sources and promote source correction. Additional monitoring will be considered, if necessary, for source identification and to evaluate TMDL effectiveness. Monitoring results will be used to evaluate whether the TMDL goals are being met. Monitoring to identify phosphorus sources in the basin will continue to focus on sources of high phosphorus loading in Rock Creek, Ravensdale Creek, and the Lake Sawyer shoreline area. Investigations of sources in all areas will include the potential for on-site septic system failures.

Ecology will initiate water quality monitoring for compliance where ambient monitoring shows that adequate progress toward phosphorus targets is not occurring. Ecology will coordinate compliance monitoring to identify the specific source(s) of phosphorus pollution, and will refer identified sources to the appropriate agency that has technical assistance resources or enforcement authority. Sampling will be adjusted to help locate sources by bracketing geographic areas where contamination is occurring and thereby focus on the specific source of

phosphorus pollution. This strategy allows implementation of appropriate BMPs in the specific areas of concern, and maximizes use of the limited resources available for source control and TMDL implementation.

Effectiveness monitoring

Effectiveness monitoring determines if the interim targets and water quality standards have been met after the water quality implementation plan is implemented (i.e. the in-stream water quality monitoring). Effectiveness monitoring of TMDLs is usually conducted by Ecology's Environmental Assessment Program. After implementation has had time to take effect, an effectiveness monitoring plan may be developed in order to accurately assess the needs of Lake Sawyer and its tributaries at that time.

Enforcement

The Water Pollution Control Act (chapter 90.48 RCW) provides broad authority to issue permits and regulations, and to prohibit illegal discharges to surface water. It designates Ecology as the state water pollution control agency for all the purposes of the federal Clean Water Act. The act openly declares that it is the policy of the state to maintain the highest possible standards to ensure the purity of all waters of the state and to require the use of all known, available, and reasonable means to prevent and control water pollution. The act defines waters of the state and pollution and authorizes Ecology to control and prevent pollution, and to make and enforce rules, including water quality standards. Under this statute, Ecology is authorized to administer wastewater disposal permits and to require prior approval of plans and methods of operation of sewage or other disposal systems.

Local governments are expected to continue exercising their authority to enforce their ordinances. Ecology will also encourage local government to enforce local ordinances pertaining to stormwater discharge or water quality where in effect and applicable. Those conducting restoration projects or installing BMPs will be responsible for monitoring plant survival rates and maintenance of improvements, structures and fencing.

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Funding Opportunities

Multiple sources of financial assistance for water cleanup activities are available through Ecology's grant and loan programs, local conservation districts, and other sources. Refer to the website (http://www.ecy.wa.gov/programs/wq/tmdl/TMDLFunding.html) to find out more about funding sources and opportunities.

Centennial Clean Water Fund (CCWF)

A 1986 state statute created the Water Quality Account, which includes the Centennial Clean Water Fund (CCWF). Ecology offers CCWF grants and loans to local governments, tribes, and other public entities for water pollution control projects. During the FY 2004 funding cycle, Ecology is proposing to award $12.5 million from the CCWF. The application process is the same for CCWF, 319 Nonpoint Source Fund, and the state Water Pollution Control Revolving Fund.

Section 319 Nonpoint Source Fund

The 319 Fund provides grants to local governments, tribes, state agencies, and nonprofit organizations to address nonpoint source pollution and to improve and protect water quality. Nonpoint source pollution includes many diffuse sources of pollution, such as stormwater runoff from urban development, agricultural and timber practices, failing septic systems, pet waste, gardening, and other activities. Non-governmental organizations can apply to Ecology for funding through a 319 grant to provide additional implementation assistance.

State Water Pollution Control Revolving Fund

Ecology administers the Washington State Water Pollution Control Revolving Fund. This program uses federal funding from U.S. Environmental Protection Agency and monies appropriated from the state's Water Quality Account to provide low-interest loans to local governments, tribes, and other public entities. The loans are primarily for upgrading or expanding water pollution control facilities such as public sewage and stormwater plants, and for activities to address estuary management and nonpoint source water quality problems.

Coastal Protection Fund

Since July 1998, water quality penalties issued under Chapter 90.48 RCW have been deposited into a sub-account of the Coastal Protection Fund. A portion of this fund is made available to regional Ecology offices to support on-the-ground projects to perform environmental restoration and enhancement. Local governments, tribes, and state agencies must propose projects through Ecology staff. Stakeholders with projects that will reduce bacterial or nutrient pollution are encouraged to contact their local TMDL lead to determine if their project proposal is a good candidate for Coastal Protection funding.

Salmon Recovery Funding Board (SRFB)

The Salmon Recovery Funding Board (SRFB) provides grants to local governments, tribes, nonprofit organizations, and state agencies for salmon habitat restoration, land acquisition and habitat assessments. Funded projects and programs must produce sustainable and measurable benefits for fish and fish habitat. Most projects designed to improve salmon habitat also provide water quality benefits. As of October 2002, the SRFB has provided grants for 517 projects statewide with an accumulated value of $96.4 million.

Aquatic Weeds Management Fund

The Aquatic Weeds Management Fund (AWMF) provides financial and technical assistance to local and state governments, tribes, and special purpose districts to reduce the propagation of freshwater aquatic weeds and to manage the problems these weeds cause. An annual three-dollar license fee assessed to the owners of boat trailers provides funding.
http://www.ecy.wa.gov/programs/wq/plants/grants/

Reasonable Assurance

When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint sources) in the water body. For the Lake Sawyer Total Phosphorus TMDL, both point and nonpoint sources exist. TMDLs (and related action plans) must show "reasonable assurance" that these sources will be reduced to their allocated amounts. Education, outreach, technical and financial assistance, permit administration, and enforcement will all be used to ensure that the goals of this water cleanup plan are met.

Ecology believes that the following activities already support this TMDL and add to the assurance that total phosphorus in Lake Sawyer will meet conditions provided by state water quality standards. This assumes that the activities described below are continued and maintained. In addition, compliance by Black Diamond, Maple Valley, and King County with their municipal stormwater permits will help reduce phosphorus loading to Lake Sawyer via stormwater.

The goal of the Lake Sawyer Water Quality Implementation Plan for total phosphorus is for the waters of the basin to meet the state's water quality standards. Since Lake Sawyer's water quality data indicates that the lake is generally meeting its long-term TMDL goal of 16 μg/L, the continued collaboration of local governments and active community interests helps provide reasonable assurance that the short and long-term Lake Sawyer TMDL goals will be met by 2014.

While Ecology is authorized under Chapter 90.48 RCW to impose strict requirements or issue enforcement actions to achieve compliance with state water quality standards, it is the goal of all participants in the Lake Sawyer TMDL process to achieve clean water through partnerships and voluntary control actions.

Ecology will consider and issue notices of noncompliance, in accordance with the Regulatory Reform Act, in situations where the cause or contribution of cause of noncompliance with wasteload allocations, load allocations, or permit limits can be established.

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Summary of Public Involvement Methods

Ecology solicited members to join the Lake Sawyer Steering Committee in preparation for the development of the Lake Sawyer water quality implementation plan. Members include representatives from the city of Black Diamond, King Conservation District, King County Lake Stewardship Program, Muckleshoot Indian Tribe, residents and members from the Lake Sawyer Community Club, and Ecology.

Future public involvement will include but will not be limited to informational websites from the city of Black Diamond and the Lake Sawyer Community Club. Information contained on these sites will cover education and outreach, upcoming events happening with in the watershed, and general lake water quality information. The city's Watershed Steward Director has taken steps to organize a sub-committee that will remain active in developing small implementation projects and seeking out funding opportunities to implement projects within the watershed.

King County Lake Stewardship Program has also been diligent in training and seeking out volunteers for the volunteer monitoring program which help to monitor the water quality of the lake. Provided that the city continues its contract with King County and funding the volunteer monitoring program, this program will continue to help provide a great opportunity for public involvement and sampling data that can help determine if Lake Sawyer and its tributaries are meeting water quality goals.

Meetings of the Lake Sawyer Steering Committee occurred on the following dates:

- May 20, 2008
- July 14, 2008
- September 8, 2008

The Lake Sawyer draft implementation plan was introduced at a public meeting on January, 21, 2009. The public comment period was from February 1 through February 16, 2009.

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Conclusions

Lake Sawyer's water quality has generally improved since the lake's phosphorus TMDL was approved in 1993. Significant urban growth is planned in the Lake Sawyer watershed in coming years, which could have a negative impact on water quality. Ecology's 2002 Lake Sawyer Effectiveness Monitoring Report concluded that the lake is meeting its long-term goal of reducing phosphorus, but further actions are still needed to control nutrient input from the watershed in order for the lake to meet and maintain water quality standards into the future.

Organizations involved in water quality improvement at Lake Sawyer include Lake Sawyer Community Club; King Conservation District; Lake Sawyer Steering Committee; King County Stormwater Division; King County Lake Stewardship Program; city of Black Diamond; Black Diamond City Council; city of Maple Valley; and Ecology. Lake Sawyer Community Club will meet at least annually to discuss implementation projects and may post projects and updates on their webpage. King Conservation District will continue to advise and assist in situations involving small farms and livestock. The Lake Sawyer Steering Committee will serve as sounding board for implementation projects, monitoring updates, and adaptive management.

Municipal stormwater permit holders Black Diamond, Maple Valley, and King County will develop stormwater management programs and implement requirements of their respective permits. Permit holders will include actions to reduce phosphorus in stormwater to meet Lake Sawyer TMDL requirements. The phosphorus stormwater treatment menu will be applied to stormwater conveyed to the lake in accordance with the Lake Sawyer's *sensitive lake* status. Ecology Northwest Region municipal stormwater specialists will assist with municipal stormwater permit compliance.

The city of Black Diamond updated several key components within the city's infrastructure and recently hired a Watershed Steward Director whose primary focus will be to coordinate with the residents in the Lake Sawyer Watershed and continue to actively seek out and implement new best management practices. Black Diamond will continue to contract with King County's Lake Stewardship Program to monitor phosphorus in Lake Sawyer to track trends in lake quality and enable adaptive management.

Ecology will administer permits and manage TMDL implementation activities in Lake Sawyer watershed with special attention to phosphorus. Ecology's Northwest Region water quality lake specialist will continue to coordinate TMDL-related activities and provide technical assistance for the TMDL. Ecology will also conduct at least three sampling surveys in Lake Sawyer watershed to help further define pollution sources and promote source correction. Ecology grant programs will provide project funding opportunities and Northwest Region grant project managers will assist grant applicants to develop water quality improvement projects.

This implementation plan serves as an evolving document that will help guide the Lake Sawyer Steering Committee as well as other interested parties to track water quality trends and update best management practices suitable for implementation in the watershed. Phosphorus TMDL

reductions are expected to be achieved by 2014 and adaptive management measures are in place to help ensure this schedule will be met.

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Appendices

Appendix A. Glossary and acronyms

303(d) List: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which designated uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years.

Best management practices (BMPs): Physical, structural, and/or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

Char: Char (genus *Salvelinus*) are distinguished from trout and salmon by the absence of teeth in the roof of the mouth, presence of light colored spots on a dark background, absence of spots on the dorsal fin, small scales, and differences in the structure of their skeleton. (Trout and salmon have dark spots on a lighter background).

Chlorophyll-*a*: Specific green fat-soluble photosynthetic pigment used to indicate biological productivity.

Clean Water Act (CWA): Federal Act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the CWA establishes the TMDL program.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Effective shade: The fraction of incoming solar shortwave radiation that is blocked from reaching the surface of a stream or other defined area.

Enterococci: A subgroup of the fecal streptococci that includes *S. faecalis*, *S. faecium*, *S. gallinarum*, and *S. avium*. The enterococci are differentiated from other streptococci by their ability to grow in 6.5% sodium chloride, at pH 9.6, and at 10 degrees C and 45 degrees C.

Epilimnion: The top most layer of thermally stratified lake.

Existing uses: Those uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of non self-replicating introduced native species, do not need to receive full support as an existing use.

Extraordinary primary contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform are "indicator" organisms that indicate presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100mL).

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from ten to 10,000 fold over a given period. The calculation is performed by either: (1) taking the *n*th root of a product of *n* factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Hypolimnion: The dense bottom layer of a thermally stratified lake.

Load allocation (LA): The portion of a receiving waters' loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading capacity: The greatest amount of a substance that a water body can receive and still meet water quality standards.

Margin of safety (MOS): Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

Metalimnion: The middle layer of a thermally stratified lake sometimes referred to as the thermocline.

Municipal separate storm sewer systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (1) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, storm water, or other wastes; and (2) designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and (4) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water

pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

Phase I Stormwater Permit: The first phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to medium and large municipal separate storm sewer systems (MS4s) and construction sites of five or more acres.

Phase II Stormwater Permit: The second phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to smaller municipal separate storm sewer systems (MS4s) and construction sites over one acre.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or is likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

Salmonid: Any fish that belong to the family *Salmonidae*. Basically, any species of salmon, trout, or char. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

Secchi transparency: A common method used to assess and compare water clarity measuring the water depth at which a black and white disk disappears from view when lowered from the water surface.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, saltwaters, wetlands and all other surface waters and water courses within the jurisdiction of the state of Washington.

Thermal stratification: A change in temperature at different depths in a water body.

Total Maximum Daily Load (TMDL): A distribution of a substance in a water body designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: 1) individual wasteload allocations (WLAs) for point sources, 2) the load allocations (LAs) for nonpoint sources, 3) the contribution of natural sources, and 4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Trophic state: The measurement of lake biological productivity based on water clarity (Secchi) and concentrations of TP and chlorophyll-*a*.

Wasteload allocation (WLA): The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. WLAs constitute one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Appendix B. Criteria for lakes

The Department of Ecology, by process of adoption of state water quality standards, has re-defined criteria for fresh waters and lake class. Prior to development, Ecology classified water bodies in A, AA, B, and C classes. Classification is now defined by actual use (i.e., swimming, water supply, and fish habitat). The new classifications only apply to fresh water.

Protection of Characteristic uses [WAC 173-201A-030(5)] Lake Class Characteristic uses shall include, but not be limited to, the following:

1) Water supply (domestic, industrial, agricultural).
2) Stock watering.
3) *Fish and shellfish:
   Salmonid migration, rearing, spawning, and harvesting.
   Other fish migration, rearing, spawning, and harvesting.
   Clam and mussel rearing, spawning, and harvesting.
   Crayfish rearing, spawning, and harvesting.
4) *Wildlife habitat.
5) *Recreation (primary contact recreation, sport fishing, boating, and esthetic enjoyment).
6) Commerce and navigation.

Washington State's recommended total phosphorus lake criteria for the Pacific Coast range, Puget Sound lowlands and Northern Rockies eco-regions.

Trophic State	Ambient TP Range (µg/L)	TP Criteria
Ultra-Oligotrophic	0 – 4	4 or less
Oligotrophic	>4 – 10	10 or less
Lower Mesotrophic	>10 – 20	20 or less
Mesotrophic – Eutrophic	>20	Lake Specific Study

*Lake Sawyer lies within the Puget Sound Lowlands Region

The Tropic State Index (Carlson 1977) is used to determine the trophic status of a lake, and its lake overall health. Total phosphorus, secchi depth, and chlorophyll *a* are the three parameters measured.

The range in TSI parameters as they relate to lake trophic status.

Trophic State	Secchi Depth (m)	Chloro(*a*) (µg/L)	TP (µg/L)	TSI
Oligotrophic	> 4	< 3	< 14	< 40
Mesotrophic	2 – 4	3 – 9	14 – 25	40 – 50
Eutrophic	< 2	> 9	> 25	> 50

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Appendix C. Tables of listings, wasteload and load allocations, and water bodies

Total Phosphorus (P) target in-lake average = 16 μg/L	
Total Phosphorus Source	**Loading capacity distribution (kg/June-August)**
Lake Sawyer	1.9 kg per day or (715 kg/yr)
Wasteload Allocation	0 kg per day for Black Diamond wastewater treatment plant
Tributaries Ravensdale Creek and Rock Creek	1.4 kg per day includes a 0.08 kg per day allocation for uncertainty
Internal Recycling	0.54 kg/ per day includes a 0.34 kg per day for uncertainty

Components of a TMDL

1) **Wasteload allocations (WLA)**: Represents the contribution of discrete "point" sources of pollutants (e.g., municipal, industrial, and construction stormwater discharges);

2) **Load allocations (LA)**: Represent "nonpoint" sources of a pollutant, (natural sources, most agricultural activities, and other sources that are not regulated by an Ecology permit); and

3) **Margin of safety (MOS):** Allows for uncertainty in the estimation of, and ability to achieve, the previous two allocations.

Thus, the TMDL equation is as follows:

TMDL = WLA + LA + MOS

The sum of these three components may not exceed the **Loading Capacity**.

Components of a TMDL. These three parts of a TMDL may not exceed the maximum amount of a pollutant that a water body can receive before it is considered polluted.

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Appendix D. 303 (d) Listings in the Lake Sawyer Watershed.

Study area water bodies on the 2008 303(d) list for parameter(s).

Water body	Parameter	Medium	Listing ID	Township	Range	Section
Lake Sawyer	2,3,7,8-TCDD	Tissue	51577	21.0N	06.0E	04
Lake Sawyer	PCB	Tissue	52691	21.0N	06.0E	04

Additional 303(d) listings not addressed by this report.

Water body	Parameter	Medium	Listing ID	Township	Range	Section
Ravensdale Creek	Water	Temperature	15883	22.0N	06.0E	36
Covington Creek	Water	Dissolved Oxygen	13162	21.0	05.0E	12
Covington Creek	Water	Fecal Coliform	47477	21.0	06.0E	18

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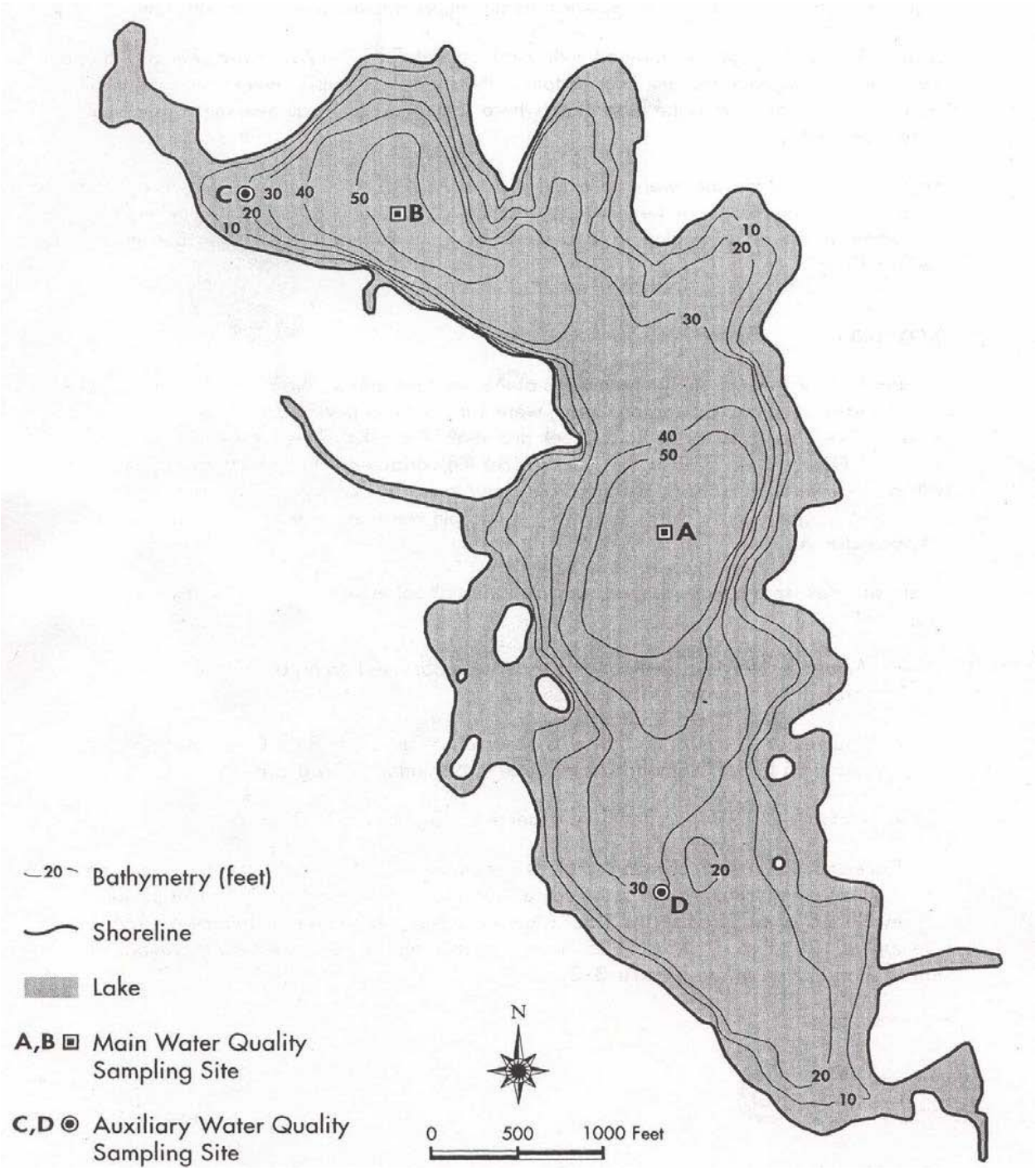
Appendix E. Bathymetric map of Lake Sawyer



Main and Auxiliary Water Quality Sampling Stations in Lake Sawyer from 1994 to 1995 (Map from Lake Sawyer Management Plan, King County 2000).

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Appendix F. Lake Sawyer Focus Sheet

Focus on Lake Sawyer

DEPARTMENT OF ECOLOGY
State of Washington

Water Quality Program **February 2009**

Too Much Phosphorus for Lake Sawyer

Phosphorus is a basic element found in nature and a primary nutrient that all living organisms need to survive. Lakes typically build up phosphorus levels as they age, and ultimately fill in with vegetation and sediment. This process, called eutrophication, usually takes thousands of years.

High lake phosphorus can cause excessive plant and algae growth and drastically speed up it's aging process. Human activities such as home building, road construction, failing septic tanks, lawn fertilizers, soaps, and deforestation are some of the primary sources of phosphorus that can increase amounts of phosphorus in a lake and may cause algae blooms.

Many of these pollution sources are transported to nearby water bodies by stormwater and have negative affects by degrading water clarity, aquatic habitat, fish survival, swimming, boating and aesthetic enjoyment.

Lake Sawyer

Lake Sawyer, along with Rock Creek and Ginder Creek, have had poor water quality since the 1970s. In 1981, City of Black Diamond obtained funding to develop their wastewater treatment plant and designed it to discharge into a natural wetland that ultimately drains to Lake Sawyer.

The wetland portion of the treatment plant system soon failed resulting in increased amounts of phosphorus polluting Lake Sawyer. This led to moving Black Diamond's wastewater discharges to the King County Metro wastewater treatment plant at Renton.

In 1993, the Department of Ecology's (Ecology) Lake Sawyer Total Maximum Daily Load (TMDL) assessment was approved. Then in 2000, King County developed a Lake Management Plan for Lake Sawyer that provides recommendations to help reduce the amount of phosphorus to the lake. Lack of funding has prevented many of these recommendations from being implemented.

MORE INFORMATION

The Department of Ecology's Freshwater Algae Program provides identification and toxicity testing of algae for Washington State water bodies.

To learn more about the program, visit our website at:

http://www.ecy.wa.gov/programs/wq/plants/algae/index.html

Contact information:
Tricia Shoblom
425-649-7288
tsho461@ecy.wa.gov

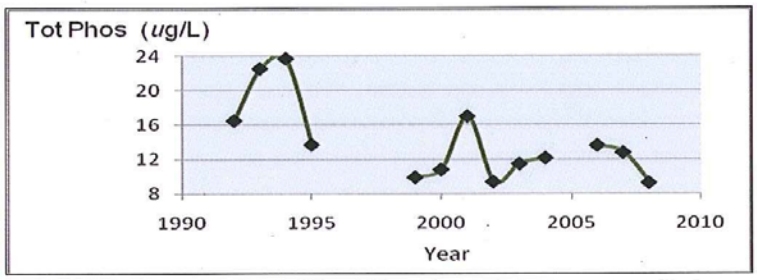
Special accommodations:

If you need this publication in an alternate format, call the Water Quality Program at 360-407-6404. Persons with hearing loss, call 711 for Washington Relay Service. Persons with a speech disability, call 877-833-6341.

Publication Number: 09-10-004 1

What's being done?

Since re-directing Black Diamond waste water away from Lake Sawyer there has been a general decline in phosphorus but the lake still has too much. In 2008, Ecology and the Lake Sawyer community did follow-up work to the 1993 TMDL and produced the *Lake Sawyer Total Phosphorus Total Maximum Daily Load Water Quality Implementation Plan.* It incorporates recommendations from the Lake Sawyer Management Plan and other documents developed for the lake, and provides a framework for corrective actions to address sources of phosphorus pollution.



Upper Lake Sawyer Annual Total Phosphorus (micrograms per liter)

Data provided by King County

What you can do

We all live in a watershed and can take actions to reduce polluted runoff and nutrients from our property that reach our lakes and streams. Here are some things you can do:

- Cover and store manure, yard waste, fertilizers, and other chemicals away from the water. Contact **King County** at 206-296-4692 or 1-888-TOXIC-ED or http://www.govlink.org/hazwaste/house/index.cfm
- Maintain or enhance vegetation alongside water bodies, to filter pollutants from run-off water. Never remove the natural riparian (stream or lakeside) vegetation.
- If you have large animals, keep them away from the lake or stream. Animals trample shorelines, destroy riparian vegetation, and directly add nutrients to the stream.
- If you must clear or grade the land or build a road, be careful to prevent erosion and keep sediments (dirt with contaminants) out of the waterways.
- If you use a septic system, inspect it regularly to make sure its functioning properly. For more information about the King County Wastewater Program, call 206-296-4932 or go to: http://www.kingcounty.gov/healthservices/health/ehs/wastewater
- Carefully use *only* phosphate-free soaps, detergents and cleaners in your home or business.
- Reduce or eliminate the use of fertilizers and chemicals on your lawn and garden. Rain carries these nutrients into our nearby water bodies. For more information, visit: http://your.kingcounty.gov/solidwaste/naturalyardcare/index.asp

*See ***'Washington Waters - Ours to Protect'*** website: http://www.ecy.wa.gov/washington_waters

Appendix G. Response to comments

Commenter 1. The City of Black Diamond

1. Executive Summary, second paragraph – We understand that salmonids also utilize Rock Creek within this system for spawning.

   Comment Noted. The report was revised according to this comment.

2. Under sediment – Particularly in Black Diamond's history, mining has seemed to have been a contributor to Phosphorous loading in the past.

   Comment Noted. The discussion of Black Diamond's mining history has been expanded accordingly.

3. Do not feed wildlife – You might include some information on how feeding wildlife contributes to the problems this watershed is facing.

   Wildlife can contribute to pollution problems and in some situations become nuisances due to concentration and overpopulation. The Lake Sawyer Water Quality Implementation Plan supports efforts to keep wildlife species as natural as possible and promotes the message of Do Not Feed Wildlife.

4. Under Corrective/preventative actions – does this program apply to residents of unincorporated King County as well?

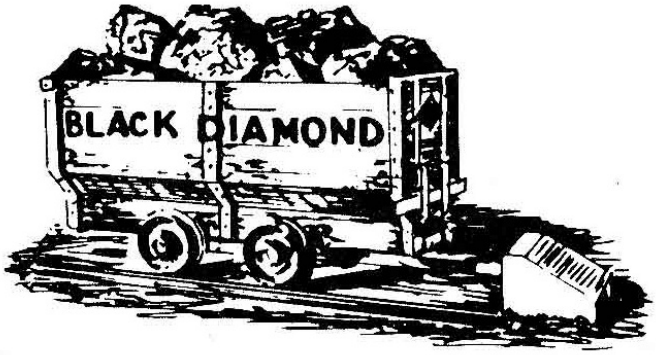
   All of the potential sources of pollution listed in the Lake Sawyer Water Quality Implementation Plan have corrective/preventative actions that can be taken to address those sources, and therefore can be applied to the entire watershed regardless of jurisdiction.

APPENDIX B – Stormwater Management Program (SWMP)

CITY OF BLACK DIAMOND

STORMWATER MANAGEMENT PROGRAM (SWMP)

2008 ANNUAL UPDATE



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THIS PLAN IS BASED ON THE REQUIREMENTS OUTLINED IN THE WESTERN WASHINGTON PHASE II MUNICIPAL STORMWATER PERMIT. MUCH OF THE LANGUAGE INCLUDED IN THIS DOCUMENT DESCRIBING PERMIT REQUIREMENTS HAS BEEN TAKEN DIRECTLY FROM THIS PERMIT AND HAS BEEN SUMMARIZED FOR EASE OF THE READER.

FOR COMPLETE REQUIREMENTS AND DETAILS, PLEASE REFER TO SECTION S5.C OF THE WESTERN WASHINGTON PHASE II MUNICIPAL STORMWATER PERMIT.

SECTION 1 – INTRODUCTION

1.1 INTRODUCTION

This document constitutes the City of Black Diamond's Stormwater Management Program (SWMP) as required under Condition S5 of the Western Washington Phase II Municipal Stormwater Permit (the Permit). The purpose of this document is to detail actions that the City of Black Diamond has taken or will take to maintain compliance with conditions in the permit. This SWMP will be an attachment to the *Annual Report Form for Cities, Towns, and Counties* which is required to be submitted to the Department of Ecology by March 31st each year.

The City's SWMP is intended to reduce the discharge of pollutants from the City's Municipal Separate Storm Sewer System to the maximum extent practicable, meet Washington State's All Known and Reasonable Treatment requirements, and protect water quality. This goal is accomplished by the inclusion of all Permit SWMP components, minimum measures, and implementation schedules into the City's SWMP.

In compliance with Permit requirements, where the City is already implementing actions or activities called for in this document, the City will continue those actions or activities regardless of the schedule called for in this document.

SECTION 2 –MONITORING AND REPORTING

2.1 PERMIT REQUIREMENTS AND DATES

Section S5.A, S8, and S9 of the Western Washington Phase II Municipal Stormwater Permit requires the City to develop, monitor, and report the City's Stormwater Management Program (SWMP). The Stormwater Management Program shall be designed to reduce the discharge of pollutants from the City stormwater system to the maximum extent practicable and to protect water quality. Specific program requirements are outlined below.

The City's goal is to complete the following by **March 31, 2008**:

- Submit the *Annual Report Form for Cities, Towns, and Counties* which is intended to summarize the City's compliance with the conditions of the Permit. The annual report shall be submitted by March 31 of each calendar year covering the previous calendar year.

- Prepare written documentation of the SWMP and update at least annually for submittal with the City's annual reports to the Department of Ecology.

- Include with the annual report, notification of any annexations, incorporations, or jurisdictional boundary changes resulting in an increase or decrease in the City's geographic area of permit coverage during the reporting period and the implications for the SWMP.

- Track the number of inspections, official enforcement actions and types of public education activities for inclusion in the City's annual reports to the Department of Ecology.

- Provide a description of any stormwater monitoring or studies conducted by the City during the reporting period for inclusion in the City's annual reports to the Department of Ecology.

- Assess the appropriateness of the BMP's identified by the City for each component of the SWMP; and any changes made, or anticipated to be made, to the BMP's that were previously selected to implement the SWMP, and why, for inclusion in the City's annual reports to the Department of Ecology.

The City's goal is to complete the following by **January 1, 2009**:

- Track the cost or estimated cost of development and implementation of each component of the SWMP.

The City's goal is to complete the following by **December 31, 2010**:

- Identify at least two suitable questions (such as How effective is a targeted action? Or Is the SWMP achieving a targeted environmental outcome?) and select sites where monitoring will be conducted. The City shall develop a monitoring plan.

The City's goal is to complete the following by **August 19, 2011**:

- Fully develop and implement a Stormwater Management Program (SWMP) designed to reduce the discharge of pollutants to the maximum extent practicable and to protect water quality.

- Coordinate, as necessary, with other entities covered under a municipal stormwater NPDES permit to encourage coordinated stormwater-related policies, programs and projects within adjoining or shared areas.

The City's goal is to complete the following by **March 31, 2012**:

- Include monitoring program reporting in the fourth annual report.

2.2 CURRENT ACTIVITIES

The City has submitted the Annual Compliance Report to the Department of Ecology by March 31, 2008.

2.3 PLANNED ACTIVITIES

Actions recommended for continued Permit compliance include:

- Development of separate storm utility and tracking of costs associated with SWMP implementation.

- Implement a monitoring compliance strategy, including development of monitoring plans necessary to implement Permit requirements and activities.

- Complete annual update to the City's SWMP.

- Summarize annual activities for the Annual Compliance Report.

SECTION 3 –PUBLIC EDUCATION AND OUTREACH

3.1 PERMIT REQUIREMENTS AND DATES

Section S5.C.1 of the Western Washington Phase II Municipal Stormwater Permit requires the City to include an education program to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts. Specific program components are outlined below.

The City's goal is to complete the following by **February 15, 2009**:

- Include an education program aimed at residents, businesses, industries, elected officials, policy makers, planning staff and other City employees to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts.

- Prioritize education and outreach efforts to target the following audiences as further described in the Permit: General public; General public, businesses, including home-based and mobile businesses; Homeowners, landscapers and property managers; and Engineers, contractors, developers, review staff and land use planners.

- Measure the understanding and adoption of the targeted behaviors among the targeted audiences. The resulting measurements shall be used to direct education and outreach resources most effectively, as well as to evaluate changes in adoption of the targeted behaviors.

- Track and maintain records of public education and outreach activities.

3.2 CURRENT ACTIVITIES

The City does not currently have a written Education and Outreach program for stormwater-quality related topics; however, the City has performed some public education and outreach activities in the past. For example the City provides storm drain stenciling on catch basins in order to increase awareness and prevent discharge of non-stormwater materials into the stormwater system.

3.3 PLANNED ACTIVITIES

The City shall develop its Public Education and Outreach program in 2008. Actions recommended for continued Permit compliance include:

- Implement new or modify existing education and outreach activities including tracking and success monitoring.

- Evaluate understanding and adoption of target behaviors.

- Summarize annual activities for the “Public Education and Outreach” components of the Annual Compliance Report.

SECTION 4 – PUBLIC INVOLVEMENT AND PARTICIPATION

4.1 PERMIT REQUIREMENTS AND DATES

Section S5.C.2 of the Western Washington Phase II Municipal Stormwater Permit requires the City to provide ongoing opportunities for public involvement. Specific program components are outlined below.

The City's goal is to complete the following by **February 15, 2008**:

- Provide ongoing opportunities for public involvement through advisory councils, watershed committees, participation in developing rate-structures, stewardship programs, environmental activities or other similar activities.

- Create opportunities for the public to participate in the decision-making processes involving the development, implementation and update of the entire SWMP.

- Develop and implement a process for consideration of public comments on the SWMP.

- Make the SWMP, the annual report, and all other submittals required by the Phase II Permit, available to the public.

- Post on the City's website the annual report, and SWMP that was submitted with the latest annual report.

4.2 CURRENT ACTIVITIES

The current compliance activities associated with the above Permit requirements include:

- The City has implemented a series of public involvement activities intended to meet the Permit requirements for public involvement in development of the Stormwater Management Program. This process has involved presentations to the City Council at sessions open to the public.

- The City plans to make the SWMP document and Annual Compliance Report available to the public on the City website.

4.3 PLANNED ACTIVITIES

The City shall offer the public opportunities to be involved in the decision making process on stormwater issues. Actions recommended for continued compliance include:

- Indentifying public involvement opportunities for annual SWMP update and reporting process.
- Make SWMP document and Annual Compliance Report available to public by posting on the City website.
- Summarize annual activities for the "Public Involvement and Participation" component of the Annual Compliance Report.

SECTION 5 – ILLICIT DISCHARGE DETECTION AND ELIMINATION

5.1 PERMIT REQUIREMENTS AND DATES

Section S5.C.3 of the Western Washington Phase II Municipal Stormwater Permit requires the City to develop and implement an ongoing program to detect and remove illicit connections, discharges, and improper disposal, including spills, into the municipal separate storm sewers owner or operated by the City. Specific program components are outlined below.

The City's goal is to complete the following by **February 15, 2009**:

- Publicly list and publicize a hotline or other local telephone number for public reporting of spills and other illicit discharges. The City shall keep a record of calls received and follow-up actions taken.

The City's goal is to complete the following by **August 15, 2009**:

- Develop and implement an ordinance or other regulatory mechanism to effectively prohibit non-stormwater, illegal discharges, and/or dumping into the City's municipal separate storm sewer system.

- Ensure municipal field staff responsible for identification, investigation, termination, cleanup, and reporting of illicit discharges, improper disposal and illicit connections are trained to conduct these activities.

- Provide follow-up training as needed to address changes in procedures, techniques, or requirements.

The City's goal is to complete the following by **February 15, 2010**:

- Prioritize receiving waters for visual inspection.

- Ensure all municipal field staff, which, as part of their normal job responsibilities, might come into contact with or otherwise observe an illicit discharge or illicit connection to the storm sewer system shall be trained on the identification of an illicit discharge/connection, and on the proper procedures for reporting and responding to the illicit discharge/connection.

The City's goal is to complete the following by **February 15, 2011**:

- Conduct field assessments of three high priority water bodies.

- Conduct field assessments on at least one high priority water body annually henceforth.

- Develop a municipal storm sewer system map, to be available upon request, that shall be periodically updated and shall include the location of all known municipal separate storm sewer outfalls and receiving waters and structural stormwater BMP's owned, operated, or maintained by the City. Include tributary conveyances, associated drainage areas, and land use for all storm sewer outfalls with a 24 inch nominal diameter or larger, or an equivalent cross-sectional area for non-pipe systems. The map shall include all connections to the municipal separate storm sewer authorized or allowed by the City, as well as geographic areas that do not discharge stormwater to surface waters.

The City's goal is to complete the following by **August 19, 2011**:

- Develop and fully implement an ongoing program to detect and address non-stormwater discharges, spills, illicit connections and illegal dumping into the City's municipal separate storm sewer system. Include procedures for locating priority areas likely to have illicit discharges and field assessment activities including visual inspection of priority outfalls.

- Develop and implement procedures for characterizing the nature of, and potential public or environmental threat posed by, any illicit discharges found by or reported to the City

- Develop and implement procedures for tracing the source of an illicit discharge; including visual inspections, and when necessary, opening manholes, using mobile cameras, collecting and analyzing water samples, and/or other detailed inspection procedures

- Develop and implement procedures for removing the source of the discharge, including notification of appropriate authorities; notification of the property owner; technical assistance for eliminating the discharge; follow-up inspections; and escalating enforcement actions if the discharge is not eliminated.

- Inform and distribute appropriate information to public employees, businesses, and the general public regarding the hazards associated with illegal discharges and improper disposal of waste.

- Develop and implement procedures for program evaluation and assessment, including tracking the number and type of spills or illicit discharges identified; inspections made; and any feedback received from public education efforts.

5.2 CURRENT ACTIVITIES

The City currently implements activities and programs that meet some of the Permit requirements. The current compliance activities associated with the above Permit requirements include:

- The City Municipal codes (BDMC 14.04.390) prohibits discharge of polluted waters into the storm drainage system.
- The City monitors City wide drainage features for illicit discharges.
- Water quality complaints and reports of spills or dumping are investigated and resolved.

5.3 PLANNED ACTIVITIES

The City currently conducts some illicit discharge detection and elimination activities, but should expand current efforts in order to maintain compliance as Permit requirements are phased in over the next several years. Actions recommended for continued compliance include:

- Documentation of existing programs and procedures.
- Review and update codes
- Update and augment education programs on the hazards of illicit discharges, and on reducing pollutants in permitted non-stormwater discharges.
- Create and publicize hotline for public reporting of spills and other illicit discharges.
- Develop and implement stormwater outfall illicit discharge screening program.
- City is planning for update and mapping of storm system inventory beginning in 2008.
- Select and implement IDDE issue tracking/resolution system.
- Revise current IDDE response process into a standard, City-wide EDDE response and enforcement process.
- Create IDDE training program.
- Summarize annual activities for the “Illicit Discharge Detection and Elimination” component of the Annual Compliance Report.

SECTION 6 – CONTROLLING RUNOFF FROM NEW DEVELOPMENT, REDEVELOPMENT AND CONSTRUCTION SITES

6.1 PERMIT REQUIREMENTS AND DATES

Section S5.C.4 of the Western Washington Phase II Municipal Stormwater Permit requires the City to develop, implement, and enforce a program to reduce pollutants in stormwater runoff from new development, redevelopment and construction site activities. Specific program components are outlined below.

The City's goal is to complete the following by **August 15, 2009**:

- Develop, implement, and enforce a program to reduce pollutants in stormwater runoff from new development, redevelopment and construction site activities. This program shall be applied to all sites that disturb a land area 1 acre or greater, including projects less than one acre that are part of a larger common plan of the development or sale. The program shall apply to private and public development, including roads.

- Adopt an ordinance or other enforceable mechanism that addresses runoff from new development, redevelopment, and construction site projects in conformance with Permit requirements. Retain existing local requirements to apply stormwater controls at smaller sites, or at lower thresholds.

- Adopt an ordinance or other enforceable mechanism that includes a site planning process and BMP selection and design criteria in conformance with Permit requirements.

- Document how the BMP selection and design criteria and requirements will protect water quality, reduce the discharge of pollutants to the maximum extent practicable, and satisfy State AKART requirements.

- Adopt an ordinance or other enforceable mechanism that provides the legal authority, through the approval process for new development, to inspect private stormwater facilities that discharge to the City's stormwater system.

- Adopt an ordinance or other enforceable mechanism that allows non-structural preventive actions and source reduction approaches such as Low Impact Development Techniques (LID), measures to minimize the creation of impervious surfaces and measures to minimize the disturbance of native soils and vegetation.

- Develop and implement a permitting process with plan review, inspection and enforcement capability for both private and public projects. At a minimum, this program shall be applied to all sites that disturb a land area 1 acre or greater, including projects less than one acre that are part of a larger common plan of the development or sale.

- Review storrmwater site plans for proposed development activities.

- Inspect, prior to clearing and construction, all known development sites that have a high potential for sediment transport.

- Inspect all known permitted development sites during construction to verify proper installation and maintenance of required erosion and sediment controls. Enforce as necessary based on the inspection.

- Inspect all permitted development sites upon completion of construction and prior to final approval or occupancy to ensure proper installation of permanent stormwater controls such as stormwater facilities and structural BMPs. Also, verify a maintenance plan is completed and responsibility for maintenance is assigned. Enforce as necessary based on the inspection.

- Develop and implement an enforcement strategy to respond to issues of non-compliance.

- Develop and implement a long-term operation and maintenance (O&M) program for post-construction stormwater facilities and BMPs.

- Adopt an ordinance or other enforceable mechanism that clearly identifies the party responsible for maintenance, requires inspection of facilities, and establishes enforcement procedures.

- Establish maintenance standards that are as protective or more protective of facility function than those specified in the 2005 Stormwater Management Manual for Western Washington.

- Perform maintenance within required timeframes when an inspection identifies an exceedence of the maintenance standard. For each exceedence of the required timeframe, the City shall document the circumstances and how they were beyond their control.

- Inspect annually all municipally owned or operated permanent stormwater treatment and flow control facilities, other than catch basins, and take appropriate maintenance actions in accordance with the adopted maintenance standards. The annual inspection requirement may be reduced based on inspection records.

- Inspect all new flow control and water quality treatment facilities, including catch basins, for new residential developments that are a part of a larger common plan of development or sale, every 6 months during the period of heaviest house construction (i.e., 1 to 2 years following subdivision approval) to identify maintenance needs and enforce compliance with maintenance standards as needed.

- Implement a procedure for keeping records of inspections and enforcement actions by staff, including inspection reports, warning letters, notices of violations, other enforcement records, maintenance inspections and maintenance activities.

- Provide copies of the "Notice of Intent for Construction Activity" and copies of the "Notice of Intent for Industrial Activity" to representatives of proposed new development and redevelopment.

- Ensure that all staff responsible for implementing the program to control stormwater runoff from new development, redevelopment, and construction sites, including permitting, plan review, construction site inspections, and enforcement, are trained to conduct these activities.

6.2 CURRENT ACTIVITIES

The City currently implements activities and programs that meet some of the Permit requirements. The current compliance activities associated with the above Permit requirements include:

- The Black Diamond Municipal Code (BDMC Section 14.04.390) restricts the discharge of pollutants in stormwater runoff to the municipal separate storm sewer system from some development and construction site activities. The City enforces this program through the Code (BDMC Section 14.04.400).

- The City requires submittal of Erosion and Sediment Control (ESC) plans and stormwater management plants (i.e. for post-construction, permanent site drainage, and water quality facilities).

- The City has prepared draft, updated Storm Drainage standards for adoption. These standards have been developed in conformance with the 2005 Stormwater Management Manual for Western Washington.

- The City conducts construction and stormwater site inspections during the pre-construction and construction phases.

- The City regularly inspects existing private storm water quality and detention ponds.

6.3 PLANNED ACTIVITIES

The City has a program to help reduce stormwater runoff from new development and construction sites but has a goal to expand current efforts in order to maintain compliance as Permit requirements are phased in over the next several years. Actions that are recommended for continued compliance include:

- Review procedures for tracking and documenting Permit-related plan review, inspection, enforcement, and compliance activities and update as necessary.

- Update codes and standards as necessary.

- Distribute copies of the Notice of Intents for Construction Activity and Industrial Activity.

- Determine staff training needs and develop training strategies.

- Summarize annual activities for the “Controlling Runoff from New Development, Redevelopment and Construction Sites” component of the Annual Compliance Report.

SECTION 7 – POLLUTION PREVENTION AND OPERATION AND MAINTENANCE FOR MUNICIPAL OPERATIONS

7.1 PERMIT REQUIREMENTS AND DATES

Section S5.C.5 of the Western Washington Phase II Municipal Stormwater Permit requires the City to develop and implement an operations and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations. Specific program components are outlined below.

The City's goal is to complete the following by **February 15, 2010**:

- Establish maintenance standards that are as protective, or more protective, of facility function than those specified in the 2005 Stormwater Management Manual for Western Washington.

- Perform maintenance within required timeframes when an inspection identifies an exceedence of the maintenance standard. For each exceedence of the required timeframe, the City shall document the circumstances and how they were beyond their control.

- Inspect annually all municipally owned or operated permanent stormwater treatment and flow control facilities, other than catch basins, and take appropriate maintenance actions in accordance with the adopted maintenance standards. The annual inspection requirement may be reduced based on inspection records.

- Conduct spot checks of potentially damaged stormwater facilities (other than catch basins) after major storm events.

- Establish and implement practices to reduce stormwater impacts associated with runoff from streets, parking lots, roads or highways owned or maintained by the City, and road maintenance activities conducted by the City.

- Establish and implement policies and procedures to reduce pollutants in discharges from all lands owned or maintained by the City and subject to this Permit, including but not limited to: parks, open space, road right-of-way, maintenance yards, and stormwater treatment and flow control facilities.

- Develop and implement an on-going training program for City employees whose construction, operations or maintenance job functions may impact stormwater quality.

- Develop and implement a Stormwater Pollution Prevention Plan (SWPPP) for all heavy equipment maintenance or storage yards, and material storage facilities owned or operated by the City in areas subject to this Permit that are not required to have coverage under the Industrial Stormwater General Permit.

The City's goal is to complete the following by **February 15, 2012**:

- Inspect at least once, and clean if necessary, all catch basins and inlets owned or operated by the City.

7.2 CURRENT ACTIVITIES

The City currently has activities and programs that meet some of the Permit requirements. The current compliance activities associated with the above Permit requirements include:

- The City has a program for catch basin inspections.
- Many of the City's landscape, open space, and facility management activities are managed to minimize the potential for stormwater pollution.
- The City inspects City owned stormwater treatment facilities.

7.3 PLANNED ACTIVITIES

The City has a program to limit stormwater pollution potential related to its municipal operations and maintenance program, but has a goal to expand current efforts in order to maintain compliance as Permit requirements are phased in over the next several years. Actions that are recommended for continued compliance include:

- Update inspection, operation and maintenance processes and procedures for City-owned or operated stormwater catch-basins and flow control and treatment facilities.
- Develop and establish policies and procedures to reduce pollutants in stormwater discharges from lands owned or maintained by the City.
- Develop and implement training programs for staff whose work could impact stormwater quality.
- Update tracking and documentation methods and procedures associated with inspection, maintenance or repair activities.

- Create and implement Stormwater Pollution Prevention Plans (SWPPPs) for City Facilities.

- Summarize annual activities for the “Pollution Prevention and Operation and Maintenance for Municipal Operations” component of the Annual Compliance Report.

APPENDIX C – Existing Storm System Map

APPENDIX D – Basin Index Map

APPENDIX E – Drainage Sub-basin Hydrology and Culvert Hydraulics

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MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:19 AM

****

Input File Name: Basin 1-2.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Jones Lake 1
Comments : Basin Tributary to Unnamed Creek East of Jones Lake

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)	Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	241.290	241.290	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	274.000	274.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	0.000	0.000	0.000	No
Impervious	7.710	7.710	0.000	
SUBBASIN TOTAL	523.000	523.000	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	347.7	ft
Pond Bottom Width	:	173.8	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	60444.	sq-ft
Area at Riser Crest El	:	70156.	sq-ft
	:	1.611	acres
Volume at Riser Crest	:	195719.	cu-ft
	:	4.493	ac-ft
Area at Max Elevation	:	75255.	sq-ft
	:	1.728	acres
Volume at Max Elevation	:	304714.	cu-ft
	:	6.995	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 48.00	in
Common Length	: 2.183	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 13.54	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 26.2	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	1.388	0.000	0.000	0.000
100.04	1.390	0.049	0.915	0.000
100.07	1.393	0.097	1.294	0.000
100.14	1.398	0.195	1.829	0.000
100.21	1.403	0.293	2.241	0.000
100.28	1.408	0.391	2.587	0.000
100.35	1.413	0.490	2.893	0.000
100.42	1.418	0.589	3.169	0.000
100.49	1.423	0.689	3.423	0.000
100.56	1.428	0.788	3.659	0.000
100.63	1.433	0.889	3.881	0.000
100.70	1.438	0.989	4.091	0.000
100.77	1.443	1.090	4.290	0.000
100.84	1.449	1.191	4.481	0.000
100.91	1.454	1.293	4.664	0.000
100.93	1.455	1.322	4.715	0.000
100.95	1.457	1.351	4.766	0.000
100.97	1.458	1.380	4.815	0.000
100.99	1.460	1.409	4.865	0.000
101.01	1.461	1.435	4.924	0.000
101.03	1.462	1.460	4.998	0.000
101.04	1.463	1.486	5.079	0.000
101.06	1.465	1.512	5.168	0.000
101.13	1.470	1.614	5.573	0.000
101.20	1.475	1.717	6.042	0.000
101.27	1.480	1.821	6.559	0.000
101.34	1.485	1.925	7.117	0.000
101.41	1.491	2.029	7.708	0.000
101.48	1.496	2.133	8.330	0.000
101.55	1.501	2.238	8.977	0.000
101.62	1.506	2.343	9.648	0.000
101.69	1.511	2.449	10.341	0.000
101.76	1.517	2.555	11.052	0.000
101.83	1.522	2.661	11.780	0.000
101.90	1.527	2.768	12.524	0.000
101.97	1.532	2.875	13.282	0.000
102.04	1.538	2.983	14.053	0.000
102.11	1.543	3.090	14.835	0.000
102.18	1.548	3.199	15.627	0.000
102.25	1.553	3.307	16.429	0.000
102.32	1.559	3.416	17.239	0.000
102.39	1.564	3.525	18.056	0.000
102.46	1.569	3.635	18.880	0.000
102.53	1.575	3.745	19.710	0.000
102.60	1.580	3.855	20.544	0.000
102.67	1.585	3.966	21.382	0.000
102.74	1.591	4.077	22.224	0.000
102.81	1.596	4.189	23.069	0.000
102.88	1.601	4.301	23.915	0.000
102.91	1.604	4.349	24.279	0.000
102.94	1.606	4.397	24.642	0.000
102.97	1.608	4.445	25.006	0.000
103.00	1.611	4.494	25.370	0.000
103.02	1.612	4.522	25.663	0.000
103.04	1.613	4.550	26.024	0.000
103.05	1.615	4.578	26.428	0.000
103.07	1.616	4.606	26.868	0.000
103.09	1.617	4.635	27.339	0.000

103.11	1.619	4.663	27.836	0.000
103.12	1.620	4.691	28.358	0.000
103.14	1.621	4.720	28.904	0.000
103.21	1.627	4.833	31.367	0.000
103.28	1.632	4.948	34.192	0.000
103.35	1.638	5.062	37.265	0.000
103.42	1.643	5.177	40.552	0.000
103.49	1.648	5.292	44.025	0.000
103.56	1.654	5.408	47.656	0.000
103.63	1.659	5.524	51.417	0.000
103.70	1.665	5.640	55.281	0.000
103.77	1.670	5.757	59.221	0.000
103.84	1.676	5.874	62.929	0.000
103.91	1.681	5.991	66.417	0.000
103.98	1.687	6.109	69.873	0.000
104.05	1.692	6.227	73.269	0.000
104.12	1.698	6.346	76.579	0.000
104.19	1.703	6.465	79.776	0.000
104.26	1.709	6.584	82.838	0.000
104.33	1.714	6.704	85.743	0.000
104.40	1.720	6.824	88.475	0.000
104.47	1.725	6.945	91.021	0.000
104.54	1.731	7.066	93.371	0.000
104.61	1.736	7.187	95.524	0.000
104.68	1.742	7.309	97.485	0.000
104.75	1.747	7.431	99.264	0.000
104.82	1.753	7.554	100.882	0.000
104.89	1.759	7.677	102.370	0.000
104.96	1.764	7.800	103.768	0.000
105.03	1.770	7.924	105.823	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff
Predevelopment Runoff

Date	Annual Max (cfs)
1940 04 30	11.314
1940 12 20	6.467
1941 12 15	15.527
1942 11 23	6.470
1944 01 22	5.492
1945 02 07	15.015
1946 01 23	8.946
1947 02 01	9.551
1948 03 21	16.026
1949 03 19	8.297
1950 03 03	44.945
1951 02 09	12.686
1952 06 29	7.256
1953 01 11	7.054
1954 01 22	8.326
1955 04 12	4.780
1956 03 04	8.980
1957 02 25	8.152
1958 01 16	8.394
1959 01 12	10.376
1959 12 15	11.557
1961 02 14	9.600
1962 03 04	5.382
1963 02 03	6.427
1964 01 01	9.343
1965 02 26	9.436
1966 04 11	9.380
1967 01 19	15.099
1968 02 03	8.427
1968 12 03	9.103
1970 01 13	8.907
1970 12 06	9.628
1972 02 27	24.492
1973 01 13	7.851
1974 02 18	9.970
1974 12 26	15.629
1975 12 02	8.813
1977 05 31	4.827
1978 09 22	9.613
1979 03 04	9.088
1979 12 14	12.793
1980 11 21	8.577
1981 10 06	21.705
1983 01 05	10.028
1984 03 14	9.954
1985 02 11	6.757
1986 01 18	17.422
1986 11 24	17.068
1988 04 06	8.622
1989 04 05	9.142
1990 01 09	28.626
1990 11 24	25.337
1992 01 27	9.220
1993 03 22	7.028
1994 03 03	5.811
1995 02 19	10.584
1996 02 08	26.395

Pond Outflow Node
Postdevelopment Runoff

Date	Annual Max (cfs)
1940 05 01	9.035
1940 12 20	4.952
1941 12 15	7.232
1943 03 28	4.700
1944 01 23	3.932
1945 02 07	12.917
1946 02 05	7.866
1947 02 02	7.239
1948 03 21	11.867
1949 02 22	7.877
1950 03 03	25.075
1951 02 09	11.976
1952 01 24	3.356
1953 01 11	5.790
1954 01 22	8.006
1955 04 12	3.519
1956 01 06	7.800
1957 02 25	7.455
1958 01 16	7.768
1959 01 13	8.780
1959 11 21	8.671
1960 11 20	7.925
1962 03 04	4.692
1963 02 03	5.136
1964 01 01	6.770
1965 02 27	7.583
1966 04 11	7.017
1967 01 19	11.453
1968 02 04	6.255
1968 12 03	7.283
1970 01 14	5.834
1970 12 06	7.369
1972 02 28	17.109
1972 12 23	6.953
1974 02 19	8.486
1974 12 27	10.685
1975 12 03	7.441
1977 05 31	4.049
1977 12 15	7.580
1979 03 05	5.684
1979 12 15	11.804
1980 12 26	5.097
1981 10 06	15.843
1983 01 05	8.855
1984 03 21	5.439
1985 02 11	4.962
1986 01 18	16.156
1986 11 24	15.586
1988 04 06	7.407
1989 04 05	7.648
1990 01 09	24.994
1991 04 05	20.084
1992 01 27	6.433
1993 03 23	6.057
1994 03 03	4.779
1995 02 19	9.991
1996 02 08	21.032

1997 01 02	16.255	1997 01 02	12.526
1998 02 28	6.905	1998 03 23	4.250
1998 11 04	16.930	1998 11 25	12.761
2000 02 05	9.650	2000 02 06	8.361
2001 05 05	7.450	2001 05 05	5.570
2002 05 03	22.801	2002 05 03	7.350
2003 02 06	16.863	2003 03 31	15.580
2004 01 23	5.795	2004 01 23	4.599
2005 02 05	10.529	2005 02 07	5.927
2005 11 27	10.122	2005 11 27	9.358
2006 12 14	8.683	2006 12 15	6.893
2008 03 21	13.224	2008 01 07	10.523
2009 02 17	16.941	2009 02 17	14.906
2010 06 10	17.871	2010 01 10	9.311
2011 03 08	17.378	2010 11 17	13.906
2012 01 31	11.342	2012 02 02	5.679
2013 01 20	22.670	2013 01 20	18.312
2013 12 06	12.991	2014 04 05	8.699
2015 02 28	7.441	2015 03 30	5.632
2016 01 04	16.596	2016 01 04	14.305
2017 06 14	7.434	2017 03 07	4.574
2018 04 17	11.073	2018 01 31	8.272
2019 03 29	9.047	2019 02 14	8.100
2020 03 30	8.076	2020 04 15	6.119
2021 02 10	13.269	2021 02 10	12.755
2021 12 20	10.262	2021 12 20	7.197
2023 02 02	11.760	2023 03 30	10.136
2024 01 19	9.412	2024 01 19	8.595
2024 12 22	17.939	2024 12 22	15.749
2026 03 09	10.332	2026 03 09	8.776
2027 01 27	9.152	2027 01 28	8.573
2028 02 19	10.523	2028 02 19	10.387
2028 12 04	9.216	2028 12 04	8.610
2029 11 04	11.741	2030 02 16	9.541
2030 12 30	10.865	2030 12 30	10.318
2032 01 20	17.353	2032 01 20	15.938
2033 03 01	6.360	2033 03 01	4.503
2034 01 15	19.251	2034 01 16	16.301
2035 02 19	11.260	2035 02 19	9.037
2035 12 04	11.901	2035 12 04	8.559
2037 03 08	5.032	2037 03 09	3.128
2037 11 24	10.361	2037 12 15	7.135
2039 02 07	6.372	2038 12 11	4.486
2040 01 14	20.498	2040 01 14	9.048
2040 12 25	10.969	2040 12 25	10.034
2042 02 20	10.911	2042 02 20	6.962
2043 03 31	21.252	2043 03 31	8.561
2044 05 01	9.516	2044 05 01	6.861
2045 02 07	9.534	2045 03 23	7.584
2046 02 16	9.383	2046 02 16	8.765
2047 01 31	7.075	2047 02 01	6.097
2048 04 20	6.448	2048 04 21	5.599
2049 03 16	7.282	2049 03 16	4.941
2049 12 04	12.939	2049 12 04	10.582
2051 04 06	8.092	2051 04 06	6.262
2052 04 16	6.289	2052 04 17	4.363
2053 06 04	24.996	2052 12 10	7.259
2054 04 08	4.325	2054 04 08	3.516
2055 02 17	14.530	2055 02 17	11.766
2056 02 07	28.177	2056 02 07	23.066
2056 11 19	30.441	2056 11 19	23.535
2058 01 24	12.991	2058 05 21	10.060
2058 11 25	13.145	2058 12 28	10.630

2060	01 19	6.602	2060	01 19	4.249
2061	01 10	9.183	2061	01 10	8.510
2062	02 03	36.273	2062	02 03	18.589
2062	12 29	8.970	2062	12 30	7.838
2063	12 23	14.294	2063	12 23	12.798
2064	11 29	8.112	2064	11 30	6.568
2066	01 13	5.077	2066	01 13	4.217
2067	01 19	8.913	2067	01 19	7.810
2068	01 18	18.407	2068	01 18	15.361
2069	01 04	5.986	2069	01 04	4.714
2070	04 09	7.252	2070	04 09	4.644
2071	02 14	5.378	2071	02 14	4.532
2071	11 03	6.498	2071	11 03	5.352
2072	12 25	20.023	2072	12 25	19.121
2074	03 16	12.323	2074	03 16	9.391
2075	02 12	5.089	2075	01 17	3.613
2076	03 24	14.151	2076	03 24	8.894
2077	02 12	3.914	2077	02 12	3.080
2077	11 25	7.481	2077	12 02	5.175
2078	11 03	7.172	2079	02 25	6.447
2079	12 17	24.721	2079	12 17	20.860
2080	11 21	11.767	2080	11 21	10.466
2082	02 13	11.728	2082	02 14	11.558
2083	03 29	8.957	2083	02 12	6.833
2083	11 26	10.789	2083	11 26	8.617
2084	12 14	7.471	2084	12 14	6.303
2086	01 18	9.736	2086	01 18	8.912
2086	12 21	10.811	2086	12 21	7.993
2088	01 14	7.558	2088	01 14	5.669
2088	11 05	17.466	2088	11 05	12.835
2089	12 03	6.266	2089	12 06	4.705
2090	12 04	9.989	2090	12 04	8.188
2092	04 28	20.673	2092	01 31	10.362
2093	06 15	6.148	2093	03 22	4.751
2094	03 01	4.736	2094	03 02	4.135
2094	11 29	7.248	2094	11 30	6.549
2096	01 14	7.843	2096	01 14	7.199
2097	01 29	19.449	2097	01 30	12.861

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	3.914	1.00	3.080
1.01	4.325	1.01	3.128
1.02	4.736	1.02	3.356
1.02	4.780	1.02	3.516
1.03	4.827	1.03	3.519
1.04	5.032	1.04	3.613
1.04	5.077	1.04	3.932
1.05	5.089	1.05	4.049
1.06	5.378	1.06	4.135
1.06	5.382	1.06	4.217
1.07	5.492	1.07	4.249
1.08	5.795	1.08	4.250
1.09	5.811	1.09	4.363
1.09	5.986	1.09	4.486
1.10	6.148	1.10	4.503
1.11	6.266	1.11	4.532
1.12	6.289	1.12	4.574
1.12	6.360	1.12	4.599
1.13	6.372	1.13	4.644
1.14	6.427	1.14	4.692
1.15	6.448	1.15	4.700
1.16	6.467	1.16	4.705
1.17	6.470	1.17	4.714
1.18	6.498	1.18	4.751
1.18	6.602	1.18	4.779
1.19	6.757	1.19	4.941
1.20	6.905	1.20	4.952
1.21	7.028	1.21	4.962
1.22	7.054	1.22	5.097
1.23	7.075	1.23	5.136
1.24	7.172	1.24	5.175
1.25	7.248	1.25	5.352
1.26	7.252	1.26	5.439
1.27	7.256	1.27	5.570
1.28	7.282	1.28	5.599
1.29	7.434	1.29	5.632
1.30	7.441	1.30	5.669
1.31	7.450	1.31	5.679
1.32	7.471	1.32	5.684
1.33	7.481	1.33	5.790
1.35	7.558	1.35	5.834
1.36	7.843	1.36	5.927
1.37	7.851	1.37	6.057
1.38	8.076	1.38	6.097
1.39	8.092	1.39	6.119
1.40	8.112	1.40	6.255
1.42	8.152	1.42	6.262
1.43	8.297	1.43	6.303
1.44	8.326	1.44	6.433
1.46	8.394	1.46	6.447
1.47	8.427	1.47	6.549
1.48	8.577	1.48	6.568
1.50	8.622	1.50	6.770
1.51	8.683	1.51	6.833
1.53	8.813	1.53	6.861
1.54	8.907	1.54	6.893

1.56	8.913		1.56	6.953
1.57	8.946		1.57	6.962
1.59	8.957		1.59	7.017
1.60	8.970		1.60	7.135
1.62	8.980		1.62	7.197
1.64	9.047		1.64	7.199
1.65	9.088		1.65	7.232
1.67	9.103		1.67	7.239
1.69	9.142		1.69	7.259
1.71	9.152		1.71	7.283
1.73	9.183		1.73	7.350
1.75	9.216		1.75	7.369
1.77	9.220		1.77	7.407
1.79	9.343		1.79	7.441
1.81	9.380		1.81	7.455
1.83	9.383		1.83	7.580
1.85	9.412		1.85	7.583
1.87	9.436		1.87	7.584
1.89	9.516		1.89	7.648
1.92	9.534		1.92	7.768
1.94	9.551		1.94	7.800
1.96	9.600		1.96	7.810
1.99	9.613		1.99	7.838
2.01	9.628		2.01	7.866
2.04	9.650		2.04	7.877
2.07	9.736		2.07	7.925
2.09	9.954		2.09	7.993
2.12	9.970		2.12	8.006
2.15	9.989		2.15	8.100
2.18	10.028		2.18	8.188
2.21	10.122		2.21	8.272
2.24	10.262		2.24	8.361
2.27	10.332		2.27	8.486
2.31	10.361		2.31	8.510
2.34	10.376		2.34	8.559
2.38	10.523		2.38	8.561
2.41	10.529		2.41	8.573
2.45	10.584		2.45	8.595
2.49	10.789		2.49	8.610
2.53	10.811		2.53	8.617
2.57	10.865		2.57	8.671
2.61	10.911		2.61	8.699
2.65	10.969		2.65	8.765
2.70	11.073		2.70	8.776
2.75	11.260		2.75	8.780
2.80	11.314		2.80	8.855
2.85	11.342		2.85	8.894
2.90	11.557		2.90	8.912
2.95	11.728		2.95	9.035
3.01	11.741		3.01	9.037
3.07	11.760		3.07	9.048
3.13	11.767		3.13	9.311
3.19	11.901		3.19	9.358
3.26	12.323		3.26	9.391
3.32	12.686		3.32	9.541
3.40	12.793		3.40	9.991
3.47	12.939		3.47	10.034
3.55	12.991		3.55	10.060
3.63	12.991		3.63	10.136
3.72	13.145		3.72	10.318
3.80	13.224		3.80	10.362
3.90	13.269		3.90	10.387
4.00	14.151		4.00	10.466

4.10	14.294		4.10	10.523
4.21	14.530		4.21	10.582
4.32	15.015		4.32	10.630
4.45	15.099		4.45	10.685
4.58	15.527		4.58	11.453
4.71	15.629		4.71	11.558
4.86	16.026		4.86	11.766
5.01	16.255		5.01	11.804
5.17	16.596		5.17	11.867
5.35	16.863		5.35	11.976
5.54	16.930		5.54	12.526
5.74	16.941		5.74	12.755
5.95	17.068		5.95	12.761
6.19	17.353		6.19	12.798
6.44	17.378		6.44	12.835
6.71	17.422		6.71	12.861
7.01	17.466		7.01	12.917
7.33	17.871		7.33	13.906
7.69	17.939		7.69	14.305
8.08	18.407		8.08	14.906
8.52	19.251		8.52	15.361
9.00	19.449		9.00	15.580
9.55	20.023		9.55	15.586
10.16	20.498		10.16	15.749
10.86	20.673		10.86	15.843
11.66	21.252		11.66	15.938
12.59	21.705		12.59	16.156
13.68	22.670		13.68	16.301
14.97	22.801		14.97	17.109
16.54	24.492		16.54	18.312
18.47	24.721		18.47	18.589
20.92	24.996		20.92	19.121
24.10	25.337		24.10	20.084
28.44	26.395		28.44	20.860
34.68	28.177		34.68	21.032
44.42	28.626		44.42	23.066
61.77	30.441		61.77	23.535
101.36	36.273		101.36	24.994
282.36	44.945		282.36	25.075

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	6.499	6.499	
2-Year	10.034	10.034	7.852
5-Year	14.993	14.993	11.801
10-Year	19.100	19.100	15.707
25-Year	25.465	25.465	20.255
50-Year	31.214	31.214	23.234
100-Year	37.964	37.964	24.954
200-Year	45.910	45.910	25.047

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.225	2.9703E-01	0.125	3.5150E-01
0.449	2.2729E-01	0.251	2.8771E-01
0.674	1.8315E-01	0.376	2.4669E-01
0.899	1.5080E-01	0.501	2.1606E-01
1.124	1.2532E-01	0.627	1.9155E-01
1.348	1.0489E-01	0.752	1.7123E-01
1.573	8.8283E-02	0.878	1.5507E-01
1.798	7.4614E-02	1.003	1.4037E-01
2.023	6.3457E-02	1.128	1.2632E-01
2.247	5.4126E-02	1.254	1.1502E-01
2.472	4.6452E-02	1.379	1.0429E-01
2.697	3.9870E-02	1.504	9.4360E-02
2.921	3.4318E-02	1.630	8.5916E-02
3.146	2.9615E-02	1.755	7.8658E-02
3.371	2.5575E-02	1.881	7.2035E-02
3.596	2.2116E-02	2.006	6.5727E-02
3.820	1.9119E-02	2.131	6.0309E-02
4.045	1.6558E-02	2.257	5.5472E-02
4.270	1.4382E-02	2.382	5.0731E-02
4.494	1.2525E-02	2.507	4.6607E-02
4.719	1.0932E-02	2.633	4.2810E-02
5.017	9.1858E-03	2.758	3.9262E-02
5.169	8.4373E-03	2.884	3.6038E-02
5.393	7.4590E-03	3.009	3.3006E-02
5.618	6.5731E-03	3.134	3.0396E-02
5.843	5.8006E-03	3.260	2.7842E-02
6.068	5.1486E-03	3.385	2.5576E-02
6.292	4.6035E-03	3.510	2.3363E-02
6.517	4.0916E-03	3.636	2.1337E-02
6.742	3.6663E-03	3.761	1.9535E-02
6.966	3.2699E-03	3.887	1.7872E-02
7.191	2.9638E-03	4.012	1.6242E-02
7.416	2.6591E-03	4.137	1.4802E-02
7.641	2.3963E-03	4.263	1.3511E-02
7.865	2.1581E-03	4.388	1.2295E-02
8.090	1.9458E-03	4.513	1.1192E-02
8.315	1.7588E-03	4.639	1.0187E-02
8.540	1.5848E-03	4.764	9.2185E-03
8.764	1.4440E-03	4.890	8.2611E-03
8.989	1.3177E-03	5.017	7.6335E-03
9.214	1.1949E-03	5.140	7.0966E-03
9.438	1.0946E-03	5.266	6.6670E-03
9.663	9.9059E-04	5.391	6.2496E-03
9.888	9.1694E-04	5.516	5.8432E-03
10.034	8.7346E-04	5.642	5.4713E-03
10.337	7.8554E-04	5.767	5.1082E-03
10.562	7.1767E-04	5.893	4.7941E-03
10.787	6.7146E-04	6.018	4.4923E-03
11.011	6.2742E-04	6.143	4.2381E-03
11.236	5.8049E-04	6.269	3.9688E-03
11.461	5.3789E-04	6.394	3.7176E-03
11.686	5.0612E-04	6.519	3.4815E-03
11.910	4.7147E-04	6.645	3.2627E-03
12.135	4.3753E-04	6.770	3.0598E-03
12.360	4.0576E-04	6.896	2.8887E-03
12.585	3.6461E-04	7.021	2.7169E-03

12.809	3.3645E-04	7.146	2.5609E-03
13.034	3.0974E-04	7.272	2.4187E-03
13.259	2.8736E-04	7.397	2.2880E-03
13.483	2.6714E-04	7.522	2.1530E-03
13.708	2.5126E-04	7.648	2.0202E-03
13.933	2.3176E-04	7.773	1.9061E-03
14.158	2.1588E-04	7.899	1.7906E-03
14.382	1.9638E-04	8.024	1.7018E-03
14.607	1.8267E-04	8.149	1.6101E-03
14.832	1.6895E-04	8.275	1.5227E-03
14.993	1.5931E-04	8.400	1.4325E-03
15.281	1.4801E-04	8.525	1.3487E-03
15.506	1.4368E-04	8.651	1.2787E-03
15.731	1.2996E-04	8.776	1.2180E-03
15.955	1.2274E-04	8.902	1.1581E-03
16.180	1.1408E-04	9.027	1.1097E-03
16.405	1.0541E-04	9.152	1.0650E-03
16.630	9.6026E-05	9.278	1.0245E-03
16.854	8.9528E-05	9.403	9.8192E-04
17.079	7.9420E-05	9.528	9.4293E-04
17.304	7.3644E-05	9.654	9.0322E-04
17.529	6.6424E-05	9.779	8.6712E-04
17.753	6.3536E-05	9.905	8.2525E-04
17.978	5.8482E-05	10.034	7.8570E-04
18.203	5.1984E-05	10.155	7.4799E-04
18.427	4.9096E-05	10.281	7.2128E-04
18.652	4.4764E-05	10.406	6.8446E-04
18.877	4.1154E-05	10.531	6.5558E-04
19.102	3.7544E-05	10.657	6.2598E-04
19.326	3.4656E-05	10.782	6.0071E-04
19.551	3.1768E-05	10.908	5.7977E-04
19.776	3.1768E-05	11.033	5.5450E-04
20.000	2.6714E-05	11.158	5.3284E-04
20.225	2.5270E-05	11.284	5.2128E-04
20.450	2.5270E-05	11.409	4.9529E-04
20.675	2.2382E-05	11.534	4.7724E-04
20.899	2.0938E-05	11.660	4.6280E-04
21.124	2.0938E-05	11.785	4.4475E-04
21.349	2.0216E-05	11.910	4.2742E-04
21.574	2.0216E-05	12.036	4.1371E-04
21.798	1.9494E-05	12.161	3.9854E-04
22.023	1.7328E-05	12.287	3.7905E-04
22.248	1.5162E-05	12.412	3.5739E-04
22.472	1.4440E-05	12.537	3.3429E-04
22.697	1.2996E-05	12.663	3.1696E-04
22.922	1.2274E-05	12.788	3.0396E-04
23.147	1.2274E-05	12.913	2.8952E-04
23.371	1.1552E-05	13.039	2.8014E-04
23.596	1.1552E-05	13.164	2.6786E-04
23.821	1.1552E-05	13.290	2.5559E-04
24.046	1.1552E-05	13.415	2.5053E-04
24.270	1.1552E-05	13.540	2.3682E-04
24.495	1.0830E-05	13.666	2.2743E-04
24.720	1.0830E-05	13.791	2.1588E-04
24.944	9.3860E-06	13.916	2.0794E-04
25.169	8.6640E-06	14.042	1.9855E-04
25.394	7.9420E-06	14.167	1.9205E-04
25.619	7.9420E-06	14.293	1.8483E-04
25.843	7.2200E-06	14.418	1.7400E-04
26.068	7.2200E-06	14.543	1.6317E-04
26.293	7.2200E-06	14.669	1.5667E-04
26.517	5.7760E-06	14.794	1.5162E-04
26.742	5.7760E-06	14.919	1.4657E-04

26.967	5.7760E-06	14.993	1.4220E-04
27.192	5.7760E-06	15.170	1.3140E-04
27.416	5.7760E-06	15.296	1.2924E-04
27.641	5.7760E-06	15.421	1.2130E-04
27.866	5.7760E-06	15.546	1.1263E-04
28.091	5.7760E-06	15.672	1.0686E-04
28.315	5.0540E-06	15.797	1.0397E-04
28.540	4.3320E-06	15.922	9.8914E-05
28.765	3.6100E-06	16.048	9.1694E-05
28.989	3.6100E-06	16.173	8.8084E-05
29.214	3.6100E-06	16.299	8.8084E-05
29.439	3.6100E-06	16.424	8.3030E-05
29.664	3.6100E-06	16.549	7.8698E-05
29.888	3.6100E-06	16.675	7.7254E-05
30.113	3.6100E-06	16.800	7.5810E-05
30.338	3.6100E-06	16.925	7.4366E-05
30.563	2.8880E-06	17.051	7.0756E-05
30.787	2.8880E-06	17.176	6.5702E-05
31.012	2.8880E-06	17.302	6.2814E-05
31.214	2.9315E-06	17.427	6.0648E-05
31.461	2.1660E-06	17.552	5.7038E-05
31.686	2.1660E-06	17.678	5.3428E-05
31.911	2.1660E-06	17.803	4.9818E-05
32.136	2.1660E-06	17.928	4.6208E-05
32.360	2.1660E-06	18.054	4.4042E-05
32.585	2.1660E-06	18.179	3.9710E-05
32.810	2.1660E-06	18.305	3.7544E-05
33.034	2.1660E-06	18.430	3.4656E-05
33.259	2.1660E-06	18.555	3.3934E-05
33.484	2.1660E-06	18.681	3.1046E-05
33.709	2.1660E-06	18.806	2.8158E-05
33.933	2.1660E-06	18.931	2.5992E-05
34.158	2.1660E-06	19.057	2.4548E-05
34.383	2.1660E-06	19.182	2.0938E-05
34.608	2.1660E-06	19.308	2.0938E-05
34.832	2.1660E-06	19.433	1.9494E-05
35.057	2.1660E-06	19.558	1.8050E-05
35.282	2.1660E-06	19.684	1.7328E-05
35.506	2.1660E-06	19.809	1.6606E-05
35.731	2.1660E-06	19.934	1.5162E-05
35.956	2.1660E-06	20.060	1.3718E-05
36.181	2.1660E-06	20.185	1.2274E-05
36.405	1.4440E-06	20.311	1.2274E-05
36.630	1.4440E-06	20.436	1.2274E-05
36.855	1.4440E-06	20.561	1.1552E-05
37.080	1.4440E-06	20.687	1.1552E-05
37.304	1.4440E-06	20.812	9.3860E-06
37.529	1.4440E-06	20.937	8.6640E-06
37.754	1.4440E-06	21.063	7.9420E-06
37.978	1.4440E-06	21.188	7.9420E-06
38.203	1.4440E-06	21.314	7.9420E-06
38.428	1.4440E-06	21.439	7.9420E-06
38.653	1.4440E-06	21.564	7.2200E-06
38.877	7.2200E-07	21.690	7.2200E-06
39.102	7.2200E-07	21.815	5.7760E-06
39.327	7.2200E-07	21.940	5.7760E-06
39.551	7.2200E-07	22.066	5.0540E-06
39.776	7.2200E-07	22.191	5.0540E-06
40.001	7.2200E-07	22.316	5.0540E-06
40.226	7.2200E-07	22.442	5.0540E-06
40.450	7.2200E-07	22.567	4.3320E-06
40.675	7.2200E-07	22.693	4.3320E-06
40.900	7.2200E-07	22.818	4.3320E-06

41.125	7.2200E-07	22.943	4.3320E-06
41.349	7.2200E-07	23.069	3.6100E-06
41.574	7.2200E-07	23.194	3.6100E-06
41.799	7.2200E-07	23.319	3.6100E-06
42.023	7.2200E-07	23.445	3.6100E-06
42.248	7.2200E-07	23.570	2.1660E-06
42.473	7.2200E-07	23.696	2.1660E-06
42.698	7.2200E-07	23.821	2.1660E-06
42.922	7.2200E-07	23.946	2.1660E-06
43.147	7.2200E-07	24.072	1.4440E-06
43.372	7.2200E-07	24.197	1.4440E-06
43.597	7.2200E-07	24.322	1.4440E-06
43.821	7.2200E-07	24.448	1.4440E-06
44.046	7.2200E-07	24.573	1.4440E-06
44.271	7.2200E-07	24.699	1.4440E-06
44.495	7.2200E-07	24.824	1.4440E-06
44.720	7.2200E-07	24.949	1.4440E-06
44.945	7.2200E-07	25.075	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-17.5%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-9.0%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-8.1%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

****

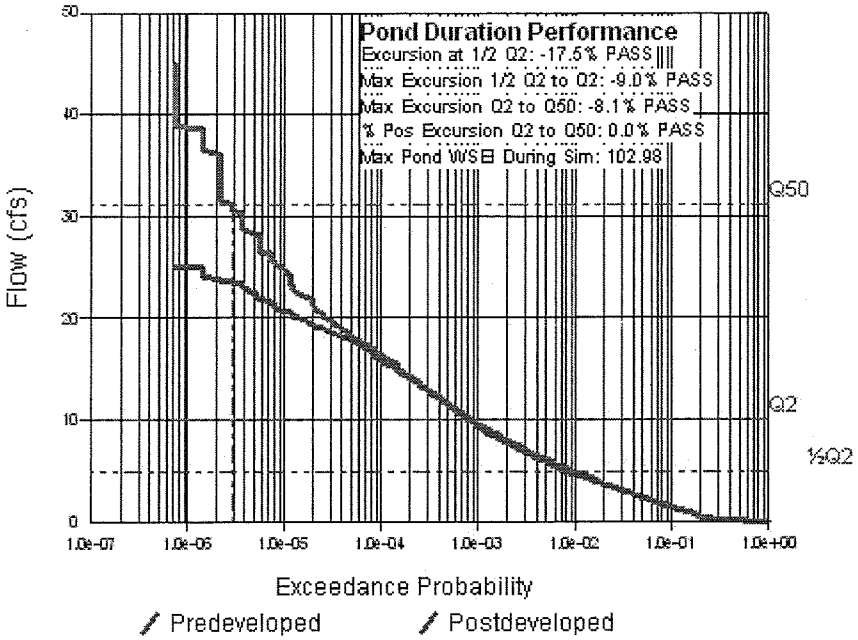
********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 487690. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 731535. cu-ft
2-Year Stormwater Pond Discharge Rate: 7.852 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****

Flow Duration Plot



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MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:22 AM
****

Input File Name: Basin 3.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Jones Lake 2
Comments : Basin Tributary to Unnamed Creek East of Jones Lake

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)	Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	249.000	249.000	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	274.000	274.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	0.000	0.000	0.000	No
Impervious	7.710	7.710	0.000	
SUBBASIN TOTAL	530.710	530.710	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	347.9	ft
Pond Bottom Width	:	173.9	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	60509.	sq-ft
Area at Riser Crest El	:	70225.	sq-ft
	:	1.612	acres
Volume at Riser Crest	:	195920.	cu-ft
	:	4.498	ac-ft
Area at Max Elevation	:	75327.	sq-ft
	:	1.729	acres
Volume at Max Elevation	:	305022.	cu-ft
	:	7.002	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 48.00	in
Common Length	: 2.252	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	:	Circular Orifice	
Invert Elevation	:	100.00	ft
Diameter	:	13.71	in
Orientation	:	Horizontal	
Elbow	:	No	

--- Device Number 2 ---

Device Type	:	Vertical Rectangular Orifice	
Invert Elevation	:	100.99	ft
Length	:	27.0	in
Height	:	24.1	in
Orientation	:	Vertical	
Elbow	:	No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	1.389	0.000	0.000	0.000
100.04	1.392	0.049	0.939	0.000
100.07	1.394	0.097	1.327	0.000
100.14	1.399	0.195	1.877	0.000
100.21	1.404	0.293	2.299	0.000
100.28	1.409	0.392	2.654	0.000
100.35	1.414	0.491	2.968	0.000
100.42	1.419	0.590	3.251	0.000
100.49	1.425	0.689	3.512	0.000
100.56	1.430	0.789	3.754	0.000
100.63	1.435	0.889	3.982	0.000
100.70	1.440	0.990	4.197	0.000
100.77	1.445	1.091	4.402	0.000
100.84	1.450	1.192	4.598	0.000
100.91	1.455	1.294	4.785	0.000
100.93	1.457	1.323	4.838	0.000
100.95	1.458	1.352	4.889	0.000
100.97	1.460	1.381	4.941	0.000
100.99	1.461	1.411	4.991	0.000
101.01	1.462	1.436	5.053	0.000
101.03	1.464	1.462	5.128	0.000
101.04	1.465	1.487	5.212	0.000
101.06	1.466	1.513	5.303	0.000
101.13	1.471	1.616	5.721	0.000
101.20	1.477	1.719	6.204	0.000
101.27	1.482	1.823	6.737	0.000
101.34	1.487	1.927	7.312	0.000
101.41	1.492	2.031	7.922	0.000
101.48	1.497	2.135	8.563	0.000
101.55	1.502	2.240	9.232	0.000
101.62	1.508	2.346	9.925	0.000
101.69	1.513	2.452	10.641	0.000
101.76	1.518	2.558	11.376	0.000
101.83	1.523	2.664	12.129	0.000
101.90	1.529	2.771	12.899	0.000
101.97	1.534	2.878	13.684	0.000
102.04	1.539	2.986	14.482	0.000
102.11	1.544	3.094	15.292	0.000
102.18	1.550	3.202	16.114	0.000
102.25	1.555	3.311	16.945	0.000
102.32	1.560	3.420	17.786	0.000
102.39	1.566	3.529	18.634	0.000
102.46	1.571	3.639	19.490	0.000
102.53	1.576	3.749	20.352	0.000
102.60	1.582	3.859	21.219	0.000
102.67	1.587	3.970	22.092	0.000
102.74	1.592	4.082	22.968	0.000
102.81	1.598	4.193	23.847	0.000
102.88	1.603	4.305	24.729	0.000
102.91	1.605	4.353	25.108	0.000
102.94	1.608	4.402	25.487	0.000
102.97	1.610	4.450	25.866	0.000
103.00	1.612	4.498	26.246	0.000
103.02	1.613	4.526	26.548	0.000
103.04	1.615	4.555	26.917	0.000
103.05	1.616	4.583	27.330	0.000
103.07	1.618	4.611	27.777	0.000
103.09	1.619	4.640	28.255	0.000

103.11	1.620	4.668	28.760	0.000
103.12	1.622	4.696	29.290	0.000
103.14	1.623	4.725	29.842	0.000
103.21	1.628	4.838	32.253	0.000
103.28	1.634	4.953	35.026	0.000
103.35	1.639	5.067	38.117	0.000
103.42	1.645	5.182	41.422	0.000
103.49	1.650	5.297	44.911	0.000
103.56	1.655	5.413	48.558	0.000
103.63	1.661	5.529	52.335	0.000
103.70	1.666	5.646	56.215	0.000
103.77	1.672	5.762	60.170	0.000
103.84	1.677	5.880	63.884	0.000
103.91	1.683	5.997	67.372	0.000
103.98	1.688	6.115	70.828	0.000
104.05	1.694	6.234	74.223	0.000
104.12	1.699	6.352	77.532	0.000
104.19	1.705	6.471	80.730	0.000
104.26	1.710	6.591	83.792	0.000
104.33	1.716	6.711	86.699	0.000
104.40	1.721	6.831	89.433	0.000
104.47	1.727	6.952	91.982	0.000
104.54	1.732	7.073	94.337	0.000
104.61	1.738	7.194	96.495	0.000
104.68	1.744	7.316	98.462	0.000
104.75	1.749	7.438	100.248	0.000
104.82	1.755	7.561	101.875	0.000
104.89	1.760	7.684	103.371	0.000
104.96	1.766	7.807	104.778	0.000
105.03	1.772	7.930	106.838	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	11.618	1940 05 01	9.367
1940 12 20	6.641	1940 12 20	5.125
1941 12 15	15.921	1941 12 15	7.502
1942 11 23	6.625	1943 03 28	4.848
1944 01 22	5.607	1944 01 23	4.053
1945 02 07	15.422	1945 02 07	13.328
1946 01 23	9.174	1946 02 05	8.116
1947 02 01	9.789	1947 02 02	7.497
1948 03 21	16.433	1948 03 21	12.278
1949 03 19	8.509	1949 02 22	8.129
1950 03 03	45.820	1950 03 03	25.973
1951 02 09	13.044	1951 02 09	12.345
1952 06 29	7.313	1952 01 24	3.460
1953 01 11	7.244	1953 01 11	5.997
1954 01 22	8.570	1954 01 22	8.255
1955 04 12	4.894	1955 04 12	3.628
1955 12 21	9.198	1956 01 06	8.039
1957 02 25	8.375	1957 02 25	7.682
1958 01 16	8.598	1958 01 16	8.024
1959 01 12	10.657	1959 01 13	9.051
1959 12 15	11.860	1959 11 21	8.932
1961 02 14	9.831	1960 11 20	8.194
1962 03 04	5.533	1962 03 04	4.840
1963 02 03	6.600	1963 02 03	5.319
1964 01 01	9.588	1964 01 01	7.014
1965 02 26	9.693	1965 02 27	7.844
1966 04 11	9.629	1966 04 11	7.264
1967 01 19	15.504	1967 01 19	11.886
1968 02 03	8.643	1968 02 04	6.485
1968 12 03	9.343	1968 12 03	7.535
1970 01 13	9.129	1970 01 14	6.014
1970 12 06	9.878	1970 12 06	7.598
1972 02 27	24.995	1972 02 28	17.688
1973 01 13	8.063	1972 12 23	7.191
1974 02 18	10.246	1974 02 19	8.780
1974 12 26	16.045	1974 12 27	11.072
1975 12 02	9.037	1975 12 03	7.673
1977 05 31	4.947	1977 05 31	4.173
1978 09 22	9.824	1977 12 15	7.823
1979 03 04	9.319	1979 03 05	5.897
1979 12 14	13.121	1979 12 15	12.162
1980 11 21	8.761	1980 12 26	5.277
1981 10 06	22.284	1981 10 06	16.390
1983 01 05	10.305	1983 01 05	9.132
1984 03 14	10.204	1984 03 21	5.636
1985 02 11	6.927	1985 02 11	5.140
1986 01 18	17.904	1986 01 18	16.658
1986 11 24	17.544	1986 11 24	16.066
1988 04 06	8.853	1988 04 06	7.653
1989 04 05	9.388	1989 04 05	7.894
1990 01 09	29.403	1990 01 09	25.848
1990 11 24	26.028	1991 04 05	20.711
1992 01 27	9.456	1992 01 27	6.663
1993 03 22	7.223	1993 03 23	6.264
1994 03 03	5.972	1994 03 03	4.931
1995 02 19	10.881	1995 02 19	10.300
1996 02 08	27.043	1996 02 08	21.686

1997 01 02	16.667	1997 01 02	12.906
1998 02 28	7.064	1998 03 23	4.386
1998 11 04	17.302	1998 11 25	13.156
2000 02 05	9.902	2000 02 06	8.637
2001 05 05	7.639	2001 05 05	5.752
2002 05 03	23.409	2002 05 03	7.687
2003 02 06	17.267	2003 03 31	16.063
2004 01 23	5.952	2004 01 23	4.745
2005 02 05	10.801	2005 02 07	6.137
2005 11 27	10.402	2005 11 27	9.651
2006 12 14	8.893	2006 12 15	7.121
2008 03 21	13.562	2008 01 07	10.862
2009 02 17	17.405	2009 02 17	15.410
2010 06 10	18.227	2010 01 10	9.665
2011 03 08	17.770	2010 11 17	14.344
2012 01 31	11.631	2012 02 02	5.878
2013 01 20	23.283	2013 01 20	18.929
2013 12 06	13.310	2014 04 05	8.975
2015 02 28	7.621	2015 03 30	5.824
2016 01 04	17.032	2016 01 04	14.781
2017 06 14	7.596	2017 03 07	4.718
2018 04 17	11.356	2018 01 31	8.542
2019 03 29	9.289	2019 02 14	8.355
2020 03 30	8.285	2020 04 15	6.332
2021 02 10	13.635	2021 02 10	13.146
2021 12 20	10.512	2021 12 20	7.458
2023 02 02	12.059	2023 03 30	10.444
2024 01 19	9.669	2024 01 19	8.867
2024 12 22	18.445	2024 12 22	16.248
2026 03 09	10.613	2026 03 09	9.071
2027 01 27	9.411	2027 01 28	8.849
2028 02 19	10.836	2028 02 19	10.703
2028 12 04	9.472	2028 12 04	8.881
2029 11 04	12.025	2030 02 16	9.849
2030 12 30	11.177	2030 12 30	10.641
2032 01 20	17.844	2032 01 20	16.442
2033 03 01	6.522	2033 03 01	4.649
2034 01 15	19.762	2034 01 16	16.822
2035 02 19	11.563	2035 02 19	9.337
2035 12 04	12.205	2035 12 04	8.852
2037 03 08	5.139	2037 03 09	3.223
2037 11 24	10.609	2037 12 15	7.353
2039 02 07	6.525	2038 12 11	4.628
2040 01 14	21.044	2040 01 14	9.445
2040 12 25	11.267	2040 12 25	10.352
2042 02 20	11.194	2042 02 20	7.224
2043 03 31	21.696	2043 03 31	8.926
2044 05 01	9.773	2044 05 01	7.102
2045 02 07	9.768	2045 03 23	7.840
2046 02 16	9.644	2046 02 16	9.037
2047 01 31	7.246	2047 02 01	6.289
2048 04 20	6.601	2048 04 21	5.777
2049 03 16	7.457	2049 03 16	5.121
2049 12 04	13.280	2049 12 04	10.970
2051 04 06	8.309	2051 04 06	6.481
2052 04 16	6.438	2052 04 17	4.496
2053 06 04	25.681	2052 12 10	7.516
2054 04 08	4.422	2054 04 08	3.622
2055 02 17	14.925	2055 02 17	12.190
2056 02 07	28.887	2056 02 07	23.802
2056 11 19	31.314	2056 11 19	24.329
2058 01 24	13.313	2058 05 21	10.420
2058 11 25	13.483	2058 12 28	10.965

2060	01	19	6.765	01	4.386
2061	01	10	9.446	01	8.792
2062	02	03	37.232	02	19.434
2062	12	29	9.217	12	8.076
2063	12	23	14.691	12	13.205
2064	11	29	8.295	11	6.787
2066	01	13	5.215	01	4.350
2067	01	19	9.132	01	8.056
2068	01	18	18.910	01	15.856
2069	01	04	6.144	01	4.862
2070	04	09	7.432	04	4.795
2071	02	14	5.526	02	4.676
2071	11	03	6.669	11	5.537
2072	12	25	20.588	12	19.708
2074	03	16	12.646	03	9.706
2075	02	12	5.187	01	3.721
2076	03	24	14.516	03	9.233
2077	02	12	4.013	02	3.174
2077	11	25	7.659	12	5.355
2078	11	03	7.328	02	6.651
2079	12	17	25.423	12	21.537
2080	11	21	12.087	11	10.806
2082	02	13	12.072	02	11.911
2083	03	29	9.169	02	7.048
2083	11	26	11.077	11	8.912
2084	12	14	7.671	12	6.523
2086	01	18	10.013	01	9.211
2086	12	21	11.086	12	8.264
2088	01	14	7.741	01	5.875
2088	11	05	17.923	11	13.312
2089	12	03	6.415	12	4.853
2090	12	04	10.259	12	8.483
2092	04	28	21.232	01	10.679
2093	06	15	6.286	03	4.904
2094	03	01	4.869	03	4.264
2094	11	29	7.449	11	6.753
2096	01	14	8.055	01	7.432
2097	01	29	19.856	01	13.286

********** Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	4.013	1.00	3.174
1.01	4.422	1.01	3.223
1.02	4.869	1.02	3.460
1.02	4.894	1.02	3.622
1.03	4.947	1.03	3.628
1.04	5.139	1.04	3.721
1.04	5.187	1.04	4.053
1.05	5.215	1.05	4.173
1.06	5.526	1.06	4.264
1.06	5.533	1.06	4.350
1.07	5.607	1.07	4.386
1.08	5.952	1.08	4.386
1.09	5.972	1.09	4.496
1.09	6.144	1.09	4.628
1.10	6.286	1.10	4.649
1.11	6.415	1.11	4.676
1.12	6.438	1.12	4.718
1.12	6.522	1.12	4.745
1.13	6.525	1.13	4.795
1.14	6.600	1.14	4.840
1.15	6.601	1.15	4.848
1.16	6.625	1.16	4.853
1.17	6.641	1.17	4.862
1.18	6.669	1.18	4.904
1.18	6.765	1.18	4.931
1.19	6.927	1.19	5.121
1.20	7.064	1.20	5.125
1.21	7.223	1.21	5.140
1.22	7.244	1.22	5.277
1.23	7.246	1.23	5.319
1.24	7.313	1.24	5.355
1.25	7.328	1.25	5.537
1.26	7.432	1.26	5.636
1.27	7.449	1.27	5.752
1.28	7.457	1.28	5.777
1.29	7.596	1.29	5.824
1.30	7.621	1.30	5.875
1.31	7.639	1.31	5.878
1.32	7.659	1.32	5.897
1.33	7.671	1.33	5.997
1.35	7.741	1.35	6.014
1.36	8.055	1.36	6.137
1.37	8.063	1.37	6.264
1.38	8.285	1.38	6.289
1.39	8.295	1.39	6.332
1.40	8.309	1.40	6.481
1.42	8.375	1.42	6.485
1.43	8.509	1.43	6.523
1.44	8.570	1.44	6.651
1.46	8.598	1.46	6.663
1.47	8.643	1.47	6.753
1.48	8.761	1.48	6.787
1.50	8.853	1.50	7.014
1.51	8.893	1.51	7.048
1.53	9.037	1.53	7.102
1.54	9.129	1.54	7.121

1.56	9.132	1.56	7.191
1.57	9.169	1.57	7.224
1.59	9.174	1.59	7.264
1.60	9.198	1.60	7.353
1.62	9.217	1.62	7.432
1.64	9.289	1.64	7.458
1.65	9.319	1.65	7.497
1.67	9.343	1.67	7.502
1.69	9.388	1.69	7.516
1.71	9.411	1.71	7.535
1.73	9.446	1.73	7.598
1.75	9.456	1.75	7.653
1.77	9.472	1.77	7.673
1.79	9.588	1.79	7.682
1.81	9.629	1.81	7.687
1.83	9.644	1.83	7.823
1.85	9.669	1.85	7.840
1.87	9.693	1.87	7.844
1.89	9.768	1.89	7.894
1.92	9.773	1.92	8.024
1.94	9.789	1.94	8.039
1.96	9.824	1.96	8.056
1.99	9.831	1.99	8.076
2.01	9.878	2.01	8.116
2.04	9.902	2.04	8.129
2.07	10.013	2.07	8.194
2.09	10.204	2.09	8.255
2.12	10.246	2.12	8.264
2.15	10.259	2.15	8.355
2.18	10.305	2.18	8.483
2.21	10.402	2.21	8.542
2.24	10.512	2.24	8.637
2.27	10.609	2.27	8.780
2.31	10.613	2.31	8.792
2.34	10.657	2.34	8.849
2.38	10.801	2.38	8.852
2.41	10.836	2.41	8.867
2.45	10.881	2.45	8.881
2.49	11.077	2.49	8.912
2.53	11.086	2.53	8.926
2.57	11.177	2.57	8.932
2.61	11.194	2.61	8.975
2.65	11.267	2.65	9.037
2.70	11.356	2.70	9.051
2.75	11.563	2.75	9.071
2.80	11.618	2.80	9.132
2.85	11.631	2.85	9.211
2.90	11.860	2.90	9.233
2.95	12.025	2.95	9.337
3.01	12.059	3.01	9.367
3.07	12.072	3.07	9.445
3.13	12.087	3.13	9.651
3.19	12.205	3.19	9.665
3.26	12.646	3.26	9.706
3.32	13.044	3.32	9.849
3.40	13.121	3.40	10.300
3.47	13.280	3.47	10.352
3.55	13.310	3.55	10.420
3.63	13.313	3.63	10.444
3.72	13.483	3.72	10.641
3.80	13.562	3.80	10.679
3.90	13.635	3.90	10.703
4.00	14.516	4.00	10.806

4.10	14.691	4.10	10.862
4.21	14.925	4.21	10.965
4.32	15.422	4.32	10.970
4.45	15.504	4.45	11.072
4.58	15.921	4.58	11.886
4.71	16.045	4.71	11.911
4.86	16.433	4.86	12.162
5.01	16.667	5.01	12.190
5.17	17.032	5.17	12.278
5.35	17.267	5.35	12.345
5.54	17.302	5.54	12.906
5.74	17.405	5.74	13.146
5.95	17.544	5.95	13.156
6.19	17.770	6.19	13.205
6.44	17.844	6.44	13.286
6.71	17.904	6.71	13.312
7.01	17.923	7.01	13.328
7.33	18.227	7.33	14.344
7.69	18.445	7.69	14.781
8.08	18.910	8.08	15.410
8.52	19.762	8.52	15.856
9.00	19.856	9.00	16.063
9.55	20.588	9.55	16.066
10.16	21.044	10.16	16.248
10.86	21.232	10.86	16.390
11.66	21.696	11.66	16.442
12.59	22.284	12.59	16.658
13.68	23.283	13.68	16.822
14.97	23.409	14.97	17.688
16.54	24.995	16.54	18.929
18.47	25.423	18.47	19.434
20.92	25.681	20.92	19.708
24.10	26.028	24.10	20.711
28.44	27.043	28.44	21.537
34.68	28.887	34.68	21.686
44.42	29.403	44.42	23.802
61.77	31.314	61.77	24.329
101.36	37.232	101.36	25.848
282.36	45.820	282.36	25.973

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	6.661	6.661	
2-Year	10.295	10.295	8.096
5-Year	15.386	15.386	12.188
10-Year	19.598	19.598	16.201
25-Year	26.118	26.118	20.893
50-Year	32.002	32.002	23.991
100-Year	38.904	38.904	25.807
200-Year	47.023	47.023	25.931

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.229	2.9774E-01	0.130	3.5064E-01
0.458	2.2809E-01	0.260	2.8679E-01
0.687	1.8405E-01	0.390	2.4575E-01
0.916	1.5177E-01	0.519	2.1514E-01
1.145	1.2632E-01	0.649	1.9067E-01
1.375	1.0587E-01	0.779	1.7034E-01
1.604	8.9309E-02	0.909	1.5453E-01
1.833	7.5550E-02	1.039	1.3946E-01
2.062	6.4335E-02	1.169	1.2551E-01
2.291	5.4960E-02	1.299	1.1437E-01
2.520	4.7210E-02	1.428	1.0345E-01
2.749	4.0596E-02	1.558	9.3580E-02
2.978	3.4964E-02	1.688	8.5220E-02
3.207	3.0221E-02	1.818	7.8101E-02
3.436	2.6105E-02	1.948	7.1349E-02
3.666	2.2606E-02	2.078	6.5120E-02
3.895	1.9591E-02	2.208	5.9733E-02
4.124	1.6980E-02	2.338	5.4850E-02
4.353	1.4774E-02	2.467	5.0195E-02
4.582	1.2856E-02	2.597	4.6108E-02
4.811	1.1253E-02	2.727	4.2318E-02
5.147	9.2637E-03	2.857	3.8798E-02
5.269	8.6698E-03	2.987	3.5591E-02
5.498	7.6676E-03	3.117	3.2616E-02
5.727	6.7839E-03	3.247	3.0039E-02
5.957	5.9839E-03	3.376	2.7438E-02
6.186	5.3110E-03	3.506	2.5250E-02
6.415	4.7414E-03	3.636	2.3010E-02
6.644	4.2165E-03	3.766	2.1018E-02
6.873	3.7919E-03	3.896	1.9264E-02
7.102	3.3876E-03	4.026	1.7579E-02
7.331	3.0447E-03	4.156	1.5969E-02
7.560	2.7407E-03	4.285	1.4539E-02
7.789	2.4794E-03	4.415	1.3279E-02
8.018	2.2375E-03	4.545	1.2091E-02
8.248	2.0245E-03	4.675	1.0969E-02
8.477	1.8238E-03	4.805	9.9672E-03
8.706	1.6462E-03	4.935	8.9976E-03
8.935	1.4895E-03	5.065	8.1066E-03
9.164	1.3610E-03	5.147	7.7274E-03
9.393	1.2332E-03	5.324	7.0085E-03
9.622	1.1343E-03	5.454	6.5962E-03
9.851	1.0325E-03	5.584	6.1738E-03
10.080	9.5015E-04	5.714	5.7652E-03
10.295	8.8365E-04	5.844	5.4114E-03
10.539	8.1514E-04	5.974	5.0497E-03
10.768	7.4871E-04	6.104	4.7342E-03
10.997	6.9529E-04	6.233	4.4403E-03
11.226	6.4402E-04	6.363	4.1818E-03
11.455	6.0070E-04	6.493	3.9226E-03
11.684	5.6099E-04	6.623	3.6721E-03
11.913	5.1840E-04	6.753	3.4288E-03
12.142	4.8446E-04	6.883	3.2252E-03
12.371	4.5847E-04	7.013	3.0259E-03
12.600	4.2526E-04	7.142	2.8497E-03
12.830	3.8555E-04	7.272	2.6830E-03

13.059	3.5161E-04	7.402	2.5313E-03
13.288	3.2634E-04	7.532	2.3884E-03
13.517	2.9963E-04	7.662	2.2454E-03
13.746	2.7941E-04	7.792	2.1212E-03
13.975	2.5992E-04	7.922	1.9877E-03
14.204	2.4476E-04	8.052	1.8707E-03
14.433	2.2382E-04	8.181	1.7675E-03
14.662	2.0866E-04	8.311	1.6685E-03
14.891	1.9277E-04	8.441	1.5870E-03
15.121	1.7833E-04	8.571	1.4953E-03
15.386	1.6387E-04	8.701	1.4115E-03
15.579	1.5306E-04	8.831	1.3328E-03
15.808	1.4657E-04	8.961	1.2649E-03
16.037	1.3718E-04	9.090	1.1956E-03
16.266	1.2563E-04	9.220	1.1444E-03
16.495	1.2057E-04	9.350	1.0931E-03
16.724	1.0974E-04	9.480	1.0548E-03
16.953	1.0325E-04	9.610	1.0050E-03
17.182	9.3138E-05	9.740	9.7109E-04
17.412	8.5196E-05	9.870	9.2633E-04
17.641	7.7254E-05	9.999	8.8662E-04
17.870	7.0756E-05	10.129	8.4402E-04
18.099	6.4980E-05	10.295	8.0223E-04
18.328	6.2814E-05	10.389	7.7110E-04
18.557	5.8482E-05	10.519	7.3789E-04
18.786	5.1984E-05	10.649	7.0684E-04
19.015	4.6930E-05	10.779	6.6930E-04
19.244	4.3320E-05	10.909	6.4042E-04
19.473	4.0432E-05	11.038	6.1442E-04
19.703	3.6822E-05	11.168	5.9132E-04
19.932	3.3212E-05	11.298	5.7110E-04
20.161	3.1768E-05	11.428	5.4728E-04
20.390	3.1768E-05	11.558	5.2706E-04
20.619	2.5992E-05	11.688	5.0757E-04
20.848	2.5270E-05	11.818	4.8663E-04
21.077	2.4548E-05	11.947	4.7147E-04
21.306	2.1660E-05	12.077	4.5414E-04
21.535	2.0938E-05	12.207	4.3464E-04
21.764	2.0216E-05	12.337	4.2309E-04
21.994	2.0216E-05	12.467	4.0721E-04
22.223	2.0216E-05	12.597	3.9132E-04
22.452	1.8050E-05	12.727	3.6966E-04
22.681	1.7328E-05	12.856	3.4584E-04
22.910	1.5162E-05	12.986	3.2490E-04
23.139	1.4440E-05	13.116	3.1046E-04
23.368	1.2996E-05	13.246	2.9819E-04
23.597	1.2274E-05	13.376	2.8447E-04
23.826	1.2274E-05	13.506	2.7075E-04
24.055	1.1552E-05	13.636	2.5920E-04
24.285	1.1552E-05	13.766	2.5198E-04
24.514	1.1552E-05	13.895	2.4331E-04
24.743	1.1552E-05	14.025	2.3176E-04
24.972	1.1552E-05	14.155	2.2382E-04
25.201	1.0830E-05	14.285	2.1082E-04
25.430	9.3860E-06	14.415	2.0433E-04
25.659	9.3860E-06	14.545	1.9277E-04
25.888	8.6640E-06	14.675	1.8555E-04
26.117	7.9420E-06	14.804	1.7761E-04
26.346	7.9420E-06	14.934	1.6895E-04
26.576	7.2200E-06	15.064	1.6028E-04
26.805	7.2200E-06	15.194	1.5451E-04
27.034	7.2200E-06	15.386	1.4458E-04
27.263	5.7760E-06	15.454	1.4007E-04

27.492	5.7760E-06	15.584	1.3429E-04
27.721	5.7760E-06	15.713	1.2996E-04
27.950	5.7760E-06	15.843	1.2707E-04
28.179	5.7760E-06	15.973	1.1841E-04
28.408	5.7760E-06	16.103	1.0974E-04
28.637	5.7760E-06	16.233	1.0613E-04
28.867	5.7760E-06	16.363	1.0036E-04
29.096	5.0540E-06	16.493	9.3860E-05
29.325	4.3320E-06	16.623	9.0250E-05
29.554	3.6100E-06	16.752	8.8084E-05
29.783	3.6100E-06	16.882	8.3030E-05
30.012	3.6100E-06	17.012	8.1586E-05
30.241	3.6100E-06	17.142	7.7254E-05
30.470	3.6100E-06	17.272	7.7254E-05
30.699	3.6100E-06	17.402	7.3644E-05
30.928	3.6100E-06	17.532	7.1478E-05
31.158	3.6100E-06	17.661	6.6424E-05
31.387	2.8880E-06	17.791	6.4258E-05
31.616	2.8880E-06	17.921	6.1370E-05
31.845	2.8880E-06	18.051	5.9204E-05
32.002	2.9734E-06	18.181	5.3428E-05
32.303	2.1660E-06	18.311	5.0540E-05
32.532	2.1660E-06	18.441	4.6930E-05
32.761	2.1660E-06	18.570	4.3320E-05
32.990	2.1660E-06	18.700	4.1154E-05
33.219	2.1660E-06	18.830	3.8988E-05
33.448	2.1660E-06	18.960	3.6100E-05
33.678	2.1660E-06	19.090	3.3934E-05
33.907	2.1660E-06	19.220	3.1768E-05
34.136	2.1660E-06	19.350	2.8880E-05
34.365	2.1660E-06	19.480	2.6714E-05
34.594	2.1660E-06	19.609	2.5270E-05
34.823	2.1660E-06	19.739	2.1660E-05
35.052	2.1660E-06	19.869	2.0938E-05
35.281	2.1660E-06	19.999	1.9494E-05
35.510	2.1660E-06	20.129	1.8772E-05
35.739	2.1660E-06	20.259	1.8050E-05
35.969	2.1660E-06	20.389	1.7328E-05
36.198	2.1660E-06	20.518	1.4440E-05
36.427	2.1660E-06	20.648	1.3718E-05
36.656	2.1660E-06	20.778	1.2996E-05
36.885	2.1660E-06	20.908	1.2274E-05
37.114	2.1660E-06	21.038	1.2274E-05
37.343	1.4440E-06	21.168	1.2274E-05
37.572	1.4440E-06	21.298	1.0830E-05
37.801	1.4440E-06	21.427	1.0108E-05
38.030	1.4440E-06	21.557	9.3860E-06
38.260	1.4440E-06	21.687	7.9420E-06
38.489	1.4440E-06	21.817	7.9420E-06
38.718	1.4440E-06	21.947	7.9420E-06
38.947	1.4440E-06	22.077	7.9420E-06
39.176	1.4440E-06	22.207	7.2200E-06
39.405	1.4440E-06	22.336	7.2200E-06
39.634	7.2200E-07	22.466	7.2200E-06
39.863	7.2200E-07	22.596	5.7760E-06
40.092	7.2200E-07	22.726	5.0540E-06
40.321	7.2200E-07	22.856	5.0540E-06
40.551	7.2200E-07	22.986	5.0540E-06
40.780	7.2200E-07	23.116	5.0540E-06
41.009	7.2200E-07	23.246	5.0540E-06
41.238	7.2200E-07	23.375	5.0540E-06
41.467	7.2200E-07	23.505	5.0540E-06
41.696	7.2200E-07	23.635	4.3320E-06

41.925	7.2200E-07	23.765	4.3320E-06
42.154	7.2200E-07	23.895	3.6100E-06
42.383	7.2200E-07	24.025	3.6100E-06
42.612	7.2200E-07	24.155	3.6100E-06
42.842	7.2200E-07	24.284	2.8880E-06
43.071	7.2200E-07	24.414	2.1660E-06
43.300	7.2200E-07	24.544	2.1660E-06
43.529	7.2200E-07	24.674	2.1660E-06
43.758	7.2200E-07	24.804	2.1660E-06
43.987	7.2200E-07	24.934	1.4440E-06
44.216	7.2200E-07	25.064	1.4440E-06
44.445	7.2200E-07	25.193	1.4440E-06
44.674	7.2200E-07	25.323	1.4440E-06
44.903	7.2200E-07	25.453	1.4440E-06
45.133	7.2200E-07	25.583	1.4440E-06
45.362	7.2200E-07	25.713	1.4440E-06
45.591	7.2200E-07	25.843	1.4440E-06
45.820	7.2200E-07	25.973	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-16.9%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-8.9%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-7.9%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

****

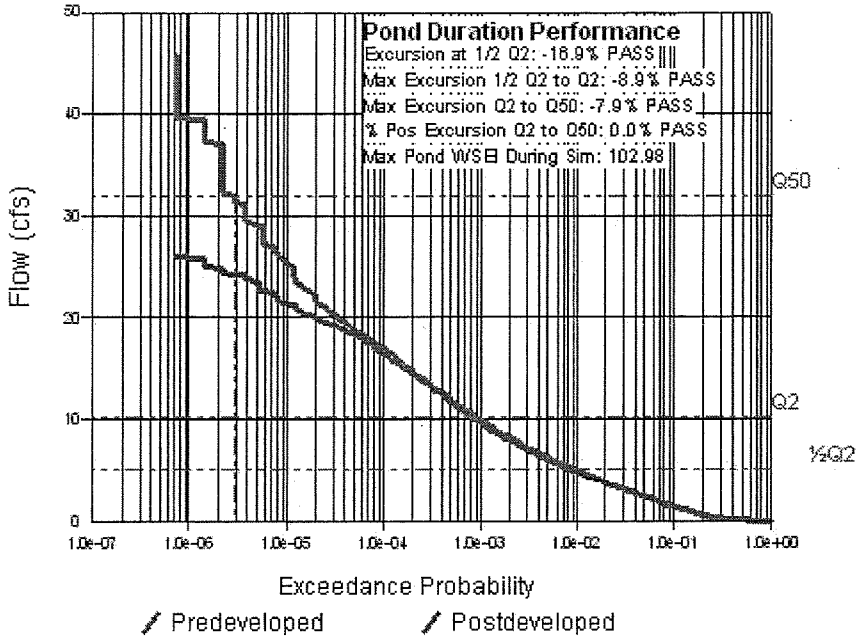
********** **Water Quality Facility Data** **********

Basic Wet Pond Volume (91% Exceedance): 502023. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 753035. cu-ft
2-Year Stormwater Pond Discharge Rate: 8.096 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****

Flow Duration Plot



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MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:25 AM
****

Input File Name: Basin 14.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Jones Lake 3
Comments : East Downtown and Upland Areas tributary to Jones Lake

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)			
		Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	373.490	373.490	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	33.840	33.840	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	0.000	0.000	0.000	No
Impervious	6.170	6.170	0.000	
SUBBASIN TOTAL	413.500	413.500	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	345.4	ft
Pond Bottom Width	:	172.7	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	59667.	sq-ft
Area at Riser Crest El	:	69318.	sq-ft
	:	1.591	acres
Volume at Riser Crest	:	193297.	cu-ft
	:	4.437	ac-ft
Area at Max Elevation	:	74387.	sq-ft
	:	1.708	acres
Volume at Max Elevation	:	301012.	cu-ft
	:	6.910	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 54.00	in
Common Length	: 3.520	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 17.54	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 42.2	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	1.370	0.000	0.000	0.000
100.04	1.372	0.048	1.536	0.000
100.07	1.375	0.096	2.173	0.000
100.14	1.380	0.192	3.073	0.000
100.21	1.385	0.289	3.763	0.000
100.28	1.390	0.386	4.346	0.000
100.35	1.395	0.484	4.858	0.000
100.42	1.400	0.582	5.322	0.000
100.49	1.405	0.680	5.749	0.000
100.56	1.410	0.778	6.145	0.000
100.63	1.415	0.877	6.518	0.000
100.70	1.420	0.976	6.871	0.000
100.77	1.425	1.076	7.206	0.000
100.84	1.430	1.176	7.527	0.000
100.91	1.435	1.276	7.834	0.000
100.93	1.437	1.305	7.920	0.000
100.95	1.438	1.334	8.004	0.000
100.97	1.440	1.362	8.088	0.000
100.99	1.441	1.391	8.171	0.000
101.01	1.443	1.417	8.270	0.000
101.03	1.444	1.442	8.391	0.000
101.04	1.445	1.467	8.525	0.000
101.06	1.446	1.492	8.671	0.000
101.13	1.451	1.594	9.339	0.000
101.20	1.457	1.696	10.110	0.000
101.27	1.462	1.798	10.964	0.000
101.34	1.467	1.900	11.885	0.000
101.41	1.472	2.003	12.866	0.000
101.48	1.477	2.106	13.899	0.000
101.55	1.482	2.210	14.979	0.000
101.62	1.488	2.314	16.103	0.000
101.69	1.493	2.418	17.267	0.000
101.76	1.498	2.523	18.467	0.000
101.83	1.503	2.628	19.702	0.000
101.90	1.508	2.733	20.968	0.000
101.97	1.514	2.839	22.264	0.000
102.04	1.519	2.945	23.587	0.000
102.11	1.524	3.052	24.937	0.000
102.18	1.529	3.159	26.311	0.000
102.25	1.535	3.266	27.708	0.000
102.32	1.540	3.373	29.127	0.000
102.39	1.545	3.481	30.566	0.000
102.46	1.550	3.590	32.024	0.000
102.53	1.556	3.698	33.501	0.000
102.60	1.561	3.807	34.994	0.000
102.67	1.566	3.917	36.504	0.000
102.74	1.572	4.027	38.028	0.000
102.81	1.577	4.137	39.567	0.000
102.88	1.582	4.247	41.119	0.000
102.91	1.584	4.295	41.788	0.000
102.94	1.587	4.343	42.460	0.000
102.97	1.589	4.390	43.133	0.000
103.00	1.591	4.438	43.808	0.000
103.02	1.593	4.466	44.286	0.000
103.04	1.594	4.494	44.834	0.000
103.05	1.595	4.522	45.427	0.000
103.07	1.597	4.550	46.057	0.000
103.09	1.598	4.577	46.719	0.000

103.11	1.599	4.605	47.409	0.000
103.12	1.601	4.633	48.125	0.000
103.14	1.602	4.661	48.865	0.000
103.21	1.607	4.774	52.039	0.000
103.28	1.613	4.887	55.507	0.000
103.35	1.618	5.000	59.227	0.000
103.42	1.624	5.113	63.166	0.000
103.49	1.629	5.227	67.297	0.000
103.56	1.634	5.341	71.594	0.000
103.63	1.640	5.456	76.035	0.000
103.70	1.645	5.571	79.293	0.000
103.77	1.651	5.686	83.312	0.000
103.84	1.656	5.802	87.378	0.000
103.91	1.661	5.918	91.470	0.000
103.98	1.667	6.034	95.564	0.000
104.05	1.672	6.151	99.637	0.000
104.12	1.678	6.268	103.664	0.000
104.19	1.683	6.386	107.622	0.000
104.26	1.689	6.504	111.489	0.000
104.33	1.694	6.622	115.244	0.000
104.40	1.700	6.741	118.866	0.000
104.47	1.705	6.860	122.337	0.000
104.54	1.711	6.980	125.643	0.000
104.61	1.716	7.100	128.769	0.000
104.68	1.722	7.220	131.708	0.000
104.75	1.727	7.341	134.454	0.000
104.82	1.733	7.462	137.007	0.000
104.89	1.739	7.583	139.371	0.000
104.96	1.744	7.705	141.558	0.000
105.03	1.750	7.827	143.583	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	18.567	1940 04 30	16.535
1940 12 20	10.435	1940 12 20	9.076
1941 12 15	27.873	1941 12 15	14.203
1942 11 23	10.509	1943 03 28	8.551
1944 01 22	8.655	1944 01 23	6.757
1945 02 07	25.473	1945 02 07	23.289
1946 01 23	14.600	1946 02 05	13.384
1947 02 01	16.193	1947 02 02	12.916
1948 03 21	26.156	1948 03 21	22.262
1949 03 19	13.764	1949 02 22	13.442
1950 03 03	57.081	1950 03 03	43.183
1951 02 09	20.559	1951 02 09	20.055
1952 06 29	19.163	1952 06 29	7.199
1953 01 11	11.568	1953 01 11	10.372
1954 01 22	13.818	1954 01 22	13.535
1955 04 12	7.405	1955 04 12	5.979
1955 12 22	14.644	1955 12 21	13.473
1957 02 25	13.382	1957 02 25	12.560
1958 01 16	13.991	1958 01 16	13.148
1959 01 12	17.104	1959 01 13	15.516
1959 12 15	19.499	1959 12 15	15.979
1961 02 14	16.114	1960 11 20	13.917
1962 03 04	8.794	1962 03 04	8.226
1963 02 03	10.389	1963 02 03	9.319
1964 01 01	15.657	1964 01 01	12.333
1965 02 26	15.472	1965 02 27	13.667
1966 04 11	15.514	1966 04 11	12.867
1967 01 19	25.477	1967 01 19	21.417
1968 02 03	13.584	1968 02 04	11.575
1968 12 03	14.835	1968 12 03	12.914
1970 01 13	14.764	1970 01 14	10.025
1970 12 06	16.169	1970 12 06	13.093
1972 02 28	33.442	1972 02 28	28.527
1972 12 23	12.769	1972 12 23	12.145
1974 02 18	16.195	1974 02 19	15.126
1974 12 26	27.205	1974 12 27	20.968
1975 12 02	14.646	1975 12 03	12.638
1977 05 31	7.749	1977 05 31	7.130
1978 09 22	16.790	1977 12 15	13.008
1979 03 04	14.979	1979 03 04	10.804
1979 12 14	22.599	1979 12 15	19.846
1980 11 21	14.957	1980 12 26	9.244
1981 10 06	38.272	1981 10 06	29.852
1983 01 05	16.602	1983 01 05	15.317
1984 03 14	16.979	1984 03 21	9.837
1985 02 11	10.926	1985 02 11	9.136
1986 01 18	29.664	1986 01 18	27.231
1986 11 24	28.666	1986 11 24	27.218
1988 04 06	14.051	1988 04 06	12.888
1989 04 05	15.189	1989 04 05	13.238
1990 01 09	50.733	1990 01 09	47.405
1990 11 24	45.470	1990 11 24	38.813
1992 01 27	15.364	1992 01 27	12.470
1993 03 22	11.398	1993 03 23	10.727
1994 03 03	9.390	1994 03 03	8.495
1995 02 19	17.322	1995 02 19	16.783
1996 02 08	39.257	1996 02 08	34.050

1997	01	02	26.510	1997	01	02	21.072
1998	02	28	11.072	1998	03	23	7.469
1998	11	04	33.083	1998	11	25	21.786
2000	02	05	15.931	2000	02	06	14.343
2001	05	05	12.341	2001	05	05	9.667
2002	05	03	41.851	2002	05	03	21.472
2003	03	31	26.653	2003	03	31	26.173
2004	01	23	9.316	2004	01	23	8.087
2005	02	05	18.830	2005	02	07	10.968
2005	11	27	16.728	2005	11	27	16.033
2006	12	14	14.476	2006	12	14	12.022
2008	03	21	22.862	2008	01	06	18.355
2009	02	17	28.065	2009	02	17	26.855
2010	06	10	37.988	2010	01	10	17.694
2010	11	17	27.484	2010	11	17	24.688
2012	01	31	19.544	2012	01	31	10.443
2013	01	20	40.728	2013	01	20	36.097
2013	12	06	23.204	2014	04	05	14.961
2015	02	28	12.069	2015	03	30	9.804
2016	01	04	28.275	2016	01	04	25.526
2017	06	14	13.308	2017	03	07	7.954
2018	04	17	18.433	2018	01	31	14.131
2019	03	29	14.549	2019	02	14	13.682
2020	03	30	13.505	2020	04	14	10.798
2021	02	10	22.210	2021	02	10	21.450
2021	12	20	17.503	2021	12	20	13.103
2023	02	02	21.383	2023	03	30	17.036
2024	01	19	15.495	2024	01	19	14.598
2024	12	22	30.847	2024	12	22	28.118
2026	03	09	16.872	2026	03	09	15.730
2027	01	27	15.084	2027	01	27	14.624
2028	02	19	17.484	2028	02	19	17.380
2028	12	04	15.040	2028	12	04	14.653
2029	11	04	19.735	2030	02	16	16.073
2030	12	30	17.920	2030	12	30	17.581
2032	01	20	29.186	2032	01	20	28.052
2033	03	01	10.139	2033	03	01	8.058
2034	01	15	30.128	2034	01	16	27.438
2035	02	19	18.594	2035	02	19	16.550
2035	12	04	20.264	2035	12	04	15.636
2037	03	08	7.945	2037	03	08	5.548
2037	11	24	17.811	2037	12	15	12.031
2039	02	07	10.168	2038	12	11	7.996
2040	01	14	37.281	2040	01	14	22.360
2040	12	25	18.119	2040	12	25	17.298
2042	02	20	18.340	2042	02	20	13.429
2043	03	31	29.986	2043	03	31	16.707
2044	05	01	16.055	2044	05	01	12.573
2045	02	07	16.052	2045	03	23	13.167
2046	02	16	15.547	2046	02	16	14.729
2047	01	31	11.587	2047	02	01	10.330
2048	04	20	10.243	2048	04	21	9.434
2049	03	16	12.153	2049	03	16	9.157
2049	12	04	21.442	2049	12	04	19.936
2051	04	06	13.685	2051	04	06	10.815
2052	04	16	10.142	2052	04	17	7.466
2053	06	04	46.268	2053	06	04	21.209
2054	04	08	6.833	2054	02	24	6.071
2055	02	17	24.338	2055	02	17	21.478
2056	02	07	42.462	2056	02	07	37.832
2056	11	19	52.716	2056	11	19	42.361
2058	01	24	22.957	2058	05	21	18.406
2058	11	25	22.456	2058	12	28	18.015

2060	01	19	10.645	2060	01	19	7.597
2061	01	10	15.100	2061	01	10	14.609
2062	02	03	62.621	2062	02	03	44.332
2062	12	29	14.709	2062	12	29	13.729
2063	12	23	24.041	2063	12	23	22.599
2064	11	29	13.679	2064	11	30	11.256
2066	01	13	8.248	2066	01	13	7.455
2067	01	19	14.924	2067	01	19	13.256
2068	01	18	30.843	2068	01	18	27.752
2069	01	04	9.658	2069	01	04	8.206
2070	04	09	11.850	2070	04	09	8.349
2071	02	14	8.738	2071	02	14	7.975
2071	11	03	10.653	2071	11	03	9.853
2072	12	25	33.811	2072	12	25	33.039
2074	03	16	20.287	2074	03	16	16.785
2075	02	12	8.320	2075	01	17	6.200
2076	03	24	24.059	2076	03	24	17.913
2077	08	24	6.240	2077	02	12	5.354
2077	11	25	12.032	2077	12	02	8.948
2078	11	03	11.924	2079	02	25	10.914
2079	12	17	42.407	2079	12	17	36.826
2080	11	21	19.617	2080	11	21	18.140
2082	02	14	19.435	2082	02	14	19.334
2083	03	29	14.486	2083	02	11	11.661
2083	11	26	17.824	2083	11	26	15.865
2084	12	14	12.214	2084	12	14	11.141
2086	01	18	15.881	2086	01	18	15.313
2086	12	21	18.230	2086	12	21	13.911
2088	01	14	12.338	2088	01	14	10.425
2088	11	05	30.777	2088	11	05	26.225
2089	12	03	10.049	2089	12	06	8.247
2090	12	04	16.493	2090	12	04	14.918
2092	04	28	37.504	2092	01	31	17.389
2093	06	15	10.724	2093	03	22	8.545
2094	03	01	7.781	2094	03	02	7.208
2094	11	29	11.964	2094	11	29	11.331
2096	01	14	12.852	2096	01	14	12.291
2097	01	29	26.663	2097	01	29	21.838

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	6.240	1.00	5.354
1.01	6.833	1.01	5.548
1.02	7.405	1.02	5.979
1.02	7.749	1.02	6.071
1.03	7.781	1.03	6.200
1.04	7.945	1.04	6.757
1.04	8.248	1.04	7.130
1.05	8.320	1.05	7.199
1.06	8.655	1.06	7.208
1.06	8.738	1.06	7.455
1.07	8.794	1.07	7.466
1.08	9.316	1.08	7.469
1.09	9.390	1.09	7.597
1.09	9.658	1.09	7.954
1.10	10.049	1.10	7.975
1.11	10.139	1.11	7.996
1.12	10.142	1.12	8.058
1.12	10.168	1.12	8.087
1.13	10.243	1.13	8.206
1.14	10.389	1.14	8.226
1.15	10.435	1.15	8.247
1.16	10.509	1.16	8.349
1.17	10.645	1.17	8.495
1.18	10.653	1.18	8.545
1.18	10.724	1.18	8.551
1.19	10.926	1.19	8.948
1.20	11.072	1.20	9.076
1.21	11.398	1.21	9.136
1.22	11.568	1.22	9.157
1.23	11.587	1.23	9.244
1.24	11.850	1.24	9.319
1.25	11.924	1.25	9.434
1.26	11.964	1.26	9.667
1.27	12.032	1.27	9.804
1.28	12.069	1.28	9.837
1.29	12.153	1.29	9.853
1.30	12.214	1.30	10.025
1.31	12.338	1.31	10.330
1.32	12.341	1.32	10.372
1.33	12.769	1.33	10.425
1.35	12.852	1.35	10.443
1.36	13.308	1.36	10.727
1.37	13.382	1.37	10.798
1.38	13.505	1.38	10.804
1.39	13.584	1.39	10.815
1.40	13.679	1.40	10.914
1.42	13.685	1.42	10.968
1.43	13.764	1.43	11.141
1.44	13.818	1.44	11.256
1.46	13.991	1.46	11.331
1.47	14.051	1.47	11.575
1.48	14.476	1.48	11.661
1.50	14.486	1.50	12.022
1.51	14.549	1.51	12.031
1.53	14.600	1.53	12.145
1.54	14.644	1.54	12.291

1.56	14.646		1.56	12.333
1.57	14.709		1.57	12.470
1.59	14.764		1.59	12.560
1.60	14.835		1.60	12.573
1.62	14.924		1.62	12.638
1.64	14.957		1.64	12.867
1.65	14.979		1.65	12.888
1.67	15.040		1.67	12.914
1.69	15.084		1.69	12.916
1.71	15.100		1.71	13.008
1.73	15.189		1.73	13.093
1.75	15.364		1.75	13.103
1.77	15.472		1.77	13.148
1.79	15.495		1.79	13.167
1.81	15.514		1.81	13.238
1.83	15.547		1.83	13.256
1.85	15.657		1.85	13.384
1.87	15.881		1.87	13.429
1.89	15.931		1.89	13.442
1.92	16.052		1.92	13.473
1.94	16.055		1.94	13.535
1.96	16.114		1.96	13.667
1.99	16.169		1.99	13.682
2.01	16.193		2.01	13.729
2.04	16.195		2.04	13.911
2.07	16.493		2.07	13.917
2.09	16.602		2.09	14.131
2.12	16.728		2.12	14.203
2.15	16.790		2.15	14.343
2.18	16.872		2.18	14.598
2.21	16.979		2.21	14.609
2.24	17.104		2.24	14.624
2.27	17.322		2.27	14.653
2.31	17.484		2.31	14.729
2.34	17.503		2.34	14.918
2.38	17.811		2.38	14.961
2.41	17.824		2.41	15.126
2.45	17.920		2.45	15.313
2.49	18.119		2.49	15.317
2.53	18.230		2.53	15.516
2.57	18.340		2.57	15.636
2.61	18.433		2.61	15.730
2.65	18.567		2.65	15.865
2.70	18.594		2.70	15.979
2.75	18.830		2.75	16.033
2.80	19.163		2.80	16.073
2.85	19.435		2.85	16.535
2.90	19.499		2.90	16.550
2.95	19.544		2.95	16.707
3.01	19.617		3.01	16.783
3.07	19.735		3.07	16.785
3.13	20.264		3.13	17.036
3.19	20.287		3.19	17.298
3.26	20.559		3.26	17.380
3.32	21.383		3.32	17.389
3.40	21.442		3.40	17.581
3.47	22.210		3.47	17.694
3.55	22.456		3.55	17.913
3.63	22.599		3.63	18.015
3.72	22.862		3.72	18.140
3.80	22.957		3.80	18.355
3.90	23.204		3.90	18.406
4.00	24.041		4.00	19.334

4.10	24.059	4.10	19.846
4.21	24.338	4.21	19.936
4.32	25.473	4.32	20.055
4.45	25.477	4.45	20.968
4.58	26.156	4.58	21.072
4.71	26.510	4.71	21.209
4.86	26.653	4.86	21.417
5.01	26.663	5.01	21.450
5.17	27.205	5.17	21.472
5.35	27.484	5.35	21.478
5.54	27.873	5.54	21.786
5.74	28.065	5.74	21.838
5.95	28.275	5.95	22.262
6.19	28.666	6.19	22.360
6.44	29.186	6.44	22.599
6.71	29.664	6.71	23.289
7.01	29.986	7.01	24.688
7.33	30.128	7.33	25.526
7.69	30.777	7.69	26.173
8.08	30.843	8.08	26.225
8.52	30.847	8.52	26.855
9.00	33.083	9.00	27.218
9.55	33.442	9.55	27.231
10.16	33.811	10.16	27.438
10.86	37.281	10.86	27.752
11.66	37.504	11.66	28.052
12.59	37.988	12.59	28.118
13.68	38.272	13.68	28.527
14.97	39.257	14.97	29.852
16.54	40.728	16.54	33.039
18.47	41.851	18.47	34.050
20.92	42.407	20.92	36.097
24.10	42.462	24.10	36.826
28.44	45.470	28.44	37.832
34.68	46.268	34.68	38.813
44.42	50.733	44.42	42.361
61.77	52.716	61.77	43.183
101.36	57.081	101.36	44.332
282.36	62.621	282.36	47.405

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	10.634	10.634	
2-Year	16.853	16.853	13.705
5-Year	25.325	25.325	21.448
10-Year	32.170	32.170	27.385
25-Year	42.538	42.538	37.048
50-Year	51.700	51.700	42.656
100-Year	62.257	62.257	44.301
200-Year	74.456	74.456	46.371

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.313	3.2240E-01	0.237	3.5045E-01
0.626	2.4930E-01	0.474	2.7931E-01
0.939	2.0518E-01	0.711	2.3573E-01
1.252	1.7324E-01	0.948	2.0423E-01
1.566	1.4802E-01	1.185	1.7951E-01
1.879	1.2723E-01	1.422	1.5911E-01
2.192	1.0979E-01	1.659	1.4260E-01
2.505	9.5022E-02	1.896	1.2687E-01
2.818	8.2578E-02	2.133	1.1401E-01
3.131	7.1861E-02	2.370	1.0212E-01
3.444	6.2871E-02	2.607	9.1402E-02
3.757	5.5123E-02	2.844	8.2246E-02
4.070	4.8453E-02	3.081	7.4593E-02
4.383	4.2628E-02	3.318	6.7138E-02
4.697	3.7547E-02	3.555	6.0710E-02
5.010	3.3143E-02	3.792	5.5261E-02
5.323	2.9292E-02	4.029	4.9940E-02
5.636	2.5888E-02	4.266	4.5441E-02
5.949	2.2859E-02	4.503	4.1236E-02
6.262	2.0247E-02	4.741	3.7478E-02
6.575	1.7924E-02	4.978	3.4055E-02
6.888	1.5859E-02	5.215	3.0948E-02
7.201	1.4079E-02	5.452	2.8208E-02
7.514	1.2522E-02	5.689	2.5648E-02
7.828	1.1183E-02	5.926	2.3288E-02
8.141	1.0013E-02	6.163	2.1142E-02
8.426	9.0720E-03	6.400	1.9189E-02
8.767	8.1052E-03	6.637	1.7405E-02
9.080	7.2893E-03	6.874	1.5743E-02
9.393	6.5550E-03	7.111	1.4266E-02
9.706	5.9348E-03	7.348	1.2940E-02
10.019	5.3580E-03	7.585	1.1743E-02
10.332	4.8497E-03	7.822	1.0624E-02
10.645	4.4331E-03	8.059	9.4900E-03
10.959	4.0331E-03	8.296	8.5586E-03
11.272	3.6678E-03	8.426	8.1635E-03
11.585	3.3407E-03	8.770	7.2864E-03
11.898	3.0613E-03	9.007	6.7529E-03
12.211	2.7992E-03	9.244	6.2496E-03
12.524	2.5501E-03	9.481	5.8071E-03
12.837	2.3357E-03	9.718	5.4157E-03
13.150	2.1465E-03	9.955	5.0143E-03
13.463	1.9653E-03	10.192	4.6649E-03
13.777	1.7913E-03	10.429	4.3645E-03
14.090	1.6433E-03	10.666	4.0699E-03
14.403	1.5162E-03	10.903	3.7927E-03
14.716	1.4101E-03	11.140	3.5161E-03
15.029	1.2909E-03	11.377	3.2627E-03
15.342	1.1992E-03	11.614	3.0468E-03
15.655	1.1242E-03	11.851	2.8562E-03
15.968	1.0368E-03	12.088	2.6664E-03
16.281	9.6459E-04	12.325	2.4988E-03
16.594	9.0539E-04	12.562	2.3299E-03
16.853	8.4646E-04	12.799	2.1862E-03
17.221	7.8481E-04	13.036	2.0425E-03
17.534	7.2922E-04	13.273	1.9003E-03

17.847	6.8373E-04	13.510	1.7862E-03
18.160	6.4330E-04	13.747	1.6685E-03
18.473	6.0865E-04	13.985	1.5523E-03
18.786	5.7038E-04	14.222	1.4570E-03
19.099	5.4944E-04	14.459	1.3812E-03
19.412	5.1045E-04	14.696	1.2989E-03
19.725	4.8879E-04	14.933	1.2252E-03
20.039	4.6208E-04	15.170	1.1646E-03
20.352	4.2959E-04	15.407	1.0967E-03
20.665	4.0071E-04	15.644	1.0527E-03
20.978	3.7111E-04	15.881	9.9275E-04
21.291	3.4295E-04	16.118	9.4005E-04
21.604	3.1985E-04	16.355	8.9023E-04
21.917	2.9602E-04	16.592	8.4907E-04
22.230	2.8014E-04	16.853	7.8979E-04
22.543	2.5920E-04	17.066	7.5882E-04
22.856	2.4404E-04	17.303	7.1695E-04
23.170	2.3176E-04	17.540	6.8229E-04
23.483	2.1804E-04	17.777	6.4764E-04
23.796	2.0577E-04	18.014	6.2164E-04
24.109	1.9061E-04	18.251	5.9276E-04
24.422	1.7545E-04	18.488	5.6966E-04
24.735	1.6750E-04	18.725	5.4511E-04
25.048	1.5523E-04	18.962	5.2128E-04
25.325	1.4867E-04	19.199	4.9962E-04
25.674	1.4079E-04	19.436	4.8013E-04
25.988	1.3068E-04	19.673	4.6425E-04
26.301	1.2491E-04	19.910	4.4403E-04
26.614	1.1480E-04	20.147	4.2237E-04
26.927	1.1047E-04	20.384	4.0360E-04
27.240	1.0252E-04	20.621	3.7688E-04
27.553	9.6026E-05	20.858	3.5161E-04
27.866	9.0972E-05	21.095	3.3068E-04
28.179	8.0142E-05	21.332	3.1407E-04
28.492	7.3644E-05	21.569	2.9602E-04
28.805	7.1478E-05	21.806	2.8158E-04
29.119	6.6424E-05	22.043	2.6786E-04
29.432	6.2814E-05	22.280	2.5126E-04
29.745	5.7760E-05	22.517	2.3898E-04
30.058	5.2706E-05	22.754	2.3032E-04
30.371	4.9096E-05	22.991	2.1949E-04
30.684	4.6930E-05	23.228	2.1155E-04
30.997	4.1876E-05	23.466	2.0144E-04
31.310	3.8988E-05	23.703	1.8844E-04
31.623	3.4656E-05	23.940	1.7906E-04
31.936	3.3212E-05	24.177	1.7184E-04
32.250	3.1046E-05	24.414	1.6245E-04
32.563	2.8880E-05	24.651	1.5740E-04
32.876	2.8158E-05	24.888	1.5018E-04
33.189	2.5992E-05	25.125	1.4079E-04
33.502	2.4548E-05	25.325	1.3653E-04
33.815	2.3104E-05	25.599	1.2852E-04
34.128	2.2382E-05	25.836	1.2202E-04
34.441	2.0938E-05	26.073	1.1769E-04
34.754	1.9494E-05	26.310	1.0974E-04
35.068	1.8772E-05	26.547	1.0180E-04
35.381	1.8050E-05	26.784	9.9636E-05
35.694	1.7328E-05	27.021	9.4582E-05
36.007	1.6606E-05	27.258	8.5918E-05
36.320	1.6606E-05	27.495	8.3752E-05
36.633	1.6606E-05	27.732	8.3030E-05
36.946	1.6606E-05	27.969	7.7976E-05
37.259	1.6606E-05	28.206	7.0756E-05

37.572	1.5162E-05	28.443	6.7146E-05
37.885	1.5162E-05	28.680	6.4258E-05
38.199	1.2996E-05	28.917	5.8482E-05
38.512	1.2274E-05	29.154	5.7760E-05
38.825	1.1552E-05	29.391	5.5594E-05
39.138	1.1552E-05	29.628	5.2706E-05
39.451	1.0830E-05	29.865	4.9096E-05
39.764	1.0830E-05	30.102	4.6208E-05
40.077	1.0830E-05	30.339	4.3320E-05
40.390	1.0830E-05	30.576	3.9710E-05
40.703	1.0830E-05	30.813	3.6100E-05
41.016	1.0108E-05	31.050	3.3934E-05
41.330	1.0108E-05	31.287	3.1768E-05
41.643	1.0108E-05	31.524	2.8158E-05
41.956	9.3860E-06	31.761	2.6714E-05
42.269	9.3860E-06	31.998	2.5992E-05
42.582	7.9420E-06	32.235	2.4548E-05
42.895	7.9420E-06	32.472	2.3826E-05
43.208	7.9420E-06	32.710	2.0938E-05
43.521	7.2200E-06	32.947	2.0216E-05
43.834	7.2200E-06	33.184	1.8050E-05
44.147	7.2200E-06	33.421	1.7328E-05
44.461	7.2200E-06	33.658	1.5162E-05
44.774	7.2200E-06	33.895	1.4440E-05
45.087	7.2200E-06	34.132	1.3718E-05
45.400	6.4980E-06	34.369	1.3718E-05
45.713	5.7760E-06	34.606	1.2996E-05
46.026	5.7760E-06	34.843	1.2996E-05
46.339	5.0540E-06	35.080	1.2996E-05
46.652	5.0540E-06	35.317	1.2996E-05
46.965	5.0540E-06	35.554	1.2274E-05
47.279	5.0540E-06	35.791	1.2274E-05
47.592	5.0540E-06	36.028	1.1552E-05
47.905	5.0540E-06	36.265	1.0830E-05
48.218	5.0540E-06	36.502	1.0830E-05
48.531	5.0540E-06	36.739	1.0830E-05
48.844	5.0540E-06	36.976	1.0108E-05
49.157	5.0540E-06	37.213	9.3860E-06
49.470	5.0540E-06	37.450	8.6640E-06
49.783	4.3320E-06	37.687	8.6640E-06
50.096	4.3320E-06	37.924	7.9420E-06
50.410	4.3320E-06	38.161	7.9420E-06
50.723	4.3320E-06	38.398	7.2200E-06
51.036	3.6100E-06	38.635	7.2200E-06
51.349	3.6100E-06	38.872	5.7760E-06
51.700	3.6084E-06	39.109	5.7760E-06
51.975	3.6100E-06	39.346	5.0540E-06
52.288	3.6100E-06	39.583	4.3320E-06
52.601	3.6100E-06	39.820	4.3320E-06
52.914	2.8880E-06	40.057	4.3320E-06
53.227	2.8880E-06	40.294	4.3320E-06
53.541	2.8880E-06	40.531	4.3320E-06
53.854	2.1660E-06	40.768	4.3320E-06
54.167	2.1660E-06	41.005	4.3320E-06
54.480	2.1660E-06	41.242	4.3320E-06
54.793	2.1660E-06	41.479	4.3320E-06
55.106	2.1660E-06	41.716	4.3320E-06
55.419	2.1660E-06	41.954	4.3320E-06
55.732	1.4440E-06	42.191	4.3320E-06
56.045	1.4440E-06	42.428	3.6100E-06
56.358	1.4440E-06	42.665	3.6100E-06
56.672	1.4440E-06	42.902	3.6100E-06
56.985	1.4440E-06	43.139	3.6100E-06

57.298	7.2200E-07	43.376	2.8880E-06
57.611	7.2200E-07	43.613	2.8880E-06
57.924	7.2200E-07	43.850	2.8880E-06
58.237	7.2200E-07	44.087	2.8880E-06
58.550	7.2200E-07	44.324	2.1660E-06
58.863	7.2200E-07	44.561	1.4440E-06
59.176	7.2200E-07	44.798	1.4440E-06
59.490	7.2200E-07	45.035	1.4440E-06
59.803	7.2200E-07	45.272	1.4440E-06
60.116	7.2200E-07	45.509	7.2200E-07
60.429	7.2200E-07	45.746	7.2200E-07
60.742	7.2200E-07	45.983	7.2200E-07
61.055	7.2200E-07	46.220	7.2200E-07
61.368	7.2200E-07	46.457	7.2200E-07
61.681	7.2200E-07	46.694	7.2200E-07
61.994	7.2200E-07	46.931	7.2200E-07
62.307	7.2200E-07	47.168	7.2200E-07
62.621	7.2200E-07	47.405	7.2200E-07

***** Flow Duration Performance According to Dept. of Ecology Criteria ******

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-9.8%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-6.1%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-5.6%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

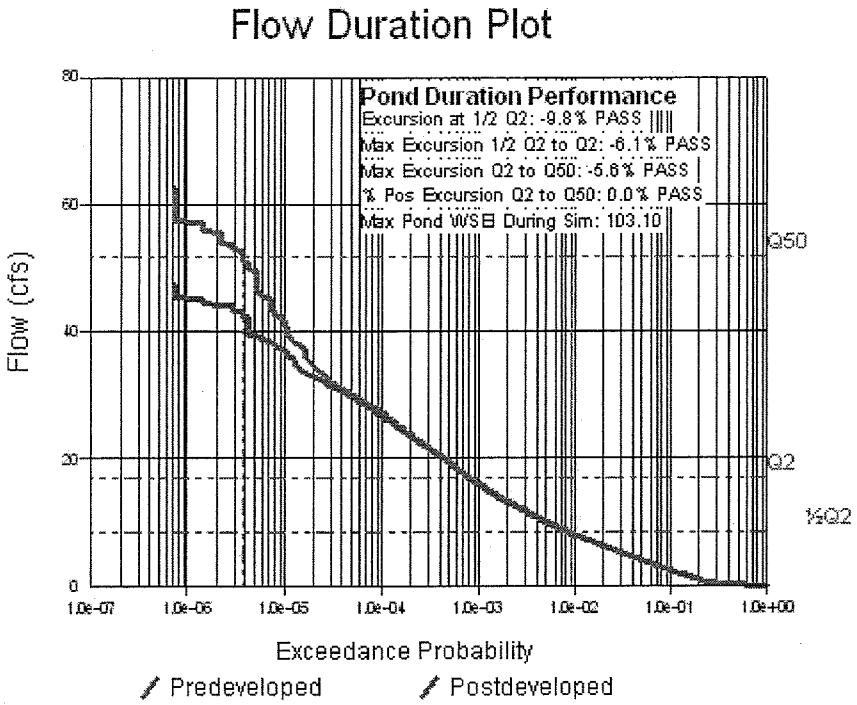
****

********** **Water Quality Facility Data** **********

Basic Wet Pond Volume (91% Exceedance): 814933. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 1222399. cu-ft
2-Year Stormwater Pond Discharge Rate: 13.705 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -9.8% PASS
Max Excursion 1/2 Q2 to Q2: -6.1% PASS
Max Excursion Q2 to Q50: -5.6% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEl During Sim: 103.10
Q50
Q2
½Q2
Flow (cfs)
80
60
40
20
0
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:28 AM

****

Input File Name: Basin 16.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Lake Twelve 1
Comments : Lake 12 Basin

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)	Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	271.850	271.850	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	18.050	18.050	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	49.760	49.760	0.000	No
Impervious	7.590	7.590	0.000	
SUBBASIN TOTAL	347.250	347.250	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 ---------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	357.2	ft
Pond Bottom Width	:	178.6	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	63812.	sq-ft
Area at Riser Crest El	:	73782.	sq-ft
	:	1.694	acres
Volume at Riser Crest	:	206210.	cu-ft
	:	4.734	ac-ft
Area at Max Elevation	:	79010.	sq-ft
	:	1.814	acres
Volume at Max Elevation	:	320741.	cu-ft
	:	7.363	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 54.00	in
Common Length	: 3.068	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 17.16	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 36.8	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	1.465	0.000	0.000	0.000
100.04	1.468	0.051	1.469	0.000
100.07	1.470	0.103	2.078	0.000
100.14	1.475	0.206	2.939	0.000
100.21	1.480	0.309	3.599	0.000
100.28	1.486	0.413	4.156	0.000
100.35	1.491	0.517	4.646	0.000
100.42	1.496	0.622	5.090	0.000
100.49	1.501	0.727	5.498	0.000
100.56	1.507	0.832	5.877	0.000
100.63	1.512	0.938	6.234	0.000
100.70	1.517	1.044	6.571	0.000
100.77	1.522	1.150	6.892	0.000
100.84	1.528	1.257	7.198	0.000
100.91	1.533	1.364	7.492	0.000
100.93	1.534	1.395	7.574	0.000
100.95	1.536	1.425	7.655	0.000
100.97	1.537	1.456	7.735	0.000
100.99	1.539	1.487	7.815	0.000
101.01	1.540	1.514	7.907	0.000
101.03	1.541	1.541	8.018	0.000
101.04	1.543	1.568	8.142	0.000
101.06	1.544	1.595	8.274	0.000
101.13	1.549	1.703	8.879	0.000
101.20	1.555	1.812	9.573	0.000
101.27	1.560	1.921	10.337	0.000
101.34	1.565	2.030	11.159	0.000
101.41	1.571	2.140	12.030	0.000
101.48	1.576	2.250	12.947	0.000
101.55	1.581	2.360	13.903	0.000
101.62	1.587	2.471	14.895	0.000
101.69	1.592	2.582	15.920	0.000
101.76	1.597	2.694	16.975	0.000
101.83	1.603	2.806	18.058	0.000
101.90	1.608	2.918	19.167	0.000
101.97	1.614	3.031	20.300	0.000
102.04	1.619	3.144	21.456	0.000
102.11	1.624	3.258	22.632	0.000
102.18	1.630	3.372	23.828	0.000
102.25	1.635	3.486	25.042	0.000
102.32	1.641	3.601	26.272	0.000
102.39	1.646	3.716	27.519	0.000
102.46	1.652	3.831	28.780	0.000
102.53	1.657	3.947	30.054	0.000
102.60	1.662	4.063	31.341	0.000
102.67	1.668	4.180	32.640	0.000
102.74	1.673	4.297	33.950	0.000
102.81	1.679	4.414	35.270	0.000
102.88	1.684	4.532	36.600	0.000
102.91	1.687	4.582	37.172	0.000
102.94	1.689	4.633	37.746	0.000
102.97	1.691	4.684	38.321	0.000
103.00	1.694	4.734	38.898	0.000
103.02	1.695	4.764	39.322	0.000
103.04	1.697	4.794	39.818	0.000
103.05	1.698	4.823	40.361	0.000
103.07	1.699	4.853	40.942	0.000
103.09	1.701	4.883	41.556	0.000

103.11	1.702	4.913	42.199	0.000
103.12	1.703	4.942	42.869	0.000
103.14	1.705	4.972	43.564	0.000
103.21	1.710	5.092	46.564	0.000
103.28	1.716	5.212	49.867	0.000
103.35	1.721	5.332	53.429	0.000
103.42	1.727	5.453	57.215	0.000
103.49	1.733	5.574	61.197	0.000
103.56	1.738	5.695	65.349	0.000
103.63	1.744	5.817	69.646	0.000
103.70	1.749	5.939	74.064	0.000
103.77	1.755	6.062	77.992	0.000
103.84	1.761	6.185	82.073	0.000
103.91	1.766	6.309	86.183	0.000
103.98	1.772	6.432	90.298	0.000
104.05	1.777	6.557	94.393	0.000
104.12	1.783	6.681	98.443	0.000
104.19	1.789	6.806	102.424	0.000
104.26	1.794	6.932	106.312	0.000
104.33	1.800	7.057	110.085	0.000
104.40	1.806	7.184	113.721	0.000
104.47	1.811	7.310	117.203	0.000
104.54	1.817	7.437	120.513	0.000
104.61	1.823	7.564	123.639	0.000
104.68	1.828	7.692	126.570	0.000
104.75	1.834	7.820	129.302	0.000
104.82	1.840	7.949	131.835	0.000
104.89	1.846	8.078	134.172	0.000
104.96	1.851	8.207	136.325	0.000
105.03	1.857	8.337	138.313	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	20.318	1940 04 30	17.718
1941 05 17	7.855	1941 01 18	6.693
1941 12 15	22.540	1941 12 15	10.712
1943 03 27	9.481	1943 03 28	7.516
1944 01 22	6.761	1944 01 22	5.060
1945 02 07	20.375	1945 02 07	17.470
1946 02 27	16.079	1946 02 05	12.273
1947 02 01	17.297	1947 02 02	12.774
1948 03 21	28.005	1948 03 21	23.614
1949 02 16	16.662	1949 02 22	12.727
1950 03 03	57.979	1950 03 03	38.654
1951 02 09	19.150	1951 02 09	18.051
1952 06 29	13.842	1952 06 29	5.633
1953 03 24	8.758	1953 01 11	7.202
1954 01 22	12.190	1954 01 22	11.583
1955 04 12	8.403	1955 04 12	5.637
1956 03 04	15.189	1956 01 06	12.476
1957 02 25	12.863	1957 02 25	10.692
1958 02 24	15.242	1958 01 16	11.176
1959 01 12	17.414	1959 01 13	14.172
1959 12 15	18.360	1960 01 29	14.208
1961 02 14	17.923	1960 11 20	9.719
1962 03 04	7.787	1962 03 04	6.855
1963 02 03	9.646	1963 02 03	7.407
1964 01 01	15.149	1964 01 01	10.172
1965 02 26	16.374	1965 02 27	13.650
1966 04 11	16.848	1966 04 11	12.924
1967 01 19	27.214	1967 01 19	22.113
1968 02 03	15.418	1968 02 04	11.864
1968 12 03	15.214	1968 12 03	11.356
1970 01 13	12.586	1970 03 06	7.910
1971 04 09	12.602	1970 12 06	8.826
1972 02 27	34.226	1972 02 27	28.402
1973 01 13	13.901	1973 01 13	11.225
1974 02 18	17.309	1974 02 18	15.756
1974 12 26	21.362	1974 12 27	14.703
1976 01 26	15.382	1976 01 27	12.522
1977 05 31	5.850	1977 05 31	5.260
1978 09 22	12.638	1977 12 15	10.234
1979 03 04	16.802	1979 03 04	11.748
1979 12 14	16.573	1979 12 17	15.384
1980 11 21	11.296	1980 12 26	6.907
1981 10 06	27.958	1981 10 06	21.056
1983 01 05	15.216	1983 01 05	13.209
1984 03 14	17.680	1984 03 20	9.579
1985 02 11	10.303	1985 02 11	7.601
1986 01 18	28.497	1986 01 18	25.268
1986 11 24	21.154	1986 11 24	19.733
1988 04 06	11.728	1988 04 06	9.781
1989 04 05	15.058	1989 04 05	12.204
1990 01 09	50.648	1990 01 09	48.429
1990 11 24	42.660	1990 11 24	35.466
1992 01 27	14.704	1992 01 27	10.557
1993 06 09	13.154	1993 03 23	8.645
1994 03 03	7.295	1994 03 03	6.473
1995 02 19	17.324	1995 02 19	16.026
1996 02 08	40.514	1996 02 08	34.518

1997	01	02	27.031	20.485
1998	02	28	12.413	6.859
1998	11	04	24.093	16.893
2000	02	28	15.969	13.353
2001	05	05	11.478	7.654
2002	05	03	34.336	15.915
2003	02	06	26.443	24.863
2004	04	19	7.701	6.233
2005	02	05	14.646	7.743
2006	02	27	15.915	13.736
2007	03	09	11.755	8.511
2008	03	21	24.259	16.185
2009	02	17	29.815	28.178
2010	06	10	28.565	16.184
2011	03	08	28.095	23.422
2012	01	31	19.153	9.751
2013	01	20	38.927	34.798
2014	02	13	19.369	14.216
2015	04	12	11.471	8.113
2016	01	04	30.177	26.698
2017	06	14	11.776	6.824
2018	04	17	20.188	13.936
2019	03	29	15.035	13.326
2020	04	14	13.291	9.613
2021	02	10	21.680	19.851
2021	12	20	13.070	9.100
2023	02	02	17.274	14.703
2024	03	11	15.058	11.720
2024	12	22	23.866	21.564
2026	03	09	18.327	16.614
2027	03	15	16.721	12.159
2028	06	01	18.097	14.967
2028	12	04	14.245	12.633
2030	02	16	16.899	16.223
2031	02	26	16.672	14.999
2032	01	20	28.938	27.130
2033	03	01	9.815	6.977
2034	02	18	29.281	24.544
2035	02	19	20.269	16.861
2036	03	24	16.962	15.011
2037	03	08	6.196	4.347
2037	11	24	13.302	8.863
2039	02	07	8.879	6.310
2040	01	14	32.703	18.039
2040	12	25	14.276	12.929
2042	02	20	20.329	14.523
2043	03	31	29.813	15.497
2044	05	01	15.582	11.382
2045	02	07	16.511	12.219
2046	02	16	16.235	12.902
2047	04	17	13.267	8.129
2048	04	20	11.205	7.713
2049	03	16	11.389	8.208
2049	12	04	15.926	13.900
2051	04	06	12.290	9.004
2052	04	16	8.787	5.817
2053	06	04	40.768	17.435
2054	04	08	6.072	4.676
2055	02	17	25.624	21.906
2056	02	07	41.993	36.043
2056	11	19	42.158	32.394
2058	01	24	22.755	19.140
2059	01	17	23.114	15.413

2060	01 19	9.201	2060	01 19	6.211
2061	01 10	14.056	2061	01 10	13.413
2062	02 03	58.230	2062	02 03	35.193
2062	12 29	14.128	2062	12 29	12.090
2063	12 23	24.230	2063	12 23	21.774
2064	11 29	11.091	2064	11 30	7.945
2066	01 12	6.425	2066	01 13	5.780
2067	01 19	17.431	2067	01 19	13.197
2068	01 18	32.046	2068	01 18	28.188
2069	01 04	9.432	2069	04 23	7.292
2070	04 09	13.574	2070	04 09	8.043
2071	03 23	8.709	2071	02 14	6.181
2072	02 27	10.654	2071	11 03	6.953
2072	12 25	31.411	2072	12 25	29.905
2074	03 16	20.587	2074	03 16	16.024
2075	02 12	7.527	2075	01 17	4.713
2076	03 24	25.752	2076	03 24	19.349
2077	08 24	5.449	2077	02 12	4.061
2077	11 25	9.176	2077	11 25	6.581
2079	02 24	10.204	2079	02 25	8.794
2079	12 17	34.176	2079	12 17	29.175
2081	02 17	18.722	2080	11 21	14.678
2082	02 18	20.039	2082	02 13	18.322
2083	03 29	16.802	2083	02 19	11.339
2083	11 26	18.740	2083	11 26	15.477
2085	03 23	12.048	2084	12 14	9.415
2086	01 18	12.183	2086	01 18	11.400
2086	12 21	14.814	2086	12 21	10.268
2088	03 25	10.548	2088	01 14	7.307
2088	11 05	22.514	2088	11 05	17.052
2090	01 06	10.177	2090	06 10	7.804
2090	12 04	15.910	2090	12 04	13.410
2092	04 28	34.262	2092	04 29	15.355
2093	06 15	9.968	2093	03 22	7.229
2094	03 01	6.698	2094	03 01	6.097
2095	02 18	11.608	2094	12 27	8.160
2096	01 14	12.722	2096	01 14	11.229
2097	01 29	30.035	2097	01 29	24.298

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	5.449	1.00	4.061
1.01	5.850	1.01	4.347
1.02	6.072	1.02	4.676
1.02	6.196	1.02	4.713
1.03	6.425	1.03	5.060
1.04	6.698	1.04	5.260
1.04	6.761	1.04	5.633
1.05	7.295	1.05	5.637
1.06	7.527	1.06	5.780
1.06	7.701	1.06	5.817
1.07	7.787	1.07	6.097
1.08	7.855	1.08	6.181
1.09	8.403	1.09	6.211
1.09	8.709	1.09	6.233
1.10	8.758	1.10	6.310
1.11	8.787	1.11	6.473
1.12	8.879	1.12	6.581
1.12	9.176	1.12	6.693
1.13	9.201	1.13	6.824
1.14	9.432	1.14	6.855
1.15	9.481	1.15	6.859
1.16	9.646	1.16	6.907
1.17	9.815	1.17	6.953
1.18	9.968	1.18	6.977
1.18	10.177	1.18	7.202
1.19	10.204	1.19	7.229
1.20	10.303	1.20	7.292
1.21	10.548	1.21	7.307
1.22	10.654	1.22	7.407
1.23	11.091	1.23	7.516
1.24	11.205	1.24	7.601
1.25	11.296	1.25	7.654
1.26	11.389	1.26	7.713
1.27	11.471	1.27	7.743
1.28	11.478	1.28	7.804
1.29	11.608	1.29	7.910
1.30	11.728	1.30	7.945
1.31	11.755	1.31	8.043
1.32	11.776	1.32	8.113
1.33	12.048	1.33	8.129
1.35	12.183	1.35	8.160
1.36	12.190	1.36	8.208
1.37	12.290	1.37	8.511
1.38	12.413	1.38	8.645
1.39	12.586	1.39	8.794
1.40	12.602	1.40	8.826
1.42	12.638	1.42	8.863
1.43	12.722	1.43	9.004
1.44	12.863	1.44	9.100
1.46	13.070	1.46	9.415
1.47	13.154	1.47	9.579
1.48	13.267	1.48	9.613
1.50	13.291	1.50	9.719
1.51	13.302	1.51	9.751
1.53	13.574	1.53	9.781
1.54	13.842	1.54	10.172

1.56	13.901	1.56	10.234
1.57	14.056	1.57	10.268
1.59	14.128	1.59	10.557
1.60	14.245	1.60	10.692
1.62	14.276	1.62	10.712
1.64	14.646	1.64	11.176
1.65	14.704	1.65	11.225
1.67	14.814	1.67	11.229
1.69	15.035	1.69	11.339
1.71	15.058	1.71	11.356
1.73	15.058	1.73	11.382
1.75	15.149	1.75	11.400
1.77	15.189	1.77	11.583
1.79	15.214	1.79	11.720
1.81	15.216	1.81	11.748
1.83	15.242	1.83	11.864
1.85	15.382	1.85	12.090
1.87	15.418	1.87	12.159
1.89	15.582	1.89	12.204
1.92	15.910	1.92	12.219
1.94	15.915	1.94	12.273
1.96	15.926	1.96	12.476
1.99	15.969	1.99	12.522
2.01	16.079	2.01	12.633
2.04	16.235	2.04	12.727
2.07	16.374	2.07	12.774
2.09	16.511	2.09	12.902
2.12	16.573	2.12	12.924
2.15	16.662	2.15	12.929
2.18	16.672	2.18	13.197
2.21	16.721	2.21	13.209
2.24	16.802	2.24	13.326
2.27	16.802	2.27	13.353
2.31	16.848	2.31	13.410
2.34	16.899	2.34	13.413
2.38	16.962	2.38	13.650
2.41	17.274	2.41	13.736
2.45	17.297	2.45	13.900
2.49	17.309	2.49	13.936
2.53	17.324	2.53	14.172
2.57	17.414	2.57	14.208
2.61	17.431	2.61	14.216
2.65	17.680	2.65	14.523
2.70	17.923	2.70	14.678
2.75	18.097	2.75	14.703
2.80	18.327	2.80	14.703
2.85	18.360	2.85	14.967
2.90	18.722	2.90	14.999
2.95	18.740	2.95	15.011
3.01	19.150	3.01	15.355
3.07	19.153	3.07	15.384
3.13	19.369	3.13	15.413
3.19	20.039	3.19	15.477
3.26	20.188	3.26	15.497
3.32	20.269	3.32	15.756
3.40	20.318	3.40	15.915
3.47	20.329	3.47	16.024
3.55	20.375	3.55	16.026
3.63	20.587	3.63	16.184
3.72	21.154	3.72	16.185
3.80	21.362	3.80	16.223
3.90	21.680	3.90	16.614
4.00	22.514	4.00	16.861

4.10	22.540		4.10	16.893
4.21	22.755		4.21	17.052
4.32	23.114		4.32	17.435
4.45	23.866		4.45	17.470
4.58	24.093		4.58	17.718
4.71	24.230		4.71	18.039
4.86	24.259		4.86	18.051
5.01	25.624		5.01	18.322
5.17	25.752		5.17	19.140
5.35	26.443		5.35	19.349
5.54	27.031		5.54	19.733
5.74	27.214		5.74	19.851
5.95	27.958		5.95	20.485
6.19	28.005		6.19	21.056
6.44	28.095		6.44	21.564
6.71	28.497		6.71	21.774
7.01	28.565		7.01	21.906
7.33	28.938		7.33	22.113
7.69	29.281		7.69	23.422
8.08	29.813		8.08	23.614
8.52	29.815		8.52	24.298
9.00	30.035		9.00	24.544
9.55	30.177		9.55	24.863
10.16	31.411		10.16	25.268
10.86	32.046		10.86	26.698
11.66	32.703		11.66	27.130
12.59	34.176		12.59	28.178
13.68	34.226		13.68	28.188
14.97	34.262		14.97	28.402
16.54	34.336		16.54	29.175
18.47	38.927		18.47	29.905
20.92	40.514		20.92	32.394
24.10	40.768		24.10	34.518
28.44	41.993		28.44	34.798
34.68	42.158		34.68	35.193
44.42	42.660		44.42	35.466
61.77	50.648		61.77	36.043
101.36	57.979		101.36	38.654
282.36	58.230		282.36	48.429

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	9.784	9.784	
2-Year	16.118	16.118	12.577
5-Year	24.240	24.240	18.305
10-Year	30.474	30.474	25.163
25-Year	39.480	39.480	34.580
50-Year	47.086	47.086	35.673
100-Year	55.518	55.518	38.582
200-Year	64.893	64.893	45.138

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.291	3.0564E-01	0.242	3.2537E-01
0.582	2.3103E-01	0.484	2.5161E-01
0.873	1.8512E-01	0.726	2.0644E-01
1.165	1.5191E-01	0.969	1.7342E-01
1.456	1.2602E-01	1.211	1.4757E-01
1.747	1.0524E-01	1.453	1.2805E-01
2.038	8.8557E-02	1.695	1.0986E-01
2.329	7.4673E-02	1.937	9.4966E-02
2.620	6.3570E-02	2.179	8.2976E-02
2.912	5.4357E-02	2.421	7.1966E-02
3.203	4.6627E-02	2.664	6.3003E-02
3.494	4.0092E-02	2.906	5.5876E-02
3.785	3.4693E-02	3.148	4.9146E-02
4.076	3.0061E-02	3.390	4.3334E-02
4.367	2.6146E-02	3.632	3.8616E-02
4.658	2.2815E-02	3.874	3.4158E-02
4.950	1.9898E-02	4.116	3.0515E-02
5.241	1.7378E-02	4.359	2.7096E-02
5.532	1.5302E-02	4.601	2.4165E-02
5.823	1.3514E-02	4.843	2.1489E-02
6.114	1.1915E-02	5.085	1.9177E-02
6.405	1.0553E-02	5.327	1.7062E-02
6.696	9.4337E-03	5.569	1.5221E-02
6.988	8.3716E-03	5.811	1.3565E-02
7.279	7.4973E-03	6.054	1.2083E-02
7.570	6.6973E-03	6.296	1.0872E-02
7.861	6.0237E-03	6.538	9.7333E-03
8.059	5.5796E-03	6.780	8.6691E-03
8.443	4.8843E-03	7.022	7.7817E-03
8.735	4.4049E-03	7.264	6.9016E-03
9.026	3.9977E-03	7.506	6.1161E-03
9.317	3.6057E-03	7.749	5.3435E-03
9.608	3.2772E-03	8.059	4.6051E-03
9.899	2.9912E-03	8.233	4.3082E-03
10.190	2.7198E-03	8.475	3.9501E-03
10.481	2.4830E-03	8.717	3.6230E-03
10.773	2.2707E-03	8.959	3.3299E-03
11.064	2.0938E-03	9.201	3.0736E-03
11.355	1.9082E-03	9.444	2.8172E-03
11.646	1.7574E-03	9.686	2.5992E-03
11.937	1.6231E-03	9.928	2.4093E-03
12.228	1.4945E-03	10.170	2.2259E-03
12.519	1.3819E-03	10.412	2.0693E-03
12.811	1.2707E-03	10.654	1.9104E-03
13.102	1.1812E-03	10.896	1.7833E-03
13.393	1.1011E-03	11.139	1.6577E-03
13.684	1.0245E-03	11.381	1.5386E-03
13.975	9.3716E-04	11.623	1.4447E-03
14.266	8.7290E-04	11.865	1.3465E-03
14.558	8.0792E-04	12.107	1.2664E-03
14.849	7.4438E-04	12.349	1.1891E-03
15.140	6.9384E-04	12.591	1.1068E-03
15.431	6.3608E-04	12.834	1.0354E-03
15.722	5.9060E-04	13.076	9.7542E-04
16.118	5.3838E-04	13.318	9.1189E-04
16.304	5.1190E-04	13.560	8.5557E-04

16.596	4.7435E-04	13.802	8.0575E-04
16.887	4.3609E-04	14.044	7.5233E-04
17.178	4.0288E-04	14.286	7.0756E-04
17.469	3.7688E-04	14.529	6.6930E-04
17.760	3.5306E-04	14.771	6.3247E-04
18.051	3.3501E-04	15.013	5.9132E-04
18.343	3.1335E-04	15.255	5.5739E-04
18.634	2.9385E-04	15.497	5.1840E-04
18.925	2.7797E-04	15.739	4.9240E-04
19.216	2.5848E-04	15.981	4.6425E-04
19.507	2.4115E-04	16.118	4.4505E-04
19.798	2.3321E-04	16.466	4.1082E-04
20.089	2.2093E-04	16.708	3.8699E-04
20.381	2.0433E-04	16.950	3.6244E-04
20.672	1.8989E-04	17.192	3.4295E-04
20.963	1.8267E-04	17.434	3.2346E-04
21.254	1.7111E-04	17.676	3.0468E-04
21.545	1.6028E-04	17.919	2.8591E-04
21.836	1.5234E-04	18.161	2.7436E-04
22.127	1.4584E-04	18.403	2.6209E-04
22.419	1.3935E-04	18.645	2.5342E-04
22.710	1.3140E-04	18.887	2.4043E-04
23.001	1.2202E-04	19.129	2.2671E-04
23.292	1.1335E-04	19.371	2.1660E-04
23.583	1.0613E-04	19.614	2.0577E-04
23.874	9.7470E-05	19.856	1.9566E-04
24.240	8.7253E-05	20.098	1.8700E-04
24.457	8.3752E-05	20.340	1.7689E-04
24.748	7.8698E-05	20.582	1.6606E-04
25.039	7.3644E-05	20.824	1.5451E-04
25.330	6.9312E-05	21.066	1.4801E-04
25.621	6.7868E-05	21.309	1.4151E-04
25.912	6.2092E-05	21.551	1.3501E-04
26.204	5.9926E-05	21.793	1.2563E-04
26.495	5.4872E-05	22.035	1.2057E-04
26.786	5.4150E-05	22.277	1.1552E-04
27.077	5.1984E-05	22.519	1.1119E-04
27.368	4.8374E-05	22.761	1.0613E-04
27.659	4.4764E-05	23.004	1.0108E-04
27.950	4.3320E-05	23.246	9.3138E-05
28.242	4.1154E-05	23.488	8.8806E-05
28.533	3.8266E-05	23.730	7.8698E-05
28.824	3.7544E-05	23.972	7.6532E-05
29.115	3.6100E-05	24.240	6.9561E-05
29.406	3.3934E-05	24.456	6.7868E-05
29.697	3.3934E-05	24.699	6.4258E-05
29.989	3.1046E-05	24.941	5.9204E-05
30.280	2.7436E-05	25.183	5.5594E-05
30.571	2.5992E-05	25.425	5.1984E-05
30.862	2.5992E-05	25.667	5.0540E-05
31.153	2.5270E-05	25.909	4.9096E-05
31.444	2.3826E-05	26.151	4.5486E-05
31.735	2.3826E-05	26.394	4.4042E-05
32.027	2.3826E-05	26.636	4.0432E-05
32.318	2.3104E-05	26.878	3.7544E-05
32.609	2.1660E-05	27.120	3.6100E-05
32.900	2.0938E-05	27.362	3.3934E-05
33.191	1.9494E-05	27.604	3.2490E-05
33.482	1.9494E-05	27.846	3.1768E-05
33.774	1.8772E-05	28.089	3.0324E-05
34.065	1.8772E-05	28.331	2.5992E-05
34.356	1.5162E-05	28.573	2.4548E-05
34.647	1.4440E-05	28.815	2.3826E-05

34.938	1.3718E-05	29.057	2.3826E-05
35.229	1.3718E-05	29.299	2.2382E-05
35.520	1.2996E-05	29.541	2.0938E-05
35.812	1.2996E-05	29.784	2.0216E-05
36.103	1.2996E-05	30.026	1.8772E-05
36.394	1.2274E-05	30.268	1.8050E-05
36.685	1.2274E-05	30.510	1.7328E-05
36.976	1.1552E-05	30.752	1.7328E-05
37.267	1.1552E-05	30.994	1.7328E-05
37.558	1.1552E-05	31.236	1.5162E-05
37.850	1.0830E-05	31.479	1.5162E-05
38.141	1.0830E-05	31.721	1.4440E-05
38.432	1.0830E-05	31.963	1.4440E-05
38.723	1.0108E-05	32.205	1.3718E-05
39.014	9.3860E-06	32.447	1.1552E-05
39.305	9.3860E-06	32.689	1.0830E-05
39.597	9.3860E-06	32.931	1.0830E-05
39.888	9.3860E-06	33.174	1.0830E-05
40.179	9.3860E-06	33.416	9.3860E-06
40.470	9.3860E-06	33.658	8.6640E-06
40.761	8.6640E-06	33.900	8.6640E-06
41.052	7.9420E-06	34.142	8.6640E-06
41.343	7.9420E-06	34.384	8.6640E-06
41.635	7.9420E-06	34.626	7.2200E-06
41.926	7.9420E-06	34.869	6.4980E-06
42.217	6.4980E-06	35.111	6.4980E-06
42.508	6.4980E-06	35.353	5.7760E-06
42.799	5.7760E-06	35.595	5.0540E-06
43.090	5.7760E-06	35.837	5.0540E-06
43.381	5.7760E-06	36.079	4.3320E-06
43.673	5.0540E-06	36.321	4.3320E-06
43.964	5.0540E-06	36.564	4.3320E-06
44.255	5.0540E-06	36.806	4.3320E-06
44.546	5.0540E-06	37.048	3.6100E-06
44.837	5.0540E-06	37.290	3.6100E-06
45.128	5.0540E-06	37.532	3.6100E-06
45.420	5.0540E-06	37.774	3.6100E-06
45.711	5.0540E-06	38.016	3.6100E-06
46.002	4.3320E-06	38.259	2.8880E-06
46.293	3.6100E-06	38.501	2.8880E-06
46.584	3.6100E-06	38.743	2.1660E-06
46.875	3.6100E-06	38.985	2.1660E-06
47.086	3.6078E-06	39.227	2.1660E-06
47.458	3.6100E-06	39.469	2.1660E-06
47.749	3.6100E-06	39.711	2.1660E-06
48.040	3.6100E-06	39.954	2.1660E-06
48.331	3.6100E-06	40.196	2.1660E-06
48.622	3.6100E-06	40.438	2.1660E-06
48.913	3.6100E-06	40.680	2.1660E-06
49.204	3.6100E-06	40.922	2.1660E-06
49.496	2.8880E-06	41.164	2.1660E-06
49.787	2.8880E-06	41.406	2.1660E-06
50.078	2.8880E-06	41.649	2.1660E-06
50.369	2.8880E-06	41.891	2.1660E-06
50.660	2.1660E-06	42.133	2.1660E-06
50.951	1.4440E-06	42.375	2.1660E-06
51.243	1.4440E-06	42.617	2.1660E-06
51.534	1.4440E-06	42.859	2.1660E-06
51.825	1.4440E-06	43.101	2.1660E-06
52.116	1.4440E-06	43.344	1.4440E-06
52.407	1.4440E-06	43.586	1.4440E-06
52.698	1.4440E-06	43.828	1.4440E-06
52.989	1.4440E-06	44.070	1.4440E-06

53.281	1.4440E-06	44.312	1.4440E-06
53.572	1.4440E-06	44.554	7.2200E-07
53.863	1.4440E-06	44.796	7.2200E-07
54.154	1.4440E-06	45.039	7.2200E-07
54.445	1.4440E-06	45.281	7.2200E-07
54.736	1.4440E-06	45.523	7.2200E-07
55.028	1.4440E-06	45.765	7.2200E-07
55.319	1.4440E-06	46.007	7.2200E-07
55.610	1.4440E-06	46.249	7.2200E-07
55.901	1.4440E-06	46.491	7.2200E-07
56.192	1.4440E-06	46.734	7.2200E-07
56.483	1.4440E-06	47.086	7.2200E-07
56.774	1.4440E-06	47.218	7.2200E-07
57.066	1.4440E-06	47.460	7.2200E-07
57.357	1.4440E-06	47.702	7.2200E-07
57.648	1.4440E-06	47.944	7.2200E-07
57.939	1.4440E-06	48.186	7.2200E-07
58.230	7.2200E-07	48.429	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-17.4%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-16.3%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-12.0%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

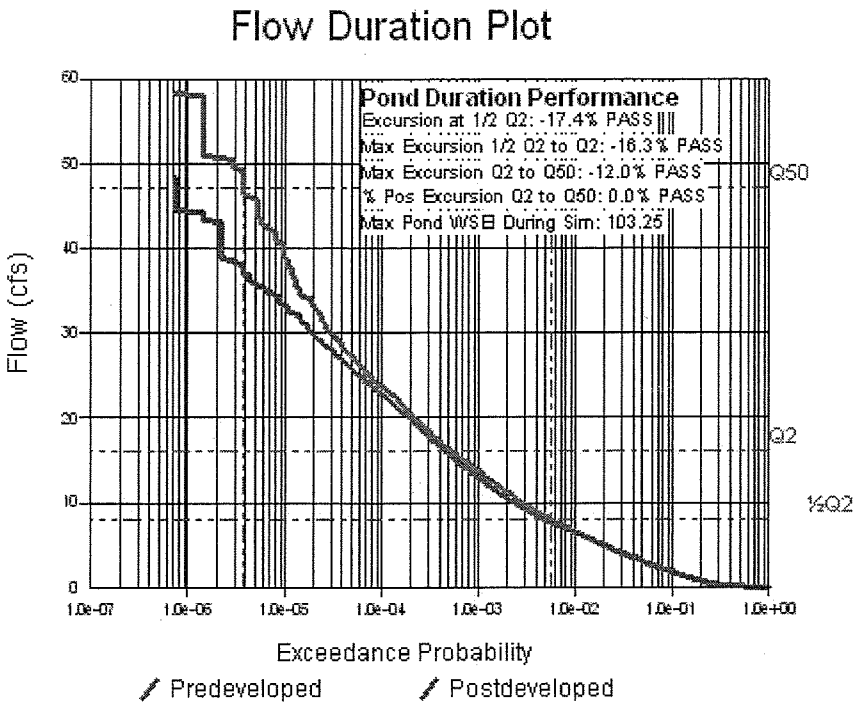
****

********** **Water Quality Facility Data** **********

Basic Wet Pond Volume (91% Exceedance): 645388. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 968082. cu-ft
2-Year Stormwater Pond Discharge Rate: 12.577 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -17.4% PASS
Max Excursion 1/2 Q2 to Q2: -16.3% PASS
Max Excursion Q2 to Q50: -12.0% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEL During Sim: 103.25
Q50
Q2
½Q2
Flow (cfs)
60
50
40
30
20
10
0
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 12:38 PM
****

Input File Name: Basin 9.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Ravensdale 1, 2, &3
Comments : Ravensdale Creek Tributary Areas. 2,250 acres outside of Black Diamond Ci

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)	Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	1904.970	1904.970	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	75.400	75.400	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	88.290	88.290	0.000	No
Wetland	255.110	255.110	0.000	No
Impervious	41.670	41.670	0.000	
SUBBASIN TOTAL	2365.440	2365.440	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 ----------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	882.4	ft
Pond Bottom Width	:	441.2	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	389274.	sq-ft
Area at Riser Crest El	:	413422.	sq-ft
	:	9.491	acres
Volume at Riser Crest	:	1203863.	cu-ft
	:	27.637	ac-ft
Area at Max Elevation	:	425739.	sq-ft
	:	9.774	acres
Volume at Max Elevation	:	1833168.	cu-ft
	:	42.084	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 120.00	in
Common Length	: 19.300	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	:	Circular Orifice	
Invert Elevation	:	100.00	ft
Diameter	:	41.49	in
Orientation	:	Horizontal	
Elbow	:	No	

--- Device Number 2 ---

Device Type	:	Vertical Rectangular Orifice	
Invert Elevation	:	100.99	ft
Length	:	231.6	in
Height	:	24.1	in
Orientation	:	Vertical	
Elbow	:	No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	8.937	0.000	0.000	0.000
100.04	8.943	0.313	8.592	0.000
100.07	8.949	0.626	12.151	0.000
100.14	8.962	1.253	17.184	0.000
100.21	8.975	1.881	21.046	0.000
100.28	8.988	2.509	24.301	0.000
100.35	9.000	3.139	27.170	0.000
100.42	9.013	3.769	29.763	0.000
100.49	9.026	4.401	32.147	0.000
100.56	9.039	5.033	34.367	0.000
100.63	9.052	5.666	36.452	0.000
100.70	9.065	6.300	38.423	0.000
100.77	9.077	6.935	40.299	0.000
100.84	9.090	7.571	42.091	0.000
100.91	9.103	8.208	43.809	0.000
100.93	9.107	8.390	44.288	0.000
100.95	9.110	8.572	44.762	0.000
100.97	9.114	8.754	45.230	0.000
100.99	9.118	8.937	45.694	0.000
101.01	9.121	9.096	46.245	0.000
101.03	9.124	9.256	46.916	0.000
101.04	9.127	9.416	47.663	0.000
101.06	9.131	9.575	48.472	0.000
101.13	9.144	10.215	52.180	0.000
101.20	9.156	10.856	56.479	0.000
101.27	9.169	11.497	61.249	0.000
101.34	9.182	12.139	66.421	0.000
101.41	9.195	12.782	71.950	0.000
101.48	9.208	13.427	77.802	0.000
101.55	9.221	14.072	83.952	0.000
101.62	9.234	14.718	90.380	0.000
101.69	9.247	15.364	97.069	0.000
101.76	9.260	16.012	104.004	0.000
101.83	9.273	16.661	111.173	0.000
101.90	9.286	17.310	118.567	0.000
101.97	9.299	17.961	126.175	0.000
102.04	9.312	18.612	133.989	0.000
102.11	9.325	19.264	142.002	0.000
102.18	9.338	19.918	150.207	0.000
102.25	9.351	20.572	158.597	0.000
102.32	9.364	21.227	167.168	0.000
102.39	9.377	21.883	175.913	0.000
102.46	9.390	22.539	184.829	0.000
102.53	9.403	23.197	193.909	0.000
102.60	9.416	23.856	203.151	0.000
102.67	9.429	24.516	212.550	0.000
102.74	9.442	25.176	222.103	0.000
102.81	9.455	25.837	231.806	0.000
102.88	9.468	26.500	241.655	0.000
102.91	9.474	26.784	245.920	0.000
102.94	9.480	27.068	250.212	0.000
102.97	9.485	27.353	254.529	0.000
103.00	9.491	27.637	258.872	0.000
103.02	9.494	27.803	261.512	0.000
103.04	9.497	27.970	264.239	0.000
103.05	9.501	28.136	267.026	0.000
103.07	9.504	28.302	269.863	0.000
103.09	9.507	28.469	272.744	0.000

103.11	9.511	28.635	275.665	0.000
103.12	9.514	28.802	278.624	0.000
103.14	9.517	28.968	281.618	0.000
103.21	9.530	29.635	293.912	0.000
103.28	9.543	30.302	293.912	0.000
103.35	9.557	30.971	302.406	0.000
103.42	9.570	31.640	311.293	0.000
103.49	9.583	32.310	320.271	0.000
103.56	9.596	32.982	329.332	0.000
103.63	9.609	33.654	338.469	0.000
103.70	9.622	34.327	347.677	0.000
103.77	9.636	35.001	356.950	0.000
103.84	9.649	35.676	366.285	0.000
103.91	9.662	36.352	375.677	0.000
103.98	9.675	37.029	385.123	0.000
104.05	9.688	37.706	394.618	0.000
104.12	9.702	38.385	404.159	0.000
104.19	9.715	39.065	413.741	0.000
104.26	9.728	39.745	423.360	0.000
104.33	9.741	40.427	433.010	0.000
104.40	9.755	41.109	442.688	0.000
104.47	9.768	41.792	452.387	0.000
104.54	9.781	42.476	462.103	0.000
104.61	9.794	43.161	471.830	0.000
104.68	9.808	43.847	481.562	0.000
104.75	9.821	44.534	491.293	0.000
104.82	9.834	45.222	501.017	0.000
104.89	9.848	45.911	510.728	0.000
104.96	9.861	46.600	520.419	0.000
105.03	9.874	47.291	530.082	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	120.388	1940 04 30	106.672
1940 12 20	48.644	1941 01 18	41.371
1941 12 15	131.846	1941 12 15	65.415
1943 03 27	55.056	1943 03 28	44.498
1944 01 22	38.916	1944 01 23	31.512
1945 02 07	123.143	1945 02 07	108.528
1946 02 27	93.604	1946 02 05	75.322
1947 02 01	100.597	1947 02 02	77.013
1948 03 21	165.161	1948 03 21	143.069
1949 02 16	95.046	1949 02 22	77.269
1950 03 03	353.226	1950 03 03	254.569
1951 02 09	117.436	1951 02 09	111.864
1952 06 29	44.182	1952 01 24	28.504
1953 01 11	53.104	1953 01 11	44.892
1954 01 22	75.024	1954 01 22	71.727
1955 04 12	48.679	1955 04 12	33.215
1956 03 04	89.584	1956 01 06	76.365
1957 02 25	77.218	1957 02 25	66.847
1958 02 24	87.683	1958 01 16	69.509
1959 01 12	103.790	1959 01 13	87.855
1959 12 15	108.653	1960 01 29	85.760
1961 02 14	104.254	1960 11 20	61.638
1962 03 04	47.501	1962 03 04	41.977
1963 02 03	57.972	1963 02 03	45.001
1964 01 01	89.644	1964 01 01	63.726
1965 02 26	97.276	1965 02 27	82.864
1966 04 11	97.735	1966 04 11	77.905
1967 01 19	160.779	1967 01 19	133.402
1968 02 03	90.447	1968 02 04	71.421
1968 12 03	90.279	1968 12 03	69.798
1970 01 13	73.898	1970 03 06	47.237
1970 12 06	72.764	1970 12 06	56.429
1972 02 27	205.948	1972 02 27	176.608
1973 01 13	80.772	1973 01 13	67.888
1974 02 18	103.410	1974 02 18	94.696
1974 12 26	126.226	1974 12 27	91.648
1976 01 26	89.247	1976 01 27	75.919
1977 05 31	35.315	1977 05 31	32.361
1977 12 15	72.655	1977 12 15	64.717
1979 03 04	97.626	1979 03 04	68.798
1979 12 17	99.376	1979 12 17	97.049
1980 12 26	62.236	1980 12 26	42.527
1981 10 06	166.955	1981 10 06	130.716
1983 01 05	91.892	1983 01 05	81.663
1984 03 14	102.145	1984 03 20	58.065
1985 02 11	60.491	1985 02 11	45.342
1986 01 18	170.518	1986 01 18	153.826
1986 11 24	132.312	1986 11 24	125.027
1988 04 06	71.284	1988 04 06	61.941
1989 04 05	89.742	1989 04 05	75.091
1990 01 09	303.977	1990 01 09	287.256
1990 11 24	253.848	1990 11 24	216.943
1992 01 27	87.095	1992 01 27	63.092
1993 06 09	73.275	1993 03 23	54.151
1994 03 03	45.474	1994 03 03	40.283
1995 02 19	104.363	1995 02 19	97.987
1996 02 08	245.335	1996 02 08	212.495

1997	01	02	160.954	1997	01	02	125.107
1998	02	28	72.161	1998	03	23	41.168
1998	12	13	132.925	1998	11	25	101.885
2000	02	28	93.590	2000	03	26	81.110
2001	05	05	66.656	2001	05	05	45.371
2002	05	03	192.831	2002	05	03	89.213
2003	02	06	158.537	2003	03	31	153.101
2004	01	23	45.429	2004	01	23	38.655
2005	02	05	84.852	2005	02	07	48.877
2006	02	27	95.502	2006	02	27	84.668
2007	03	09	68.097	2006	12	15	54.759
2008	03	21	141.033	2008	01	06	99.609
2009	02	17	177.680	2009	02	17	170.921
2010	06	10	133.013	2010	01	10	98.588
2011	03	08	167.454	2011	03	08	142.905
2012	01	31	112.565	2012	01	31	59.141
2013	01	20	230.935	2013	01	20	213.848
2014	02	13	113.001	2014	04	05	87.377
2015	04	12	66.529	2015	03	30	50.621
2016	01	04	177.492	2016	01	04	161.519
2017	06	14	62.248	2017	03	07	41.603
2018	04	17	117.633	2018	04	17	83.825
2019	03	29	89.944	2019	03	30	80.879
2020	04	14	77.986	2020	04	14	58.973
2021	02	10	129.899	2021	02	10	121.495
2021	12	20	75.103	2021	12	20	57.079
2023	02	02	97.342	2023	03	30	91.064
2024	01	19	87.397	2024	01	19	73.266
2024	12	22	146.445	2024	12	22	135.190
2026	03	09	108.254	2026	03	09	99.732
2027	03	15	95.951	2027	01	27	75.874
2028	06	01	100.646	2028	02	19	92.353
2028	12	04	85.708	2028	12	04	78.642
2030	02	16	102.443	2030	02	16	98.376
2031	02	26	98.222	2030	12	30	93.040
2032	01	20	174.485	2032	01	20	166.377
2033	03	01	58.196	2033	03	01	41.625
2034	02	18	175.425	2034	01	16	154.946
2035	02	19	119.776	2035	02	19	101.570
2036	03	24	101.162	2036	03	24	90.271
2037	03	08	35.550	2037	03	08	25.791
2037	11	24	75.547	2037	12	15	56.641
2039	02	07	52.633	2039	02	07	38.005
2040	01	14	194.064	2040	01	14	110.340
2040	12	25	87.958	2040	12	25	81.638
2042	02	20	118.304	2042	02	20	86.509
2043	03	31	177.567	2043	03	31	96.123
2044	05	01	91.878	2044	05	01	70.020
2045	02	07	93.823	2045	03	23	75.030
2046	02	16	95.022	2046	02	16	79.860
2047	04	17	74.200	2047	02	01	51.968
2048	04	20	64.336	2048	04	21	47.068
2049	03	16	66.727	2049	03	16	49.709
2049	12	04	96.798	2049	12	04	85.233
2051	04	06	73.442	2051	04	06	56.842
2052	04	16	51.165	2052	04	17	36.202
2053	06	04	232.007	2053	06	04	98.939
2054	04	08	35.332	2054	04	08	28.910
2055	02	17	151.935	2055	02	17	132.536
2056	02	07	256.347	2056	02	07	225.660
2056	11	19	262.152	2056	11	19	208.651
2058	01	24	132.959	2058	05	21	114.002
2059	01	17	135.336	2058	12	28	96.023

2060	01 19	55.128	2060	01 19	37.557
2061	01 10	85.647	2061	01 10	82.016
2062	02 03	354.232	2062	02 03	221.246
2062	12 29	84.974	2062	12 29	74.442
2063	12 23	144.619	2063	12 23	133.336
2064	11 29	61.940	2064	11 30	51.099
2066	01 13	39.628	2066	01 13	35.554
2067	01 19	100.566	2067	01 19	79.639
2068	01 18	192.135	2068	01 18	171.909
2069	01 04	56.408	2069	04 23	43.539
2070	04 09	77.081	2070	04 09	47.480
2071	03 23	50.368	2071	02 14	38.337
2072	02 27	61.610	2071	11 03	42.414
2072	12 25	190.441	2072	12 25	184.409
2074	03 16	122.446	2074	03 16	98.546
2075	02 12	40.896	2075	01 17	29.159
2076	03 24	147.184	2076	03 24	114.294
2077	02 12	29.309	2077	02 12	25.113
2077	11 25	54.346	2077	12 02	40.605
2079	02 24	61.049	2079	02 25	55.169
2079	12 17	211.368	2079	12 17	185.099
2081	02 17	108.807	2080	11 21	91.519
2082	02 18	117.832	2082	02 13	111.413
2083	03 29	95.093	2083	02 19	68.509
2083	11 26	110.943	2083	11 26	94.010
2084	12 14	70.015	2084	12 14	58.733
2086	01 18	76.715	2086	01 18	72.570
2086	12 21	88.437	2086	12 21	64.736
2088	03 25	60.041	2088	01 14	45.062
2088	11 05	130.873	2088	11 05	104.302
2090	01 06	60.614	2090	06 10	46.149
2090	12 04	94.993	2090	12 04	81.987
2092	04 28	193.270	2092	01 31	93.674
2093	06 15	53.856	2093	03 22	43.554
2094	03 01	40.933	2094	03 01	37.070
2095	02 18	66.709	2094	12 27	51.280
2096	01 14	75.934	2096	01 14	68.795
2097	01 29	178.984	2097	01 29	148.792

********** **Ranked Annual Maxima Data** **********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	29.309	1.00	25.113
1.01	35.315	1.01	25.791
1.02	35.332	1.02	28.504
1.02	35.550	1.02	28.910
1.03	38.916	1.03	29.159
1.04	39.628	1.04	31.512
1.04	40.896	1.04	32.361
1.05	40.933	1.05	33.215
1.06	44.182	1.06	35.554
1.06	45.429	1.06	36.202
1.07	45.474	1.07	37.070
1.08	47.501	1.08	37.557
1.09	48.644	1.09	38.005
1.09	48.679	1.09	38.337
1.10	50.368	1.10	38.655
1.11	51.165	1.11	40.283
1.12	52.633	1.12	40.605
1.12	53.104	1.12	41.168
1.13	53.856	1.13	41.371
1.14	54.346	1.14	41.603
1.15	55.056	1.15	41.625
1.16	55.128	1.16	41.977
1.17	56.408	1.17	42.414
1.18	57.972	1.18	42.527
1.18	58.196	1.18	43.539
1.19	60.041	1.19	43.554
1.20	60.491	1.20	44.498
1.21	60.614	1.21	44.892
1.22	61.049	1.22	45.001
1.23	61.610	1.23	45.062
1.24	61.940	1.24	45.342
1.25	62.236	1.25	45.371
1.26	62.248	1.26	46.149
1.27	64.336	1.27	47.068
1.28	66.529	1.28	47.237
1.29	66.656	1.29	47.480
1.30	66.709	1.30	48.877
1.31	66.727	1.31	49.709
1.32	68.097	1.32	50.621
1.33	70.015	1.33	51.099
1.35	71.284	1.35	51.280
1.36	72.161	1.36	51.968
1.37	72.655	1.37	54.151
1.38	72.764	1.38	54.759
1.39	73.275	1.39	55.169
1.40	73.442	1.40	56.429
1.42	73.898	1.42	56.641
1.43	74.200	1.43	56.842
1.44	75.024	1.44	57.079
1.46	75.103	1.46	58.065
1.47	75.547	1.47	58.733
1.48	75.934	1.48	58.973
1.50	76.715	1.50	59.141
1.51	77.081	1.51	61.638
1.53	77.218	1.53	61.941
1.54	77.986	1.54	63.092

1.56	80.772		1.56	63.726
1.57	84.852		1.57	64.717
1.59	84.974		1.59	64.736
1.60	85.647		1.60	65.415
1.62	85.708		1.62	66.847
1.64	87.095		1.64	67.888
1.65	87.397		1.65	68.509
1.67	87.683		1.67	68.795
1.69	87.958		1.69	68.798
1.71	88.437		1.71	69.509
1.73	89.247		1.73	69.798
1.75	89.584		1.75	70.020
1.77	89.644		1.77	71.421
1.79	89.742		1.79	71.727
1.81	89.944		1.81	72.570
1.83	90.279		1.83	73.266
1.85	90.447		1.85	74.442
1.87	91.878		1.87	75.030
1.89	91.892		1.89	75.091
1.92	93.590		1.92	75.322
1.94	93.604		1.94	75.874
1.96	93.823		1.96	75.919
1.99	94.993		1.99	76.365
2.01	95.022		2.01	77.013
2.04	95.046		2.04	77.269
2.07	95.093		2.07	77.905
2.09	95.502		2.09	78.642
2.12	95.951		2.12	79.639
2.15	96.798		2.15	79.860
2.18	97.276		2.18	80.879
2.21	97.342		2.21	81.110
2.24	97.626		2.24	81.638
2.27	97.735		2.27	81.663
2.31	98.222		2.31	81.987
2.34	99.376		2.34	82.016
2.38	100.566		2.38	82.864
2.41	100.597		2.41	83.825
2.45	100.646		2.45	84.668
2.49	101.162		2.49	85.233
2.53	102.145		2.53	85.760
2.57	102.443		2.57	86.509
2.61	103.410		2.61	87.377
2.65	103.790		2.65	87.855
2.70	104.254		2.70	89.213
2.75	104.363		2.75	90.271
2.80	108.254		2.80	91.064
2.85	108.653		2.85	91.519
2.90	108.807		2.90	91.648
2.95	110.943		2.95	92.353
3.01	112.565		3.01	93.040
3.07	113.001		3.07	93.674
3.13	117.436		3.13	94.010
3.19	117.633		3.19	94.696
3.26	117.832		3.26	96.023
3.32	118.304		3.32	96.123
3.40	119.776		3.40	97.049
3.47	120.388		3.47	97.987
3.55	122.446		3.55	98.376
3.63	123.143		3.63	98.546
3.72	126.226		3.72	98.588
3.80	129.899		3.80	98.939
3.90	130.873		3.90	99.609
4.00	131.846		4.00	99.732

4.10	132.312	4.10	101.570
4.21	132.925	4.21	101.885
4.32	132.959	4.32	104.302
4.45	133.013	4.45	106.672
4.58	135.336	4.58	108.528
4.71	141.033	4.71	110.340
4.86	144.619	4.86	111.413
5.01	146.445	5.01	111.864
5.17	147.184	5.17	114.002
5.35	151.935	5.35	114.294
5.54	158.537	5.54	121.495
5.74	160.779	5.74	125.027
5.95	160.954	5.95	125.107
6.19	165.161	6.19	130.716
6.44	166.955	6.44	132.536
6.71	167.454	6.71	133.336
7.01	170.518	7.01	133.402
7.33	174.485	7.33	135.190
7.69	175.425	7.69	142.905
8.08	177.492	8.08	143.069
8.52	177.567	8.52	148.792
9.00	177.680	9.00	153.101
9.55	178.984	9.55	153.826
10.16	190.441	10.16	154.946
10.86	192.135	10.86	161.519
11.66	192.831	11.66	166.377
12.59	193.270	12.59	170.921
13.68	194.064	13.68	171.909
14.97	205.948	14.97	176.608
16.54	211.368	16.54	184.409
18.47	230.935	18.47	185.099
20.92	232.007	20.92	208.651
24.10	245.335	24.10	212.495
28.44	253.848	28.44	213.848
34.68	256.347	34.68	216.943
44.42	262.152	44.42	221.246
61.77	303.977	61.77	225.660
101.36	353.226	101.36	254.569
282.36	354.232	282.36	287.256

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	56.721	56.721	
2-Year	94.246	94.246	76.688
5-Year	142.878	142.878	111.835
10-Year	180.537	180.537	154.657
25-Year	235.398	235.398	212.793
50-Year	282.099	282.099	222.831
100-Year	334.218	334.218	253.781
200-Year	392.561	392.561	276.253

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
1.771	2.9883E-01	1.436	3.1953E-01
3.542	2.2835E-01	2.873	2.5050E-01
5.313	1.8442E-01	4.309	2.0746E-01
7.085	1.5260E-01	5.745	1.7589E-01
8.856	1.2749E-01	7.181	1.5117E-01
10.627	1.0726E-01	8.618	1.3265E-01
12.398	9.0833E-02	10.054	1.1449E-01
14.169	7.7130E-02	11.490	9.9883E-02
15.940	6.6039E-02	12.927	8.7918E-02
17.712	5.6657E-02	14.363	7.6762E-02
19.483	4.8851E-02	15.799	6.7685E-02
21.254	4.2223E-02	17.235	6.0509E-02
23.025	3.6650E-02	18.672	5.3377E-02
24.796	3.1858E-02	20.108	4.7483E-02
26.567	2.7840E-02	21.544	4.2380E-02
28.339	2.4344E-02	22.981	3.7705E-02
30.110	2.1256E-02	24.417	3.3844E-02
31.881	1.8645E-02	25.853	3.0208E-02
33.652	1.6381E-02	27.289	2.7098E-02
35.423	1.4436E-02	28.726	2.4185E-02
37.194	1.2797E-02	30.162	2.1639E-02
38.966	1.1314E-02	31.598	1.9348E-02
40.737	1.0091E-02	33.034	1.7304E-02
42.508	8.9817E-03	34.471	1.5509E-02
44.279	8.0135E-03	35.907	1.3847E-02
46.050	7.1716E-03	37.592	1.2170E-02
47.123	6.7220E-03	38.780	1.1151E-02
49.592	5.7789E-03	40.216	1.0030E-02
51.364	5.2121E-03	41.652	8.9766E-03
53.135	4.7082E-03	43.088	7.9637E-03
54.906	4.2576E-03	44.525	7.0337E-03
56.677	3.8295E-03	45.961	6.1363E-03
58.448	3.4699E-03	47.397	5.5645E-03
60.219	3.1566E-03	48.834	5.0721E-03
61.991	2.8858E-03	50.270	4.6865E-03
63.762	2.6375E-03	51.706	4.2973E-03
65.533	2.3999E-03	53.142	3.9537E-03
67.304	2.2151E-03	54.579	3.6490E-03
69.075	2.0173E-03	56.015	3.3754E-03
70.846	1.8534E-03	57.451	3.1133E-03
72.618	1.6981E-03	58.888	2.8793E-03
74.389	1.5675E-03	60.324	2.6700E-03
76.160	1.4404E-03	61.760	2.4714E-03
77.931	1.3393E-03	63.196	2.3082E-03
79.702	1.2519E-03	64.633	2.1537E-03
81.473	1.1552E-03	66.069	1.9884E-03
83.245	1.0671E-03	67.505	1.8433E-03
85.016	9.8192E-04	68.942	1.7162E-03
86.787	9.1333E-04	70.378	1.5985E-03
88.558	8.5124E-04	71.814	1.5003E-03
90.329	7.7543E-04	73.250	1.4122E-03
92.100	7.2561E-04	75.185	1.2876E-03
94.246	6.6661E-04	76.123	1.2361E-03
95.643	6.2597E-04	77.559	1.1646E-03
97.414	5.8699E-04	78.995	1.0960E-03
99.185	5.4439E-04	80.432	1.0252E-03

100.956	5.0829E-04	81.868	9.6965E-04
102.727	4.7580E-04	83.304	9.0828E-04
104.499	4.4259E-04	84.741	8.6424E-04
106.270	4.1082E-04	86.177	8.1730E-04
108.041	3.8555E-04	87.613	7.6243E-04
109.812	3.5378E-04	89.049	7.2272E-04
111.583	3.3356E-04	90.486	6.8157E-04
113.354	3.1263E-04	91.922	6.4114E-04
115.125	2.9530E-04	93.358	5.9998E-04
116.897	2.7941E-04	94.795	5.6099E-04
118.668	2.6064E-04	96.231	5.3284E-04
120.439	2.4692E-04	97.667	5.0829E-04
122.210	2.2815E-04	99.103	4.7363E-04
123.981	2.2093E-04	100.540	4.5269E-04
125.752	2.0938E-04	101.976	4.2670E-04
127.524	1.9711E-04	103.412	4.0937E-04
129.295	1.8555E-04	104.849	3.8627E-04
131.066	1.7328E-04	106.285	3.6389E-04
132.837	1.6389E-04	107.721	3.4295E-04
134.608	1.5306E-04	109.157	3.2201E-04
136.379	1.4223E-04	110.594	3.0468E-04
138.151	1.3574E-04	112.030	2.8952E-04
139.922	1.2563E-04	113.466	2.7869E-04
141.693	1.1769E-04	114.903	2.6570E-04
142.878	1.1361E-04	115.999	2.5924E-04
145.235	1.0252E-04	117.775	2.4331E-04
147.006	9.6748E-05	119.211	2.2887E-04
148.778	8.7362E-05	120.648	2.1804E-04
150.549	8.3030E-05	122.084	2.0577E-04
152.320	7.4366E-05	123.520	1.9783E-04
154.091	6.8590E-05	124.957	1.9061E-04
155.862	6.7146E-05	126.393	1.7833E-04
157.633	6.3536E-05	127.829	1.7111E-04
159.404	5.8482E-05	129.265	1.6389E-04
161.176	5.6316E-05	130.702	1.5379E-04
162.947	5.4150E-05	132.138	1.4368E-04
164.718	5.1984E-05	133.574	1.3862E-04
166.489	4.9818E-05	135.011	1.3213E-04
168.260	4.6208E-05	136.447	1.2418E-04
170.031	4.3320E-05	137.883	1.1913E-04
171.803	4.0432E-05	139.319	1.1552E-04
173.574	3.7544E-05	140.756	1.0902E-04
175.345	3.6822E-05	142.192	1.0036E-04
177.116	3.5378E-05	143.628	9.1694E-05
178.887	3.1768E-05	145.064	8.8806E-05
180.658	3.0324E-05	146.501	8.3030E-05
182.430	3.0324E-05	147.937	7.6532E-05
184.201	2.8158E-05	149.373	7.1478E-05
185.972	2.6714E-05	150.810	6.9312E-05
187.743	2.5992E-05	152.246	6.6424E-05
189.514	2.5992E-05	153.682	6.2814E-05
191.285	2.5270E-05	155.118	5.7760E-05
193.057	2.3104E-05	156.555	5.2706E-05
194.828	2.0216E-05	157.991	4.9818E-05
196.599	2.0216E-05	159.427	4.9096E-05
198.370	1.9494E-05	160.864	4.6208E-05
200.141	1.9494E-05	162.300	4.4042E-05
201.912	1.8050E-05	163.736	4.1876E-05
203.684	1.8050E-05	165.172	4.0432E-05
205.455	1.8050E-05	166.609	3.7544E-05
207.226	1.6606E-05	168.045	3.6100E-05
208.997	1.5162E-05	169.481	3.3934E-05
210.768	1.5162E-05	170.918	3.2490E-05

212.539	1.3718E-05	172.354	3.1046E-05
214.310	1.3718E-05	173.790	2.8158E-05
216.082	1.3718E-05	175.226	2.8158E-05
217.853	1.2996E-05	176.663	2.4548E-05
219.624	1.2274E-05	178.099	2.3104E-05
221.395	1.2274E-05	179.535	2.3104E-05
223.166	1.1552E-05	180.972	2.1660E-05
224.937	1.1552E-05	182.408	2.0938E-05
226.709	1.0830E-05	183.844	2.0938E-05
228.480	1.0830E-05	185.280	1.9494E-05
230.251	1.0108E-05	186.717	1.9494E-05
232.022	8.6640E-06	188.153	1.9494E-05
233.793	8.6640E-06	189.589	1.8772E-05
235.564	8.6640E-06	191.025	1.6606E-05
237.336	8.6640E-06	192.462	1.6606E-05
239.107	8.6640E-06	193.898	1.5162E-05
240.878	8.6640E-06	195.334	1.5162E-05
242.649	8.6640E-06	196.771	1.3718E-05
244.420	8.6640E-06	198.207	1.2274E-05
246.191	7.9420E-06	199.643	1.2274E-05
247.963	7.9420E-06	201.079	1.2274E-05
249.734	7.9420E-06	202.516	1.1552E-05
251.505	7.9420E-06	203.952	1.1552E-05
253.276	7.9420E-06	205.388	1.1552E-05
255.047	7.2200E-06	206.825	1.1552E-05
256.818	6.4980E-06	208.261	1.0830E-05
258.589	6.4980E-06	209.697	1.0108E-05
260.361	6.4980E-06	211.133	1.0108E-05
262.132	6.4980E-06	212.570	9.3860E-06
263.903	5.0540E-06	214.006	8.6640E-06
265.674	5.0540E-06	215.442	7.9420E-06
267.445	5.0540E-06	216.879	7.2200E-06
269.216	5.0540E-06	218.315	6.4980E-06
270.988	5.0540E-06	219.751	6.4980E-06
272.759	5.0540E-06	221.187	5.7760E-06
274.530	5.0540E-06	222.624	5.0540E-06
276.301	5.0540E-06	224.060	5.0540E-06
278.072	4.3320E-06	225.496	5.0540E-06
279.843	4.3320E-06	226.933	4.3320E-06
282.099	3.5403E-06	228.369	4.3320E-06
283.386	3.6100E-06	229.805	3.6100E-06
285.157	3.6100E-06	231.801	3.6301E-06
286.928	3.6100E-06	232.678	3.6100E-06
288.699	3.6100E-06	234.114	3.6100E-06
290.470	3.6100E-06	235.550	3.6100E-06
292.242	3.6100E-06	236.986	3.6100E-06
294.013	3.6100E-06	238.423	3.6100E-06
295.784	2.8880E-06	239.859	3.6100E-06
297.555	2.8880E-06	241.295	2.8880E-06
299.326	2.8880E-06	242.732	2.8880E-06
301.097	2.8880E-06	244.168	2.8880E-06
302.869	2.8880E-06	245.604	2.8880E-06
304.640	2.1660E-06	247.040	2.8880E-06
306.411	2.1660E-06	248.477	2.8880E-06
308.182	2.1660E-06	249.913	2.8880E-06
309.953	1.4440E-06	251.349	2.8880E-06
311.724	1.4440E-06	252.786	2.8880E-06
313.495	1.4440E-06	254.222	2.8880E-06
315.267	1.4440E-06	255.658	2.1660E-06
317.038	1.4440E-06	257.094	2.1660E-06
318.809	1.4440E-06	258.531	2.1660E-06
320.580	1.4440E-06	259.967	2.1660E-06
322.351	1.4440E-06	261.403	2.1660E-06

324.122	1.4440E-06	262.840	2.1660E-06
325.894	1.4440E-06	264.276	2.1660E-06
327.665	1.4440E-06	265.712	2.1660E-06
329.436	1.4440E-06	267.148	2.1660E-06
331.207	1.4440E-06	268.585	2.1660E-06
332.978	1.4440E-06	270.021	1.4440E-06
334.749	1.4440E-06	271.457	1.4440E-06
336.521	1.4440E-06	272.894	7.2200E-07
338.292	1.4440E-06	274.330	7.2200E-07
340.063	1.4440E-06	275.766	7.2200E-07
341.834	1.4440E-06	277.202	7.2200E-07
343.605	1.4440E-06	278.639	7.2200E-07
345.376	1.4440E-06	280.075	7.2200E-07
347.148	1.4440E-06	281.511	7.2200E-07
348.919	1.4440E-06	282.947	7.2200E-07
350.690	1.4440E-06	284.384	7.2200E-07
352.461	1.4440E-06	285.820	7.2200E-07
354.232	7.2200E-07	287.256	7.2200E-07

***** Flow Duration Performance According to Dept. of Ecology Criteria ******

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-15.9%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-11.9%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-8.8%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

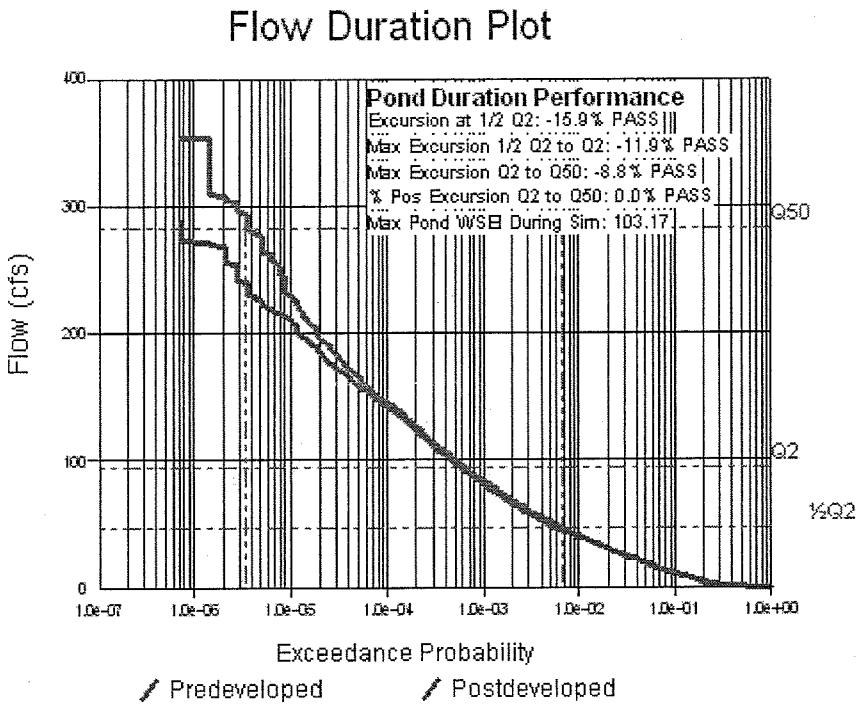
****

********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 4120872. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 6181307. cu-ft
2-Year Stormwater Pond Discharge Rate: 76.688 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -15.9% PASS
Max Excursion 1/2 Q2 to Q2: -11.9% PASS
Max Excursion Q2 to Q50: -8.8% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEl During Sim: 103.17
Q50
Q2
½Q2
Flow (cfs)
400
300
200
100
0
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:36 AM

****

Input File Name: Basin 8.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Lake Sawyer 1
Comments : Lake Sawyer Direct Tributary Areas

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********** **Watershed Definition** **********

Number of Subbasins: 1

 ********** Subbasin Number: 1 **********
 ***Tributary to Node: 1
 ***Bypass to Node   : None

	Area (Acres)	Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	165.450	165.450	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	849.070	849.070	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	297.900	297.900	0.000	No
Impervious	48.100	48.100	0.000	
SUBBASIN TOTAL	1360.520	1360.520	0.000	

 *** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

 *** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	698.3	ft
Pond Bottom Width	:	349.1	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	243782.	sq-ft
Area at Riser Crest El	:	262959.	sq-ft
	:	6.037	acres
Volume at Riser Crest	:	759929.	cu-ft
	:	17.446	ac-ft
Area at Max Elevation	:	272790.	sq-ft
	:	6.262	acres
Volume at Max Elevation	:	1161674.	cu-ft
	:	26.668	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 84.00	in
Common Length	: 5.455	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	:	Circular Orifice	
Invert Elevation	:	100.00	ft
Diameter	:	31.90	in
Orientation	:	Horizontal	
Elbow	:	No	

--- Device Number 2 ---

Device Type	:	Vertical Rectangular Orifice	
Invert Elevation	:	100.60	ft
Length	:	65.5	in
Height	:	28.8	in
Orientation	:	Vertical	
Elbow	:	No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	5.596	0.000	0.000	0.000
100.04	5.602	0.196	5.080	0.000
100.07	5.607	0.392	7.184	0.000
100.14	5.617	0.785	10.160	0.000
100.21	5.627	1.178	12.443	0.000
100.28	5.637	1.573	14.368	0.000
100.35	5.647	1.968	16.063	0.000
100.42	5.657	2.363	17.597	0.000
100.49	5.667	2.760	19.006	0.000
100.52	5.671	2.916	19.532	0.000
100.55	5.675	3.072	20.045	0.000
100.57	5.679	3.228	20.544	0.000
100.60	5.683	3.384	21.032	0.000
100.62	5.686	3.483	21.378	0.000
100.64	5.688	3.583	21.755	0.000
100.65	5.691	3.682	22.151	0.000
100.67	5.693	3.782	22.560	0.000
100.74	5.704	4.181	24.304	0.000
100.81	5.714	4.581	26.171	0.000
100.88	5.724	4.981	28.135	0.000
100.95	5.734	5.382	30.178	0.000
101.02	5.744	5.784	32.290	0.000
101.09	5.755	6.186	34.466	0.000
101.16	5.765	6.589	36.700	0.000
101.23	5.775	6.993	38.987	0.000
101.30	5.785	7.398	41.323	0.000
101.37	5.796	7.803	43.708	0.000
101.44	5.806	8.209	46.136	0.000
101.51	5.816	8.616	48.607	0.000
101.58	5.826	9.024	51.119	0.000
101.65	5.837	9.432	53.669	0.000
101.72	5.847	9.841	56.256	0.000
101.79	5.857	10.250	58.878	0.000
101.86	5.868	10.661	61.535	0.000
101.93	5.878	11.072	64.224	0.000
102.00	5.888	11.484	66.944	0.000
102.07	5.899	11.896	69.695	0.000
102.14	5.909	12.309	72.474	0.000
102.21	5.919	12.723	75.282	0.000
102.28	5.930	13.138	78.117	0.000
102.35	5.940	13.554	80.977	0.000
102.42	5.950	13.970	83.863	0.000
102.49	5.961	14.387	86.772	0.000
102.56	5.971	14.804	89.706	0.000
102.63	5.982	15.223	92.661	0.000
102.70	5.992	15.642	95.638	0.000
102.77	6.002	16.062	98.636	0.000
102.84	6.013	16.482	101.654	0.000
102.91	6.023	16.903	104.691	0.000
102.93	6.027	17.039	105.671	0.000
102.96	6.030	17.174	106.654	0.000
102.98	6.033	17.310	107.638	0.000
103.00	6.037	17.446	108.624	0.000
103.02	6.039	17.552	109.521	0.000
103.04	6.042	17.657	110.527	0.000
103.05	6.045	17.763	111.604	0.000
103.07	6.047	17.869	112.738	0.000
103.09	6.050	17.975	113.922	0.000

103.11	6.052	18.081	115.150	0.000
103.12	6.055	18.187	116.419	0.000
103.14	6.058	18.293	117.725	0.000
103.21	6.068	18.717	123.285	0.000
103.28	6.079	19.142	129.309	0.000
103.35	6.089	19.568	135.734	0.000
103.42	6.100	19.995	142.516	0.000
103.49	6.110	20.422	149.622	0.000
103.56	6.121	20.850	157.024	0.000
103.63	6.131	21.279	161.848	0.000
103.70	6.142	21.708	168.617	0.000
103.77	6.152	22.139	175.569	0.000
103.84	6.163	22.570	182.688	0.000
103.91	6.173	23.001	189.957	0.000
103.98	6.184	23.434	197.358	0.000
104.05	6.194	23.867	204.874	0.000
104.12	6.205	24.301	212.487	0.000
104.19	6.215	24.736	220.180	0.000
104.26	6.226	25.171	227.935	0.000
104.33	6.237	25.607	235.733	0.000
104.40	6.247	26.044	243.556	0.000
104.47	6.258	26.481	251.384	0.000
104.54	6.268	26.920	259.200	0.000
104.61	6.279	27.358	266.984	0.000
104.68	6.290	27.798	274.718	0.000
104.75	6.300	28.238	282.381	0.000
104.82	6.311	28.679	289.957	0.000
104.89	6.322	29.121	297.427	0.000
104.96	6.332	29.563	304.773	0.000
105.03	6.343	30.006	311.977	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 23	58.293	1940 04 30	46.366
1941 05 16	20.865	1941 05 16	15.516
1941 12 15	41.461	1942 03 02	21.145
1943 02 10	26.156	1943 03 28	18.561
1944 01 22	14.219	1944 01 22	11.159
1945 04 11	41.635	1945 02 07	22.873
1946 02 27	48.294	1946 02 27	27.999
1947 02 01	49.602	1947 02 01	32.933
1948 03 21	79.610	1948 03 21	60.271
1949 02 16	56.963	1949 02 16	39.255
1950 03 03	187.866	1950 03 03	105.989
1951 02 09	53.940	1951 02 09	43.022
1952 06 29	35.477	1952 06 29	16.297
1953 03 28	25.151	1953 03 28	16.246
1954 02 12	26.539	1954 01 21	22.497
1955 04 12	26.147	1955 04 12	16.544
1956 03 04	46.700	1956 01 06	27.825
1957 02 25	29.832	1957 02 25	19.972
1958 02 24	50.533	1958 02 24	29.300
1959 01 12	44.402	1959 01 24	26.864
1960 01 29	43.416	1960 01 29	35.436
1961 02 14	54.713	1961 02 14	26.058
1962 03 24	19.644	1962 04 27	13.948
1963 05 05	30.220	1963 05 05	17.025
1964 01 01	37.027	1964 01 01	19.982
1965 02 26	43.742	1965 02 27	32.136
1966 04 11	47.324	1966 04 11	29.889
1967 01 19	74.498	1967 01 19	54.297
1968 02 03	46.146	1968 02 03	31.905
1968 12 03	39.905	1968 12 03	25.499
1970 04 09	37.194	1970 04 09	23.842
1971 04 09	43.503	1971 04 09	25.999
1972 02 27	108.939	1972 02 27	83.749
1973 01 13	42.768	1973 01 13	28.639
1974 02 28	49.409	1974 02 18	41.009
1975 02 19	48.061	1975 02 19	37.676
1976 01 26	48.695	1976 01 27	33.510
1977 08 26	15.017	1977 08 26	9.665
1978 03 11	41.079	1978 03 11	27.872
1979 03 04	50.081	1979 03 04	33.353
1980 04 19	32.505	1980 04 19	23.456
1980 12 26	21.959	1980 11 21	13.646
1982 03 11	50.057	1982 02 20	29.884
1983 01 27	41.012	1983 03 08	25.154
1984 03 14	49.039	1984 03 14	27.101
1985 02 11	25.063	1985 02 11	18.305
1986 01 18	65.872	1986 01 18	54.799
1987 01 31	48.586	1987 02 01	43.591
1988 04 06	21.300	1988 04 06	16.016
1989 04 05	37.183	1989 04 05	25.211
1990 01 09	129.799	1990 01 09	106.625
1991 04 04	103.423	1991 04 04	76.455
1992 01 27	36.704	1992 04 17	25.459
1993 06 09	43.766	1993 06 09	25.645
1994 03 20	15.548	1994 04 08	11.865
1995 02 18	43.166	1995 02 18	33.537
1996 02 08	113.020	1996 02 08	87.182

1997 01 02	72.646	1997 03 18	47.892
1998 02 28	39.006	1998 02 28	19.848
1998 12 27	63.804	1998 12 27	44.616
2000 02 28	43.384	2000 03 26	30.612
2001 05 05	27.067	2001 05 05	16.649
2002 05 03	68.765	2002 05 03	36.252
2003 02 06	76.459	2003 03 31	57.962
2004 04 19	21.618	2004 03 03	13.774
2005 02 05	23.962	2005 02 07	14.353
2006 02 27	40.638	2006 02 27	25.589
2007 03 09	35.278	2007 03 09	22.814
2008 03 21	68.093	2008 03 22	43.227
2009 02 17	81.091	2009 02 17	72.794
2010 06 10	56.809	2010 01 10	34.823
2011 03 08	91.114	2011 03 08	66.076
2012 01 31	48.822	2012 02 19	25.331
2013 01 20	98.406	2013 01 20	74.837
2014 02 13	56.211	2014 02 13	33.388
2015 04 12	35.473	2015 04 12	25.295
2016 01 04	83.693	2016 01 04	67.853
2017 03 07	29.831	2017 04 14	18.559
2018 04 17	58.571	2018 04 17	35.799
2019 03 29	44.517	2019 03 30	33.378
2020 04 14	36.776	2020 04 14	21.962
2021 03 26	57.773	2021 02 10	42.653
2022 02 23	22.820	2022 03 26	16.041
2023 03 29	34.355	2023 03 29	25.698
2024 03 11	43.909	2024 01 19	21.084
2024 12 22	39.151	2024 12 22	25.561
2026 03 09	52.979	2026 03 09	44.217
2027 03 15	50.860	2027 03 15	34.554
2028 06 01	58.352	2028 06 01	32.058
2029 04 28	47.239	2029 04 28	29.769
2030 02 16	52.579	2030 02 16	41.949
2031 02 26	48.120	2031 02 25	29.881
2032 01 20	68.587	2032 01 20	59.860
2033 03 01	24.581	2033 03 01	17.002
2034 02 18	95.793	2034 02 18	67.289
2035 02 19	56.578	2035 02 19	41.881
2036 03 24	49.994	2036 03 24	39.845
2037 05 15	16.387	2037 05 15	9.593
2038 04 05	28.258	2038 04 22	19.923
2039 02 07	19.843	2039 02 07	14.751
2040 03 13	67.965	2040 03 13	46.206
2041 04 11	40.819	2041 03 04	27.908
2042 02 20	59.239	2042 02 20	38.125
2043 03 31	89.486	2043 03 31	41.227
2044 04 10	49.350	2044 05 01	31.167
2045 02 07	45.809	2045 02 07	28.201
2046 02 16	46.515	2046 02 16	30.082
2047 04 17	45.827	2047 04 17	27.304
2048 04 20	33.794	2048 04 21	21.841
2049 03 16	32.207	2049 03 16	22.146
2050 03 09	34.388	2050 03 09	21.160
2051 04 05	33.324	2051 05 07	23.866
2052 04 16	19.676	2052 04 16	13.056
2053 06 04	82.749	2053 06 04	41.047
2054 04 08	15.310	2054 04 08	11.263
2055 02 17	68.207	2055 02 17	52.274
2056 02 07	109.009	2056 02 07	75.792
2057 01 01	77.649	2057 01 01	50.836
2058 05 21	62.591	2058 05 21	46.813
2059 01 17	62.377	2059 03 29	35.990

2060	03	09	27.283	2060	03 09	17.046
2061	02	28	43.365	2061	02 28	30.142
2062	02	03	133.726	2062	02 03	66.642
2063	05	05	33.635	2062	12 29	24.183
2064	01	15	63.413	2063	12 23	44.219
2065	02	16	24.852	2065	02 16	19.415
2066	01	12	13.152	2066	01 13	10.235
2067	01	19	55.000	2067	01 19	37.999
2068	01	18	83.616	2068	01 18	67.329
2069	01	03	29.122	2069	01 03	19.037
2070	04	09	41.872	2070	04 09	23.649
2071	03	23	24.233	2071	03 23	14.114
2072	04	28	37.988	2072	04 28	22.754
2072	12	25	67.053	2072	12 25	56.392
2074	03	16	53.582	2074	03 09	31.731
2075	02	12	21.039	2075	02 12	12.342
2076	03	24	72.503	2076	03 24	49.540
2077	08	24	23.775	2077	08 24	12.076
2078	04	13	18.806	2077	11 25	12.943
2079	02	24	28.017	2079	02 24	21.230
2079	12	17	52.611	2079	12 17	39.127
2081	02	17	54.433	2080	12 26	34.085
2082	02	18	71.929	2082	02 13	43.320
2083	03	29	53.761	2083	02 19	31.338
2083	11	26	50.383	2083	11 26	35.961
2085	03	23	32.397	2085	04 27	21.069
2086	02	24	25.129	2086	02 24	17.647
2087	03	02	34.135	2087	03 03	23.828
2088	03	25	24.697	2088	04 05	16.926
2089	01	17	41.948	2089	01 17	35.477
2090	03	13	34.253	2090	06 10	22.156
2090	12	04	37.631	2091	04 03	28.172
2092	04	28	75.024	2092	04 29	40.690
2093	06	15	31.440	2093	06 15	20.165
2094	06	18	20.459	2094	03 01	11.937
2095	02	18	37.911	2095	02 18	25.594
2096	04	01	32.851	2096	01 14	23.966
2097	01	29	100.715	2097	01 29	71.365

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	13.152	1.00	9.593
1.01	14.219	1.01	9.665
1.02	15.017	1.02	10.235
1.02	15.310	1.02	11.159
1.03	15.548	1.03	11.263
1.04	16.387	1.04	11.865
1.04	18.806	1.04	11.937
1.05	19.644	1.05	12.076
1.06	19.676	1.06	12.342
1.06	19.843	1.06	12.943
1.07	20.459	1.07	13.056
1.08	20.865	1.08	13.646
1.09	21.039	1.09	13.774
1.09	21.300	1.09	13.948
1.10	21.618	1.10	14.114
1.11	21.959	1.11	14.353
1.12	22.820	1.12	14.751
1.12	23.775	1.12	15.516
1.13	23.962	1.13	16.016
1.14	24.233	1.14	16.041
1.15	24.581	1.15	16.246
1.16	24.697	1.16	16.297
1.17	24.852	1.17	16.544
1.18	25.063	1.18	16.649
1.18	25.129	1.18	16.926
1.19	25.151	1.19	17.002
1.20	26.147	1.20	17.025
1.21	26.156	1.21	17.046
1.22	26.539	1.22	17.647
1.23	27.067	1.23	18.305
1.24	27.283	1.24	18.559
1.25	28.017	1.25	18.561
1.26	28.258	1.26	19.037
1.27	29.122	1.27	19.415
1.28	29.831	1.28	19.848
1.29	29.832	1.29	19.923
1.30	30.220	1.30	19.972
1.31	31.440	1.31	19.982
1.32	32.207	1.32	20.165
1.33	32.397	1.33	21.069
1.35	32.505	1.35	21.084
1.36	32.851	1.36	21.145
1.37	33.324	1.37	21.160
1.38	33.635	1.38	21.230
1.39	33.794	1.39	21.841
1.40	34.135	1.40	21.962
1.42	34.253	1.42	22.146
1.43	34.355	1.43	22.156
1.44	34.388	1.44	22.497
1.46	35.278	1.46	22.754
1.47	35.473	1.47	22.814
1.48	35.477	1.48	22.873
1.50	36.704	1.50	23.456
1.51	36.776	1.51	23.649
1.53	37.027	1.53	23.828
1.54	37.183	1.54	23.842

1.56	37.194	1.56	23.866
1.57	37.631	1.57	23.966
1.59	37.911	1.59	24.183
1.60	37.988	1.60	25.154
1.62	39.006	1.62	25.211
1.64	39.151	1.64	25.295
1.65	39.905	1.65	25.331
1.67	40.638	1.67	25.459
1.69	40.819	1.69	25.499
1.71	41.012	1.71	25.561
1.73	41.079	1.73	25.589
1.75	41.461	1.75	25.594
1.77	41.635	1.77	25.645
1.79	41.872	1.79	25.698
1.81	41.948	1.81	25.999
1.83	42.768	1.83	26.058
1.85	43.166	1.85	26.864
1.87	43.365	1.87	27.101
1.89	43.384	1.89	27.304
1.92	43.416	1.92	27.825
1.94	43.503	1.94	27.872
1.96	43.742	1.96	27.908
1.99	43.766	1.99	27.999
2.01	43.909	2.01	28.172
2.04	44.402	2.04	28.201
2.07	44.517	2.07	28.639
2.09	45.809	2.09	29.300
2.12	45.827	2.12	29.769
2.15	46.146	2.15	29.881
2.18	46.515	2.18	29.884
2.21	46.700	2.21	29.889
2.24	47.239	2.24	30.082
2.27	47.324	2.27	30.142
2.31	48.061	2.31	30.612
2.34	48.120	2.34	31.167
2.38	48.294	2.38	31.338
2.41	48.586	2.41	31.731
2.45	48.695	2.45	31.905
2.49	48.822	2.49	32.058
2.53	49.039	2.53	32.136
2.57	49.350	2.57	32.933
2.61	49.409	2.61	33.353
2.65	49.602	2.65	33.378
2.70	49.994	2.70	33.388
2.75	50.057	2.75	33.510
2.80	50.081	2.80	33.537
2.85	50.383	2.85	34.085
2.90	50.533	2.90	34.554
2.95	50.860	2.95	34.823
3.01	52.579	3.01	35.436
3.07	52.611	3.07	35.477
3.13	52.979	3.13	35.799
3.19	53.582	3.19	35.961
3.26	53.761	3.26	35.990
3.32	53.940	3.32	36.252
3.40	54.433	3.40	37.676
3.47	54.713	3.47	37.999
3.55	55.000	3.55	38.125
3.63	56.211	3.63	39.127
3.72	56.578	3.72	39.255
3.80	56.809	3.80	39.845
3.90	56.963	3.90	40.690
4.00	57.773	4.00	41.009

4.10	58.293	4.10	41.047
4.21	58.352	4.21	41.227
4.32	58.571	4.32	41.881
4.45	59.239	4.45	41.949
4.58	62.377	4.58	42.653
4.71	62.591	4.71	43.022
4.86	63.413	4.86	43.227
5.01	63.804	5.01	43.320
5.17	65.872	5.17	43.591
5.35	67.053	5.35	44.217
5.54	67.965	5.54	44.219
5.74	68.093	5.74	44.616
5.95	68.207	5.95	46.206
6.19	68.587	6.19	46.366
6.44	68.765	6.44	46.813
6.71	71.929	6.71	47.892
7.01	72.503	7.01	49.540
7.33	72.646	7.33	50.836
7.69	74.498	7.69	52.274
8.08	75.024	8.08	54.297
8.52	76.459	8.52	54.799
9.00	77.649	9.00	56.392
9.55	79.610	9.55	57.962
10.16	81.091	10.16	59.860
10.86	82.749	10.86	60.271
11.66	83.616	11.66	66.076
12.59	83.693	12.59	66.642
13.68	89.486	13.68	67.289
14.97	91.114	14.97	67.329
16.54	95.793	16.54	67.853
18.47	98.406	18.47	71.365
20.92	100.715	20.92	72.794
24.10	103.423	24.10	74.837
28.44	108.939	28.44	75.792
34.68	109.009	34.68	76.455
44.42	113.020	44.42	83.749
61.77	129.799	61.77	87.182
101.36	133.726	101.36	105.989
282.36	187.866	282.36	106.625

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	25.652	25.652	
2-Year	43.379	43.379	28.085
5-Year	64.838	64.838	43.314
10-Year	80.516	80.516	59.370
25-Year	102.173	102.173	75.048
50-Year	119.688	119.688	84.982
100-Year	138.400	138.400	105.476
200-Year	158.456	158.456	106.411

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.939	1.9765E-01	0.533	2.6751E-01
1.879	1.1344E-01	1.066	1.8378E-01
2.818	7.1246E-02	1.599	1.3371E-01
3.757	4.8347E-02	2.132	1.0062E-01
4.697	3.4992E-02	2.666	7.7668E-02
5.636	2.6554E-02	3.199	6.1971E-02
6.575	2.0897E-02	3.732	5.1048E-02
7.515	1.6918E-02	4.265	4.3286E-02
8.454	1.4040E-02	4.798	3.7697E-02
9.393	1.1816E-02	5.331	3.2530E-02
10.333	1.0050E-02	5.864	2.7655E-02
11.272	8.6380E-03	6.397	2.4026E-02
12.211	7.4547E-03	6.931	2.1196E-02
13.151	6.5789E-03	7.464	1.8667E-02
14.090	5.8374E-03	7.997	1.6439E-02
15.029	5.1941E-03	8.530	1.4624E-02
15.969	4.6230E-03	9.063	1.3164E-02
16.908	4.1363E-03	9.596	1.1916E-02
17.847	3.7075E-03	10.129	1.0902E-02
18.787	3.3219E-03	10.662	9.8683E-03
19.726	2.9905E-03	11.196	8.9016E-03
20.665	2.7393E-03	11.729	8.1167E-03
21.689	2.4569E-03	12.262	7.4186E-03
22.544	2.2303E-03	12.795	6.7976E-03
23.483	2.0317E-03	13.328	6.1904E-03
24.423	1.8389E-03	13.861	5.6258E-03
25.362	1.6693E-03	14.394	5.1594E-03
26.301	1.5227E-03	14.927	4.6764E-03
27.241	1.3776E-03	15.461	4.2822E-03
28.180	1.2577E-03	15.994	3.9349E-03
29.119	1.1444E-03	16.527	3.5833E-03
30.059	1.0433E-03	17.060	3.2671E-03
30.998	9.4943E-04	17.593	2.9869E-03
31.937	8.7290E-04	18.126	2.7328E-03
32.877	7.9420E-04	18.659	2.4887E-03
33.816	7.2272E-04	19.192	2.3017E-03
34.755	6.5774E-04	19.726	2.1126E-03
35.694	5.9926E-04	20.259	1.9241E-03
36.634	5.5233E-04	20.792	1.7487E-03
37.573	5.1334E-04	21.325	1.6057E-03
38.512	4.7435E-04	21.689	1.5273E-03
39.452	4.2598E-04	22.391	1.3769E-03
40.391	3.9710E-04	22.924	1.2859E-03
41.330	3.6317E-04	23.457	1.2000E-03
42.270	3.3429E-04	23.991	1.1169E-03
43.379	3.0857E-04	24.524	1.0426E-03
44.148	2.8880E-04	25.057	9.6748E-04
45.088	2.6570E-04	25.590	8.8951E-04
46.027	2.4909E-04	26.123	8.3608E-04
46.966	2.3393E-04	26.656	7.8698E-04
47.906	2.1660E-04	27.189	7.2417E-04
48.845	1.9566E-04	27.722	6.8446E-04
49.784	1.8194E-04	28.256	6.4475E-04
50.724	1.7400E-04	28.789	6.1442E-04
51.663	1.6389E-04	29.322	5.8193E-04
52.602	1.5667E-04	29.855	5.3573E-04

53.542	1.4584E-04	30.388	5.0035E-04
54.481	1.2924E-04	30.921	4.7435E-04
55.420	1.2130E-04	31.454	4.4692E-04
56.360	1.1480E-04	31.987	4.2815E-04
57.299	1.0758E-04	32.521	4.0432E-04
58.238	1.0108E-04	33.054	3.8194E-04
59.178	9.6748E-05	33.587	3.6461E-04
60.117	9.0250E-05	34.120	3.4656E-04
61.056	8.8806E-05	34.653	3.3212E-04
61.996	8.4474E-05	35.186	3.1624E-04
62.935	7.7976E-05	35.719	3.0107E-04
63.874	7.1478E-05	36.252	2.8736E-04
64.838	6.7086E-05	36.785	2.7508E-04
65.753	6.5702E-05	37.319	2.6281E-04
66.692	6.2092E-05	37.852	2.5126E-04
67.632	5.7038E-05	38.385	2.3393E-04
68.571	5.1984E-05	38.918	2.2454E-04
69.510	4.8374E-05	39.451	2.1804E-04
70.450	4.6930E-05	39.984	2.0938E-04
71.389	4.6208E-05	40.517	1.9783E-04
72.328	4.4042E-05	41.050	1.8339E-04
73.268	4.1154E-05	41.584	1.7472E-04
74.207	4.1154E-05	42.117	1.6823E-04
75.146	3.8988E-05	42.650	1.6317E-04
76.086	3.3934E-05	43.379	1.5329E-04
77.025	3.1046E-05	43.716	1.4873E-04
77.964	2.9602E-05	44.249	1.4079E-04
78.904	2.8158E-05	44.782	1.3285E-04
79.843	2.5270E-05	45.315	1.2707E-04
80.782	2.4548E-05	45.849	1.2346E-04
81.722	2.3104E-05	46.382	1.1552E-04
82.661	2.1660E-05	46.915	1.1047E-04
83.600	2.0216E-05	47.448	1.0758E-04
84.540	1.8050E-05	47.981	1.0325E-04
85.479	1.8050E-05	48.514	9.7470E-05
86.418	1.7328E-05	49.047	9.6026E-05
87.358	1.7328E-05	49.580	9.0972E-05
88.297	1.6606E-05	50.114	8.8806E-05
89.236	1.5884E-05	50.647	8.8084E-05
90.176	1.4440E-05	51.180	8.0864E-05
91.115	1.2996E-05	51.713	7.5088E-05
92.054	1.2996E-05	52.246	7.4366E-05
92.994	1.1552E-05	52.779	7.2922E-05
93.933	1.1552E-05	53.312	7.1478E-05
94.872	1.1552E-05	53.845	7.0756E-05
95.812	1.0830E-05	54.379	6.6424E-05
96.751	1.0830E-05	54.912	6.2092E-05
97.690	1.0108E-05	55.445	5.9926E-05
98.630	9.3860E-06	55.978	5.7038E-05
99.569	9.3860E-06	56.511	5.1984E-05
100.508	9.3860E-06	57.044	4.9096E-05
101.448	8.6640E-06	57.577	4.7652E-05
102.387	8.6640E-06	58.110	4.4764E-05
103.326	8.6640E-06	58.644	4.3320E-05
104.266	7.9420E-06	59.177	4.1154E-05
105.205	7.2200E-06	59.710	3.8988E-05
106.144	7.2200E-06	60.243	3.5378E-05
107.084	7.2200E-06	60.776	3.3212E-05
108.023	6.4980E-06	61.309	3.3212E-05
108.962	5.7760E-06	61.842	3.1768E-05
109.902	5.0540E-06	62.375	3.1046E-05
110.841	5.0540E-06	62.909	2.9602E-05
111.780	5.0540E-06	63.442	2.7436E-05

112.719	5.0540E-06	63.975	2.6714E-05
113.659	4.3320E-06	64.508	2.5992E-05
114.598	4.3320E-06	64.838	2.5540E-05
115.537	4.3320E-06	65.574	2.4548E-05
116.477	4.3320E-06	66.107	2.3826E-05
117.416	3.6100E-06	66.640	2.3104E-05
118.355	3.6100E-06	67.173	2.3104E-05
119.688	3.2940E-06	67.707	2.1660E-05
120.234	2.8880E-06	68.240	2.0216E-05
121.173	2.8880E-06	68.773	1.9494E-05
122.113	2.8880E-06	69.306	1.8050E-05
123.052	2.8880E-06	69.839	1.5884E-05
123.991	2.8880E-06	70.372	1.5162E-05
124.931	2.8880E-06	70.905	1.5162E-05
125.870	2.8880E-06	71.438	1.3718E-05
126.809	2.8880E-06	71.972	1.3718E-05
127.749	2.8880E-06	72.505	1.2996E-05
128.688	2.8880E-06	73.038	1.0830E-05
129.627	2.8880E-06	73.571	1.0830E-05
130.567	2.1660E-06	74.104	1.0830E-05
131.506	2.1660E-06	74.637	1.0830E-05
132.445	2.1660E-06	75.170	9.3860E-06
133.385	2.1660E-06	75.703	9.3860E-06
134.324	1.4440E-06	76.237	8.6640E-06
135.263	1.4440E-06	76.770	7.9420E-06
136.203	1.4440E-06	77.303	7.9420E-06
137.142	1.4440E-06	77.836	7.9420E-06
138.081	1.4440E-06	78.369	7.9420E-06
139.021	1.4440E-06	78.902	7.2200E-06
139.960	1.4440E-06	79.435	7.2200E-06
140.899	1.4440E-06	79.968	7.2200E-06
141.839	1.4440E-06	80.502	6.4980E-06
142.778	7.2200E-07	81.035	6.4980E-06
143.717	7.2200E-07	81.568	6.4980E-06
144.657	7.2200E-07	82.101	6.4980E-06
145.596	7.2200E-07	82.634	6.4980E-06
146.535	7.2200E-07	83.167	5.7760E-06
147.475	7.2200E-07	83.700	5.7760E-06
148.414	7.2200E-07	84.233	5.0540E-06
149.353	7.2200E-07	84.767	4.3320E-06
150.293	7.2200E-07	85.300	4.3320E-06
151.232	7.2200E-07	85.833	4.3320E-06
152.171	7.2200E-07	86.366	4.3320E-06
153.111	7.2200E-07	86.899	4.3320E-06
154.050	7.2200E-07	87.432	3.6100E-06
154.989	7.2200E-07	87.965	3.6100E-06
155.929	7.2200E-07	88.498	3.6100E-06
156.868	7.2200E-07	89.032	3.6100E-06
157.807	7.2200E-07	89.565	3.6100E-06
158.747	7.2200E-07	90.098	3.6100E-06
159.686	7.2200E-07	90.631	3.6100E-06
160.625	7.2200E-07	91.164	3.6100E-06
161.565	7.2200E-07	91.697	2.8880E-06
162.504	7.2200E-07	92.230	2.8880E-06
163.443	7.2200E-07	92.763	2.8880E-06
164.383	7.2200E-07	93.297	2.8880E-06
165.322	7.2200E-07	93.830	2.8880E-06
166.261	7.2200E-07	94.363	2.8880E-06
167.201	7.2200E-07	94.896	2.1660E-06
168.140	7.2200E-07	95.429	2.1660E-06
169.079	7.2200E-07	95.962	2.1660E-06
170.019	7.2200E-07	96.495	2.1660E-06
170.958	7.2200E-07	97.028	2.1660E-06

171.897	7.2200E-07	97.562	2.1660E-06
172.837	7.2200E-07	98.095	2.1660E-06
173.776	7.2200E-07	98.628	2.1660E-06
174.715	7.2200E-07	99.161	2.1660E-06
175.655	7.2200E-07	99.694	2.1660E-06
176.594	7.2200E-07	100.227	2.1660E-06
177.533	7.2200E-07	100.760	2.1660E-06
178.473	7.2200E-07	101.293	2.1660E-06
179.412	7.2200E-07	101.827	2.1660E-06
180.351	7.2200E-07	102.360	1.4440E-06
181.290	7.2200E-07	102.893	1.4440E-06
182.230	7.2200E-07	103.426	1.4440E-06
183.169	7.2200E-07	103.959	1.4440E-06
184.108	7.2200E-07	104.492	1.4440E-06
185.048	7.2200E-07	105.025	1.4440E-06
185.987	7.2200E-07	105.558	1.4440E-06
186.926	7.2200E-07	106.092	7.2200E-07
187.866	7.2200E-07	106.625	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-37.9%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-37.9%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-48.6%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

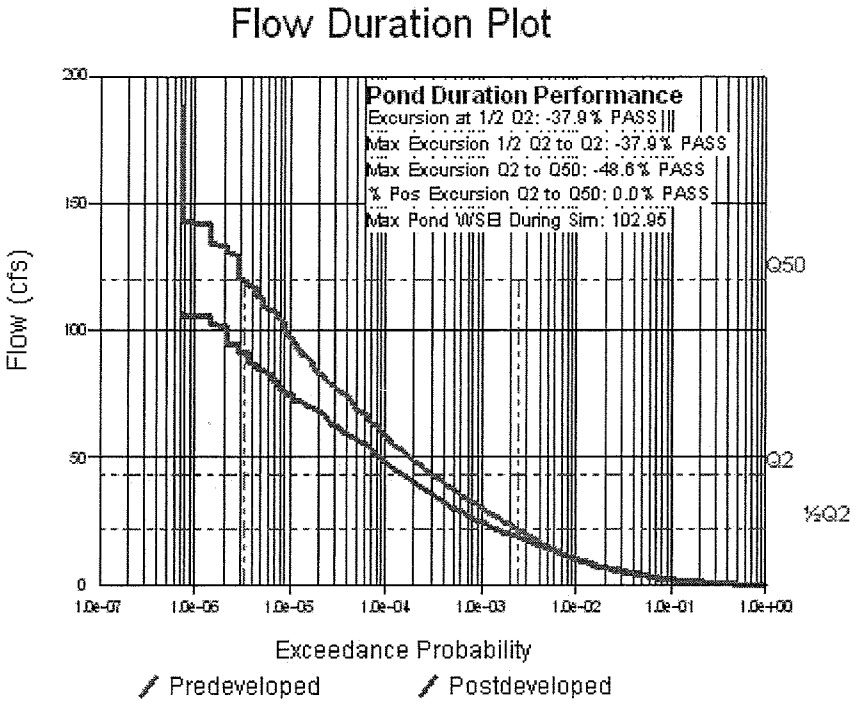
****

********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 1013880. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 1520820. cu-ft
2-Year Stormwater Pond Discharge Rate: 28.085 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -37.9% PASS
Max Excursion 1/2 Q2 to Q2: -37.9% PASS
Max Excursion Q2 to Q50: -48.6% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEL During Sim: 102.95
Flow (cfs)
200
150
100
50
0
Q50
Q2
½Q2
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:42 AM
****

Input File Name: Basin 7.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Lake Marjorie
Comments : Basin Tributary to Lake Marjorie Pot Hole

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)			
		Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	0.000	0.000	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	96.060	96.060	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	5.590	5.590	0.000	No
Impervious	4.320	4.320	0.000	
SUBBASIN TOTAL	105.970	105.970	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	103.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	159.0	ft
Pond Bottom Width	:	79.5	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	12638.	sq-ft
Area at Riser Crest El	:	17254.	sq-ft
	:	0.396	acres
Volume at Riser Crest	:	44658.	cu-ft
	:	1.025	ac-ft
Area at Max Elevation	:	18086.	sq-ft
	:	0.415	acres
Volume at Max Elevation	:	53483.	cu-ft
	:	1.228	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 24.00	in
Common Length	: 0.160	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	:	Circular Orifice	
Invert Elevation	:	100.00	ft
Diameter	:	6.21	in
Orientation	:	Horizontal	
Elbow	:	No	

--- Device Number 2 ---

Device Type	:	Vertical Rectangular Orifice	
Invert Elevation	:	100.60	ft
Length	:	1.9	in
Height	:	28.8	in
Orientation	:	Vertical	
Elbow	:	No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	0.290	0.000	0.000	0.000
100.03	0.291	0.009	0.178	0.000
100.06	0.292	0.017	0.252	0.000
100.12	0.294	0.035	0.357	0.000
100.18	0.296	0.053	0.437	0.000
100.24	0.298	0.071	0.505	0.000
100.30	0.300	0.089	0.564	0.000
100.36	0.302	0.107	0.618	0.000
100.42	0.304	0.125	0.668	0.000
100.48	0.306	0.143	0.714	0.000
100.54	0.308	0.161	0.757	0.000
100.56	0.309	0.166	0.768	0.000
100.57	0.309	0.171	0.778	0.000
100.59	0.310	0.175	0.788	0.000
100.60	0.310	0.180	0.798	0.000
100.62	0.311	0.185	0.809	0.000
100.63	0.311	0.189	0.821	0.000
100.65	0.312	0.194	0.832	0.000
100.66	0.312	0.199	0.844	0.000
100.72	0.314	0.218	0.893	0.000
100.78	0.316	0.236	0.943	0.000
100.84	0.318	0.255	0.995	0.000
100.90	0.320	0.275	1.048	0.000
100.96	0.322	0.294	1.102	0.000
101.02	0.324	0.313	1.157	0.000
101.08	0.327	0.333	1.213	0.000
101.14	0.329	0.352	1.270	0.000
101.20	0.331	0.372	1.327	0.000
101.26	0.333	0.392	1.385	0.000
101.32	0.335	0.412	1.445	0.000
101.38	0.337	0.432	1.504	0.000
101.44	0.339	0.453	1.565	0.000
101.50	0.341	0.473	1.626	0.000
101.56	0.343	0.494	1.688	0.000
101.62	0.345	0.514	1.751	0.000
101.68	0.348	0.535	1.815	0.000
101.74	0.350	0.556	1.879	0.000
101.80	0.352	0.577	1.943	0.000
101.86	0.354	0.598	2.009	0.000
101.92	0.356	0.619	2.075	0.000
101.98	0.358	0.641	2.142	0.000
102.04	0.361	0.663	2.209	0.000
102.10	0.363	0.684	2.277	0.000
102.16	0.365	0.706	2.346	0.000
102.22	0.367	0.728	2.415	0.000
102.28	0.369	0.750	2.485	0.000
102.34	0.372	0.772	2.556	0.000
102.40	0.374	0.795	2.627	0.000
102.46	0.376	0.817	2.699	0.000
102.52	0.378	0.840	2.771	0.000
102.58	0.380	0.863	2.844	0.000
102.64	0.383	0.885	2.918	0.000
102.70	0.385	0.908	2.992	0.000
102.76	0.387	0.932	3.067	0.000
102.82	0.389	0.955	3.142	0.000
102.88	0.392	0.978	3.218	0.000
102.94	0.394	1.002	3.294	0.000
102.95	0.394	1.008	3.314	0.000

102.97	0.395	1.014	3.333	0.000
102.99	0.396	1.020	3.352	0.000
103.00	0.396	1.026	3.372	0.000
103.02	0.397	1.032	3.429	0.000
103.03	0.397	1.038	3.518	0.000
103.05	0.398	1.043	3.627	0.000
103.06	0.398	1.049	3.753	0.000
103.08	0.399	1.055	3.893	0.000
103.09	0.400	1.061	4.046	0.000
103.11	0.400	1.067	4.211	0.000
103.12	0.401	1.073	4.386	0.000
103.18	0.403	1.098	5.178	0.000
103.24	0.405	1.122	6.093	0.000
103.30	0.408	1.146	7.099	0.000
103.36	0.410	1.171	8.169	0.000
103.42	0.412	1.195	9.273	0.000
103.48	0.414	1.220	10.382	0.000
103.54	0.417	1.245	11.465	0.000
103.60	0.419	1.270	12.495	0.000
103.66	0.421	1.295	13.445	0.000
103.72	0.424	1.321	14.297	0.000
103.78	0.426	1.346	15.036	0.000
103.84	0.428	1.372	15.660	0.000
103.90	0.431	1.398	16.178	0.000
103.96	0.433	1.424	16.615	0.000
104.02	0.436	1.450	17.128	0.000
104.82	0.468	11.078	149.168	0.000
104.89	0.471	11.254	152.707	0.000
104.96	0.473	11.432	155.981	0.000
105.03	0.476	11.609	158.991	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 23	1.827	1940 04 30	1.241
1941 09 02	1.558	1941 05 16	0.722
1941 12 15	2.035	1941 12 15	0.911
1943 03 27	0.943	1943 03 27	0.658
1944 01 22	1.048	1944 01 22	0.647
1945 04 11	1.600	1945 02 07	0.990
1946 02 27	1.677	1946 01 24	0.912
1947 02 01	1.763	1947 02 02	0.957
1948 03 21	2.651	1948 03 21	1.549
1949 02 16	1.905	1949 02 16	1.062
1950 03 03	8.925	1950 03 03	3.315
1951 02 09	1.772	1951 02 09	1.152
1952 06 29	3.054	1952 06 29	0.929
1953 09 30	1.422	1953 09 30	0.724
1953 12 19	1.316	1954 02 12	0.724
1955 02 28	1.027	1954 11 05	0.674
1956 03 04	1.663	1956 01 06	0.784
1957 04 14	1.072	1957 04 14	0.634
1958 02 24	1.688	1958 02 24	0.869
1959 01 12	1.420	1959 01 24	0.826
1959 12 15	1.611	1960 01 29	1.012
1961 02 14	1.948	1961 02 14	0.791
1962 07 05	1.633	1962 04 27	0.705
1963 05 05	1.232	1963 05 05	0.627
1964 09 17	1.621	1964 09 17	0.729
1965 05 04	1.370	1965 02 27	0.895
1966 04 11	1.497	1966 04 11	0.824
1967 01 19	2.284	1967 01 19	1.389
1968 08 23	1.937	1968 02 03	0.894
1968 12 03	1.354	1968 12 03	0.865
1970 04 09	1.414	1970 04 09	0.777
1971 04 09	1.610	1971 04 09	0.793
1972 02 27	4.816	1972 02 27	2.459
1973 01 13	1.502	1973 01 13	0.883
1974 04 06	1.670	1974 02 18	1.089
1975 02 19	1.687	1975 02 19	1.053
1976 01 26	1.662	1976 01 27	0.997
1977 08 26	1.349	1977 08 26	0.627
1978 09 17	1.792	1978 09 22	0.885
1979 03 04	1.665	1979 03 04	0.951
1979 12 14	1.404	1979 12 15	0.816
1980 11 21	1.584	1980 11 21	0.766
1981 10 06	2.254	1981 10 06	1.004
1982 10 28	1.605	1982 10 28	0.891
1984 03 14	1.738	1984 02 20	0.858
1985 06 06	1.130	1985 06 07	0.753
1986 01 18	2.083	1986 01 18	1.510
1986 10 26	2.005	1987 02 01	1.190
1988 05 28	1.015	1988 04 06	0.639
1989 08 21	1.287	1989 04 05	0.745
1990 01 09	3.923	1990 01 09	2.526
1991 04 04	3.323	1990 11 24	1.869
1992 01 27	1.435	1992 01 27	0.869
1993 06 09	1.595	1993 06 09	0.836
1994 09 03	0.925	1994 06 18	0.559
1995 02 18	1.456	1995 02 18	0.980
1996 02 08	4.028	1996 02 08	2.407

1997	01	02	2.541	1997	03	18	1.322
1998	02	28	1.511	1998	02	28	0.721
1998	11	04	2.959	1998	12	27	1.218
2000	02	28	1.549	2000	03	26	0.963
2001	05	05	1.102	2001	05	04	0.624
2002	05	03	2.570	2002	05	03	1.068
2003	02	06	3.223	2003	02	06	1.667
2004	04	19	1.056	2004	03	03	0.606
2005	02	05	1.239	2005	02	07	0.604
2006	07	08	1.262	2006	02	27	0.735
2007	03	09	1.293	2007	03	09	0.751
2008	03	21	2.280	2008	03	22	1.153
2009	02	17	2.491	2009	02	17	1.861
2010	06	10	3.866	2010	06	10	1.166
2011	03	08	3.379	2011	03	08	1.759
2012	01	31	1.792	2012	02	19	0.790
2013	01	20	3.019	2013	01	20	1.855
2014	02	13	1.932	2013	11	16	0.909
2015	04	12	1.269	2015	04	12	0.811
2016	01	27	2.747	2016	01	04	1.705
2017	06	14	1.524	2017	06	14	0.692
2018	04	17	1.929	2018	04	17	0.952
2018	11	09	1.474	2019	03	30	0.943
2020	03	30	1.197	2020	04	14	0.678
2021	03	26	2.270	2021	02	10	1.177
2021	12	20	1.429	2021	12	20	0.760
2023	02	02	1.542	2023	03	29	0.825
2024	03	11	1.697	2024	01	19	0.755
2025	06	14	1.509	2024	12	22	0.829
2026	03	09	1.630	2026	03	09	1.205
2027	03	15	1.745	2027	03	15	1.036
2028	06	01	1.991	2028	06	01	0.920
2029	04	28	1.691	2028	10	11	0.924
2030	02	16	2.033	2030	02	16	1.224
2031	09	24	1.846	2031	02	04	0.878
2032	04	12	2.279	2032	01	20	1.535
2033	08	24	1.141	2033	03	01	0.644
2034	02	18	3.730	2034	02	18	1.902
2035	02	19	1.790	2035	02	19	1.163
2036	03	24	1.674	2036	03	24	1.077
2037	05	15	1.439	2037	08	24	0.683
2037	11	24	1.458	2037	11	24	0.756
2038	11	03	1.210	2038	12	10	0.681
2040	01	14	2.557	2040	03	13	1.193
2041	04	11	1.441	2041	03	04	0.918
2042	02	20	1.900	2042	02	20	1.025
2043	03	31	4.057	2043	03	31	1.211
2044	05	01	1.675	2044	05	01	0.887
2045	02	07	1.743	2045	02	07	0.946
2046	02	16	1.525	2046	02	16	0.885
2047	04	17	1.566	2047	04	17	0.847
2047	12	02	1.416	2047	12	02	0.920
2049	03	16	1.261	2049	03	16	0.770
2049	12	04	1.427	2049	12	04	1.122
2051	04	05	1.368	2051	04	05	0.792
2051	10	25	1.149	2052	04	09	0.663
2053	06	04	2.846	2053	06	04	1.074
2053	10	14	1.027	2054	04	08	0.540
2055	02	17	2.068	2055	02	17	1.357
2056	02	07	3.875	2056	02	07	1.892
2057	01	01	2.866	2057	01	01	1.411
2058	01	24	2.255	2058	05	21	1.167
2059	03	28	2.146	2059	03	29	1.149

2060	05	15	1.893	0.713
2061	09	01	1.973	0.865
2062	02	03	4.653	1.697
2063	05	05	1.185	0.779
2064	01	15	1.985	1.096
2064	11	29	1.425	0.783
2066	08	26	0.768	0.528
2067	01	19	1.843	1.043
2068	01	18	2.504	1.692
2069	01	03	1.024	0.700
2070	04	09	1.435	0.751
2071	09	27	1.020	0.526
2072	04	28	1.416	0.752
2072	12	25	2.064	1.546
2074	03	16	1.788	0.929
2075	08	27	1.394	0.636
2076	03	24	2.360	1.313
2077	08	24	2.137	0.717
2077	11	25	1.135	0.763
2078	11	03	1.280	0.748
2079	12	17	1.919	1.358
2081	02	17	2.007	0.913
2082	02	18	2.784	1.224
2083	03	29	1.898	0.891
2084	04	30	1.697	1.017
2085	09	06	1.423	0.702
2086	09	23	1.224	0.899
2086	10	26	1.737	0.815
2088	03	25	1.267	0.726
2088	11	05	1.774	1.036
2090	03	13	1.325	0.719
2091	04	03	1.336	0.886
2092	04	28	2.578	1.106
2093	06	15	1.243	0.714
2093	10	23	1.490	0.694
2095	02	18	1.273	0.789
2096	08	02	1.671	0.721
2097	01	29	4.069	2.058

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	0.768	1.00	0.526
1.01	0.925	1.01	0.528
1.02	0.943	1.02	0.540
1.02	1.015	1.02	0.559
1.03	1.020	1.03	0.604
1.04	1.024	1.04	0.606
1.04	1.027	1.04	0.624
1.05	1.027	1.05	0.627
1.06	1.048	1.06	0.627
1.06	1.056	1.06	0.634
1.07	1.072	1.07	0.636
1.08	1.102	1.08	0.639
1.09	1.130	1.09	0.644
1.09	1.135	1.09	0.647
1.10	1.141	1.10	0.658
1.11	1.149	1.11	0.663
1.12	1.185	1.12	0.674
1.12	1.197	1.12	0.678
1.13	1.210	1.13	0.681
1.14	1.224	1.14	0.683
1.15	1.232	1.15	0.692
1.16	1.239	1.16	0.694
1.17	1.243	1.17	0.700
1.18	1.261	1.18	0.702
1.18	1.262	1.18	0.705
1.19	1.267	1.19	0.713
1.20	1.269	1.20	0.714
1.21	1.273	1.21	0.717
1.22	1.280	1.22	0.719
1.23	1.287	1.23	0.721
1.24	1.293	1.24	0.721
1.25	1.316	1.25	0.722
1.26	1.325	1.26	0.724
1.27	1.336	1.27	0.724
1.28	1.349	1.28	0.726
1.29	1.354	1.29	0.729
1.30	1.368	1.30	0.735
1.31	1.370	1.31	0.745
1.32	1.394	1.32	0.748
1.33	1.404	1.33	0.751
1.35	1.414	1.35	0.751
1.36	1.416	1.36	0.752
1.37	1.416	1.37	0.753
1.38	1.420	1.38	0.755
1.39	1.422	1.39	0.756
1.40	1.423	1.40	0.760
1.42	1.425	1.42	0.763
1.43	1.427	1.43	0.766
1.44	1.429	1.44	0.770
1.46	1.435	1.46	0.777
1.47	1.435	1.47	0.779
1.48	1.439	1.48	0.783
1.50	1.441	1.50	0.784
1.51	1.456	1.51	0.789
1.53	1.458	1.53	0.790
1.54	1.474	1.54	0.791

1.56	1.490	1.56	0.792
1.57	1.497	1.57	0.793
1.59	1.502	1.59	0.811
1.60	1.509	1.60	0.815
1.62	1.511	1.62	0.816
1.64	1.524	1.64	0.824
1.65	1.525	1.65	0.825
1.67	1.542	1.67	0.826
1.69	1.549	1.69	0.829
1.71	1.558	1.71	0.836
1.73	1.566	1.73	0.847
1.75	1.584	1.75	0.858
1.77	1.595	1.77	0.865
1.79	1.600	1.79	0.865
1.81	1.605	1.81	0.869
1.83	1.610	1.83	0.869
1.85	1.611	1.85	0.878
1.87	1.621	1.87	0.883
1.89	1.630	1.89	0.885
1.92	1.633	1.92	0.885
1.94	1.662	1.94	0.886
1.96	1.663	1.96	0.887
1.99	1.665	1.99	0.891
2.01	1.670	2.01	0.891
2.04	1.671	2.04	0.894
2.07	1.674	2.07	0.895
2.09	1.675	2.09	0.899
2.12	1.677	2.12	0.909
2.15	1.687	2.15	0.911
2.18	1.688	2.18	0.912
2.21	1.691	2.21	0.913
2.24	1.697	2.24	0.918
2.27	1.697	2.27	0.920
2.31	1.737	2.31	0.920
2.34	1.738	2.34	0.924
2.38	1.743	2.38	0.929
2.41	1.745	2.41	0.929
2.45	1.763	2.45	0.943
2.49	1.772	2.49	0.946
2.53	1.774	2.53	0.951
2.57	1.788	2.57	0.952
2.61	1.790	2.61	0.957
2.65	1.792	2.65	0.963
2.70	1.792	2.70	0.980
2.75	1.827	2.75	0.990
2.80	1.843	2.80	0.997
2.85	1.846	2.85	1.004
2.90	1.893	2.90	1.012
2.95	1.898	2.95	1.017
3.01	1.900	3.01	1.025
3.07	1.905	3.07	1.036
3.13	1.919	3.13	1.036
3.19	1.929	3.19	1.043
3.26	1.932	3.26	1.053
3.32	1.937	3.32	1.062
3.40	1.948	3.40	1.068
3.47	1.973	3.47	1.074
3.55	1.985	3.55	1.077
3.63	1.991	3.63	1.089
3.72	2.005	3.72	1.096
3.80	2.007	3.80	1.106
3.90	2.033	3.90	1.122
4.00	2.035	4.00	1.149

4.10	2.064	4.10	1.152
4.21	2.068	4.21	1.153
4.32	2.083	4.32	1.163
4.45	2.137	4.45	1.166
4.58	2.146	4.58	1.167
4.71	2.254	4.71	1.177
4.86	2.255	4.86	1.190
5.01	2.270	5.01	1.193
5.17	2.279	5.17	1.205
5.35	2.280	5.35	1.211
5.54	2.284	5.54	1.218
5.74	2.360	5.74	1.224
5.95	2.491	5.95	1.224
6.19	2.504	6.19	1.241
6.44	2.541	6.44	1.313
6.71	2.557	6.71	1.322
7.01	2.570	7.01	1.357
7.33	2.578	7.33	1.358
7.69	2.651	7.69	1.389
8.08	2.747	8.08	1.411
8.52	2.784	8.52	1.510
9.00	2.846	9.00	1.535
9.55	2.866	9.55	1.546
10.16	2.959	10.16	1.549
10.86	3.019	10.86	1.667
11.66	3.054	11.66	1.692
12.59	3.223	12.59	1.697
13.68	3.323	13.68	1.705
14.97	3.379	14.97	1.759
16.54	3.730	16.54	1.855
18.47	3.866	18.47	1.861
20.92	3.875	20.92	1.869
24.10	3.923	24.10	1.892
28.44	4.028	28.44	1.902
34.68	4.057	34.68	2.058
44.42	4.069	44.42	2.407
61.77	4.653	61.77	2.459
101.36	4.816	101.36	2.526
282.36	8.925	282.36	3.315

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	1.218	1.218	
2-Year	1.646	1.646	0.891
5-Year	2.285	2.285	1.192
10-Year	2.842	2.842	1.548
25-Year	3.747	3.747	1.894
50-Year	4.603	4.603	2.426
100-Year	5.649	5.649	2.525
200-Year	6.929	6.929	3.049

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.045	1.1075E-01	0.017	1.8776E-01
0.089	7.5078E-02	0.033	1.3409E-01
0.134	5.6435E-02	0.050	1.1075E-01
0.179	4.4171E-02	0.066	9.6142E-02
0.223	3.5303E-02	0.083	8.5887E-02
0.268	2.8612E-02	0.099	7.7953E-02
0.312	2.3218E-02	0.116	7.1548E-02
0.357	1.9065E-02	0.133	6.6170E-02
0.402	1.5693E-02	0.149	6.1410E-02
0.446	1.2951E-02	0.166	5.7323E-02
0.491	1.0714E-02	0.182	5.3071E-02
0.536	8.9059E-03	0.199	4.7665E-02
0.580	7.4121E-03	0.215	4.3045E-02
0.625	6.2056E-03	0.232	3.9150E-02
0.669	5.2360E-03	0.249	3.5764E-02
0.714	4.3818E-03	0.265	3.2104E-02
0.759	3.7270E-03	0.282	2.8795E-02
0.823	2.8894E-03	0.298	2.5979E-02
0.848	2.6238E-03	0.315	2.3479E-02
0.893	2.2360E-03	0.331	2.1274E-02
0.937	1.8570E-03	0.348	1.9332E-02
0.982	1.5985E-03	0.365	1.7447E-02
1.026	1.3631E-03	0.381	1.5594E-02
1.071	1.1436E-03	0.398	1.3933E-02
1.116	1.0050E-03	0.414	1.2559E-02
1.160	8.8445E-04	0.431	1.1340E-02
1.205	7.7037E-04	0.447	1.0155E-02
1.250	6.6568E-04	0.464	9.0626E-03
1.294	5.8554E-04	0.481	8.1066E-03
1.339	5.1767E-04	0.497	7.2864E-03
1.383	4.4908E-04	0.514	6.5081E-03
1.428	3.9421E-04	0.530	5.7962E-03
1.473	3.3645E-04	0.547	5.2157E-03
1.517	2.9602E-04	0.563	4.7017E-03
1.562	2.6281E-04	0.580	4.1746E-03
1.607	2.3465E-04	0.597	3.7255E-03
1.646	2.1549E-04	0.613	3.3660E-03
1.696	1.8916E-04	0.630	3.0151E-03
1.740	1.6895E-04	0.646	2.7154E-03
1.785	1.5306E-04	0.663	2.4411E-03
1.830	1.4007E-04	0.679	2.1877E-03
1.874	1.2635E-04	0.696	1.9638E-03
1.919	1.1408E-04	0.713	1.7472E-03
1.964	1.0541E-04	0.729	1.5487E-03
2.008	9.5304E-05	0.746	1.3956E-03
2.053	8.6640E-05	0.762	1.2440E-03
2.097	7.5810E-05	0.779	1.1191E-03
2.142	7.0756E-05	0.795	9.9420E-04
2.187	6.9312E-05	0.812	8.9095E-04
2.231	6.1370E-05	0.823	8.3559E-04
2.285	5.6096E-05	0.845	7.4366E-04
2.321	5.1984E-05	0.862	6.7868E-04
2.365	4.9096E-05	0.878	6.2237E-04
2.410	4.5486E-05	0.895	5.7399E-04
2.454	4.4042E-05	0.912	5.3645E-04
2.499	4.1154E-05	0.928	4.9962E-04

2.544	3.9710E-05	0.945	4.6713E-04
2.588	3.6100E-05	0.961	4.3681E-04
2.633	3.5378E-05	0.978	4.0288E-04
2.678	3.2490E-05	0.994	3.7544E-04
2.722	3.1768E-05	1.011	3.5522E-04
2.767	3.1046E-05	1.028	3.3284E-04
2.812	2.8158E-05	1.044	3.1551E-04
2.856	2.6714E-05	1.061	2.9891E-04
2.901	2.3104E-05	1.077	2.7292E-04
2.945	2.3104E-05	1.094	2.5342E-04
2.990	2.0216E-05	1.110	2.3248E-04
3.035	1.8772E-05	1.127	2.1877E-04
3.079	1.8050E-05	1.144	2.0794E-04
3.124	1.8050E-05	1.160	1.9566E-04
3.169	1.7328E-05	1.177	1.8628E-04
3.213	1.6606E-05	1.193	1.7689E-04
3.258	1.5162E-05	1.210	1.6750E-04
3.302	1.4440E-05	1.226	1.5812E-04
3.347	1.3718E-05	1.243	1.4945E-04
3.392	1.2996E-05	1.260	1.4079E-04
3.436	1.2274E-05	1.276	1.3213E-04
3.481	1.2274E-05	1.293	1.2346E-04
3.526	1.1552E-05	1.309	1.1913E-04
3.570	1.1552E-05	1.326	1.0974E-04
3.615	1.1552E-05	1.342	1.0180E-04
3.659	1.1552E-05	1.359	9.8192E-05
3.704	1.0830E-05	1.376	9.4582E-05
3.749	7.9420E-06	1.392	8.9528E-05
3.793	7.9420E-06	1.409	8.4474E-05
3.838	7.9420E-06	1.425	8.0142E-05
3.883	5.7760E-06	1.442	7.9420E-05
3.927	5.0540E-06	1.458	7.6532E-05
3.972	5.0540E-06	1.475	7.4366E-05
4.016	5.0540E-06	1.492	7.2200E-05
4.061	3.6100E-06	1.508	6.6424E-05
4.106	2.8880E-06	1.525	6.1370E-05
4.150	2.8880E-06	1.541	5.7038E-05
4.195	2.8880E-06	1.558	5.3428E-05
4.240	2.8880E-06	1.574	4.9818E-05
4.284	2.8880E-06	1.591	4.6930E-05
4.329	2.8880E-06	1.608	4.3320E-05
4.373	2.8880E-06	1.624	4.2598E-05
4.418	2.8880E-06	1.646	4.0424E-05
4.463	2.8880E-06	1.657	3.8988E-05
4.507	2.8880E-06	1.674	3.7544E-05
4.552	2.8880E-06	1.690	3.5378E-05
4.603	2.9136E-06	1.707	3.1046E-05
4.641	2.8880E-06	1.724	2.9602E-05
4.686	2.1660E-06	1.740	2.8880E-05
4.730	2.1660E-06	1.757	2.7436E-05
4.775	2.1660E-06	1.773	2.5270E-05
4.820	1.4440E-06	1.790	2.4548E-05
4.864	1.4440E-06	1.806	2.3104E-05
4.909	1.4440E-06	1.823	2.2382E-05
4.954	1.4440E-06	1.840	2.2382E-05
4.998	1.4440E-06	1.856	2.0938E-05
5.043	1.4440E-06	1.873	1.5884E-05
5.087	1.4440E-06	1.889	1.5162E-05
5.132	1.4440E-06	1.906	1.2996E-05
5.177	1.4440E-06	1.922	1.2996E-05
5.221	1.4440E-06	1.939	1.2996E-05
5.266	1.4440E-06	1.956	1.2274E-05
5.311	1.4440E-06	1.972	1.2274E-05

5.355	1.4440E-06	1.989	1.1552E-05
5.400	1.4440E-06	2.005	1.1552E-05
5.444	1.4440E-06	2.022	1.0830E-05
5.489	1.4440E-06	2.038	1.0830E-05
5.534	1.4440E-06	2.055	1.0830E-05
5.578	1.4440E-06	2.072	1.0108E-05
5.623	1.4440E-06	2.088	1.0108E-05
5.668	1.4440E-06	2.105	1.0108E-05
5.712	1.4440E-06	2.121	1.0108E-05
5.757	1.4440E-06	2.138	1.0108E-05
5.802	1.4440E-06	2.154	9.3860E-06
5.846	1.4440E-06	2.171	9.3860E-06
5.891	1.4440E-06	2.188	9.3860E-06
5.935	1.4440E-06	2.204	8.6640E-06
5.980	1.4440E-06	2.221	8.6640E-06
6.025	1.4440E-06	2.237	8.6640E-06
6.069	1.4440E-06	2.254	7.2200E-06
6.114	1.4440E-06	2.270	7.2200E-06
6.159	1.4440E-06	2.285	6.6410E-06
6.203	1.4440E-06	2.304	5.7760E-06
6.248	1.4440E-06	2.320	5.7760E-06
6.292	1.4440E-06	2.337	5.7760E-06
6.337	1.4440E-06	2.353	5.0540E-06
6.382	1.4440E-06	2.370	5.0540E-06
6.426	1.4440E-06	2.386	5.0540E-06
6.471	1.4440E-06	2.403	5.0540E-06
6.516	1.4440E-06	2.420	4.3320E-06
6.560	1.4440E-06	2.436	4.3320E-06
6.605	1.4440E-06	2.453	4.3320E-06
6.649	1.4440E-06	2.469	2.8880E-06
6.694	1.4440E-06	2.486	2.8880E-06
6.739	1.4440E-06	2.502	2.8880E-06
6.783	7.2200E-07	2.519	2.8880E-06
6.828	7.2200E-07	2.536	2.1660E-06
6.873	7.2200E-07	2.552	2.1660E-06
6.917	7.2200E-07	2.569	2.1660E-06
6.962	7.2200E-07	2.585	2.1660E-06
7.006	7.2200E-07	2.602	2.1660E-06
7.051	7.2200E-07	2.618	2.1660E-06
7.096	7.2200E-07	2.635	2.1660E-06
7.140	7.2200E-07	2.652	2.1660E-06
7.185	7.2200E-07	2.668	2.1660E-06
7.230	7.2200E-07	2.685	2.1660E-06
7.274	7.2200E-07	2.701	2.1660E-06
7.319	7.2200E-07	2.718	1.4440E-06
7.363	7.2200E-07	2.735	1.4440E-06
7.408	7.2200E-07	2.751	1.4440E-06
7.453	7.2200E-07	2.768	1.4440E-06
7.497	7.2200E-07	2.784	1.4440E-06
7.542	7.2200E-07	2.801	1.4440E-06
7.587	7.2200E-07	2.817	1.4440E-06
7.631	7.2200E-07	2.834	7.2200E-07
7.676	7.2200E-07	2.851	7.2200E-07
7.720	7.2200E-07	2.867	7.2200E-07
7.765	7.2200E-07	2.884	7.2200E-07
7.810	7.2200E-07	2.900	7.2200E-07
7.854	7.2200E-07	2.917	7.2200E-07
7.899	7.2200E-07	2.933	7.2200E-07
7.944	7.2200E-07	2.950	7.2200E-07
7.988	7.2200E-07	2.967	7.2200E-07
8.033	7.2200E-07	2.983	7.2200E-07
8.077	7.2200E-07	3.000	7.2200E-07
8.122	7.2200E-07	3.016	7.2200E-07

8.167	7.2200E-07	3.033	7.2200E-07
8.211	7.2200E-07	3.049	7.2200E-07
8.256	7.2200E-07	3.066	7.2200E-07
8.301	7.2200E-07	3.083	7.2200E-07
8.345	7.2200E-07	3.099	7.2200E-07
8.390	7.2200E-07	3.116	7.2200E-07
8.435	7.2200E-07	3.132	7.2200E-07
8.479	7.2200E-07	3.149	7.2200E-07
8.524	7.2200E-07	3.165	7.2200E-07
8.568	7.2200E-07	3.182	7.2200E-07
8.613	7.2200E-07	3.199	7.2200E-07
8.658	7.2200E-07	3.215	7.2200E-07
8.702	7.2200E-07	3.232	7.2200E-07
8.747	7.2200E-07	3.248	7.2200E-07
8.792	7.2200E-07	3.265	7.2200E-07
8.836	7.2200E-07	3.281	7.2200E-07
8.881	7.2200E-07	3.298	7.2200E-07
8.925	7.2200E-07	3.315	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-70.9%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-70.9%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-81.7%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

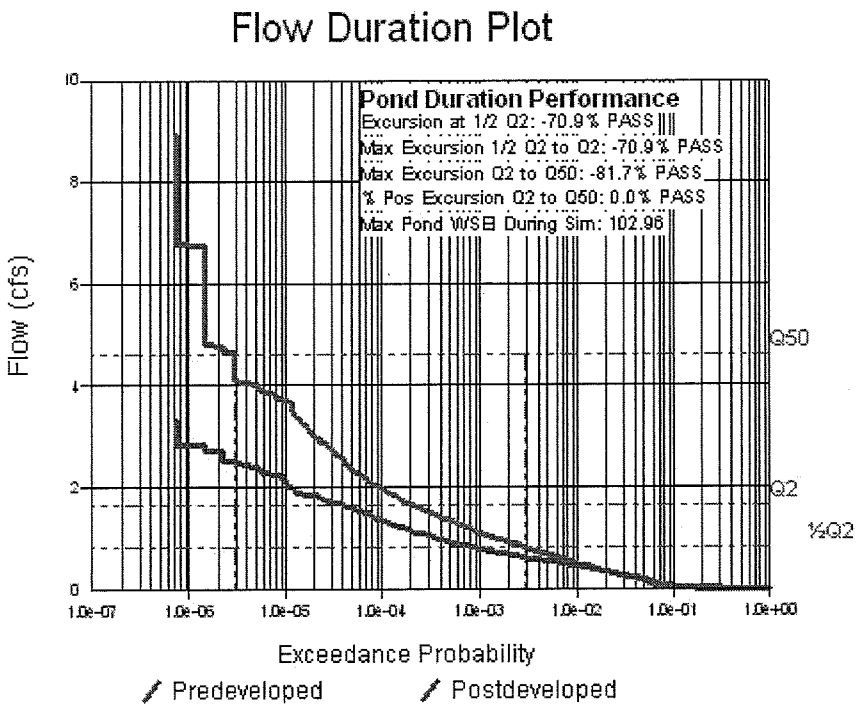
****

********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 31379. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 47069. cu-ft
2-Year Stormwater Pond Discharge Rate: 0.891 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -70.9% PASS
Max Excursion 1/2 Q2 to Q2: -70.9% PASS
Max Excursion Q2 to Q50: -81.7% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEl During Sim: 102.96
Flow (cfs)
10
8
6
4
2
0
Q50
Q2
½Q2
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:47 AM
****

Input File Name: Basin 6.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Rock Creek 1
Comments : Basin Tributary to Rock Creek flowing to Lake Sawyer Inlet at South End of

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* Default HSPF Parameters Used (Not Modified by User) **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)			
		Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	453.430	453.430	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	212.930	212.930	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	0.000	0.000	0.000	No
Impervious	18.800	18.800	0.000	
SUBBASIN TOTAL	685.160	685.160	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 ----------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	397.7	ft
Pond Bottom Width	:	198.9	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	79084.	sq-ft
Area at Riser Crest El	:	90146.	sq-ft
	:	2.069	acres
Volume at Riser Crest	:	253663.	cu-ft
	:	5.823	ac-ft
Area at Max Elevation	:	95920.	sq-ft
	:	2.202	acres
Volume at Max Elevation	:	393148.	cu-ft
	:	9.025	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 60.00	in
Common Length	: 3.991	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 19.03	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 47.9	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	1.816	0.000	0.000	0.000
100.04	1.818	0.064	1.807	0.000
100.07	1.821	0.127	2.556	0.000
100.14	1.827	0.255	3.614	0.000
100.21	1.833	0.383	4.426	0.000
100.28	1.839	0.512	5.111	0.000
100.35	1.844	0.640	5.714	0.000
100.42	1.850	0.770	6.259	0.000
100.49	1.856	0.900	6.761	0.000
100.56	1.862	1.030	7.228	0.000
100.63	1.868	1.160	7.666	0.000
100.70	1.873	1.291	8.081	0.000
100.77	1.879	1.422	8.475	0.000
100.84	1.885	1.554	8.852	0.000
100.91	1.891	1.686	9.214	0.000
100.93	1.893	1.724	9.314	0.000
100.95	1.894	1.762	9.414	0.000
100.97	1.896	1.800	9.513	0.000
100.99	1.898	1.838	9.610	0.000
101.01	1.899	1.871	9.725	0.000
101.03	1.901	1.904	9.865	0.000
101.04	1.902	1.938	10.021	0.000
101.06	1.904	1.971	10.189	0.000
101.13	1.909	2.104	10.959	0.000
101.20	1.915	2.238	11.846	0.000
101.27	1.921	2.373	12.826	0.000
101.34	1.927	2.507	13.884	0.000
101.41	1.933	2.642	15.010	0.000
101.48	1.939	2.778	16.197	0.000
101.55	1.945	2.914	17.438	0.000
101.62	1.951	3.050	18.729	0.000
101.69	1.957	3.187	20.067	0.000
101.76	1.963	3.324	21.447	0.000
101.83	1.969	3.462	22.867	0.000
101.90	1.975	3.600	24.325	0.000
101.97	1.981	3.738	25.817	0.000
102.04	1.987	3.877	27.342	0.000
102.11	1.993	4.016	28.899	0.000
102.18	1.999	4.156	30.485	0.000
102.25	2.005	4.296	32.098	0.000
102.32	2.011	4.437	33.738	0.000
102.39	2.017	4.578	35.403	0.000
102.46	2.023	4.719	37.091	0.000
102.53	2.029	4.861	38.802	0.000
102.60	2.035	5.003	40.534	0.000
102.67	2.041	5.146	42.286	0.000
102.74	2.047	5.289	44.058	0.000
102.81	2.053	5.432	45.847	0.000
102.88	2.059	5.576	47.654	0.000
102.91	2.062	5.638	48.433	0.000
102.94	2.064	5.700	49.215	0.000
102.97	2.067	5.762	50.000	0.000
103.00	2.069	5.824	50.788	0.000
103.02	2.071	5.860	51.341	0.000
103.04	2.073	5.896	51.970	0.000
103.05	2.074	5.933	52.650	0.000
103.07	2.076	5.969	53.370	0.000
103.09	2.077	6.005	54.126	0.000

103.11	2.079	6.042	54.913	0.000
103.12	2.080	6.078	55.730	0.000
103.14	2.082	6.114	56.573	0.000
103.21	2.088	6.260	60.181	0.000
103.28	2.094	6.407	64.119	0.000
103.35	2.100	6.553	68.339	0.000
103.42	2.106	6.701	72.807	0.000
103.49	2.112	6.848	77.495	0.000
103.56	2.119	6.996	82.378	0.000
103.63	2.125	7.145	85.642	0.000
103.70	2.131	7.294	90.085	0.000
103.77	2.137	7.443	94.624	0.000
103.84	2.143	7.593	99.240	0.000
103.91	2.149	7.743	103.911	0.000
103.98	2.156	7.894	108.615	0.000
104.05	2.162	8.045	113.332	0.000
104.12	2.168	8.197	118.038	0.000
104.19	2.174	8.349	122.711	0.000
104.26	2.181	8.501	127.329	0.000
104.33	2.187	8.654	131.871	0.000
104.40	2.193	8.807	136.314	0.000
104.47	2.199	8.961	140.640	0.000
104.54	2.206	9.115	144.829	0.000
104.61	2.212	9.269	148.865	0.000
104.68	2.218	9.424	152.731	0.000
104.75	2.224	9.579	156.414	0.000
104.82	2.231	9.735	159.906	0.000
104.89	2.237	9.891	163.198	0.000
104.96	2.243	10.048	166.288	0.000
105.03	2.250	10.205	169.176	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	22.164	1940 04 30	19.526
1940 12 20	12.668	1940 12 20	10.544
1941 12 15	30.934	1941 12 15	16.403
1942 11 23	13.060	1943 03 28	9.621
1944 01 22	11.361	1944 01 22	7.997
1945 02 07	29.479	1945 02 07	26.769
1946 01 23	17.815	1946 02 05	15.773
1947 02 01	19.105	1947 02 02	15.293
1948 03 21	30.468	1948 03 21	25.656
1949 03 19	16.501	1949 02 22	15.525
1950 03 03	71.900	1950 03 03	49.959
1951 02 09	24.114	1951 02 09	23.174
1952 06 29	16.638	1952 06 29	7.144
1953 01 11	13.871	1953 01 11	12.035
1954 01 22	16.037	1954 01 22	15.577
1955 04 12	9.653	1955 04 12	7.148
1955 12 21	17.589	1955 12 21	15.814
1957 02 25	15.966	1957 02 25	14.356
1958 01 16	16.906	1958 01 16	15.478
1959 01 12	20.378	1959 01 13	18.094
1959 12 15	22.879	1959 12 15	18.478
1961 02 14	18.954	1960 11 20	16.249
1962 03 04	10.460	1962 03 04	9.492
1963 02 03	12.580	1963 02 03	10.700
1964 01 01	18.492	1964 01 01	14.258
1965 02 26	18.515	1965 02 27	16.073
1966 04 11	18.481	1966 04 11	14.984
1967 01 19	29.440	1967 01 19	24.665
1968 02 03	16.581	1968 02 04	13.599
1968 12 03	17.988	1968 12 03	15.289
1970 01 13	17.831	1970 01 14	11.696
1970 12 06	19.096	1970 12 06	15.109
1972 02 27	40.962	1972 02 28	33.806
1973 01 13	15.434	1972 12 23	14.153
1974 02 18	19.346	1974 02 19	17.777
1974 12 26	30.824	1974 12 27	23.740
1975 12 02	17.557	1976 01 27	14.844
1977 05 31	9.615	1977 05 31	8.175
1978 09 22	19.754	1977 12 15	15.186
1979 03 04	18.060	1979 03 04	12.653
1979 12 14	25.422	1979 12 15	22.878
1980 11 21	17.692	1980 12 26	10.662
1981 10 06	42.772	1981 10 06	33.456
1983 01 05	19.599	1983 01 05	17.791
1984 03 14	19.672	1984 03 20	11.450
1985 02 11	13.505	1985 02 11	10.492
1986 01 18	34.045	1986 01 18	31.647
1986 11 24	33.283	1986 11 24	31.459
1988 04 06	16.978	1988 04 06	15.081
1989 04 05	17.911	1989 04 05	15.317
1990 01 09	55.232	1990 01 09	51.408
1990 11 24	49.663	1990 11 24	41.785
1992 01 27	18.383	1992 01 27	14.419
1993 06 09	13.769	1993 03 23	12.476
1994 03 03	11.323	1994 03 03	9.793
1995 02 19	20.536	1995 02 19	19.633
1996 02 08	47.021	1996 02 08	40.262

1997	01	02	30.887	1997	01	02	24.728
1998	02	28	13.929	1998	03	23	8.680
1998	11	04	34.739	1998	11	25	25.550
2000	02	05	19.125	2000	02	06	16.828
2001	05	05	14.843	2001	05	05	10.861
2002	05	03	44.846	2002	05	03	19.975
2003	03	31	30.957	2003	03	31	30.248
2004	01	23	11.343	2004	01	23	9.408
2005	02	05	20.898	2005	02	07	12.674
2005	11	27	19.768	2005	11	27	18.737
2006	12	14	17.478	2006	12	14	14.031
2008	03	21	25.995	2008	01	06	21.309
2009	02	17	32.753	2009	02	17	30.758
2010	06	10	36.944	2010	01	10	20.464
2010	11	17	31.727	2010	11	17	28.401
2012	01	31	22.342	2012	01	31	12.003
2013	01	20	44.510	2013	01	20	39.645
2013	12	06	26.057	2014	04	05	17.419
2015	02	28	14.997	2015	03	30	11.290
2016	01	04	32.227	2016	01	04	29.311
2017	06	14	15.275	2017	03	07	9.185
2018	04	17	21.635	2018	01	31	16.533
2019	03	29	17.564	2019	02	14	15.812
2020	03	30	16.015	2020	04	14	12.488
2021	02	10	25.938	2021	02	10	24.543
2021	12	20	20.635	2021	12	20	15.510
2023	02	02	23.420	2023	03	30	19.655
2024	01	19	18.467	2024	01	19	16.799
2024	12	22	34.867	2024	12	22	31.600
2026	03	09	20.233	2026	03	09	18.583
2027	01	27	17.778	2027	01	27	17.079
2028	02	19	20.135	2028	02	19	19.982
2028	12	04	18.010	2028	12	04	17.178
2029	11	04	23.650	2030	02	16	19.216
2030	12	30	21.039	2030	12	30	20.522
2032	01	20	33.700	2032	01	20	32.178
2033	03	01	12.688	2033	03	01	9.415
2034	01	15	35.662	2034	01	16	31.892
2035	02	19	22.091	2035	02	19	19.332
2035	12	04	23.684	2035	12	04	18.483
2037	03	08	10.402	2037	03	08	6.841
2037	11	24	20.917	2037	12	15	14.020
2039	02	07	12.843	2038	12	11	9.518
2040	01	14	40.377	2040	01	14	22.722
2040	12	25	21.537	2040	12	25	20.215
2042	02	20	21.553	2042	02	20	15.520
2043	03	31	36.291	2043	03	31	18.843
2044	05	01	18.578	2044	05	01	14.297
2045	02	07	19.143	2045	03	23	15.418
2046	02	16	18.271	2046	02	16	17.100
2047	01	31	14.259	2047	02	01	12.004
2048	04	20	13.034	2048	04	21	10.960
2049	03	16	14.684	2049	03	16	10.747
2049	12	04	25.564	2049	12	04	23.239
2051	04	06	15.915	2051	04	06	12.638
2052	04	16	12.715	2052	04	17	8.618
2053	06	04	48.838	2053	06	04	19.712
2054	04	08	8.851	2054	02	24	7.319
2055	02	17	28.351	2055	02	17	24.890
2056	02	07	50.464	2056	02	07	44.301
2056	11	19	58.925	2056	11	19	47.531
2058	01	24	25.711	2058	05	21	21.489
2058	11	25	26.121	2058	12	28	20.937

2060	01	19	13.248	2060	01 19 8.935
2061	01	10	17.795	2061	01 10 17.014
2062	02	03	68.858	2062	02 03 43.741
2062	12	29	17.546	2062	12 29 16.042
2063	12	23	27.909	2063	12 23 25.957
2064	11	29	16.577	2064	11 30 13.219
2066	01	13	9.911	2066	01 13 8.682
2067	01	19	17.793	2067	01 19 15.410
2068	01	18	35.558	2068	01 18 31.875
2069	01	04	11.823	2069	01 04 9.491
2070	04	09	14.532	2070	04 09 9.745
2071	03	23	10.795	2071	02 14 9.267
2071	11	03	12.787	2071	11 03 11.371
2072	12	25	38.914	2072	12 25 37.802
2074	03	16	23.748	2074	03 16 19.342
2075	02	12	10.700	2075	01 17 7.205
2076	03	24	27.509	2076	03 24 20.308
2077	08	24	9.300	2077	02 12 6.257
2077	11	25	15.130	2077	11 25 10.559
2078	11	03	14.751	2079	02 25 12.590
2079	12	17	47.972	2079	12 17 41.943
2080	11	21	23.085	2080	11 21 21.141
2082	02	13	22.510	2082	02 14 22.140
2083	03	29	17.496	2083	02 11 13.561
2083	11	26	21.265	2083	11 26 18.585
2084	12	14	14.731	2084	12 14 13.000
2086	01	18	18.830	2086	01 18 17.942
2086	12	21	21.538	2086	12 21 16.319
2088	01	14	15.231	2088	01 14 12.376
2088	11	05	34.577	2088	11 05 28.878
2089	12	03	12.679	2089	12 05 9.507
2090	12	04	19.633	2090	12 04 17.460
2092	04	28	40.519	2092	01 31 20.014
2093	06	15	12.564	2093	03 22 10.018
2094	03	01	9.190	2094	03 01 8.309
2094	11	29	14.160	2094	11 29 13.000
2096	01	14	15.334	2096	01 14 14.190
2097	01	29	33.374	2097	01 29 26.468

********** **Ranked Annual Maxima Data** **********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	8.851	1.00	6.257
1.01	9.190	1.01	6.841
1.02	9.300	1.02	7.144
1.02	9.615	1.02	7.148
1.03	9.653	1.03	7.205
1.04	9.911	1.04	7.319
1.04	10.402	1.04	7.997
1.05	10.460	1.05	8.175
1.06	10.700	1.06	8.309
1.06	10.795	1.06	8.618
1.07	11.323	1.07	8.680
1.08	11.343	1.08	8.682
1.09	11.361	1.09	8.935
1.09	11.823	1.09	9.185
1.10	12.564	1.10	9.267
1.11	12.580	1.11	9.408
1.12	12.668	1.12	9.415
1.12	12.679	1.12	9.491
1.13	12.688	1.13	9.492
1.14	12.715	1.14	9.507
1.15	12.787	1.15	9.518
1.16	12.843	1.16	9.621
1.17	13.034	1.17	9.745
1.18	13.060	1.18	9.793
1.18	13.248	1.18	10.018
1.19	13.505	1.19	10.492
1.20	13.769	1.20	10.544
1.21	13.871	1.21	10.559
1.22	13.929	1.22	10.662
1.23	14.160	1.23	10.700
1.24	14.259	1.24	10.747
1.25	14.532	1.25	10.861
1.26	14.684	1.26	10.960
1.27	14.731	1.27	11.290
1.28	14.751	1.28	11.371
1.29	14.843	1.29	11.450
1.30	14.997	1.30	11.696
1.31	15.130	1.31	12.003
1.32	15.231	1.32	12.004
1.33	15.275	1.33	12.035
1.35	15.334	1.35	12.376
1.36	15.434	1.36	12.476
1.37	15.915	1.37	12.488
1.38	15.966	1.38	12.590
1.39	16.015	1.39	12.638
1.40	16.037	1.40	12.653
1.42	16.501	1.42	12.674
1.43	16.577	1.43	13.000
1.44	16.581	1.44	13.000
1.46	16.638	1.46	13.219
1.47	16.906	1.47	13.561
1.48	16.978	1.48	13.599
1.50	17.478	1.50	14.020
1.51	17.496	1.51	14.031
1.53	17.546	1.53	14.153
1.54	17.557	1.54	14.190

1.56	17.564		1.56	14.258
1.57	17.589		1.57	14.297
1.59	17.692		1.59	14.356
1.60	17.778		1.60	14.419
1.62	17.793		1.62	14.844
1.64	17.795		1.64	14.984
1.65	17.815		1.65	15.081
1.67	17.831		1.67	15.109
1.69	17.911		1.69	15.186
1.71	17.988		1.71	15.289
1.73	18.010		1.73	15.293
1.75	18.060		1.75	15.317
1.77	18.271		1.77	15.410
1.79	18.383		1.79	15.418
1.81	18.467		1.81	15.478
1.83	18.481		1.83	15.510
1.85	18.492		1.85	15.520
1.87	18.515		1.87	15.525
1.89	18.578		1.89	15.577
1.92	18.830		1.92	15.773
1.94	18.954		1.94	15.812
1.96	19.096		1.96	15.814
1.99	19.105		1.99	16.042
2.01	19.125		2.01	16.073
2.04	19.143		2.04	16.249
2.07	19.346		2.07	16.319
2.09	19.599		2.09	16.403
2.12	19.633		2.12	16.533
2.15	19.672		2.15	16.799
2.18	19.754		2.18	16.828
2.21	19.768		2.21	17.014
2.24	20.135		2.24	17.079
2.27	20.233		2.27	17.100
2.31	20.378		2.31	17.178
2.34	20.536		2.34	17.419
2.38	20.635		2.38	17.460
2.41	20.898		2.41	17.777
2.45	20.917		2.45	17.791
2.49	21.039		2.49	17.942
2.53	21.265		2.53	18.094
2.57	21.537		2.57	18.478
2.61	21.538		2.61	18.483
2.65	21.553		2.65	18.583
2.70	21.635		2.70	18.585
2.75	22.091		2.75	18.737
2.80	22.164		2.80	18.843
2.85	22.342		2.85	19.216
2.90	22.510		2.90	19.332
2.95	22.879		2.95	19.342
3.01	23.085		3.01	19.526
3.07	23.420		3.07	19.633
3.13	23.650		3.13	19.655
3.19	23.684		3.19	19.712
3.26	23.748		3.26	19.975
3.32	24.114		3.32	19.982
3.40	25.422		3.40	20.014
3.47	25.564		3.47	20.215
3.55	25.711		3.55	20.308
3.63	25.938		3.63	20.464
3.72	25.995		3.72	20.522
3.80	26.057		3.80	20.937
3.90	26.121		3.90	21.141
4.00	27.509		4.00	21.309

4.10	27.909		4.10	21.489
4.21	28.351		4.21	22.140
4.32	29.440		4.32	22.722
4.45	29.479		4.45	22.878
4.58	30.468		4.58	23.174
4.71	30.824		4.71	23.239
4.86	30.887		4.86	23.740
5.01	30.934		5.01	24.543
5.17	30.957		5.17	24.665
5.35	31.727		5.35	24.728
5.54	32.227		5.54	24.890
5.74	32.753		5.74	25.550
5.95	33.283		5.95	25.656
6.19	33.374		6.19	25.957
6.44	33.700		6.44	26.468
6.71	34.045		6.71	26.769
7.01	34.577		7.01	28.401
7.33	34.739		7.33	28.878
7.69	34.867		7.69	29.311
8.08	35.558		8.08	30.248
8.52	35.662		8.52	30.758
9.00	36.291		9.00	31.459
9.55	36.944		9.55	31.600
10.16	38.914		10.16	31.647
10.86	40.377		10.86	31.875
11.66	40.519		11.66	31.892
12.59	40.962		12.59	32.178
13.68	42.772		13.68	33.456
14.97	44.510		14.97	33.806
16.54	44.846		16.54	37.802
18.47	47.021		18.47	39.645
20.92	47.972		20.92	40.262
24.10	48.838		24.10	41.785
28.44	49.663		28.44	41.943
34.68	50.464		34.68	43.741
44.42	55.232		44.42	44.301
61.77	58.925		61.77	47.531
101.36	68.858		101.36	49.959
282.36	71.900		282.36	51.408

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	13.047	13.047	
2-Year	19.821	19.821	16.057
5-Year	29.069	29.069	24.491
10-Year	36.552	36.552	31.635
25-Year	47.906	47.906	41.820
50-Year	57.954	57.954	45.461
100-Year	69.546	69.546	49.893
200-Year	82.960	82.960	50.920

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.360	3.1605E-01	0.257	3.4713E-01
0.719	2.4817E-01	0.514	2.8276E-01
1.079	2.0494E-01	0.771	2.4152E-01
1.438	1.7268E-01	1.028	2.1070E-01
1.798	1.4707E-01	1.285	1.8592E-01
2.157	1.2605E-01	1.542	1.6535E-01
2.517	1.0847E-01	1.799	1.4958E-01
2.876	9.3900E-02	2.056	1.3296E-01
3.236	8.1356E-02	2.313	1.1908E-01
3.595	7.0758E-02	2.570	1.0796E-01
3.955	6.1803E-02	2.827	9.6655E-02
4.314	5.4112E-02	3.084	8.7037E-02
4.674	4.7589E-02	3.342	7.8748E-02
5.033	4.1883E-02	3.599	7.1966E-02
5.393	3.6881E-02	3.856	6.5054E-02
5.752	3.2631E-02	4.113	5.9151E-02
6.112	2.8830E-02	4.370	5.4082E-02
6.471	2.5504E-02	4.627	4.9292E-02
6.831	2.2617E-02	4.884	4.4947E-02
7.190	2.0048E-02	5.141	4.1164E-02
7.550	1.7793E-02	5.398	3.7547E-02
7.909	1.5828E-02	5.655	3.4325E-02
8.269	1.4070E-02	5.912	3.1349E-02
8.628	1.2515E-02	6.169	2.8666E-02
8.988	1.1185E-02	6.426	2.6204E-02
9.347	1.0026E-02	6.683	2.3973E-02
9.707	8.9730E-03	6.940	2.1889E-02
9.911	8.4539E-03	7.197	2.0004E-02
10.426	7.3110E-03	7.454	1.8187E-02
10.785	6.5709E-03	7.711	1.6559E-02
11.145	5.9146E-03	7.968	1.5069E-02
11.504	5.3587E-03	8.225	1.3698E-02
11.864	4.8504E-03	8.482	1.2512E-02
12.223	4.4056E-03	8.739	1.1411E-02
12.583	3.9992E-03	8.996	1.0354E-02
12.942	3.6490E-03	9.253	9.3882E-03
13.302	3.3335E-03	9.510	8.4301E-03
13.661	3.0519E-03	9.767	7.6258E-03
14.021	2.7876E-03	9.911	7.2928E-03
14.380	2.5559E-03	10.282	6.5529E-03
14.740	2.3458E-03	10.539	6.1103E-03
15.099	2.1552E-03	10.796	5.6742E-03
15.459	1.9826E-03	11.053	5.2865E-03
15.818	1.8093E-03	11.310	4.9342E-03
16.178	1.6606E-03	11.567	4.6237E-03
16.537	1.5386E-03	11.824	4.3039E-03
16.897	1.4281E-03	12.081	4.0555E-03
17.256	1.3119E-03	12.338	3.8042E-03
17.616	1.2158E-03	12.595	3.5472E-03
17.975	1.1263E-03	12.852	3.3097E-03
18.335	1.0455E-03	13.109	3.0988E-03
18.694	9.6171E-04	13.366	2.9017E-03
19.054	8.9745E-04	13.623	2.7205E-03
19.413	8.3896E-04	13.880	2.5674E-03
19.821	7.7355E-04	14.137	2.3985E-03
20.132	7.3716E-04	14.394	2.2736E-03

20.492	6.8301E-04	14.651	2.1212E-03
20.851	6.4475E-04	14.908	1.9985E-03
21.211	6.0576E-04	15.165	1.8830E-03
21.570	5.6316E-04	15.422	1.7675E-03
21.930	5.3500E-04	15.679	1.6570E-03
22.289	5.0612E-04	15.936	1.5653E-03
22.649	4.8157E-04	16.193	1.4678E-03
23.008	4.5053E-04	16.451	1.3819E-03
23.368	4.2598E-04	16.708	1.3126E-03
23.727	3.9349E-04	16.965	1.2368E-03
24.087	3.6894E-04	17.222	1.1740E-03
24.446	3.4223E-04	17.479	1.1148E-03
24.806	3.1551E-04	17.736	1.0693E-03
25.165	2.9458E-04	17.993	1.0180E-03
25.525	2.7725E-04	18.250	9.6315E-04
25.884	2.5848E-04	18.507	9.1622E-04
26.244	2.4115E-04	18.764	8.6640E-04
26.603	2.2815E-04	19.021	8.2958E-04
26.963	2.1660E-04	19.278	7.8121E-04
27.322	2.0433E-04	19.535	7.5449E-04
27.682	1.8989E-04	19.821	7.0632E-04
28.041	1.7761E-04	20.049	6.7435E-04
28.401	1.6317E-04	20.306	6.4330E-04
28.760	1.5090E-04	20.563	6.1154E-04
29.069	1.4801E-04	20.820	5.9349E-04
29.479	1.3790E-04	21.077	5.6533E-04
29.839	1.3140E-04	21.334	5.4439E-04
30.198	1.2491E-04	21.591	5.2273E-04
30.558	1.1985E-04	21.848	5.0323E-04
30.917	1.0902E-04	22.105	4.8085E-04
31.277	1.0252E-04	22.362	4.6136E-04
31.636	9.7470E-05	22.619	4.4908E-04
31.996	9.0972E-05	22.876	4.3031E-04
32.355	8.0864E-05	23.134	4.1371E-04
32.715	7.5088E-05	23.391	3.9277E-04
33.074	7.1478E-05	23.648	3.7039E-04
33.434	6.7868E-05	23.905	3.4728E-04
33.793	6.4980E-05	24.162	3.2779E-04
34.153	6.0648E-05	24.419	3.0902E-04
34.512	5.7760E-05	24.676	2.9313E-04
34.872	5.0540E-05	24.933	2.7941E-04
35.231	4.8374E-05	25.190	2.6353E-04
35.591	4.2598E-05	25.447	2.5414E-04
35.950	4.0432E-05	25.704	2.4331E-04
36.310	3.6822E-05	25.961	2.3032E-04
36.669	3.4656E-05	26.218	2.2238E-04
37.029	3.1768E-05	26.475	2.1082E-04
37.388	2.9602E-05	26.732	2.0216E-04
37.748	2.6714E-05	26.989	1.8989E-04
38.107	2.6714E-05	27.246	1.8339E-04
38.467	2.6714E-05	27.503	1.7689E-04
38.826	2.5270E-05	27.760	1.6750E-04
39.186	2.3826E-05	28.017	1.5812E-04
39.545	2.2382E-05	28.274	1.5379E-04
39.905	2.2382E-05	28.531	1.4657E-04
40.264	2.1660E-05	28.788	1.4151E-04
40.624	2.0216E-05	29.069	1.3537E-04
40.983	1.7328E-05	29.302	1.3140E-04
41.343	1.5884E-05	29.560	1.2130E-04
41.702	1.5162E-05	29.817	1.1552E-04
42.062	1.4440E-05	30.074	1.1408E-04
42.421	1.4440E-05	30.331	1.0758E-04
42.781	1.2274E-05	30.588	1.0180E-04

43.140	1.2274E-05	30.845	9.3860E-05
43.500	1.2274E-05	31.102	9.0972E-05
43.859	1.2274E-05	31.359	8.7362E-05
44.219	1.2274E-05	31.616	8.3030E-05
44.578	1.1552E-05	31.873	8.0864E-05
44.938	1.0108E-05	32.130	7.8698E-05
45.297	1.0108E-05	32.387	7.1478E-05
45.657	1.0108E-05	32.644	6.7868E-05
46.016	1.0108E-05	32.901	6.4258E-05
46.376	1.0108E-05	33.158	6.0648E-05
46.735	1.0108E-05	33.415	5.7038E-05
47.095	9.3860E-06	33.672	5.3428E-05
47.454	9.3860E-06	33.929	5.1262E-05
47.814	9.3860E-06	34.186	4.7652E-05
48.173	8.6640E-06	34.443	4.4042E-05
48.533	8.6640E-06	34.700	4.3320E-05
48.892	7.9420E-06	34.957	4.2598E-05
49.252	7.9420E-06	35.214	3.9710E-05
49.611	7.2200E-06	35.471	3.6822E-05
49.971	6.4980E-06	35.728	3.3934E-05
50.330	6.4980E-06	35.985	3.1768E-05
50.690	5.7760E-06	36.243	3.1046E-05
51.049	5.0540E-06	36.500	2.9602E-05
51.409	5.0540E-06	36.757	2.6714E-05
51.768	5.0540E-06	37.014	2.5992E-05
52.128	5.0540E-06	37.271	2.3826E-05
52.487	5.0540E-06	37.528	2.1660E-05
52.847	5.0540E-06	37.785	2.0938E-05
53.206	5.0540E-06	38.042	1.8772E-05
53.566	5.0540E-06	38.299	1.8772E-05
53.925	5.0540E-06	38.556	1.7328E-05
54.285	5.0540E-06	38.813	1.6606E-05
54.644	5.0540E-06	39.070	1.5162E-05
55.004	5.0540E-06	39.327	1.3718E-05
55.363	3.6100E-06	39.584	1.3718E-05
55.723	3.6100E-06	39.841	1.2274E-05
56.082	3.6100E-06	40.098	1.2274E-05
56.442	3.6100E-06	40.355	1.1552E-05
56.801	3.6100E-06	40.612	1.1552E-05
57.161	3.6100E-06	40.869	1.1552E-05
57.520	3.6100E-06	41.126	1.1552E-05
57.954	3.6006E-06	41.383	1.0830E-05
58.239	3.6100E-06	41.640	1.0108E-05
58.599	3.6100E-06	41.897	9.3860E-06
58.958	2.8880E-06	42.154	8.6640E-06
59.318	2.8880E-06	42.411	8.6640E-06
59.677	2.8880E-06	42.668	8.6640E-06
60.037	2.8880E-06	42.926	7.9420E-06
60.396	2.8880E-06	43.183	7.9420E-06
60.756	2.1660E-06	43.440	7.2200E-06
61.115	2.1660E-06	43.697	7.2200E-06
61.475	2.1660E-06	43.954	6.4980E-06
61.834	2.1660E-06	44.211	6.4980E-06
62.194	2.1660E-06	44.468	5.0540E-06
62.553	2.1660E-06	44.725	4.3320E-06
62.913	2.1660E-06	44.982	4.3320E-06
63.272	2.1660E-06	45.239	4.3320E-06
63.632	2.1660E-06	45.496	4.3320E-06
63.991	2.1660E-06	45.753	4.3320E-06
64.351	2.1660E-06	46.010	4.3320E-06
64.710	2.1660E-06	46.267	4.3320E-06
65.070	1.4440E-06	46.524	4.3320E-06
65.429	1.4440E-06	46.781	4.3320E-06

65.789	1.4440E-06	47.038	4.3320E-06
66.148	1.4440E-06	47.295	4.3320E-06
66.508	1.4440E-06	47.552	3.6100E-06
66.867	1.4440E-06	47.809	2.8880E-06
67.227	1.4440E-06	48.066	2.1660E-06
67.586	1.4440E-06	48.323	2.1660E-06
67.946	1.4440E-06	48.580	2.1660E-06
68.305	1.4440E-06	48.837	2.1660E-06
68.665	1.4440E-06	49.094	2.1660E-06
69.024	7.2200E-07	49.352	2.1660E-06
69.384	7.2200E-07	49.609	2.1660E-06
69.743	7.2200E-07	49.866	2.1660E-06
70.103	7.2200E-07	50.123	1.4440E-06
70.462	7.2200E-07	50.380	1.4440E-06
70.822	7.2200E-07	50.637	7.2200E-07
71.181	7.2200E-07	50.894	7.2200E-07
71.541	7.2200E-07	51.151	7.2200E-07
71.900	7.2200E-07	51.408	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-13.8%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-7.7%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-6.2%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

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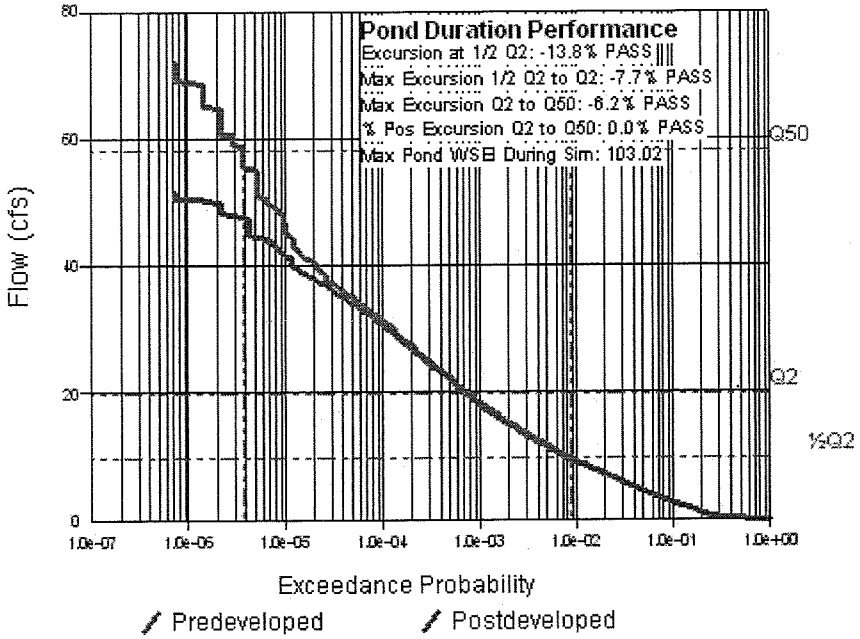
********** **Water Quality Facility Data** **********

Basic Wet Pond Volume (91% Exceedance): 925490. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 1388235. cu-ft
2-Year Stormwater Pond Discharge Rate: 16.057 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****

Flow Duration Plot



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MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:51 AM

****

Input File Name: Basin 10.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Rock Creek 2
Comments : Basin west of downtown tributary to un-named stream crossing Roberts west

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)	Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	103.590	103.590	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	58.780	58.780	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	30.390	30.390	0.000	No
Wetland	6.850	6.850	0.000	No
Impervious	5.360	5.360	0.000	
SUBBASIN TOTAL	204.970	204.970	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 ---------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.00	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	296.4	ft
Pond Bottom Width	:	148.2	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	43922.	sq-ft
Area at Riser Crest El	:	52249.	sq-ft
	:	1.199	acres
Volume at Riser Crest	:	144076.	cu-ft
	:	3.308	ac-ft
Area at Max Elevation	:	55168.	sq-ft
	:	1.266	acres
Volume at Max Elevation	:	197754.	cu-ft
	:	4.540	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 42.00	in
Common Length	: 1.119	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 10.31	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 13.4	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	1.008	0.000	0.000	0.000
100.04	1.010	0.035	0.531	0.000
100.07	1.013	0.071	0.751	0.000
100.14	1.017	0.142	1.062	0.000
100.21	1.021	0.213	1.301	0.000
100.28	1.026	0.285	1.502	0.000
100.35	1.030	0.357	1.679	0.000
100.42	1.034	0.429	1.839	0.000
100.49	1.039	0.501	1.987	0.000
100.56	1.043	0.574	2.124	0.000
100.63	1.047	0.647	2.253	0.000
100.70	1.052	0.721	2.375	0.000
100.77	1.056	0.795	2.491	0.000
100.84	1.060	0.869	2.601	0.000
100.91	1.065	0.943	2.707	0.000
100.93	1.066	0.964	2.737	0.000
100.95	1.067	0.986	2.766	0.000
100.97	1.068	1.007	2.795	0.000
100.99	1.070	1.029	2.824	0.000
101.01	1.071	1.047	2.857	0.000
101.03	1.072	1.066	2.898	0.000
101.04	1.073	1.085	2.942	0.000
101.06	1.074	1.104	2.990	0.000
101.13	1.079	1.179	3.207	0.000
101.20	1.083	1.255	3.454	0.000
101.27	1.087	1.331	3.723	0.000
101.34	1.092	1.407	4.009	0.000
101.41	1.096	1.483	4.308	0.000
101.48	1.101	1.560	4.619	0.000
101.55	1.105	1.637	4.939	0.000
101.62	1.110	1.715	5.266	0.000
101.69	1.114	1.793	5.599	0.000
101.76	1.119	1.871	5.936	0.000
101.83	1.123	1.949	6.277	0.000
101.90	1.128	2.028	6.620	0.000
101.97	1.132	2.107	6.965	0.000
102.04	1.137	2.187	7.310	0.000
102.11	1.141	2.266	7.656	0.000
102.18	1.146	2.346	8.060	0.000
102.25	1.150	2.427	8.473	0.000
102.32	1.155	2.508	8.895	0.000
102.39	1.159	2.589	9.325	0.000
102.46	1.164	2.670	9.764	0.000
102.53	1.169	2.751	10.211	0.000
102.60	1.173	2.833	10.665	0.000
102.67	1.178	2.916	11.128	0.000
102.74	1.182	2.998	11.598	0.000
102.81	1.187	3.081	12.076	0.000
102.88	1.192	3.164	12.561	0.000
102.91	1.194	3.200	12.771	0.000
102.94	1.195	3.236	12.983	0.000
102.97	1.197	3.272	13.196	0.000
103.00	1.199	3.308	13.410	0.000
103.02	1.201	3.329	13.612	0.000
103.04	1.202	3.350	13.880	0.000
103.05	1.203	3.371	14.189	0.000
103.07	1.204	3.392	14.532	0.000
103.09	1.205	3.413	14.905	0.000

103.11	1.206	3.434	15.304	0.000
103.12	1.208	3.455	15.727	0.000
103.14	1.209	3.477	16.172	0.000
103.21	1.213	3.561	18.149	0.000
103.28	1.218	3.646	20.395	0.000
103.35	1.223	3.732	22.867	0.000
103.42	1.227	3.818	25.529	0.000
103.49	1.232	3.904	28.350	0.000
103.56	1.237	3.990	31.297	0.000
103.63	1.241	4.077	34.338	0.000
103.70	1.246	4.164	37.442	0.000
103.77	1.251	4.251	40.575	0.000
103.84	1.256	4.339	43.562	0.000
103.91	1.260	4.427	46.389	0.000
103.98	1.265	4.515	49.136	0.000
104.05	1.270	4.604	51.774	0.000
104.12	1.275	4.693	54.274	0.000
104.19	1.279	4.783	56.613	0.000
104.26	1.284	4.872	58.773	0.000
104.33	1.289	4.962	60.742	0.000
104.40	1.294	5.053	62.512	0.000
104.47	1.299	5.143	64.089	0.000
104.54	1.303	5.235	65.484	0.000
104.61	1.308	27.358	266.984	0.000
104.68	1.313	27.798	274.718	0.000
104.75	1.318	28.238	282.381	0.000
104.82	1.323	28.679	289.957	0.000
104.89	1.328	29.121	297.427	0.000
104.96	1.332	29.563	304.773	0.000
105.03	1.337	30.006	311.977	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	6.915	1940 05 01	4.562
1940 12 19	3.060	1940 12 20	2.284
1941 12 15	9.912	1941 12 15	3.383
1942 11 23	3.233	1943 03 28	2.306
1944 01 22	2.910	1944 01 23	1.815
1945 02 07	7.848	1945 02 07	5.698
1946 02 27	5.822	1946 02 05	3.636
1947 02 01	6.595	1947 02 02	3.544
1948 03 21	10.559	1948 03 21	6.347
1949 02 16	5.993	1949 02 22	3.723
1950 03 03	28.100	1950 03 03	13.177
1951 02 09	6.589	1951 02 09	5.788
1952 06 29	4.675	1952 01 24	1.612
1953 01 11	3.347	1953 01 11	2.492
1953 12 19	4.651	1954 01 22	3.718
1955 04 12	2.765	1955 04 12	1.702
1956 03 04	5.438	1956 01 06	3.637
1957 02 25	4.390	1957 02 25	3.438
1958 02 24	5.366	1958 01 16	3.500
1959 01 12	6.011	1959 01 13	4.122
1959 12 15	6.876	1959 12 15	3.858
1961 02 14	7.194	1960 11 20	3.191
1962 03 24	2.669	1962 03 04	2.248
1963 02 03	3.306	1963 02 03	2.393
1964 01 01	5.590	1964 01 01	2.956
1965 02 26	5.469	1965 02 27	3.510
1966 04 11	5.312	1966 04 11	3.145
1967 01 19	9.824	1967 01 19	6.065
1968 02 03	5.254	1968 02 04	2.957
1968 12 03	5.266	1968 12 03	3.261
1970 01 13	4.777	1970 01 14	2.559
1970 12 06	4.835	1970 12 06	3.048
1972 02 27	15.424	1972 02 27	8.986
1973 01 13	4.944	1973 01 13	2.940
1974 02 18	5.644	1974 02 19	4.176
1974 12 26	8.248	1974 12 27	4.507
1976 01 26	5.563	1976 01 27	3.451
1977 05 31	2.342	1977 05 31	1.876
1977 12 15	5.114	1977 12 15	3.280
1979 03 04	5.798	1979 03 05	2.778
1979 12 14	6.563	1979 12 17	5.292
1980 11 21	4.439	1980 12 26	2.359
1981 10 06	11.677	1981 10 06	6.980
1983 01 05	5.335	1983 01 05	4.079
1984 03 14	6.536	1984 03 21	2.635
1985 02 11	3.619	1985 02 11	2.357
1986 01 18	10.364	1986 01 18	8.062
1986 11 24	8.654	1986 11 24	7.119
1988 04 06	4.283	1988 04 06	3.041
1989 04 05	5.346	1989 04 05	3.582
1990 01 09	20.805	1990 01 09	17.486
1990 11 24	17.615	1990 11 24	11.239
1992 01 27	5.580	1992 01 27	2.935
1993 06 09	4.070	1993 03 23	2.668
1994 03 03	2.809	1994 03 03	2.211
1995 02 19	5.778	1995 02 19	4.878
1996 02 08	15.923	1996 02 08	11.479

1997 01 02	10.698	1997 01 02	6.538
1998 02 28	4.831	1998 03 23	2.088
1998 12 13	9.616	1998 11 25	5.752
2000 02 28	5.879	2000 03 26	3.742
2001 05 05	3.913	2001 05 05	2.457
2002 05 03	11.648	2002 05 03	3.192
2003 02 06	10.363	2003 03 31	7.879
2004 01 01	2.842	2004 01 23	2.150
2005 02 05	5.920	2005 02 07	2.608
2006 02 27	5.617	2006 02 27	4.145
2006 12 14	4.585	2006 12 15	2.821
2008 03 21	9.271	2008 01 07	4.838
2009 02 17	11.219	2009 02 17	8.738
2010 06 10	10.583	2010 01 10	4.665
2011 03 08	11.104	2010 11 17	6.455
2012 01 31	7.734	2012 01 31	2.728
2013 01 20	15.875	2013 01 20	10.734
2013 12 06	8.287	2014 04 05	4.171
2015 02 28	4.104	2015 03 30	2.559
2016 01 04	11.340	2016 01 04	7.991
2017 06 14	4.075	2017 03 07	2.222
2018 04 17	7.231	2018 01 31	3.756
2019 03 29	5.190	2019 02 14	3.763
2020 03 30	4.423	2020 04 15	2.734
2021 02 10	7.632	2021 02 10	6.049
2021 12 20	5.070	2021 12 20	2.903
2023 02 02	6.533	2023 03 30	4.763
2024 03 11	5.701	2024 01 19	3.814
2024 12 22	9.311	2024 12 22	7.286
2026 03 09	6.208	2026 03 09	4.447
2027 03 15	5.336	2027 01 28	3.761
2028 06 01	5.542	2028 02 19	4.896
2028 12 04	4.997	2028 12 04	3.853
2030 02 16	6.559	2030 02 16	4.811
2031 02 26	5.782	2030 12 30	4.726
2032 01 20	10.135	2032 01 20	8.340
2033 03 01	3.453	2033 03 01	2.177
2034 02 18	12.101	2034 01 16	7.835
2035 02 19	6.900	2035 02 19	4.575
2036 02 27	6.154	2036 03 24	4.015
2037 03 08	2.613	2037 03 08	1.517
2037 11 24	5.191	2037 12 15	3.086
2039 02 07	3.440	2038 12 11	2.136
2040 01 14	14.353	2040 01 14	4.877
2040 12 25	5.599	2040 12 25	4.488
2042 02 20	7.131	2042 02 20	3.368
2043 03 31	13.515	2043 03 31	4.131
2044 05 01	5.413	2044 05 01	3.115
2045 02 07	5.616	2045 03 23	3.284
2046 02 16	5.551	2046 02 16	4.137
2047 01 31	4.242	2047 02 01	2.687
2048 04 20	3.746	2048 04 21	2.530
2049 03 16	4.650	2049 03 16	2.488
2049 12 04	6.206	2049 12 04	4.282
2051 04 06	4.585	2051 04 06	2.744
2052 04 16	3.290	2052 04 17	2.007
2053 06 04	14.250	2053 06 05	3.580
2054 04 08	2.321	2054 02 24	1.667
2055 02 17	8.981	2055 02 17	6.004
2056 02 07	16.601	2056 02 07	12.077
2056 11 19	17.482	2056 11 19	11.545
2058 01 24	9.849	2058 05 21	4.678
2059 01 17	8.642	2058 12 28	5.029

2060	01 19	3.698	2060	01 19	2.060
2061	02 28	4.792	2061	01 10	3.960
2062	02 03	26.619	2062	02 03	10.929
2062	12 29	4.803	2062	12 30	3.586
2063	12 23	8.426	2063	12 23	6.466
2064	11 29	4.250	2064	11 30	2.739
2066	01 12	2.460	2066	01 13	1.982
2067	01 19	6.359	2067	01 19	3.722
2068	01 18	11.898	2068	01 18	8.456
2069	01 04	3.271	2069	01 04	2.277
2070	04 09	4.197	2070	04 09	2.314
2071	03 23	3.002	2071	02 14	2.122
2072	02 27	3.572	2071	11 03	2.412
2072	12 25	11.356	2072	12 25	9.789
2074	03 16	7.614	2074	03 16	4.638
2075	02 12	3.054	2075	01 17	1.676
2076	03 24	8.506	2076	03 24	4.438
2077	08 24	2.658	2077	02 12	1.437
2077	11 25	3.726	2077	12 02	2.292
2078	11 03	3.689	2079	02 25	2.840
2079	12 17	13.722	2079	12 17	10.358
2081	02 17	7.528	2080	11 21	4.635
2082	02 18	8.281	2082	02 13	5.679
2083	03 29	5.591	2083	02 12	3.168
2083	11 26	6.506	2083	11 26	4.062
2084	12 14	4.101	2084	12 14	2.767
2086	01 18	4.553	2086	01 18	3.839
2086	12 21	6.100	2086	12 21	3.400
2088	03 25	3.946	2088	01 14	2.494
2088	11 05	8.592	2088	11 05	5.035
2090	01 06	3.479	2090	06 10	2.287
2090	12 04	5.539	2090	12 04	3.657
2092	04 28	11.056	2092	01 31	4.946
2093	06 15	3.397	2093	03 22	2.289
2094	03 01	2.316	2094	03 02	1.977
2095	02 18	3.680	2094	11 30	2.737
2096	01 14	4.411	2096	01 14	3.279
2097	01 29	12.802	2097	01 30	7.112

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	2.316	1.00	1.437
1.01	2.321	1.01	1.517
1.02	2.342	1.02	1.612
1.02	2.460	1.02	1.667
1.03	2.613	1.03	1.676
1.04	2.658	1.04	1.702
1.04	2.669	1.04	1.815
1.05	2.765	1.05	1.876
1.06	2.809	1.06	1.977
1.06	2.842	1.06	1.982
1.07	2.910	1.07	2.007
1.08	3.002	1.08	2.060
1.09	3.054	1.09	2.088
1.09	3.060	1.09	2.122
1.10	3.233	1.10	2.136
1.11	3.271	1.11	2.150
1.12	3.290	1.12	2.177
1.12	3.306	1.12	2.211
1.13	3.347	1.13	2.222
1.14	3.397	1.14	2.248
1.15	3.440	1.15	2.277
1.16	3.453	1.16	2.284
1.17	3.479	1.17	2.287
1.18	3.572	1.18	2.289
1.18	3.619	1.18	2.292
1.19	3.680	1.19	2.306
1.20	3.689	1.20	2.314
1.21	3.698	1.21	2.357
1.22	3.726	1.22	2.359
1.23	3.746	1.23	2.393
1.24	3.913	1.24	2.412
1.25	3.946	1.25	2.457
1.26	4.070	1.26	2.488
1.27	4.075	1.27	2.492
1.28	4.101	1.28	2.494
1.29	4.104	1.29	2.530
1.30	4.197	1.30	2.559
1.31	4.242	1.31	2.559
1.32	4.250	1.32	2.608
1.33	4.283	1.33	2.635
1.35	4.390	1.35	2.668
1.36	4.411	1.36	2.687
1.37	4.423	1.37	2.728
1.38	4.439	1.38	2.734
1.39	4.553	1.39	2.737
1.40	4.585	1.40	2.739
1.42	4.585	1.42	2.744
1.43	4.650	1.43	2.767
1.44	4.651	1.44	2.778
1.46	4.675	1.46	2.821
1.47	4.777	1.47	2.840
1.48	4.792	1.48	2.903
1.50	4.803	1.50	2.935
1.51	4.831	1.51	2.940
1.53	4.835	1.53	2.956
1.54	4.944	1.54	2.957

1.56	4.997	1.56	3.041
1.57	5.070	1.57	3.048
1.59	5.114	1.59	3.086
1.60	5.190	1.60	3.115
1.62	5.191	1.62	3.145
1.64	5.254	1.64	3.168
1.65	5.266	1.65	3.191
1.67	5.312	1.67	3.192
1.69	5.335	1.69	3.261
1.71	5.336	1.71	3.279
1.73	5.346	1.73	3.280
1.75	5.366	1.75	3.284
1.77	5.413	1.77	3.368
1.79	5.438	1.79	3.383
1.81	5.469	1.81	3.400
1.83	5.539	1.83	3.438
1.85	5.542	1.85	3.451
1.87	5.551	1.87	3.500
1.89	5.563	1.89	3.510
1.92	5.580	1.92	3.544
1.94	5.590	1.94	3.580
1.96	5.591	1.96	3.582
1.99	5.599	1.99	3.586
2.01	5.616	2.01	3.636
2.04	5.617	2.04	3.637
2.07	5.644	2.07	3.657
2.09	5.701	2.09	3.718
2.12	5.778	2.12	3.722
2.15	5.782	2.15	3.723
2.18	5.798	2.18	3.742
2.21	5.822	2.21	3.756
2.24	5.879	2.24	3.761
2.27	5.920	2.27	3.763
2.31	5.993	2.31	3.814
2.34	6.011	2.34	3.839
2.38	6.100	2.38	3.853
2.41	6.154	2.41	3.858
2.45	6.206	2.45	3.960
2.49	6.208	2.49	4.015
2.53	6.359	2.53	4.062
2.57	6.506	2.57	4.079
2.61	6.533	2.61	4.122
2.65	6.536	2.65	4.131
2.70	6.559	2.70	4.137
2.75	6.563	2.75	4.145
2.80	6.589	2.80	4.171
2.85	6.595	2.85	4.176
2.90	6.876	2.90	4.282
2.95	6.900	2.95	4.438
3.01	6.915	3.01	4.447
3.07	7.131	3.07	4.488
3.13	7.194	3.13	4.507
3.19	7.231	3.19	4.562
3.26	7.528	3.26	4.575
3.32	7.614	3.32	4.635
3.40	7.632	3.40	4.638
3.47	7.734	3.47	4.665
3.55	7.848	3.55	4.678
3.63	8.248	3.63	4.726
3.72	8.281	3.72	4.763
3.80	8.287	3.80	4.811
3.90	8.426	3.90	4.838
4.00	8.506	4.00	4.877

4.10	8.592	4.10	4.878
4.21	8.642	4.21	4.896
4.32	8.654	4.32	4.946
4.45	8.981	4.45	5.029
4.58	9.271	4.58	5.035
4.71	9.311	4.71	5.292
4.86	9.616	4.86	5.679
5.01	9.824	5.01	5.698
5.17	9.849	5.17	5.752
5.35	9.912	5.35	5.788
5.54	10.135	5.54	6.004
5.74	10.363	5.74	6.049
5.95	10.364	5.95	6.065
6.19	10.559	6.19	6.347
6.44	10.583	6.44	6.455
6.71	10.698	6.71	6.466
7.01	11.056	7.01	6.538
7.33	11.104	7.33	6.980
7.69	11.219	7.69	7.112
8.08	11.340	8.08	7.119
8.52	11.356	8.52	7.286
9.00	11.648	9.00	7.835
9.55	11.677	9.55	7.879
10.16	11.898	10.16	7.991
10.86	12.101	10.86	8.062
11.66	12.802	11.66	8.340
12.59	13.515	12.59	8.456
13.68	13.722	13.68	8.738
14.97	14.250	14.97	8.986
16.54	14.353	16.54	9.789
18.47	15.424	18.47	10.358
20.92	15.875	20.92	10.734
24.10	15.923	24.10	10.929
28.44	16.601	28.44	11.239
34.68	17.482	34.68	11.479
44.42	17.615	44.42	11.545
61.77	20.805	61.77	12.077
101.36	26.619	101.36	13.177
282.36	28.100	282.36	17.486

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	3.538	3.538	
2-Year	5.824	5.824	3.611
5-Year	9.060	9.060	5.697
10-Year	11.760	11.760	7.962
25-Year	15.973	15.973	10.998
50-Year	19.803	19.803	11.736
100-Year	24.324	24.324	13.147
200-Year	29.677	29.677	16.035

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.141	2.7097E-01	0.087	3.1994E-01
0.281	1.9709E-01	0.175	2.5023E-01
0.422	1.5044E-01	0.262	2.0593E-01
0.562	1.1694E-01	0.350	1.7294E-01
0.703	9.2081E-02	0.437	1.4707E-01
0.843	7.3159E-02	0.525	1.2904E-01
0.984	5.8725E-02	0.612	1.0987E-01
1.124	4.7485E-02	0.699	9.4935E-02
1.265	3.8696E-02	0.787	8.2611E-02
1.405	3.1795E-02	0.874	7.1240E-02
1.546	2.6208E-02	0.962	6.2346E-02
1.686	2.1667E-02	1.049	5.5329E-02
1.827	1.8004E-02	1.137	4.8393E-02
1.967	1.5097E-02	1.224	4.2599E-02
2.108	1.2636E-02	1.311	3.7787E-02
2.248	1.0668E-02	1.399	3.3141E-02
2.389	9.0163E-03	1.486	2.9374E-02
2.529	7.6778E-03	1.574	2.5858E-02
2.670	6.5825E-03	1.661	2.2806E-02
2.810	5.6814E-03	1.749	1.9999E-02
2.912	5.0939E-03	1.836	1.7607E-02
3.091	4.2129E-03	1.923	1.5456E-02
3.232	3.6620E-03	2.011	1.3597E-02
3.372	3.1840E-03	2.098	1.2022E-02
3.513	2.8122E-03	2.186	1.0639E-02
3.653	2.5017E-03	2.273	9.4207E-03
3.794	2.2151E-03	2.361	8.3897E-03
3.934	1.9429E-03	2.448	7.3911E-03
4.075	1.7371E-03	2.535	6.5796E-03
4.215	1.5610E-03	2.623	5.8099E-03
4.356	1.3992E-03	2.710	5.0728E-03
4.496	1.2469E-03	2.798	4.3833E-03
4.637	1.1249E-03	2.912	3.7287E-03
4.777	1.0101E-03	2.973	3.4613E-03
4.918	9.1405E-04	3.060	3.1234E-03
5.058	8.2164E-04	3.147	2.8404E-03
5.199	7.3716E-04	3.235	2.5956E-03
5.339	6.6857E-04	3.322	2.3840E-03
5.480	6.0937E-04	3.410	2.1848E-03
5.620	5.4872E-04	3.497	2.0216E-03
5.824	4.6319E-04	3.585	1.8527E-03
5.901	4.3464E-04	3.672	1.7018E-03
6.042	3.9566E-04	3.759	1.5602E-03
6.182	3.6822E-04	3.847	1.4411E-03
6.323	3.4223E-04	3.934	1.3473E-03
6.463	3.1118E-04	4.022	1.2527E-03
6.604	2.8302E-04	4.109	1.1646E-03
6.744	2.6425E-04	4.197	1.0902E-03
6.885	2.4548E-04	4.284	1.0289E-03
7.025	2.2454E-04	4.371	9.7470E-04
7.166	2.1082E-04	4.459	9.1333E-04
7.306	1.9494E-04	4.546	8.5341E-04
7.447	1.7978E-04	4.634	8.0431E-04
7.587	1.6967E-04	4.721	7.4872E-04
7.728	1.5740E-04	4.809	6.9890E-04
7.868	1.4873E-04	4.896	6.4908E-04

8.009	1.3935E-04	4.983	6.1298E-04
8.149	1.2852E-04	5.071	5.8121E-04
8.290	1.1841E-04	5.158	5.4944E-04
8.430	1.1047E-04	5.246	5.2345E-04
8.571	1.0108E-04	5.333	4.9674E-04
8.711	9.1694E-05	5.421	4.7435E-04
8.852	8.5918E-05	5.508	4.4620E-04
9.060	7.8099E-05	5.595	4.2670E-04
9.133	7.5810E-05	5.683	3.9999E-04
9.273	6.9312E-05	5.770	3.7977E-04
9.414	6.4258E-05	5.824	3.6349E-04
9.554	6.2814E-05	5.945	3.3356E-04
9.695	5.7760E-05	6.033	3.0974E-04
9.835	5.5594E-05	6.120	2.9241E-04
9.976	5.1262E-05	6.207	2.7869E-04
10.116	4.8374E-05	6.295	2.6497E-04
10.257	4.6208E-05	6.382	2.5126E-04
10.397	4.4042E-05	6.470	2.3754E-04
10.538	4.1876E-05	6.557	2.2526E-04
10.678	3.8988E-05	6.645	2.1660E-04
10.819	3.4656E-05	6.732	2.0360E-04
10.959	3.4656E-05	6.819	1.9494E-04
11.100	3.2490E-05	6.907	1.7978E-04
11.240	2.8880E-05	6.994	1.6967E-04
11.381	2.7436E-05	7.082	1.6245E-04
11.521	2.5992E-05	7.169	1.5451E-04
11.662	2.5270E-05	7.257	1.4223E-04
11.802	2.4548E-05	7.344	1.3501E-04
11.943	2.2382E-05	7.431	1.2852E-04
12.083	2.1660E-05	7.519	1.2130E-04
12.224	2.0938E-05	7.606	1.1408E-04
12.364	2.0938E-05	7.694	1.0686E-04
12.505	2.0216E-05	7.781	1.0108E-04
12.645	2.0216E-05	7.869	9.4582E-05
12.786	2.0216E-05	7.956	9.0972E-05
12.926	1.8772E-05	8.043	8.3752E-05
13.067	1.8772E-05	8.131	8.0142E-05
13.207	1.7328E-05	8.218	7.2922E-05
13.348	1.7328E-05	8.306	7.2200E-05
13.488	1.7328E-05	8.393	6.5702E-05
13.629	1.6606E-05	8.481	5.9204E-05
13.769	1.5884E-05	8.568	5.6316E-05
13.910	1.4440E-05	8.655	5.3428E-05
14.050	1.3718E-05	8.743	4.9096E-05
14.191	1.2996E-05	8.830	4.5486E-05
14.331	1.2274E-05	8.918	4.3320E-05
14.472	1.1552E-05	9.005	4.1154E-05
14.612	1.1552E-05	9.060	4.0965E-05
14.753	1.0830E-05	9.180	3.6822E-05
14.893	1.0830E-05	9.267	3.6822E-05
15.034	1.0830E-05	9.355	3.5378E-05
15.174	1.0830E-05	9.442	3.3212E-05
15.315	1.0830E-05	9.530	3.0324E-05
15.455	9.3860E-06	9.617	2.8880E-05
15.596	9.3860E-06	9.705	2.8880E-05
15.736	9.3860E-06	9.792	2.5270E-05
15.877	8.6640E-06	9.879	2.2382E-05
16.017	7.9420E-06	9.967	2.0216E-05
16.158	7.9420E-06	10.054	2.0216E-05
16.298	7.9420E-06	10.142	1.9494E-05
16.439	7.9420E-06	10.229	1.8772E-05
16.579	7.9420E-06	10.317	1.6606E-05
16.720	7.2200E-06	10.404	1.3718E-05

16.860	6.4980E-06	10.492	1.3718E-05
17.001	6.4980E-06	10.579	1.1552E-05
17.141	6.4980E-06	10.666	1.0830E-05
17.282	6.4980E-06	10.754	1.0108E-05
17.422	6.4980E-06	10.841	1.0108E-05
17.563	5.7760E-06	10.929	1.0108E-05
17.703	5.0540E-06	11.016	8.6640E-06
17.844	5.0540E-06	11.104	7.9420E-06
17.984	5.0540E-06	11.191	7.9420E-06
18.125	5.0540E-06	11.278	7.2200E-06
18.265	4.3320E-06	11.366	6.4980E-06
18.406	4.3320E-06	11.453	6.4980E-06
18.546	4.3320E-06	11.541	5.7760E-06
18.687	4.3320E-06	11.628	4.3320E-06
18.827	4.3320E-06	11.716	4.3320E-06
18.968	4.3320E-06	11.803	3.6100E-06
19.108	4.3320E-06	11.890	3.6100E-06
19.249	4.3320E-06	11.978	3.6100E-06
19.389	4.3320E-06	12.065	3.6100E-06
19.530	4.3320E-06	12.153	2.8880E-06
19.670	4.3320E-06	12.240	2.8880E-06
19.803	4.3320E-06	12.328	2.8880E-06
19.951	4.3320E-06	12.415	2.8880E-06
20.092	4.3320E-06	12.502	2.8880E-06
20.232	4.3320E-06	12.590	2.8880E-06
20.373	4.3320E-06	12.677	2.8880E-06
20.513	4.3320E-06	12.765	2.8880E-06
20.654	3.6100E-06	12.852	2.8880E-06
20.794	3.6100E-06	12.940	2.8880E-06
20.935	2.8880E-06	13.027	2.8880E-06
21.075	2.8880E-06	13.114	2.8880E-06
21.216	2.8880E-06	13.202	2.1660E-06
21.356	2.1660E-06	13.289	2.1660E-06
21.497	2.1660E-06	13.377	2.1660E-06
21.637	2.1660E-06	13.464	2.1660E-06
21.778	2.1660E-06	13.552	1.4440E-06
21.918	2.1660E-06	13.639	1.4440E-06
22.059	2.1660E-06	13.726	1.4440E-06
22.199	2.1660E-06	13.814	1.4440E-06
22.340	2.1660E-06	13.901	1.4440E-06
22.480	2.1660E-06	13.989	1.4440E-06
22.621	2.1660E-06	14.076	1.4440E-06
22.761	2.1660E-06	14.164	1.4440E-06
22.902	2.1660E-06	14.251	1.4440E-06
23.042	2.1660E-06	14.338	1.4440E-06
23.183	2.1660E-06	14.426	1.4440E-06
23.323	2.1660E-06	14.513	1.4440E-06
23.464	2.1660E-06	14.601	1.4440E-06
23.604	2.1660E-06	14.688	1.4440E-06
23.745	2.1660E-06	14.776	1.4440E-06
23.885	2.1660E-06	14.863	1.4440E-06
24.026	2.1660E-06	14.950	1.4440E-06
24.166	2.1660E-06	15.038	1.4440E-06
24.307	1.4440E-06	15.125	1.4440E-06
24.447	1.4440E-06	15.213	1.4440E-06
24.588	1.4440E-06	15.300	1.4440E-06
24.728	1.4440E-06	15.388	1.4440E-06
24.869	1.4440E-06	15.475	1.4440E-06
25.009	1.4440E-06	15.562	1.4440E-06
25.150	1.4440E-06	15.650	1.4440E-06
25.290	1.4440E-06	15.737	1.4440E-06
25.431	1.4440E-06	15.825	1.4440E-06
25.571	1.4440E-06	15.912	1.4440E-06

25.712	1.4440E-06	16.000	1.4440E-06
25.852	1.4440E-06	16.087	1.4440E-06
25.993	1.4440E-06	16.174	1.4440E-06
26.133	1.4440E-06	16.262	1.4440E-06
26.274	1.4440E-06	16.349	7.2200E-07
26.414	1.4440E-06	16.437	7.2200E-07
26.555	1.4440E-06	16.524	7.2200E-07
26.695	7.2200E-07	16.612	7.2200E-07
26.836	7.2200E-07	16.699	7.2200E-07
26.976	7.2200E-07	16.786	7.2200E-07
27.117	7.2200E-07	16.874	7.2200E-07
27.257	7.2200E-07	16.961	7.2200E-07
27.398	7.2200E-07	17.049	7.2200E-07
27.538	7.2200E-07	17.136	7.2200E-07
27.679	7.2200E-07	17.224	7.2200E-07
27.819	7.2200E-07	17.311	7.2200E-07
27.960	7.2200E-07	17.398	7.2200E-07
28.100	7.2200E-07	17.486	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-27.0%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-21.4%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-21.1%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

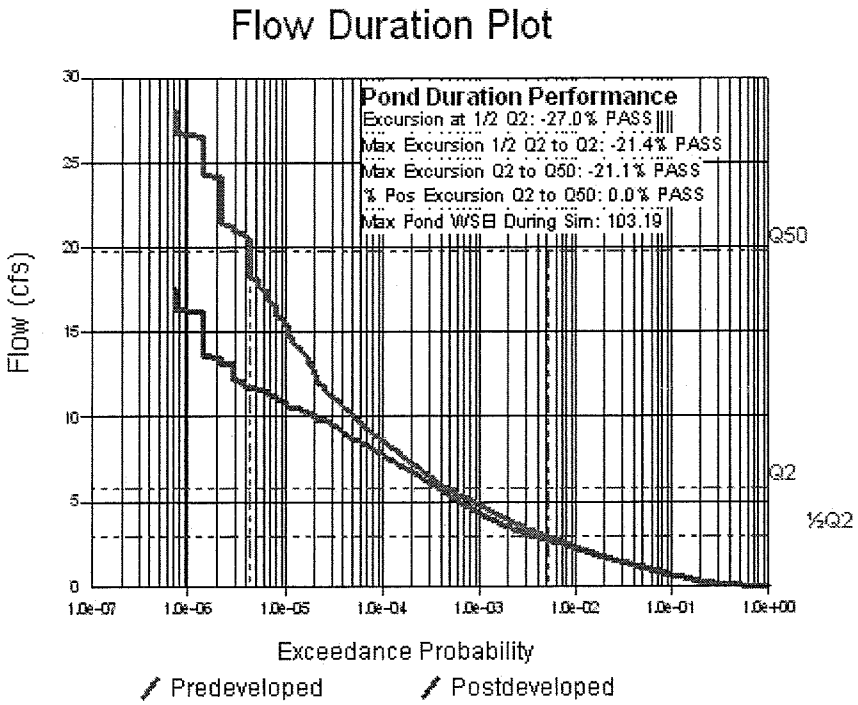
****

********** **Water Quality Facility Data** **********

Basic Wet Pond Volume (91% Exceedance): 226333. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 339499. cu-ft
2-Year Stormwater Pond Discharge Rate: 3.611 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -27.0% PASS
Max Excursion 1/2 Q2 to Q2: -21.4% PASS
Max Excursion Q2 to Q50: -21.1% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEl During Sim: 103.19
Q50
Q2
½Q2
Flow (cfs)
30
25
20
15
10
5
0
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:54 AM
****

Input File Name: Basin 5.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Rock Creek 3
Comments : Basin Tributary to unnamed creek flowing from Black Diamond Lake to Rock C

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)			
		Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	120.520	120.520	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	0.000	0.000	0.000	No
Impervious	1.790	1.790	0.000	
SUBBASIN TOTAL	122.310	122.310	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.00	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	163.2	ft
Pond Bottom Width	:	81.6	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	13315.	sq-ft
Area at Riser Crest El	:	18045.	sq-ft
	:	0.414	acres
Volume at Riser Crest	:	46861.	cu-ft
	:	1.076	ac-ft
Area at Max Elevation	:	19766.	sq-ft
	:	0.454	acres
Volume at Max Elevation	:	65739.	cu-ft
	:	1.509	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 36.00	in
Common Length	: 1.018	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 9.09	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 12.2	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	0.306	0.000	0.000	0.000
100.04	0.307	0.011	0.412	0.000
100.07	0.308	0.021	0.583	0.000
100.14	0.310	0.043	0.824	0.000
100.21	0.313	0.065	1.009	0.000
100.28	0.315	0.087	1.165	0.000
100.35	0.318	0.109	1.303	0.000
100.42	0.320	0.131	1.427	0.000
100.49	0.322	0.154	1.542	0.000
100.56	0.325	0.177	1.648	0.000
100.63	0.327	0.199	1.748	0.000
100.70	0.330	0.222	1.843	0.000
100.77	0.332	0.245	1.933	0.000
100.84	0.335	0.269	2.019	0.000
100.91	0.337	0.292	2.101	0.000
100.93	0.338	0.299	2.124	0.000
100.95	0.338	0.306	2.147	0.000
100.97	0.339	0.313	2.169	0.000
100.99	0.340	0.319	2.191	0.000
101.01	0.340	0.325	2.219	0.000
101.03	0.341	0.331	2.252	0.000
101.04	0.342	0.337	2.289	0.000
101.06	0.342	0.343	2.330	0.000
101.13	0.345	0.367	2.514	0.000
101.20	0.347	0.392	2.726	0.000
101.27	0.350	0.416	2.957	0.000
101.34	0.352	0.441	3.203	0.000
101.41	0.355	0.465	3.462	0.000
101.48	0.357	0.490	3.731	0.000
101.55	0.360	0.515	4.007	0.000
101.62	0.362	0.541	4.289	0.000
101.69	0.365	0.566	4.576	0.000
101.76	0.368	0.592	4.867	0.000
101.83	0.370	0.618	5.159	0.000
101.90	0.373	0.644	5.453	0.000
101.97	0.375	0.670	5.748	0.000
102.04	0.378	0.696	6.064	0.000
102.11	0.380	0.723	6.415	0.000
102.18	0.383	0.749	6.773	0.000
102.25	0.386	0.776	7.140	0.000
102.32	0.388	0.803	7.516	0.000
102.39	0.391	0.831	7.899	0.000
102.46	0.394	0.858	8.289	0.000
102.53	0.396	0.886	8.687	0.000
102.60	0.399	0.914	9.093	0.000
102.67	0.402	0.942	9.506	0.000
102.74	0.404	0.970	9.926	0.000
102.81	0.407	0.998	10.353	0.000
102.88	0.410	1.027	10.786	0.000
102.91	0.411	1.039	10.974	0.000
102.94	0.412	1.051	11.163	0.000
102.97	0.413	1.064	11.354	0.000
103.00	0.414	1.076	11.545	0.000
103.02	0.415	1.083	11.723	0.000
103.04	0.416	1.091	11.956	0.000
103.05	0.416	1.098	12.225	0.000
103.07	0.417	1.105	12.523	0.000
103.09	0.418	1.113	12.845	0.000

103.11	0.418	1.120	13.191	0.000
103.12	0.419	1.127	13.556	0.000
103.14	0.420	1.135	13.941	0.000
103.21	0.422	1.164	15.645	0.000
103.28	0.425	1.194	17.576	0.000
103.35	0.428	1.224	19.692	0.000
103.42	0.431	1.254	21.958	0.000
103.49	0.433	1.284	24.341	0.000
103.56	0.436	1.314	26.806	0.000
103.63	0.439	1.345	29.319	0.000
103.70	0.442	1.376	31.843	0.000
103.77	0.445	1.407	34.343	0.000
103.84	0.447	1.438	36.655	0.000
103.91	0.450	1.469	38.765	0.000
103.98	0.453	1.501	40.745	0.000
104.05	0.456	1.533	42.570	0.000
104.12	0.459	1.565	44.224	0.000
104.19	0.461	1.597	45.697	0.000
104.26	0.464	1.629	46.991	0.000
104.33	0.467	1.662	48.117	0.000
104.40	0.470	1.695	49.105	0.000
104.47	0.473	1.728	49.997	0.000
104.54	0.476	1.761	51.246	0.000
104.61	0.479	10.550	137.035	0.000
104.68	0.482	10.725	141.319	0.000
104.75	0.484	10.901	145.368	0.000
104.82	0.487	11.078	149.168	0.000
104.89	0.490	11.254	152.707	0.000
104.96	0.493	11.432	155.981	0.000
105.03	0.496	11.609	158.991	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	5.161	1940 04 30	4.724
1940 12 20	2.950	1940 12 20	2.675
1941 12 15	6.895	1941 12 15	3.888
1942 11 23	2.799	1943 03 28	2.452
1944 01 22	2.243	1944 01 23	1.951
1945 02 07	6.890	1945 02 07	6.389
1946 02 05	4.016	1946 02 05	3.901
1947 02 01	4.208	1947 02 02	3.748
1948 03 21	6.919	1948 03 21	6.036
1949 02 22	3.913	1949 02 22	3.872
1950 03 03	14.627	1950 03 03	11.421
1951 02 09	5.905	1951 02 09	5.788
1952 06 29	2.161	1952 01 24	1.678
1953 01 11	3.228	1953 01 11	2.992
1954 01 22	3.971	1954 01 22	3.900
1955 04 12	2.066	1955 04 12	1.734
1955 12 21	4.109	1955 12 21	3.865
1957 02 25	3.762	1957 02 25	3.613
1958 01 16	3.862	1958 01 16	3.822
1959 01 12	4.760	1959 01 13	4.399
1959 12 15	5.215	1959 12 15	4.487
1961 02 14	4.103	1960 11 20	3.940
1962 03 04	2.506	1962 03 04	2.422
1963 02 03	2.928	1963 02 03	2.740
1964 01 01	4.216	1964 01 01	3.548
1965 02 26	4.336	1965 02 27	3.960
1966 04 11	4.249	1966 04 11	3.737
1967 01 19	6.852	1967 01 19	5.907
1968 02 03	3.745	1968 02 04	3.402
1968 12 03	4.123	1968 12 03	3.749
1970 01 13	3.924	1970 01 14	2.910
1970 12 06	4.326	1970 12 06	3.691
1972 02 28	9.032	1972 02 28	7.936
1972 12 23	3.609	1972 12 23	3.502
1974 02 18	4.604	1974 02 19	4.357
1974 12 26	7.101	1974 12 27	5.679
1975 12 02	3.922	1976 01 27	3.643
1977 05 31	2.135	1977 05 31	1.993
1977 12 10	4.014	1977 12 15	3.758
1979 03 04	4.035	1979 03 04	3.173
1979 12 15	5.777	1979 12 15	5.698
1980 11 21	3.528	1980 12 26	2.686
1981 10 06	9.882	1981 10 06	8.023
1983 01 05	4.646	1983 01 05	4.364
1984 03 14	4.376	1984 03 20	2.919
1985 02 11	2.988	1985 02 11	2.690
1986 01 18	8.072	1986 01 18	7.880
1986 11 24	7.944	1986 11 24	7.622
1988 04 06	3.935	1988 04 06	3.723
1989 04 05	4.175	1989 04 05	3.788
1990 01 09	13.002	1990 01 09	12.646
1990 11 24	11.653	1990 11 24	10.189
1992 01 27	4.115	1992 01 27	3.554
1993 03 22	3.257	1993 03 23	3.132
1994 03 03	2.688	1994 03 03	2.524
1995 02 19	4.923	1995 02 19	4.844
1996 02 08	10.709	1996 02 09	9.722

1997	01	02	7.011	1997	01	02	6.011
1998	02	28	2.916	1998	03	23	2.160
1998	11	04	7.038	1998	11	25	6.196
2000	02	05	4.345	2000	02	06	4.136
2001	05	05	3.316	2001	05	05	2.765
2002	05	03	10.367	2002	05	03	5.600
2003	03	31	7.701	2003	03	31	7.596
2004	01	23	2.652	2004	01	23	2.388
2005	02	05	4.712	2005	02	07	3.242
2005	11	27	4.698	2005	11	27	4.557
2006	12	14	3.776	2006	12	14	3.448
2008	03	21	5.854	2008	01	06	5.141
2009	02	17	7.756	2009	02	17	7.339
2010	06	10	7.073	2010	01	10	4.886
2010	11	17	7.481	2010	11	17	6.868
2012	01	31	5.017	2012	01	31	3.065
2013	01	20	10.388	2013	01	20	9.543
2013	12	06	5.682	2014	04	05	4.298
2015	02	28	3.229	2015	03	30	2.854
2016	01	04	7.422	2016	01	04	6.974
2017	06	14	3.082	2017	03	07	2.311
2018	04	17	4.882	2018	01	31	4.075
2019	03	29	4.087	2019	02	14	3.963
2020	03	30	3.629	2020	04	14	3.153
2021	02	10	6.275	2021	02	10	6.215
2021	12	20	4.474	2021	12	20	3.722
2023	02	02	5.225	2023	03	30	4.916
2024	01	19	4.330	2024	01	19	4.194
2024	12	22	8.399	2024	12	22	7.853
2026	03	09	4.739	2026	03	09	4.490
2027	01	27	4.294	2027	01	28	4.203
2028	02	19	5.059	2028	02	19	5.030
2028	12	04	4.267	2028	12	04	4.214
2029	11	04	5.100	2030	02	16	4.649
2030	12	30	5.129	2030	12	30	5.046
2032	01	20	8.139	2032	01	20	7.907
2033	03	01	2.824	2033	03	01	2.381
2034	01	15	8.426	2034	01	16	7.843
2035	02	19	5.138	2035	02	19	4.671
2035	12	04	5.308	2035	12	04	4.400
2037	03	08	2.060	2037	03	09	1.559
2037	11	24	4.479	2037	12	15	3.469
2039	02	07	2.765	2038	12	11	2.331
2040	01	14	9.318	2040	01	14	5.846
2040	12	25	5.065	2040	12	25	4.897
2042	02	20	4.886	2042	02	20	3.899
2043	03	31	7.564	2043	03	31	4.614
2044	05	01	4.337	2044	05	01	3.608
2045	02	07	4.171	2045	03	23	3.784
2046	02	16	4.356	2046	02	16	4.260
2047	01	31	3.071	2047	02	01	2.984
2048	04	21	2.819	2048	04	21	2.746
2049	03	16	3.155	2049	03	16	2.717
2049	12	04	5.862	2049	12	04	5.406
2051	04	06	3.698	2051	04	06	3.162
2052	04	16	2.710	2052	04	17	2.152
2053	06	04	11.514	2053	06	04	5.564
2054	04	08	1.918	2054	02	24	1.733
2055	02	17	6.653	2055	02	17	5.960
2056	02	07	11.666	2056	02	07	10.611
2056	11	19	14.362	2056	11	19	12.142
2058	05	21	5.747	2058	05	21	5.173
2058	11	25	5.882	2058	12	28	5.194

2060	01 19	2.893	2060	01 19	2.183
2061	01 10	4.326	2061	01 10	4.210
2062	02 03	16.044	2062	02 03	11.812
2062	12 29	4.150	2062	12 29	3.941
2063	12 23	6.633	2063	12 23	6.300
2064	11 30	3.461	2064	11 30	3.254
2066	01 13	2.330	2066	01 13	2.128
2067	01 19	4.049	2067	01 19	3.845
2068	01 18	8.405	2068	01 18	7.693
2069	01 04	2.715	2069	01 04	2.446
2070	04 09	3.186	2070	04 09	2.488
2071	02 14	2.488	2071	02 14	2.329
2071	11 03	2.936	2071	11 03	2.788
2072	12 25	9.402	2072	12 25	9.244
2074	03 16	5.481	2074	03 16	4.713
2075	02 12	1.993	2075	01 17	1.758
2076	03 24	6.260	2076	03 24	4.941
2077	02 12	1.731	2077	02 12	1.528
2077	11 25	3.223	2077	12 02	2.617
2079	02 25	3.186	2079	02 25	3.149
2079	12 17	11.612	2079	12 17	10.367
2080	11 21	5.411	2080	11 21	5.120
2082	02 14	5.650	2082	02 14	5.618
2083	03 29	3.762	2083	02 11	3.399
2083	11 26	4.912	2083	11 26	4.504
2084	12 14	3.400	2084	12 14	3.244
2086	01 18	4.561	2086	01 18	4.419
2086	12 21	4.812	2086	12 21	3.988
2088	01 14	3.281	2088	01 14	3.048
2088	11 05	7.876	2088	11 05	6.874
2090	01 06	2.782	2089	12 05	2.455
2090	12 04	4.576	2090	12 04	4.247
2092	04 28	9.464	2092	01 31	5.031
2093	03 22	2.729	2093	03 22	2.542
2094	03 01	2.209	2094	03 02	2.059
2094	11 29	3.363	2094	11 29	3.224
2096	01 14	3.600	2096	01 14	3.539
2097	01 29	6.955	2097	01 29	5.853

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	1.731	1.00	1.528
1.01	1.918	1.01	1.559
1.02	1.993	1.02	1.678
1.02	2.060	1.02	1.733
1.03	2.066	1.03	1.734
1.04	2.135	1.04	1.758
1.04	2.161	1.04	1.951
1.05	2.209	1.05	1.993
1.06	2.243	1.06	2.059
1.06	2.330	1.06	2.128
1.07	2.488	1.07	2.152
1.08	2.506	1.08	2.160
1.09	2.652	1.09	2.183
1.09	2.688	1.09	2.311
1.10	2.710	1.10	2.329
1.11	2.715	1.11	2.331
1.12	2.729	1.12	2.381
1.12	2.765	1.12	2.388
1.13	2.782	1.13	2.422
1.14	2.799	1.14	2.446
1.15	2.819	1.15	2.452
1.16	2.824	1.16	2.455
1.17	2.893	1.17	2.488
1.18	2.916	1.18	2.524
1.18	2.928	1.18	2.542
1.19	2.936	1.19	2.617
1.20	2.950	1.20	2.675
1.21	2.988	1.21	2.686
1.22	3.071	1.22	2.690
1.23	3.082	1.23	2.717
1.24	3.155	1.24	2.740
1.25	3.186	1.25	2.746
1.26	3.186	1.26	2.765
1.27	3.223	1.27	2.788
1.28	3.228	1.28	2.854
1.29	3.229	1.29	2.910
1.30	3.257	1.30	2.919
1.31	3.281	1.31	2.984
1.32	3.316	1.32	2.992
1.33	3.363	1.33	3.048
1.35	3.400	1.35	3.065
1.36	3.461	1.36	3.132
1.37	3.528	1.37	3.149
1.38	3.600	1.38	3.153
1.39	3.609	1.39	3.162
1.40	3.629	1.40	3.173
1.42	3.698	1.42	3.224
1.43	3.745	1.43	3.242
1.44	3.762	1.44	3.244
1.46	3.762	1.46	3.254
1.47	3.776	1.47	3.399
1.48	3.862	1.48	3.402
1.50	3.913	1.50	3.448
1.51	3.922	1.51	3.469
1.53	3.924	1.53	3.502
1.54	3.935	1.54	3.539

1.56	3.971		1.56	3.548
1.57	4.014		1.57	3.554
1.59	4.016		1.59	3.608
1.60	4.035		1.60	3.613
1.62	4.049		1.62	3.643
1.64	4.087		1.64	3.691
1.65	4.103		1.65	3.722
1.67	4.109		1.67	3.723
1.69	4.115		1.69	3.737
1.71	4.123		1.71	3.748
1.73	4.150		1.73	3.749
1.75	4.171		1.75	3.758
1.77	4.175		1.77	3.784
1.79	4.208		1.79	3.788
1.81	4.216		1.81	3.822
1.83	4.249		1.83	3.845
1.85	4.267		1.85	3.865
1.87	4.294		1.87	3.872
1.89	4.326		1.89	3.888
1.92	4.326		1.92	3.899
1.94	4.330		1.94	3.900
1.96	4.336		1.96	3.901
1.99	4.337		1.99	3.940
2.01	4.345		2.01	3.941
2.04	4.356		2.04	3.960
2.07	4.376		2.07	3.963
2.09	4.474		2.09	3.988
2.12	4.479		2.12	4.075
2.15	4.561		2.15	4.136
2.18	4.576		2.18	4.194
2.21	4.604		2.21	4.203
2.24	4.646		2.24	4.210
2.27	4.698		2.27	4.214
2.31	4.712		2.31	4.247
2.34	4.739		2.34	4.260
2.38	4.760		2.38	4.298
2.41	4.812		2.41	4.357
2.45	4.882		2.45	4.364
2.49	4.886		2.49	4.399
2.53	4.912		2.53	4.400
2.57	4.923		2.57	4.419
2.61	5.017		2.61	4.487
2.65	5.059		2.65	4.490
2.70	5.065		2.70	4.504
2.75	5.100		2.75	4.557
2.80	5.129		2.80	4.614
2.85	5.138		2.85	4.649
2.90	5.161		2.90	4.671
2.95	5.215		2.95	4.713
3.01	5.225		3.01	4.724
3.07	5.308		3.07	4.844
3.13	5.411		3.13	4.886
3.19	5.481		3.19	4.897
3.26	5.650		3.26	4.916
3.32	5.682		3.32	4.941
3.40	5.747		3.40	5.030
3.47	5.777		3.47	5.031
3.55	5.854		3.55	5.046
3.63	5.862		3.63	5.120
3.72	5.882		3.72	5.141
3.80	5.905		3.80	5.173
3.90	6.260		3.90	5.194
4.00	6.275		4.00	5.406

4.10	6.633	4.10	5.564
4.21	6.653	4.21	5.600
4.32	6.852	4.32	5.618
4.45	6.890	4.45	5.679
4.58	6.895	4.58	5.698
4.71	6.919	4.71	5.788
4.86	6.955	4.86	5.846
5.01	7.011	5.01	5.853
5.17	7.038	5.17	5.907
5.35	7.073	5.35	5.960
5.54	7.101	5.54	6.011
5.74	7.422	5.74	6.036
5.95	7.481	5.95	6.196
6.19	7.564	6.19	6.215
6.44	7.701	6.44	6.300
6.71	7.756	6.71	6.389
7.01	7.876	7.01	6.868
7.33	7.944	7.33	6.874
7.69	8.072	7.69	6.974
8.08	8.139	8.08	7.339
8.52	8.399	8.52	7.596
9.00	8.405	9.00	7.622
9.55	8.426	9.55	7.693
10.16	9.032	10.16	7.843
10.86	9.318	10.86	7.853
11.66	9.402	11.66	7.880
12.59	9.464	12.59	7.907
13.68	9.882	13.68	7.936
14.97	10.367	14.97	8.023
16.54	10.388	16.54	9.244
18.47	10.709	18.47	9.543
20.92	11.514	20.92	9.722
24.10	11.612	24.10	10.189
28.44	11.653	28.44	10.367
34.68	11.666	34.68	10.611
44.42	13.002	44.42	11.421
61.77	14.362	61.77	11.812
101.36	14.627	101.36	12.142
282.36	16.044	282.36	12.646

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	2.871	2.871	
2-Year	4.520	4.520	3.941
5-Year	6.718	6.718	5.852
10-Year	8.462	8.462	7.805
25-Year	11.059	11.059	10.229
50-Year	13.318	13.318	11.561
100-Year	15.885	15.885	12.133
200-Year	18.811	18.811	12.476

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.080	3.1793E-01	0.063	3.3913E-01
0.160	2.5189E-01	0.126	2.7539E-01
0.241	2.1073E-01	0.190	2.3510E-01
0.321	1.8042E-01	0.253	2.0557E-01
0.401	1.5649E-01	0.316	1.8199E-01
0.481	1.3656E-01	0.379	1.6261E-01
0.562	1.1975E-01	0.443	1.4674E-01
0.642	1.0510E-01	0.506	1.3161E-01
0.722	9.2576E-02	0.569	1.1907E-01
0.802	8.1705E-02	0.632	1.0757E-01
0.882	7.2250E-02	0.696	9.7002E-02
0.963	6.4162E-02	0.759	8.7868E-02
1.043	5.7063E-02	0.822	8.0273E-02
1.123	5.0853E-02	0.885	7.2688E-02
1.203	4.5355E-02	0.948	6.6073E-02
1.284	4.0491E-02	1.012	6.0514E-02
1.364	3.6218E-02	1.075	5.5120E-02
1.444	3.2469E-02	1.138	5.0370E-02
1.524	2.9084E-02	1.201	4.6153E-02
1.604	2.6061E-02	1.265	4.2154E-02
1.685	2.3349E-02	1.328	3.8631E-02
1.765	2.0961E-02	1.391	3.5328E-02
1.845	1.8829E-02	1.454	3.2377E-02
1.925	1.6904E-02	1.517	2.9681E-02
2.005	1.5169E-02	1.581	2.7232E-02
2.086	1.3635E-02	1.644	2.4957E-02
2.166	1.2294E-02	1.707	2.2825E-02
2.260	1.0935E-02	1.770	2.0891E-02
2.326	1.0076E-02	1.834	1.9075E-02
2.407	9.1665E-03	1.897	1.7436E-02
2.487	8.3572E-03	1.960	1.5875E-02
2.567	7.5897E-03	2.023	1.4438E-02
2.647	6.9262E-03	2.087	1.3101E-02
2.727	6.3117E-03	2.150	1.1865E-02
2.808	5.7731E-03	2.213	1.0653E-02
2.888	5.2684E-03	2.260	1.0005E-02
2.968	4.8266E-03	2.339	9.0792E-03
3.048	4.4461E-03	2.403	8.4626E-03
3.129	4.0844E-03	2.466	7.8900E-03
3.209	3.7710E-03	2.529	7.3550E-03
3.289	3.4656E-03	2.592	6.8807E-03
3.369	3.1833E-03	2.656	6.4107E-03
3.449	2.9400E-03	2.719	5.9796E-03
3.530	2.7198E-03	2.782	5.5890E-03
3.610	2.5126E-03	2.845	5.2092E-03
3.690	2.3133E-03	2.909	4.8706E-03
3.770	2.1429E-03	2.972	4.5710E-03
3.851	1.9877E-03	3.035	4.2945E-03
3.931	1.8332E-03	3.098	4.0309E-03
4.011	1.6873E-03	3.161	3.7631E-03
4.091	1.5516E-03	3.225	3.5068E-03
4.171	1.4505E-03	3.288	3.2793E-03
4.252	1.3487E-03	3.351	3.0728E-03
4.332	1.2613E-03	3.414	2.8887E-03
4.412	1.1834E-03	3.478	2.7183E-03
4.520	1.0886E-03	3.541	2.5544E-03

4.573	1.0476E-03	3.604	2.3963E-03
4.653	9.8625E-04	3.667	2.2498E-03
4.733	9.2922E-04	3.730	2.1126E-03
4.813	8.7001E-04	3.794	1.9819E-03
4.893	8.1875E-04	3.857	1.8635E-03
4.974	7.7543E-04	3.920	1.7480E-03
5.054	7.2705E-04	3.983	1.6527E-03
5.134	6.7868E-04	4.047	1.5400E-03
5.214	6.4402E-04	4.110	1.4584E-03
5.294	6.0720E-04	4.173	1.3797E-03
5.375	5.7616E-04	4.236	1.3083E-03
5.455	5.5016E-04	4.300	1.2440E-03
5.535	5.2056E-04	4.363	1.1790E-03
5.615	4.9674E-04	4.426	1.1227E-03
5.696	4.7074E-04	4.520	1.0491E-03
5.776	4.4475E-04	4.552	1.0216E-03
5.856	4.2598E-04	4.616	9.7831E-04
5.936	4.0143E-04	4.679	9.2849E-04
6.016	3.7905E-04	4.742	8.8590E-04
6.097	3.5595E-04	4.805	8.4258E-04
6.177	3.3284E-04	4.869	7.9998E-04
6.257	3.1479E-04	4.932	7.6099E-04
6.337	2.9385E-04	4.995	7.2489E-04
6.418	2.7580E-04	5.058	6.9168E-04
6.498	2.5775E-04	5.121	6.5630E-04
6.578	2.4548E-04	5.185	6.3392E-04
6.658	2.3104E-04	5.248	6.0576E-04
6.718	2.2286E-04	5.311	5.8338E-04
6.819	2.0794E-04	5.374	5.5883E-04
6.899	1.9566E-04	5.438	5.3428E-04
6.979	1.8628E-04	5.501	5.1623E-04
7.059	1.7328E-04	5.564	4.8807E-04
7.140	1.6028E-04	5.627	4.7291E-04
7.220	1.5379E-04	5.691	4.5630E-04
7.300	1.4368E-04	5.754	4.3753E-04
7.380	1.3429E-04	5.817	4.2309E-04
7.460	1.2779E-04	5.880	4.0288E-04
7.541	1.1985E-04	5.943	3.8194E-04
7.621	1.1119E-04	6.007	3.6317E-04
7.701	1.0686E-04	6.070	3.3573E-04
7.781	1.0325E-04	6.133	3.1696E-04
7.862	9.6748E-05	6.196	3.0468E-04
7.942	9.0972E-05	6.260	2.8736E-04
8.022	8.5196E-05	6.323	2.7580E-04
8.102	7.8698E-05	6.386	2.6642E-04
8.182	7.5088E-05	6.449	2.5342E-04
8.263	7.2200E-05	6.513	2.4404E-04
8.343	6.7868E-05	6.576	2.3321E-04
8.423	6.1370E-05	6.639	2.2382E-04
8.503	5.5594E-05	6.718	2.1220E-04
8.583	5.1984E-05	6.765	2.0577E-04
8.664	4.9096E-05	6.829	1.9638E-04
8.744	4.5486E-05	6.892	1.8628E-04
8.824	4.2598E-05	6.955	1.7906E-04
8.904	4.0432E-05	7.018	1.6823E-04
8.985	3.6100E-05	7.082	1.5956E-04
9.065	3.3934E-05	7.145	1.5379E-04
9.145	3.1768E-05	7.208	1.4657E-04
9.225	2.9602E-05	7.271	1.4007E-04
9.305	2.6714E-05	7.334	1.3285E-04
9.386	2.5270E-05	7.398	1.2635E-04
9.466	2.3104E-05	7.461	1.1841E-04
9.546	2.0938E-05	7.524	1.1335E-04

9.626	2.0216E-05	7.587	1.0902E-04
9.707	1.8772E-05	7.651	1.0397E-04
9.787	1.7328E-05	7.714	9.7470E-05
9.867	1.6606E-05	7.777	9.3138E-05
9.947	1.5884E-05	7.840	9.0250E-05
10.027	1.4440E-05	7.904	8.4474E-05
10.108	1.2996E-05	7.967	8.0864E-05
10.188	1.2274E-05	8.030	7.6532E-05
10.268	1.2274E-05	8.093	7.4366E-05
10.348	1.2274E-05	8.156	7.1478E-05
10.429	1.0830E-05	8.220	6.8590E-05
10.509	1.0108E-05	8.283	6.2814E-05
10.589	1.0108E-05	8.346	6.0648E-05
10.669	1.0108E-05	8.409	5.9926E-05
10.749	9.3860E-06	8.473	5.7038E-05
10.830	9.3860E-06	8.536	4.9818E-05
10.910	9.3860E-06	8.599	4.8374E-05
10.990	9.3860E-06	8.662	4.4764E-05
11.070	9.3860E-06	8.726	4.1876E-05
11.151	9.3860E-06	8.789	3.8988E-05
11.231	9.3860E-06	8.852	3.6100E-05
11.311	9.3860E-06	8.915	3.4656E-05
11.391	9.3860E-06	8.978	3.1046E-05
11.471	9.3860E-06	9.042	2.8158E-05
11.552	8.6640E-06	9.105	2.7436E-05
11.632	7.9420E-06	9.168	2.5270E-05
11.712	6.4980E-06	9.231	2.2382E-05
11.792	6.4980E-06	9.295	2.0216E-05
11.872	5.7760E-06	9.358	2.0216E-05
11.953	5.7760E-06	9.421	1.8772E-05
12.033	5.7760E-06	9.484	1.8050E-05
12.113	5.0540E-06	9.547	1.5884E-05
12.193	5.0540E-06	9.611	1.5162E-05
12.274	5.0540E-06	9.674	1.3718E-05
12.354	5.0540E-06	9.737	1.1552E-05
12.434	5.0540E-06	9.800	1.1552E-05
12.514	5.0540E-06	9.864	1.1552E-05
12.594	5.0540E-06	9.927	1.0830E-05
12.675	5.0540E-06	9.990	1.0830E-05
12.755	5.0540E-06	10.053	1.0830E-05
12.835	5.0540E-06	10.117	1.0830E-05
12.915	5.0540E-06	10.180	1.0108E-05
12.996	4.3320E-06	10.243	7.9420E-06
13.076	3.6100E-06	10.306	7.9420E-06
13.156	3.6100E-06	10.369	7.2200E-06
13.236	3.6100E-06	10.433	7.2200E-06
13.318	3.6101E-06	10.496	6.4980E-06
13.397	3.6100E-06	10.559	5.7760E-06
13.477	3.6100E-06	10.622	5.0540E-06
13.557	3.6100E-06	10.686	5.0540E-06
13.637	3.6100E-06	10.749	5.0540E-06
13.718	3.6100E-06	10.812	5.0540E-06
13.798	2.8880E-06	10.875	5.0540E-06
13.878	2.8880E-06	10.939	5.0540E-06
13.958	2.8880E-06	11.002	5.0540E-06
14.038	2.8880E-06	11.065	5.0540E-06
14.119	2.8880E-06	11.128	5.0540E-06
14.199	2.8880E-06	11.191	5.0540E-06
14.279	2.1660E-06	11.255	4.3320E-06
14.359	2.1660E-06	11.318	4.3320E-06
14.440	1.4440E-06	11.381	4.3320E-06
14.520	1.4440E-06	11.444	3.6100E-06
14.600	1.4440E-06	11.508	3.6100E-06

14.680	7.2200E-07	11.571	3.6100E-06
14.760	7.2200E-07	11.634	3.6100E-06
14.841	7.2200E-07	11.697	3.6100E-06
14.921	7.2200E-07	11.760	3.6100E-06
15.001	7.2200E-07	11.824	2.1660E-06
15.081	7.2200E-07	11.887	2.1660E-06
15.161	7.2200E-07	11.950	2.1660E-06
15.242	7.2200E-07	12.013	1.4440E-06
15.322	7.2200E-07	12.077	1.4440E-06
15.402	7.2200E-07	12.140	1.4440E-06
15.482	7.2200E-07	12.203	7.2200E-07
15.563	7.2200E-07	12.266	7.2200E-07
15.643	7.2200E-07	12.330	7.2200E-07
15.723	7.2200E-07	12.393	7.2200E-07
15.803	7.2200E-07	12.456	7.2200E-07
15.883	7.2200E-07	12.519	7.2200E-07
15.964	7.2200E-07	12.582	7.2200E-07
16.044	7.2200E-07	12.646	7.2200E-07

***** Flow Duration Performance According to Dept. of Ecology Criteria ******

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-8.5%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-3.7%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-2.9%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

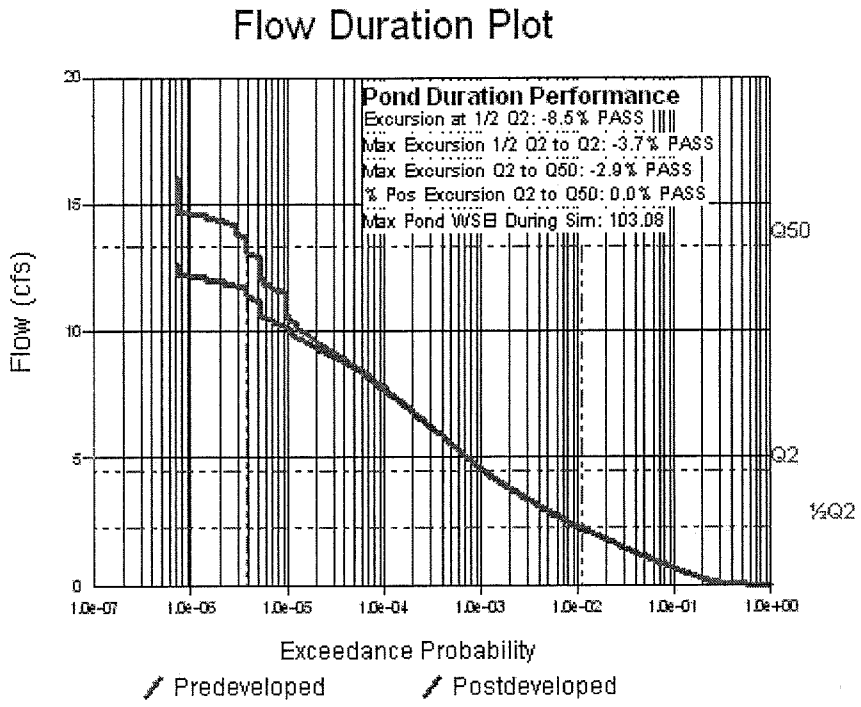
****

********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 237610. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 356414. cu-ft
2-Year Stormwater Pond Discharge Rate: 3.941 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -8.5% PASS
Max Excursion 1/2 Q2 to Q2: -3.7% PASS
Max Excursion Q2 to Q50: -2.9% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEl During Sim: 103.08
Q50
Q2
½Q2
Flow (cfs)
20
15
10
5
0
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 10:58 AM

****

Input File Name: Basin 4.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Rock Creek 4
Comments : Basin Tributary Black Diamond Lake

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* Default HSPF Parameters Used (Not Modified by User) **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)			
		Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	377.590	377.590	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	0.000	0.000	0.000	No
Impervious	10.880	10.880	0.000	
SUBBASIN TOTAL	388.470	388.470	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	306.3	ft
Pond Bottom Width	:	153.2	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	46914.	sq-ft
Area at Riser Crest El	:	55508.	sq-ft
	:	1.274	acres
Volume at Riser Crest	:	153453.	cu-ft
	:	3.523	ac-ft
Area at Max Elevation	:	60049.	sq-ft
	:	1.379	acres
Volume at Max Elevation	:	240059.	cu-ft
	:	5.511	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 54.00	in
Common Length	: 3.246	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 16.74	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 38.9	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	1.077	0.000	0.000	0.000
100.04	1.079	0.038	1.400	0.000
100.07	1.081	0.076	1.979	0.000
100.14	1.086	0.151	2.799	0.000
100.21	1.090	0.228	3.428	0.000
100.28	1.095	0.304	3.958	0.000
100.35	1.099	0.381	4.426	0.000
100.42	1.104	0.458	4.848	0.000
100.49	1.108	0.535	5.237	0.000
100.56	1.113	0.613	5.598	0.000
100.63	1.117	0.691	5.938	0.000
100.70	1.122	0.770	6.259	0.000
100.77	1.126	0.848	6.564	0.000
100.84	1.131	0.927	6.856	0.000
100.91	1.135	1.006	7.136	0.000
100.93	1.137	1.029	7.214	0.000
100.95	1.138	1.052	7.291	0.000
100.97	1.139	1.075	7.368	0.000
100.99	1.140	1.098	7.443	0.000
101.01	1.142	1.117	7.534	0.000
101.03	1.143	1.137	7.644	0.000
101.04	1.144	1.157	7.768	0.000
101.06	1.145	1.178	7.901	0.000
101.13	1.150	1.258	8.513	0.000
101.20	1.154	1.338	9.221	0.000
101.27	1.159	1.419	10.004	0.000
101.34	1.163	1.501	10.849	0.000
101.41	1.168	1.582	11.749	0.000
101.48	1.172	1.664	12.696	0.000
101.55	1.177	1.746	13.686	0.000
101.62	1.182	1.829	14.716	0.000
101.69	1.186	1.912	15.782	0.000
101.76	1.191	1.995	16.880	0.000
101.83	1.196	2.079	18.010	0.000
101.90	1.200	2.162	19.167	0.000
101.97	1.205	2.247	20.352	0.000
102.04	1.210	2.331	21.561	0.000
102.11	1.214	2.416	22.793	0.000
102.18	1.219	2.501	24.046	0.000
102.25	1.224	2.587	25.320	0.000
102.32	1.228	2.672	26.613	0.000
102.39	1.233	2.759	27.923	0.000
102.46	1.238	2.845	29.250	0.000
102.53	1.242	2.932	30.593	0.000
102.60	1.247	3.019	31.950	0.000
102.67	1.252	3.106	33.321	0.000
102.74	1.257	3.194	34.705	0.000
102.81	1.261	3.282	36.100	0.000
102.88	1.266	3.371	37.506	0.000
102.91	1.268	3.409	38.112	0.000
102.94	1.270	3.447	38.720	0.000
102.97	1.272	3.485	39.329	0.000
103.00	1.274	3.523	39.941	0.000
103.02	1.275	3.546	40.383	0.000
103.04	1.277	3.568	40.897	0.000
103.05	1.278	3.590	41.457	0.000
103.07	1.279	3.613	42.054	0.000
103.09	1.280	3.635	42.685	0.000

103.11	1.281	3.657	43.344	0.000
103.12	1.283	3.680	44.030	0.000
103.14	1.284	3.702	44.740	0.000
103.21	1.289	3.792	47.798	0.000
103.28	1.293	3.883	51.156	0.000
103.35	1.298	3.973	54.770	0.000
103.42	1.303	4.064	58.607	0.000
103.49	1.308	4.156	62.638	0.000
103.56	1.313	4.248	66.837	0.000
103.63	1.318	4.340	71.182	0.000
103.70	1.322	4.432	75.074	0.000
103.77	1.327	4.525	79.088	0.000
103.84	1.332	4.618	83.154	0.000
103.91	1.337	4.711	87.248	0.000
103.98	1.342	4.805	91.346	0.000
104.05	1.347	4.899	95.423	0.000
104.12	1.352	4.994	99.455	0.000
104.19	1.357	5.088	103.418	0.000
104.26	1.362	5.184	107.289	0.000
104.33	1.367	5.279	111.046	0.000
104.40	1.371	5.375	114.668	0.000
104.47	1.376	5.471	118.137	0.000
104.54	1.381	5.567	121.437	0.000
104.61	1.386	5.664	124.555	0.000
104.68	1.391	5.761	127.481	0.000
104.75	1.396	5.859	130.210	0.000
104.82	1.401	5.957	132.742	0.000
104.89	1.406	6.055	135.082	0.000
104.96	1.411	6.153	137.240	0.000
105.03	1.416	6.252	139.234	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	17.351	1940 04 30	15.993
1940 12 20	9.917	1940 12 20	8.810
1941 12 15	23.777	1941 12 15	13.616
1942 11 23	9.875	1943 03 28	7.978
1944 01 22	8.303	1944 01 23	6.391
1945 02 07	23.138	1945 02 07	21.598
1946 01 23	13.716	1946 02 05	12.799
1947 02 01	14.611	1947 02 02	12.385
1948 03 21	23.313	1948 03 21	20.776
1949 02 22	12.806	1949 02 22	12.575
1950 03 03	48.623	1950 03 03	39.547
1951 02 09	19.180	1951 02 09	18.783
1952 06 29	10.478	1952 01 24	5.610
1953 01 11	10.868	1953 01 11	9.888
1954 01 22	12.919	1954 01 22	12.642
1955 04 12	7.294	1955 04 12	5.764
1955 12 21	13.804	1955 12 21	12.937
1957 02 25	12.577	1957 02 25	11.761
1958 01 16	12.816	1958 01 16	12.489
1959 01 12	15.991	1959 01 13	14.717
1959 12 15	17.761	1959 12 15	15.409
1961 02 14	14.306	1960 11 20	13.118
1962 03 04	8.296	1962 03 04	7.845
1963 02 03	9.843	1963 02 03	8.959
1964 01 01	14.356	1964 01 01	11.923
1965 02 26	14.546	1965 02 27	13.235
1966 04 11	14.392	1966 04 11	12.548
1967 01 19	23.007	1967 01 19	19.971
1968 02 03	12.786	1968 02 04	11.377
1968 12 03	13.999	1968 12 03	12.672
1970 01 13	13.632	1970 01 14	10.075
1970 12 06	14.785	1970 12 06	12.482
1972 02 28	29.908	1972 02 28	26.529
1973 01 13	12.098	1972 12 23	11.557
1974 02 18	15.281	1974 02 19	14.421
1974 12 26	24.039	1974 12 27	19.691
1975 12 02	13.510	1976 01 27	12.105
1977 05 31	7.343	1977 05 31	6.589
1978 09 22	14.572	1977 12 15	12.349
1979 03 04	13.887	1979 03 04	10.948
1979 12 14	19.619	1979 12 15	18.546
1980 11 21	12.982	1980 12 26	8.838
1981 10 06	33.400	1981 10 06	27.064
1983 01 05	15.482	1983 01 05	14.465
1984 03 14	15.068	1984 03 20	9.534
1985 02 11	10.350	1985 02 11	8.860
1986 01 18	26.894	1986 01 18	25.668
1986 11 24	26.370	1986 11 24	25.278
1988 04 06	13.278	1988 04 06	12.302
1989 04 05	14.030	1989 04 05	12.595
1990 01 09	43.371	1990 01 09	41.519
1990 11 24	39.046	1990 11 24	34.636
1992 01 27	14.142	1992 01 27	12.267
1993 03 22	10.812	1993 03 23	10.292
1994 03 03	8.943	1994 03 03	8.228
1995 02 19	16.286	1995 02 19	15.843
1996 02 08	35.265	1996 02 09	31.467

1997	01	02	23.623	1997	01 02	19.874
1998	02	28	10.403	1998	03 23	7.100
1998	11	04	25.653	1998	11 25	20.567
2000	02	05	14.826	2000	02 06	13.842
2001	05	05	11.423	2001	05 05	9.136
2002	05	03	35.011	2002	05 03	19.850
2003	03	31	24.957	2003	03 31	24.567
2004	01	23	8.897	2004	01 23	7.757
2005	02	05	16.143	2005	02 07	10.904
2005	11	27	15.633	2005	11 27	15.120
2006	12	14	13.258	2006	12 14	11.425
2008	03	21	20.008	2008	01 06	17.267
2009	02	17	25.773	2009	02 17	24.757
2010	06	10	26.594	2010	01 10	16.848
2010	11	17	25.002	2010	11 17	23.030
2012	01	31	17.182	2012	01 31	10.384
2013	01	20	34.909	2013	01 20	32.089
2013	12	06	19.840	2014	04 05	14.260
2015	02	28	11.360	2015	03 30	9.284
2016	01	04	25.011	2016	01 04	23.444
2017	06	14	11.262	2017	03 07	7.466
2018	04	17	16.639	2018	01 31	13.371
2019	03	29	13.707	2019	02 14	12.864
2020	03	30	12.400	2020	04 14	10.275
2021	02	10	20.482	2021	02 10	20.015
2021	12	20	15.678	2021	12 20	12.543
2023	02	02	18.007	2023	03 30	15.934
2024	01	19	14.514	2024	01 19	13.673
2024	12	22	27.739	2024	12 22	25.999
2026	03	09	15.888	2026	03 09	15.117
2027	01	27	14.162	2027	01 27	13.828
2028	02	19	16.323	2028	02 19	16.231
2028	12	04	14.160	2028	12 04	13.877
2029	11	04	17.925	2030	02 16	15.368
2030	12	30	16.831	2030	12 30	16.568
2032	01	20	26.843	2032	01 20	26.146
2033	03	01	9.749	2033	03 01	7.839
2034	01	15	27.655	2034	01 16	25.677
2035	02	19	17.289	2035	02 19	15.664
2035	12	04	18.252	2035	12 04	15.233
2037	03	08	7.612	2037	03 08	5.441
2037	11	24	15.808	2037	12 15	11.373
2039	02	07	9.729	2038	12 11	7.826
2040	01	14	31.508	2040	01 14	20.797
2040	12	25	16.908	2040	12 25	16.392
2042	02	20	16.671	2042	02 20	13.358
2043	03	31	25.534	2043	03 31	15.728
2044	05	01	14.548	2044	05 01	11.924
2045	02	07	14.575	2045	03 23	12.554
2046	02	16	14.462	2046	02 16	13.840
2047	01	31	10.803	2047	02 01	9.758
2048	04	20	9.833	2048	04 21	8.933
2049	03	16	11.112	2049	03 16	9.064
2049	12	04	19.898	2049	12 04	18.852
2051	04	06	12.459	2051	04 06	10.362
2052	04	16	9.590	2052	04 17	7.021
2053	06	04	38.459	2053	06 04	19.473
2054	04	08	6.568	2054	02 24	5.848
2055	02	17	22.262	2055	02 17	20.158
2056	02	07	38.231	2056	02 07	34.690
2056	11	19	47.127	2056	11 19	38.976
2058	01	24	19.607	2058	05 21	17.451
2058	11	25	20.170	2058	11 26	17.005

2060	01	19	10.096	2060	01 19	7.293
2061	01	10	14.215	2061	01 10	13.770
2062	02	03	53.402	2062	02 03	40.969
2062	12	29	13.845	2062	12 29	13.124
2063	12	23	22.071	2063	12 23	21.166
2064	11	29	12.320	2064	11 30	10.753
2066	01	13	7.791	2066	01 13	7.040
2067	01	19	13.546	2067	01 19	12.521
2068	01	18	27.945	2068	01 18	25.663
2069	01	04	9.208	2069	01 04	7.874
2070	04	09	11.093	2070	04 09	8.188
2071	02	14	8.273	2071	02 14	7.574
2071	11	03	9.948	2071	11 03	9.309
2072	12	25	30.967	2072	12 25	30.553
2074	03	16	18.409	2074	03 16	15.833
2075	02	12	7.642	2075	01 17	5.803
2076	03	24	21.219	2076	03 24	17.069
2077	02	12	5.966	2077	02 12	5.059
2077	11	25	11.409	2077	11 25	8.781
2078	11	03	10.869	2079	02 25	10.224
2079	12	17	38.249	2079	12 17	34.066
2080	11	21	18.143	2080	11 21	17.151
2082	02	13	18.151	2082	02 14	18.062
2083	03	29	13.116	2083	02 11	11.041
2083	11	26	16.605	2083	11 26	15.284
2084	12	14	11.500	2084	12 14	10.705
2086	01	18	15.004	2086	01 18	14.487
2086	12	21	16.576	2086	12 21	13.325
2088	01	14	11.539	2088	01 14	10.164
2088	11	05	26.834	2088	11 05	24.092
2089	12	03	9.554	2089	12 05	7.935
2090	12	04	15.393	2090	12 04	14.250
2092	04	28	31.776	2092	04 29	16.434
2093	06	15	9.327	2093	03 22	8.330
2094	03	01	7.298	2094	03 02	6.753
2094	11	29	11.194	2094	11 29	10.602
2096	01	14	12.002	2096	01 14	11.504
2097	01	29	23.524	2097	01 29	20.350

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	5.966	1.00	5.059
1.01	6.568	1.01	5.441
1.02	7.294	1.02	5.610
1.02	7.298	1.02	5.764
1.03	7.343	1.03	5.803
1.04	7.612	1.04	5.848
1.04	7.642	1.04	6.391
1.05	7.791	1.05	6.589
1.06	8.273	1.06	6.753
1.06	8.296	1.06	7.021
1.07	8.303	1.07	7.040
1.08	8.897	1.08	7.100
1.09	8.943	1.09	7.293
1.09	9.208	1.09	7.466
1.10	9.327	1.10	7.574
1.11	9.554	1.11	7.757
1.12	9.590	1.12	7.826
1.12	9.729	1.12	7.839
1.13	9.749	1.13	7.845
1.14	9.833	1.14	7.874
1.15	9.843	1.15	7.935
1.16	9.875	1.16	7.978
1.17	9.917	1.17	8.188
1.18	9.948	1.18	8.228
1.18	10.096	1.18	8.330
1.19	10.350	1.19	8.781
1.20	10.403	1.20	8.810
1.21	10.478	1.21	8.838
1.22	10.803	1.22	8.860
1.23	10.812	1.23	8.933
1.24	10.868	1.24	8.959
1.25	10.869	1.25	9.064
1.26	11.093	1.26	9.136
1.27	11.112	1.27	9.284
1.28	11.194	1.28	9.309
1.29	11.262	1.29	9.534
1.30	11.360	1.30	9.758
1.31	11.409	1.31	9.888
1.32	11.423	1.32	10.075
1.33	11.500	1.33	10.164
1.35	11.539	1.35	10.224
1.36	12.002	1.36	10.275
1.37	12.098	1.37	10.292
1.38	12.320	1.38	10.362
1.39	12.400	1.39	10.384
1.40	12.459	1.40	10.602
1.42	12.577	1.42	10.705
1.43	12.786	1.43	10.753
1.44	12.806	1.44	10.904
1.46	12.816	1.46	10.948
1.47	12.919	1.47	11.041
1.48	12.982	1.48	11.373
1.50	13.116	1.50	11.377
1.51	13.258	1.51	11.425
1.53	13.278	1.53	11.504
1.54	13.510	1.54	11.557

1.56	13.546		1.56	11.761
1.57	13.632		1.57	11.923
1.59	13.707		1.59	11.924
1.60	13.716		1.60	12.105
1.62	13.804		1.62	12.267
1.64	13.845		1.64	12.302
1.65	13.887		1.65	12.349
1.67	13.999		1.67	12.385
1.69	14.030		1.69	12.482
1.71	14.142		1.71	12.489
1.73	14.160		1.73	12.521
1.75	14.162		1.75	12.543
1.77	14.215		1.77	12.548
1.79	14.306		1.79	12.554
1.81	14.356		1.81	12.575
1.83	14.392		1.83	12.595
1.85	14.462		1.85	12.642
1.87	14.514		1.87	12.672
1.89	14.546		1.89	12.799
1.92	14.548		1.92	12.864
1.94	14.572		1.94	12.937
1.96	14.575		1.96	13.118
1.99	14.611		1.99	13.124
2.01	14.785		2.01	13.235
2.04	14.826		2.04	13.325
2.07	15.004		2.07	13.358
2.09	15.068		2.09	13.371
2.12	15.281		2.12	13.616
2.15	15.393		2.15	13.673
2.18	15.482		2.18	13.770
2.21	15.633		2.21	13.828
2.24	15.678		2.24	13.840
2.27	15.808		2.27	13.842
2.31	15.888		2.31	13.877
2.34	15.991		2.34	14.250
2.38	16.143		2.38	14.260
2.41	16.286		2.41	14.421
2.45	16.323		2.45	14.465
2.49	16.576		2.49	14.487
2.53	16.605		2.53	14.717
2.57	16.639		2.57	15.117
2.61	16.671		2.61	15.120
2.65	16.831		2.65	15.233
2.70	16.908		2.70	15.284
2.75	17.182		2.75	15.368
2.80	17.289		2.80	15.409
2.85	17.351		2.85	15.664
2.90	17.761		2.90	15.728
2.95	17.925		2.95	15.833
3.01	18.007		3.01	15.843
3.07	18.143		3.07	15.934
3.13	18.151		3.13	15.993
3.19	18.252		3.19	16.231
3.26	18.409		3.26	16.392
3.32	19.180		3.32	16.434
3.40	19.607		3.40	16.568
3.47	19.619		3.47	16.848
3.55	19.840		3.55	17.005
3.63	19.898		3.63	17.069
3.72	20.008		3.72	17.151
3.80	20.170		3.80	17.267
3.90	20.482		3.90	17.451
4.00	21.219		4.00	18.062

4.10	22.071	4.10	18.546
4.21	22.262	4.21	18.783
4.32	23.007	4.32	18.852
4.45	23.138	4.45	19.473
4.58	23.313	4.58	19.691
4.71	23.524	4.71	19.850
4.86	23.623	4.86	19.874
5.01	23.777	5.01	19.971
5.17	24.039	5.17	20.015
5.35	24.957	5.35	20.158
5.54	25.002	5.54	20.350
5.74	25.011	5.74	20.567
5.95	25.534	5.95	20.776
6.19	25.653	6.19	20.797
6.44	25.773	6.44	21.166
6.71	26.370	6.71	21.598
7.01	26.594	7.01	23.030
7.33	26.834	7.33	23.444
7.69	26.843	7.69	24.092
8.08	26.894	8.08	24.567
8.52	27.655	8.52	24.757
9.00	27.739	9.00	25.278
9.55	27.945	9.55	25.663
10.16	29.908	10.16	25.668
10.86	30.967	10.86	25.677
11.66	31.508	11.66	25.999
12.59	31.776	12.59	26.146
13.68	33.400	13.68	26.529
14.97	34.909	14.97	27.064
16.54	35.011	16.54	30.553
18.47	35.265	18.47	31.467
20.92	38.231	20.92	32.089
24.10	38.249	24.10	34.066
28.44	38.459	28.44	34.636
34.68	39.046	34.68	34.690
44.42	43.371	44.42	38.976
61.77	47.127	61.77	39.547
101.36	48.623	101.36	40.969
282.36	53.402	282.36	41.519

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	9.950	9.950	
2-Year	15.352	15.352	13.179
5-Year	22.576	22.576	19.964
10-Year	28.320	28.320	25.667
25-Year	36.895	36.895	34.192
50-Year	44.368	44.368	39.181
100-Year	52.875	52.875	40.930
200-Year	62.591	62.591	41.334

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.267	3.2114E-01	0.208	3.4397E-01
0.534	2.5409E-01	0.415	2.7967E-01
0.801	2.1166E-01	0.623	2.3853E-01
1.068	1.8018E-01	0.830	2.0802E-01
1.335	1.5523E-01	1.038	1.8345E-01
1.602	1.3449E-01	1.246	1.6325E-01
1.869	1.1721E-01	1.453	1.4701E-01
2.136	1.0232E-01	1.661	1.3115E-01
2.403	8.9745E-02	1.868	1.1790E-01
2.670	7.8831E-02	2.076	1.0646E-01
2.937	6.9541E-02	2.284	9.5760E-02
3.204	6.1512E-02	2.491	8.6454E-02
3.471	5.4521E-02	2.699	7.8482E-02
3.738	4.8446E-02	2.906	7.1389E-02
4.005	4.3109E-02	3.114	6.4762E-02
4.272	3.8400E-02	3.322	5.9026E-02
4.539	3.4196E-02	3.529	5.3904E-02
4.806	3.0572E-02	3.737	4.9116E-02
5.073	2.7291E-02	3.944	4.4931E-02
5.340	2.4375E-02	4.152	4.1010E-02
5.607	2.1812E-02	4.360	3.7527E-02
5.874	1.9538E-02	4.567	3.4297E-02
6.141	1.7492E-02	4.775	3.1361E-02
6.408	1.5661E-02	4.982	2.8685E-02
6.675	1.4067E-02	5.190	2.6267E-02
6.942	1.2631E-02	5.398	2.4012E-02
7.209	1.1393E-02	5.605	2.1992E-02
7.476	1.0244E-02	5.813	2.0093E-02
7.676	9.5307E-03	6.020	1.8315E-02
8.010	8.4301E-03	6.228	1.6696E-02
8.277	7.6770E-03	6.436	1.5221E-02
8.544	6.9543E-03	6.643	1.3860E-02
8.811	6.3247E-03	6.851	1.2638E-02
9.078	5.7659E-03	7.058	1.1514E-02
9.345	5.2475E-03	7.266	1.0419E-02
9.612	4.8035E-03	7.474	9.3355E-03
9.879	4.3840E-03	7.676	8.5734E-03
10.146	4.0382E-03	7.889	7.9189E-03
10.413	3.7118E-03	8.096	7.4005E-03
10.680	3.3855E-03	8.304	6.8951E-03
10.947	3.1176E-03	8.511	6.3940E-03
11.214	2.8757E-03	8.719	5.9789E-03
11.481	2.6627E-03	8.927	5.5688E-03
11.748	2.4534E-03	9.134	5.1919E-03
12.015	2.2599E-03	9.342	4.8374E-03
12.282	2.0873E-03	9.549	4.5363E-03
12.549	1.9321E-03	9.757	4.2591E-03
12.816	1.7841E-03	9.965	3.9790E-03
13.083	1.6462E-03	10.172	3.7313E-03
13.350	1.5184E-03	10.380	3.4959E-03
13.617	1.4245E-03	10.587	3.2649E-03
13.884	1.3148E-03	10.795	3.0541E-03
14.151	1.2166E-03	11.003	2.8685E-03
14.418	1.1436E-03	11.210	2.6967E-03
14.685	1.0650E-03	11.418	2.5147E-03
14.952	9.9781E-04	11.625	2.3660E-03

15.352	9.0729E-04	11.833	2.2310E-03
15.486	8.7723E-04	12.041	2.0938E-03
15.753	8.3030E-04	12.248	1.9805E-03
16.021	7.7326E-04	12.456	1.8570E-03
16.288	7.2705E-04	12.663	1.7321E-03
16.555	6.8301E-04	12.871	1.6317E-03
16.822	6.4258E-04	13.079	1.5321E-03
17.089	6.1226E-04	13.286	1.4397E-03
17.356	5.7543E-04	13.494	1.3631E-03
17.623	5.4728E-04	13.701	1.2859E-03
17.890	5.2128E-04	13.909	1.2180E-03
18.157	4.9168E-04	14.117	1.1566E-03
18.424	4.7002E-04	14.324	1.1025E-03
18.691	4.4547E-04	14.532	1.0534E-03
18.958	4.1948E-04	14.739	9.9781E-04
19.225	3.9277E-04	14.947	9.5232E-04
19.492	3.6461E-04	15.155	9.0106E-04
19.759	3.4006E-04	15.352	8.6182E-04
20.026	3.1985E-04	15.570	8.2019E-04
20.293	2.9674E-04	15.777	7.8048E-04
20.560	2.8014E-04	15.985	7.4150E-04
20.827	2.6497E-04	16.193	7.0467E-04
21.094	2.5053E-04	16.400	6.6569E-04
21.361	2.3321E-04	16.608	6.3969E-04
21.628	2.2093E-04	16.815	6.0865E-04
21.895	2.1155E-04	17.023	5.8771E-04
22.162	1.9855E-04	17.231	5.6316E-04
22.429	1.8628E-04	17.438	5.3861E-04
22.576	1.8083E-04	17.646	5.1984E-04
22.963	1.6389E-04	17.853	4.9385E-04
23.230	1.5379E-04	18.061	4.7508E-04
23.497	1.4584E-04	18.269	4.5991E-04
23.764	1.3935E-04	18.476	4.4403E-04
24.031	1.3357E-04	18.684	4.2887E-04
24.298	1.2346E-04	18.891	4.0793E-04
24.565	1.1408E-04	19.099	3.8916E-04
24.832	1.0974E-04	19.307	3.6822E-04
25.099	1.0252E-04	19.514	3.4078E-04
25.366	9.6748E-05	19.722	3.2418E-04
25.633	9.0972E-05	19.929	3.0829E-04
25.900	8.5196E-05	20.137	2.9241E-04
26.167	7.9420E-05	20.345	2.7364E-04
26.434	7.4366E-05	20.552	2.6136E-04
26.701	7.0034E-05	20.760	2.4981E-04
26.968	6.2814E-05	20.967	2.3609E-04
27.235	5.9926E-05	21.175	2.2743E-04
27.502	5.7760E-05	21.383	2.1877E-04
27.769	5.4872E-05	21.590	2.1010E-04
28.036	4.8374E-05	21.798	2.0072E-04
28.303	4.4764E-05	22.005	1.9638E-04
28.570	4.1154E-05	22.213	1.7906E-04
28.837	3.9710E-05	22.421	1.7400E-04
29.104	3.6822E-05	22.576	1.6831E-04
29.371	3.3212E-05	22.836	1.5812E-04
29.638	3.1046E-05	23.043	1.5018E-04
29.905	2.9602E-05	23.251	1.4657E-04
30.172	2.6714E-05	23.458	1.3574E-04
30.439	2.6714E-05	23.666	1.3068E-04
30.706	2.5992E-05	23.874	1.2563E-04
30.973	2.3104E-05	24.081	1.1985E-04
31.240	2.2382E-05	24.289	1.1552E-04
31.507	2.0216E-05	24.496	1.0974E-04
31.774	1.9494E-05	24.704	1.0397E-04

32.041	1.6606E-05	24.912	9.9636E-05
32.308	1.5884E-05	25.119	9.2416E-05
32.575	1.5162E-05	25.327	8.6640E-05
32.842	1.5162E-05	25.534	8.5196E-05
33.109	1.4440E-05	25.742	8.0142E-05
33.376	1.4440E-05	25.950	7.7976E-05
33.643	1.2274E-05	26.157	7.2200E-05
33.910	1.2274E-05	26.365	7.0034E-05
34.177	1.2274E-05	26.572	6.4258E-05
34.444	1.1552E-05	26.780	6.1370E-05
34.711	1.1552E-05	26.988	5.9204E-05
34.978	1.0830E-05	27.195	5.7038E-05
35.245	1.0108E-05	27.403	5.2706E-05
35.512	9.3860E-06	27.610	5.1984E-05
35.779	9.3860E-06	27.818	4.6930E-05
36.046	9.3860E-06	28.026	4.4764E-05
36.313	9.3860E-06	28.233	4.2598E-05
36.580	9.3860E-06	28.441	4.1154E-05
36.847	9.3860E-06	28.648	3.7544E-05
37.114	9.3860E-06	28.856	3.3934E-05
37.381	9.3860E-06	29.064	3.1046E-05
37.648	9.3860E-06	29.271	2.8158E-05
37.915	9.3860E-06	29.479	2.6714E-05
38.182	9.3860E-06	29.686	2.5992E-05
38.449	7.9420E-06	29.894	2.3826E-05
38.716	7.2200E-06	30.102	2.2382E-05
38.983	6.4980E-06	30.309	2.0938E-05
39.250	5.7760E-06	30.517	2.0938E-05
39.517	5.7760E-06	30.724	1.8050E-05
39.784	5.7760E-06	30.932	1.8050E-05
40.051	5.0540E-06	31.140	1.6606E-05
40.318	5.0540E-06	31.347	1.5162E-05
40.585	5.0540E-06	31.555	1.3718E-05
40.852	5.0540E-06	31.762	1.2996E-05
41.119	5.0540E-06	31.970	1.2274E-05
41.386	5.0540E-06	32.178	1.1552E-05
41.653	5.0540E-06	32.385	1.1552E-05
41.920	5.0540E-06	32.593	1.1552E-05
42.187	5.0540E-06	32.800	1.1552E-05
42.454	5.0540E-06	33.008	1.1552E-05
42.721	5.0540E-06	33.216	1.0108E-05
42.988	5.0540E-06	33.423	1.0108E-05
43.255	4.3320E-06	33.631	1.0108E-05
43.522	3.6100E-06	33.838	1.0108E-05
43.789	3.6100E-06	34.046	9.3860E-06
44.056	3.6100E-06	34.254	8.6640E-06
44.368	3.6109E-06	34.461	7.2200E-06
44.590	3.6100E-06	34.669	6.4980E-06
44.857	3.6100E-06	34.876	5.0540E-06
45.124	3.6100E-06	35.084	5.0540E-06
45.391	3.6100E-06	35.292	5.0540E-06
45.658	3.6100E-06	35.499	5.0540E-06
45.925	2.8880E-06	35.707	5.0540E-06
46.192	2.8880E-06	35.914	5.0540E-06
46.459	2.8880E-06	36.122	5.0540E-06
46.726	2.8880E-06	36.330	5.0540E-06
46.993	2.8880E-06	36.537	5.0540E-06
47.260	2.1660E-06	36.745	4.3320E-06
47.527	1.4440E-06	36.952	4.3320E-06
47.794	1.4440E-06	37.160	4.3320E-06
48.061	1.4440E-06	37.368	4.3320E-06
48.329	1.4440E-06	37.575	4.3320E-06
48.596	1.4440E-06	37.783	4.3320E-06

48.863	7.2200E-07	37.990	4.3320E-06
49.130	7.2200E-07	38.198	4.3320E-06
49.397	7.2200E-07	38.405	4.3320E-06
49.664	7.2200E-07	38.613	4.3320E-06
49.931	7.2200E-07	38.821	4.3320E-06
50.198	7.2200E-07	39.028	3.6100E-06
50.465	7.2200E-07	39.236	3.6100E-06
50.732	7.2200E-07	39.443	3.6100E-06
50.999	7.2200E-07	39.651	2.1660E-06
51.266	7.2200E-07	39.859	2.1660E-06
51.533	7.2200E-07	40.066	2.1660E-06
51.800	7.2200E-07	40.274	1.4440E-06
52.067	7.2200E-07	40.481	1.4440E-06
52.334	7.2200E-07	40.689	1.4440E-06
52.601	7.2200E-07	40.897	1.4440E-06
52.868	7.2200E-07	41.104	7.2200E-07
53.135	7.2200E-07	41.312	7.2200E-07
53.402	7.2200E-07	41.519	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-10.1%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-4.6%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-3.7%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

****

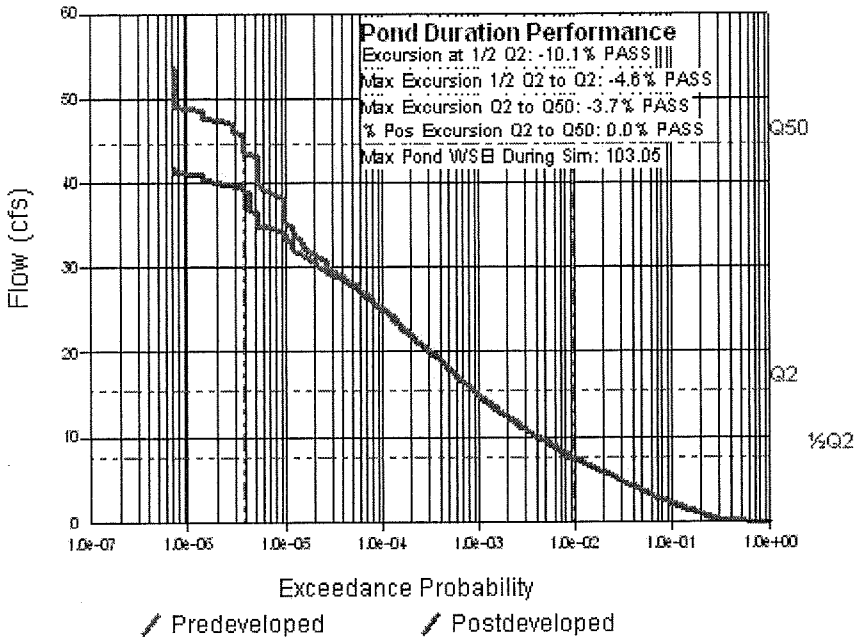
********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 756454. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 1134681. cu-ft
2-Year Stormwater Pond Discharge Rate: 13.179 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****

Flow Duration Plot



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MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 11:01 AM
****

Input File Name: Basin 11.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Ginder Creek 1
Comments : Downtown Basin tributary to Grinder Creek.

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* Default HSPF Parameters Used (Not Modified by User) **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)			
		Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	612.910	612.910	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	128.810	128.810	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	0.000	0.000	0.000	No
Impervious	65.190	65.190	0.000	
SUBBASIN TOTAL	806.910	806.910	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 ---------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	570.8	ft
Pond Bottom Width	:	285.4	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	162916.	sq-ft
Area at Riser Crest El	:	178652.	sq-ft
	:	4.101	acres
Volume at Riser Crest	:	512172.	cu-ft
	:	11.758	ac-ft
Area at Max Elevation	:	186763.	sq-ft
	:	4.287	acres
Volume at Max Elevation	:	786169.	cu-ft
	:	18.048	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 84.00	in
Common Length	: 7.921	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	:	Circular Orifice	
Invert Elevation	:	100.00	ft
Diameter	:	29.51	in
Orientation	:	Horizontal	
Elbow	:	No	

--- Device Number 2 ---

Device Type	:	Vertical Rectangular Orifice	
Invert Elevation	:	100.99	ft
Length	:	95.0	in
Height	:	24.1	in
Orientation	:	Vertical	
Elbow	:	No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	3.740	0.000	0.000	0.000
100.04	3.744	0.131	4.349	0.000
100.07	3.748	0.262	6.150	0.000
100.14	3.757	0.525	8.697	0.000
100.21	3.765	0.788	10.652	0.000
100.28	3.773	1.052	12.299	0.000
100.35	3.781	1.316	13.751	0.000
100.42	3.790	1.581	15.064	0.000
100.49	3.798	1.847	16.270	0.000
100.56	3.806	2.113	17.394	0.000
100.63	3.815	2.380	18.449	0.000
100.70	3.823	2.647	19.447	0.000
100.77	3.831	2.915	20.396	0.000
100.84	3.840	3.183	21.303	0.000
100.91	3.848	3.452	22.173	0.000
100.93	3.850	3.529	22.415	0.000
100.95	3.853	3.606	22.655	0.000
100.97	3.855	3.684	22.892	0.000
100.99	3.858	3.761	23.127	0.000
101.01	3.860	3.828	23.391	0.000
101.03	3.862	3.896	23.705	0.000
101.04	3.864	3.963	24.049	0.000
101.06	3.866	4.031	24.418	0.000
101.13	3.874	4.302	26.085	0.000
101.20	3.883	4.573	27.987	0.000
101.27	3.891	4.846	30.074	0.000
101.34	3.900	5.118	32.319	0.000
101.41	3.908	5.391	34.703	0.000
101.48	3.916	5.665	37.212	0.000
101.55	3.925	5.940	39.835	0.000
101.62	3.933	6.215	42.563	0.000
101.69	3.942	6.490	45.391	0.000
101.76	3.950	6.767	48.311	0.000
101.83	3.959	7.043	51.318	0.000
101.90	3.967	7.321	54.409	0.000
101.97	3.976	7.599	57.579	0.000
102.04	3.984	7.877	60.824	0.000
102.11	3.993	8.157	64.142	0.000
102.18	4.001	8.436	67.529	0.000
102.25	4.010	8.717	70.982	0.000
102.32	4.018	8.998	74.500	0.000
102.39	4.027	9.279	78.080	0.000
102.46	4.035	9.561	81.719	0.000
102.53	4.044	9.844	85.417	0.000
102.60	4.052	10.128	89.170	0.000
102.67	4.061	10.412	92.977	0.000
102.74	4.069	10.696	96.836	0.000
102.81	4.078	10.981	100.747	0.000
102.88	4.087	11.267	104.706	0.000
102.91	4.090	11.390	106.418	0.000
102.94	4.094	11.512	108.139	0.000
102.97	4.098	11.635	109.868	0.000
103.00	4.101	11.758	111.605	0.000
103.02	4.103	11.830	112.733	0.000
103.04	4.106	11.902	113.955	0.000
103.05	4.108	11.974	115.238	0.000
103.07	4.110	12.046	116.573	0.000
103.09	4.112	12.118	117.951	0.000

103.11	4.114	12.190	119.370	0.000
103.12	4.116	12.262	120.825	0.000
103.14	4.119	12.334	122.313	0.000
103.21	4.127	12.622	128.569	0.000
103.28	4.136	12.912	135.249	0.000
103.35	4.144	13.201	142.298	0.000
103.42	4.153	13.492	144.229	0.000
103.49	4.162	13.783	150.157	0.000
103.56	4.170	14.074	156.272	0.000
103.63	4.179	14.367	162.557	0.000
103.70	4.188	14.659	168.996	0.000
103.77	4.196	14.953	175.575	0.000
103.84	4.205	15.247	182.281	0.000
103.91	4.214	15.542	189.099	0.000
103.98	4.223	15.837	196.016	0.000
104.05	4.231	16.133	203.018	0.000
104.12	4.240	16.429	210.092	0.000
104.19	4.249	16.726	217.221	0.000
104.26	4.257	17.024	224.393	0.000
104.33	4.266	17.322	231.591	0.000
104.40	4.275	17.621	238.800	0.000
104.47	4.284	17.921	246.006	0.000
104.54	4.293	18.221	253.191	0.000
104.61	4.301	18.522	260.341	0.000
104.68	4.310	18.823	267.440	0.000
104.75	4.319	19.125	274.473	0.000
104.82	4.328	19.428	281.423	0.000
104.89	4.337	19.731	288.276	0.000
104.96	4.345	20.035	295.016	0.000
105.03	4.354	20.340	301.630	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	48.066	1940 04 30	41.665
1941 09 02	32.145	1940 12 20	22.696
1941 12 15	81.979	1941 12 15	43.530
1942 11 23	32.466	1942 11 23	21.847
1944 01 22	30.899	1944 01 22	20.662
1945 02 07	66.540	1945 02 07	59.623
1946 02 27	41.894	1946 01 24	32.621
1947 02 01	47.946	1947 02 01	32.113
1948 03 21	69.780	1948 03 21	57.485
1949 02 16	41.751	1949 02 16	30.821
1950 03 03	147.615	1950 03 03	110.188
1951 02 09	46.862	1951 02 09	43.986
1952 06 29	96.227	1952 06 29	39.463
1953 01 08	30.916	1953 01 11	23.838
1953 12 19	40.904	1954 01 22	29.570
1955 02 28	26.534	1955 04 12	17.120
1955 12 20	38.539	1955 12 21	31.322
1957 02 25	33.769	1957 02 25	27.343
1958 01 16	42.942	1958 01 16	30.863
1959 01 12	44.160	1959 01 13	36.833
1959 12 15	53.730	1959 12 15	42.211
1961 02 14	48.611	1960 11 20	34.132
1962 07 05	35.394	1961 12 17	20.188
1962 11 25	28.097	1963 02 03	21.768
1964 01 01	43.013	1964 01 01	28.127
1965 02 26	39.584	1965 02 27	32.741
1966 01 05	42.431	1966 04 11	30.656
1967 01 19	66.684	1967 01 19	53.671
1968 08 23	45.188	1968 02 03	29.041
1968 12 03	40.619	1968 12 03	33.681
1970 01 13	43.520	1970 01 14	29.479
1970 12 06	45.063	1970 12 06	31.248
1972 02 27	87.260	1972 02 27	69.418
1973 01 13	36.602	1973 01 13	29.045
1973 11 11	42.036	1974 02 18	36.318
1974 12 26	74.152	1974 12 27	54.962
1975 12 02	41.888	1976 01 27	30.157
1977 08 26	26.394	1977 05 31	17.730
1978 09 22	58.234	1978 09 22	34.455
1979 03 04	42.648	1979 03 04	30.273
1979 12 14	65.014	1979 12 14	49.717
1980 11 21	52.916	1980 11 21	27.139
1981 10 06	104.238	1981 10 06	76.829
1983 01 05	41.448	1983 01 05	35.816
1984 03 14	49.102	1984 03 14	24.549
1985 02 11	31.615	1985 02 11	22.859
1986 01 18	75.083	1986 01 18	65.525
1986 11 24	70.919	1986 11 24	66.850
1988 04 06	37.393	1988 04 06	30.478
1989 04 05	39.471	1989 04 05	29.620
1990 01 09	132.725	1990 01 09	119.786
1990 11 24	120.713	1990 11 24	102.138
1992 01 27	45.943	1992 01 27	35.115
1993 06 09	35.554	1993 03 23	24.207
1994 03 03	25.277	1994 03 03	20.565
1995 02 19	41.674	1995 02 19	38.961
1996 02 08	95.038	1996 02 08	79.629

1997	01	02	70.755	1997	01	02	51.001
1998	02	28	35.486	1997	10	30	20.899
1998	11	04	115.404	1998	11	04	56.367
2000	02	05	46.311	2000	02	06	38.594
2001	05	05	35.255	2001	05	05	24.004
2002	05	03	115.517	2002	05	03	60.204
2003	02	06	65.280	2003	03	31	57.460
2004	01	01	31.712	2004	01	23	20.057
2005	02	05	54.106	2005	02	07	27.125
2005	11	27	41.474	2005	11	27	38.781
2006	12	14	44.308	2006	12	14	28.166
2008	03	21	64.725	2008	01	06	44.843
2009	02	17	72.880	2009	02	17	68.831
2010	06	10	142.301	2010	06	10	72.142
2010	11	17	70.336	2010	11	17	60.778
2012	01	31	55.626	2012	01	31	27.367
2013	01	20	109.409	2013	01	20	93.756
2013	12	06	70.953	2013	11	16	43.163
2015	02	28	36.954	2015	02	28	24.491
2016	01	04	75.733	2016	01	04	66.894
2017	06	14	46.325	2017	06	14	21.756
2018	04	17	51.103	2018	04	17	33.032
2019	03	29	37.150	2019	03	30	31.677
2020	03	30	37.568	2020	04	14	24.203
2020	11	24	63.115	2021	02	10	50.458
2021	12	20	53.587	2021	12	20	36.000
2023	02	02	63.028	2023	03	30	37.717
2024	03	11	44.463	2024	01	19	35.032
2024	12	22	75.574	2024	12	22	65.846
2026	03	09	43.570	2026	03	09	39.877
2027	03	15	44.525	2027	03	15	33.913
2028	06	01	47.126	2028	02	19	37.660
2028	10	11	45.266	2028	12	04	34.631
2029	11	04	60.746	2029	11	04	42.309
2030	12	30	43.102	2030	12	30	40.528
2032	01	20	70.160	2032	01	20	66.347
2033	03	01	29.383	2033	03	01	21.522
2034	01	15	70.931	2034	01	16	61.207
2035	02	19	48.453	2035	02	19	42.494
2035	12	04	58.021	2035	12	04	44.245
2037	05	15	31.168	2037	03	08	17.898
2037	11	24	55.817	2037	11	24	34.099
2038	12	10	31.818	2038	12	11	22.939
2040	01	14	102.950	2040	01	14	61.510
2040	12	25	46.707	2040	12	25	42.928
2042	02	20	50.931	2042	02	20	35.559
2043	03	31	82.100	2043	03	31	41.660
2044	05	01	41.797	2044	05	01	27.130
2044	11	02	49.082	2045	02	07	32.198
2045	12	06	43.831	2045	12	06	33.009
2047	01	31	35.524	2046	11	24	22.587
2047	12	02	37.910	2047	12	02	26.829
2049	03	16	37.598	2049	03	16	24.353
2049	12	04	59.927	2049	12	04	56.960
2051	02	02	39.776	2051	04	06	23.507
2052	04	16	31.635	2052	04	16	19.621
2053	06	04	123.156	2053	06	04	56.701
2054	05	16	23.252	2054	02	24	17.061
2055	02	17	62.421	2055	02	17	53.401
2056	02	07	100.485	2056	02	07	86.684
2056	11	19	125.988	2056	11	19	95.347
2058	01	24	68.214	2058	05	21	45.635
2058	11	25	63.769	2058	11	26	49.635

2060	05	15	49.097	2060	01	19	20.841
2061	09	01	44.107	2061	01	10	33.341
2062	02	03	162.650	2062	02	03	113.458
2062	12	29	37.336	2062	12	29	33.070
2063	12	23	60.127	2063	12	23	54.716
2064	11	29	45.849	2064	11	29	29.312
2066	01	12	22.333	2066	01	13	18.759
2067	01	19	44.564	2067	01	19	31.474
2068	01	18	77.414	2068	01	18	68.283
2069	01	04	25.707	2069	01	04	19.709
2070	04	09	35.044	2070	04	09	21.907
2071	03	23	26.196	2071	02	14	19.428
2072	02	27	31.567	2071	11	03	25.325
2072	12	25	81.884	2072	12	25	79.316
2074	03	16	53.044	2074	03	16	39.911
2075	02	12	32.522	2075	02	12	16.767
2076	03	24	65.949	2076	03	24	47.329
2077	08	24	44.244	2077	08	24	18.387
2077	11	25	37.550	2077	11	25	27.290
2078	11	03	41.348	2078	11	03	24.342
2079	12	17	102.536	2079	12	17	85.918
2081	02	17	52.438	2080	11	21	44.642
2082	02	18	47.972	2081	10	31	42.531
2083	03	29	43.444	2083	02	11	26.638
2083	11	26	47.263	2083	11	26	40.521
2085	03	23	34.862	2084	12	14	25.373
2086	01	18	37.188	2086	01	18	35.879
2086	12	21	52.370	2086	12	21	38.486
2088	03	25	38.635	2088	01	14	27.676
2088	11	05	86.281	2088	11	05	72.631
2089	12	03	31.446	2089	11	03	21.702
2090	12	04	42.817	2090	12	04	36.993
2092	04	28	100.906	2092	04	29	47.102
2093	06	15	36.232	2093	03	22	21.882
2093	10	23	29.959	2094	03	01	17.250
2094	11	29	29.689	2094	11	29	25.217
2095	11	10	35.735	2096	01	14	27.282
2097	01	29	72.493	2097	01	29	58.440

********** Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	22.333	1.00	16.767
1.01	23.252	1.01	17.061
1.02	25.277	1.02	17.120
1.02	25.707	1.02	17.250
1.03	26.196	1.03	17.730
1.04	26.394	1.04	17.898
1.04	26.534	1.04	18.387
1.05	28.097	1.05	18.759
1.06	29.383	1.06	19.428
1.06	29.689	1.06	19.621
1.07	29.959	1.07	19.709
1.08	30.899	1.08	20.057
1.09	30.916	1.09	20.188
1.09	31.168	1.09	20.565
1.10	31.446	1.10	20.662
1.11	31.567	1.11	20.841
1.12	31.615	1.12	20.899
1.12	31.635	1.12	21.522
1.13	31.712	1.13	21.702
1.14	31.818	1.14	21.756
1.15	32.145	1.15	21.768
1.16	32.466	1.16	21.847
1.17	32.522	1.17	21.882
1.18	33.769	1.18	21.907
1.18	34.862	1.18	22.587
1.19	35.044	1.19	22.696
1.20	35.255	1.20	22.859
1.21	35.394	1.21	22.939
1.22	35.486	1.22	23.507
1.23	35.524	1.23	23.838
1.24	35.554	1.24	24.004
1.25	35.735	1.25	24.203
1.26	36.232	1.26	24.207
1.27	36.602	1.27	24.342
1.28	36.954	1.28	24.353
1.29	37.150	1.29	24.491
1.30	37.188	1.30	24.549
1.31	37.336	1.31	25.217
1.32	37.393	1.32	25.325
1.33	37.550	1.33	25.373
1.35	37.568	1.35	26.638
1.36	37.598	1.36	26.829
1.37	37.910	1.37	27.125
1.38	38.539	1.38	27.130
1.39	38.635	1.39	27.139
1.40	39.471	1.40	27.282
1.42	39.584	1.42	27.290
1.43	39.776	1.43	27.343
1.44	40.619	1.44	27.367
1.46	40.904	1.46	27.676
1.47	41.348	1.47	28.127
1.48	41.448	1.48	28.166
1.50	41.474	1.50	29.041
1.51	41.674	1.51	29.045
1.53	41.751	1.53	29.312
1.54	41.797	1.54	29.479

1.56	41.888	1.56	29.570
1.57	41.894	1.57	29.620
1.59	42.036	1.59	30.157
1.60	42.431	1.60	30.273
1.62	42.648	1.62	30.478
1.64	42.817	1.64	30.656
1.65	42.942	1.65	30.821
1.67	43.013	1.67	30.863
1.69	43.102	1.69	31.248
1.71	43.444	1.71	31.322
1.73	43.520	1.73	31.474
1.75	43.570	1.75	31.677
1.77	43.831	1.77	32.113
1.79	44.107	1.79	32.198
1.81	44.160	1.81	32.621
1.83	44.244	1.83	32.741
1.85	44.308	1.85	33.009
1.87	44.463	1.87	33.032
1.89	44.525	1.89	33.070
1.92	44.564	1.92	33.341
1.94	45.063	1.94	33.681
1.96	45.188	1.96	33.913
1.99	45.266	1.99	34.099
2.01	45.849	2.01	34.132
2.04	45.943	2.04	34.455
2.07	46.311	2.07	34.631
2.09	46.325	2.09	35.032
2.12	46.707	2.12	35.115
2.15	46.862	2.15	35.559
2.18	47.126	2.18	35.816
2.21	47.263	2.21	35.879
2.24	47.946	2.24	36.000
2.27	47.972	2.27	36.318
2.31	48.066	2.31	36.833
2.34	48.453	2.34	36.993
2.38	48.611	2.38	37.660
2.41	49.082	2.41	37.717
2.45	49.097	2.45	38.486
2.49	49.102	2.49	38.594
2.53	50.931	2.53	38.781
2.57	51.103	2.57	38.961
2.61	52.370	2.61	39.463
2.65	52.438	2.65	39.877
2.70	52.916	2.70	39.911
2.75	53.044	2.75	40.521
2.80	53.587	2.80	40.528
2.85	53.730	2.85	41.660
2.90	54.106	2.90	41.665
2.95	55.626	2.95	42.211
3.01	55.817	3.01	42.309
3.07	58.021	3.07	42.494
3.13	58.234	3.13	42.531
3.19	59.927	3.19	42.928
3.26	60.127	3.26	43.163
3.32	60.746	3.32	43.530
3.40	62.421	3.40	43.986
3.47	63.028	3.47	44.245
3.55	63.115	3.55	44.642
3.63	63.769	3.63	44.843
3.72	64.725	3.72	45.635
3.80	65.014	3.80	47.102
3.90	65.280	3.90	47.329
4.00	65.949	4.00	49.635

4.10	66.540		4.10	49.717
4.21	66.684		4.21	50.458
4.32	68.214		4.32	51.001
4.45	69.780		4.45	53.401
4.58	70.160		4.58	53.671
4.71	70.336		4.71	54.716
4.86	70.755		4.86	54.962
5.01	70.919		5.01	56.367
5.17	70.931		5.17	56.701
5.35	70.953		5.35	56.960
5.54	72.493		5.54	57.460
5.74	72.880		5.74	57.485
5.95	74.152		5.95	58.440
6.19	75.083		6.19	59.623
6.44	75.574		6.44	60.204
6.71	75.733		6.71	60.778
7.01	77.414		7.01	61.207
7.33	81.884		7.33	61.510
7.69	81.979		7.69	65.525
8.08	82.100		8.08	65.846
8.52	86.281		8.52	66.347
9.00	87.260		9.00	66.850
9.55	95.038		9.55	66.894
10.16	96.227		10.16	68.283
10.86	100.485		10.86	68.831
11.66	100.906		11.66	69.418
12.59	102.536		12.59	72.142
13.68	102.950		13.68	72.631
14.97	104.238		14.97	76.829
16.54	109.409		16.54	79.316
18.47	115.404		18.47	79.629
20.92	115.517		20.92	85.918
24.10	120.713		24.10	86.684
28.44	123.156		28.44	93.756
34.68	125.988		34.68	95.347
44.42	132.725		44.42	102.138
61.77	142.301		61.77	110.188
101.36	147.615		101.36	113.458
282.36	162.650		282.36	119.786

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	32.869	32.869	
2-Year	47.700	47.700	34.116
5-Year	68.664	68.664	56.276
10-Year	86.138	86.138	67.924
25-Year	113.381	113.381	88.245
50-Year	138.126	138.126	105.029
100-Year	167.319	167.319	113.369
200-Year	201.855	201.855	117.656

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.813	3.2348E-01	0.599	3.5637E-01
1.627	2.4638E-01	1.198	2.8193E-01
2.440	1.9836E-01	1.797	2.3559E-01
3.253	1.6297E-01	2.396	2.0138E-01
4.066	1.3532E-01	2.995	1.7429E-01
4.880	1.1322E-01	3.594	1.5203E-01
5.693	9.5277E-02	4.193	1.3429E-01
6.506	8.0641E-02	4.791	1.1823E-01
7.319	6.8450E-02	5.390	1.0376E-01
8.133	5.8222E-02	5.989	9.2052E-02
8.946	4.9827E-02	6.588	8.1234E-02
9.759	4.2805E-02	7.187	7.1511E-02
10.572	3.6858E-02	7.786	6.3314E-02
11.386	3.1816E-02	8.385	5.6578E-02
12.199	2.7587E-02	8.984	5.0561E-02
13.012	2.3927E-02	9.583	4.4987E-02
13.825	2.0705E-02	10.182	4.0345E-02
14.639	1.8101E-02	10.781	3.6330E-02
15.452	1.5828E-02	11.380	3.2438E-02
16.265	1.3818E-02	11.979	2.9092E-02
17.078	1.2117E-02	12.578	2.6120E-02
17.892	1.0694E-02	13.176	2.3379E-02
18.705	9.4069E-03	13.775	2.1054E-02
19.518	8.2828E-03	14.374	1.8780E-02
20.331	7.3485E-03	14.973	1.6872E-02
21.145	6.5406E-03	15.572	1.5093E-02
21.958	5.8193E-03	16.171	1.3567E-02
22.771	5.1984E-03	16.770	1.2161E-02
23.850	4.4596E-03	17.369	1.0958E-02
24.398	4.1623E-03	17.968	9.8459E-03
25.211	3.7364E-03	18.567	8.8893E-03
26.024	3.3631E-03	19.166	8.0337E-03
26.837	3.0317E-03	19.765	7.2460E-03
27.651	2.7602E-03	20.364	6.5522E-03
28.464	2.4996E-03	20.963	5.8908E-03
29.277	2.2534E-03	21.562	5.2923E-03
30.090	2.0490E-03	22.160	4.7031E-03
30.904	1.8866E-03	22.759	4.1927E-03
31.717	1.7249E-03	23.358	3.7270E-03
32.530	1.5761E-03	23.850	3.4484E-03
33.343	1.4303E-03	24.556	3.1400E-03
34.157	1.3126E-03	25.155	2.9111E-03
34.970	1.2101E-03	25.754	2.6895E-03
35.783	1.1148E-03	26.353	2.4967E-03
36.596	1.0159E-03	26.952	2.3169E-03
37.410	9.1694E-04	27.551	2.1494E-03
38.223	8.4474E-04	28.150	1.9971E-03
39.036	7.8409E-04	28.749	1.8620E-03
39.849	7.2561E-04	29.348	1.7328E-03
40.663	6.6785E-04	29.947	1.6093E-03
41.476	6.2381E-04	30.545	1.4989E-03
42.289	5.7038E-04	31.144	1.4108E-03
43.102	5.2489E-04	31.743	1.3162E-03
43.916	4.7291E-04	32.342	1.2332E-03
44.729	4.3103E-04	32.941	1.1523E-03
45.542	3.9927E-04	33.540	1.0823E-03

46.355	3.6605E-04	34.139	1.0007E-03
47.169	3.4006E-04	34.738	9.4077E-04
47.700	3.2449E-04	35.337	8.7940E-04
48.795	2.9746E-04	35.936	8.2453E-04
49.608	2.7508E-04	36.535	7.7615E-04
50.422	2.5775E-04	37.134	7.3211E-04
51.235	2.4476E-04	37.733	6.7796E-04
52.048	2.3176E-04	38.332	6.3897E-04
52.861	2.1877E-04	38.931	6.0215E-04
53.675	2.0505E-04	39.529	5.7471E-04
54.488	1.9350E-04	40.128	5.4656E-04
55.301	1.7761E-04	40.727	5.1334E-04
56.114	1.6750E-04	41.326	4.8374E-04
56.928	1.5523E-04	41.925	4.6136E-04
57.741	1.4368E-04	42.524	4.2670E-04
58.554	1.3501E-04	43.123	4.0215E-04
59.367	1.2707E-04	43.722	3.7111E-04
60.181	1.1769E-04	44.321	3.5089E-04
60.994	1.1047E-04	44.920	3.2995E-04
61.807	1.0325E-04	45.519	3.1335E-04
62.620	9.9636E-05	46.118	2.9891E-04
63.434	9.5304E-05	46.717	2.8158E-04
64.247	9.1694E-05	47.316	2.6858E-04
65.060	8.5918E-05	47.700	2.5518E-04
65.873	8.2308E-05	48.513	2.4187E-04
66.687	7.5088E-05	49.112	2.2671E-04
67.500	7.2200E-05	49.711	2.1516E-04
68.664	6.7016E-05	50.310	2.0072E-04
69.126	6.4980E-05	50.909	1.8700E-04
69.940	6.1370E-05	51.508	1.8194E-04
70.753	5.7760E-05	52.107	1.7328E-04
71.566	5.1262E-05	52.706	1.6606E-04
72.379	4.8374E-05	53.305	1.5595E-04
73.193	4.4764E-05	53.904	1.5018E-04
74.006	4.1876E-05	54.503	1.4296E-04
74.819	3.8988E-05	55.102	1.3140E-04
75.632	3.5378E-05	55.701	1.2635E-04
76.446	3.4656E-05	56.300	1.2130E-04
77.259	3.2490E-05	56.898	1.1335E-04
78.072	3.1046E-05	57.497	1.0830E-04
78.885	2.8880E-05	58.096	1.0108E-04
79.699	2.8158E-05	58.695	9.4582E-05
80.512	2.7436E-05	59.294	9.3138E-05
81.325	2.6714E-05	59.893	8.6640E-05
82.138	2.4548E-05	60.492	8.1586E-05
82.952	2.3826E-05	61.091	8.0142E-05
83.765	2.2382E-05	61.690	7.5810E-05
84.578	2.2382E-05	62.289	7.4366E-05
85.391	2.2382E-05	62.888	7.1478E-05
86.205	2.2382E-05	63.487	6.5702E-05
87.018	2.0216E-05	64.086	5.9926E-05
87.831	1.8772E-05	64.685	5.5594E-05
88.644	1.8050E-05	65.283	5.4872E-05
89.458	1.8050E-05	65.882	5.1984E-05
90.271	1.7328E-05	66.481	5.0540E-05
91.084	1.7328E-05	67.080	4.7652E-05
91.897	1.7328E-05	67.679	4.6930E-05
92.711	1.7328E-05	68.278	4.2598E-05
93.524	1.7328E-05	68.664	4.0675E-05
94.337	1.7328E-05	69.476	3.6822E-05
95.150	1.6606E-05	70.075	3.6822E-05
95.964	1.6606E-05	70.674	3.6822E-05
96.777	1.5884E-05	71.273	3.6822E-05

97.590	1.5884E-05	71.872	3.5378E-05
98.404	1.5884E-05	72.471	3.3212E-05
99.217	1.5162E-05	73.070	2.8158E-05
100.030	1.5162E-05	73.669	2.4548E-05
100.843	1.4440E-05	74.267	2.3826E-05
101.657	1.2996E-05	74.866	2.3826E-05
102.470	1.2996E-05	75.465	2.3826E-05
103.283	1.1552E-05	76.064	2.3104E-05
104.096	1.1552E-05	76.663	2.1660E-05
104.910	1.0830E-05	77.262	2.0938E-05
105.723	1.0108E-05	77.861	1.8772E-05
106.536	1.0108E-05	78.460	1.8050E-05
107.349	1.0108E-05	79.059	1.7328E-05
108.163	1.0108E-05	79.658	1.5884E-05
108.976	1.0108E-05	80.257	1.5162E-05
109.789	9.3860E-06	80.856	1.4440E-05
110.602	9.3860E-06	81.455	1.3718E-05
111.416	9.3860E-06	82.054	1.2996E-05
112.229	9.3860E-06	82.652	1.2996E-05
113.042	8.6640E-06	83.251	1.2274E-05
113.855	8.6640E-06	83.850	1.2274E-05
114.669	8.6640E-06	84.449	1.2274E-05
115.482	7.9420E-06	85.048	1.2274E-05
116.295	7.2200E-06	85.647	1.1552E-05
117.108	7.2200E-06	86.246	1.0830E-05
117.922	7.2200E-06	86.845	1.0108E-05
118.735	7.2200E-06	87.444	1.0108E-05
119.548	7.2200E-06	88.043	1.0108E-05
120.361	7.2200E-06	88.642	1.0108E-05
121.175	6.4980E-06	89.241	9.3860E-06
121.988	6.4980E-06	89.840	9.3860E-06
122.801	6.4980E-06	90.439	9.3860E-06
123.614	5.7760E-06	91.038	9.3860E-06
124.428	5.7760E-06	91.636	8.6640E-06
125.241	5.7760E-06	92.235	8.6640E-06
126.054	5.0540E-06	92.834	7.9420E-06
126.867	5.0540E-06	93.433	7.9420E-06
127.681	4.3320E-06	94.032	7.2200E-06
128.494	4.3320E-06	94.631	7.2200E-06
129.307	4.3320E-06	95.230	7.2200E-06
130.120	4.3320E-06	95.829	5.7760E-06
130.934	4.3320E-06	96.428	5.7760E-06
131.747	4.3320E-06	97.027	5.7760E-06
132.560	4.3320E-06	97.626	5.7760E-06
133.373	3.6100E-06	98.225	5.7760E-06
134.187	3.6100E-06	98.824	5.7760E-06
135.000	3.6100E-06	99.423	5.0540E-06
135.813	3.6100E-06	100.022	5.0540E-06
136.626	3.6100E-06	100.620	5.0540E-06
137.440	3.6100E-06	101.219	4.3320E-06
138.126	3.5945E-06	101.818	4.3320E-06
139.066	3.6100E-06	102.417	3.6100E-06
139.879	2.8880E-06	103.016	3.6100E-06
140.693	2.8880E-06	103.615	3.6100E-06
141.506	2.8880E-06	104.214	3.6100E-06
142.319	2.1660E-06	104.813	3.6100E-06
143.132	2.1660E-06	105.412	3.6100E-06
143.946	2.1660E-06	106.011	3.6100E-06
144.759	2.1660E-06	106.610	3.6100E-06
145.572	2.1660E-06	107.209	3.6100E-06
146.385	1.4440E-06	107.808	3.6100E-06
147.199	1.4440E-06	108.407	3.6100E-06
148.012	7.2200E-07	109.005	3.6100E-06

148.825	7.2200E-07	109.604	3.6100E-06
149.638	7.2200E-07	110.203	2.8880E-06
150.452	7.2200E-07	110.802	2.1660E-06
151.265	7.2200E-07	111.401	2.1660E-06
152.078	7.2200E-07	112.000	2.1660E-06
152.891	7.2200E-07	112.599	2.1660E-06
153.705	7.2200E-07	113.198	2.1660E-06
154.518	7.2200E-07	113.797	1.4440E-06
155.331	7.2200E-07	114.396	1.4440E-06
156.144	7.2200E-07	114.995	1.4440E-06
156.958	7.2200E-07	115.594	1.4440E-06
157.771	7.2200E-07	116.193	1.4440E-06
158.584	7.2200E-07	116.792	1.4440E-06
159.397	7.2200E-07	117.391	7.2200E-07
160.211	7.2200E-07	117.989	7.2200E-07
161.024	7.2200E-07	118.588	7.2200E-07
161.837	7.2200E-07	119.187	7.2200E-07
162.650	7.2200E-07	119.786	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-22.7%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-20.3%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-20.1%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

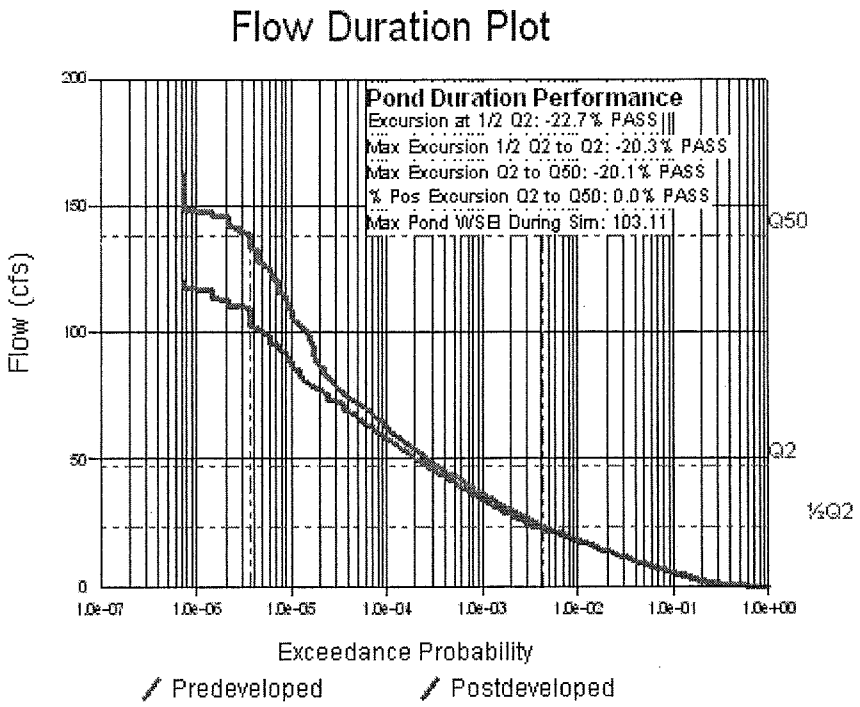
****

********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 1665249. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 2497873. cu-ft
2-Year Stormwater Pond Discharge Rate: 34.116 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -22.7% PASS
Max Excursion 1/2 Q2 to Q2: -20.3% PASS
Max Excursion Q2 to Q50: -20.1% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEl During Sim: 103.11
Flow (cfs)
200
150
100
50
0
Q50
Q2
½Q2
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 11:11 AM
****

Input File Name: Basin 12.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Ginder Creek 2
Comments : Basin north of downtown flowing to a small unnamed stream feeding Grinder (

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* Default HSPF Parameters Used (Not Modified by User) **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)	Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	52.040	52.040	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	1.090	1.090	0.000	No
Impervious	0.000	0.000	0.000	
SUBBASIN TOTAL	53.130	53.130	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 ---------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	103.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	101.2	ft
Pond Bottom Width	:	50.6	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	5117.	sq-ft
Area at Riser Crest El	:	8173.	sq-ft
	:	0.188	acres
Volume at Riser Crest	:	19757.	cu-ft
	:	0.454	ac-ft
Area at Max Elevation	:	8745.	sq-ft
	:	0.201	acres
Volume at Max Elevation	:	23977.	cu-ft
	:	0.550	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 24.00	in
Common Length	: 0.440	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 5.83	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 5.3	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	0.117	0.000	0.000	0.000
100.03	0.118	0.004	0.157	0.000
100.06	0.119	0.007	0.222	0.000
100.12	0.120	0.014	0.314	0.000
100.18	0.121	0.021	0.384	0.000
100.24	0.123	0.029	0.444	0.000
100.30	0.124	0.036	0.496	0.000
100.36	0.125	0.044	0.543	0.000
100.42	0.126	0.051	0.587	0.000
100.48	0.128	0.059	0.627	0.000
100.54	0.129	0.067	0.666	0.000
100.60	0.130	0.074	0.702	0.000
100.66	0.132	0.082	0.736	0.000
100.72	0.133	0.090	0.769	0.000
100.78	0.134	0.098	0.800	0.000
100.84	0.136	0.106	0.830	0.000
100.90	0.137	0.114	0.859	0.000
100.92	0.137	0.117	0.870	0.000
100.95	0.138	0.121	0.880	0.000
100.97	0.138	0.124	0.891	0.000
100.99	0.139	0.127	0.901	0.000
101.01	0.139	0.129	0.911	0.000
101.02	0.140	0.131	0.922	0.000
101.04	0.140	0.133	0.935	0.000
101.05	0.140	0.135	0.949	0.000
101.11	0.142	0.144	1.012	0.000
101.17	0.143	0.152	1.082	0.000
101.23	0.144	0.161	1.158	0.000
101.29	0.146	0.170	1.237	0.000
101.35	0.147	0.178	1.317	0.000
101.41	0.149	0.187	1.398	0.000
101.47	0.150	0.196	1.488	0.000
101.53	0.151	0.205	1.586	0.000
101.59	0.153	0.214	1.687	0.000
101.65	0.154	0.224	1.792	0.000
101.71	0.156	0.233	1.901	0.000
101.77	0.157	0.242	2.013	0.000
101.83	0.158	0.252	2.128	0.000
101.89	0.160	0.261	2.247	0.000
101.95	0.161	0.271	2.368	0.000
102.01	0.163	0.281	2.492	0.000
102.07	0.164	0.290	2.619	0.000
102.13	0.166	0.300	2.749	0.000
102.19	0.167	0.310	2.882	0.000
102.25	0.169	0.320	3.017	0.000
102.31	0.170	0.331	3.155	0.000
102.37	0.172	0.341	3.296	0.000
102.43	0.173	0.351	3.438	0.000
102.49	0.175	0.362	3.584	0.000
102.55	0.176	0.372	3.731	0.000
102.61	0.178	0.383	3.881	0.000
102.67	0.179	0.393	4.034	0.000
102.73	0.181	0.404	4.188	0.000
102.79	0.182	0.415	4.345	0.000
102.85	0.184	0.426	4.504	0.000
102.91	0.185	0.437	4.665	0.000
102.93	0.186	0.441	4.726	0.000
102.96	0.186	0.445	4.788	0.000

102.98	0.187	0.450	4.849	0.000
103.00	0.188	0.454	4.911	0.000
103.02	0.188	0.457	4.989	0.000
103.03	0.188	0.460	5.097	0.000
103.05	0.189	0.462	5.224	0.000
103.06	0.189	0.465	5.367	0.000
103.08	0.190	0.468	5.524	0.000
103.09	0.190	0.471	5.694	0.000
103.11	0.190	0.474	5.874	0.000
103.12	0.191	0.477	6.065	0.000
103.18	0.192	0.488	6.916	0.000
103.24	0.194	0.500	7.886	0.000
103.30	0.195	0.511	8.944	0.000
103.36	0.197	0.523	10.065	0.000
103.42	0.199	0.535	11.220	0.000
103.48	0.200	0.547	12.380	0.000
103.54	0.202	0.559	13.518	0.000
103.60	0.203	0.571	14.605	0.000
103.66	0.205	0.583	15.619	0.000
103.72	0.207	0.596	16.539	0.000
103.78	0.208	0.608	17.354	0.000
103.84	0.210	0.621	18.003	0.000
103.90	0.212	0.633	18.520	0.000
103.96	0.213	0.646	18.958	0.000
104.02	0.215	0.659	19.501	0.000
104.75	0.235	28.238	282.381	0.000
104.82	0.237	28.679	289.957	0.000
104.89	0.239	29.121	297.427	0.000
104.96	0.241	29.563	304.773	0.000
105.03	0.244	30.006	311.977	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	2.200	1940 04 30	2.019
1940 12 20	1.176	1940 12 20	1.102
1941 12 15	2.707	1941 12 15	1.520
1943 03 28	1.087	1943 03 28	1.038
1944 01 23	0.863	1944 01 23	0.808
1945 02 07	2.784	1945 02 07	2.588
1946 02 05	1.701	1946 02 05	1.654
1947 02 01	1.723	1947 02 02	1.587
1948 03 21	2.943	1948 03 21	2.605
1949 02 22	1.679	1949 02 22	1.664
1950 03 03	6.278	1950 03 03	4.854
1951 02 09	2.544	1951 02 09	2.497
1952 01 24	0.734	1952 01 24	0.690
1953 01 11	1.284	1953 01 11	1.229
1954 01 22	1.691	1954 01 22	1.662
1955 04 12	0.831	1955 04 12	0.730
1955 12 21	1.721	1956 01 06	1.631
1957 02 25	1.573	1957 02 25	1.535
1958 01 16	1.629	1958 01 16	1.610
1959 01 12	2.001	1959 01 13	1.850
1959 12 15	2.129	1959 12 15	1.833
1961 02 14	1.689	1960 11 20	1.616
1962 03 04	1.045	1962 03 04	1.021
1963 02 03	1.208	1963 02 03	1.146
1964 01 01	1.730	1964 01 01	1.456
1965 02 26	1.839	1965 02 27	1.679
1966 04 11	1.793	1966 04 11	1.576
1967 01 19	2.920	1967 01 19	2.540
1968 02 03	1.578	1968 02 04	1.438
1968 12 03	1.713	1968 12 03	1.562
1970 01 13	1.531	1970 01 14	1.175
1970 12 06	1.690	1970 12 06	1.474
1972 02 28	3.855	1972 02 28	3.412
1973 01 13	1.511	1972 12 23	1.467
1974 02 18	1.980	1974 02 19	1.876
1974 12 26	2.836	1974 12 27	2.285
1976 01 27	1.632	1976 01 27	1.544
1977 05 31	0.863	1977 05 31	0.818
1977 12 15	1.628	1977 12 15	1.565
1979 03 04	1.682	1979 03 04	1.341
1979 12 15	2.409	1979 12 15	2.386
1980 12 26	1.271	1980 12 26	1.108
1981 10 06	3.911	1981 10 06	3.212
1983 01 05	1.936	1983 01 05	1.833
1984 03 14	1.803	1984 03 20	1.249
1985 02 11	1.204	1985 02 11	1.128
1986 01 18	3.421	1986 01 18	3.356
1986 11 24	3.216	1986 11 24	3.096
1988 04 06	1.588	1988 04 06	1.547
1989 04 05	1.748	1989 04 05	1.614
1990 01 09	5.570	1990 01 09	5.475
1990 11 24	4.876	1990 11 24	4.243
1992 01 27	1.667	1992 01 27	1.428
1993 03 22	1.361	1993 03 23	1.314
1994 03 03	1.097	1994 03 03	1.051
1995 02 19	2.100	1995 02 19	2.076
1996 02 08	4.637	1996 02 09	4.205

1997 01 02	2.952	1997 01 02	2.583
1998 02 28	1.161	1998 03 23	0.921
1998 12 13	2.634	1998 11 25	2.546
2000 03 26	1.812	2000 03 26	1.749
2001 05 05	1.330	2001 05 05	1.161
2002 05 03	4.198	2002 05 03	2.281
2003 03 31	3.339	2003 03 31	3.291
2004 01 23	1.067	2004 01 23	0.996
2005 02 05	1.853	2005 02 07	1.315
2005 11 27	1.895	2005 11 27	1.880
2006 12 14	1.487	2006 12 15	1.414
2008 03 21	2.448	2008 01 07	2.169
2009 02 17	3.325	2009 02 17	3.137
2010 06 10	2.433	2010 01 10	2.037
2010 11 17	3.030	2010 11 17	2.798
2012 01 31	2.057	2012 01 31	1.283
2013 01 20	4.340	2013 01 20	4.036
2013 12 06	2.180	2014 04 05	1.838
2015 02 28	1.257	2015 03 30	1.207
2016 01 04	3.156	2016 01 04	2.988
2017 06 14	1.136	2017 03 07	0.981
2018 04 17	2.055	2018 01 31	1.729
2019 02 14	1.728	2019 02 14	1.685
2020 03 30	1.484	2020 04 14	1.342
2021 02 10	2.678	2021 02 10	2.653
2021 12 20	1.689	2021 12 20	1.495
2023 03 30	2.120	2023 03 30	2.097
2024 01 19	1.812	2024 01 19	1.770
2024 12 22	3.450	2024 12 22	3.245
2026 03 09	2.019	2026 03 09	1.914
2027 01 27	1.811	2027 01 28	1.775
2028 02 19	2.159	2028 02 19	2.148
2028 12 04	1.790	2028 12 04	1.773
2030 02 16	2.056	2030 02 16	1.994
2030 12 30	2.159	2030 12 30	2.129
2032 01 20	3.485	2032 01 20	3.383
2033 03 01	1.135	2033 03 01	1.003
2034 01 15	3.593	2034 01 16	3.356
2035 02 19	2.187	2035 02 19	1.990
2035 12 04	2.055	2036 03 24	1.801
2037 03 08	0.720	2037 03 09	0.618
2037 11 24	1.674	2037 12 15	1.439
2039 02 07	1.063	2038 12 11	0.959
2040 01 14	3.811	2040 01 14	2.401
2040 12 25	2.063	2040 12 25	2.007
2042 02 20	2.058	2042 02 20	1.638
2043 03 31	3.175	2043 03 31	1.956
2044 05 01	1.815	2044 05 01	1.521
2045 02 07	1.679	2045 03 23	1.600
2046 02 16	1.839	2046 02 16	1.816
2047 02 01	1.279	2047 02 01	1.256
2048 04 21	1.185	2048 04 21	1.156
2049 03 16	1.262	2049 03 16	1.145
2049 12 04	2.307	2049 12 04	2.141
2051 04 06	1.517	2051 04 06	1.334
2052 04 16	1.032	2052 04 17	0.900
2053 06 04	4.791	2053 06 04	2.336
2054 04 08	0.761	2054 04 08	0.715
2055 02 17	2.835	2055 02 17	2.562
2056 02 07	5.038	2056 02 07	4.580
2056 11 19	5.979	2056 11 19	5.042
2058 05 21	2.446	2058 05 21	2.218
2059 01 17	2.441	2058 12 28	2.206

2060	01 19	1.123	2060	01 19	0.906
2061	01 10	1.836	2061	01 10	1.794
2062	02 03	6.758	2062	02 03	4.866
2062	12 29	1.739	2062	12 29	1.646
2063	12 23	2.820	2063	12 23	2.696
2064	11 30	1.380	2064	11 30	1.333
2066	01 13	0.953	2066	01 13	0.883
2067	01 19	1.698	2067	01 19	1.630
2068	01 18	3.602	2068	01 18	3.299
2069	01 04	1.118	2069	01 04	1.041
2070	04 09	1.315	2070	04 09	1.058
2071	02 14	1.014	2071	02 14	0.973
2071	11 03	1.179	2071	11 03	1.132
2072	12 25	3.983	2072	12 25	3.915
2074	03 16	2.310	2074	03 16	2.010
2075	01 17	0.754	2075	01 17	0.724
2076	03 24	2.646	2076	03 24	2.108
2077	02 12	0.671	2077	02 12	0.631
2077	11 25	1.199	2077	12 02	1.087
2079	02 25	1.346	2079	02 25	1.329
2079	12 17	4.815	2079	12 17	4.313
2080	11 21	2.206	2080	11 21	2.136
2082	02 14	2.442	2082	02 14	2.430
2083	03 29	1.561	2083	02 11	1.445
2083	11 26	2.064	2083	11 26	1.888
2084	12 14	1.419	2084	12 14	1.356
2086	01 18	1.876	2086	01 18	1.829
2086	12 21	1.886	2086	12 21	1.646
2088	01 14	1.293	2088	01 14	1.238
2088	11 05	3.085	2088	11 05	2.684
2090	01 06	1.157	2090	01 07	1.026
2090	12 04	1.903	2090	12 04	1.770
2092	04 28	3.934	2092	01 31	2.155
2093	03 22	1.129	2093	03 22	1.061
2094	03 01	0.920	2094	03 02	0.865
2094	11 29	1.358	2094	11 30	1.329
2096	01 14	1.536	2096	01 14	1.514
2097	01 29	2.980	2097	01 29	2.537

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	0.671	1.00	0.618
1.01	0.720	1.01	0.631
1.02	0.734	1.02	0.690
1.02	0.754	1.02	0.715
1.03	0.761	1.03	0.724
1.04	0.831	1.04	0.730
1.04	0.863	1.04	0.808
1.05	0.863	1.05	0.818
1.06	0.920	1.06	0.865
1.06	0.953	1.06	0.883
1.07	1.014	1.07	0.900
1.08	1.032	1.08	0.906
1.09	1.045	1.09	0.921
1.09	1.063	1.09	0.959
1.10	1.067	1.10	0.973
1.11	1.087	1.11	0.981
1.12	1.097	1.12	0.996
1.12	1.118	1.12	1.003
1.13	1.123	1.13	1.021
1.14	1.129	1.14	1.026
1.15	1.135	1.15	1.038
1.16	1.136	1.16	1.041
1.17	1.157	1.17	1.051
1.18	1.161	1.18	1.058
1.18	1.176	1.18	1.061
1.19	1.179	1.19	1.087
1.20	1.185	1.20	1.102
1.21	1.199	1.21	1.108
1.22	1.204	1.22	1.128
1.23	1.208	1.23	1.132
1.24	1.257	1.24	1.145
1.25	1.262	1.25	1.146
1.26	1.271	1.26	1.156
1.27	1.279	1.27	1.161
1.28	1.284	1.28	1.175
1.29	1.293	1.29	1.207
1.30	1.315	1.30	1.229
1.31	1.330	1.31	1.238
1.32	1.346	1.32	1.249
1.33	1.358	1.33	1.256
1.35	1.361	1.35	1.283
1.36	1.380	1.36	1.314
1.37	1.419	1.37	1.315
1.38	1.484	1.38	1.329
1.39	1.487	1.39	1.329
1.40	1.511	1.40	1.333
1.42	1.517	1.42	1.334
1.43	1.531	1.43	1.341
1.44	1.536	1.44	1.342
1.46	1.561	1.46	1.356
1.47	1.573	1.47	1.414
1.48	1.578	1.48	1.428
1.50	1.588	1.50	1.438
1.51	1.628	1.51	1.439
1.53	1.629	1.53	1.445
1.54	1.632	1.54	1.456

1.56	1.667	1.56	1.467
1.57	1.674	1.57	1.474
1.59	1.679	1.59	1.495
1.60	1.679	1.60	1.514
1.62	1.682	1.62	1.520
1.64	1.689	1.64	1.521
1.65	1.689	1.65	1.535
1.67	1.690	1.67	1.544
1.69	1.691	1.69	1.547
1.71	1.698	1.71	1.562
1.73	1.701	1.73	1.565
1.75	1.713	1.75	1.576
1.77	1.721	1.77	1.587
1.79	1.723	1.79	1.600
1.81	1.728	1.81	1.610
1.83	1.730	1.83	1.614
1.85	1.739	1.85	1.616
1.87	1.748	1.87	1.630
1.89	1.790	1.89	1.631
1.92	1.793	1.92	1.638
1.94	1.803	1.94	1.646
1.96	1.811	1.96	1.646
1.99	1.812	1.99	1.654
2.01	1.812	2.01	1.662
2.04	1.815	2.04	1.664
2.07	1.836	2.07	1.679
2.09	1.839	2.09	1.685
2.12	1.839	2.12	1.729
2.15	1.853	2.15	1.749
2.18	1.876	2.18	1.770
2.21	1.886	2.21	1.770
2.24	1.895	2.24	1.773
2.27	1.903	2.27	1.775
2.31	1.936	2.31	1.794
2.34	1.980	2.34	1.801
2.38	2.001	2.38	1.816
2.41	2.019	2.41	1.829
2.45	2.055	2.45	1.833
2.49	2.055	2.49	1.833
2.53	2.056	2.53	1.838
2.57	2.057	2.57	1.850
2.61	2.058	2.61	1.876
2.65	2.063	2.65	1.880
2.70	2.064	2.70	1.888
2.75	2.100	2.75	1.914
2.80	2.120	2.80	1.956
2.85	2.129	2.85	1.990
2.90	2.159	2.90	1.994
2.95	2.159	2.95	2.007
3.01	2.180	3.01	2.010
3.07	2.187	3.07	2.019
3.13	2.200	3.13	2.037
3.19	2.206	3.19	2.076
3.26	2.307	3.26	2.097
3.32	2.310	3.32	2.108
3.40	2.409	3.40	2.129
3.47	2.433	3.47	2.136
3.55	2.441	3.55	2.141
3.63	2.442	3.63	2.148
3.72	2.446	3.72	2.155
3.80	2.448	3.80	2.169
3.90	2.544	3.90	2.206
4.00	2.634	4.00	2.218

4.10	2.646	4.10	2.281
4.21	2.678	4.21	2.285
4.32	2.707	4.32	2.336
4.45	2.784	4.45	2.386
4.58	2.820	4.58	2.401
4.71	2.835	4.71	2.430
4.86	2.836	4.86	2.497
5.01	2.920	5.01	2.537
5.17	2.943	5.17	2.540
5.35	2.952	5.35	2.546
5.54	2.980	5.54	2.562
5.74	3.030	5.74	2.583
5.95	3.085	5.95	2.588
6.19	3.156	6.19	2.605
6.44	3.175	6.44	2.653
6.71	3.216	6.71	2.684
7.01	3.325	7.01	2.696
7.33	3.339	7.33	2.798
7.69	3.421	7.69	2.988
8.08	3.450	8.08	3.096
8.52	3.485	8.52	3.137
9.00	3.593	9.00	3.212
9.55	3.602	9.55	3.245
10.16	3.811	10.16	3.291
10.86	3.855	10.86	3.299
11.66	3.911	11.66	3.356
12.59	3.934	12.59	3.356
13.68	3.983	13.68	3.383
14.97	4.198	14.97	3.412
16.54	4.340	16.54	3.915
18.47	4.637	18.47	4.036
20.92	4.791	20.92	4.205
24.10	4.815	24.10	4.243
28.44	4.876	28.44	4.313
34.68	5.038	34.68	4.580
44.42	5.570	44.42	4.854
61.77	5.979	61.77	4.866
101.36	6.278	101.36	5.042
282.36	6.758	282.36	5.475

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	1.153	1.153	
2-Year	1.859	1.859	1.658
5-Year	2.796	2.796	2.534
10-Year	3.536	3.536	3.279
25-Year	4.635	4.635	4.259
50-Year	5.588	5.588	4.858
100-Year	6.667	6.667	5.037
200-Year	7.895	7.895	5.329

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.034	3.0727E-01	0.027	3.2408E-01
0.068	2.4655E-01	0.055	2.6585E-01
0.101	2.0792E-01	0.082	2.2834E-01
0.135	1.7896E-01	0.110	2.0030E-01
0.169	1.5581E-01	0.137	1.7768E-01
0.203	1.3617E-01	0.164	1.5955E-01
0.237	1.1961E-01	0.192	1.4270E-01
0.270	1.0505E-01	0.219	1.2863E-01
0.304	9.2587E-02	0.246	1.1575E-01
0.338	8.1688E-02	0.274	1.0412E-01
0.372	7.2376E-02	0.301	9.4010E-02
0.405	6.4317E-02	0.329	8.5265E-02
0.439	5.7224E-02	0.356	7.7099E-02
0.473	5.1035E-02	0.383	7.0149E-02
0.507	4.5573E-02	0.411	6.3716E-02
0.541	4.0721E-02	0.438	5.8148E-02
0.574	3.6473E-02	0.465	5.2931E-02
0.608	3.2691E-02	0.493	4.8447E-02
0.642	2.9321E-02	0.520	4.4152E-02
0.676	2.6249E-02	0.548	4.0368E-02
0.710	2.3581E-02	0.575	3.6926E-02
0.743	2.1198E-02	0.602	3.3725E-02
0.777	1.9043E-02	0.630	3.0905E-02
0.811	1.7073E-02	0.657	2.8310E-02
0.845	1.5354E-02	0.684	2.5874E-02
0.879	1.3844E-02	0.712	2.3699E-02
0.912	1.2465E-02	0.739	2.1626E-02
0.929	1.1862E-02	0.767	1.9742E-02
0.980	1.0270E-02	0.794	1.8002E-02
1.014	9.3449E-03	0.821	1.6365E-02
1.047	8.5044E-03	0.849	1.4838E-02
1.081	7.7572E-03	0.876	1.3355E-02
1.115	7.0612E-03	0.903	1.1960E-02
1.149	6.4511E-03	0.929	1.0980E-02
1.183	5.9074E-03	0.958	1.0122E-02
1.216	5.3890E-03	0.986	9.3860E-03
1.250	4.9638E-03	1.013	8.7189E-03
1.284	4.5558E-03	1.040	8.1247E-03
1.318	4.2136E-03	1.068	7.5695E-03
1.352	3.8685E-03	1.095	7.0568E-03
1.385	3.5746E-03	1.122	6.5637E-03
1.419	3.2945E-03	1.150	6.1298E-03
1.453	3.0360E-03	1.177	5.7226E-03
1.487	2.8043E-03	1.205	5.3406E-03
1.521	2.5913E-03	1.232	4.9861E-03
1.554	2.3905E-03	1.259	4.6764E-03
1.588	2.2122E-03	1.287	4.3825E-03
1.622	2.0570E-03	1.314	4.0945E-03
1.656	1.8830E-03	1.341	3.8042E-03
1.690	1.7436E-03	1.369	3.5494E-03
1.723	1.6130E-03	1.396	3.3068E-03
1.757	1.4982E-03	1.424	3.0880E-03
1.791	1.4007E-03	1.451	2.8996E-03
1.825	1.3025E-03	1.478	2.7248E-03
1.859	1.2211E-03	1.506	2.5588E-03
1.892	1.1516E-03	1.533	2.3985E-03

1.926	1.0866E-03	1.560	2.2433E-03
1.960	1.0317E-03	1.588	2.1169E-03
1.994	9.7470E-04	1.615	1.9812E-03
2.027	9.1189E-04	1.643	1.8454E-03
2.061	8.5774E-04	1.670	1.7386E-03
2.095	8.0142E-04	1.697	1.6375E-03
2.129	7.5882E-04	1.725	1.5436E-03
2.163	7.1334E-04	1.752	1.4483E-03
2.196	6.5991E-04	1.779	1.3704E-03
2.230	6.2814E-04	1.807	1.3032E-03
2.264	6.0287E-04	1.834	1.2361E-03
2.298	5.7182E-04	1.859	1.1776E-03
2.332	5.3572E-04	1.889	1.1140E-03
2.365	5.1695E-04	1.916	1.0635E-03
2.399	4.8518E-04	1.944	1.0231E-03
2.433	4.7002E-04	1.971	9.6893E-04
2.467	4.4331E-04	1.999	9.3066E-04
2.500	4.2670E-04	2.026	8.8012E-04
2.534	3.9927E-04	2.053	8.4474E-04
2.568	3.7544E-04	2.081	7.9781E-04
2.602	3.5378E-04	2.108	7.6027E-04
2.636	3.2779E-04	2.135	7.1984E-04
2.669	3.1118E-04	2.163	6.8735E-04
2.703	2.9458E-04	2.190	6.5052E-04
2.737	2.7653E-04	2.218	6.1948E-04
2.771	2.6353E-04	2.245	5.9926E-04
2.796	2.5258E-04	2.272	5.7616E-04
2.838	2.3393E-04	2.300	5.5666E-04
2.872	2.2526E-04	2.327	5.2778E-04
2.906	2.1371E-04	2.354	5.1190E-04
2.940	2.0072E-04	2.382	4.8374E-04
2.974	1.8916E-04	2.409	4.6858E-04
3.007	1.7978E-04	2.437	4.5486E-04
3.041	1.6534E-04	2.464	4.3464E-04
3.075	1.5595E-04	2.491	4.1876E-04
3.109	1.4512E-04	2.519	4.0071E-04
3.142	1.4007E-04	2.546	3.7833E-04
3.176	1.2924E-04	2.573	3.5595E-04
3.210	1.2274E-04	2.601	3.3284E-04
3.244	1.1696E-04	2.628	3.1407E-04
3.278	1.1119E-04	2.656	3.0396E-04
3.311	1.0613E-04	2.683	2.9169E-04
3.345	9.8914E-05	2.710	2.7653E-04
3.379	9.2416E-05	2.738	2.6786E-04
3.413	8.8806E-05	2.765	2.5414E-04
3.447	8.1586E-05	2.796	2.4168E-04
3.480	7.4366E-05	2.820	2.3537E-04
3.514	7.2200E-05	2.847	2.2310E-04
3.548	6.7868E-05	2.875	2.1371E-04
3.582	6.3536E-05	2.902	2.0649E-04
3.616	5.7760E-05	2.929	1.9566E-04
3.649	5.2706E-05	2.957	1.8628E-04
3.683	5.1262E-05	2.984	1.8122E-04
3.717	4.6930E-05	3.011	1.6895E-04
3.751	4.2598E-05	3.039	1.6101E-04
3.785	4.1154E-05	3.066	1.5306E-04
3.818	3.8266E-05	3.094	1.4657E-04
3.852	3.4656E-05	3.121	1.3935E-04
3.886	3.1046E-05	3.148	1.2852E-04
3.920	3.0324E-05	3.176	1.2346E-04
3.953	2.7436E-05	3.203	1.1985E-04
3.987	2.3104E-05	3.230	1.1335E-04
4.021	2.3104E-05	3.258	1.0686E-04

4.055	2.1660E-05	3.285	1.0180E-04
4.089	2.0938E-05	3.313	9.6748E-05
4.122	2.0216E-05	3.340	9.1694E-05
4.156	1.8050E-05	3.367	8.4474E-05
4.190	1.7328E-05	3.395	8.2308E-05
4.224	1.5162E-05	3.422	7.9420E-05
4.258	1.2996E-05	3.449	7.4366E-05
4.291	1.2996E-05	3.477	7.1478E-05
4.325	1.2996E-05	3.504	6.9312E-05
4.359	1.1552E-05	3.532	6.4258E-05
4.393	1.0830E-05	3.559	6.1370E-05
4.427	1.0830E-05	3.586	5.7038E-05
4.460	1.0830E-05	3.614	5.5594E-05
4.494	1.0108E-05	3.641	5.1984E-05
4.528	1.0108E-05	3.668	4.9096E-05
4.562	1.0108E-05	3.696	4.2598E-05
4.595	1.0108E-05	3.723	4.1154E-05
4.629	1.0108E-05	3.751	3.8988E-05
4.663	9.3860E-06	3.778	3.7544E-05
4.697	9.3860E-06	3.805	3.6822E-05
4.731	9.3860E-06	3.833	3.1046E-05
4.764	9.3860E-06	3.860	3.0324E-05
4.798	8.6640E-06	3.888	2.8158E-05
4.832	7.9420E-06	3.915	2.3826E-05
4.866	7.9420E-06	3.942	2.3104E-05
4.900	7.2200E-06	3.970	2.2382E-05
4.933	7.2200E-06	3.997	2.0216E-05
4.967	7.2200E-06	4.024	1.8772E-05
5.001	7.2200E-06	4.052	1.7328E-05
5.035	7.2200E-06	4.079	1.6606E-05
5.069	6.4980E-06	4.107	1.5884E-05
5.102	5.7760E-06	4.134	1.5884E-05
5.136	5.7760E-06	4.161	1.2996E-05
5.170	5.7760E-06	4.189	1.2274E-05
5.204	5.0540E-06	4.216	1.0830E-05
5.237	5.0540E-06	4.243	1.0108E-05
5.271	5.0540E-06	4.271	1.0108E-05
5.305	5.0540E-06	4.298	1.0108E-05
5.339	5.0540E-06	4.326	9.3860E-06
5.373	5.0540E-06	4.353	8.6640E-06
5.406	5.0540E-06	4.380	7.2200E-06
5.440	5.0540E-06	4.408	7.2200E-06
5.474	5.0540E-06	4.435	7.2200E-06
5.508	5.0540E-06	4.462	7.2200E-06
5.542	4.3320E-06	4.490	6.4980E-06
5.588	3.5556E-06	4.517	6.4980E-06
5.609	3.6100E-06	4.545	5.7760E-06
5.643	3.6100E-06	4.572	5.7760E-06
5.677	3.6100E-06	4.599	5.0540E-06
5.711	3.6100E-06	4.627	5.0540E-06
5.744	3.6100E-06	4.654	4.3320E-06
5.778	3.6100E-06	4.681	4.3320E-06
5.812	3.6100E-06	4.709	4.3320E-06
5.846	2.1660E-06	4.736	4.3320E-06
5.879	2.1660E-06	4.764	4.3320E-06
5.913	2.1660E-06	4.791	4.3320E-06
5.947	2.1660E-06	4.818	4.3320E-06
5.981	1.4440E-06	4.846	4.3320E-06
6.015	1.4440E-06	4.873	2.8880E-06
6.048	1.4440E-06	4.900	2.8880E-06
6.082	1.4440E-06	4.928	2.8880E-06
6.116	1.4440E-06	4.955	2.8880E-06
6.150	1.4440E-06	4.983	2.8880E-06

6.184	1.4440E-06	5.010	2.8880E-06
6.217	1.4440E-06	5.037	2.1660E-06
6.251	1.4440E-06	5.065	1.4440E-06
6.285	7.2200E-07	5.092	7.2200E-07
6.319	7.2200E-07	5.119	7.2200E-07
6.353	7.2200E-07	5.147	7.2200E-07
6.386	7.2200E-07	5.174	7.2200E-07
6.420	7.2200E-07	5.202	7.2200E-07
6.454	7.2200E-07	5.229	7.2200E-07
6.488	7.2200E-07	5.256	7.2200E-07
6.522	7.2200E-07	5.284	7.2200E-07
6.555	7.2200E-07	5.311	7.2200E-07
6.589	7.2200E-07	5.338	7.2200E-07
6.623	7.2200E-07	5.366	7.2200E-07
6.657	7.2200E-07	5.393	7.2200E-07
6.690	7.2200E-07	5.421	7.2200E-07
6.724	7.2200E-07	5.448	7.2200E-07
6.758	7.2200E-07	5.475	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-7.4%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-3.2%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-2.0%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

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POND MEETS ALL DURATION DESIGN CRITERIA: PASS

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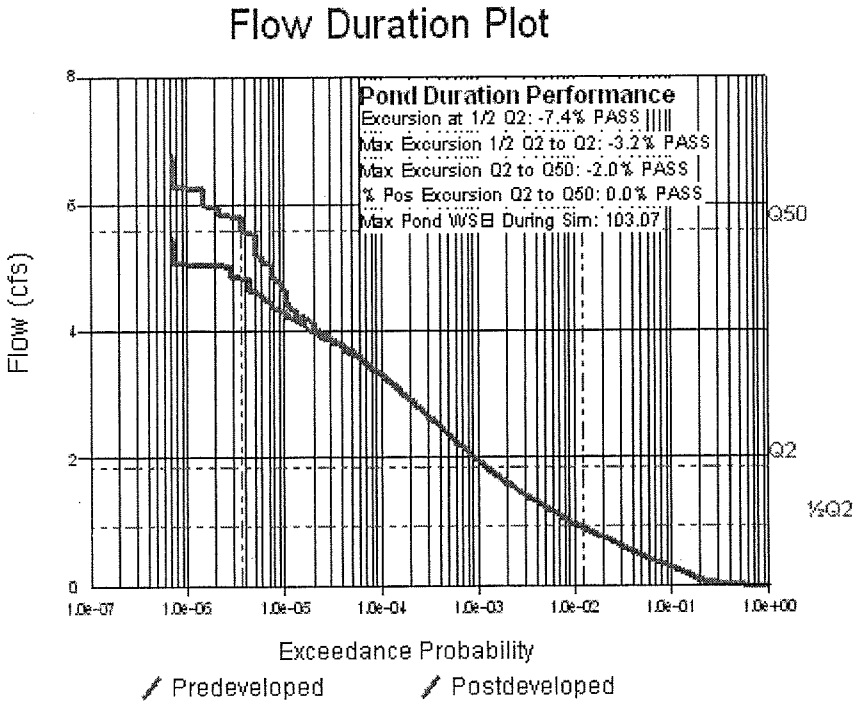
********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 102100. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 153149. cu-ft
2-Year Stormwater Pond Discharge Rate: 1.658 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -7.4% PASS
Max Excursion 1/2 Q2 to Q2: -3.2% PASS
Max Excursion Q2 to Q50: -2.0% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEL During Sim: 103.07
Q50
Q2
½Q2
Flow (cfs)
8
6
4
2
0
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 11:17 AM

****

Input File Name: Basin 13.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Ginder Creek 3
Comments : East Downtown and upland areas tributary to Jones Lake.

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* Default HSPF Parameters Used (Not Modified by User) **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)			
		Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	165.120	165.120	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	1.090	1.090	0.000	No
Impervious	3.620	3.620	0.000	
SUBBASIN TOTAL	169.830	169.830	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.00	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	200.1	ft
Pond Bottom Width	:	100.1	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	20025.	sq-ft
Area at Riser Crest El	:	25752.	sq-ft
	:	0.591	acres
Volume at Riser Crest	:	68486.	cu-ft
	:	1.572	ac-ft
Area at Max Elevation	:	27806.	sq-ft
	:	0.638	acres
Volume at Max Elevation	:	95236.	cu-ft
	:	2.186	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	:	Circular	
Riser Diameter	:	36.00	in
Common Length	:	1.428	ft
Riser Crest Elevation	:	103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	:	Circular Orifice	
Invert Elevation	:	100.00	ft
Diameter	:	10.91	in
Orientation	:	Horizontal	
Elbow	:	No	

--- Device Number 2 ---

Device Type	:	Vertical Rectangular Orifice	
Invert Elevation	:	100.99	ft
Length	:	17.1	in
Height	:	24.1	in
Orientation	:	Vertical	
Elbow	:	No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	0.460	0.000	0.000	0.000
100.04	0.461	0.016	0.594	0.000
100.07	0.463	0.032	0.841	0.000
100.14	0.466	0.065	1.189	0.000
100.21	0.468	0.097	1.456	0.000
100.28	0.471	0.130	1.681	0.000
100.35	0.474	0.163	1.880	0.000
100.42	0.477	0.197	2.059	0.000
100.49	0.480	0.230	2.224	0.000
100.56	0.483	0.264	2.377	0.000
100.63	0.486	0.298	2.522	0.000
100.70	0.489	0.332	2.658	0.000
100.77	0.492	0.366	2.788	0.000
100.84	0.495	0.401	2.912	0.000
100.91	0.498	0.436	3.031	0.000
100.93	0.499	0.446	3.064	0.000
100.95	0.500	0.456	3.096	0.000
100.97	0.501	0.466	3.129	0.000
100.99	0.501	0.476	3.161	0.000
101.01	0.502	0.484	3.200	0.000
101.03	0.503	0.493	3.247	0.000
101.04	0.504	0.502	3.301	0.000
101.06	0.504	0.511	3.358	0.000
101.13	0.507	0.546	3.621	0.000
101.20	0.511	0.582	3.924	0.000
101.27	0.514	0.618	4.257	0.000
101.34	0.517	0.654	4.614	0.000
101.41	0.520	0.690	4.990	0.000
101.48	0.523	0.727	5.384	0.000
101.55	0.526	0.763	5.791	0.000
101.62	0.529	0.800	6.211	0.000
101.69	0.532	0.837	6.642	0.000
101.76	0.535	0.875	7.081	0.000
101.83	0.538	0.912	7.527	0.000
101.90	0.541	0.950	7.980	0.000
101.97	0.544	0.988	8.439	0.000
102.04	0.548	1.026	8.901	0.000
102.11	0.551	1.065	9.366	0.000
102.18	0.554	1.103	9.834	0.000
102.25	0.557	1.142	10.303	0.000
102.32	0.560	1.181	10.773	0.000
102.39	0.563	1.221	11.243	0.000
102.46	0.566	1.260	11.762	0.000
102.53	0.570	1.300	12.322	0.000
102.60	0.573	1.340	12.893	0.000
102.67	0.576	1.380	13.474	0.000
102.74	0.579	1.420	14.064	0.000
102.81	0.582	1.461	14.665	0.000
102.88	0.586	1.502	15.275	0.000
102.91	0.587	1.520	15.539	0.000
102.94	0.588	1.537	15.805	0.000
102.97	0.590	1.555	16.072	0.000
103.00	0.591	1.573	16.342	0.000
103.02	0.592	1.583	16.562	0.000
103.04	0.593	1.593	16.835	0.000
103.05	0.594	1.604	17.142	0.000
103.07	0.594	1.614	17.477	0.000
103.09	0.595	1.625	17.836	0.000

103.11	0.596	1.635	18.216	0.000
103.12	0.597	1.645	18.616	0.000
103.14	0.598	1.656	19.034	0.000
103.21	0.601	1.698	20.867	0.000
103.28	0.604	1.740	22.917	0.000
103.35	0.608	1.782	25.147	0.000
103.42	0.611	1.825	27.522	0.000
103.49	0.614	1.868	30.011	0.000
103.56	0.617	1.911	32.581	0.000
103.63	0.621	1.954	35.198	0.000
103.70	0.624	1.998	37.829	0.000
103.77	0.627	2.042	40.440	0.000
103.84	0.631	2.086	42.815	0.000
103.91	0.634	2.130	44.951	0.000
103.98	0.637	2.175	46.961	0.000
104.05	0.641	2.219	48.822	0.000
104.12	0.644	2.264	50.518	0.000
104.19	0.647	2.309	52.040	0.000
104.26	0.651	2.355	53.389	0.000
104.33	0.654	2.401	54.579	0.000
104.40	0.658	2.446	55.634	0.000
104.47	0.661	2.493	56.596	0.000
104.54	0.664	2.539	57.897	0.000
104.61	0.668	27.358	266.984	0.000
104.68	0.671	27.798	274.718	0.000
104.75	0.675	28.238	282.381	0.000
104.82	0.678	28.679	289.957	0.000
104.89	0.682	29.121	297.427	0.000
104.96	0.685	29.563	304.773	0.000
105.03	0.689	30.006	311.977	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	7.477	1940 04 30	6.837
1940 12 20	4.192	1940 12 20	3.728
1941 12 15	9.976	1941 12 15	5.617
1942 11 23	4.081	1943 03 28	3.435
1944 01 22	3.356	1944 01 23	2.729
1945 02 07	9.820	1945 02 07	9.079
1946 01 23	5.816	1946 02 05	5.519
1947 02 01	6.196	1947 02 02	5.333
1948 03 21	10.037	1948 03 21	8.796
1949 02 22	5.552	1949 02 22	5.458
1950 03 03	21.032	1950 03 03	16.153
1951 02 09	8.334	1951 02 09	8.148
1952 06 29	3.783	1952 01 24	2.376
1953 01 11	4.590	1953 01 11	4.201
1954 01 22	5.593	1954 01 22	5.474
1955 04 12	3.072	1955 04 12	2.436
1955 12 21	5.918	1955 12 21	5.523
1957 02 25	5.394	1957 02 25	5.049
1958 01 16	5.456	1958 01 16	5.379
1959 01 12	6.864	1959 01 13	6.293
1959 12 15	7.546	1959 12 15	6.463
1961 02 14	6.073	1960 11 20	5.559
1962 03 04	3.560	1962 03 04	3.380
1963 02 03	4.202	1963 02 03	3.842
1964 01 01	6.108	1964 01 01	5.066
1965 02 26	6.262	1965 02 27	5.675
1966 04 11	6.178	1966 04 11	5.369
1967 01 19	9.916	1967 01 19	8.537
1968 02 03	5.480	1968 02 04	4.879
1968 12 03	5.979	1968 12 03	5.348
1970 01 13	5.706	1970 01 14	4.139
1970 12 06	6.202	1970 12 06	5.230
1972 02 28	12.923	1972 02 28	11.171
1973 01 13	5.191	1972 12 23	4.945
1974 02 18	6.615	1974 02 19	6.228
1974 12 26	10.158	1974 12 27	8.158
1975 12 02	5.672	1976 01 27	5.207
1977 05 31	3.058	1977 05 31	2.805
1978 09 22	5.926	1977 12 15	5.290
1979 03 04	5.927	1979 03 04	4.621
1979 12 14	8.212	1979 12 15	7.959
1980 11 21	5.261	1980 12 26	3.763
1981 10 06	14.081	1981 10 06	11.253
1983 01 05	6.636	1983 01 05	6.191
1984 03 14	6.409	1984 03 20	4.124
1985 02 11	4.358	1985 02 11	3.767
1986 01 18	11.564	1986 01 18	11.049
1986 11 24	11.215	1986 11 24	10.683
1988 04 06	5.630	1988 04 06	5.243
1989 04 05	6.015	1989 04 05	5.391
1990 01 09	18.681	1990 01 09	18.106
1990 11 24	16.743	1990 11 24	14.563
1992 01 27	5.988	1992 01 27	5.127
1993 03 22	4.641	1993 03 23	4.404
1994 03 03	3.805	1994 03 03	3.508
1995 02 19	7.036	1995 02 19	6.850
1996 02 08	15.316	1996 02 09	13.685

1997	01	02	10.140	1997	01	02	8.561
1998	02	28	4.363	1998	03	23	3.049
1998	11	04	10.441	1998	11	25	8.727
2000	02	05	6.236	2000	03	26	5.811
2001	05	05	4.822	2001	05	05	3.882
2002	05	03	14.857	2002	05	03	8.057
2003	03	31	10.870	2003	03	31	10.673
2004	01	23	3.772	2004	01	23	3.311
2005	02	05	6.782	2005	02	07	4.565
2005	11	27	6.639	2005	11	27	6.407
2006	12	14	5.505	2006	12	14	4.857
2008	03	21	8.555	2008	01	06	7.352
2009	02	17	11.145	2009	02	17	10.505
2010	06	10	10.702	2010	01	10	7.059
2010	11	17	10.624	2010	11	17	9.676
2012	01	31	7.303	2012	01	31	4.371
2013	01	20	14.957	2013	01	20	13.683
2013	12	06	8.262	2014	04	05	6.128
2015	02	28	4.745	2015	03	30	4.009
2016	01	04	10.767	2016	01	04	10.027
2017	06	14	4.619	2017	03	07	3.224
2018	04	17	7.130	2018	01	31	5.762
2019	03	29	5.892	2019	02	14	5.562
2020	03	30	5.268	2020	04	14	4.436
2021	02	10	8.809	2021	02	10	8.673
2021	12	20	6.498	2021	12	20	5.278
2023	02	02	7.559	2023	03	30	6.887
2024	01	19	6.211	2024	01	19	5.872
2024	12	22	11.855	2024	12	22	10.916
2026	03	09	6.849	2026	03	09	6.480
2027	01	27	6.080	2027	01	27	5.933
2028	02	19	7.079	2028	02	19	7.037
2028	12	04	6.083	2028	12	04	5.953
2029	11	04	7.419	2030	02	16	6.631
2030	12	30	7.252	2030	12	30	7.126
2032	01	20	11.616	2032	01	20	11.162
2033	03	01	4.116	2033	03	01	3.339
2034	01	15	11.961	2034	01	16	10.978
2035	02	19	7.446	2035	02	19	6.721
2035	12	04	7.632	2035	12	04	6.258
2037	03	08	3.079	2037	03	08	2.251
2037	11	24	6.530	2037	12	15	4.865
2039	02	07	4.049	2038	12	11	3.276
2040	01	14	13.406	2040	01	14	8.491
2040	12	25	7.169	2040	12	25	6.909
2042	02	20	7.144	2042	02	20	5.664
2043	03	31	10.948	2043	03	31	6.626
2044	05	01	6.238	2044	05	01	5.120
2045	02	07	6.147	2045	03	23	5.399
2046	02	16	6.202	2046	02	16	5.981
2047	01	31	4.520	2047	02	01	4.199
2048	04	20	4.131	2048	04	21	3.852
2049	03	16	4.644	2049	03	16	3.862
2049	12	04	8.371	2049	12	04	7.747
2051	04	06	5.309	2051	04	06	4.454
2052	04	16	3.980	2052	04	17	3.013
2053	06	04	16.472	2053	06	04	8.011
2054	04	08	2.747	2054	02	24	2.464
2055	02	17	9.600	2055	02	17	8.605
2056	02	07	16.603	2056	02	07	15.033
2056	11	19	20.238	2056	11	19	16.855
2058	05	21	8.325	2058	05	21	7.473
2059	01	17	8.499	2058	12	28	7.322

2060 01 19	4.217	2060 01 19	3.087
2061 01 10	6.139	2061 01 10	5.949
2062 02 03	22.966	2062 02 03	16.510
2062 12 29	5.944	2062 12 29	5.613
2063 12 23	9.518	2063 12 23	9.015
2064 11 29	5.051	2064 11 30	4.578
2066 01 13	3.308	2066 01 13	2.990
2067 01 19	5.768	2067 01 19	5.398
2068 01 18	12.082	2068 01 18	10.959
2069 01 04	3.924	2069 01 04	3.405
2070 04 09	4.713	2070 04 09	3.519
2071 02 14	3.523	2071 02 14	3.236
2071 11 03	4.189	2071 11 03	3.921
2072 12 25	13.348	2072 12 25	13.095
2074 03 16	7.908	2074 03 16	6.761
2075 02 12	3.063	2075 01 17	2.471
2076 03 24	9.111	2076 03 24	7.214
2077 02 12	2.494	2077 02 12	2.152
2077 11 25	4.706	2077 12 02	3.640
2079 02 25	4.469	2079 02 25	4.408
2079 12 17	16.398	2079 12 17	14.585
2080 11 21	7.721	2080 11 21	7.254
2082 02 14	7.900	2082 02 14	7.864
2083 03 29	5.580	2083 02 11	4.776
2083 11 26	7.120	2083 11 26	6.501
2084 12 14	4.904	2084 12 14	4.594
2086 01 18	6.419	2086 01 18	6.201
2086 12 21	6.953	2086 12 21	5.606
2088 01 14	4.774	2088 01 14	4.290
2088 11 05	11.270	2088 11 05	9.799
2090 01 06	4.033	2089 12 05	3.399
2090 12 04	6.585	2090 12 04	6.074
2092 04 28	13.596	2092 01 31	7.053
2093 03 22	3.910	2093 03 22	3.567
2094 03 01	3.131	2094 03 02	2.901
2094 11 29	4.756	2094 11 29	4.522
2096 01 14	5.145	2096 01 14	4.979
2097 01 29	10.144	2097 01 29	8.596

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	2.494	1.00	2.152
1.01	2.747	1.01	2.251
1.02	3.058	1.02	2.376
1.02	3.063	1.02	2.436
1.03	3.072	1.03	2.464
1.04	3.079	1.04	2.471
1.04	3.131	1.04	2.729
1.05	3.308	1.05	2.805
1.06	3.356	1.06	2.901
1.06	3.523	1.06	2.990
1.07	3.560	1.07	3.013
1.08	3.772	1.08	3.049
1.09	3.783	1.09	3.087
1.09	3.805	1.09	3.224
1.10	3.910	1.10	3.236
1.11	3.924	1.11	3.276
1.12	3.980	1.12	3.311
1.12	4.033	1.12	3.339
1.13	4.049	1.13	3.380
1.14	4.081	1.14	3.399
1.15	4.116	1.15	3.405
1.16	4.131	1.16	3.435
1.17	4.189	1.17	3.508
1.18	4.192	1.18	3.519
1.18	4.202	1.18	3.567
1.19	4.217	1.19	3.640
1.20	4.358	1.20	3.728
1.21	4.363	1.21	3.763
1.22	4.469	1.22	3.767
1.23	4.520	1.23	3.842
1.24	4.590	1.24	3.852
1.25	4.619	1.25	3.862
1.26	4.641	1.26	3.882
1.27	4.644	1.27	3.921
1.28	4.706	1.28	4.009
1.29	4.713	1.29	4.124
1.30	4.745	1.30	4.139
1.31	4.756	1.31	4.199
1.32	4.774	1.32	4.201
1.33	4.822	1.33	4.290
1.35	4.904	1.35	4.371
1.36	5.051	1.36	4.404
1.37	5.145	1.37	4.408
1.38	5.191	1.38	4.436
1.39	5.261	1.39	4.454
1.40	5.268	1.40	4.522
1.42	5.309	1.42	4.565
1.43	5.394	1.43	4.578
1.44	5.456	1.44	4.594
1.46	5.480	1.46	4.621
1.47	5.505	1.47	4.776
1.48	5.552	1.48	4.857
1.50	5.580	1.50	4.865
1.51	5.593	1.51	4.879
1.53	5.630	1.53	4.945
1.54	5.672	1.54	4.979

1.56	5.706	1.56	5.049
1.57	5.768	1.57	5.066
1.59	5.816	1.59	5.120
1.60	5.892	1.60	5.127
1.62	5.918	1.62	5.207
1.64	5.926	1.64	5.230
1.65	5.927	1.65	5.243
1.67	5.944	1.67	5.278
1.69	5.979	1.69	5.290
1.71	5.988	1.71	5.333
1.73	6.015	1.73	5.348
1.75	6.073	1.75	5.369
1.77	6.080	1.77	5.379
1.79	6.083	1.79	5.391
1.81	6.108	1.81	5.398
1.83	6.139	1.83	5.399
1.85	6.147	1.85	5.458
1.87	6.178	1.87	5.474
1.89	6.196	1.89	5.519
1.92	6.202	1.92	5.523
1.94	6.202	1.94	5.559
1.96	6.211	1.96	5.562
1.99	6.236	1.99	5.606
2.01	6.238	2.01	5.613
2.04	6.262	2.04	5.617
2.07	6.409	2.07	5.664
2.09	6.419	2.09	5.675
2.12	6.498	2.12	5.762
2.15	6.530	2.15	5.811
2.18	6.585	2.18	5.872
2.21	6.615	2.21	5.933
2.24	6.636	2.24	5.949
2.27	6.639	2.27	5.953
2.31	6.782	2.31	5.981
2.34	6.849	2.34	6.074
2.38	6.864	2.38	6.128
2.41	6.953	2.41	6.191
2.45	7.036	2.45	6.201
2.49	7.079	2.49	6.228
2.53	7.120	2.53	6.258
2.57	7.130	2.57	6.293
2.61	7.144	2.61	6.407
2.65	7.169	2.65	6.463
2.70	7.252	2.70	6.480
2.75	7.303	2.75	6.501
2.80	7.419	2.80	6.626
2.85	7.446	2.85	6.631
2.90	7.477	2.90	6.721
2.95	7.546	2.95	6.761
3.01	7.559	3.01	6.837
3.07	7.632	3.07	6.850
3.13	7.721	3.13	6.887
3.19	7.900	3.19	6.909
3.26	7.908	3.26	7.037
3.32	8.212	3.32	7.053
3.40	8.262	3.40	7.059
3.47	8.325	3.47	7.126
3.55	8.334	3.55	7.214
3.63	8.371	3.63	7.254
3.72	8.499	3.72	7.322
3.80	8.555	3.80	7.352
3.90	8.809	3.90	7.473
4.00	9.111	4.00	7.747

4.10	9.518	4.10	7.864
4.21	9.600	4.21	7.959
4.32	9.820	4.32	8.011
4.45	9.916	4.45	8.057
4.58	9.976	4.58	8.148
4.71	10.037	4.71	8.158
4.86	10.140	4.86	8.491
5.01	10.144	5.01	8.537
5.17	10.158	5.17	8.561
5.35	10.441	5.35	8.596
5.54	10.624	5.54	8.605
5.74	10.702	5.74	8.673
5.95	10.767	5.95	8.727
6.19	10.870	6.19	8.796
6.44	10.948	6.44	9.015
6.71	11.145	6.71	9.079
7.01	11.215	7.01	9.676
7.33	11.270	7.33	9.799
7.69	11.564	7.69	10.027
8.08	11.616	8.08	10.505
8.52	11.855	8.52	10.673
9.00	11.961	9.00	10.683
9.55	12.082	9.55	10.916
10.16	12.923	10.16	10.959
10.86	13.348	10.86	10.978
11.66	13.406	11.66	11.049
12.59	13.596	12.59	11.162
13.68	14.081	13.68	11.171
14.97	14.857	14.97	11.253
16.54	14.957	16.54	13.095
18.47	15.316	18.47	13.683
20.92	16.398	20.92	13.685
24.10	16.472	24.10	14.563
28.44	16.603	28.44	14.585
34.68	16.743	34.68	15.033
44.42	18.681	44.42	16.153
61.77	20.238	61.77	16.510
101.36	21.032	101.36	16.855
282.36	22.966	282.36	18.106

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	4.176	4.176	
2-Year	6.520	6.520	5.609
5-Year	9.646	9.646	8.534
10-Year	12.126	12.126	10.948
25-Year	15.822	15.822	14.568
50-Year	19.038	19.038	16.282
100-Year	22.693	22.693	16.845
200-Year	26.861	26.861	17.685

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.115	3.1924E-01	0.091	3.4079E-01
0.230	2.5239E-01	0.181	2.7640E-01
0.344	2.1029E-01	0.272	2.3529E-01
0.459	1.7922E-01	0.362	2.0502E-01
0.574	1.5467E-01	0.453	1.8084E-01
0.689	1.3423E-01	0.543	1.6093E-01
0.804	1.1718E-01	0.634	1.4476E-01
0.919	1.0249E-01	0.724	1.2931E-01
1.033	8.9982E-02	0.815	1.1649E-01
1.148	7.9170E-02	0.905	1.0499E-01
1.263	6.9848E-02	0.996	9.4436E-02
1.378	6.1892E-02	1.086	8.5310E-02
1.493	5.4876E-02	1.177	7.7721E-02
1.608	4.8796E-02	1.267	7.0331E-02
1.722	4.3394E-02	1.358	6.3831E-02
1.837	3.8673E-02	1.448	5.8285E-02
1.952	3.4476E-02	1.539	5.3030E-02
2.067	3.0858E-02	1.630	4.8359E-02
2.182	2.7569E-02	1.720	4.4155E-02
2.297	2.4649E-02	1.811	4.0302E-02
2.411	2.2046E-02	1.901	3.6878E-02
2.526	1.9757E-02	1.992	3.3628E-02
2.641	1.7679E-02	2.082	3.0790E-02
2.756	1.5883E-02	2.173	2.8166E-02
2.871	1.4223E-02	2.263	2.5760E-02
2.986	1.2795E-02	2.354	2.3544E-02
3.100	1.1528E-02	2.444	2.1521E-02
3.260	1.0014E-02	2.535	1.9605E-02
3.330	9.4358E-03	2.625	1.7899E-02
3.445	8.5341E-03	2.716	1.6292E-02
3.560	7.8092E-03	2.806	1.4811E-02
3.675	7.0785E-03	2.897	1.3459E-02
3.789	6.4273E-03	2.988	1.2241E-02
3.904	5.8771E-03	3.078	1.1107E-02
4.019	5.3551E-03	3.169	9.9124E-03
4.134	4.8901E-03	3.260	9.0542E-03
4.249	4.4793E-03	3.350	8.3774E-03
4.364	4.1118E-03	3.440	7.8063E-03
4.478	3.7775E-03	3.531	7.2778E-03
4.593	3.4584E-03	3.621	6.7543E-03
4.708	3.1898E-03	3.712	6.2987E-03
4.823	2.9465E-03	3.802	5.8901E-03
4.938	2.7140E-03	3.893	5.4728E-03
5.052	2.5039E-03	3.983	5.1045E-03
5.167	2.3097E-03	4.074	4.7717E-03
5.282	2.1378E-03	4.164	4.4569E-03
5.397	1.9660E-03	4.255	4.1724E-03
5.512	1.8296E-03	4.345	3.9183E-03
5.627	1.6801E-03	4.436	3.6750E-03
5.741	1.5480E-03	4.527	3.4208E-03
5.856	1.4426E-03	4.617	3.1840E-03
5.971	1.3429E-03	4.708	2.9992E-03
6.086	1.2418E-03	4.798	2.8035E-03
6.201	1.1660E-03	4.889	2.6303E-03
6.316	1.0895E-03	4.979	2.4627E-03
6.430	1.0296E-03	5.070	2.3198E-03

6.520	9.8062E-04	5.160	2.1812E-03
6.660	9.0756E-04	5.251	2.0447E-03
6.775	8.4691E-04	5.341	1.9292E-03
6.890	7.9781E-04	5.432	1.7963E-03
7.005	7.5088E-04	5.522	1.6880E-03
7.119	7.0612E-04	5.613	1.5935E-03
7.234	6.6641E-04	5.703	1.4852E-03
7.349	6.2886E-04	5.794	1.4065E-03
7.464	5.9276E-04	5.884	1.3213E-03
7.579	5.5522E-04	5.975	1.2599E-03
7.694	5.2923E-04	6.066	1.1920E-03
7.808	5.0829E-04	6.156	1.1357E-03
7.923	4.8157E-04	6.247	1.0787E-03
8.038	4.5703E-04	6.337	1.0325E-03
8.153	4.3103E-04	6.428	9.8048E-04
8.268	4.0432E-04	6.520	9.3053E-04
8.383	3.7544E-04	6.609	8.8301E-04
8.497	3.5522E-04	6.699	8.4835E-04
8.612	3.3356E-04	6.790	7.9420E-04
8.727	3.1118E-04	6.880	7.5955E-04
8.842	2.9313E-04	6.971	7.2489E-04
8.957	2.7436E-04	7.061	6.8518E-04
9.071	2.5992E-04	7.152	6.5486E-04
9.186	2.4476E-04	7.242	6.2237E-04
9.301	2.2815E-04	7.333	6.0432E-04
9.416	2.1949E-04	7.423	5.7399E-04
9.531	2.0721E-04	7.514	5.5522E-04
9.646	2.0001E-04	7.605	5.2851E-04
9.760	1.8555E-04	7.695	5.0829E-04
9.875	1.7328E-04	7.786	4.9168E-04
9.990	1.6245E-04	7.876	4.6858E-04
10.105	1.5234E-04	7.967	4.5125E-04
10.220	1.4440E-04	8.057	4.3392E-04
10.335	1.3574E-04	8.148	4.1804E-04
10.449	1.2635E-04	8.238	3.9927E-04
10.564	1.1985E-04	8.329	3.7688E-04
10.679	1.1047E-04	8.419	3.5234E-04
10.794	1.0613E-04	8.510	3.3068E-04
10.909	1.0180E-04	8.600	3.1118E-04
11.024	9.5304E-05	8.691	2.9674E-04
11.138	8.9528E-05	8.781	2.8158E-04
11.253	8.5196E-05	8.872	2.7075E-04
11.368	7.7254E-05	8.963	2.5703E-04
11.483	7.0756E-05	9.053	2.4548E-04
11.598	6.7868E-05	9.144	2.3248E-04
11.713	6.2814E-05	9.234	2.2743E-04
11.827	5.9204E-05	9.325	2.1660E-04
11.942	5.4872E-05	9.415	2.0794E-04
12.057	5.1984E-05	9.506	1.9783E-04
12.172	4.7652E-05	9.596	1.9061E-04
12.287	4.4042E-05	9.646	1.8480E-04
12.402	4.0432E-05	9.777	1.7111E-04
12.516	3.8266E-05	9.868	1.6173E-04
12.631	3.6100E-05	9.958	1.5595E-04
12.746	3.2490E-05	10.049	1.4945E-04
12.861	3.1046E-05	10.139	1.4151E-04
12.976	2.8880E-05	10.230	1.3646E-04
13.091	2.6714E-05	10.320	1.2635E-04
13.205	2.6714E-05	10.411	1.2130E-04
13.320	2.5270E-05	10.502	1.1408E-04
13.435	2.2382E-05	10.592	1.0902E-04
13.550	2.1660E-05	10.683	1.0325E-04
13.665	1.9494E-05	10.773	9.8192E-05

13.779	1.8050E-05	10.864	9.3860E-05
13.894	1.6606E-05	10.954	8.9528E-05
14.009	1.5884E-05	11.045	8.2308E-05
14.124	1.5162E-05	11.135	7.9420E-05
14.239	1.4440E-05	11.226	7.7254E-05
14.354	1.4440E-05	11.316	7.3644E-05
14.468	1.2996E-05	11.407	6.8590E-05
14.583	1.2274E-05	11.497	6.4980E-05
14.698	1.2274E-05	11.588	6.2092E-05
14.813	1.2274E-05	11.678	6.0648E-05
14.928	1.0830E-05	11.769	5.4150E-05
15.043	1.0108E-05	11.859	5.1262E-05
15.157	1.0108E-05	11.950	4.8374E-05
15.272	1.0108E-05	12.041	4.7652E-05
15.387	9.3860E-06	12.131	4.4042E-05
15.502	9.3860E-06	12.222	4.1154E-05
15.617	9.3860E-06	12.312	3.8266E-05
15.732	9.3860E-06	12.403	3.6100E-05
15.846	9.3860E-06	12.493	3.3212E-05
15.961	9.3860E-06	12.584	3.1768E-05
16.076	9.3860E-06	12.674	2.8880E-05
16.191	9.3860E-06	12.765	2.6714E-05
16.306	9.3860E-06	12.855	2.5270E-05
16.421	8.6640E-06	12.946	2.3826E-05
16.535	7.9420E-06	13.036	2.2382E-05
16.650	7.2200E-06	13.127	1.9494E-05
16.765	6.4980E-06	13.217	1.8772E-05
16.880	6.4980E-06	13.308	1.7328E-05
16.995	5.7760E-06	13.398	1.7328E-05
17.110	5.7760E-06	13.489	1.7328E-05
17.224	5.7760E-06	13.580	1.5162E-05
17.339	5.0540E-06	13.670	1.2996E-05
17.454	5.0540E-06	13.761	1.1552E-05
17.569	5.0540E-06	13.851	1.1552E-05
17.684	5.0540E-06	13.942	1.1552E-05
17.799	5.0540E-06	14.032	1.1552E-05
17.913	5.0540E-06	14.123	1.1552E-05
18.028	5.0540E-06	14.213	1.1552E-05
18.143	5.0540E-06	14.304	1.0108E-05
18.258	5.0540E-06	14.394	1.0108E-05
18.373	5.0540E-06	14.485	1.0108E-05
18.487	5.0540E-06	14.575	9.3860E-06
18.602	5.0540E-06	14.666	7.2200E-06
18.717	3.6100E-06	14.756	6.4980E-06
18.832	3.6100E-06	14.847	6.4980E-06
18.947	3.6100E-06	14.938	6.4980E-06
19.038	3.6061E-06	15.028	5.7760E-06
19.176	3.6100E-06	15.119	5.0540E-06
19.291	3.6100E-06	15.209	5.0540E-06
19.406	3.6100E-06	15.300	5.0540E-06
19.521	3.6100E-06	15.390	5.0540E-06
19.636	3.6100E-06	15.481	5.0540E-06
19.751	2.8880E-06	15.571	5.0540E-06
19.865	2.8880E-06	15.662	4.3320E-06
19.980	2.8880E-06	15.752	4.3320E-06
20.095	2.8880E-06	15.843	4.3320E-06
20.210	2.8880E-06	15.933	4.3320E-06
20.325	1.4440E-06	16.024	4.3320E-06
20.440	1.4440E-06	16.114	4.3320E-06
20.554	1.4440E-06	16.205	3.6100E-06
20.669	1.4440E-06	16.295	3.6100E-06
20.784	1.4440E-06	16.386	3.6100E-06
20.899	1.4440E-06	16.477	3.6100E-06

21.014	1.4440E-06	16.567	2.8880E-06
21.129	7.2200E-07	16.658	2.8880E-06
21.243	7.2200E-07	16.748	2.8880E-06
21.358	7.2200E-07	16.839	2.8880E-06
21.473	7.2200E-07	16.929	1.4440E-06
21.588	7.2200E-07	17.020	1.4440E-06
21.703	7.2200E-07	17.110	1.4440E-06
21.818	7.2200E-07	17.201	7.2200E-07
21.932	7.2200E-07	17.291	7.2200E-07
22.047	7.2200E-07	17.382	7.2200E-07
22.162	7.2200E-07	17.472	7.2200E-07
22.277	7.2200E-07	17.563	7.2200E-07
22.392	7.2200E-07	17.653	7.2200E-07
22.507	7.2200E-07	17.744	7.2200E-07
22.621	7.2200E-07	17.834	7.2200E-07
22.736	7.2200E-07	17.925	7.2200E-07
22.851	7.2200E-07	18.016	7.2200E-07
22.966	7.2200E-07	18.106	7.2200E-07

***** Flow Duration Performance According to Dept. of Ecology Criteria ******

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-9.8%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-4.4%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-2.5%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

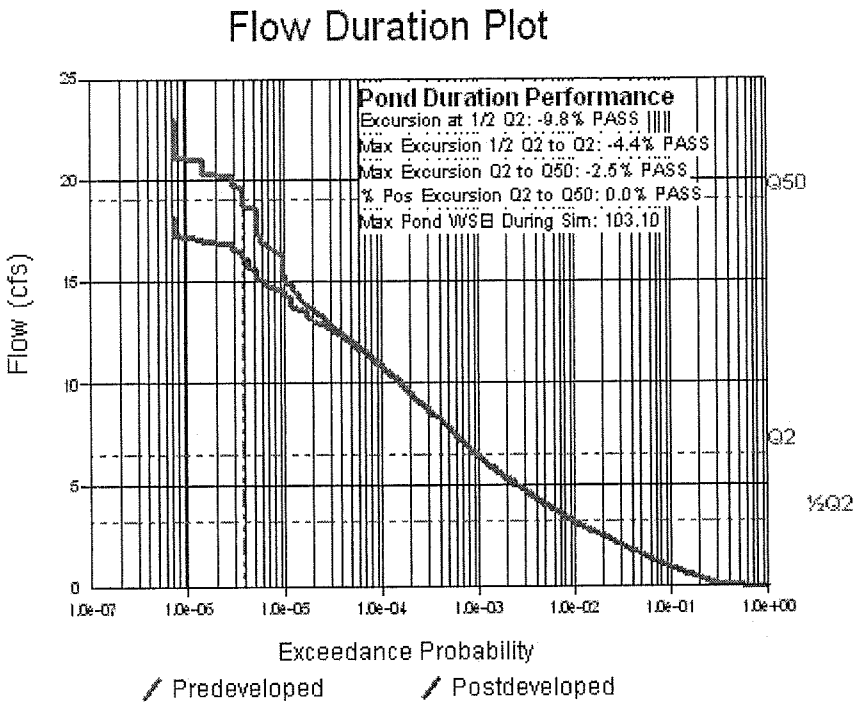
****

********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 328836. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 493253. cu-ft
2-Year Stormwater Pond Discharge Rate: 5.609 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -9.8% PASS
Max Excursion 1/2 Q2 to Q2: -4.4% PASS
Max Excursion Q2 to Q50: -2.5% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEL During Sim: 103.10
Q50
Q2
½Q2
Flow (cfs)
25
20
15
10
5
0
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

****

MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 11:20 AM

****

Input File Name: Basin 15.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Ginder Creek 4
Comments : Area tributary to the pit east of Mud Lake.

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* **Default HSPF Parameters Used (Not Modified by User)** **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)	Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	165.130	165.130	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	0.000	0.000	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	32.580	32.580	0.000	No
Impervious	2.410	2.410	0.000	
SUBBASIN TOTAL	200.120	200.120	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.00	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	277.8	ft
Pond Bottom Width	:	138.9	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	38595.	sq-ft
Area at Riser Crest El	:	46421.	sq-ft
	:	1.066	acres
Volume at Riser Crest	:	127343.	cu-ft
	:	2.923	ac-ft
Area at Max Elevation	:	49173.	sq-ft
	:	1.129	acres
Volume at Max Elevation	:	175110.	cu-ft
	:	4.020	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 42.00	in
Common Length	: 1.664	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	: Circular Orifice	
Invert Elevation	: 100.00	ft
Diameter	: 12.55	in
Orientation	: Horizontal	
Elbow	: No	

--- Device Number 2 ---

Device Type	: Vertical Rectangular Orifice	
Invert Elevation	: 100.99	ft
Length	: 20.0	in
Height	: 24.1	in
Orientation	: Vertical	
Elbow	: No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	0.886	0.000	0.000	0.000
100.04	0.888	0.031	0.786	0.000
100.07	0.890	0.062	1.112	0.000
100.14	0.894	0.125	1.572	0.000
100.21	0.898	0.187	1.925	0.000
100.28	0.902	0.250	2.223	0.000
100.35	0.906	0.314	2.485	0.000
100.42	0.910	0.377	2.723	0.000
100.49	0.914	0.441	2.941	0.000
100.56	0.918	0.505	3.144	0.000
100.63	0.923	0.570	3.334	0.000
100.70	0.927	0.634	3.515	0.000
100.77	0.931	0.699	3.686	0.000
100.84	0.935	0.765	3.850	0.000
100.91	0.939	0.830	4.007	0.000
100.93	0.940	0.849	4.051	0.000
100.95	0.941	0.868	4.095	0.000
100.97	0.942	0.887	4.137	0.000
100.99	0.944	0.906	4.180	0.000
101.01	0.945	0.922	4.229	0.000
101.03	0.946	0.939	4.289	0.000
101.04	0.947	0.955	4.356	0.000
101.06	0.948	0.972	4.427	0.000
101.13	0.952	1.038	4.751	0.000
101.20	0.956	1.105	5.122	0.000
101.27	0.960	1.172	5.528	0.000
101.34	0.964	1.239	5.962	0.000
101.41	0.969	1.307	6.420	0.000
101.48	0.973	1.375	6.899	0.000
101.55	0.977	1.443	7.396	0.000
101.62	0.981	1.512	7.908	0.000
101.69	0.985	1.581	8.433	0.000
101.76	0.990	1.650	8.970	0.000
101.83	0.994	1.719	9.518	0.000
101.90	0.998	1.789	10.074	0.000
101.97	1.002	1.859	10.638	0.000
102.04	1.007	1.929	11.209	0.000
102.11	1.011	2.000	11.785	0.000
102.18	1.015	2.071	12.366	0.000
102.25	1.019	2.142	12.950	0.000
102.32	1.024	2.213	13.538	0.000
102.39	1.028	2.285	14.127	0.000
102.46	1.032	2.357	14.718	0.000
102.53	1.037	2.430	15.310	0.000
102.60	1.041	2.503	15.901	0.000
102.67	1.045	2.576	16.516	0.000
102.74	1.050	2.649	17.215	0.000
102.81	1.054	2.722	17.925	0.000
102.88	1.058	2.796	18.646	0.000
102.91	1.060	2.828	18.958	0.000
102.94	1.062	2.860	19.272	0.000
102.97	1.064	2.892	19.588	0.000
103.00	1.066	2.924	19.907	0.000
103.02	1.067	2.942	20.166	0.000
103.04	1.068	2.961	20.487	0.000
103.05	1.069	2.980	20.847	0.000
103.07	1.070	2.999	21.240	0.000
103.09	1.071	3.017	21.661	0.000

103.11	1.072	3.036	22.108	0.000
103.12	1.073	3.055	22.577	0.000
103.14	1.074	3.074	23.067	0.000
103.21	1.079	3.149	25.215	0.000
103.28	1.083	3.225	27.622	0.000
103.35	1.088	3.301	30.246	0.000
103.42	1.092	3.377	33.052	0.000
103.49	1.096	3.454	36.012	0.000
103.56	1.101	3.530	39.095	0.000
103.63	1.105	3.608	42.271	0.000
103.70	1.110	3.685	45.509	0.000
103.77	1.114	3.763	48.778	0.000
103.84	1.119	3.841	51.833	0.000
103.91	1.123	3.920	54.677	0.000
103.98	1.128	3.998	57.441	0.000
104.05	1.132	4.077	60.099	0.000
104.12	1.137	4.157	62.625	0.000
104.19	1.141	4.237	64.996	0.000
104.26	1.146	4.317	67.196	0.000
104.33	1.150	4.397	69.212	0.000
104.40	1.155	4.478	71.039	0.000
104.47	1.159	4.559	72.681	0.000
104.54	1.164	4.640	74.149	0.000
104.61	1.168	27.358	266.984	0.000
104.68	1.173	27.798	274.718	0.000
104.75	1.177	28.238	282.381	0.000
104.82	1.182	28.679	289.957	0.000
104.89	1.186	29.121	297.427	0.000
104.96	1.191	29.563	304.773	0.000
105.03	1.196	30.006	311.977	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	11.372	1940 04 30	9.670
1941 05 17	4.291	1941 01 18	3.595
1941 12 15	10.863	1941 12 15	5.110
1943 03 27	5.183	1943 03 28	3.998
1944 01 22	3.071	1944 01 23	2.673
1945 02 07	10.532	1945 02 07	8.826
1946 02 27	8.725	1946 02 05	6.780
1947 02 01	9.192	1947 02 02	6.918
1948 03 21	15.285	1948 03 21	12.445
1949 02 16	9.045	1949 02 22	7.154
1950 03 03	31.155	1950 03 03	19.753
1951 02 09	10.873	1951 02 09	10.147
1952 02 04	3.269	1952 01 24	2.438
1953 03 28	4.656	1953 01 11	3.795
1954 01 22	6.834	1954 01 22	6.472
1955 04 12	4.596	1955 04 12	2.980
1956 03 04	8.426	1956 01 06	6.941
1957 02 25	7.095	1957 02 25	5.848
1958 02 24	8.347	1958 01 16	6.075
1959 01 12	9.631	1959 01 13	7.633
1959 12 15	9.718	1960 01 29	7.671
1961 02 14	9.517	1961 02 24	5.285
1962 03 04	4.290	1962 03 04	3.710
1963 02 03	5.270	1963 02 03	3.938
1964 01 01	8.094	1964 01 01	5.497
1965 02 26	9.156	1965 02 27	7.473
1966 04 11	9.317	1966 04 11	7.006
1967 01 19	14.977	1967 01 19	11.911
1968 02 03	8.575	1968 02 04	6.398
1968 12 03	8.361	1968 12 03	5.981
1970 01 13	6.366	1970 03 06	4.225
1971 04 09	6.878	1971 04 09	4.826
1972 02 27	18.456	1972 02 27	15.265
1973 01 13	7.558	1973 01 13	5.996
1974 02 18	9.819	1974 02 19	8.687
1974 12 26	10.683	1975 02 19	7.534
1976 01 26	8.384	1976 01 27	6.959
1977 05 31	2.926	1977 05 31	2.729
1978 03 11	6.643	1977 12 15	5.488
1979 03 04	9.197	1979 03 04	6.052
1979 12 17	8.755	1979 12 17	8.358
1980 12 26	5.210	1980 12 26	3.627
1981 10 06	13.584	1981 10 06	10.167
1983 01 05	8.320	1983 01 05	7.153
1984 03 14	9.361	1984 03 20	5.282
1985 02 11	5.501	1985 02 11	3.991
1986 01 18	15.519	1986 01 18	13.536
1986 11 24	10.984	1986 11 24	10.162
1988 04 06	6.223	1988 04 06	5.158
1989 04 05	8.240	1989 04 05	6.751
1990 01 09	27.452	1990 01 09	26.636
1990 11 24	22.386	1990 11 24	18.257
1992 01 27	7.839	1992 01 27	5.281
1993 06 09	7.064	1993 03 23	4.661
1994 04 08	3.905	1994 03 03	3.446
1995 02 19	9.744	1995 02 19	8.855
1996 02 08	22.564	1996 02 08	19.100

1997	01	02	14.603	1997	01	02	11.425
1998	02	28	6.589	1998	03	23	3.722
1998	12	27	11.784	1998	12	27	8.809
2000	02	28	8.558	2000	03	26	7.355
2001	05	05	6.018	2001	05	05	3.967
2002	05	03	16.947	2002	05	03	7.589
2003	03	31	14.597	2003	03	31	14.016
2004	03	03	3.948	2004	01	23	3.306
2005	02	05	7.047	2005	02	07	4.082
2006	02	27	8.958	2006	02	27	7.559
2007	03	09	6.505	2006	12	15	4.484
2008	03	21	12.930	2008	03	22	8.548
2009	02	17	16.421	2009	02	17	15.020
2010	06	10	10.528	2010	01	10	8.423
2011	03	08	15.630	2011	03	08	12.469
2012	01	31	10.013	2012	01	31	5.059
2013	01	20	20.925	2013	01	20	17.546
2014	02	13	10.511	2014	04	05	7.840
2015	04	12	6.389	2015	03	30	4.450
2016	01	04	16.407	2016	01	04	14.359
2017	06	14	5.415	2017	03	07	3.720
2018	04	17	10.994	2018	04	17	7.391
2019	03	29	8.382	2019	03	30	7.315
2020	04	14	7.427	2020	04	14	5.268
2021	02	10	11.983	2021	02	10	10.954
2021	12	20	6.132	2021	12	20	4.587
2023	03	30	8.629	2023	03	30	8.185
2024	01	19	7.954	2024	01	19	6.416
2024	12	22	12.859	2024	12	22	11.477
2026	03	09	10.231	2026	03	09	9.099
2027	03	15	9.187	2027	01	27	6.560
2028	06	01	9.742	2028	02	19	8.332
2028	12	04	7.802	2028	12	04	6.825
2030	02	16	9.574	2030	02	16	9.010
2031	02	26	9.248	2030	12	30	8.212
2032	01	20	16.147	2032	01	20	14.774
2033	03	01	5.273	2033	03	01	3.644
2034	02	18	16.206	2034	01	16	13.317
2035	02	19	11.303	2035	02	19	9.157
2036	03	24	9.524	2036	03	24	8.279
2037	03	08	2.819	2037	03	09	2.122
2037	11	24	6.135	2037	12	15	4.807
2039	02	07	4.525	2039	02	07	3.269
2040	01	14	16.539	2040	03	13	9.447
2040	12	25	7.470	2040	12	25	6.766
2042	02	20	11.115	2042	02	20	7.601
2043	03	31	15.677	2043	03	31	8.024
2044	05	01	8.434	2044	05	01	6.225
2045	02	07	8.660	2045	03	23	6.691
2046	02	16	8.933	2046	02	16	7.185
2047	04	17	7.265	2047	02	01	4.489
2048	04	20	6.012	2048	04	21	4.171
2049	03	16	6.210	2049	03	16	4.304
2049	12	04	8.032	2049	12	04	6.578
2051	04	06	6.518	2051	04	06	4.973
2052	04	16	4.406	2052	04	17	3.131
2053	06	04	20.793	2053	06	04	7.961
2054	04	08	3.041	2054	04	08	2.479
2055	02	17	14.190	2055	02	17	11.831
2056	02	07	23.360	2056	02	07	19.668
2056	11	19	22.335	2056	11	19	16.984
2058	05	21	12.592	2058	05	21	10.412
2059	01	17	12.404	2058	12	28	8.546

2060	01 19	4.709	2060	01 19	3.212
2061	01 10	7.879	2061	01 10	7.422
2062	02 03	30.629	2062	02 03	17.053
2062	12 29	7.817	2062	12 29	6.396
2063	12 23	13.414	2063	12 23	11.676
2064	11 29	5.144	2065	02 05	4.295
2066	01 13	3.385	2066	01 13	3.046
2067	01 19	9.441	2067	01 19	7.348
2068	01 18	17.753	2068	01 18	15.169
2069	01 03	5.170	2069	04 23	3.981
2070	04 09	7.404	2070	04 09	4.295
2071	03 23	4.610	2071	02 14	3.287
2072	02 27	5.861	2072	02 27	3.584
2072	12 25	17.262	2072	12 25	16.006
2074	03 16	11.237	2074	03 16	8.618
2075	02 12	3.398	2075	01 17	2.495
2076	03 24	13.909	2076	03 24	10.125
2077	02 12	2.439	2077	02 12	2.130
2077	11 25	4.414	2077	12 02	3.456
2079	02 24	5.666	2079	02 25	4.861
2079	12 17	18.132	2079	12 17	15.265
2080	12 26	10.268	2080	12 26	7.795
2082	02 18	10.986	2082	02 13	10.338
2083	03 29	9.069	2083	02 19	6.286
2083	11 26	10.342	2083	11 26	8.121
2085	03 23	6.392	2084	12 14	5.060
2086	01 18	6.589	2086	01 18	6.021
2086	12 21	7.416	2086	12 21	5.366
2088	03 25	5.178	2088	04 05	3.941
2088	11 05	10.796	2088	11 05	7.998
2090	01 06	5.658	2090	06 10	4.217
2090	12 04	8.691	2090	12 04	7.035
2092	04 28	17.701	2092	01 31	8.478
2093	03 22	4.880	2093	03 22	3.827
2094	03 01	3.668	2094	03 01	3.290
2095	02 18	6.448	2094	12 27	4.469
2096	01 14	7.001	2096	01 14	6.210
2097	01 29	16.431	2097	01 30	12.729

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	2.439	1.00	2.122
1.01	2.819	1.01	2.130
1.02	2.926	1.02	2.438
1.02	3.041	1.02	2.479
1.03	3.071	1.03	2.495
1.04	3.269	1.04	2.673
1.04	3.385	1.04	2.729
1.05	3.398	1.05	2.980
1.06	3.668	1.06	3.046
1.06	3.905	1.06	3.131
1.07	3.948	1.07	3.212
1.08	4.290	1.08	3.269
1.09	4.291	1.09	3.287
1.09	4.406	1.09	3.290
1.10	4.414	1.10	3.306
1.11	4.525	1.11	3.446
1.12	4.596	1.12	3.456
1.12	4.610	1.12	3.584
1.13	4.656	1.13	3.595
1.14	4.709	1.14	3.627
1.15	4.880	1.15	3.644
1.16	5.144	1.16	3.710
1.17	5.170	1.17	3.720
1.18	5.178	1.18	3.722
1.18	5.183	1.18	3.795
1.19	5.210	1.19	3.827
1.20	5.270	1.20	3.938
1.21	5.273	1.21	3.941
1.22	5.415	1.22	3.967
1.23	5.501	1.23	3.981
1.24	5.658	1.24	3.991
1.25	5.666	1.25	3.998
1.26	5.861	1.26	4.082
1.27	6.012	1.27	4.171
1.28	6.018	1.28	4.217
1.29	6.132	1.29	4.225
1.30	6.135	1.30	4.295
1.31	6.210	1.31	4.295
1.32	6.223	1.32	4.304
1.33	6.366	1.33	4.450
1.35	6.389	1.35	4.469
1.36	6.392	1.36	4.484
1.37	6.448	1.37	4.489
1.38	6.505	1.38	4.587
1.39	6.518	1.39	4.661
1.40	6.589	1.40	4.807
1.42	6.589	1.42	4.826
1.43	6.643	1.43	4.861
1.44	6.834	1.44	4.973
1.46	6.878	1.46	5.059
1.47	7.001	1.47	5.060
1.48	7.047	1.48	5.110
1.50	7.064	1.50	5.158
1.51	7.095	1.51	5.268
1.53	7.265	1.53	5.281
1.54	7.404	1.54	5.282

1.56	7.416	1.56	5.285
1.57	7.427	1.57	5.366
1.59	7.470	1.59	5.488
1.60	7.558	1.60	5.497
1.62	7.802	1.62	5.848
1.64	7.817	1.64	5.981
1.65	7.839	1.65	5.996
1.67	7.879	1.67	6.021
1.69	7.954	1.69	6.052
1.71	8.032	1.71	6.075
1.73	8.094	1.73	6.210
1.75	8.240	1.75	6.225
1.77	8.320	1.77	6.286
1.79	8.347	1.79	6.396
1.81	8.361	1.81	6.398
1.83	8.382	1.83	6.416
1.85	8.384	1.85	6.472
1.87	8.426	1.87	6.560
1.89	8.434	1.89	6.578
1.92	8.558	1.92	6.691
1.94	8.575	1.94	6.751
1.96	8.629	1.96	6.766
1.99	8.660	1.99	6.780
2.01	8.691	2.01	6.825
2.04	8.725	2.04	6.918
2.07	8.755	2.07	6.941
2.09	8.933	2.09	6.959
2.12	8.958	2.12	7.006
2.15	9.045	2.15	7.035
2.18	9.069	2.18	7.153
2.21	9.156	2.21	7.154
2.24	9.187	2.24	7.185
2.27	9.192	2.27	7.315
2.31	9.197	2.31	7.348
2.34	9.248	2.34	7.355
2.38	9.317	2.38	7.391
2.41	9.361	2.41	7.422
2.45	9.441	2.45	7.473
2.49	9.517	2.49	7.534
2.53	9.524	2.53	7.559
2.57	9.574	2.57	7.589
2.61	9.631	2.61	7.601
2.65	9.718	2.65	7.633
2.70	9.742	2.70	7.671
2.75	9.744	2.75	7.795
2.80	9.819	2.80	7.840
2.85	10.013	2.85	7.961
2.90	10.231	2.90	7.998
2.95	10.268	2.95	8.024
3.01	10.342	3.01	8.121
3.07	10.511	3.07	8.185
3.13	10.528	3.13	8.212
3.19	10.532	3.19	8.279
3.26	10.683	3.26	8.332
3.32	10.796	3.32	8.358
3.40	10.863	3.40	8.423
3.47	10.873	3.47	8.478
3.55	10.984	3.55	8.546
3.63	10.986	3.63	8.548
3.72	10.994	3.72	8.618
3.80	11.115	3.80	8.687
3.90	11.237	3.90	8.809
4.00	11.303	4.00	8.826

4.10	11.372	4.10	8.855
4.21	11.784	4.21	9.010
4.32	11.983	4.32	9.099
4.45	12.404	4.45	9.157
4.58	12.592	4.58	9.447
4.71	12.859	4.71	9.670
4.86	12.930	4.86	10.125
5.01	13.414	5.01	10.147
5.17	13.584	5.17	10.162
5.35	13.909	5.35	10.167
5.54	14.190	5.54	10.338
5.74	14.597	5.74	10.412
5.95	14.603	5.95	10.954
6.19	14.977	6.19	11.425
6.44	15.285	6.44	11.477
6.71	15.519	6.71	11.676
7.01	15.630	7.01	11.831
7.33	15.677	7.33	11.911
7.69	16.147	7.69	12.445
8.08	16.206	8.08	12.469
8.52	16.407	8.52	12.729
9.00	16.421	9.00	13.317
9.55	16.431	9.55	13.536
10.16	16.539	10.16	14.016
10.86	16.947	10.86	14.359
11.66	17.262	11.66	14.774
12.59	17.701	12.59	15.020
13.68	17.753	13.68	15.169
14.97	18.132	14.97	15.265
16.54	18.456	16.54	15.265
18.47	20.793	18.47	16.006
20.92	20.925	20.92	16.984
24.10	22.335	24.10	17.053
28.44	22.386	28.44	17.546
34.68	22.564	34.68	18.257
44.42	23.360	44.42	19.100
61.77	27.452	61.77	19.668
101.36	30.629	101.36	19.753
282.36	31.155	282.36	26.636

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	5.054	5.054	
2-Year	8.621	8.621	6.802
5-Year	13.063	13.063	10.146
10-Year	16.387	16.387	13.892
25-Year	21.081	21.081	17.162
50-Year	24.959	24.959	19.304
100-Year	29.176	29.176	19.751
200-Year	33.779	33.779	24.319

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.156	2.9588E-01	0.133	3.1153E-01
0.312	2.2569E-01	0.266	2.4202E-01
0.467	1.8244E-01	0.400	1.9935E-01
0.623	1.5106E-01	0.533	1.6840E-01
0.779	1.2637E-01	0.666	1.4393E-01
0.935	1.0639E-01	0.799	1.2564E-01
1.090	8.9953E-02	0.932	1.0782E-01
1.246	7.6384E-02	1.065	9.3670E-02
1.402	6.5356E-02	1.199	8.1712E-02
1.558	5.6104E-02	1.332	7.1062E-02
1.714	4.8353E-02	1.465	6.2482E-02
1.869	4.1765E-02	1.598	5.5517E-02
2.025	3.6295E-02	1.731	4.8809E-02
2.181	3.1665E-02	1.865	4.3282E-02
2.337	2.7702E-02	1.998	3.8457E-02
2.492	2.4225E-02	2.131	3.4184E-02
2.648	2.1214E-02	2.264	3.0554E-02
2.804	1.8636E-02	2.397	2.7186E-02
2.960	1.6407E-02	2.530	2.4233E-02
3.115	1.4527E-02	2.664	2.1570E-02
3.271	1.2897E-02	2.797	1.9264E-02
3.427	1.1493E-02	2.930	1.7182E-02
3.583	1.0231E-02	3.063	1.5295E-02
3.739	9.1824E-03	3.196	1.3675E-02
3.894	8.2084E-03	3.330	1.2244E-02
4.050	7.3911E-03	3.463	1.0956E-02
4.206	6.6345E-03	3.596	9.7838E-03
4.311	6.1741E-03	3.729	8.7449E-03
4.517	5.3912E-03	3.862	7.7810E-03
4.673	4.8930E-03	3.995	6.8828E-03
4.829	4.4584E-03	4.129	5.9948E-03
4.985	4.0367E-03	4.311	5.0819E-03
5.141	3.6620E-03	4.395	4.7955E-03
5.296	3.3515E-03	4.528	4.3970E-03
5.452	3.0627E-03	4.661	4.0317E-03
5.608	2.7934E-03	4.794	3.7024E-03
5.764	2.5458E-03	4.928	3.4129E-03
5.919	2.3472E-03	5.061	3.1364E-03
6.075	2.1523E-03	5.194	2.8851E-03
6.231	1.9790E-03	5.327	2.6555E-03
6.387	1.8346E-03	5.460	2.4548E-03
6.543	1.6801E-03	5.594	2.2989E-03
6.698	1.5675E-03	5.727	2.1321E-03
6.854	1.4628E-03	5.860	1.9660E-03
7.010	1.3552E-03	5.993	1.8223E-03
7.166	1.2462E-03	6.126	1.6996E-03
7.321	1.1675E-03	6.259	1.5841E-03
7.477	1.0873E-03	6.393	1.4917E-03
7.633	1.0072E-03	6.526	1.3935E-03
7.789	9.3571E-04	6.659	1.3263E-03
7.944	8.6351E-04	6.792	1.2411E-03
8.100	7.9998E-04	6.925	1.1610E-03
8.256	7.5232E-04	7.059	1.0779E-03
8.412	6.8807E-04	7.192	1.0101E-03
8.621	6.2368E-04	7.325	9.3932E-04
8.723	5.9276E-04	7.458	8.8229E-04

8.879	5.6533E-04	7.591	8.3175E-04
9.035	5.3356E-04	7.724	7.8698E-04
9.191	4.9313E-04	7.858	7.3789E-04
9.346	4.5919E-04	7.991	6.9096E-04
9.502	4.2887E-04	8.124	6.5413E-04
9.658	3.9566E-04	8.257	6.1515E-04
9.814	3.7183E-04	8.390	5.7760E-04
9.970	3.4800E-04	8.524	5.4872E-04
10.125	3.2923E-04	8.621	5.2312E-04
10.281	3.0468E-04	8.790	4.8879E-04
10.437	2.9097E-04	8.923	4.7074E-04
10.593	2.7219E-04	9.056	4.4042E-04
10.748	2.6281E-04	9.189	4.1587E-04
10.904	2.4548E-04	9.323	3.9421E-04
11.060	2.2815E-04	9.456	3.7616E-04
11.216	2.1299E-04	9.589	3.5089E-04
11.372	2.0288E-04	9.722	3.2923E-04
11.527	1.9277E-04	9.855	3.1190E-04
11.683	1.8050E-04	9.989	2.9891E-04
11.839	1.6967E-04	10.122	2.8158E-04
11.995	1.5667E-04	10.255	2.6786E-04
12.150	1.4945E-04	10.388	2.5703E-04
12.306	1.4296E-04	10.521	2.4187E-04
12.462	1.3935E-04	10.654	2.3248E-04
12.618	1.2779E-04	10.788	2.2238E-04
12.774	1.2057E-04	10.921	2.0721E-04
12.929	1.1191E-04	11.054	1.9638E-04
13.063	1.0154E-04	11.187	1.9133E-04
13.241	9.6748E-05	11.320	1.8483E-04
13.397	9.1694E-05	11.454	1.7400E-04
13.552	8.7362E-05	11.587	1.6606E-04
13.708	8.4474E-05	11.720	1.5595E-04
13.864	7.9420E-05	11.853	1.4584E-04
14.020	7.3644E-05	11.986	1.3357E-04
14.175	6.7146E-05	12.119	1.2707E-04
14.331	6.4258E-05	12.253	1.1985E-04
14.487	6.3536E-05	12.386	1.1624E-04
14.643	5.7760E-05	12.519	1.0686E-04
14.799	5.4872E-05	12.652	1.0252E-04
14.954	5.2706E-05	12.785	9.8914E-05
15.110	4.9818E-05	12.919	9.3860E-05
15.266	4.7652E-05	13.063	9.0039E-05
15.422	4.6208E-05	13.185	8.7362E-05
15.577	4.4042E-05	13.318	8.1586E-05
15.733	4.0432E-05	13.451	7.6532E-05
15.889	3.8266E-05	13.584	6.7868E-05
16.045	3.6822E-05	13.718	6.4258E-05
16.201	3.5378E-05	13.851	6.1370E-05
16.356	3.4656E-05	13.984	5.8482E-05
16.512	3.0324E-05	14.117	5.4150E-05
16.668	2.9602E-05	14.250	5.1262E-05
16.824	2.8158E-05	14.383	4.8374E-05
16.979	2.7436E-05	14.517	4.4042E-05
17.135	2.6714E-05	14.650	4.3320E-05
17.291	2.3826E-05	14.783	3.8988E-05
17.447	2.3104E-05	14.916	3.6822E-05
17.603	2.2382E-05	15.049	3.3934E-05
17.758	2.0938E-05	15.183	3.0324E-05
17.914	2.0938E-05	15.316	2.6714E-05
18.070	2.0216E-05	15.449	2.5270E-05
18.226	1.8772E-05	15.582	2.3826E-05
18.381	1.8050E-05	15.715	2.3104E-05
18.537	1.7328E-05	15.848	2.3104E-05

18.693	1.7328E-05	15.982	2.2382E-05
18.849	1.6606E-05	16.115	2.1660E-05
19.004	1.5884E-05	16.248	2.1660E-05
19.160	1.5162E-05	16.381	2.0938E-05
19.316	1.4440E-05	16.514	1.8772E-05
19.472	1.3718E-05	16.648	1.7328E-05
19.628	1.2996E-05	16.781	1.6606E-05
19.783	1.2996E-05	16.914	1.5162E-05
19.939	1.2274E-05	17.047	1.4440E-05
20.095	1.2274E-05	17.180	1.2996E-05
20.251	1.1552E-05	17.313	1.2274E-05
20.406	1.0830E-05	17.447	1.1552E-05
20.562	1.0830E-05	17.580	9.3860E-06
20.718	1.0830E-05	17.713	8.6640E-06
20.874	9.3860E-06	17.846	7.2200E-06
21.030	8.6640E-06	17.979	6.4980E-06
21.185	8.6640E-06	18.113	6.4980E-06
21.341	8.6640E-06	18.246	6.4980E-06
21.497	8.6640E-06	18.379	5.0540E-06
21.653	8.6640E-06	18.512	5.0540E-06
21.808	8.6640E-06	18.645	5.0540E-06
21.964	8.6640E-06	18.778	5.0540E-06
22.120	8.6640E-06	18.912	5.0540E-06
22.276	8.6640E-06	19.045	5.0540E-06
22.432	7.2200E-06	19.178	4.3320E-06
22.587	6.4980E-06	19.311	4.3320E-06
22.743	6.4980E-06	19.444	4.3320E-06
22.899	6.4980E-06	19.578	4.3320E-06
23.055	6.4980E-06	19.711	3.6100E-06
23.210	6.4980E-06	19.844	2.8880E-06
23.366	5.7760E-06	19.977	2.8880E-06
23.522	5.0540E-06	20.110	2.1660E-06
23.678	5.0540E-06	20.243	2.1660E-06
23.834	5.0540E-06	20.377	2.1660E-06
23.989	5.0540E-06	20.510	2.1660E-06
24.145	4.3320E-06	20.643	2.1660E-06
24.301	4.3320E-06	20.776	2.1660E-06
24.457	4.3320E-06	20.909	2.1660E-06
24.612	4.3320E-06	21.043	2.1660E-06
24.768	4.3320E-06	21.176	1.4440E-06
24.959	4.3698E-06	21.309	1.4440E-06
25.080	4.3320E-06	21.442	1.4440E-06
25.235	3.6100E-06	21.575	1.4440E-06
25.391	3.6100E-06	21.708	1.4440E-06
25.547	3.6100E-06	21.842	1.4440E-06
25.703	3.6100E-06	21.975	1.4440E-06
25.859	3.6100E-06	22.108	1.4440E-06
26.014	3.6100E-06	22.241	1.4440E-06
26.170	3.6100E-06	22.374	1.4440E-06
26.326	2.8880E-06	22.507	1.4440E-06
26.482	2.8880E-06	22.641	1.4440E-06
26.637	2.8880E-06	22.774	1.4440E-06
26.793	2.1660E-06	22.907	1.4440E-06
26.949	2.1660E-06	23.040	1.4440E-06
27.105	2.1660E-06	23.173	1.4440E-06
27.261	2.1660E-06	23.307	1.4440E-06
27.416	2.1660E-06	23.440	1.4440E-06
27.572	1.4440E-06	23.573	1.4440E-06
27.728	1.4440E-06	23.706	1.4440E-06
27.884	1.4440E-06	23.839	1.4440E-06
28.039	1.4440E-06	23.972	1.4440E-06
28.195	1.4440E-06	24.106	1.4440E-06
28.351	1.4440E-06	24.239	1.4440E-06

28.507	1.4440E-06	24.372	1.4440E-06
28.663	1.4440E-06	24.505	7.2200E-07
28.818	1.4440E-06	24.638	7.2200E-07
28.974	1.4440E-06	24.772	7.2200E-07
29.130	1.4440E-06	24.959	7.2304E-07
29.286	1.4440E-06	25.038	7.2200E-07
29.441	1.4440E-06	25.171	7.2200E-07
29.597	1.4440E-06	25.304	7.2200E-07
29.753	1.4440E-06	25.437	7.2200E-07
29.909	1.4440E-06	25.571	7.2200E-07
30.064	1.4440E-06	25.704	7.2200E-07
30.220	1.4440E-06	25.837	7.2200E-07
30.376	1.4440E-06	25.970	7.2200E-07
30.532	1.4440E-06	26.103	7.2200E-07
30.688	7.2200E-07	26.237	7.2200E-07
30.843	7.2200E-07	26.370	7.2200E-07
30.999	7.2200E-07	26.503	7.2200E-07
31.155	7.2200E-07	26.636	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-17.7%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-16.3%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-10.7%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

****

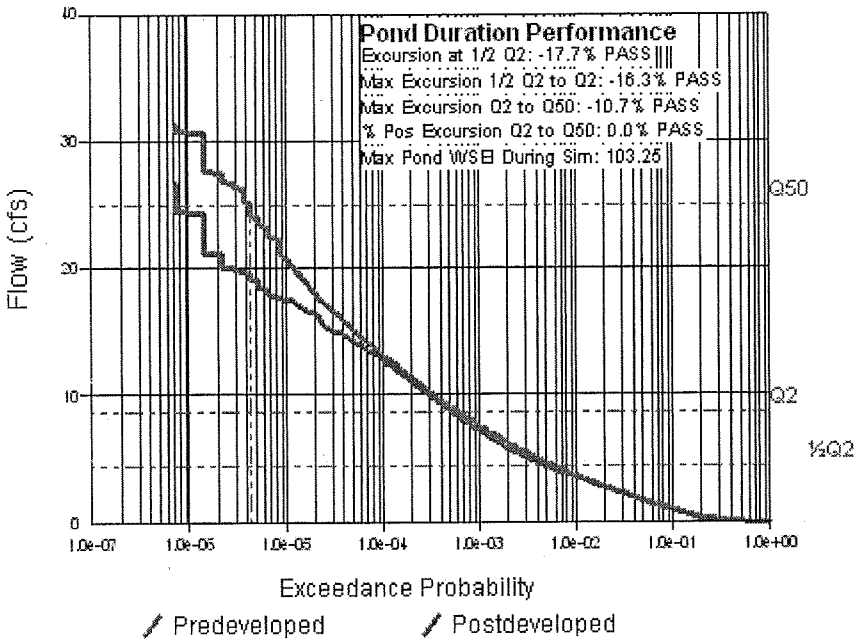
********** **Water Quality Facility Data** **********

Basic Wet Pond Volume (91% Exceedance): 367641. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 551461. cu-ft
2-Year Stormwater Pond Discharge Rate: 6.802 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****

Flow Duration Plot



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MGS FLOOD
PROJECT REPORT

Program Version: 2.26.0 Run Date: 06/25/2009 11:26 AM

****

Input File Name: Basin Ginder Lake.fld
Project Name : Black Diamond Stormwater Master Plan
Analysis Title: Ginder Creek 5
Comments : Basin Tributary to Ginder Lake

Extended Timeseries Selected
Climatic Region Number: 14

Full Period of Record Available used for Routing
Precipitation Station : 960052 Puget East 52 in MAP 10/01/1939-10/01/2097
Evaporation Station : 961052 Puget East 52 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

********* Default HSPF Parameters Used (Not Modified by User) **********

********* Watershed Definition **********

Number of Subbasins: 1

********** Subbasin Number: 1 **********
***Tributary to Node: 1
***Bypass to Node : None

	Area(Acres)			
		Developed		
	Predeveloped	To Node	Bypass Node	Include GW
Till Forest	373.490	373.490	0.000	No
Till Pasture	0.000	0.000	0.000	No
Till Grass	33.840	33.840	0.000	No
Outwash Forest	0.000	0.000	0.000	No
Outwash Pasture	0.000	0.000	0.000	No
Outwash Grass	0.000	0.000	0.000	No
Wetland	0.000	0.000	0.000	No
Impervious	6.170	6.170	0.000	
SUBBASIN TOTAL	413.500	413.500	0.000	

*** Subbasin Connection Summary ***
Subbasin 1 --------------> Node 1

*** By-Pass Area Connection Summary ***
No By-Passed Areas in Watershed

Pond Inflow Node : 1
Pond Outflow Node: 99

********* Retention/Detention Facility Summary **********

Hydraulic Structures Add-in Routines Used

---------- Pond Geometry ----------

Prismatic Pond Option Used

Pond Floor Elevation	:	100.00	ft
Riser Crest Elevation	:	103.00	ft
Maximum Pond Elevation	:	104.50	ft
Maximum Storage Depth	:	3.00	ft
Pond Bottom Length	:	345.4	ft
Pond Bottom Width	:	172.7	ft
Side Slope	:	3.00	ft/ft
Infiltration Rate	:	0.00	in/hr
Pond Bottom Area	:	59667.	sq-ft
Area at Riser Crest El	:	69318.	sq-ft
	:	1.591	acres
Volume at Riser Crest	:	193297.	cu-ft
	:	4.437	ac-ft
Area at Max Elevation	:	74387.	sq-ft
	:	1.708	acres
Volume at Max Elevation	:	301012.	cu-ft
	:	6.910	ac-ft

---------- Riser Geometry ----------

Riser Structure Type	: Circular	
Riser Diameter	: 54.00	in
Common Length	: 3.520	ft
Riser Crest Elevation	: 103.00	ft

---------- Hydraulic Structure Geometry ----------

Number of Devices: 3

--- Device Number 1 ---

Device Type	:	Circular Orifice	
Invert Elevation	:	100.00	ft
Diameter	:	17.54	in
Orientation	:	Horizontal	
Elbow	:	No	

--- Device Number 2 ---

Device Type	:	Vertical Rectangular Orifice	
Invert Elevation	:	100.99	ft
Length	:	42.2	in
Height	:	24.1	in
Orientation	:	Vertical	
Elbow	:	No	

**** Computed Pond Hydraulic Table *****

Elev (ft)	Surf Area (acres)	Volume (ac-ft)	Discharge (cfs)	Infilt (cfs)
100.00	1.370	0.000	0.000	0.000
100.04	1.372	0.048	1.536	0.000
100.07	1.375	0.096	2.173	0.000
100.14	1.380	0.192	3.073	0.000
100.21	1.385	0.289	3.763	0.000
100.28	1.390	0.386	4.346	0.000
100.35	1.395	0.484	4.858	0.000
100.42	1.400	0.582	5.322	0.000
100.49	1.405	0.680	5.749	0.000
100.56	1.410	0.778	6.145	0.000
100.63	1.415	0.877	6.518	0.000
100.70	1.420	0.976	6.871	0.000
100.77	1.425	1.076	7.206	0.000
100.84	1.430	1.176	7.527	0.000
100.91	1.435	1.276	7.834	0.000
100.93	1.437	1.305	7.920	0.000
100.95	1.438	1.334	8.004	0.000
100.97	1.440	1.362	8.088	0.000
100.99	1.441	1.391	8.171	0.000
101.01	1.443	1.417	8.270	0.000
101.03	1.444	1.442	8.391	0.000
101.04	1.445	1.467	8.525	0.000
101.06	1.446	1.492	8.671	0.000
101.13	1.451	1.594	9.339	0.000
101.20	1.457	1.696	10.110	0.000
101.27	1.462	1.798	10.964	0.000
101.34	1.467	1.900	11.885	0.000
101.41	1.472	2.003	12.866	0.000
101.48	1.477	2.106	13.899	0.000
101.55	1.482	2.210	14.979	0.000
101.62	1.488	2.314	16.103	0.000
101.69	1.493	2.418	17.267	0.000
101.76	1.498	2.523	18.467	0.000
101.83	1.503	2.628	19.702	0.000
101.90	1.508	2.733	20.968	0.000
101.97	1.514	2.839	22.264	0.000
102.04	1.519	2.945	23.587	0.000
102.11	1.524	3.052	24.937	0.000
102.18	1.529	3.159	26.311	0.000
102.25	1.535	3.266	27.708	0.000
102.32	1.540	3.373	29.127	0.000
102.39	1.545	3.481	30.566	0.000
102.46	1.550	3.590	32.024	0.000
102.53	1.556	3.698	33.501	0.000
102.60	1.561	3.807	34.994	0.000
102.67	1.566	3.917	36.504	0.000
102.74	1.572	4.027	38.028	0.000
102.81	1.577	4.137	39.567	0.000
102.88	1.582	4.247	41.119	0.000
102.91	1.584	4.295	41.788	0.000
102.94	1.587	4.343	42.460	0.000
102.97	1.589	4.390	43.133	0.000
103.00	1.591	4.438	43.808	0.000
103.02	1.593	4.466	44.286	0.000
103.04	1.594	4.494	44.834	0.000
103.05	1.595	4.522	45.427	0.000
103.07	1.597	4.550	46.057	0.000
103.09	1.598	4.577	46.719	0.000

103.11	1.599	4.605	47.409	0.000
103.12	1.601	4.633	48.125	0.000
103.14	1.602	4.661	48.865	0.000
103.21	1.607	4.774	52.039	0.000
103.28	1.613	4.887	55.507	0.000
103.35	1.618	5.000	59.227	0.000
103.42	1.624	5.113	63.166	0.000
103.49	1.629	5.227	67.297	0.000
103.56	1.634	5.341	71.594	0.000
103.63	1.640	5.456	76.035	0.000
103.70	1.645	5.571	79.293	0.000
103.77	1.651	5.686	83.312	0.000
103.84	1.656	5.802	87.378	0.000
103.91	1.661	5.918	91.470	0.000
103.98	1.667	6.034	95.564	0.000
104.05	1.672	6.151	99.637	0.000
104.12	1.678	6.268	103.664	0.000
104.19	1.683	6.386	107.622	0.000
104.26	1.689	6.504	111.489	0.000
104.33	1.694	6.622	115.244	0.000
104.40	1.700	6.741	118.866	0.000
104.47	1.705	6.860	122.337	0.000
104.54	1.711	6.980	125.643	0.000
104.61	1.716	7.100	128.769	0.000
104.68	1.722	7.220	131.708	0.000
104.75	1.727	7.341	134.454	0.000
104.82	1.733	7.462	137.007	0.000
104.89	1.739	7.583	139.371	0.000
104.96	1.744	7.705	141.558	0.000
105.03	1.750	7.827	143.583	0.000

********** Annual Maxima Flow Data **********

Subbasin 1 Runoff Predevelopment Runoff Date	Annual Max (cfs)	Pond Outflow Node Postdevelopment Runoff Date	Annual Max (cfs)
1940 04 30	18.567	1940 04 30	16.535
1940 12 20	10.435	1940 12 20	9.076
1941 12 15	27.873	1941 12 15	14.203
1942 11 23	10.509	1943 03 28	8.551
1944 01 22	8.655	1944 01 23	6.757
1945 02 07	25.473	1945 02 07	23.289
1946 01 23	14.600	1946 02 05	13.384
1947 02 01	16.193	1947 02 02	12.916
1948 03 21	26.156	1948 03 21	22.262
1949 03 19	13.764	1949 02 22	13.442
1950 03 03	57.081	1950 03 03	43.183
1951 02 09	20.559	1951 02 09	20.055
1952 06 29	19.163	1952 06 29	7.199
1953 01 11	11.568	1953 01 11	10.372
1954 01 22	13.818	1954 01 22	13.535
1955 04 12	7.405	1955 04 12	5.979
1955 12 22	14.644	1955 12 21	13.473
1957 02 25	13.382	1957 02 25	12.560
1958 01 16	13.991	1958 01 16	13.148
1959 01 12	17.104	1959 01 13	15.516
1959 12 15	19.499	1959 12 15	15.979
1961 02 14	16.114	1960 11 20	13.917
1962 03 04	8.794	1962 03 04	8.226
1963 02 03	10.389	1963 02 03	9.319
1964 01 01	15.657	1964 01 01	12.333
1965 02 26	15.472	1965 02 27	13.667
1966 04 11	15.514	1966 04 11	12.867
1967 01 19	25.477	1967 01 19	21.417
1968 02 03	13.584	1968 02 04	11.575
1968 12 03	14.835	1968 12 03	12.914
1970 01 13	14.764	1970 01 14	10.025
1970 12 06	16.169	1970 12 06	13.093
1972 02 28	33.442	1972 02 28	28.527
1972 12 23	12.769	1972 12 23	12.145
1974 02 18	16.195	1974 02 19	15.126
1974 12 26	27.205	1974 12 27	20.968
1975 12 02	14.646	1975 12 03	12.638
1977 05 31	7.749	1977 05 31	7.130
1978 09 22	16.790	1977 12 15	13.008
1979 03 04	14.979	1979 03 04	10.804
1979 12 14	22.599	1979 12 15	19.846
1980 11 21	14.957	1980 12 26	9.244
1981 10 06	38.272	1981 10 06	29.852
1983 01 05	16.602	1983 01 05	15.317
1984 03 14	16.979	1984 03 21	9.837
1985 02 11	10.926	1985 02 11	9.136
1986 01 18	29.664	1986 01 18	27.231
1986 11 24	28.666	1986 11 24	27.218
1988 04 06	14.051	1988 04 06	12.888
1989 04 05	15.189	1989 04 05	13.238
1990 01 09	50.733	1990 01 09	47.405
1990 11 24	45.470	1990 11 24	38.813
1992 01 27	15.364	1992 01 27	12.470
1993 03 22	11.398	1993 03 23	10.727
1994 03 03	9.390	1994 03 03	8.495
1995 02 19	17.322	1995 02 19	16.783
1996 02 08	39.257	1996 02 08	34.050

1997	01	02	26.510	1997	01	02	21.072
1998	02	28	11.072	1998	03	23	7.469
1998	11	04	33.083	1998	11	25	21.786
2000	02	05	15.931	2000	02	06	14.343
2001	05	05	12.341	2001	05	05	9.667
2002	05	03	41.851	2002	05	03	21.472
2003	03	31	26.653	2003	03	31	26.173
2004	01	23	9.316	2004	01	23	8.087
2005	02	05	18.830	2005	02	07	10.968
2005	11	27	16.728	2005	11	27	16.033
2006	12	14	14.476	2006	12	14	12.022
2008	03	21	22.862	2008	01	06	18.355
2009	02	17	28.065	2009	02	17	26.855
2010	06	10	37.988	2010	01	10	17.694
2010	11	17	27.484	2010	11	17	24.688
2012	01	31	19.544	2012	01	31	10.443
2013	01	20	40.728	2013	01	20	36.097
2013	12	06	23.204	2014	04	05	14.961
2015	02	28	12.069	2015	03	30	9.804
2016	01	04	28.275	2016	01	04	25.526
2017	06	14	13.308	2017	03	07	7.954
2018	04	17	18.433	2018	01	31	14.131
2019	03	29	14.549	2019	02	14	13.682
2020	03	30	13.505	2020	04	14	10.798
2021	02	10	22.210	2021	02	10	21.450
2021	12	20	17.503	2021	12	20	13.103
2023	02	02	21.383	2023	03	30	17.036
2024	01	19	15.495	2024	01	19	14.598
2024	12	22	30.847	2024	12	22	28.118
2026	03	09	16.872	2026	03	09	15.730
2027	01	27	15.084	2027	01	27	14.624
2028	02	19	17.484	2028	02	19	17.380
2028	12	04	15.040	2028	12	04	14.653
2029	11	04	19.735	2030	02	16	16.073
2030	12	30	17.920	2030	12	30	17.581
2032	01	20	29.186	2032	01	20	28.052
2033	03	01	10.139	2033	03	01	8.058
2034	01	15	30.128	2034	01	16	27.438
2035	02	19	18.594	2035	02	19	16.550
2035	12	04	20.264	2035	12	04	15.636
2037	03	08	7.945	2037	03	08	5.548
2037	11	24	17.811	2037	12	15	12.031
2039	02	07	10.168	2038	12	11	7.996
2040	01	14	37.281	2040	01	14	22.360
2040	12	25	18.119	2040	12	25	17.298
2042	02	20	18.340	2042	02	20	13.429
2043	03	31	29.986	2043	03	31	16.707
2044	05	01	16.055	2044	05	01	12.573
2045	02	07	16.052	2045	03	23	13.167
2046	02	16	15.547	2046	02	16	14.729
2047	01	31	11.587	2047	02	01	10.330
2048	04	20	10.243	2048	04	21	9.434
2049	03	16	12.153	2049	03	16	9.157
2049	12	04	21.442	2049	12	04	19.936
2051	04	06	13.685	2051	04	06	10.815
2052	04	16	10.142	2052	04	17	7.466
2053	06	04	46.268	2053	06	04	21.209
2054	04	08	6.833	2054	02	24	6.071
2055	02	17	24.338	2055	02	17	21.478
2056	02	07	42.462	2056	02	07	37.832
2056	11	19	52.716	2056	11	19	42.361
2058	01	24	22.957	2058	05	21	18.406
2058	11	25	22.456	2058	12	28	18.015

2060 01 19	10.645	2060 01 19	7.597
2061 01 10	15.100	2061 01 10	14.609
2062 02 03	62.621	2062 02 03	44.332
2062 12 29	14.709	2062 12 29	13.729
2063 12 23	24.041	2063 12 23	22.599
2064 11 29	13.679	2064 11 30	11.256
2066 01 13	8.248	2066 01 13	7.455
2067 01 19	14.924	2067 01 19	13.256
2068 01 18	30.843	2068 01 18	27.752
2069 01 04	9.658	2069 01 04	8.206
2070 04 09	11.850	2070 04 09	8.349
2071 02 14	8.738	2071 02 14	7.975
2071 11 03	10.653	2071 11 03	9.853
2072 12 25	33.811	2072 12 25	33.039
2074 03 16	20.287	2074 03 16	16.785
2075 02 12	8.320	2075 01 17	6.200
2076 03 24	24.059	2076 03 24	17.913
2077 08 24	6.240	2077 02 12	5.354
2077 11 25	12.032	2077 12 02	8.948
2078 11 03	11.924	2079 02 25	10.914
2079 12 17	42.407	2079 12 17	36.826
2080 11 21	19.617	2080 11 21	18.140
2082 02 14	19.435	2082 02 14	19.334
2083 03 29	14.486	2083 02 11	11.661
2083 11 26	17.824	2083 11 26	15.865
2084 12 14	12.214	2084 12 14	11.141
2086 01 18	15.881	2086 01 18	15.313
2086 12 21	18.230	2086 12 21	13.911
2088 01 14	12.338	2088 01 14	10.425
2088 11 05	30.777	2088 11 05	26.225
2089 12 03	10.049	2089 12 06	8.247
2090 12 04	16.493	2090 12 04	14.918
2092 04 28	37.504	2092 01 31	17.389
2093 06 15	10.724	2093 03 22	8.545
2094 03 01	7.781	2094 03 02	7.208
2094 11 29	11.964	2094 11 29	11.331
2096 01 14	12.852	2096 01 14	12.291
2097 01 29	26.663	2097 01 29	21.838

********** **Ranked Annual Maxima Data**********

Recurrence Interval Computed Using Gringorten Plotting Position

Subbasin 1 Runoff Predevelopment Runoff		Pond Outflow Node Postdevelopment Runoff	
Tr(yrs)	Q(cfs)	Tr(yrs)	Q(cfs)
1.00	6.240	1.00	5.354
1.01	6.833	1.01	5.548
1.02	7.405	1.02	5.979
1.02	7.749	1.02	6.071
1.03	7.781	1.03	6.200
1.04	7.945	1.04	6.757
1.04	8.248	1.04	7.130
1.05	8.320	1.05	7.199
1.06	8.655	1.06	7.208
1.06	8.738	1.06	7.455
1.07	8.794	1.07	7.466
1.08	9.316	1.08	7.469
1.09	9.390	1.09	7.597
1.09	9.658	1.09	7.954
1.10	10.049	1.10	7.975
1.11	10.139	1.11	7.996
1.12	10.142	1.12	8.058
1.12	10.168	1.12	8.087
1.13	10.243	1.13	8.206
1.14	10.389	1.14	8.226
1.15	10.435	1.15	8.247
1.16	10.509	1.16	8.349
1.17	10.645	1.17	8.495
1.18	10.653	1.18	8.545
1.18	10.724	1.18	8.551
1.19	10.926	1.19	8.948
1.20	11.072	1.20	9.076
1.21	11.398	1.21	9.136
1.22	11.568	1.22	9.157
1.23	11.587	1.23	9.244
1.24	11.850	1.24	9.319
1.25	11.924	1.25	9.434
1.26	11.964	1.26	9.667
1.27	12.032	1.27	9.804
1.28	12.069	1.28	9.837
1.29	12.153	1.29	9.853
1.30	12.214	1.30	10.025
1.31	12.338	1.31	10.330
1.32	12.341	1.32	10.372
1.33	12.769	1.33	10.425
1.35	12.852	1.35	10.443
1.36	13.308	1.36	10.727
1.37	13.382	1.37	10.798
1.38	13.505	1.38	10.804
1.39	13.584	1.39	10.815
1.40	13.679	1.40	10.914
1.42	13.685	1.42	10.968
1.43	13.764	1.43	11.141
1.44	13.818	1.44	11.256
1.46	13.991	1.46	11.331
1.47	14.051	1.47	11.575
1.48	14.476	1.48	11.661
1.50	14.486	1.50	12.022
1.51	14.549	1.51	12.031
1.53	14.600	1.53	12.145
1.54	14.644	1.54	12.291

1.56	14.646		1.56	12.333
1.57	14.709		1.57	12.470
1.59	14.764		1.59	12.560
1.60	14.835		1.60	12.573
1.62	14.924		1.62	12.638
1.64	14.957		1.64	12.867
1.65	14.979		1.65	12.888
1.67	15.040		1.67	12.914
1.69	15.084		1.69	12.916
1.71	15.100		1.71	13.008
1.73	15.189		1.73	13.093
1.75	15.364		1.75	13.103
1.77	15.472		1.77	13.148
1.79	15.495		1.79	13.167
1.81	15.514		1.81	13.238
1.83	15.547		1.83	13.256
1.85	15.657		1.85	13.384
1.87	15.881		1.87	13.429
1.89	15.931		1.89	13.442
1.92	16.052		1.92	13.473
1.94	16.055		1.94	13.535
1.96	16.114		1.96	13.667
1.99	16.169		1.99	13.682
2.01	16.193		2.01	13.729
2.04	16.195		2.04	13.911
2.07	16.493		2.07	13.917
2.09	16.602		2.09	14.131
2.12	16.728		2.12	14.203
2.15	16.790		2.15	14.343
2.18	16.872		2.18	14.598
2.21	16.979		2.21	14.609
2.24	17.104		2.24	14.624
2.27	17.322		2.27	14.653
2.31	17.484		2.31	14.729
2.34	17.503		2.34	14.918
2.38	17.811		2.38	14.961
2.41	17.824		2.41	15.126
2.45	17.920		2.45	15.313
2.49	18.119		2.49	15.317
2.53	18.230		2.53	15.516
2.57	18.340		2.57	15.636
2.61	18.433		2.61	15.730
2.65	18.567		2.65	15.865
2.70	18.594		2.70	15.979
2.75	18.830		2.75	16.033
2.80	19.163		2.80	16.073
2.85	19.435		2.85	16.535
2.90	19.499		2.90	16.550
2.95	19.544		2.95	16.707
3.01	19.617		3.01	16.783
3.07	19.735		3.07	16.785
3.13	20.264		3.13	17.036
3.19	20.287		3.19	17.298
3.26	20.559		3.26	17.380
3.32	21.383		3.32	17.389
3.40	21.442		3.40	17.581
3.47	22.210		3.47	17.694
3.55	22.456		3.55	17.913
3.63	22.599		3.63	18.015
3.72	22.862		3.72	18.140
3.80	22.957		3.80	18.355
3.90	23.204		3.90	18.406
4.00	24.041		4.00	19.334

4.10	24.059	4.10	19.846
4.21	24.338	4.21	19.936
4.32	25.473	4.32	20.055
4.45	25.477	4.45	20.968
4.58	26.156	4.58	21.072
4.71	26.510	4.71	21.209
4.86	26.653	4.86	21.417
5.01	26.663	5.01	21.450
5.17	27.205	5.17	21.472
5.35	27.484	5.35	21.478
5.54	27.873	5.54	21.786
5.74	28.065	5.74	21.838
5.95	28.275	5.95	22.262
6.19	28.666	6.19	22.360
6.44	29.186	6.44	22.599
6.71	29.664	6.71	23.289
7.01	29.986	7.01	24.688
7.33	30.128	7.33	25.526
7.69	30.777	7.69	26.173
8.08	30.843	8.08	26.225
8.52	30.847	8.52	26.855
9.00	33.083	9.00	27.218
9.55	33.442	9.55	27.231
10.16	33.811	10.16	27.438
10.86	37.281	10.86	27.752
11.66	37.504	11.66	28.052
12.59	37.988	12.59	28.118
13.68	38.272	13.68	28.527
14.97	39.257	14.97	29.852
16.54	40.728	16.54	33.039
18.47	41.851	18.47	34.050
20.92	42.407	20.92	36.097
24.10	42.462	24.10	36.826
28.44	45.470	28.44	37.832
34.68	46.268	34.68	38.813
44.42	50.733	44.42	42.361
61.77	52.716	61.77	43.183
101.36	57.081	101.36	44.332
282.36	62.621	282.36	47.405

********** Flow Frequency Data for Selected Recurrence Intervals **********

Tr (Years)	Subbasin 1 Runoff Predevelopment* Flow(cfs)	Subbasin 1 Runoff Postdevelopment* Flow(cfs)	Pond Outflow Node Postdevelopment** Flow(cfs)
6-Month	10.634	10.634	
2-Year	16.853	16.853	13.705
5-Year	25.325	25.325	21.448
10-Year	32.170	32.170	27.385
25-Year	42.538	42.538	37.048
50-Year	51.700	51.700	42.656
100-Year	62.257	62.257	44.301
200-Year	74.456	74.456	46.371

* Recurrence Interval Computed Using Generalized Extreme Value Distribution
** Computed Using Gringorten Plotting Position

********** Flow Duration Performance**********

Predevelopment Discharge (cfs)	Exceedance Probability	Postdevelopment Discharge (cfs)	Exceedance Probability
0.000E+00	1.0000E+00	0.000E+00	1.0000E+00
0.313	3.2240E-01	0.237	3.5045E-01
0.626	2.4930E-01	0.474	2.7931E-01
0.939	2.0518E-01	0.711	2.3573E-01
1.252	1.7324E-01	0.948	2.0423E-01
1.566	1.4802E-01	1.185	1.7951E-01
1.879	1.2723E-01	1.422	1.5911E-01
2.192	1.0979E-01	1.659	1.4260E-01
2.505	9.5022E-02	1.896	1.2687E-01
2.818	8.2578E-02	2.133	1.1401E-01
3.131	7.1861E-02	2.370	1.0212E-01
3.444	6.2871E-02	2.607	9.1402E-02
3.757	5.5123E-02	2.844	8.2246E-02
4.070	4.8453E-02	3.081	7.4593E-02
4.383	4.2628E-02	3.318	6.7138E-02
4.697	3.7547E-02	3.555	6.0710E-02
5.010	3.3143E-02	3.792	5.5261E-02
5.323	2.9292E-02	4.029	4.9940E-02
5.636	2.5888E-02	4.266	4.5441E-02
5.949	2.2859E-02	4.503	4.1236E-02
6.262	2.0247E-02	4.741	3.7478E-02
6.575	1.7924E-02	4.978	3.4055E-02
6.888	1.5859E-02	5.215	3.0948E-02
7.201	1.4079E-02	5.452	2.8208E-02
7.514	1.2522E-02	5.689	2.5648E-02
7.828	1.1183E-02	5.926	2.3288E-02
8.141	1.0013E-02	6.163	2.1142E-02
8.426	9.0720E-03	6.400	1.9189E-02
8.767	8.1052E-03	6.637	1.7405E-02
9.080	7.2893E-03	6.874	1.5743E-02
9.393	6.5550E-03	7.111	1.4266E-02
9.706	5.9348E-03	7.348	1.2940E-02
10.019	5.3580E-03	7.585	1.1743E-02
10.332	4.8497E-03	7.822	1.0624E-02
10.645	4.4331E-03	8.059	9.4900E-03
10.959	4.0331E-03	8.296	8.5586E-03
11.272	3.6678E-03	8.426	8.1635E-03
11.585	3.3407E-03	8.770	7.2864E-03
11.898	3.0613E-03	9.007	6.7529E-03
12.211	2.7992E-03	9.244	6.2496E-03
12.524	2.5501E-03	9.481	5.8071E-03
12.837	2.3357E-03	9.718	5.4157E-03
13.150	2.1465E-03	9.955	5.0143E-03
13.463	1.9653E-03	10.192	4.6649E-03
13.777	1.7913E-03	10.429	4.3645E-03
14.090	1.6433E-03	10.666	4.0699E-03
14.403	1.5162E-03	10.903	3.7927E-03
14.716	1.4101E-03	11.140	3.5161E-03
15.029	1.2909E-03	11.377	3.2627E-03
15.342	1.1992E-03	11.614	3.0468E-03
15.655	1.1242E-03	11.851	2.8562E-03
15.968	1.0368E-03	12.088	2.6664E-03
16.281	9.6459E-04	12.325	2.4988E-03
16.594	9.0539E-04	12.562	2.3299E-03
16.853	8.4646E-04	12.799	2.1862E-03
17.221	7.8481E-04	13.036	2.0425E-03
17.534	7.2922E-04	13.273	1.9003E-03

17.847	6.8373E-04	13.510	1.7862E-03
18.160	6.4330E-04	13.747	1.6685E-03
18.473	6.0865E-04	13.985	1.5523E-03
18.786	5.7038E-04	14.222	1.4570E-03
19.099	5.4944E-04	14.459	1.3812E-03
19.412	5.1045E-04	14.696	1.2989E-03
19.725	4.8879E-04	14.933	1.2252E-03
20.039	4.6208E-04	15.170	1.1646E-03
20.352	4.2959E-04	15.407	1.0967E-03
20.665	4.0071E-04	15.644	1.0527E-03
20.978	3.7111E-04	15.881	9.9275E-04
21.291	3.4295E-04	16.118	9.4005E-04
21.604	3.1985E-04	16.355	8.9023E-04
21.917	2.9602E-04	16.592	8.4907E-04
22.230	2.8014E-04	16.853	7.8979E-04
22.543	2.5920E-04	17.066	7.5882E-04
22.856	2.4404E-04	17.303	7.1695E-04
23.170	2.3176E-04	17.540	6.8229E-04
23.483	2.1804E-04	17.777	6.4764E-04
23.796	2.0577E-04	18.014	6.2164E-04
24.109	1.9061E-04	18.251	5.9276E-04
24.422	1.7545E-04	18.488	5.6966E-04
24.735	1.6750E-04	18.725	5.4511E-04
25.048	1.5523E-04	18.962	5.2128E-04
25.325	1.4867E-04	19.199	4.9962E-04
25.674	1.4079E-04	19.436	4.8013E-04
25.988	1.3068E-04	19.673	4.6425E-04
26.301	1.2491E-04	19.910	4.4403E-04
26.614	1.1480E-04	20.147	4.2237E-04
26.927	1.1047E-04	20.384	4.0360E-04
27.240	1.0252E-04	20.621	3.7688E-04
27.553	9.6026E-05	20.858	3.5161E-04
27.866	9.0972E-05	21.095	3.3068E-04
28.179	8.0142E-05	21.332	3.1407E-04
28.492	7.3644E-05	21.569	2.9602E-04
28.805	7.1478E-05	21.806	2.8158E-04
29.119	6.6424E-05	22.043	2.6786E-04
29.432	6.2814E-05	22.280	2.5126E-04
29.745	5.7760E-05	22.517	2.3898E-04
30.058	5.2706E-05	22.754	2.3032E-04
30.371	4.9096E-05	22.991	2.1949E-04
30.684	4.6930E-05	23.228	2.1155E-04
30.997	4.1876E-05	23.466	2.0144E-04
31.310	3.8988E-05	23.703	1.8844E-04
31.623	3.4656E-05	23.940	1.7906E-04
31.936	3.3212E-05	24.177	1.7184E-04
32.250	3.1046E-05	24.414	1.6245E-04
32.563	2.8880E-05	24.651	1.5740E-04
32.876	2.8158E-05	24.888	1.5018E-04
33.189	2.5992E-05	25.125	1.4079E-04
33.502	2.4548E-05	25.325	1.3653E-04
33.815	2.3104E-05	25.599	1.2852E-04
34.128	2.2382E-05	25.836	1.2202E-04
34.441	2.0938E-05	26.073	1.1769E-04
34.754	1.9494E-05	26.310	1.0974E-04
35.068	1.8772E-05	26.547	1.0180E-04
35.381	1.8050E-05	26.784	9.9636E-05
35.694	1.7328E-05	27.021	9.4582E-05
36.007	1.6606E-05	27.258	8.5918E-05
36.320	1.6606E-05	27.495	8.3752E-05
36.633	1.6606E-05	27.732	8.3030E-05
36.946	1.6606E-05	27.969	7.7976E-05
37.259	1.6606E-05	28.206	7.0756E-05

37.572	1.5162E-05	28.443	6.7146E-05
37.885	1.5162E-05	28.680	6.4258E-05
38.199	1.2996E-05	28.917	5.8482E-05
38.512	1.2274E-05	29.154	5.7760E-05
38.825	1.1552E-05	29.391	5.5594E-05
39.138	1.1552E-05	29.628	5.2706E-05
39.451	1.0830E-05	29.865	4.9096E-05
39.764	1.0830E-05	30.102	4.6208E-05
40.077	1.0830E-05	30.339	4.3320E-05
40.390	1.0830E-05	30.576	3.9710E-05
40.703	1.0830E-05	30.813	3.6100E-05
41.016	1.0108E-05	31.050	3.3934E-05
41.330	1.0108E-05	31.287	3.1768E-05
41.643	1.0108E-05	31.524	2.8158E-05
41.956	9.3860E-06	31.761	2.6714E-05
42.269	9.3860E-06	31.998	2.5992E-05
42.582	7.9420E-06	32.235	2.4548E-05
42.895	7.9420E-06	32.472	2.3826E-05
43.208	7.9420E-06	32.710	2.0938E-05
43.521	7.2200E-06	32.947	2.0216E-05
43.834	7.2200E-06	33.184	1.8050E-05
44.147	7.2200E-06	33.421	1.7328E-05
44.461	7.2200E-06	33.658	1.5162E-05
44.774	7.2200E-06	33.895	1.4440E-05
45.087	7.2200E-06	34.132	1.3718E-05
45.400	6.4980E-06	34.369	1.3718E-05
45.713	5.7760E-06	34.606	1.2996E-05
46.026	5.7760E-06	34.843	1.2996E-05
46.339	5.0540E-06	35.080	1.2996E-05
46.652	5.0540E-06	35.317	1.2996E-05
46.965	5.0540E-06	35.554	1.2274E-05
47.279	5.0540E-06	35.791	1.2274E-05
47.592	5.0540E-06	36.028	1.1552E-05
47.905	5.0540E-06	36.265	1.0830E-05
48.218	5.0540E-06	36.502	1.0830E-05
48.531	5.0540E-06	36.739	1.0830E-05
48.844	5.0540E-06	36.976	1.0108E-05
49.157	5.0540E-06	37.213	9.3860E-06
49.470	5.0540E-06	37.450	8.6640E-06
49.783	4.3320E-06	37.687	8.6640E-06
50.096	4.3320E-06	37.924	7.9420E-06
50.410	4.3320E-06	38.161	7.9420E-06
50.723	4.3320E-06	38.398	7.2200E-06
51.036	3.6100E-06	38.635	7.2200E-06
51.349	3.6100E-06	38.872	5.7760E-06
51.700	3.6084E-06	39.109	5.7760E-06
51.975	3.6100E-06	39.346	5.0540E-06
52.288	3.6100E-06	39.583	4.3320E-06
52.601	3.6100E-06	39.820	4.3320E-06
52.914	2.8880E-06	40.057	4.3320E-06
53.227	2.8880E-06	40.294	4.3320E-06
53.541	2.8880E-06	40.531	4.3320E-06
53.854	2.1660E-06	40.768	4.3320E-06
54.167	2.1660E-06	41.005	4.3320E-06
54.480	2.1660E-06	41.242	4.3320E-06
54.793	2.1660E-06	41.479	4.3320E-06
55.106	2.1660E-06	41.716	4.3320E-06
55.419	2.1660E-06	41.954	4.3320E-06
55.732	1.4440E-06	42.191	4.3320E-06
56.045	1.4440E-06	42.428	3.6100E-06
56.358	1.4440E-06	42.665	3.6100E-06
56.672	1.4440E-06	42.902	3.6100E-06
56.985	1.4440E-06	43.139	3.6100E-06

57.298	7.2200E-07	43.376	2.8880E-06
57.611	7.2200E-07	43.613	2.8880E-06
57.924	7.2200E-07	43.850	2.8880E-06
58.237	7.2200E-07	44.087	2.8880E-06
58.550	7.2200E-07	44.324	2.1660E-06
58.863	7.2200E-07	44.561	1.4440E-06
59.176	7.2200E-07	44.798	1.4440E-06
59.490	7.2200E-07	45.035	1.4440E-06
59.803	7.2200E-07	45.272	1.4440E-06
60.116	7.2200E-07	45.509	7.2200E-07
60.429	7.2200E-07	45.746	7.2200E-07
60.742	7.2200E-07	45.983	7.2200E-07
61.055	7.2200E-07	46.220	7.2200E-07
61.368	7.2200E-07	46.457	7.2200E-07
61.681	7.2200E-07	46.694	7.2200E-07
61.994	7.2200E-07	46.931	7.2200E-07
62.307	7.2200E-07	47.168	7.2200E-07
62.621	7.2200E-07	47.405	7.2200E-07

*** Flow Duration Performance According to Dept. of Ecology Criteria ****

Excursion at Predeveloped ½Q2 (Must be Less Than 0%):	-9.8%	PASS
Maximum Excursion from ½Q2 to Q2 (Must be Less Than 0%):	-6.1%	PASS
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	-5.6%	PASS
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS

****

POND MEETS ALL DURATION DESIGN CRITERIA: PASS

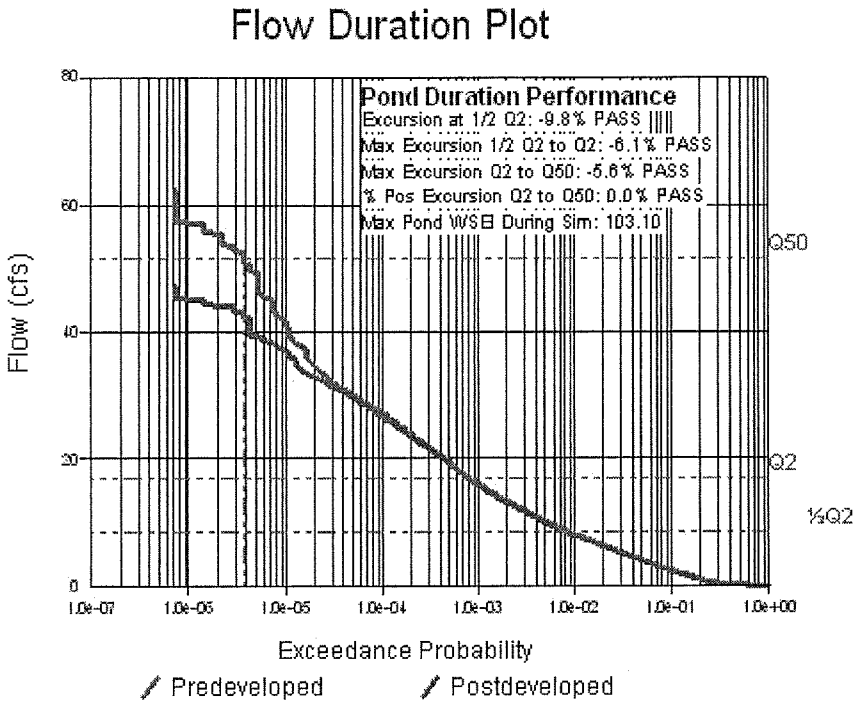
****

********** Water Quality Facility Data **********

Basic Wet Pond Volume (91% Exceedance): 814933. cu-ft
Computed Large Wet Pond Volume, 1.5*Basic Volume: 1222399. cu-ft
2-Year Stormwater Pond Discharge Rate: 13.705 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge
Discharge Rates Computed for Node: 1
On-line Design Discharge Rate (91% Exceedance): 0.00 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.00 cfs

****


Flow Duration Plot
Pond Duration Performance
Excursion at 1/2 Q2: -9.8% PASS
Max Excursion 1/2 Q2 to Q2: -6.1% PASS
Max Excursion Q2 to Q50: -5.6% PASS
% Pos Excursion Q2 to Q50: 0.0% PASS
Max Pond WSEL During Sim: 103.10
Q50
Q2
½Q2
Flow (cfs)
80
60
40
20
0
1.0e-07
1.0e-06
1.0e-05
1.0e-04
1.0e-03
1.0e-02
1.0e-01
1.0e+00
Exceedance Probability
Predeveloped
Postdeveloped

Appended on: 08:18:11 Thursday, February 26, 2009 PIPE # 373

Culvert Quick Calculator				
Type:	Circular Conc	**FHA Chart:**	1	
Ent Desc:	GROOVE END PROJECTING	**Ke:**	0.20	
Culv diam:	3.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
108.0000 ft	4.42 %	0.0130	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
547.9300	0.00	0.0000	0.0000	0.0000	0.0000		
548.1552	0.08	0.5000	0.1300	0.2183	0.1300	548.1552	-----
548.2780	0.12	1.0000	0.1805	0.3091	0.1805	548.2780	-----
548.3731	0.15	1.5000	0.2186	0.3790	0.2186	548.3731	-----
548.4540	0.17	2.0000	0.2501	0.4387	0.2501	548.4540	-----
548.5258	0.20	2.5000	0.2780	0.4915	0.2780	548.5258	-----
548.5912	0.22	3.0000	0.3029	0.5394	0.3029	548.5912	-----
548.6517	0.24	3.5000	0.3263	0.5834	0.3263	548.6517	-----
548.7084	0.26	4.0000	0.3475	0.6244	0.3475	548.7084	-----
548.7620	0.28	4.5000	0.3680	0.6632	0.3680	548.7620	-----
548.8130	0.29	5.0000	0.3871	0.6998	0.3871	548.8130	-----
548.8618	0.31	5.5000	0.4054	0.7350	0.4054	548.8618	-----
548.9087	0.33	6.0000	0.4230	0.7687	0.4222	548.9087	-----
548.9540	0.34	6.5000	0.4391	0.8009	0.4391	548.9540	-----
548.9978	0.36	7.0000	0.4552	0.8324	0.4552	548.9978	-----
549.0403	0.37	7.5000	0.4706	0.8624	0.4706	549.0403	-----
549.0817	0.38	8.0000	0.4860	0.8914	0.4860	549.0817	-----
549.1220	0.40	8.5000	0.5006	0.9196	0.5006	549.1220	-----
549.1614	0.41	9.0000	0.5145	0.9474	0.5145	549.1614	-----
549.2000	0.42	9.5000	0.5284	0.9738	0.5284	549.2000	-----
549.2377	0.44	10.0000	0.5416	1.0001	0.5416	549.2377	-----
549.2747	0.45	10.5000	0.5548	1.0258	0.5548	549.2747	-----
549.3111	0.46	11.0000	0.5680	1.0507	0.5673	549.3111	-----
549.3468	0.47	11.5000	0.5804	1.0756	0.5804	549.3468	-----
549.3820	0.48	12.0000	0.5929	1.0997	0.5922	549.3820	-----
549.4167	0.50	12.5000	0.6046	1.1232	0.6046	549.4167	-----
549.4508	0.51	13.0000	0.6163	1.1459	0.6163	549.4508	-----
549.4845	0.52	13.5000	0.6281	1.1686	0.6281	549.4845	-----
549.5178	0.53	14.0000	0.6398	1.1913	0.6390	549.5178	-----
549.5507	0.54	14.5000	0.6508	1.2133	0.6508	549.5507	-----

549.5832	0.55	15.0000	0.6617	1.2345	0.6617	549.5832	-----
549.6153	0.56	15.5000	0.6727	1.2557	0.6727	549.6153	-----
549.6471	0.57	16.0000	0.6837	1.2770	0.6830	549.6471	-----
549.6786	0.58	16.5000	0.6940	1.2975	0.6940	549.6786	-----
549.7098	0.59	17.0000	0.7042	1.3180	0.7042	549.7098	-----
549.7407	0.60	17.5000	0.7145	1.3385	0.7145	549.7407	-----
549.7714	0.61	18.0000	0.7247	1.3583	0.7247	549.7714	-----
549.8018	0.62	18.5000	0.7350	1.3773	0.7350	549.8018	-----
549.8320	0.63	19.0000	0.7452	1.3971	0.7452	549.8320	-----
549.8620	0.64	19.5000	0.7548	1.4161	0.7548	549.8620	-----
549.8917	0.65	20.0000	0.7643	1.4352	0.7643	549.8917	-----
550.1800	0.75	25.0000	0.8566	1.6124	0.8566	550.1800	-----
550.4567	0.84	30.0000	0.9408	1.7743	0.9408	550.4567	-----
550.7274	0.93	35.0000	1.0199	1.9222	1.0199	550.7274	-----
550.9957	1.02	40.0000	1.0953	2.0592	1.0953	550.9957	-----
551.2647	1.11	45.0000	1.1671	2.1852	1.1671	551.2647	-----
551.5198	1.20	50.0000	1.2360	2.3009	1.2360	551.5198	-----
552.2177	1.43	60.0000	1.3693	2.5016	1.3685	552.2177	-----
553.0425	1.70	70.0000	1.4967	2.6576	1.4960	553.0425	-----
553.9941	2.02	80.0000	1.6212	2.7704	1.6212	553.9941	-----

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Appended on: 07:43:35 Thursday, February 26, 2009

arning, History file is now 1.79 MB in size PIPE #434

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	PROJECTING	**Ke:**	0.90	
Culv diam:	4.5000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
51.0000 ft	2.04 %	0.0240	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
576.1500	0.00	0.0000	0.0000	0.0000	0.0000		
576.3666	0.05	0.5000	0.1881	0.1956	0.1881	576.3666	-----
576.4767	0.07	1.0000	0.2604	0.2780	0.2601	576.4767	-----
576.5620	0.09	1.5000	0.3150	0.3409	0.3150	576.5620	-----
576.6343	0.11	2.0000	0.3612	0.3941	0.3606	576.6343	-----
576.6985	0.12	2.5000	0.4013	0.4411	0.4013	576.6985	-----
576.7569	0.13	3.0000	0.4375	0.4837	0.4375	576.7569	-----
576.8110	0.15	3.5000	0.4705	0.5227	0.4705	576.8110	-----
576.8615	0.16	4.0000	0.5018	0.5595	0.5018	576.8615	-----
576.9093	0.17	4.5000	0.5309	0.5941	0.5309	576.9093	-----
576.9548	0.18	5.0000	0.5584	0.6265	0.5584	576.9548	-----
576.9982	0.19	5.5000	0.5842	0.6575	0.5842	576.9982	-----
577.0399	0.20	6.0000	0.6095	0.6875	0.6095	577.0399	-----
577.0802	0.21	6.5000	0.6336	0.7158	0.6331	577.0802	-----
577.1191	0.22	7.0000	0.6567	0.7432	0.6564	577.1191	-----
577.1568	0.22	7.5000	0.6787	0.7699	0.6787	577.1568	-----
577.1935	0.23	8.0000	0.7001	0.7957	0.7001	577.1935	-----
577.2292	0.24	8.5000	0.7215	0.8204	0.7210	577.2292	-----
577.2641	0.25	9.0000	0.7419	0.8446	0.7416	577.2641	-----
577.2982	0.26	9.5000	0.7616	0.8682	0.7616	577.2982	-----
577.3315	0.26	10.0000	0.7809	0.8913	0.7809	577.3315	-----
577.3641	0.27	10.5000	0.7995	0.9138	0.7995	577.3641	-----
577.3962	0.28	11.0000	0.8182	0.9358	0.8182	577.3962	-----
577.4276	0.28	11.5000	0.8363	0.9572	0.8358	577.4276	-----
577.4585	0.29	12.0000	0.8539	0.9786	0.8539	577.4585	-----
577.4890	0.30	12.5000	0.8709	0.9989	0.8709	577.4890	-----
577.5189	0.30	13.0000	0.8880	1.0193	0.8880	577.5189	-----

577.5484	0.31	13.5000	0.9050	1.0390	0.9044	577.5484	-----
577.5775	0.32	14.0000	0.9209	1.0588	0.9209	577.5775	-----
577.6062	0.32	14.5000	0.9374	1.0780	0.9374	577.6062	-----
577.6345	0.33	15.0000	0.9533	1.0967	0.9533	577.6345	-----
577.6625	0.34	15.5000	0.9687	1.1154	0.9687	577.6625	-----
577.6901	0.34	16.0000	0.9841	1.1335	0.9841	577.6901	-----
577.7175	0.35	16.5000	0.9995	1.1516	0.9995	577.7175	-----
577.7445	0.35	17.0000	1.0143	1.1698	1.0143	577.7445	-----
577.7712	0.36	17.5000	1.0291	1.1873	1.0291	577.7712	-----
577.7977	0.37	18.0000	1.0440	1.2044	1.0440	577.7977	-----
577.8239	0.37	18.5000	1.0583	1.2214	1.0583	577.8239	-----
577.8499	0.38	19.0000	1.0725	1.2384	1.0725	577.8499	-----
577.8756	0.38	19.5000	1.0868	1.2549	1.0863	577.8756	-----
577.9011	0.39	20.0000	1.1006	1.2714	1.1006	577.9011	-----
578.1456	0.44	25.0000	1.2324	1.4268	1.2318	578.1456	-----
578.3752	0.49	30.0000	1.3532	1.5680	1.3527	578.3752	-----
578.5941	0.54	35.0000	1.4659	1.6988	1.4659	578.5941	-----
578.8051	0.59	40.0000	1.5730	1.8207	1.5724	578.8051	-----
579.0101	0.64	45.0000	1.6751	1.9361	1.6746	579.0101	-----
579.2104	0.68	50.0000	1.7729	2.0454	1.7729	579.2104	-----
579.6010	0.77	60.0000	1.9608	2.2503	1.9608	579.6010	-----
579.9825	0.85	70.0000	2.1404	2.4392	2.1404	579.9825	-----
580.3589	0.94	80.0000	2.3145	2.6161	2.3145	580.3589	-----
580.7329	1.02	90.0000	2.4865	2.7820	2.4859	580.7329	-----
581.1064	1.10	100.0000	2.6573	2.9380	2.6573	581.1064	-----
581.8582	1.27	120.0000	3.0078	3.2242	3.0078	581.8582	-----
582.8191	1.48	140.0000	3.3945	3.4780	3.3940	582.8191	-----

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Appended on: 09:53:37 Monday, May 18, 2009 PIPE # 471

Culvert Quick Calculator				
Type:	Circular Conc	**FHA Chart:**	1	
Ent Desc:	GROOVE END PROJECTING	**Ke:**	0.20	
Culv diam:	3.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
36.0000 ft	1.22 %	0.0130	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
658.9900	0.00	0.0000	0.0000	0.0000	0.0000		
659.2632	0.09	0.5000	0.1761	0.2183	0.1761	659.2632	-----
659.3860	0.13	1.0000	0.2443	0.3091	0.2443	659.3860	-----
659.4811	0.16	1.5000	0.2963	0.3790	0.2963	659.4811	-----
659.5620	0.19	2.0000	0.3395	0.4387	0.3395	659.5620	-----
659.6338	0.21	2.5000	0.3776	0.4915	0.3776	659.6338	-----
659.6992	0.24	3.0000	0.4127	0.5394	0.4127	659.6992	-----
659.7597	0.26	3.5000	0.4442	0.5834	0.4442	659.7597	-----
659.8164	0.28	4.0000	0.4742	0.6244	0.4742	659.8164	-----
659.8700	0.29	4.5000	0.5021	0.6632	0.5021	659.8700	-----
659.9210	0.31	5.0000	0.5284	0.6998	0.5284	659.9210	-----
659.9698	0.33	5.5000	0.5533	0.7350	0.5541	659.9698	-----
660.0167	0.34	6.0000	0.5782	0.7687	0.5782	660.0167	-----
660.0620	0.36	6.5000	0.6010	0.8009	0.6017	660.0620	-----
660.1058	0.37	7.0000	0.6237	0.8324	0.6237	660.1058	-----
660.1483	0.39	7.5000	0.6456	0.8624	0.6456	660.1483	-----
660.1897	0.40	8.0000	0.6661	0.8914	0.6669	660.1897	-----
660.2300	0.41	8.5000	0.6866	0.9196	0.6874	660.2300	-----
660.2694	0.43	9.0000	0.7064	0.9474	0.7072	660.2694	-----
660.3080	0.44	9.5000	0.7262	0.9738	0.7262	660.3080	-----
660.3457	0.45	10.0000	0.7452	1.0001	0.7452	660.3457	-----
660.3827	0.46	10.5000	0.7635	1.0258	0.7643	660.3827	-----
660.4191	0.48	11.0000	0.7819	1.0507	0.7826	660.4191	-----
660.4548	0.49	11.5000	0.8002	1.0756	0.8002	660.4548	-----
660.4900	0.50	12.0000	0.8170	1.0997	0.8177	660.4900	-----
660.5247	0.51	12.5000	0.8346	1.1232	0.8346	660.5247	-----
660.5588	0.52	13.0000	0.8514	1.1459	0.8522	660.5588	-----
660.5925	0.53	13.5000	0.8683	1.1686	0.8683	660.5925	-----
660.6258	0.55	14.0000	0.8844	1.1913	0.8851	660.6258	-----
660.6587	0.56	14.5000	0.9005	1.2133	0.9012	660.6587	-----

660.6912	0.57	15.0000	0.9166	1.2345	0.9174	660.6912	-----
660.7233	0.58	15.5000	0.9320	1.2557	0.9327	660.7233	-----
660.7551	0.59	16.0000	0.9481	1.2770	0.9481	660.7551	-----
660.7866	0.60	16.5000	0.9635	1.2975	0.9635	660.7866	-----
660.8178	0.61	17.0000	0.9781	1.3180	0.9789	660.8178	-----
660.8487	0.62	17.5000	0.9935	1.3385	0.9935	660.8487	-----
660.8794	0.63	18.0000	1.0082	1.3583	1.0089	660.8794	-----
660.9098	0.64	18.5000	1.0228	1.3773	1.0236	660.9098	-----
660.9400	0.65	19.0000	1.0375	1.3971	1.0375	660.9400	-----
660.9700	0.66	19.5000	1.0514	1.4161	1.0521	660.9700	-----
660.9997	0.67	20.0000	1.0660	1.4352	1.0668	660.9997	-----
661.2880	0.77	25.0000	1.2023	1.6124	1.2030	661.2880	-----
661.5647	0.86	30.0000	1.3304	1.7743	1.3312	661.5647	-----
661.8354	0.95	35.0000	1.4528	1.9222	1.4535	661.8354	-----
662.1037	1.04	40.0000	1.5721	2.0592	1.5729	662.1037	-----
662.3727	1.13	45.0000	1.6901	2.1852	1.6908	662.3727	-----
662.6278	1.21	50.0000	1.8080	2.3009	1.8087	662.6278	-----
663.3257	1.45	60.0000	2.0511	2.5016	2.0526	663.3257	-----
664.1505	1.72	70.0000	2.3265	2.6576	2.3287	664.1505	-----
664.4526	1.82	80.0000	-1.0000	2.7704	3.0000	-----	664.4526
665.2233	2.08	90.0000	-1.0000	2.8458	3.0000	-----	665.2231
666.0848	2.36	100.0000	-1.0000	2.8956	3.0000	-----	666.0848
668.0798	3.03	120.0000	-1.0000	2.9484	3.0000	-----	668.0798

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PIPE #528

Culvert Quick Calculator				
Type:	Circular Conc	**FHA Chart:**	1	
Ent Desc:	GROOVE END PROJECTING	**Ke:**	0.20	
Culv diam:	3.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
232.0000 ft	4.29 %	0.0130	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
608.0600	0.00	0.0000	0.0000	0.0000	0.0000		
608.2871	0.08	0.5000	0.1315	0.2183	0.1315	608.2871	-----
608.4099	0.12	1.0000	0.1813	0.3091	0.1813	608.4099	-----
608.5051	0.15	1.5000	0.2201	0.3790	0.2201	608.5051	-----
608.5860	0.18	2.0000	0.2516	0.4387	0.2516	608.5860	-----
608.6578	0.20	2.5000	0.2802	0.4915	0.2802	608.6578	-----
608.7231	0.22	3.0000	0.3051	0.5394	0.3051	608.7231	-----
608.7837	0.24	3.5000	0.3285	0.5834	0.3285	608.7837	-----
608.8404	0.26	4.0000	0.3505	0.6244	0.3505	608.8404	-----
608.8940	0.28	4.5000	0.3702	0.6632	0.3702	608.8940	-----
608.9450	0.29	5.0000	0.3900	0.6998	0.3900	608.9450	-----
608.9938	0.31	5.5000	0.4083	0.7350	0.4083	608.9938	-----
609.0407	0.33	6.0000	0.4259	0.7687	0.4259	609.0407	-----
609.0860	0.34	6.5000	0.4427	0.8009	0.4424	609.0860	-----
609.1298	0.36	7.0000	0.4589	0.8324	0.4589	609.1298	-----
609.1723	0.37	7.5000	0.4742	0.8624	0.4742	609.1723	-----
609.2137	0.38	8.0000	0.4896	0.8914	0.4896	609.2137	-----
609.2540	0.40	8.5000	0.5043	0.9196	0.5043	609.2540	-----
609.2934	0.41	9.0000	0.5182	0.9474	0.5182	609.2934	-----
609.3319	0.42	9.5000	0.5321	0.9738	0.5321	609.3319	-----
609.3697	0.44	10.0000	0.5457	1.0001	0.5453	609.3697	-----
609.4067	0.45	10.5000	0.5592	1.0258	0.5588	609.4067	-----
609.4430	0.46	11.0000	0.5717	1.0507	0.5717	609.4430	-----
609.4788	0.47	11.5000	0.5841	1.0756	0.5841	609.4788	-----
609.5140	0.48	12.0000	0.5966	1.0997	0.5966	609.5140	-----
609.5486	0.50	12.5000	0.6090	1.1232	0.6090	609.5486	-----
609.5828	0.51	13.0000	0.6207	1.1459	0.6207	609.5828	-----

609.6165	0.52	13.5000	0.6324	1.1686	0.6324	609.6165	-----
609.6497	0.53	14.0000	0.6442	1.1913	0.6442	609.6497	-----
609.6826	0.54	14.5000	0.6559	1.2133	0.6552	609.6826	-----
609.7151	0.55	15.0000	0.6669	1.2345	0.6669	609.7151	-----
609.7473	0.56	15.5000	0.6779	1.2557	0.6779	609.7473	-----
609.7791	0.57	16.0000	0.6888	1.2770	0.6881	609.7791	-----
609.8106	0.58	16.5000	0.6991	1.2975	0.6991	609.8106	-----
609.8418	0.59	17.0000	0.7101	1.3180	0.7094	609.8418	-----
609.8727	0.60	17.5000	0.7203	1.3385	0.7203	609.8727	-----
609.9033	0.61	18.0000	0.7306	1.3583	0.7306	609.9033	-----
609.9338	0.62	18.5000	0.7408	1.3773	0.7408	609.9338	-----
609.9639	0.63	19.0000	0.7504	1.3971	0.7504	609.9639	-----
609.9939	0.64	19.5000	0.7606	1.4161	0.7606	609.9939	-----
610.0237	0.65	20.0000	0.7701	1.4352	0.7701	610.0237	-----
610.3119	0.75	25.0000	0.8632	1.6124	0.8632	610.3119	-----
610.5887	0.84	30.0000	0.9481	1.7743	0.9481	610.5887	-----
610.8593	0.93	35.0000	1.0280	1.9222	1.0280	610.8593	-----
611.1277	1.02	40.0000	1.1041	2.0592	1.1041	611.1277	-----
611.3967	1.11	45.0000	1.1766	2.1852	1.1759	611.3967	-----
611.6518	1.20	50.0000	1.2462	2.3009	1.2462	611.6518	-----
612.3497	1.43	60.0000	1.3802	2.5016	1.3802	612.3497	-----
613.1744	1.70	70.0000	1.5099	2.6576	1.5092	613.1744	-----
614.1261	2.02	80.0000	1.6359	2.7704	1.6359	614.1261	-----

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PIPE #537

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	Projecting	**Ke:**	0.90	
Culv diam:	6.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
71.0000 ft	0.06 %	0.0240	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
517.7100	0.00	0.0000	0.0000	0.0000	0.0000		
518.1215	0.07	0.5000	0.4061	0.1824	0.4003	-----	518.1215 (M1)
518.2826	0.10	1.0000	0.5636	0.2582	0.5555	-----	518.2826 (M1)
518.4053	0.12	1.5000	0.6837	0.3168	0.6735	-----	518.4053 (M1)
518.5091	0.13	2.0000	0.7852	0.3658	0.7731	-----	518.5091 (M1)
518.6006	0.15	2.5000	0.8741	0.4091	0.8610	-----	518.6006 (M1)
518.6838	0.16	3.0000	0.9554	0.4486	0.9408	-----	518.6838 (M1)
518.7602	0.18	3.5000	1.0294	0.4849	1.0140	-----	518.7602 (M1)
518.8314	0.19	4.0000	1.0990	0.5189	1.0822	-----	518.8314 (M1)
518.8986	0.20	4.5000	1.1649	0.5504	1.1466	-----	518.8986 (M1)
518.9628	0.21	5.0000	1.2272	0.5804	1.2081	-----	518.9628 (M1)
519.0233	0.22	5.5000	1.2865	0.6090	1.2660	-----	519.0233 (M1)
519.0821	0.23	6.0000	1.3429	0.6365	1.3224	-----	519.0821 (M1)
519.1380	0.24	6.5000	1.3978	0.6625	1.3759	-----	519.1380 (M1)
519.1923	0.25	7.0000	1.4506	0.6881	1.4279	-----	519.1923 (M1)
519.2450	0.26	7.5000	1.5018	0.7123	1.4784	-----	519.2450 (M1)
519.2962	0.26	8.0000	1.5516	0.7365	1.5275	-----	519.2962 (M1)
519.3459	0.27	8.5000	1.6007	0.7592	1.5751	-----	519.3459 (M1)
519.3941	0.28	9.0000	1.6476	0.7811	1.6212	-----	519.3941 (M1)
519.4415	0.29	9.5000	1.6937	0.8031	1.6666	-----	519.4415 (M1)
519.4880	0.30	10.0000	1.7391	0.8243	1.7113	-----	519.4880 (M1)
519.5332	0.30	10.5000	1.7831	0.8448	1.7545	-----	519.5332 (M1)
519.5775	0.31	11.0000	1.8267	0.8654	1.7970	-----	519.5775 (M1)
519.6210	0.32	11.5000	1.8695	0.8851	1.8387	-----	519.6210 (M1)
519.6638	0.33	12.0000	1.9113	0.9042	1.8798	-----	519.6638 (M1)
519.7065	0.33	12.5000	1.9523	0.9232	1.9208	-----	519.7065 (M1)
519.7477	0.34	13.0000	1.9926	0.9415	1.9603	-----	519.7477 (M1)

519.7883	0.35	13.5000	2.0328	0.9598	1.9991	-----	519.7883 (M1)
519.8287	0.35	14.0000	2.0724	0.9781	2.0380	-----	519.8287 (M1)
519.8684	0.36	14.5000	2.1112	0.9957	2.0760	-----	519.8684 (M1)
519.9080	0.37	15.0000	2.1493	1.0126	2.1141	-----	519.9080 (M1)
519.9462	0.37	15.5000	2.1874	1.0302	2.1508	-----	519.9462 (M1)
519.9850	0.38	16.0000	2.2255	1.0470	2.1881	-----	519.9850 (M1)
520.0224	0.39	16.5000	2.2621	1.0631	2.2240	-----	520.0224 (M1)
520.0604	0.39	17.0000	2.2987	1.0792	2.2606	-----	520.0604 (M1)
520.0970	0.40	17.5000	2.3353	1.0953	2.2958	-----	520.0970 (M1)
520.1336	0.40	18.0000	2.3712	1.1115	2.3309	-----	520.1336 (M1)
520.1701	0.41	18.5000	2.4071	1.1268	2.3661	-----	520.1701 (M1)
520.2066	0.42	19.0000	2.4430	1.1422	2.4012	-----	520.2066 (M1)
520.2424	0.42	19.5000	2.4781	1.1576	2.4357	-----	520.2424 (M1)
520.2774	0.43	20.0000	2.5126	1.1730	2.4694	-----	520.2774 (M1)
520.6192	0.48	25.0000	2.8502	1.3143	2.7990	-----	520.6192 (M1)
520.9448	0.54	30.0000	3.1740	1.4432	3.1139	-----	520.9448 (M1)
521.2638	0.59	35.0000	3.4926	1.5619	3.4237	-----	521.2638 (M1)
521.5822	0.65	40.0000	3.8148	1.6732	3.7343	-----	521.5822 (M1)
521.9089	0.70	45.0000	4.1503	1.7772	4.0543	-----	521.9089 (M1)
522.2581	0.76	50.0000	4.5165	1.8768	4.3986	-----	522.2581 (M1)
523.8486	1.02	60.0000	-1.0000	2.0629	6.0000	-----	523.8486
523.9140	1.03	70.0000	-1.0000	2.2343	6.0000	-----	523.9140
523.9895	1.05	80.0000	-1.0000	2.3947	6.0000	-----	523.9895
524.0750	1.06	90.0000	-1.0000	2.5463	6.0000	-----	524.0750
524.1706	1.08	100.0000	-1.0000	2.6906	6.0000	-----	524.1706
524.3920	1.11	120.0000	-1.0000	2.9594	6.0000	-----	524.3920
524.6537	1.16	140.0000	-1.0000	3.2084	6.0000	-----	524.6537
524.9556	1.21	160.0000	-1.0000	3.4406	6.0000	-----	524.9556

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rning, History file is now 0.76 MB in size PIPE #538

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	Projecting	**Ke:**	0.90	
Culv diam:	6.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
71.0000 ft	0.00 %	0.0240	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
517.3700	0.00	0.0000	0.0000	0.0000	0.0000		
523.3700	1.00	0.5000	-1.0000	0.1824	6.0000	-----	523.3700
523.3700	1.00	1.0000	-1.0000	0.2582	6.0000	-----	523.3700
523.3701	1.00	1.5000	-1.0000	0.3168	6.0000	-----	523.3701
523.3702	1.00	2.0000	-1.0000	0.3658	6.0000	-----	523.3702
523.3703	1.00	2.5000	-1.0000	0.4091	6.0000	-----	523.3703
523.3704	1.00	3.0000	-1.0000	0.4486	6.0000	-----	523.3704
523.3706	1.00	3.5000	-1.0000	0.4849	6.0000	-----	523.3706
523.3708	1.00	4.0000	-1.0000	0.5189	6.0000	-----	523.3708
523.3710	1.00	4.5000	-1.0000	0.5504	6.0000	-----	523.3710
523.3713	1.00	5.0000	-1.0000	0.5804	6.0000	-----	523.3713
523.3715	1.00	5.5000	-1.0000	0.6090	6.0000	-----	523.3715
523.3718	1.00	6.0000	-1.0000	0.6365	6.0000	-----	523.3718
523.3721	1.00	6.5000	-1.0000	0.6625	6.0000	-----	523.3721
523.3725	1.00	7.0000	-1.0000	0.6881	6.0000	-----	523.3725
523.3728	1.00	7.5000	-1.0000	0.7123	6.0000	-----	523.3728
523.3732	1.00	8.0000	-1.0000	0.7365	6.0000	-----	523.3732
523.3736	1.00	8.5000	-1.0000	0.7592	6.0000	-----	523.3736
523.3741	1.00	9.0000	-1.0000	0.7811	6.0000	-----	523.3741
523.3745	1.00	9.5000	-1.0000	0.8031	6.0000	-----	523.3745
523.3750	1.00	10.0000	-1.0000	0.8243	6.0000	-----	523.3750
523.3755	1.00	10.5000	-1.0000	0.8448	6.0000	-----	523.3755
523.3761	1.00	11.0000	-1.0000	0.8654	6.0000	-----	523.3761
523.3767	1.00	11.5000	-1.0000	0.8851	6.0000	-----	523.3767
523.3772	1.00	12.0000	-1.0000	0.9042	6.0000	-----	523.3772
523.3779	1.00	12.5000	-1.0000	0.9232	6.0000	-----	523.3779
523.3785	1.00	13.0000	-1.0000	0.9415	6.0000	-----	523.3785

523.3792	1.00	13.5000	-1.0000	0.9598	6.0000	-----	523.3792
523.3799	1.00	14.0000	-1.0000	0.9781	6.0000	-----	523.3799
523.3806	1.00	14.5000	-1.0000	0.9957	6.0000	-----	523.3806
523.3813	1.00	15.0000	-1.0000	1.0126	6.0000	-----	523.3813
523.3821	1.00	15.5000	-1.0000	1.0302	6.0000	-----	523.3821
523.3829	1.00	16.0000	-1.0000	1.0470	6.0000	-----	523.3829
523.3837	1.00	16.5000	-1.0000	1.0631	6.0000	-----	523.3837
523.3845	1.00	17.0000	-1.0000	1.0792	6.0000	-----	523.3845
523.3854	1.00	17.5000	-1.0000	1.0953	6.0000	-----	523.3854
523.3863	1.00	18.0000	-1.0000	1.1115	6.0000	-----	523.3863
523.3872	1.00	18.5000	-1.0000	1.1268	6.0000	-----	523.3872
523.3882	1.00	19.0000	-1.0000	1.1422	6.0000	-----	523.3882
523.3891	1.00	19.5000	-1.0000	1.1576	6.0000	-----	523.3891
523.3901	1.00	20.0000	-1.0000	1.1730	6.0000	-----	523.3901
523.4014	1.01	25.0000	-1.0000	1.3143	6.0000	-----	523.4014
523.4153	1.01	30.0000	-1.0000	1.4432	6.0000	-----	523.4153
523.4316	1.01	35.0000	-1.0000	1.5619	6.0000	-----	523.4316
523.4505	1.01	40.0000	-1.0000	1.6732	6.0000	-----	523.4505
523.4719	1.02	45.0000	-1.0000	1.7772	6.0000	-----	523.4719
523.4958	1.02	50.0000	-1.0000	1.8768	6.0000	-----	523.4958
523.5511	1.03	60.0000	-1.0000	2.0629	6.0000	-----	523.5511
523.6166	1.04	70.0000	-1.0000	2.2343	6.0000	-----	523.6166
523.6920	1.05	80.0000	-1.0000	2.3947	6.0000	-----	523.6920
523.7776	1.07	90.0000	-1.0000	2.5463	6.0000	-----	523.7776
523.8732	1.08	100.0000	-1.0000	2.6906	6.0000	-----	523.8732
524.0946	1.12	120.0000	-1.0000	2.9594	6.0000	-----	524.0946
524.3563	1.16	140.0000	-1.0000	3.2084	6.0000	-----	524.3563
524.6582	1.21	160.0000	-1.0000	3.4406	6.0000	-----	524.6582

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Appended on: 09:03:10 Thursday, February 26, 2009

rning, History file is now 0.75 MB in size

PIPE #539

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	Projecting	**Ke:**	0.90	
Culv diam:	6.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
71.0000 ft	0.82 %	0.0240	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
518.2900	0.00	0.0000	0.0000	0.0000	0.0000		
518.5762	0.05	0.5000	0.2172	0.1824	0.2172	-----	518.5762 (M1)
518.6956	0.07	1.0000	0.2999	0.2582	0.2999	-----	518.6956 (M1)
518.7880	0.08	1.5000	0.3629	0.3168	0.3629	-----	518.7880 (M1)
518.8664	0.10	2.0000	0.4156	0.3658	0.4156	-----	518.8664 (M1)
518.9358	0.11	2.5000	0.4618	0.4091	0.4618	-----	518.9358 (M1)
518.9990	0.12	3.0000	0.5035	0.4486	0.5028	-----	518.9990 (M1)
519.0573	0.13	3.5000	0.5416	0.4849	0.5409	-----	519.0573 (M1)
519.1116	0.14	4.0000	0.5768	0.5189	0.5768	-----	519.1116 (M1)
519.1629	0.15	4.5000	0.6105	0.5504	0.6097	-----	519.1629 (M1)
519.2115	0.15	5.0000	0.6420	0.5804	0.6412	-----	519.2115 (M1)
519.2578	0.16	5.5000	0.6720	0.6090	0.6713	-----	519.2578 (M1)
519.3023	0.17	6.0000	0.7006	0.6365	0.6998	-----	519.3023 (M1)
519.3451	0.18	6.5000	0.7277	0.6625	0.7269	-----	519.3451 (M1)
519.3863	0.18	7.0000	0.7540	0.6881	0.7533	-----	519.3863 (M1)
519.4260	0.19	7.5000	0.7797	0.7123	0.7789	-----	519.4260 (M1)
519.4648	0.20	8.0000	0.8038	0.7365	0.8031	-----	519.4648 (M1)
519.5022	0.20	8.5000	0.8280	0.7592	0.8273	-----	519.5022 (M1)
519.5388	0.21	9.0000	0.8507	0.7811	0.8500	-----	519.5388 (M1)
519.5743	0.21	9.5000	0.8734	0.8031	0.8727	-----	519.5743 (M1)
519.6090	0.22	10.0000	0.8954	0.8243	0.8947	-----	519.6090 (M1)
519.6430	0.23	10.5000	0.9166	0.8448	0.9159	-----	519.6430 (M1)
519.6760	0.23	11.0000	0.9379	0.8654	0.9371	-----	519.6760 (M1)
519.7085	0.24	11.5000	0.9584	0.8851	0.9576	-----	519.7085 (M1)
519.7404	0.24	12.0000	0.9781	0.9042	0.9774	-----	519.7404 (M1)
519.7716	0.25	12.5000	0.9979	0.9232	0.9972	-----	519.7716 (M1)
519.8023	0.25	13.0000	1.0170	0.9415	1.0162	-----	519.8023 (M1)

519.8323	0.26	13.5000	1.0360	0.9598	1.0353	-----	519.8323 (M1)
519.8620	0.26	14.0000	1.0551	0.9781	1.0536	-----	519.8620 (M1)
519.8911	0.27	14.5000	1.0726	0.9957	1.0719	-----	519.8911 (M1)
519.9196	0.27	15.0000	1.0909	1.0126	1.0902	-----	519.9196 (M1)
519.9479	0.28	15.5000	1.1085	1.0302	1.1078	-----	519.9479 (M1)
519.9757	0.28	16.0000	1.1261	1.0470	1.1250	-----	519.9757 (M1)
520.0031	0.29	16.5000	1.1429	1.0631	1.1422	-----	520.0031 (M1)
520.0302	0.29	17.0000	1.1598	1.0792	1.1591	-----	520.0302 (M1)
520.0568	0.29	17.5000	1.1766	1.0953	1.1759	-----	520.0568 (M1)
520.0832	0.30	18.0000	1.1935	1.1115	1.1920	-----	520.0832 (M1)
520.1093	0.30	18.5000	1.2096	1.1268	1.2081	-----	520.1093 (M1)
520.1349	0.31	19.0000	1.2257	1.1422	1.2242	-----	520.1349 (M1)
520.1601	0.31	19.5000	1.2411	1.1576	1.2404	-----	520.1601 (M1)
520.1853	0.32	20.0000	1.2572	1.1730	1.2557	-----	520.1853 (M1)
520.4217	0.36	25.0000	1.4052	1.3143	1.4037	-----	520.4217 (M1)
520.6376	0.39	30.0000	1.5399	1.4432	1.5385	-----	520.6376 (M1)
520.8380	0.42	35.0000	1.6652	1.5619	1.6637	-----	520.8380 (M1)
521.0259	0.46	40.0000	1.7838	1.6732	1.7816	-----	521.0259 (M1)
521.2034	0.49	45.0000	1.8959	1.7772	1.8944	-----	521.2034 (M1)
521.3730	0.51	50.0000	2.0035	1.8768	2.0013	-----	521.3730 (M1)
521.6910	0.57	60.0000	2.2072	2.0629	2.2050	-----	521.6910 (M1)
521.9878	0.62	70.0000	2.3990	2.2343	2.3961	-----	521.9878 (M1)
522.2671	0.66	80.0000	2.5822	2.3947	2.5800	-----	522.2671 (M1)
522.5333	0.71	90.0000	2.7601	2.5463	2.7565	-----	522.5333 (M1)
522.7882	0.75	100.0000	2.9330	2.6906	2.9293	-----	522.7882 (M1)
523.2725	0.83	120.0000	3.2706	2.9594	3.2670	-----	523.2725 (M1)
523.7328	0.91	140.0000	3.6053	3.2084	3.6010	-----	523.7328 (M1)
524.1791	0.98	160.0000	3.9481	3.4406	3.9423	-----	524.1791 (M1)

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Appended on: 10:14:10 Wednesday, February 25, 2009

Warning, History file is now 0.73 MB in size

PIPE 542

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	PROJECTING	**Ke:**	0.90	
Culv diam:	4.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
52.0000 ft	1.79 %	0.0240	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
521.9700	0.00	0.0000	0.0000	0.0000	0.0000		
522.2049	0.06	0.5000	0.1997	0.2021	0.1997	522.2049	-----
522.3188	0.09	1.0000	0.2769	0.2866	0.2769	522.3188	-----
522.4071	0.11	1.5000	0.3354	0.3516	0.3354	522.4071	-----
522.4822	0.13	2.0000	0.3843	0.4067	0.3843	522.4822	-----
522.5490	0.14	2.5000	0.4272	0.4551	0.4272	522.5490	-----
522.6098	0.16	3.0000	0.4663	0.4990	0.4663	522.6098	-----
522.6662	0.17	3.5000	0.5015	0.5396	0.5015	522.6662	-----
522.7190	0.19	4.0000	0.5347	0.5776	0.5347	522.7190	-----
522.7690	0.20	4.5000	0.5659	0.6128	0.5659	522.7690	-----
522.8166	0.21	5.0000	0.5962	0.6470	0.5962	522.8166	-----
522.8622	0.22	5.5000	0.6245	0.6792	0.6235	522.8622	-----
522.9060	0.23	6.0000	0.6509	0.7095	0.6509	522.9060	-----
522.9483	0.24	6.5000	0.6772	0.7388	0.6772	522.9483	-----
522.9893	0.25	7.0000	0.7017	0.7671	0.7017	522.9893	-----
523.0291	0.26	7.5000	0.7261	0.7954	0.7261	523.0291	-----
523.0679	0.27	8.0000	0.7495	0.8218	0.7495	523.0679	-----
523.1056	0.28	8.5000	0.7720	0.8472	0.7720	523.1056	-----
523.1425	0.29	9.0000	0.7944	0.8726	0.7935	523.1425	-----
523.1786	0.30	9.5000	0.8159	0.8970	0.8149	523.1786	-----
523.2140	0.31	10.0000	0.8364	0.9214	0.8364	523.2140	-----
523.2487	0.32	10.5000	0.8569	0.9448	0.8569	523.2487	-----
523.2828	0.33	11.0000	0.8774	0.9673	0.8765	523.2828	-----
523.3163	0.34	11.5000	0.8970	0.9897	0.8970	523.3163	-----
523.3493	0.34	12.0000	0.9155	1.0112	0.9155	523.3493	-----
523.3817	0.35	12.5000	0.9351	1.0327	0.9351	523.3817	-----
523.4137	0.36	13.0000	0.9536	1.0542	0.9536	523.4137	-----

523.4453	0.37	13.5000	0.9722	1.0747	0.9712	523.4453	-----
523.4765	0.38	14.0000	0.9897	1.0942	0.9897	523.4765	-----
523.5072	0.38	14.5000	1.0073	1.1147	1.0073	523.5072	-----
523.5377	0.39	15.0000	1.0249	1.1343	1.0249	523.5377	-----
523.5677	0.40	15.5000	1.0415	1.1538	1.0415	523.5677	-----
523.5975	0.41	16.0000	1.0591	1.1724	1.0581	523.5975	-----
523.6269	0.41	16.5000	1.0757	1.1909	1.0757	523.6269	-----
523.6560	0.42	17.0000	1.0923	1.2095	1.0913	523.6560	-----
523.6849	0.43	17.5000	1.1079	1.2280	1.1079	523.6849	-----
523.7135	0.44	18.0000	1.1245	1.2461	1.1245	523.7135	-----
523.7419	0.44	18.5000	1.1401	1.2642	1.1401	523.7419	-----
523.7700	0.45	19.0000	1.1558	1.2817	1.1558	523.7700	-----
523.7979	0.46	19.5000	1.1714	1.2983	1.1714	523.7979	-----
523.8256	0.46	20.0000	1.1870	1.3159	1.1870	523.8256	-----
524.0923	0.53	25.0000	1.3325	1.4771	1.3325	524.0923	-----
524.3451	0.59	30.0000	1.4683	1.6245	1.4683	524.3451	-----
524.5884	0.65	35.0000	1.5962	1.7603	1.5952	524.5884	-----
524.8248	0.71	40.0000	1.7183	1.8872	1.7173	524.8248	-----
525.0564	0.77	45.0000	1.8364	2.0073	1.8354	525.0564	-----
525.2846	0.83	50.0000	1.9507	2.1216	1.9507	525.2846	-----
525.7343	0.94	60.0000	2.1753	2.3335	2.1743	525.7343	-----
526.1803	1.05	70.0000	2.3979	2.5288	2.3970	526.1803	-----
526.6266	1.16	80.0000	2.6255	2.7095	2.6245	526.6266	-----
527.0764	1.28	90.0000	2.8657	2.8755	2.8647	527.0764	-----

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Appended on: 10:14:45 Wednesday, February 25, 2009

arning, History file is now 0.74 MB in size

PIPE # 543

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	Projecting	**Ke:**	0.90	
Culv diam:	4.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
52.0000 ft	0.10 %	0.0130	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
521.4700	0.00	0.0000	0.0000	0.0000	0.0000		
521.8075	0.08	0.5000	0.2974	0.2021	0.2954	-----	521.8075 (M1)
521.9439	0.12	1.0000	0.4136	0.2866	0.4097	-----	521.9439 (M1)
522.0495	0.14	1.5000	0.5024	0.3516	0.4976	-----	522.0495 (M1)
522.1384	0.17	2.0000	0.5767	0.4067	0.5708	-----	522.1384 (M1)
522.2176	0.19	2.5000	0.6421	0.4551	0.6362	-----	522.2176 (M1)
522.2896	0.20	3.0000	0.7026	0.4990	0.6958	-----	522.2896 (M1)
522.3561	0.22	3.5000	0.7573	0.5396	0.7505	-----	522.3561 (M1)
522.4180	0.24	4.0000	0.8091	0.5776	0.8013	-----	522.4180 (M1)
522.4765	0.25	4.5000	0.8579	0.6128	0.8491	-----	522.4765 (M1)
522.5323	0.27	5.0000	0.9038	0.6470	0.8950	-----	522.5323 (M1)
522.5856	0.28	5.5000	0.9478	0.6792	0.9390	-----	522.5856 (M1)
522.6367	0.29	6.0000	0.9902	0.7095	0.9810	-----	522.6367 (M1)
522.6857	0.30	6.5000	1.0308	0.7388	1.0210	-----	522.6857 (M1)
522.7333	0.32	7.0000	1.0708	0.7671	1.0601	-----	522.7333 (M1)
522.7795	0.33	7.5000	1.1089	0.7954	1.0981	-----	522.7795 (M1)
522.8239	0.34	8.0000	1.1460	0.8218	1.1343	-----	522.8239 (M1)
522.8676	0.35	8.5000	1.1821	0.8472	1.1704	-----	522.8676 (M1)
522.9102	0.36	9.0000	1.2183	0.8726	1.2056	-----	522.9102 (M1)
522.9517	0.37	9.5000	1.2524	0.8970	1.2397	-----	522.9517 (M1)
522.9922	0.38	10.0000	1.2866	0.9214	1.2729	-----	522.9922 (M1)
523.0321	0.39	10.5000	1.3198	0.9448	1.3062	-----	523.0321 (M1)
523.0711	0.40	11.0000	1.3521	0.9673	1.3384	-----	523.0711 (M1)
523.1097	0.41	11.5000	1.3843	0.9897	1.3706	-----	523.1097 (M1)
523.1474	0.42	12.0000	1.4165	1.0112	1.4019	-----	523.1474 (M1)
523.1842	0.43	12.5000	1.4478	1.0327	1.4321	-----	523.1842 (M1)
523.2206	0.44	13.0000	1.4780	1.0542	1.4624	-----	523.2206 (M1)

523.2567	0.45	13.5000	1.5083	1.0747	1.4927	-----	523.2567 (M1)
523.2921	0.46	14.0000	1.5386	1.0942	1.5220	-----	523.2921 (M1)
523.3271	0.46	14.5000	1.5679	1.1147	1.5513	-----	523.3271 (M
523.3614	0.47	15.0000	1.5972	1.1343	1.5796	-----	523.3614 (M1)
523.3958	0.48	15.5000	1.6265	1.1538	1.6089	-----	523.3958 (M1)
523.4296	0.49	16.0000	1.6548	1.1724	1.6372	-----	523.4296 (M1)
523.4626	0.50	16.5000	1.6831	1.1909	1.6646	-----	523.4626 (M1)
523.4959	0.51	17.0000	1.7114	1.2095	1.6929	-----	523.4959 (M1)
523.5285	0.51	17.5000	1.7388	1.2280	1.7202	-----	523.5285 (M1)
523.5609	0.52	18.0000	1.7671	1.2461	1.7476	-----	523.5609 (M1)
523.5931	0.53	18.5000	1.7944	1.2642	1.7749	-----	523.5931 (M1)
523.6247	0.54	19.0000	1.8218	1.2817	1.8013	-----	523.6247 (M1)
523.6565	0.55	19.5000	1.8491	1.2983	1.8286	-----	523.6565 (M1)
523.6877	0.55	20.0000	1.8755	1.3159	1.8550	-----	523.6877 (M1)
523.9904	0.63	25.0000	2.1401	1.4771	2.1147	-----	523.9904 (M1)
524.2813	0.70	30.0000	2.3999	1.6245	2.3696	-----	524.2813 (M1)
524.5705	0.78	35.0000	2.6665	1.7603	2.6294	-----	524.5705 (M1)
524.8707	0.85	40.0000	2.9546	1.8872	2.9077	-----	524.8707 (M1)
525.2095	0.93	45.0000	-1.0000	2.0073	3.2358	-----	525.2095 (M1)
525.9477	1.12	50.0000	-1.0000	2.1216	4.0000	-----	525.9477
526.1808	1.18	60.0000	-1.0000	2.3335	4.0000	-----	526.1808
526.4562	1.25	70.0000	-1.0000	2.5288	4.0000	-----	526.4562
526.7741	1.33	80.0000	-1.0000	2.7095	4.0000	-----	526.7741
527.1343	1.42	90.0000	-1.0000	2.8755	4.0000	-----	527.1343

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Appended on: 09:54:20 Wednesday, February 25, 2009 PIPE #544

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	Projecting	**Ke:**	0.90	
Culv diam:	4.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
52.0000 ft	0.17 %	0.0240	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
521.7800	0.00	0.0000	0.0000	0.0000	0.0000		
522.1541	0.09	0.5000	0.3462	0.2021	0.3481	-----	522.1541 (M1)
522.3034	0.13	1.0000	0.4819	0.2866	0.4839	-----	522.3034 (M1)
522.4187	0.16	1.5000	0.5854	0.3516	0.5884	-----	522.4187 (M1)
522.5160	0.18	2.0000	0.6733	0.4067	0.6763	-----	522.5160 (M1)
522.6026	0.21	2.5000	0.7515	0.4551	0.7544	-----	522.6026 (M1)
522.6815	0.23	3.0000	0.8218	0.4990	0.8257	-----	522.6815 (M1)
522.7541	0.24	3.5000	0.8872	0.5396	0.8911	-----	522.7541 (M1)
522.8224	0.26	4.0000	0.9478	0.5776	0.9526	-----	522.8224 (M1)
522.8865	0.28	4.5000	1.0063	0.6128	1.0103	-----	522.8865 (M1)
522.9481	0.29	5.0000	1.0610	0.6470	1.0659	-----	522.9481 (M1)
523.0073	0.31	5.5000	1.1138	0.6792	1.1196	-----	523.0073 (M1)
523.0637	0.32	6.0000	1.1646	0.7095	1.1704	-----	523.0637 (M1)
523.1179	0.33	6.5000	1.2144	0.7388	1.2192	-----	523.1179 (M1)
523.1708	0.35	7.0000	1.2612	0.7671	1.2671	-----	523.1708 (M1)
523.2225	0.36	7.5000	1.3081	0.7954	1.3140	-----	523.2225 (M1)
523.2726	0.37	8.0000	1.3530	0.8218	1.3594	-----	523.2726 (M1)
523.3216	0.39	8.5000	1.3970	0.8472	1.4038	-----	523.3216 (M1)
523.3690	0.40	9.0000	1.4399	0.8726	1.4468	-----	523.3690 (M1)
523.4162	0.41	9.5000	1.4824	0.8970	1.4897	-----	523.4162 (M1)
523.4623	0.42	10.0000	1.5239	0.9214	1.5317	-----	523.4623 (M1)
523.5074	0.43	10.5000	1.5649	0.9448	1.5728	-----	523.5074 (M1)
523.5514	0.44	11.0000	1.6050	0.9673	1.6128	-----	523.5514 (M1)
523.5953	0.45	11.5000	1.6450	0.9897	1.6528	-----	523.5953 (M1)
523.6381	0.46	12.0000	1.6841	1.0112	1.6919	-----	523.6381 (M1)
523.6808	0.48	12.5000	1.7222	1.0327	1.7310	-----	523.6808 (M1)
523.7233	0.49	13.0000	1.7603	1.0542	1.7700	-----	523.7233 (M1)
523.7648	0.50	13.5000	1.7983	1.0747	1.8081	-----	523.7648 (M1)
523.8055	0.51	14.0000	1.8364	1.0942	1.8452	-----	523.8055 (M1)
523.8467	0.52	14.5000	1.8735	1.1147	1.8833	-----	523.8467 (M1)

523.8870	0.53	15.0000	1.9106	1.1343	1.9204	-----	523.8870 (M1)
523.9272	0.54	15.5000	1.9468	1.1538	1.9575	-----	523.9272 (M1)
523.9666	0.55	16.0000	1.9834	1.1724	1.9937	-----	523.9666 (M1
524.0065	0.56	16.5000	2.0200	1.1909	2.0308	-----	524.0065 (M1)
524.0456	0.57	17.0000	2.0562	1.2095	2.0669	-----	524.0456 (M1)
524.0846	0.58	17.5000	2.0923	1.2280	2.1030	-----	524.0846 (M1)
524.1235	0.59	18.0000	2.1274	1.2461	2.1392	-----	524.1235 (M1)
524.1624	0.60	18.5000	2.1636	1.2642	2.1753	-----	524.1624 (M1)
524.2011	0.61	19.0000	2.1997	1.2817	2.2114	-----	524.2011 (M1)
524.2398	0.61	19.5000	2.2349	1.2983	2.2476	-----	524.2398 (M1)
524.2784	0.62	20.0000	2.2710	1.3159	2.2837	-----	524.2784 (M1)
524.6661	0.72	25.0000	2.6333	1.4771	2.6499	-----	524.6661 (M1)
525.0896	0.83	30.0000	3.0356	1.6245	3.0601	-----	525.0896 (M1)
526.0251	1.06	35.0000	-1.0000	1.7603	4.0000	-----	526.0251
526.1272	1.09	40.0000	-1.0000	1.8872	4.0000	-----	526.1272
526.2429	1.12	45.0000	-1.0000	2.0073	4.0000	-----	526.2429
526.3722	1.15	50.0000	-1.0000	2.1216	4.0000	-----	526.3722
526.6717	1.22	60.0000	-1.0000	2.3335	4.0000	-----	526.6717

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Appended on: 09:48:25 Wednesday, February 25, 2009 PIPE #545

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	PROJECTING	**Ke:**	0.90	
Culv diam:	4.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
52.0000 ft	1.54 %	0.0240	0.0000 ft	1

Rating Curve w/Constant TW = 0.0000 ft		
Stage (ft)	**HW/D Ratio**	**Discharge (ft/s)**
522.6800	0.00	0.0000
523.0080	0.08	0.5000
523.1508	0.12	1.0000
523.1740	0.12	1.5000
523.1973	0.13	2.0000
523.2640	0.15	2.5000
523.3248	0.16	3.0000
523.3812	0.18	3.5000
523.4340	0.19	4.0000
23.4840	0.20	4.5000
523.5316	0.21	5.0000
523.5772	0.22	5.5000
523.6210	0.24	6.0000
523.6634	0.25	6.5000
523.7043	0.26	7.0000
523.7441	0.27	7.5000
523.7829	0.28	8.0000
523.8207	0.29	8.5000
523.8575	0.29	9.0000
523.8937	0.30	9.5000
523.9290	0.31	10.0000
523.9637	0.32	10.5000
523.9978	0.33	11.0000
524.0313	0.34	11.5000
524.0643	0.35	12.0000
524.0967	0.35	12.5000
524.1288	0.36	13.0000
24.1603	0.37	13.5000
524.1915	0.38	14.0000
524.2223	0.39	14.5000

524.2527	0.39	15.0000
524.2827	0.40	15.5000
524.3125	0.41	16.0000
524.3419	0.42	16.5000
524.3711	0.42	17.0000
524.4000	0.43	17.5000
524.4285	0.44	18.0000
524.4569	0.44	18.5000
524.4850	0.45	19.0000
524.5129	0.46	19.5000
524.5406	0.47	20.0000
524.8073	0.53	25.0000
525.0601	0.60	30.0000
525.3034	0.66	35.0000
525.5399	0.71	40.0000
525.7715	0.77	45.0000
525.9996	0.83	50.0000
526.4493	0.94	60.0000
526.8953	1.05	70.0000

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Appended on: 10:02:55 Monday, May 18, 2009 PIPE #546

Culvert Quick Calculator				
Type:	CM Box	**FHA Chart:**	16-19	
Ent Desc:	90 deg headwall	**Ke:**	0.25	
Span:	0.00	**15.00 ft**	0.00	
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
25.0000 ft	0.50 %	0.0240	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
525.2700	0.00	0.0000	0.0000	0.0000	0.0000		
525.3267	0.00	0.5000	0.1743	0.0298	0.0499	-----	525.3267 (M1)
525.3573	0.01	1.0000	0.2798	0.0471	0.0755	-----	525.3573 (M1)
525.3828	0.01	1.5000	0.3735	0.0627	0.0966	-----	525.3828 (M1)
525.4053	0.01	2.0000	0.4609	0.0755	0.1149	-----	525.4053 (M1)
525.4257	0.01	2.5000	0.5449	0.0874	0.1314	-----	525.4257 (M1)
525.4444	0.01	3.0000	0.6265	0.0993	0.1460	-----	525.4444 (M1)
525.4626	0.01	3.5000	0.7065	0.1094	0.1607	-----	525.4626 (M1)
525.4798	0.01	4.0000	0.7847	0.1195	0.1744	-----	525.4798 (M1)
525.4960	0.02	4.5000	0.8623	0.1295	0.1872	-----	525.4960 (M1)
525.5115	0.02	5.0000	0.9390	0.1387	0.1991	-----	525.5115 (M1)
525.5267	0.02	5.5000	-1.0000	0.1479	0.2110	-----	525.5267 (M1)
525.5416	0.02	6.0000	-1.0000	0.1570	0.2229	-----	525.5416 (M1)
525.5558	0.02	6.5000	-1.0000	0.1653	0.2339	-----	525.5558 (M1)
525.5698	0.02	7.0000	-1.0000	0.1744	0.2449	-----	525.5698 (M1)
525.5831	0.02	7.5000	-1.0000	0.1817	0.2550	-----	525.5831 (M1)
525.5963	0.02	8.0000	-1.0000	0.1900	0.2650	-----	525.5963 (M1)
525.6092	0.02	8.5000	-1.0000	0.1982	0.2751	-----	525.6092 (M1)
525.6221	0.02	9.0000	-1.0000	0.2055	0.2852	-----	525.6221 (M1)
525.6343	0.02	9.5000	-1.0000	0.2129	0.2943	-----	525.6343 (M1)
525.6464	0.03	10.0000	-1.0000	0.2211	0.3035	-----	525.6464 (M1)
525.6584	0.03	10.5000	-1.0000	0.2284	0.3127	-----	525.6584 (M1)
525.6703	0.03	11.0000	-1.0000	0.2348	0.3218	-----	525.6703 (M1)
525.6821	0.03	11.5000	-1.0000	0.2422	0.3310	-----	525.6821 (M1)
525.6933	0.03	12.0000	-1.0000	0.2495	0.3392	-----	525.6933 (M1)
525.7044	0.03	12.5000	-1.0000	0.2559	0.3474	-----	525.7044 (M1)
525.7159	0.03	13.0000	-1.0000	0.2632	0.3566	-----	525.7159 (M1)
525.7268	0.03	13.5000	-1.0000	0.2696	0.3648	-----	525.7268 (M1)
525.7377	0.03	14.0000	-1.0000	0.2760	0.3731	-----	525.7377 (M1)
525.7480	0.03	14.5000	-1.0000	0.2824	0.3804	-----	525.7480 (M1)

525.7587	0.03	15.0000	-1.0000	0.2888	0.3886	-----	525.7587 (M1)
525.7693	0.03	15.5000	-1.0000	0.2953	0.3969	-----	525.7693 (M1)
525.7795	0.03	16.0000	-1.0000	0.3017	0.4042	-----	525.7795 (M1
525.7900	0.03	16.5000	-1.0000	0.3081	0.4124	-----	525.7900 (M1)
525.7999	0.04	17.0000	-1.0000	0.3145	0.4198	-----	525.7999 (M1)
525.8099	0.04	17.5000	-1.0000	0.3209	0.4271	-----	525.8099 (M1)
525.8197	0.04	18.0000	-1.0000	0.3264	0.4344	-----	525.8197 (M1)
525.8296	0.04	18.5000	-1.0000	0.3328	0.4417	-----	525.8296 (M1)
525.8393	0.04	19.0000	-1.0000	0.3383	0.4491	-----	525.8393 (M1)
525.8490	0.04	19.5000	-1.0000	0.3447	0.4564	-----	525.8490 (M1)
525.8587	0.04	20.0000	-1.0000	0.3502	0.4637	-----	525.8587 (M1)
525.9501	0.05	25.0000	-1.0000	0.4060	0.5315	-----	525.9501 (M1)
526.0356	0.05	30.0000	-1.0000	0.4591	0.5946	-----	526.0356 (M1)
526.1164	0.06	35.0000	-1.0000	0.5086	0.6541	-----	526.1164 (M1)
526.1932	0.06	40.0000	-1.0000	0.5562	0.7100	-----	526.1932 (M1)
526.2670	0.07	45.0000	-1.0000	0.6010	0.7640	-----	526.2670 (M1)
526.3383	0.07	50.0000	-1.0000	0.6450	0.8162	-----	526.3383 (M1)
526.4735	0.08	60.0000	-1.0000	0.7283	0.9142	-----	526.4735 (M1)
526.6014	0.09	70.0000	-1.0000	0.8080	1.0066	-----	526.6014 (M1)
526.7233	0.10	80.0000	-1.0000	0.8830	1.0945	-----	526.7233 (M1)
526.8403	0.10	90.0000	-1.0000	0.9544	1.1787	-----	526.8403 (M1
526.9528	0.11	100.0000	-1.0000	1.0240	1.2593	-----	526.9528 (M1)
527.1677	0.13	120.0000	-1.0000	1.1568	1.4140	-----	527.1677 (M1)
527.3711	0.14	140.0000	-1.0000	1.2822	1.5605	-----	527.3711 (M1)
527.5649	0.15	160.0000	-1.0000	1.4012	1.6997	-----	527.5649 (M1)
527.7510	0.17	180.0000	-1.0000	1.5157	1.8343	-----	527.7510 (M1)
527.9303	0.18	200.0000	-1.0000	1.6255	1.9633	-----	527.9303 (M1)
528.1038	0.19	220.0000	-1.0000	1.7326	2.0888	-----	528.1038 (M1)
528.2722	0.20	240.0000	-1.0000	1.8361	2.2105	-----	528.2722 (M1)
528.4362	0.21	260.0000	-1.0000	1.9368	2.3296	-----	528.4362 (M1)
528.5961	0.22	280.0000	-1.0000	2.0348	2.4458	-----	528.5961 (M1)
528.7524	0.23	300.0000	-1.0000	2.1309	2.5603	-----	528.7524 (M1)

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Culvert Calculator

All calculator output should be verified prior to design use

Entered Data:

Shape	Rectangular
Number of Barrels	1
Solving for	Headwater
Chart Number	8
Scale Number	1
Chart Description	BOX CULVERT WITH FLARED WINGWALLS; NO INLET TOP EDGE BEVEL
Scale Description	WINGWALLS FLARED 30 TO 75 DEGREES
Overtopping	Off
Flowrate	69.5400 cfs
Manning's n	0.0170
Roadway Elevation	22.0000 ft
Inlet Elevation	1.1200 ft
Outlet Elevation	1.0000 ft
Height	75.0000 in
Width	192.0000 in
Length	24.0000 ft
Entrance Loss	0.0000
Tailwater	4.0000 ft

Computed Results:

Headwater	4.7777 ft Outlet Control
Slope	0.0050 ft/ft
Velocity	1.0866 fps

Messages:

Outlet head > Inlet head.
Computing Outlet Control headwater.
Outlet not submerged.
Normal Depth: 10.1072 in
Critical Depth: 10.0482 in
Flow is subcritical.
Normal depth > critical depth.
Tailwater depth > normal depth.
M1 backwater profile.
Depth computed with direct step method.
Headwater: 4.7777 ft

DIS-CHARGE Flow cfs	HEAD-WATER ELEV. ft	INLET CONTROL DEPTH ft	OUTLET CONTROL DEPTH ft	FLOW TYPE	NORMAL DEPTH in	CRITICAL DEPTH in	OUTLET VEL. fps	OUTLET DEPTH ft	TAILWATER VEL. fps	TAILWATER DEPTH ft
13.91	1.53	0.41	0.37	NA	3.75	3.44	2.78	0.31	0.00	4.00
27.82	1.79	0.67	0.60	NA	5.74	5.46	3.64	0.48	0.00	4.00
41.72	2.01	0.89	0.81	NA	7.36	7.15	4.25	0.61	0.00	4.00
55.63	2.21	1.09	0.99	NA	8.80	8.66	4.74	0.73	0.00	4.00
69.54	2.39	1.27	1.16	NA	10.11	10.05	5.16	0.84	0.00	4.00
83.45	2.56	1.44	1.32	NA	11.33	11.35	5.53	0.94	0.00	4.00
97.36	2.73	1.61	1.47	NA	12.48	12.58	5.85	1.04	0.00	4.00

111.26	2.88	1.76	1.61	NA	13.57	13.75	6.15	1.13	0.00
4.00									
125.17	3.03	1.91	1.75	NA	14.62	14.87	6.42	1.22	0.00
4.00									
139.08	3.18	2.06	1.89	NA	15.63	15.95	6.67	1.30	0.00
4.00									
152.99	3.32	2.20	2.02	NA	16.61	17.00	6.91	1.38	0.00
4.00									
166.90	3.45	2.33	2.14	NA	17.56	18.01	7.13	1.46	0.00
4.00									
180.80	3.58	2.46	2.26	NA	18.48	19.00	7.34	1.54	0.00
4.00									
194.71	3.71	2.59	2.38	NA	19.39	19.96	7.53	1.62	0.00
4.00									
208.62	3.84	2.72	2.50	NA	20.27	20.90	7.72	1.69	0.00
4.00									
222.53	3.96	2.84	2.62	NA	21.13	21.82	7.90	1.76	0.00
4.00									
236.44	4.08	2.96	2.73	NA	21.98	22.72	8.07	1.83	0.00
4.00									
250.34	4.20	3.08	2.84	NA	22.81	23.60	8.23	1.90	0.00
4.00									
264.25	4.32	3.20	2.95	NA	23.62	24.47	8.39	1.97	0.00
4.00									
278.16	4.44	3.32	3.05	NA	24.43	25.32	8.54	2.04	0.00
4.00									
292.07	4.55	3.43	3.16	NA	25.22	26.16	8.69	2.10	0.00
4.00									
305.98	4.66	3.54	3.26	NA	26.00	26.98	8.83	2.17	0.00
4.00									
319.88	4.77	3.65	3.36	NA	26.77	27.79	8.96	2.23	0.00
4.00									
333.79	4.88	3.76	3.46	NA	27.53	28.59	9.09	2.29	0.00
4.00									
347.70	4.99	3.87	3.56	NA	28.28	29.38	9.22	2.36	0.00
4.00									

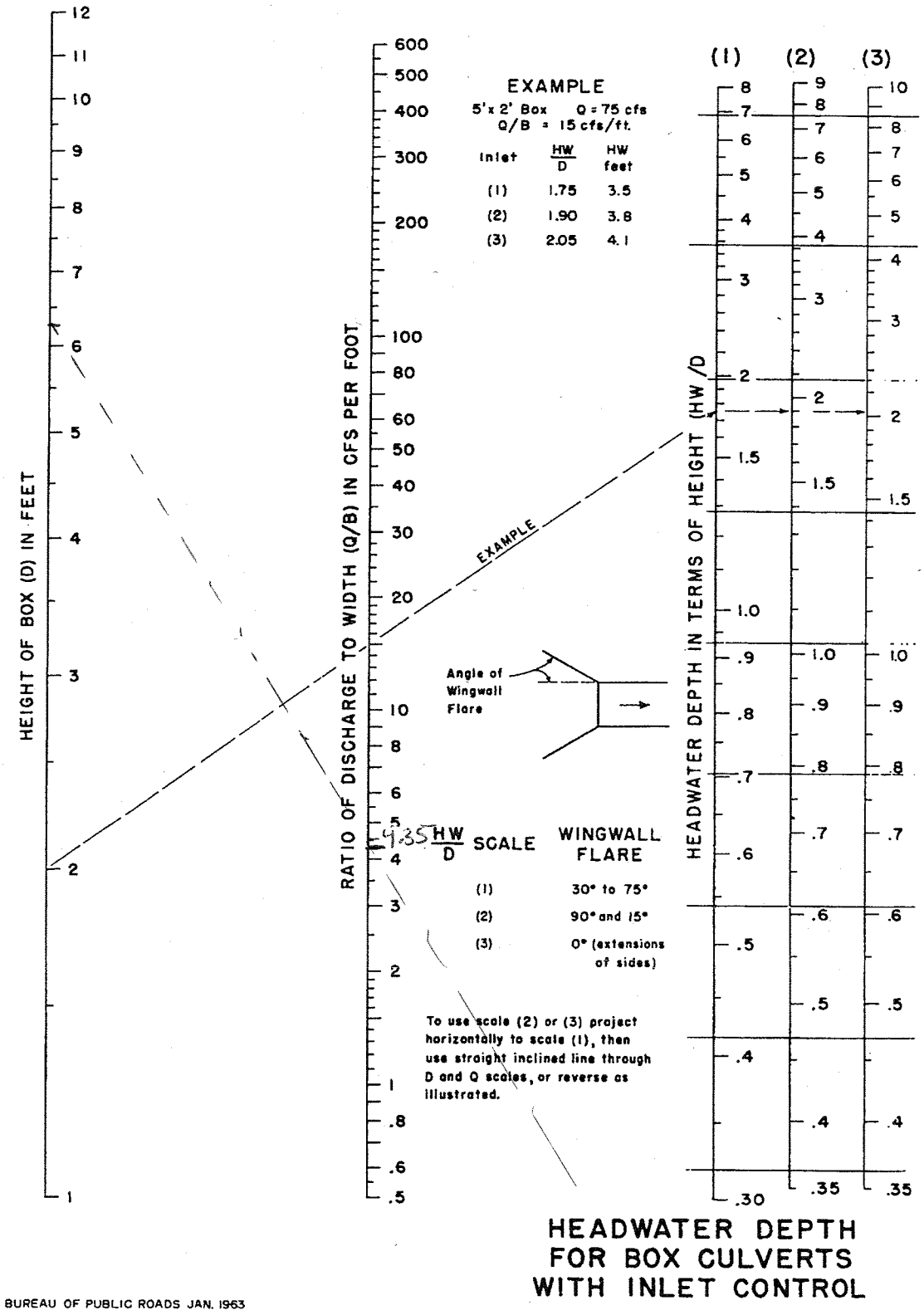

Figure-3-3.4.2E
Box Culvert Inlet Control Nomograph

Appended on: 07:54:49 Thursday, February 26, 2009

Warning, History file is now 1.83 MB in size

PIPE # 556

Culvert Quick Calculator				
Type:	Circular Conc	**FHA Chart:**	1	
Ent Desc:	GROOVE END PROJECTING	**Ke:**	0.20	
Culv diam:	4.5000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
50.0000 ft	3.04 %	0.0130	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
542.6300	0.00	0.0000	0.0000	0.0000	0.0000		
542.8238	0.04	0.5000	0.1587	0.1956	0.1288	542.8238	-----
542.9334	0.07	1.0000	0.2231	0.2780	0.1780	542.9334	-----
543.0180	0.09	1.5000	0.2739	0.3409	0.2151	543.0180	-----
543.0897	0.10	2.0000	0.3179	0.3941	0.2464	543.0897	-----
543.1530	0.12	2.5000	0.3569	0.4411	0.2733	543.1530	-----
543.2105	0.13	3.0000	0.3940	0.4837	0.2980	543.2105	-----
543.2635	0.14	3.5000	0.4292	0.5227	0.3205	543.2635	-----
543.3131	0.15	4.0000	0.4624	0.5595	0.3409	543.3131	-----
543.3597	0.16	4.5000	0.4956	0.5941	0.3606	543.3597	-----
543.4040	0.17	5.0000	0.5278	0.6265	0.3793	543.4040	-----
543.4462	0.18	5.5000	0.5591	0.6575	0.3963	543.4462	-----
543.4866	0.19	6.0000	0.5913	0.6875	0.4134	543.4866	-----
543.5255	0.20	6.5000	0.6226	0.7158	0.4293	543.5255	-----
543.5630	0.21	7.0000	0.6558	0.7432	0.4447	543.5630	-----
543.5993	0.22	7.5000	0.6890	0.7699	0.4595	543.5993	-----
543.6345	0.22	8.0000	0.7251	0.7957	0.4738	543.6345	-----
543.6687	0.23	8.5000	0.7632	0.8204	0.4875	543.6687	-----
543.7019	0.24	9.0000	0.8062	0.8446	0.5013	543.7019	-----
543.7344	0.25	9.5000	-1.0000	0.8682	0.5144	543.7344	-----
543.7660	0.25	10.0000	-1.0000	0.8913	0.5271	543.7660	-----
543.7970	0.26	10.5000	-1.0000	0.9138	0.5397	543.7970	-----
543.8273	0.27	11.0000	-1.0000	0.9358	0.5518	543.8273	-----
543.8570	0.27	11.5000	-1.0000	0.9572	0.5639	543.8570	-----
543.8861	0.28	12.0000	-1.0000	0.9786	0.5754	543.8861	-----
543.9147	0.29	12.5000	-1.0000	0.9989	0.5869	543.9147	-----
543.9428	0.29	13.0000	-1.0000	1.0193	0.5979	543.9428	-----

543.9704	0.30	13.5000	-1.0000	1.0390	0.6089	543.9704	-----
543.9976	0.30	14.0000	-1.0000	1.0588	0.6199	543.9976	-----
544.0243	0.31	14.5000	-1.0000	1.0780	0.6303	544.0243	-----
544.0506	0.32	15.0000	-1.0000	1.0967	0.6408	544.0506	-----
544.0766	0.32	15.5000	-1.0000	1.1154	0.6507	544.0766	-----
544.1022	0.33	16.0000	-1.0000	1.1335	0.6611	544.1022	-----
544.1275	0.33	16.5000	-1.0000	1.1516	0.6710	544.1275	-----
544.1524	0.34	17.0000	-1.0000	1.1698	0.6809	544.1524	-----
544.1770	0.34	17.5000	-1.0000	1.1873	0.6902	544.1770	-----
544.2013	0.35	18.0000	-1.0000	1.2044	0.6996	544.2013	-----
544.2254	0.35	18.5000	-1.0000	1.2214	0.7089	544.2254	-----
544.2491	0.36	19.0000	-1.0000	1.2384	0.7182	544.2491	-----
544.2727	0.37	19.5000	-1.0000	1.2549	0.7276	544.2727	-----
544.2959	0.37	20.0000	-1.0000	1.2714	0.7364	544.2959	-----
544.5166	0.42	25.0000	-1.0000	1.4268	0.8215	544.5166	-----
544.7204	0.46	30.0000	-1.0000	1.5680	0.8984	544.7204	-----
544.9117	0.51	35.0000	-1.0000	1.6988	0.9698	544.9117	-----
545.0936	0.55	40.0000	-1.0000	1.8207	1.0363	545.0936	-----
545.2679	0.59	45.0000	-1.0000	1.9361	1.0995	545.2679	-----
545.4364	0.62	50.0000	-1.0000	2.0454	1.1593	545.4364	-----
545.7596	0.70	60.0000	-1.0000	2.2503	1.2725	545.7596	-----
546.0699	0.76	70.0000	-1.0000	2.4392	1.3774	546.0699	-----
546.3716	0.83	80.0000	-1.0000	2.6161	1.4768	546.3716	-----
546.6678	0.90	90.0000	-1.0000	2.7820	1.5713	546.6678	-----
546.9610	0.96	100.0000	-1.0000	2.9380	1.6620	546.9610	-----
547.5455	1.09	120.0000	-1.0000	3.2242	1.8350	547.5455	-----
548.1229	1.22	140.0000	-1.0000	3.4780	1.9992	548.1229	-----
548.8749	1.39	160.0000	-1.0000	3.6988	2.1580	548.8749	-----

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Appended on: 08:17:16 Thursday, February 26, 2009 PIPE #584

Culvert Quick Calculator				
Type:	Circular CMP	**FHA Chart:**	2	
Ent Desc:	Projecting	**Ke:**	0.90	
Culv diam:	3.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
67.0000 ft	1.25 %	0.0240	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
547.9300	0.00	0.0000	0.0000	0.0000	0.0000		
548.2772	0.12	0.5000	0.1754	0.2183	0.2340	-----	548.2772 (M1)
548.4275	0.17	1.0000	0.2428	0.3091	0.3248	-----	548.4275 (M1)
548.5447	0.20	1.5000	0.2948	0.3790	0.3944	-----	548.5447 (M1)
548.6444	0.24	2.0000	0.3380	0.4387	0.4537	-----	548.6444 (M1)
548.7333	0.27	2.5000	0.3761	0.4915	0.5057	-----	548.7333 (M1)
548.8145	0.29	3.0000	0.4105	0.5394	0.5526	-----	548.8145 (M1)
548.8898	0.32	3.5000	0.4420	0.5834	0.5958	-----	548.8898 (M1)
548.9599	0.34	4.0000	0.4713	0.6244	0.6368	-----	548.9599 (M1)
549.0266	0.37	4.5000	0.4991	0.6632	0.6749	-----	549.0266 (M1)
549.0897	0.39	5.0000	0.5255	0.6998	0.7115	-----	549.0897 (M1)
549.1499	0.41	5.5000	0.5511	0.7350	0.7467	-----	549.1499 (M1)
549.2077	0.43	6.0000	0.5746	0.7687	0.7804	-----	549.2077 (M1)
549.2636	0.44	6.5000	0.5980	0.8009	0.8126	-----	549.2636 (M1)
549.3174	0.46	7.0000	0.6207	0.8324	0.8441	-----	549.3174 (M1)
549.3699	0.48	7.5000	0.6420	0.8624	0.8741	-----	549.3699 (M1)
549.4202	0.50	8.0000	0.6632	0.8914	0.9042	-----	549.4202 (M1)
549.4697	0.51	8.5000	0.6830	0.9196	0.9327	-----	549.4697 (M1)
549.5174	0.53	9.0000	0.7028	0.9474	0.9613	-----	549.5174 (M1)
549.5647	0.54	9.5000	0.7225	0.9738	0.9884	-----	549.5647 (M1)
549.6104	0.56	10.0000	0.7416	1.0001	1.0155	-----	549.6104 (M1)
549.6553	0.58	10.5000	0.7599	1.0258	1.0419	-----	549.6553 (M1)
549.6989	0.59	11.0000	0.7782	1.0507	1.0682	-----	549.6989 (M1)
549.7420	0.60	11.5000	0.7958	1.0756	1.0939	-----	549.7420 (M1)
549.7845	0.62	12.0000	0.8134	1.0997	1.1188	-----	549.7845 (M1)
549.8259	0.63	12.5000	0.8302	1.1232	1.1437	-----	549.8259 (M1)
549.8665	0.65	13.0000	0.8470	1.1459	1.1686	-----	549.8665 (M1)
549.9066	0.66	13.5000	0.8632	1.1686	1.1927	-----	549.9066 (M1)
549.9460	0.67	14.0000	0.8800	1.1913	1.2169	-----	549.9460 (M1)
549.9851	0.69	14.5000	0.8961	1.2133	1.2404	-----	549.9851 (M1)

550.0235	0.70	15.0000	0.9115	1.2345	1.2638	-----	550.0235 (M1)
550.0611	0.71	15.5000	0.9276	1.2557	1.2872	-----	550.0611 (M1)
550.0982	0.72	16.0000	0.9430	1.2770	1.3107	-----	550.0982 (M1)
550.1351	0.74	16.5000	0.9576	1.2975	1.3334	-----	550.1351 (M1)
550.1715	0.75	17.0000	0.9730	1.3180	1.3561	-----	550.1715 (M1)
550.2078	0.76	17.5000	0.9877	1.3385	1.3781	-----	550.2078 (M1)
550.2432	0.77	18.0000	1.0023	1.3583	1.4008	-----	550.2432 (M1)
550.2785	0.78	18.5000	1.0170	1.3773	1.4227	-----	550.2785 (M1)
550.3129	0.79	19.0000	1.0316	1.3971	1.4454	-----	550.3129 (M1)
550.3473	0.81	19.5000	1.0455	1.4161	1.4674	-----	550.3473 (M1)
550.3814	0.82	20.0000	1.0602	1.4352	1.4894	-----	550.3814 (M1)
550.7072	0.93	25.0000	1.1957	1.6124	1.7047	-----	550.7072 (M1)
551.0127	1.03	30.0000	1.3224	1.7743	1.9215	-----	551.0127 (M1)
551.3091	1.13	35.0000	1.4440	1.9222	2.1522	-----	551.3091 (M1)
551.6147	1.23	40.0000	1.5619	2.0592	2.4261	-----	551.6147 (M1)
552.3218	1.46	45.0000	1.6791	2.1852	3.0000	-----	552.3218
552.8447	1.64	50.0000	1.7955	2.3009	3.0000	-----	552.8447
554.0557	2.04	60.0000	2.0358	2.5016	3.0000	-----	554.0557
555.4869	2.52	70.0000	2.3046	2.6576	3.0000	-----	555.4869

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Culvert Quick Calculator				
Type:	Circular Conc	**FHA Chart:**	1	
Ent Desc:	GROOVE END PROJECTING	**Ke:**	0.20	
Culv diam:	3.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
80.0000 ft	1.09 %	0.0130	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
534.8600	0.00	0.0000	0.0000	0.0000	0.0000		
535.1351	0.09	0.5000	0.1813	0.2183	0.1813	535.1351	-----
535.2579	0.13	1.0000	0.2509	0.3091	0.2509	535.2579	-----
535.3531	0.16	1.5000	0.3043	0.3790	0.3043	535.3531	-----
535.4340	0.19	2.0000	0.3490	0.4387	0.3490	535.4340	-----
535.5058	0.22	2.5000	0.3885	0.4915	0.3885	535.5058	-----
535.5711	0.24	3.0000	0.4244	0.5394	0.4237	535.5711	-----
535.6317	0.26	3.5000	0.4567	0.5834	0.4567	535.6317	-----
535.6884	0.28	4.0000	0.4874	0.6244	0.4874	535.6884	-----
535.7419	0.29	4.5000	0.5167	0.6632	0.5160	535.7419	-----
535.7929	0.31	5.0000	0.5438	0.6998	0.5435	535.7929	-----
535.8418	0.33	5.5000	0.5695	0.7350	0.5695	535.8418	-----
535.8887	0.34	6.0000	0.5951	0.7687	0.5944	535.8887	-----
535.9339	0.36	6.5000	0.6185	0.8009	0.6185	535.9339	-----
535.9778	0.37	7.0000	0.6420	0.8324	0.6412	535.9778	-----
536.0203	0.39	7.5000	0.6647	0.8624	0.6639	536.0203	-----
536.0617	0.40	8.0000	0.6859	0.8914	0.6859	536.0617	-----
536.1020	0.41	8.5000	0.7072	0.9196	0.7072	536.1020	-----
536.1414	0.43	9.0000	0.7277	0.9474	0.7277	536.1414	-----
536.1799	0.44	9.5000	0.7482	0.9738	0.7474	536.1799	-----
536.2177	0.45	10.0000	0.7672	1.0001	0.7672	536.2177	-----
536.2547	0.46	10.5000	0.7870	1.0258	0.7863	536.2547	-----
536.2910	0.48	11.0000	0.8053	1.0507	0.8053	536.2910	-----
536.3268	0.49	11.5000	0.8236	1.0756	0.8236	536.3268	-----
536.3620	0.50	12.0000	0.8419	1.0997	0.8419	536.3620	-----
536.3966	0.51	12.5000	0.8602	1.1232	0.8595	536.3966	-----
536.4308	0.52	13.0000	0.8771	1.1459	0.8771	536.4308	-----
536.4645	0.53	13.5000	0.8947	1.1686	0.8939	536.4645	-----
536.4977	0.55	14.0000	0.9115	1.1913	0.9108	536.4977	-----
536.5306	0.56	14.5000	0.9283	1.2133	0.9276	536.5306	-----

536.5631	0.57	15.0000	0.9448	1.2345	0.9445	536.5631	-----
536.5952	0.58	15.5000	0.9613	1.2557	0.9606	536.5952	-----
536.6270	0.59	16.0000	0.9774	1.2770	0.9767	536.6270	-----
536.6585	0.60	16.5000	0.9928	1.2975	0.9928	536.6585	-----
536.6897	0.61	17.0000	1.0089	1.3180	1.0082	536.6897	-----
536.7207	0.62	17.5000	1.0243	1.3385	1.0236	536.7207	-----
536.7513	0.63	18.0000	1.0397	1.3583	1.0389	536.7513	-----
536.7818	0.64	18.5000	1.0551	1.3773	1.0543	536.7818	-----
536.8119	0.65	19.0000	1.0697	1.3971	1.0690	536.8119	-----
536.8419	0.66	19.5000	1.0851	1.4161	1.0844	536.8419	-----
536.8717	0.67	20.0000	1.0997	1.4352	1.0990	536.8717	-----
537.1599	0.77	25.0000	1.2411	1.6124	1.2404	537.1599	-----
537.4367	0.86	30.0000	1.3751	1.7743	1.3737	537.4367	-----
537.7073	0.95	35.0000	1.5033	1.9222	1.5026	537.7073	-----
537.9757	1.04	40.0000	1.6285	2.0592	1.6278	537.9757	-----
538.2447	1.13	45.0000	1.7538	2.1852	1.7523	538.2447	-----
538.4997	1.21	50.0000	1.8790	2.3009	1.8776	538.4997	-----
539.1976	1.45	60.0000	2.1449	2.5016	2.1427	539.1976	-----

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Appended on: 08:38:46 Thursday, February 26, 2009 PIPE #587

Culvert Quick Calculator				
Type:	Circular Conc	**FHA Chart:**	1	
Ent Desc:	GROOVE END PROJECTING	**Ke:**	0.20	
Culv diam:	3.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
80.0000 ft	1.28 %	0.0130	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
534.0400	0.00	0.0000	0.0000	0.0000	0.0000		
534.3123	0.09	0.5000	0.1747	0.2183	0.1740	534.3123	-----
534.4351	0.13	1.0000	0.2421	0.3091	0.2413	534.4351	-----
534.5302	0.16	1.5000	0.2930	0.3790	0.2926	534.5302	-----
534.6111	0.19	2.0000	0.3358	0.4387	0.3358	534.6111	-----
534.6829	0.21	2.5000	0.3739	0.4915	0.3739	534.6829	-----
534.7483	0.24	3.0000	0.4083	0.5394	0.4076	534.7483	-----
534.8088	0.26	3.5000	0.4398	0.5834	0.4391	534.8088	-----
534.8655	0.28	4.0000	0.4691	0.6244	0.4684	534.8655	-----
534.9191	0.29	4.5000	0.4969	0.6632	0.4962	534.9191	-----
534.9701	0.31	5.0000	0.5233	0.6998	0.5226	534.9701	-----
535.0189	0.33	5.5000	0.5482	0.7350	0.5475	535.0189	-----
535.0658	0.34	6.0000	0.5717	0.7687	0.5717	535.0658	-----
535.1111	0.36	6.5000	0.5951	0.8009	0.5944	535.1111	-----
535.1549	0.37	7.0000	0.6171	0.8324	0.6163	535.1549	-----
535.1974	0.39	7.5000	0.6383	0.8624	0.6383	535.1974	-----
535.2388	0.40	8.0000	0.6595	0.8914	0.6588	535.2388	-----
535.2791	0.41	8.5000	0.6793	0.9196	0.6793	535.2791	-----
535.3185	0.43	9.0000	0.6991	0.9474	0.6984	535.3185	-----
535.3571	0.44	9.5000	0.7189	0.9738	0.7181	535.3571	-----
535.3948	0.45	10.0000	0.7372	1.0001	0.7365	535.3948	-----
535.4318	0.46	10.5000	0.7555	1.0258	0.7548	535.4318	-----
535.4682	0.48	11.0000	0.7738	1.0507	0.7731	535.4682	-----
535.5039	0.49	11.5000	0.7914	1.0756	0.7906	535.5039	-----
535.5391	0.50	12.0000	0.8086	1.0997	0.8075	535.5391	-----
535.5737	0.51	12.5000	0.8258	1.1232	0.8251	535.5737	-----
535.6079	0.52	13.0000	0.8427	1.1459	0.8412	535.6079	-----
535.6416	0.53	13.5000	0.8588	1.1686	0.8580	535.6416	-----
535.6749	0.54	14.0000	0.8749	1.1913	0.8741	535.6749	-----
535.7077	0.56	14.5000	0.8910	1.2133	0.8903	535.7077	-----

535.7402	0.57	15.0000	0.9064	1.2345	0.9056	535.7402	-----
535.7724	0.58	15.5000	0.9225	1.2557	0.9210	535.7724	-----
535.8042	0.59	16.0000	0.9371	1.2770	0.9364	535.8042	-----
535.8357	0.60	16.5000	0.9525	1.2975	0.9518	535.8357	-----
535.8669	0.61	17.0000	0.9679	1.3180	0.9664	535.8669	-----
535.8978	0.62	17.5000	0.9825	1.3385	0.9811	535.8978	-----
535.9285	0.63	18.0000	0.9972	1.3583	0.9957	535.9285	-----
535.9589	0.64	18.5000	1.0111	1.3773	1.0104	535.9589	-----
535.9891	0.65	19.0000	1.0258	1.3971	1.0250	535.9891	-----
536.0190	0.66	19.5000	1.0397	1.4161	1.0389	536.0190	-----
536.0488	0.67	20.0000	1.0543	1.4352	1.0529	536.0488	-----
536.3371	0.77	25.0000	1.1884	1.6124	1.1869	536.3371	-----
536.6138	0.86	30.0000	1.3143	1.7743	1.3129	536.6138	-----
536.8844	0.95	35.0000	1.4352	1.9222	1.4337	536.8844	-----
537.1528	1.04	40.0000	1.5524	2.0592	1.5502	537.1528	-----
537.4218	1.13	45.0000	1.6674	2.1852	1.6659	537.4218	-----
537.6769	1.21	50.0000	1.7831	2.3009	1.7809	537.6769	-----
538.3748	1.44	60.0000	2.0197	2.5016	2.0167	538.3748	-----

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Appended on: 08:32:39 Thursday, February 26, 2009 PIPE #588

Culvert Quick Calculator				
Type:	Circular Conc	**FHA Chart:**	1	
Ent Desc:	GROOVE END PROJECTING	**Ke:**	0.20	
Culv diam:	2.0000 ft			
Length	**Slope**	**Mannings n**	**TW Elev**	**Num**
90.0000 ft	3.64 %	0.0130	0.0000 ft	1

HW at specified flow (ft)							
HW El (ft)	**HW/D Ratio**	**Discharge (ft/s)**	**TW Depth (ft)**	**dc**	**dn**	**Inlet Ctrl**	**Outlet Ctrl**
537.0500	0.00	0.0000	0.0000	0.0000	0.0000		
537.3388	0.14	0.5000	0.1509	0.2422	0.1509	537.3388	-----
537.4777	0.21	1.0000	0.2095	0.3442	0.2095	537.4777	-----
537.5865	0.27	1.5000	0.2544	0.4233	0.2544	537.5865	-----
537.6797	0.31	2.0000	0.2925	0.4907	0.2925	537.6797	-----
537.7633	0.36	2.5000	0.3257	0.5503	0.3267	537.7633	-----
537.8400	0.40	3.0000	0.3569	0.6040	0.3569	537.8400	-----
537.9118	0.43	3.5000	0.3843	0.6548	0.3843	537.9118	-----
537.9796	0.46	4.0000	0.4106	0.7017	0.4106	537.9796	-----
538.0443	0.50	4.5000	0.4351	0.7456	0.4351	538.0443	-----
538.1065	0.53	5.0000	0.4585	0.7876	0.4595	538.1065	-----
538.1666	0.56	5.5000	0.4810	0.8276	0.4819	538.1666	-----
538.2250	0.59	6.0000	0.5024	0.8657	0.5034	538.2250	-----
538.2818	0.62	6.5000	0.5239	0.9028	0.5239	538.2818	-----
538.3374	0.64	7.0000	0.5435	0.9390	0.5439	538.3374	-----
538.3919	0.67	7.5000	0.5630	0.9731	0.5630	538.3919	-----
538.4455	0.70	8.0000	0.5825	1.0063	0.5825	538.4455	-----
538.4982	0.72	8.5000	0.6011	1.0396	0.6011	538.4982	-----
538.5503	0.75	9.0000	0.6187	1.0708	0.6187	538.5503	-----
538.6018	0.78	9.5000	0.6362	1.1011	0.6362	538.6018	-----
538.6528	0.80	10.0000	0.6538	1.1313	0.6538	538.6528	-----
538.7034	0.83	10.5000	0.6704	1.1606	0.6704	538.7034	-----
538.7536	0.85	11.0000	0.6870	1.1890	0.6880	538.7536	-----
538.8036	0.88	11.5000	0.7036	1.2173	0.7036	538.8036	-----
538.8533	0.90	12.0000	0.7202	1.2446	0.7202	538.8533	-----
538.9028	0.93	12.5000	0.7358	1.2710	0.7358	538.9028	-----
538.9522	0.95	13.0000	0.7515	1.2974	0.7515	538.9522	-----
539.0015	0.98	13.5000	0.7671	1.3228	0.7671	539.0015	-----
539.0508	1.00	14.0000	0.7817	1.3472	0.7827	539.0508	-----
539.1001	1.03	14.5000	0.7974	1.3716	0.7974	539.1001	-----

539.1494	1.05	15.0000	0.8120	1.3960	0.8120	539.1494	-----
539.1988	1.07	15.5000	0.8267	1.4194	0.8276	539.1988	-----
539.2482	1.10	16.0000	0.8413	1.4419	0.8423	539.2482	-----
539.2978	1.12	16.5000	0.8560	1.4644	0.8560	539.2978	-----
539.3476	1.15	17.0000	0.8706	1.4858	0.8706	539.3476	-----
539.3976	1.17	17.5000	0.8853	1.5073	0.8853	539.3976	-----
539.4342	1.19	18.0000	0.8989	1.5278	0.8989	539.4342	-----
539.4929	1.22	18.5000	0.9126	1.5483	0.9136	539.4929	-----
539.5531	1.25	19.0000	0.9272	1.5679	0.9272	539.5531	-----
539.6149	1.28	19.5000	0.9409	1.5874	0.9409	539.6149	-----
539.6783	1.31	20.0000	0.9546	1.6060	0.9556	539.6783	-----
540.4010	1.68	25.0000	1.0903	1.7612	1.0903	540.4010	-----
541.2843	2.12	30.0000	1.2241	1.8628	1.2251	541.2843	-----
542.3281	2.64	35.0000	1.3638	1.9204	1.3638	542.3281	-----
543.5326	3.24	40.0000	1.5171	1.9517	1.5181	543.5326	-----

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Appended on: 10:09:39 Monday, May 18, 2009

Warning, History file is now 0.56 MB in size

PIPE #597

Culvert Quick Calculator			
Type:	CM Arch	**FHA Chart:**	40-42
Ent Desc:	ARCH: CM - MITERED TO SLOPE	**Ke:**	0.70
Arch Size::	8'0" x 4'2"		

Length	Slope	Mannings n	TW Elev	Num
70.0000 ft	3.34 %	0.0240	0.0000 ft	1

HW at specified flow (ft)

HW El (ft)	HW/D Ratio	Discharge (ft/s)	TW Depth (ft)	dc	dn	Inlet Ctrl	Outlet Ctrl
631.2200	0.00	0.0000	0.0000	0.0000	0.0000		
631.3417	0.03	0.5000	0.0654	0.0290	0.0654	-----	631.3417 (M1)
631.4173	0.05	1.0000	0.0989	0.0582	0.0989	-----	631.4173 (M1)
631.4822	0.06	1.5000	0.1261	0.0875	0.1261	-----	631.4822 (M1)
631.5414	0.08	2.0000	0.1498	0.1167	0.1498	-----	631.5414 (M1)
631.5958	0.09	2.5000	0.1714	0.1457	0.1717	-----	631.5958 (M1)
631.6481	0.10	3.0000	0.1912	0.1747	0.1912	-----	631.6481 (M1)
631.6977	0.11	3.5000	0.2098	0.2042	0.2098	-----	631.6977 (M1)
631.7179	0.12	4.0000	0.2271	0.2332	0.2271	631.7179	-----
631.7473	0.13	4.5000	0.2439	0.2622	0.2439	631.7473	-----
631.7766	0.13	5.0000	0.2597	0.2914	0.2599	631.7766	-----
631.8060	0.14	5.5000	0.2749	0.3207	0.2752	631.8060	-----
631.8354	0.15	6.0000	0.2897	0.3497	0.2899	631.8354	-----
631.8648	0.15	6.5000	0.3039	0.3787	0.3042	631.8648	-----
631.8942	0.16	7.0000	0.3181	0.4082	0.3181	631.8942	-----
631.9237	0.17	7.5000	0.3314	0.4372	0.3314	631.9237	-----
631.9510	0.18	8.0000	0.3446	0.4626	0.3446	631.9510	-----
631.9722	0.18	8.5000	0.3573	0.4768	0.3573	631.9722	-----
631.9930	0.19	9.0000	0.3695	0.4911	0.3698	631.9930	-----
632.0135	0.19	9.5000	0.3817	0.5053	0.3820	632.0135	-----
632.0337	0.20	10.0000	0.3939	0.5191	0.3939	632.0337	-----
632.0536	0.20	10.5000	0.4056	0.5328	0.4056	632.0536	-----
632.0727	0.20	11.0000	0.4168	0.5460	0.4171	632.0727	-----
632.0907	0.21	11.5000	0.4283	0.5577	0.4285	632.0907	-----
632.1085	0.21	12.0000	0.4392	0.5694	0.4395	632.1085	-----
632.1260	0.22	12.5000	0.4504	0.5811	0.4504	632.1260	-----
632.1444	0.22	13.0000	0.4606	0.5933	0.4606	632.1444	-----

632.1628	0.23	13.5000	0.4687	0.6060	0.4687	632.1628	-----
632.1810	0.23	14.0000	0.4768	0.6182	0.4768	632.1810	-----
632.1985	0.23	14.5000	0.4850	0.6299	0.4850	632.1985	-----
632.2151	0.24	15.0000	0.4926	0.6406	0.4929	632.2151	-----
632.2316	0.24	15.5000	0.5007	0.6518	0.5007	632.2316	-----
632.2480	0.25	16.0000	0.5084	0.6620	0.5084	632.2480	-----
632.2649	0.25	16.5000	0.5160	0.6737	0.5160	632.2649	-----
632.2821	0.25	17.0000	0.5236	0.6849	0.5236	632.2821	-----
632.2992	0.26	17.5000	0.5308	0.6966	0.5313	632.2992	-----
632.3162	0.26	18.0000	0.5384	0.7083	0.5384	632.3162	-----
632.3319	0.27	18.5000	0.5455	0.7184	0.5455	632.3319	-----
632.3475	0.27	19.0000	0.5521	0.7286	0.5521	632.3475	-----
632.3630	0.27	19.5000	0.5587	0.7383	0.5587	632.3630	-----
632.3784	0.28	20.0000	0.5653	0.7484	0.5653	632.3784	-----
632.5316	0.31	25.0000	0.6310	0.8471	0.6310	632.5316	-----
632.6737	0.35	30.0000	0.6905	0.9356	0.6905	632.6737	-----
632.8110	0.38	35.0000	0.7474	1.0190	0.7474	632.8110	-----
632.9448	0.41	40.0000	0.7998	1.0979	0.7998	632.9448	-----
633.0759	0.45	45.0000	0.8522	1.1726	0.8522	633.0759	-----
633.2050	0.48	50.0000	0.9000	1.2449	0.9000	633.2050	-----
633.4596	0.54	60.0000	0.9926	1.3807	0.9926	633.4596	-----
633.7159	0.60	70.0000	1.0745	1.5119	1.0745	633.7159	-----
633.9676	0.66	80.0000	1.1630	1.6319	1.1632	633.9676	-----
634.2246	0.72	90.0000	1.2449	1.7484	1.2454	634.2246	-----
634.4839	0.78	100.0000	1.3237	1.8603	1.3237	634.4839	-----
635.0157	0.91	120.0000	1.4768	2.0714	1.4773	635.0157	-----
635.5697	1.04	140.0000	1.6233	2.2697	1.6238	635.5697	-----

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APPENDIX F – Trunk-line Drainage Hydrology and Hydraulics

Morganville

- Bruckners Way
- Bruckners Court
- Fairfax Street
- Morgan Drive
- Union Drive
- Lynch Lane

Appended on: 07:29:21 Tuesday, May 26, 2009

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [10 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
544	0.0000	0.0000	32.4567	0.00	0.0000	48" Diam	0.0000	2.5828	
545	0.0000	0.0000	96.7672	0.00	0.0000	48" Diam	0.0000	7.7005	
546	0.0000	0.0000	5.4028	0.00	0.0000		0.0000	5.4028	
483	1.3400	0.6147	2.5183	0.24	0.3364	12" Diam	2.6486	3.2064	Bruck-B
485	1.3400	0.6147	2.2992	0.27	0.3530	12" Diam	2.4800	2.9274	
486	3.2900	1.3106	1.7757	0.74	0.6392	12" Diam	2.4727	2.2609	Bruck-C
489	2.4600	1.0428	7.2135	0.14	0.2573	12" Diam	6.5209	9.1845	Bruck-A
491	2.4600	1.0428	1.6610	0.63	0.5747	12" Diam	2.2324	2.1149	
493	2.4600	1.0428	2.5424	0.41	0.4458	12" Diam	3.0797	3.2371	
495	2.4600	1.0428	1.8300	0.57	0.5405	12" Diam	2.4073	2.3301	
496	8.0000	3.3321	2.6046	1.28	-----	12" Diam	4.2426	3.3163	Bruck-D
498	8.0000	3.3321	1.8367	1.81	-----	12" Diam	4.2426	2.3385	
499	8.0000	3.3321	3.5732	0.93	0.7651	12" Diam	5.1675	4.5496	
501	8.0000	3.3321	4.0778	0.82	0.6870	12" Diam	5.7924	5.1921	
503	8.0000	3.3321	6.0040	0.55	0.5317	12" Diam	7.8511	7.6445	
506	8.0000	3.3321	7.5300	0.44	0.4653	12" Diam	9.3061	9.5875	
432	0.0000	0.0000	5.6982	0.00	0.0000	12" Diam	0.0000	7.2552	
429	3.1800	1.4178	3.3420	0.42	0.4546	12" Diam	4.0818	4.2551	Sunny Ln
430	3.1800	1.4178	4.3644	0.32	0.3921	12" Diam	4.9638	5.5569	
431	3.1800	1.4178	4.2395	0.33	0.3979	12" Diam	4.8662	5.3979	
469	3.1100	1.4234	3.5732	0.40	0.4390	12" Diam	4.2896	4.5496	Lynch
467	0.0000	0.0000	2.9858	0.00	0.0000	12" Diam	0.0000	3.8017	
468	3.1100	1.4234	3.9207	0.36	0.4165	12" Diam	4.5976	4.9920	
419	3.1100	1.4234	3.9798	0.36	0.4136	12" Diam	4.6408	5.0673	
417	3.1100	1.4234	10.0353	0.14	0.2544	12" Diam	9.0452	12.7774	
416	3.1100	1.4234	7.1603	0.20	0.3022	12" Diam	7.1087	9.1167	
414	3.1100	1.4234	7.8239	0.18	0.2886	12" Diam	7.5810	9.9617	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							521.6900
B-544	E-544	0.0000	--na--	--na--	--na--	0.0000	527.0000
B-545	E-545	0.0000	--na--	--na--	--na--	0.0000	527.5000
B-546	E-546	0.0000	--na--	--na--	--na--	0.0000	540.0000
128	E-506	542.9575	0.2795	0.5014	------	543.1794	545.9900
127	128	544.4343	0.2795	0.0631	------	544.2180	547.9600
125	127	545.8508	0.2795	0.1359	------	545.7072	550.6700

123	125	546.4722	0.2795	0.1031	------	546.2957	551.1900
122	123	547.5376	0.2795	0.0453	------	547.3033	552.7400
SDMH-4	122	548.9825	0.0432	0.0054	0.0205	548.9651	554.8400
118	SDMH-4	549.0735	0.0095	0.0006	------	549.0646	554.7100
117	118	549.1132	0.0095	0.0005	------	549.1042	552.9000
114	117	549.1465	------	------	------	549.1465	550.5700
112	SDMH-4	549.1230	0.0274	0.0003	------	549.0959	552.9000
109	112	549.2749	0.0274	0.0067	------	549.2542	550.4700
107	109	549.3229	0.0274	0.0186	------	549.3140	561.8700
106	107	552.4618	------	------	------	552.4619	555.6200
104	E-431	543.5283	0.3826	0.7434	------	543.8891	547.8000
105	104	0.0000	------	------	------	0.0000	553.1200
103	104	544.7279	0.2587	0.0781	------	544.5473	561.6100
102	103	546.5606	------	------	------	546.5605	548.6500
152	153	538.5891	0.7847	0.2728	------	538.0771	540.7300
150	152	542.2524	1.2704	0.5993	------	541.5812	545.3600
149	150	551.3259	0.3344	0.0055	------	550.9970	555.3600
No approach losses at node 2 because inverts and/or crowns are offset.							
147	149	553.5742	------	------	------	553.5742	560.3700
No approach losses at node 146 because inverts and/or crowns are offset.							
2	147	554.2944	------	------	------	554.2944	559.4000
146	2	557.0953	------	------	------	557.0953	559.8000
144	2	0.0000	------	------	------	0.0000	556.9800

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Appended on: 07:33:52 Tuesday, May 26, 2009

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [25 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
544	0.0000	0.0000	32.4567	0.00	0.0000	48" Diam	0.0000	2.5828	
545	0.0000	0.0000	96.7672	0.00	0.0000	48" Diam	0.0000	7.7005	
546	0.0000	0.0000	5.4028	0.00	0.0000		0.0000	5.4028	
483	1.3400	0.7353	2.5183	0.29	0.3701	12" Diam	2.7820	3.2064	Bruck-B
485	1.3400	0.7353	2.2992	0.32	0.3892	12" Diam	2.6001	2.9274	
486	3.2900	1.5901	1.7757	0.90	0.7388	12" Diam	2.5562	2.2609	Bruck-C
489	2.4600	1.2481	7.2135	0.17	0.2817	12" Diam	6.8736	9.1845	Bruck-A
491	2.4600	1.2481	1.6610	0.75	0.6470	12" Diam	2.3220	2.1149	
493	2.4600	1.2481	2.5424	0.49	0.4946	12" Diam	3.2224	3.2371	
495	2.4600	1.2481	1.8300	0.68	0.6060	12" Diam	2.5070	2.3301	
496	8.0000	4.0039	2.6046	1.54	-----	12" Diam	5.0979	3.3163	Bruck-D
498	8.0000	4.0039	1.8367	2.18	-----	12" Diam	5.0979	2.3385	
499	8.0000	4.0039	3.5732	1.12	-----	12" Diam	5.0979	4.5496	
501	8.0000	4.0039	4.0778	0.98	0.8037	12" Diam	5.9182	5.1921	
503	8.0000	4.0039	6.0040	0.67	0.5972	12" Diam	8.1836	7.6445	
506	8.0000	4.0039	7.5300	0.53	0.5190	12" Diam	9.7243	9.5875	
432	0.0000	0.0000	5.6982	0.00	0.0000	12" Diam	0.0000	7.2552	
429	3.1800	1.7022	3.3420	0.51	0.5054	12" Diam	4.2760	4.2551	Sunny Ln
430	3.1800	1.7022	4.3644	0.39	0.4341	12" Diam	5.2058	5.5569	
431	3.1800	1.7022	4.2395	0.40	0.4409	12" Diam	5.1000	5.3979	
469	3.1100	1.7364	3.5732	0.49	0.4917	12" Diam	4.5173	4.5496	Lynch
467	0.0000	0.0000	2.9858	0.00	0.0000	12" Diam	0.0000	3.8017	
468	3.1100	1.7364	3.9207	0.44	0.4663	12" Diam	4.8364	4.9920	
419	3.1100	1.7364	3.9798	0.44	0.4624	12" Diam	4.8895	5.0673	
417	3.1100	1.7364	10.0353	0.17	0.2817	12" Diam	9.5628	12.7774	
416	3.1100	1.7364	7.1603	0.24	0.3354	12" Diam	7.5115	9.1167	
414	3.1100	1.7364	7.8239	0.22	0.3198	12" Diam	8.0204	9.9617	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							521.6900
B-544	E-544	0.0000	--na--	--na--	--na--	0.0000	527.0000
B-545	E-545	0.0000	--na--	--na--	--na--	0.0000	527.5000
B-546	E-546	0.0000	--na--	--na--	--na--	0.0000	540.0000
128	E-506	543.2754	0.4035	0.7240	------	543.5959	545.9900
127	128	544.7523	0.4035	0.0911	------	544.4398	547.9600
125	127	546.1688	0.4035	0.1962	------	545.9614	550.6700

123	125	547.2195	0.4035	0.1488	------	546.9647	551.1900
122	123	548.7578	0.4035	0.0654	------	548.4196	552.7400
SDMH-4	122	550.8440	0.0636	0.0079	0.0298	550.8181	554.8400
118	SDMH-4	550.9777	0.0136	0.0009	------	550.9650	554.7100
117	118	551.0345	0.0136	0.0008	------	551.0217	552.9000
114	117	551.0821	------	------	------	550.6700	550.5700
112	SDMH-4	551.0443	0.0392	0.0004	------	551.0055	552.9000
109	112	551.2619	0.0392	0.0097	------	550.5699	550.4700
107	109	550.6683	0.0392	0.0266	------	550.6556	561.8700
106	107	552.5312	------	------	------	552.5313	555.6200
104	E-431	543.6196	0.4208	0.8177	------	544.0164	547.8000
105	104	0.0000	------	------	------	0.0000	553.1200
103	104	544.8193	0.2839	0.0857	------	544.6210	561.6100
102	103	546.6519	------	------	------	546.6519	548.6500
152	153	538.6863	0.8761	0.3045	------	538.1147	540.7300
150	152	542.3496	1.4200	0.6698	------	541.5994	545.3600
149	150	551.4231	0.3712	0.0061	------	551.0580	555.3600
No approach losses at node 2 because inverts and/or crowns are offset.							
147	149	553.6714	------	------	------	553.6714	560.3700
No approach losses at node 146 because inverts and/or crowns are offset.							
2	147	554.3916	------	------	------	554.3916	559.4000
146	2	557.1925	------	------	------	557.1925	559.8000
144	2	0.0000	------	------	------	0.0000	556.9800

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Appended on: 15:07:46 Tuesday, May 26, 2009

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [100 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
544	0.0000	0.0000	32.4567	0.00	0.0000	48" Diam	0.0000	2.5828	
545	0.0000	0.0000	96.7672	0.00	0.0000	48" Diam	0.0000	7.7005	
546	0.0000	0.0000	5.4028	0.00	0.0000		0.0000	5.4028	
483	1.3400	0.9274	2.5183	0.37	0.4204	12" Diam	2.9586	3.2064	Bruck-B
485	1.3400	0.9274	2.2992	0.40	0.4419	12" Diam	2.7705	2.9274	
486	3.2900	2.0387	1.7757	1.15	-----	12" Diam	2.5958	2.2609	Bruck-C
489	2.4600	1.5755	7.2135	0.22	0.3179	12" Diam	7.3387	9.1845	Bruck-A
491	2.4600	1.5755	1.6610	0.95	0.7769	12" Diam	2.4065	2.1149	
493	2.4600	1.5755	2.5424	0.62	0.5698	12" Diam	3.4080	3.2371	
495	2.4600	1.5755	1.8300	0.86	0.7153	12" Diam	2.6207	2.3301	
496	8.0000	5.0775	2.6046	1.95	-----	12" Diam	6.4648	3.3163	Bruck-D
498	8.0000	5.0775	1.8367	2.76	-----	12" Diam	6.4648	2.3385	
499	8.0000	5.0775	3.5732	1.42	-----	12" Diam	6.4648	4.5496	
501	8.0000	5.0775	4.0778	1.25	-----	12" Diam	6.4648	5.1921	
503	8.0000	5.0775	6.0040	0.85	0.7056	12" Diam	8.5722	7.6445	
506	8.0000	5.0775	7.5300	0.67	0.6011	12" Diam	10.2974	9.5875	
432	0.0000	0.0000	5.6982	0.00	0.0000	12" Diam	0.0000	7.2552	
429	3.1800	2.1559	3.3420	0.65	0.5845	12" Diam	4.5219	4.2551	Sunny Ln
430	3.1800	2.1559	4.3644	0.49	0.4966	12" Diam	5.5382	5.5569	
431	3.1800	2.1559	4.2395	0.51	0.5054	12" Diam	5.4159	5.3979	
469	3.1100	2.2394	3.5732	0.63	0.5737	12" Diam	4.8040	4.5496	Lynch
467	0.0000	0.0000	2.9858	0.00	0.0000	12" Diam	0.0000	3.8017	
468	3.1100	2.2394	3.9207	0.57	0.5415	12" Diam	5.1582	4.9920	
419	3.1100	2.2394	3.9798	0.56	0.5366	12" Diam	5.2167	5.0673	
417	3.1100	2.2394	10.0353	0.22	0.3208	12" Diam	10.3004	12.7774	
416	3.1100	2.2394	7.1603	0.31	0.3843	12" Diam	8.0551	9.1167	
414	3.1100	2.2394	7.8239	0.29	0.3657	12" Diam	8.6115	9.9617	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							521.6900
B-544	E-544	0.0000	--na--	--na--	--na--	0.0000	527.0000
B-545	E-545	0.0000	--na--	--na--	--na--	0.0000	527.5000
B-546	E-546	0.0000	--na--	--na--	--na--	0.0000	540.0000
128	E-506	543.9045	0.6490	1.1643	------	544.4198	545.9900
127	128	546.4085	0.6490	0.1465	------	545.9061	547.9600
125	127	549.0650	0.6490	0.3156	------	548.7316	550.6700

123	125	550.7547	0.6490	0.2393	------	550.3450	551.1900
122	123	553.2286	0.6490	0.1051	------	552.6848	552.7400
SDMH-4	122	556.5836	0.1046	0.0130	0.0485	554.9400	554.8400
118	SDMH-4	555.2024	0.0216	0.0015	------	554.8100	554.7100
117	118	554.9205	0.0216	0.0012	------	553.0000	552.9000
114	117	553.0962	------	------	------	550.6700	550.5700
112	SDMH-4	555.3005	0.0625	0.0006	------	553.0000	552.9000
109	112	553.4085	0.0625	0.0154	------	550.5699	550.4700
107	109	550.7266	0.0625	0.0423	------	550.7065	561.8700
106	107	552.6378	------	------	------	552.6378	555.6200
104	E-431	543.7635	0.4763	0.9254	------	544.2126	547.8000
105	104	0.0000	------	------	------	0.0000	553.1200
103	104	544.9631	0.3175	0.0958	------	544.7415	561.6100
102	103	546.7958	------	------	------	546.7958	548.6500
152	153	538.8393	1.0075	0.3502	------	538.1820	540.7300
150	152	542.5026	1.6475	0.7771	------	541.6323	545.3600
149	150	551.5762	0.1262	0.0021	------	551.4520	555.3600
No approach losses at node 2 because inverts and/or crowns are offset.							
147	149	553.8244	------	------	------	553.8245	560.3700
No approach losses at node 146 because inverts and/or crowns are offset.							
2	147	554.5446	------	------	------	554.5446	559.4000
146	2	557.3455	------	------	------	557.3455	559.8000
144	2	0.0000	------	------	------	0.0000	556.9800

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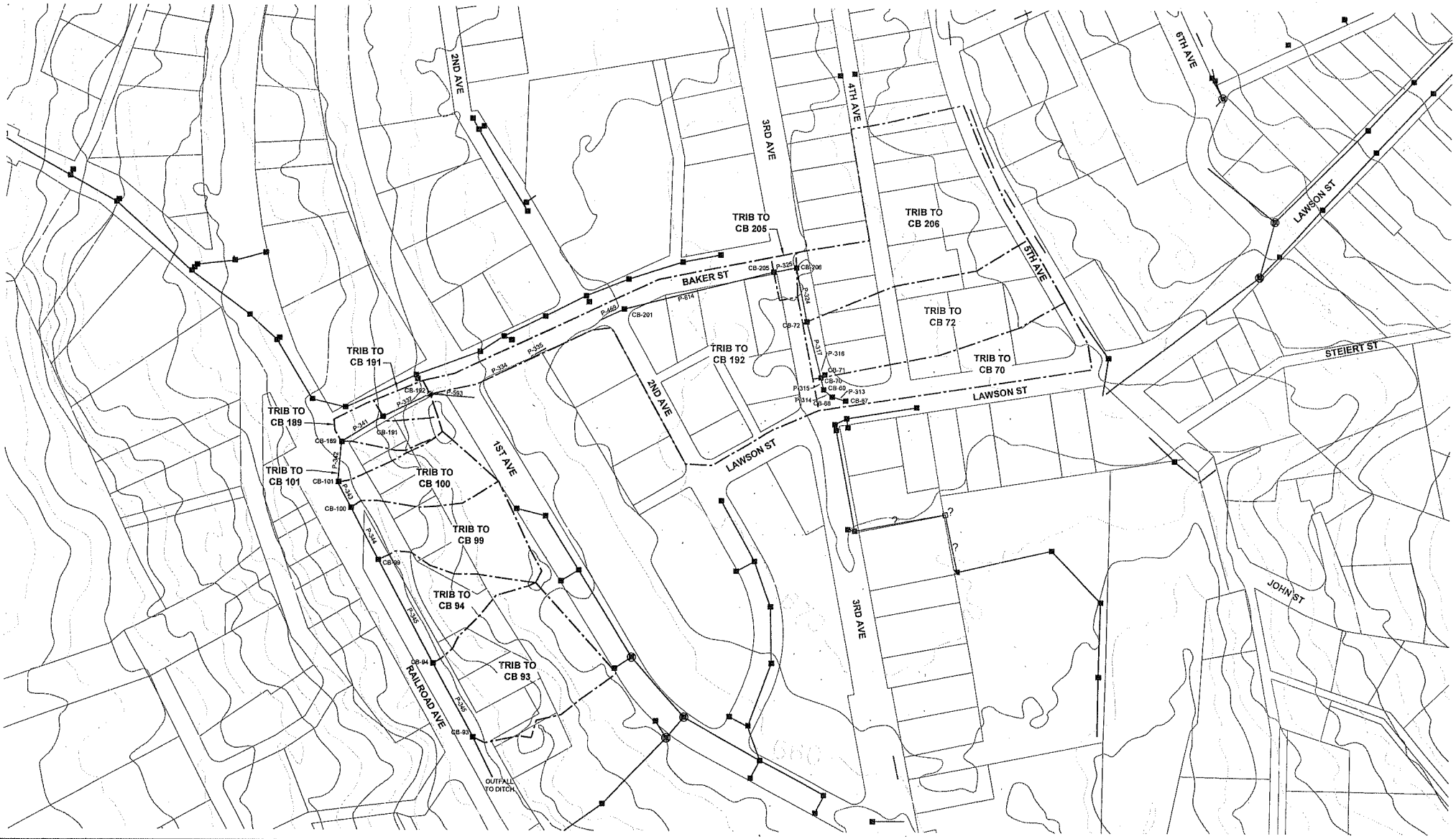
Downtown West

- 1st Ave
- 2nd Ave
- 3rd Ave
- 5th Ave
- Baker Street
- Park Street
- Railroad Ave
- Black Diamond City Shop Drainage



PACWEST ENGINEERING, LLC
5009 PACIFIC HWY E, UNIT 9-O
Fife, WA 98424
Phone (253) 926-3400
Fax (253) 926-3402

CITY OF BLACK DIAMOND
24301 ROBERTS DRIVE
BLACK DIAMOND, WA 98010
PHONE (360) 886-2560
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STORMWATER COMPREHENSIVE PLAN
RAILROAD AVE TRIBUTARY BASIN

LEGEND:
- TYPE 1 CATCH BASIN
- TYPE 2 CATCH BASIN
- PIPES
- BASIN AREA

0' 100' 200'

N W E S

MAP NUMBER:
142106-4

Appended on: 13:50:46 Wednesday, November 18, 2009

Warning, History file is now 2.25 MB in size

CB 93 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.4241	8.00	0.1560	1.2270	SBUH	TYPE1A
10 year	0.6753	8.00	0.2423	1.2270	SBUH	TYPE1A
25 year	0.8161	8.00	0.2912	1.2270	SBUH	TYPE1A
100 year	1.0413	8.00	0.3705	1.2270	SBUH	TYPE1A

Record Id: CB 93

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	1.23 ac	**DCIA**	0.00 ac
Pervious CN	92.20	**DC CN**	0.00
Pervious TC	11.12 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.37 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.85 ac	86.00
Pervious Composited CN (AMC 2)		89.66

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	245.00 ft	13.50%	0.1500	2.30 in	11.03 min
Shallow	Paved	25.00 ft	2.00%	0.0100		0.09 min
Pervious TC						11.17 min

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Appended on: 13:50:57 Wednesday, November 18, 2009

Warning, History file is now 2.25 MB in size

CB 94 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.2119	8.00	0.0762	0.5150	SBUH	TYPE1A
10 year	0.3173	8.00	0.1138	0.5150	SBUH	TYPE1A
25 year	0.3755	8.00	0.1348	0.5150	SBUH	TYPE1A
100 year	0.4680	8.00	0.1687	0.5150	SBUH	TYPE1A

Record Id: CB 94

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.51 ac	**DCIA**	0.00 ac
Pervious CN	95.06	**DC CN**	0.00
Pervious TC	11.58 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.26 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.25 ac	86.00
Pervious Composited CN (AMC 2)		92.06

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	237.00 ft	11.40%	0.1500	2.30 in	11.49 min
Shallow	Paved	25.00 ft	2.00%	0.0100		0.09 min
Pervious TC						11.63 min

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Appended on: 13:51:15 Wednesday, November 18, 2009

CB 99 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.2218	8.00	0.0892	0.7880	SBUH	TYPE1A
10 year	0.3720	8.00	0.1428	0.7880	SBUH	TYPE1A
25 year	0.4577	8.00	0.1735	0.7880	SBUH	TYPE1A
100 year	0.5959	8.00	0.2234	0.7880	SBUH	TYPE1A

Record Id: CB 99

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.79 ac	**DCIA**	0.00 ac
Pervious CN	90.07	**DC CN**	0.00
Pervious TC	13.78 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.19 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.59 ac	86.00
Pervious Composited CN (AMC 2)		88.95

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	290.00 ft	11.00%	0.1500	2.30 in	13.70 min
Shallow	Paved	22.00 ft	2.00%	0.0100		0.08 min
Pervious TC						13.82 min

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Appended on: 13:51:21 Wednesday, November 18, 2009

CB 100 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.2229	8.00	0.0747	0.4820	SBUH	TYPE1A
10 year	0.3272	8.00	0.1101	0.4820	SBUH	TYPE1A
25 year	0.3846	8.00	0.1300	0.4820	SBUH	TYPE1A
100 year	0.4759	8.00	0.1618	0.4820	SBUH	TYPE1A

Record Id: CB 100

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.48 ac	**DCIA**	0.00 ac
Pervious CN	95.93	**DC CN**	0.00
Pervious TC	7.10 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.28 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.20 ac	86.00
Pervious Composited CN (AMC 2)		93.02

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	158.00 ft	19.00%	0.1500	2.30 in	6.77 min
Shallow	Paved	56.00 ft	2.00%	0.0100		0.21 min
Pervious TC						7.10 min

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Appended on: 13:51:26 Wednesday, November 18, 2009

CB 101 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.0500	8.00	0.0167	0.1190	SBUH	TYPE1A
10 year	0.0761	8.00	0.0253	0.1190	SBUH	TYPE1A
25 year	0.0905	8.00	0.0301	0.1190	SBUH	TYPE1A
100 year	0.1135	8.00	0.0379	0.1190	SBUH	TYPE1A

Record Id: CB 101

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.12 ac	**DCIA**	0.00 ac
Pervious CN	94.08	**DC CN**	0.00
Pervious TC	6.41 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.05 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.07 ac	86.00
Pervious Composited CN (AMC 2)		91.14

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	142.00 ft	19.00%	0.1500	2.30 in	6.22 min
Shallow	Paved	52.00 ft	2.00%	0.0100		0.19 min
Pervious TC						6.52 min

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Appended on: 13:51:31 Wednesday, November 18, 2009

CB 189 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.1067	8.00	0.0364	0.2250	SBUH	TYPE1A
10 year	0.1544	8.00	0.0530	0.2250	SBUH	TYPE1A
25 year	0.1806	8.00	0.0623	0.2250	SBUH	TYPE1A
100 year	0.2223	8.00	0.0772	0.2250	SBUH	TYPE1A

Record Id: CB 189

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.22 ac	**DCIA**	0.00 ac
Pervious CN	96.74	**DC CN**	0.00
Pervious TC	8.26 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.15 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.07 ac	86.00
Pervious Composited CN (AMC 2)		94.11

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	180.00 ft	15.00%	0.1500	2.30 in	8.26 min
Pervious TC						8.26 min

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Appended on: 13:51:37 Wednesday, November 18, 2009

CB 191 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.0577	8.00	0.0192	0.1200	SBUH	TYPE1A
10 year	0.0837	8.00	0.0281	0.1200	SBUH	TYPE1A
25 year	0.0981	8.00	0.0330	0.1200	SBUH	TYPE1A
100 year	0.1209	8.00	0.0410	0.1200	SBUH	TYPE1A

Record Id: CB 191

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.12 ac	**DCIA**	0.00 ac
Pervious CN	96.53	**DC CN**	0.00
Pervious TC	6.00 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.08 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.04 ac	86.00
Pervious Composited CN (AMC 2)		93.80

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Fixed	TR 55 min					6.00 min
Pervious TC						6.00 min

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Appended on: 13:51:42 Wednesday, November 18, 2009

CB 192 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	1.0383	8.00	0.3675	2.3570	SBUH	TYPE1A
10 year	1.5232	8.00	0.5410	2.3570	SBUH	TYPE1A
25 year	1.7904	8.00	0.6380	2.3570	SBUH	TYPE1A
100 year	2.2150	8.00	0.7938	2.3570	SBUH	TYPE1A

Record Id: CB 192

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	2.36 ac	**DCIA**	0.00 ac
Pervious CN	96.05	**DC CN**	0.00
Pervious TC	10.82 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	1.41 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.95 ac	86.00
Pervious Composited CN (AMC 2)		93.16

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	137.00 ft	7.30%	0.1500	2.30 in	8.86 min
Shallow	Paved	146.00 ft	2.00%	0.0100		0.54 min
Channel (cont)	Grassed-lined stream (n=0.030)	147.00 ft	3.80%	0.0300		0.47 min
Channel (cont)	Grassed-lined stream (n=0.030)	330.00 ft	4.50%	0.0300		0.96 min
Pervious TC						11.13 min

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Appended on: 13:51:48 Wednesday, November 18, 2009

CB 205 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.0362	8.00	0.0122	0.0710	SBUH	TYPE1A
10 year	0.0513	8.00	0.0175	0.0710	SBUH	TYPE1A
25 year	0.0596	8.00	0.0204	0.0710	SBUH	TYPE1A
100 year	0.0729	8.00	0.0252	0.0710	SBUH	TYPE1A

Record Id: CB 205

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.07 ac	**DCIA**	0.00 ac
Pervious CN	97.91	**DC CN**	0.00
Pervious TC	6.00 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.06 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.01 ac	86.00
Pervious Composited CN (AMC 2)		96.99

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Fixed	TR 55 min					6.00 min
Pervious TC						6.00 min

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Appended on: 13:51:54 Wednesday, November 18, 2009

CB 206 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.6875	8.00	0.2743	1.9160	SBUH	TYPE1A
10 year	1.0462	8.00	0.4130	1.9160	SBUH	TYPE1A
25 year	1.2448	8.00	0.4911	1.9160	SBUH	TYPE1A
100 year	1.5609	8.00	0.6166	1.9160	SBUH	TYPE1A

Record Id: CB 206

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	1.92 ac	**DCIA**	0.00 ac
Pervious CN	94.43	**DC CN**	0.00
Pervious TC	17.16 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.87 ac	98.00
Open spaces, lawns,parks (>75% grass)	1.04 ac	86.00
Pervious Composited CN (AMC 2)		91.46

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	236.00 ft	5.08%	0.1500	2.30 in	15.82 min
Shallow	Paved	30.00 ft	2.00%	0.0100		0.11 min
Channel (cont)	Grassed-lined stream (n=0.030)	30.00 ft	1.00%	0.0300		0.19 min
Shallow	Short grass, pasture and lawns (n=0.030)	115.00 ft	3.50%	0.0300		0.96 min
Shallow	Paved	24.00 ft	2.00%	0.0100		0.09 min
Pervious TC						17.28 min

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Appended on: 13:52:00 Wednesday, November 18, 2009

CB 70 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.4005	8.00	0.1328	0.8590	SBUH	TYPE1A
10 year	0.5879	8.00	0.1960	0.8590	SBUH	TYPE1A
25 year	0.6911	8.00	0.2313	0.8590	SBUH	TYPE1A
100 year	0.8552	8.00	0.2880	0.8590	SBUH	TYPE1A

Record Id: CB 70

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	0.86 ac	**DCIA**	0.00 ac
Pervious CN	95.89	**DC CN**	0.00
Pervious TC	6.00 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.50 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.36 ac	86.00
Pervious Composited CN (AMC 2)		92.97

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Fixed	TR 55 min					6.00 min
Pervious TC						6.00 min

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Appended on: 13:52:05 Wednesday, November 18, 2009

CB 72 Event Summary

Event	Peak Q (cfs)	Peak T (hrs)	Hyd Vol (acft)	Area (ac)	Method	Raintype
2 year	0.4622	8.00	0.1921	1.2830	SBUH	TYPE1A
10 year	0.6912	8.00	0.2859	1.2830	SBUH	TYPE1A
25 year	0.8177	8.00	0.3385	1.2830	SBUH	TYPE1A
100 year	1.0188	8.00	0.4230	1.2830	SBUH	TYPE1A

Record Id: CB 72

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area	1.28 ac	**DCIA**	0.00 ac
Pervious CN	95.29	**DC CN**	0.00
Pervious TC	20.08 min	**DC TC**	0.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.67 ac	98.00
Open spaces, lawns,parks (>75% grass)	0.61 ac	86.00
Pervious Composited CN (AMC 2)		92.29

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT
Sheet	Short prairie grass and lawns.: 0.15	256.00 ft	3.91%	0.1500	2.30 in	18.75 min
Shallow	Paved	30.00 ft	2.00%	0.0100		0.11 min
Shallow	Short grass, pasture and lawns (n=0.030)	110.00 ft	2.30%	0.0300		1.13 min
Shallow	Paved	24.00 ft	2.00%	0.0100		0.09 min
Pervious TC						20.19 min

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Appended on: 14:07:16 Wednesday, November 18, 2009

Warning, History file is now 2.27 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [10 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
317	0.8590	0.5879	1.4149	0.42	0.4497	12" Diam	1.7165	1.8015	CB 70
324	2.1420	1.2791	2.4601	0.52	0.5117	12" Diam	3.1629	3.1323	CB 72
325	4.0580	2.3253	4.8638	0.48	0.4868	12" Diam	6.1271	6.1928	CB 206
DITCH 205-192	4.1290	2.3766	51.1551	0.05	0.3878	Ditch	2.8326	-----	CB 205
337	6.4860	3.8998	12.2133	0.32	0.3882	12" Diam	13.8380	15.5504	CB 192
341	6.6060	3.9836	11.4470	0.35	0.4067	12" Diam	13.2795	14.5747	CB 191
342	6.8310	4.1379	9.0884	0.46	0.4731	12" Diam	11.3103	11.5717	CB 189
343	6.9500	4.2140	2.9022	1.45	-----	12" Diam	5.3655	3.6952	CB 101
344	7.4320	4.5412	2.8959	1.57	-----	12" Diam	5.7820	3.6872	CB 100
345	8.2200	4.9132	2.8144	1.75	-----	12" Diam	6.2557	3.5834	CB 99
346	8.7350	5.2305	2.2095	2.37	-----	12" Diam	6.6596	2.8133	CB 94
347	9.9620	5.9058	2.6831	2.20	-----	12" Diam	7.5195	3.4162	CB 93
DITCH END7-11	9.9620	5.9058	16.4539	0.36	0.9569	Ditch	2.1181	-----	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							607.4839
End 7	End 12	609.1869	--na--	--na--	--na--	609.1869	675.5700
93	End 7	612.4179	0.6887	0.1661	------	611.8953	613.7700
94	93	615.9150	0.6077	0.2576	------	612.2700	612.1700
99	94	616.3506	0.5191	0.1738	------	612.5300	612.4300

100	99	614.8492	0.4470	0.0746	------	613.1000	613.0000
101	100	614.3319	0.4310	0.1793	------	613.4700	613.3700
189	101	617.9782	0.3995	0.3612	------	617.9399	619.3100
191	189	626.7699	0.3828	0.0204	------	626.4074	627.8700
No approach losses at node 205 because inverts and/or crowns are offset.							
192	191	637.6015	------	------	------	637.6015	638.1700
205	192	663.3578	0.5829	0.0039	------	662.7787	665.5700
206	205	664.7266	0.0412	0.0551	------	664.7405	666.3000
72	206	664.9142	0.0458	0.0007	------	664.8692	666.6300
70	72	664.9640	------	------	------	664.9640	667.1300

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Warning, History file is now 2.26 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [25 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
317	0.8590	0.6911	1.4149	0.49	0.4932	12" Diam	1.7910	1.8015	CB 70
324	2.1420	1.5088	2.4601	0.61	0.5659	12" Diam	3.2913	3.1323	CB 72
325	4.0580	2.7536	4.8638	0.57	0.5386	12" Diam	6.3855	6.1928	CB 206
DITCH 205-192	4.1290	2.8133	51.1551	0.05	0.4200	Ditch	2.9634	-----	CB 205
337	6.4860	4.6036	12.2133	0.38	0.4253	12" Diam	14.4645	15.5504	CB 192
341	6.6060	4.7017	11.4470	0.41	0.4468	12" Diam	13.8458	14.5747	CB 191
342	6.8310	4.8823	9.0884	0.54	0.5220	12" Diam	11.7741	11.5717	CB 189
343	6.9500	4.9728	2.9022	1.71	-----	12" Diam	6.3316	3.6952	CB 101
344	7.4320	5.3574	2.8959	1.85	-----	12" Diam	6.8213	3.6872	CB 100
345	8.2200	5.8151	2.8144	2.07	-----	12" Diam	7.4040	3.5834	CB 99
346	8.7350	6.1905	2.2095	2.80	-----	12" Diam	7.8820	2.8133	CB 94
347	9.9620	7.0066	2.6831	2.61	-----	12" Diam	8.9211	3.4162	CB 93
DITCH END7-11	9.9620	7.0066	16.4539	0.43	1.0331	Ditch	2.2120	-----	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							607.5601
End 7	End 12	609.2631	--na--	--na--	--na--	609.2631	675.5700
93	End 7	613.7458	0.9647	0.2327	------	613.0137	613.7700
94	93	618.6445	0.8512	0.3609	------	612.2700	612.1700
99	94	617.9862	0.7225	0.2419	------	612.5300	612.4300

100	99	615.7578	0.6225	0.1039	------	613.1000	613.0000
101	100	614.8156	0.6000	0.2495	------	613.4700	613.3700
189	101	618.2960	0.5565	0.5032	------	618.2427	619.3100
191	189	627.0651	0.5335	0.0285	------	626.5601	627.8700
No approach losses at node 205 because inverts and/or crowns are offset.							
192	191	637.8848	------	------	------	637.8848	638.1700
205	192	663.3915	0.6331	0.0049	------	662.7632	665.5700
206	205	664.8577	0.0573	0.0769	------	664.8773	666.3000
72	206	665.1190	0.0498	0.0008	------	665.0699	666.6300
70	72	665.1624	------	------	------	665.1624	667.1300

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ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [25 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
317	0.8590	0.6911	1.4149	0.49	0.4932	12" Diam	1.7910	1.8015	CB 70
324	2.1420	1.5088	2.4601	0.61	0.5659	12" Diam	3.2913	3.1323	CB 72
325	4.0580	2.7536	4.8638	0.57	0.5386	12" Diam	6.3855	6.1928	CB 206
DITCH 205-192	4.1290	2.8133	51.1551	0.05	0.4200	Ditch	2.9634	-----	CB 205
337	6.4860	4.6036	12.2133	0.38	0.4253	12" Diam	14.4645	15.5504	CB 192
341	6.6060	4.7017	11.4470	0.41	0.4468	12" Diam	13.8458	14.5747	CB 191
342	6.8310	4.8823	9.0884	0.54	0.5220	12" Diam	11.7741	11.5717	CB 189
343	6.9500	4.9728	8.5567	0.58	0.8210	18" Diam	5.0232	4.8421	CB 101
344	7.4320	5.3574	8.5382	0.63	0.8610	18" Diam	5.1052	4.8316	CB 100
345	8.2200	5.8151	8.2978	0.70	0.9254	18" Diam	5.0819	4.6956	CB 99
346	8.7350	6.1905	6.5145	0.95	1.1671	18" Diam	4.1961	3.6864	CB 94
347	9.9620	7.0066	7.9107	0.89	1.0975	18" Diam	5.0569	4.4765	CB 93
DITCH END7-11	9.9620	7.0066	16.4539	0.43	1.0331	Ditch	2.2120	-----	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							607.5601
End 7	End 12	609.2631	--na--	--na--	--na--	609.2631	675.5700
93	End 7	610.2443	0.1906	0.0460	------	610.0997	613.7700
94	93	610.8463	0.4010	0.1700	------	610.6154	612.1700
99	94	611.9468	0.4047	0.1355	------	611.6776	612.4300

100	99	612.5802	0.3918	0.0654	------	612.2538	613.0000
101	100	612.9364	0.6000	0.2495	------	612.5859	613.3700
189	101	618.2960	0.5565	0.5032	------	618.2427	619.3100
191	189	627.0651	0.5335	0.0285	------	626.5601	627.8700
No approach losses at node 205 because inverts and/or crowns are offset.							
192	191	637.8848	------	------	------	637.8848	638.1700
205	192	663.3915	0.6331	0.0042	------	662.7625	665.5700
206	205	664.8577	0.0573	0.0766	------	664.8770	666.3000
72	206	665.1188	0.0498	0.0008	------	665.0697	666.6300
70	72	665.1622	------	------	------	665.1622	667.1300

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arning, History file is now 2.22 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [10 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
556	0.0000	0.0000	9.1421	0.00	0.0000	12" Diam	0.0000	11.6401	
434	0.0000	0.0000	152.52	0.00	0.0000	54" Diam	0.0000	9.5898	
528	0.0000	0.0000	138.50	0.00	0.0000	36" Diam	0.0000	19.5938	
403	0.2500	0.1406	3.4002	0.04	0.0928	8" Diam	4.7750	9.7409	G-1
404	0.2500	0.1406	3.3583	0.04	0.0928	8" Diam	4.7750	9.6207	
405	1.3600	0.5390	6.6312	0.08	0.1929	12" Diam	5.0769	8.4432	G-2
520	2.4700	0.9453	6.5824	0.14	0.2563	12" Diam	5.9428	8.3810	G-2
297	2.2500	1.2353	9.9040	0.12	0.2388	12" Diam	8.5847	12.6101	F-3
298	2.2500	1.2353	4.2542	0.29	0.3687	12" Diam	4.6991	5.4166	
299	2.2500	1.2353	6.9334	0.18	0.2856	12" Diam	6.6735	8.8279	
300	2.2500	1.2353	12.7869	0.10	0.2100	12" Diam	10.3056	16.2808	
301	3.2700	1.6980	8.4838	0.20	0.3032	12" Diam	8.4426	10.8019	F-4
566	3.9600	2.0413	10.0941	0.20	0.3052	12" Diam	10.0593	12.8522	F-5
565	4.6500	2.3845	10.6844	0.22	0.4816	18" Diam	4.8694	6.0461	F-5
302	2.3700	0.9321	6.0837	0.15	0.2642	12" Diam	5.6176	7.7460	F-2
303	3.7300	1.5078	7.5359	0.20	0.3032	12" Diam	7.4966	9.5950	F-1
0-B	3.7300	1.5078	11.3416	0.13	0.2466	12" Diam	10.0122	14.4405	
B-20	3.7300	1.5078	5.4731	0.28	0.3589	12" Diam	5.9482	6.9686	
564	4.9300	2.1635	22.5820	0.10	0.3138	18" Diam	8.0621	12.7788	F-6
563	9.5800	4.5480	19.7323	0.23	0.4896	18" Diam	9.0778	11.1662	

562	10.3300	4.9973	23.9859	0.21	0.4647	18" Diam	10.7189	13.5733	F-7
521	10.3300	4.9973	8.7829	0.57	0.5405	12" Diam	11.5362	11.1827	
323	0.0000	0.0000	7.8204	0.00	0.0000	12" Diam	0.0000	9.9572	
319	0.0000	0.0000	2.1267	0.00	0.0000	8" Diam	0.0000	6.0926	
318	1.5800	0.6421	3.9366	0.16	0.2729	12" Diam	3.6962	5.0122	D-1
320	1.5800	0.6421	4.0800	0.16	0.2681	12" Diam	3.7909	5.1948	
321	1.5800	0.6421	1.9567	0.33	0.3940	12" Diam	2.2330	2.4913	
322	1.5800	0.6421	2.2770	0.28	0.3633	12" Diam	2.4915	2.8991	
Pipe A	1.5800	0.6421	6.1793	0.10	0.2173	12" Diam	5.1012	7.8677	
Pipe B	1.5800	0.6421	6.6067	0.10	0.2104	12" Diam	5.3389	8.4120	
580	1.5800	0.6421	15.6160	0.04	0.2076	18" Diam	4.3406	8.8368	
581	1.5800	0.6421	16.2876	0.04	0.2032	18" Diam	4.4778	9.2169	
582	1.5800	0.6421	16.1366	0.04	0.2040	18" Diam	4.4544	9.1315	
612	0.0000	0.0000	2.7172	0.00	0.0000	6" Diam	0.0000	13.8388	
326	0.1600	0.1158	6.2619	0.02	0.0942	12" Diam	3.0916	7.9728	C-1
327	0.1600	0.1158	6.8887	0.02	0.0903	12" Diam	3.2902	8.7709	
328	0.1600	0.1158	8.1996	0.01	0.0835	12" Diam	3.6943	10.4401	
329	1.1800	0.5687	4.2534	0.13	0.1644	8" Diam	8.4969	12.1852	C-2
332	2.2000	1.1888	6.1364	0.19	0.2983	12" Diam	6.0454	7.8131	C-3
333	2.2000	1.1888	6.5605	0.18	0.2886	12" Diam	6.3318	8.3531	
447	2.2000	1.1888	10.4960	0.11	0.2271	12" Diam	8.8726	13.3639	
338	2.2000	1.1888	13.3659	0.09	0.2017	12" Diam	10.5063	17.0179	
339	2.2000	1.1888	7.0416	0.17	0.2778	12" Diam	6.6760	8.9656	
340	2.2000	1.1888	5.4983	0.22	0.3159	12" Diam	5.5849	7.0007	
						12"			

446	3.2100	1.7553	6.0132	0.29	0.3696	Diam	6.6533	7.6563	C-4
349	3.2100	1.7553	10.4508	0.17	0.2769	12" Diam	9.9056	13.3064	
354	8.4100	4.2329	10.0660	0.42	0.4526	12" Diam	12.2548	12.8165	C-5
356	8.4100	4.2329	12.1146	0.35	0.4077	12" Diam	14.0655	15.4248	
358	8.4100	4.2329	12.6392	0.33	0.3989	12" Diam	14.4804	16.0927	
555	9.5100	4.8549	19.7141	0.25	0.5072	18" Diam	9.2327	11.1559	C-6
305	0.0000	0.0000	9.3956	0.00	0.0000	12" Diam	0.0000	11.9628	
306	0.0000	0.0000	5.0756	0.00	0.0000	12" Diam	0.0000	6.4624	
307	27.3200	4.7381	13.8760	0.34	0.6046	18" Diam	7.1050	7.8522	E-1
308	27.3200	4.7381	23.6349	0.20	0.4552	18" Diam	10.4585	13.3746	
309	27.3200	4.7381	22.4156	0.21	0.4684	18" Diam	10.0534	12.6846	
310	27.3200	4.7381	20.9785	0.23	0.4845	18" Diam	9.5952	11.8714	
311	27.3200	4.7381	14.2476	0.33	0.5958	18" Diam	7.2454	8.0625	
DITCH C154-C29	27.3200	4.7381	56.7127	0.08	0.5109	Ditch	3.6621	-----	
312	27.3200	4.7381	19.3289	0.25	0.5057	18" Diam	9.0463	10.9379	
317	3.7400	1.9824	1.4149	1.40	-----	12" Diam	2.5241	1.8015	B-1
324	3.7400	1.9824	2.4601	0.81	0.6802	12" Diam	3.4847	3.1323	
325	3.7400	1.9824	4.8638	0.41	0.4448	12" Diam	5.8715	6.1928	
DITCH 205-192	3.7400	1.9824	51.1551	0.04	0.3556	Ditch	2.6975	-----	
337	6.1100	3.2981	12.2133	0.27	0.3550	12" Diam	13.2062	15.5504	B-2
341	6.1100	3.2981	11.4470	0.29	0.3677	12" Diam	12.5913	14.5747	
342	6.1100	3.2981	9.0884	0.36	0.4165	12" Diam	10.6531	11.5717	
343	6.1100	3.2981	2.9022	1.14	-----	12" Diam	4.1993	3.6952	
344	6.1100	3.2981	2.8959	1.14	-----	12" Diam	4.1993	3.6872	

345	6.1100	3.2981	2.8144	1.17	-----	12" Diam	4.1993	3.5834	
346	6.1100	3.2981	2.2095	1.49	-----	12" Diam	4.1993	2.8133	
347	6.1100	3.2981	2.6831	1.23	-----	12" Diam	4.1993	3.4162	
DITCH END7-11	6.1100	3.2981	16.4539	0.20	0.7328	Ditch	1.8254	-----	
398	0.0000	0.0000	1.2233	0.00	0.0000	8" Diam	0.0000	3.5044	
397	0.8100	0.4211	1.0297	0.41	0.4453	12" Diam	1.2453	1.3111	A-2-CB97
395	1.9500	1.1602	1.6479	0.70	0.6187	12" Diam	2.2738	2.0982	A-2-CB96
394	2.6400	1.5573	1.3192	1.18	-----	12" Diam	1.9829	1.6797	A-2-CB90
380	0.0000	0.0000	0.1979	0.00	0.0000	8" Diam	0.0000	0.5668	
382	0.9500	0.4228	1.2813	0.33	0.3950	12" Diam	1.4654	1.6314	A-4
389	0.9400	0.4240	2.0355	0.21	0.3101	12" Diam	2.0440	2.5917	A-1
388	0.9400	0.4240	2.0551	0.21	0.3081	12" Diam	2.0620	2.6166	
387	1.9500	0.8267	3.8024	0.22	0.3169	12" Diam	3.8672	4.8414	A-3
386	1.9500	0.8267	4.3878	0.19	0.2944	12" Diam	4.2817	5.5867	
384	1.9500	0.8267	3.2136	0.26	0.3462	12" Diam	3.4253	4.0917	
383	2.9000	1.2495	3.3984	0.37	0.4194	12" Diam	3.9986	4.3270	
392	6.0300	3.0967	3.3282	0.93	0.7632	12" Diam	4.8148	4.2377	A-2-CB88
376	7.5500	3.7358	4.2411	0.88	0.7290	12" Diam	6.0900	5.3999	A-5
377	7.5500	3.7358	14.3438	0.26	0.3481	12" Diam	15.3602	18.2631	
378	7.5500	3.7358	7.5325	0.50	0.4976	12" Diam	9.5726	9.5907	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							691.2500
B-556	E-556	0.0000	--na--	--na--	--na--	0.0000	704.5900
B-434	E-434	0.0000	--na--	--na--	--na--	0.0000	582.0000
B-528	E-528	0.0000	--na--	--na--	--na--	0.0000	704.5900
215	E-520	625.2052	0.4002	0.0026	------	624.8076	627.8900

No approach losses at node 213 because inverts and/or crowns are offset.							
214	215	628.2921	------	------	------	628.2921	630.8700
213	214	629.9623	0.3541	0.4233	------	630.0316	631.2700
1	213	637.6079	------	------	------	637.6079	639.6000
216	E-521	625.2920	0.1242	0.0177	------	625.1855	626.2300
508	216	647.7666	1.2796	1.4501	------	647.9370	704.5900
509	508	651.2973	0.3682	0.0061	0.1907	651.1259	652.4100
522	509	654.2120	1.5713	2.0255	------	654.6662	657.0000
226	522	659.2432	1.1068	0.0048	------	658.1412	661.1700
227	226	668.2961	1.6492	0.0165	------	666.6634	668.9400
223	227	685.1498	0.6915	0.8972	------	685.3554	692.6600
217	223	690.5483	0.3429	0.2056	------	690.4110	692.6600
218	217	691.9102	1.1444	0.4457	------	691.2115	693.2700
E-297	218	695.2130	--na--	--na--	--na--	695.2130	696.0000
20	509	653.7009	0.5494	0.7356	------	653.8871	657.0600
No approach losses at node 0 because inverts and/or crowns are offset.							
CB-B	20	654.5460	------	------	------	654.5460	656.9000
0	CB-B	663.2004	0.8727	0.0132	------	662.3410	665.9600
229	0	664.1344	0.4900	0.6018	------	664.2462	666.5900
228	229	669.5381	------	------	------	669.5381	671.0400
519	E-582	647.9167	0.3113	0.0432	------	647.6485	704.5900
518	519	650.6268	0.2926	0.0308	------	650.3651	656.5400
No approach losses at node CB-A because inverts and/or crowns are offset.							
516	518	652.9881	------	------	------	652.9880	661.0000
CB-A	516	660.4559	0.4041	0.1561	------	660.2079	664.0000
77	CB-A	664.5877	0.0964	0.0946	------	664.5859	668.0300
76	77	0.0000	------	------	------	0.0000	667.1100
64	77	665.2780	0.0774	0.0012	------	665.2018	667.4200
65	64	665.3353	0.2231	0.0289	------	665.1410	666.6700
66	65	665.5552	0.2121	0.0366	------	665.3798	666.9600
63	66	0.0000	------	------	------	0.0000	667.5300
62	66	667.0357	------	------	------	667.0358	704.5900
No approach losses at node 177 because inverts and/or crowns are offset.							
488	End 13	552.8094	------	------	------	552.8093	558.4800
517	488	0.0000	------	------	------	0.0000	660.5000
177	488	574.0055	0.4510	0.0715	------	573.6260	575.4100
179	177	585.0106	0.4510	0.0782	------	584.6378	586.7600
182	179	599.3585	0.0776	0.0506	------	599.3315	601.1100
185	182	609.5497	0.6874	0.5429	------	609.4052	611.7100
187	185	611.4484	0.4843	0.2791	------	611.2431	613.3300

No approach losses at node 190 because inverts and/or crowns are offset.							
188	187	614.1324	------	------	------	614.1324	617.3600
190	188	617.9148	1.7140	0.0318	------	616.2327	621.3000
No approach losses at node 195 because inverts and/or crowns are offset.							
194	190	634.2192	------	------	------	634.2192	638.7800
195	194	645.8320	0.6225	0.0071	------	645.2166	648.2900
196	195	647.6074	0.5675	0.0104	------	647.0503	650.6000
No approach losses at node 199 because inverts and/or crowns are offset.							
198	196	650.0095	------	------	------	650.0095	652.8100
No approach losses at node 202 because inverts and/or crowns are offset.							
199	198	654.0067	------	------	------	654.0067	655.7400
No approach losses at node 203 because inverts and/or crowns are offset.							
202	199	656.7205	------	------	------	656.7205	656.7800
203	202	656.9310	0.1484	0.0011	------	656.7837	660.8800
204	203	659.0515	------	------	------	659.0515	661.8100
C-29	C-28	625.7851	--na--	--na--	--na--	625.7851	626.5600
C-154	C-29	629.6360	--na--	--na--	--na--	629.6360	631.0900
13	C-154	631.7749	1.4296	0.0121	------	630.3574	704.5900
234	13	634.1613	1.5694	0.0078	------	632.5997	639.0200
233	234	639.3677	1.6985	0.0072	------	637.6765	644.0300
232	233	645.7145	0.7839	0.0048	------	644.9354	648.8100
231	232	648.8856	------	------	------	648.8856	652.3000
No approach losses at node C-60 because inverts and/or crowns are offset.							
230	231	0.0000	------	------	------	0.0000	652.8900
C-60	230	0.0000	--na--	--na--	--na--	0.0000	663.8600
End 7	End 12	608.9628	--na--	--na--	--na--	608.9628	675.5700
93	End 7	610.2264	0.2738	0.0674	------	610.0200	613.7700
94	93	611.6182	0.2738	0.1175	------	611.4619	612.1700
99	94	613.3006	0.2738	0.0910	------	612.5300	612.4300
100	99	613.7533	0.2738	0.0480	------	613.1000	613.0000
101	100	613.8546	0.2738	0.1231	------	613.4700	613.3700
189	101	617.6826	0.2738	0.2401	------	617.6488	619.3100
191	189	626.5336	0.2738	0.0142	------	626.2740	627.8700
No approach losses at node 13 because inverts and/or crowns are offset.							
192	191	637.3965	------	------	------	637.3965	638.1700
205	192	663.3256	0.5353	0.0053	------	662.7955	665.5700
206	205	664.6225	0.1886	0.2553	------	664.6893	666.3000
72	206	665.1444	0.0989	0.0016	------	665.0471	666.6300
70	72	665.5828	------	------	------	665.5828	667.1300
11	End 12	607.9784	0.3513	0.3833	------	608.0104	608.6000

92	11	631.8800	0.3513	0.0040	------	631.5327	648.6200
) approach losses at node 88 because inverts and/or crowns are offset.							
SDMH-10	92	640.1435	------	------	------	640.1435	648.3200
88	SDMH-10	641.7346	0.0611	0.0713	0.0291	641.7739	648.3100
90	88	642.7850	0.0339	0.0002	------	642.7513	647.3000
96	90	643.4561	0.0241	0.0003	------	643.4324	645.8700
97	96	643.5264	------	------	------	643.5264	645.1700
98	97	0.0000	------	------	------	0.0000	645.2600
85	88	645.8986	0.1822	0.4966	0.0620	646.2750	648.6200
74	85	646.3438	------	------	------	646.3438	648.1300
75	74	0.0000	------	------	------	0.0000	648.0700
84	85	647.5364	0.2847	0.0235	------	647.2752	649.8900
82	84	653.6044	0.2322	0.0117	------	653.3839	656.3400
81	82	657.5108	0.0660	0.0064	------	657.4512	660.2000
79	81	658.5572	0.0649	0.0010	------	658.4933	661.0700
78	79	660.0872	------	------	------	660.0872	662.0100

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Warning, History file is now 2.27 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [25 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
556	0.0000	0.0000	9.1421	0.00	0.0000	12" Diam	0.0000	11.6401	
434	0.0000	0.0000	152.52	0.00	0.0000	54" Diam	0.0000	9.5898	
528	0.0000	0.0000	138.50	0.00	0.0000	36" Diam	0.0000	19.5938	
403	0.2500	0.1669	3.4002	0.05	0.1006	8" Diam	5.0395	9.7409	G-1
404	0.2500	0.1669	3.3583	0.05	0.1012	8" Diam	4.9926	9.6207	
405	1.3600	0.6625	6.6312	0.10	0.2134	12" Diam	5.4013	8.4432	G-2
520	2.4700	1.1680	6.5824	0.18	0.2852	12" Diam	6.3248	8.3810	G-2
297	2.2500	1.5274	9.9040	0.15	0.2651	12" Diam	9.1582	12.6101	F-3
298	2.2500	1.5274	4.2542	0.36	0.4146	12" Diam	4.9646	5.4166	
299	2.2500	1.5274	6.9334	0.22	0.3188	12" Diam	7.0849	8.8279	
300	2.2500	1.5274	12.7869	0.12	0.2329	12" Diam	10.9951	16.2808	
301	3.2700	2.0802	8.4838	0.25	0.3374	12" Diam	8.9275	10.8019	F-4
566	3.9600	2.4881	10.0941	0.25	0.3384	12" Diam	10.6358	12.8522	F-5
565	4.6500	2.8960	10.6844	0.27	0.5336	18" Diam	5.1394	6.0461	F-5
302	2.3700	1.1480	6.0837	0.19	0.2944	12" Diam	5.9457	7.7460	F-2
303	3.7300	1.8526	7.5359	0.25	0.3374	12" Diam	7.9504	9.5950	F-1
0-B	3.7300	1.8526	11.3416	0.16	0.2729	12" Diam	10.6645	14.4405	
B-20	3.7300	1.8526	5.4731	0.34	0.4009	12" Diam	6.2963	6.9686	
564	4.9300	2.6454	22.5820	0.12	0.3468	18" Diam	8.5523	12.7788	F-6
563	9.5800	5.5415	19.7323	0.28	0.5438	18" Diam	9.5832	11.1662	

562	10.3300	6.0737	23.9859	0.25	0.5145	18" Diam	11.3262	13.5733	F-7
521	10.3300	6.0737	8.7829	0.69	0.6118	12" Diam	12.0612	11.1827	
323	0.0000	0.0000	7.8204	0.00	0.0000	12" Diam	0.0000	9.9572	
319	0.0000	0.0000	2.1267	0.00	0.0000	8" Diam	0.0000	6.0926	
318	1.5800	0.7584	3.9366	0.19	0.2974	12" Diam	3.8742	5.0122	D-1
320	1.5800	0.7584	4.0800	0.19	0.2925	12" Diam	3.9644	5.1948	
321	1.5800	0.7584	1.9567	0.39	0.4321	12" Diam	2.3333	2.4913	
322	1.5800	0.7584	2.2770	0.33	0.3975	12" Diam	2.6072	2.8991	
Pipe A	1.5800	0.7584	6.1793	0.12	0.2368	12" Diam	5.3321	7.8677	
Pipe B	1.5800	0.7584	6.6067	0.11	0.2290	12" Diam	5.5918	8.4120	
580	1.5800	0.7584	15.6160	0.05	0.2252	18" Diam	4.5562	8.8368	
581	1.5800	0.7584	16.2876	0.05	0.2201	18" Diam	4.7110	9.2169	
582	1.5800	0.7584	16.1366	0.05	0.2216	18" Diam	4.6658	9.1315	
612	0.0000	0.0000	2.7172	0.00	0.0000	6" Diam	0.0000	13.8388	
326	0.1600	0.1346	6.2619	0.02	0.1011	12" Diam	3.2416	7.9728	C-1
327	0.1600	0.1346	6.8887	0.02	0.0972	12" Diam	3.4347	8.7709	
328	0.1600	0.1346	8.1996	0.02	0.0894	12" Diam	3.8852	10.4401	
329	1.1800	0.6653	4.2534	0.16	0.1781	8" Diam	8.8837	12.1852	C-2
332	2.2000	1.3908	6.1364	0.23	0.3237	12" Diam	6.3174	7.8131	C-3
333	2.2000	1.3908	6.5605	0.21	0.3130	12" Diam	6.6183	8.3531	
447	2.2000	1.3908	10.4960	0.13	0.2456	12" Diam	9.2874	13.3639	
338	2.2000	1.3908	13.3659	0.10	0.2183	12" Diam	10.9792	17.0179	
339	2.2000	1.3908	7.0416	0.20	0.3013	12" Diam	6.9773	8.9656	
340	2.2000	1.3908	5.4983	0.25	0.3433	12" Diam	5.8298	7.0007	
						12"			

446	3.2100	2.0671	6.0132	0.34	0.4048	Diam	6.9351	7.6563	C-4
349	3.2100	2.0671	10.4508	0.20	0.3013	12" Diam	10.3701	13.3064	
354	8.4100	5.0602	10.0660	0.50	0.5015	12" Diam	12.8378	12.8165	C-5
356	8.4100	5.0602	12.1146	0.42	0.4507	12" Diam	14.7329	15.4248	
358	8.4100	5.0602	12.6392	0.40	0.4399	12" Diam	15.2056	16.0927	
555	9.5100	5.8020	19.7141	0.29	0.5577	18" Diam	9.6963	11.1559	C-6
305	0.0000	0.0000	9.3956	0.00	0.0000	12" Diam	0.0000	11.9628	
306	0.0000	0.0000	5.0756	0.00	0.0000	12" Diam	0.0000	6.4624	
307	27.3200	6.1280	13.8760	0.44	0.6976	18" Diam	7.6117	7.8522	E-1
308	27.3200	6.1280	23.6349	0.26	0.5211	18" Diam	11.2306	13.3746	
309	27.3200	6.1280	22.4156	0.27	0.5358	18" Diam	10.8146	12.6846	
310	27.3200	6.1280	20.9785	0.29	0.5555	18" Diam	10.2960	11.8714	
311	27.3200	6.1280	14.2476	0.43	0.6874	18" Diam	7.7595	8.0625	
DITCH C154-C29	27.3200	6.1280	56.7127	0.11	0.5746	Ditch	3.9156	-----	
312	27.3200	6.1280	19.3289	0.32	0.5804	18" Diam	9.7051	10.9379	
317	3.7400	2.3655	1.4149	1.67	-----	12" Diam	3.0119	1.8015	B-1
324	3.7400	2.3655	2.4601	0.96	0.7866	12" Diam	3.5693	3.1323	
325	3.7400	2.3655	4.8638	0.49	0.4917	12" Diam	6.1538	6.1928	
DITCH 205-192	3.7400	2.3655	51.1551	0.05	0.3871	Ditch	2.8276	-----	
337	6.1100	3.9243	12.2133	0.32	0.3901	12" Diam	13.8314	15.5504	B-2
341	6.1100	3.9243	11.4470	0.34	0.4038	12" Diam	13.2086	14.5747	
342	6.1100	3.9243	9.0884	0.43	0.4595	12" Diam	11.1418	11.5717	
343	6.1100	3.9243	2.9022	1.35	-----	12" Diam	4.9966	3.6952	
344	6.1100	3.9243	2.8959	1.36	-----	12" Diam	4.9966	3.6872	

345	6.1100	3.9243	2.8144	1.39	-----	12" Diam	4.9966	3.5834	
346	6.1100	3.9243	2.2095	1.78	-----	12" Diam	4.9966	2.8133	
347	6.1100	3.9243	2.6831	1.46	-----	12" Diam	4.9966	3.4162	
DITCH END7-11	6.1100	3.9243	16.4539	0.24	0.7943	Ditch	1.9086	-----	
398	0.0000	0.0000	1.2233	0.00	0.0000	8" Diam	0.0000	3.5044	
397	0.8100	0.5091	1.0297	0.49	0.4966	12" Diam	1.3077	1.3111	A-2-CB97
395	1.9500	1.3856	1.6479	0.84	0.7026	12" Diam	2.3499	2.0982	A-2-CB96
394	2.6400	1.8558	1.3192	1.41	-----	12" Diam	2.3629	1.6797	A-2-CB90
380	0.0000	0.0000	0.1979	0.00	0.0000	8" Diam	0.0000	0.5668	
382	0.9500	0.5096	1.2813	0.40	0.4385	12" Diam	1.5382	1.6314	A-4
389	0.9400	0.5096	2.0355	0.25	0.3413	12" Diam	2.1529	2.5917	A-1
388	0.9400	0.5096	2.0551	0.25	0.3394	12" Diam	2.1699	2.6166	
387	1.9500	1.0020	3.8024	0.26	0.3501	12" Diam	4.0886	4.8414	A-3
386	1.9500	1.0020	4.3878	0.23	0.3247	12" Diam	4.5326	5.5867	
384	1.9500	1.0020	3.2136	0.31	0.3833	12" Diam	3.6164	4.0917	
383	2.9000	1.5116	3.3984	0.44	0.4673	12" Diam	4.1989	4.3270	
392	6.0300	3.7107	3.3282	1.11	-----	12" Diam	4.7247	4.2377	A-2-CB88
376	7.5500	4.4951	4.2411	1.06	-----	12" Diam	5.7233	5.3999	A-5
377	7.5500	4.4951	14.3438	0.31	0.3843	12" Diam	16.1682	18.2631	
378	7.5500	4.4951	7.5325	0.60	0.5562	12" Diam	10.0172	9.5907	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							691.2500
B-556	E-556	0.0000	--na--	--na--	--na--	0.0000	704.5900
B-434	E-434	0.0000	--na--	--na--	--na--	0.0000	582.0000
B-528	E-528	0.0000	--na--	--na--	--na--	0.0000	704.5900
215	E-520	625.2804	0.4530	0.0029	------	624.8303	627.8900

No approach losses at node 213 because inverts and/or crowns are offset.							
214	215	628.3427	------	------	------	628.3427	630.8700
213	214	629.9846	0.3944	0.4715	------	630.0618	631.2700
1	213	637.6302	------	------	------	637.6302	639.6000
216	E-521	625.8561	0.1834	0.0261	------	625.6988	626.2300
508	216	647.9446	1.4260	1.6160	------	648.1346	704.5900
509	508	651.4690	0.4102	0.0068	0.2134	651.2790	652.4100
522	509	654.3103	1.7565	2.2643	------	654.8181	657.0000
226	522	659.3856	1.2376	0.0054	------	658.1534	661.1700
227	226	668.4173	1.8772	0.0187	------	666.5588	668.9400
223	227	685.2451	0.7794	1.0112	------	685.4769	692.6600
217	223	690.6437	0.3827	0.2295	------	690.4904	692.6600
218	217	692.0056	1.3024	0.5073	------	691.2104	693.2700
E-297	218	695.2994	--na--	--na--	--na--	695.2994	696.0000
20	509	653.7960	0.6156	0.8242	------	654.0046	657.0600
No approach losses at node 0 because inverts and/or crowns are offset.							
CB-B	20	654.6522	------	------	------	654.6522	656.9000
0	CB-B	663.3104	0.9815	0.0149	------	662.3438	665.9600
229	0	664.2444	0.5489	0.6741	------	664.3696	666.5900
228	229	669.6127	------	------	------	669.6127	671.0400
519	E-582	647.9531	0.3446	0.0478	------	647.6563	704.5900
518	519	650.6634	0.3223	0.0339	------	650.3749	656.5400
No approach losses at node CB-A because inverts and/or crowns are offset.							
516	518	653.0246	------	------	------	653.0247	661.0000
CB-A	516	660.5005	0.4415	0.1706	------	660.2296	664.0000
77	CB-A	664.6323	0.1056	0.1036	------	664.6303	668.0300
76	77	0.0000	------	------	------	0.0000	667.1100
64	77	665.3259	0.0845	0.0013	------	665.2427	667.4200
65	64	665.3872	0.2440	0.0316	------	665.1748	666.6700
66	65	665.6004	0.2331	0.0402	------	665.4075	666.9600
63	66	0.0000	------	------	------	0.0000	667.5300
62	66	667.0809	------	------	------	667.0809	704.5900
No approach losses at node 177 because inverts and/or crowns are offset.							
488	End 13	552.9663	------	------	------	552.9662	558.4800
517	488	0.0000	------	------	------	0.0000	660.5000
177	488	574.3695	0.6446	0.1022	------	573.8271	575.4100
179	177	585.3746	0.6446	0.1117	------	584.8417	586.7600
182	179	599.7224	0.1076	0.0702	------	599.6851	601.1100
185	182	609.6447	0.7468	0.5898	------	609.4877	611.7100
187	185	611.5433	0.5277	0.3041	------	611.3197	613.3300

No approach losses at node 190 because inverts and/or crowns are offset.							
188	187	614.1974	------	------	------	614.1974	617.3600
190	188	617.9798	1.8718	0.0348	------	616.1428	621.3000
No approach losses at node 195 because inverts and/or crowns are offset.							
194	190	634.2858	------	------	------	634.2858	638.7800
195	194	645.8987	0.6802	0.0078	------	645.2263	648.2900
196	195	647.6723	0.6197	0.0114	------	647.0640	650.6000
No approach losses at node 199 because inverts and/or crowns are offset.							
198	196	650.0745	------	------	------	650.0745	652.8100
No approach losses at node 202 because inverts and/or crowns are offset.							
199	198	654.0632	------	------	------	654.0632	655.7400
No approach losses at node 203 because inverts and/or crowns are offset.							
202	199	656.7354	------	------	------	656.7355	656.7800
203	202	656.9460	0.1632	0.0012	------	656.7841	660.8800
204	203	659.0665	------	------	------	659.0665	661.8100
C-29	C-28	626.0250	--na--	--na--	--na--	626.0250	626.5600
C-154	C-29	629.7078	--na--	--na--	--na--	629.7078	631.0900
13	C-154	632.0148	1.6461	0.0139	------	630.3827	704.5900
234	13	634.4012	1.8161	0.0090	------	632.5942	639.0200
233	234	639.6076	1.9585	0.0083	------	637.6575	644.0300
232	233	645.9544	0.8997	0.0055	------	645.0602	648.8100
231	232	649.1255	------	------	------	649.1255	652.3000
No approach losses at node C-60 because inverts and/or crowns are offset.							
230	231	0.0000	------	------	------	0.0000	652.8900
C-60	230	0.0000	--na--	--na--	--na--	0.0000	663.8600
End 7	End 12	609.0243	--na--	--na--	--na--	609.0243	675.5700
93	End 7	610.6394	0.3877	0.0954	------	610.3470	613.7700
94	93	612.6098	0.3877	0.1663	------	612.2700	612.1700
99	94	614.8733	0.3877	0.1288	------	612.5300	612.4300
100	99	614.2619	0.3877	0.0680	------	613.1000	613.0000
101	100	614.1684	0.3877	0.1743	------	613.4700	613.3700
189	101	617.8967	0.3877	0.3399	------	617.8489	619.3100
191	189	626.7477	0.3877	0.0201	------	626.3801	627.8700
No approach losses at node 13 because inverts and/or crowns are offset.							
192	191	637.6106	------	------	------	637.6106	638.1700
205	192	663.3571	0.5880	0.0058	------	662.7748	665.5700
206	205	664.7388	0.1409	0.1907	------	664.7887	666.3000
72	206	665.3829	0.1409	0.0022	------	665.2443	666.6300
70	72	665.8604	------	------	------	665.8604	667.1300
11	End 12	608.2742	0.5086	0.5550	------	608.3206	608.6000

92	11	632.1759	0.5086	0.0058	------	631.6730	648.6200
No approach losses at node 88 because inverts and/or crowns are offset.							
SDMH-10	92	641.3524	------	------	------	641.3524	648.3200
88	SDMH-10	643.6370	0.0867	0.1013	0.0417	643.6933	648.3100
90	88	645.1291	0.0483	0.0003	------	645.0811	647.3000
96	90	646.0865	0.0065	0.0001	------	645.9700	645.8700
97	96	646.0579	------	------	------	645.2700	645.1700
98	97	0.0000	------	------	------	0.0000	645.2600
85	88	645.9818	0.2031	0.5536	0.0688	646.4012	648.6200
74	85	646.5011	------	------	------	646.5012	648.1300
75	74	0.0000	------	------	------	0.0000	648.0700
84	85	647.5980	0.3190	0.0263	------	647.3054	649.8900
82	84	653.6661	0.2596	0.0131	------	653.4196	656.3400
81	82	657.5725	0.0731	0.0071	------	657.5065	660.2000
79	81	658.5991	0.0720	0.0012	------	658.5283	661.0700
78	79	660.1291	------	------	------	660.1292	662.0100

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. arning, History file is now 2.32 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [100 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
556	0.0000	0.0000	9.1421	0.00	0.0000	12" Diam	0.0000	11.6401	
434	0.0000	0.0000	152.52	0.00	0.0000	54" Diam	0.0000	9.5898	
528	0.0000	0.0000	138.50	0.00	0.0000	36" Diam	0.0000	19.5938	
403	0.2500	0.2087	3.4002	0.06	0.1120	8" Diam	5.3956	9.7409	G-1
404	0.2500	0.2087	3.3583	0.06	0.1130	8" Diam	5.3284	9.6207	
405	1.3600	0.8649	6.6312	0.13	0.2437	12" Diam	5.8410	8.4432	G-2
520	2.4700	1.5289	6.5824	0.23	0.3276	12" Diam	6.8312	8.3810	G-2
297	2.2500	2.0002	9.9040	0.20	0.3052	12" Diam	9.8570	12.6101	F-3
298	2.2500	2.0002	4.2542	0.47	0.4819	12" Diam	5.3391	5.4166	
299	2.2500	2.0002	6.9334	0.29	0.3677	12" Diam	7.6363	8.8279	
300	2.2500	2.0002	12.7869	0.16	0.2671	12" Diam	11.8701	16.2808	
301	3.2700	2.7177	8.4838	0.32	0.3892	12" Diam	9.6108	10.8019	F-4
566	3.9600	3.2063	10.0941	0.32	0.3872	12" Diam	11.4155	12.8522	F-5
565	4.6500	3.7170	10.6844	0.35	0.6105	18" Diam	5.5027	6.0461	F-5
302	2.3700	1.4968	6.0837	0.25	0.3384	12" Diam	6.3983	7.7460	F-2
303	3.7300	2.4105	7.5359	0.32	0.3892	12" Diam	8.5246	9.5950	F-1
0-B	3.7300	2.4105	11.3416	0.21	0.3130	12" Diam	11.4709	14.4405	
B-20	3.7300	2.4105	5.4731	0.44	0.4644	12" Diam	6.7506	6.9686	
564	4.9300	3.4217	22.5820	0.15	0.3944	18" Diam	9.2253	12.7788	F-6
563	9.5800	7.1387	19.7323	0.36	0.6237	18" Diam	10.2722	11.1662	

562	10.3300	7.8030	23.9859	0.33	0.5885	18" Diam	12.1314	13.5733	F-7
521	10.3300	7.8030	8.7829	0.89	0.7339	12" Diam	12.6313	11.1827	
323	0.0000	0.0000	7.8204	0.00	0.0000	12" Diam	0.0000	9.9572	
319	0.0000	0.0000	2.1267	0.00	0.0000	8" Diam	0.0000	6.0926	
318	1.5800	0.9434	3.9366	0.24	0.3335	12" Diam	4.1138	5.0122	D-1
320	1.5800	0.9434	4.0800	0.23	0.3267	12" Diam	4.2325	5.1948	
321	1.5800	0.9434	1.9567	0.48	0.4897	12" Diam	2.4668	2.4913	
322	1.5800	0.9434	2.2770	0.41	0.4487	12" Diam	2.7624	2.8991	
Pipe A	1.5800	0.9434	6.1793	0.15	0.2642	12" Diam	5.6858	7.8677	
Pipe B	1.5800	0.9434	6.6067	0.14	0.2554	12" Diam	5.9628	8.4120	
580	1.5800	0.9434	15.6160	0.06	0.2501	18" Diam	4.8697	8.8368	
581	1.5800	0.9434	16.2876	0.06	0.2450	18" Diam	5.0176	9.2169	
582	1.5800	0.9434	16.1366	0.06	0.2461	18" Diam	4.9853	9.1315	
612	0.0000	0.0000	2.7172	0.00	0.0000	6" Diam	0.0000	13.8388	
326	0.1600	0.1645	6.2619	0.03	0.1118	12" Diam	3.4174	7.9728	C-1
327	0.1600	0.1645	6.8887	0.02	0.1069	12" Diam	3.6483	8.7709	
328	0.1600	0.1645	8.1996	0.02	0.0981	12" Diam	4.1375	10.4401	
329	1.1800	0.8191	4.2534	0.19	0.1982	8" Diam	9.4148	12.1852	C-2
332	2.2000	1.7122	6.1364	0.28	0.3608	12" Diam	6.7049	7.8131	C-3
333	2.2000	1.7122	6.5605	0.26	0.3481	12" Diam	7.0398	8.3531	
447	2.2000	1.7122	10.4960	0.16	0.2729	12" Diam	9.8562	13.3639	
338	2.2000	1.7122	13.3659	0.13	0.2417	12" Diam	11.6952	17.0179	
339	2.2000	1.7122	7.0416	0.24	0.3354	12" Diam	7.4065	8.9656	
340	2.2000	1.7122	5.4983	0.31	0.3833	12" Diam	6.1795	7.0007	
						12"			

446	3.2100	2.5634	6.0132	0.43	0.4556	Diam	7.3592	7.6563	C-4
349	3.2100	2.5634	10.4508	0.25	0.3374	12" Diam	11.0010	13.3064	
354	8.4100	6.3811	10.0660	0.63	0.5776	12" Diam	13.5761	12.8165	C-5
356	8.4100	6.3811	12.1146	0.53	0.5161	12" Diam	15.6089	15.4248	
358	8.4100	6.3811	12.6392	0.50	0.5024	12" Diam	16.1489	16.0927	
555	9.5100	7.3135	19.7141	0.37	0.6324	18" Diam	10.3303	11.1559	C-6
305	0.0000	0.0000	9.3956	0.00	0.0000	12" Diam	0.0000	11.9628	
306	0.0000	0.0000	5.0756	0.00	0.0000	12" Diam	0.0000	6.4624	
307	27.3200	8.4485	13.8760	0.61	0.8448	18" Diam	8.2387	7.8522	E-1
308	27.3200	8.4485	23.6349	0.36	0.6200	18" Diam	12.2523	13.3746	
309	27.3200	8.4485	22.4156	0.38	0.6383	18" Diam	11.7888	12.6846	
310	27.3200	8.4485	20.9785	0.40	0.6625	18" Diam	11.2260	11.8714	
311	27.3200	8.4485	14.2476	0.59	0.8317	18" Diam	8.3995	8.0625	
DITCH C154-C29	27.3200	8.4485	56.7127	0.15	0.6647	Ditch	4.2454	-----	
312	27.3200	8.4485	19.3289	0.44	0.6940	18" Diam	10.5658	10.9379	
317	3.7400	2.9756	1.4149	2.10	-----	12" Diam	3.7886	1.8015	B-1
324	3.7400	2.9756	2.4601	1.21	-----	12" Diam	3.7886	3.1323	
325	3.7400	2.9756	4.8638	0.61	0.5649	12" Diam	6.5046	6.1928	
DITCH 205-192	3.7400	2.9756	51.1551	0.06	0.4318	Ditch	3.0025	-----	
337	6.1100	4.9210	12.2133	0.40	0.4419	12" Diam	14.7017	15.5504	B-2
341	6.1100	4.9210	11.4470	0.43	0.4585	12" Diam	14.0103	14.5747	
342	6.1100	4.9210	9.0884	0.54	0.5239	12" Diam	11.8119	11.5717	
343	6.1100	4.9210	2.9022	1.70	-----	12" Diam	6.2656	3.6952	
344	6.1100	4.9210	2.8959	1.70	-----	12" Diam	6.2656	3.6872	

345	6.1100	4.9210	2.8144	1.75	-----	12" Diam	6.2656	3.5834	
346	6.1100	4.9210	2.2095	2.23	-----	12" Diam	6.2656	2.8133	
347	6.1100	4.9210	2.6831	1.83	-----	12" Diam	6.2656	3.4162	
DITCH END7-11	6.1100	4.9210	16.4539	0.30	0.8815	Ditch	2.0206	-----	
398	0.0000	0.0000	1.2233	0.00	0.0000	8" Diam	0.0000	3.5044	
397	0.8100	0.6499	1.0297	0.63	0.5767	12" Diam	1.3855	1.3111	A-2-CB97
395	1.9500	1.7450	1.6479	1.06	-----	12" Diam	2.2218	2.0982	A-2-CB96
394	2.6400	2.3314	1.3192	1.77	-----	12" Diam	2.9684	1.6797	A-2-CB90
380	0.0000	0.0000	0.1979	0.00	0.0000	8" Diam	0.0000	0.5668	
382	0.9500	0.6485	1.2813	0.51	0.5034	12" Diam	1.6371	1.6314	A-4
389	0.9400	0.6464	2.0355	0.32	0.3872	12" Diam	2.3013	2.5917	A-1
388	0.9400	0.6464	2.0551	0.31	0.3853	12" Diam	2.3169	2.6166	
387	1.9500	1.2830	3.8024	0.34	0.3999	12" Diam	4.3747	4.8414	A-3
386	1.9500	1.2830	4.3878	0.29	0.3706	12" Diam	4.8458	5.5867	
384	1.9500	1.2830	3.2136	0.40	0.4390	12" Diam	3.8666	4.0917	
383	2.9000	1.9315	3.3984	0.57	0.5396	12" Diam	4.4688	4.3270	
392	6.0300	4.6916	3.3282	1.41	-----	12" Diam	5.9735	4.2377	A-2-CB88
376	7.5500	5.7101	4.2411	1.35	-----	12" Diam	7.2703	5.3999	A-5
377	7.5500	5.7101	14.3438	0.40	0.4390	12" Diam	17.2086	18.2631	
378	7.5500	5.7101	7.5325	0.76	0.6509	12" Diam	10.5497	9.5907	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							691.2500
B-556	E-556	0.0000	--na--	--na--	--na--	0.0000	704.5900
B-434	E-434	0.0000	--na--	--na--	--na--	0.0000	582.0000
B-528	E-528	0.0000	--na--	--na--	--na--	0.0000	704.5900
215	E-520	625.3956	0.5298	0.0034	------	624.8693	627.8900

No approach losses at node 213 because inverts and/or crowns are offset.							
214	215	628.4191	------	------	------	628.4191	630.8700
213	214	630.0178	0.4521	0.5405	------	630.1063	631.2700
1	213	637.6634	------	------	------	637.6635	639.6000
216	E-521	626.9921	0.3028	0.0431	------	626.3300	626.2300
508	216	648.2328	0.2534	0.2872	------	648.2665	704.5900
509	508	651.7464	0.0687	0.0011	0.0359	651.7148	652.4100
522	509	654.4600	0.2588	0.3336	------	654.5348	657.0000
226	522	659.6434	0.1859	0.0008	------	659.4583	661.1700
227	226	668.6216	0.1007	0.0010	------	668.5219	668.9400
223	227	685.3956	0.9055	1.1748	------	685.6649	692.6600
217	223	690.7941	0.4426	0.2654	------	690.6169	692.6600
218	217	692.1560	1.5087	0.5876	------	691.2349	693.2700
E-297	218	695.4325	--na--	--na--	--na--	695.4325	696.0000
20	509	653.9402	0.7076	0.9474	------	654.1800	657.0600
No approach losses at node 0 because inverts and/or crowns are offset.							
CB-B	20	654.8218	------	------	------	654.8218	656.9000
0	CB-B	663.4876	0.1463	0.0022	------	663.3436	665.9600
229	0	664.4217	0.0564	0.0693	------	664.4345	666.5900
228	229	669.7275	------	------	------	669.7275	671.0400
519	E-582	648.0062	0.3909	0.0542	------	647.6695	704.5900
518	519	650.7168	0.3682	0.0387	------	650.3873	656.5400
No approach losses at node CB-A because inverts and/or crowns are offset.							
516	518	653.0781	------	------	------	653.0781	661.0000
CB-A	516	660.5670	0.5020	0.1940	------	660.2590	664.0000
77	CB-A	664.6988	0.1185	0.1163	------	664.6966	668.0300
76	77	0.0000	------	------	------	0.0000	667.1100
64	77	665.3965	0.0945	0.0015	------	665.3035	667.4200
65	64	665.4639	0.2782	0.0360	------	665.2217	666.6700
66	65	665.6679	0.2628	0.0454	------	665.4505	666.9600
63	66	0.0000	------	------	------	0.0000	667.5300
62	66	667.1484	------	------	------	667.1484	704.5900
No approach losses at node 177 because inverts and/or crowns are offset.							
488	End 13	553.2169	------	------	------	553.2169	558.4800
517	488	0.0000	------	------	------	0.0000	660.5000
177	488	575.0849	1.0250	0.1625	------	574.2224	575.4100
179	177	586.0900	1.0250	0.1777	------	585.2427	586.7600
182	179	600.4378	0.1654	0.1079	------	600.3803	601.1100
185	182	609.7956	0.1654	0.1306	------	609.7609	611.7100
187	185	611.6943	0.0738	0.0425	------	611.6630	613.3300

No approach losses at node 190 because inverts and/or crowns are offset.							
188	187	614.2974	------	------	------	614.2974	617.3600
190	188	618.0799	2.1239	0.0395	------	615.9954	621.3000
No approach losses at node 195 because inverts and/or crowns are offset.							
194	190	634.3891	------	------	------	634.3891	638.7800
195	194	646.0020	0.7695	0.0088	------	645.2413	648.2900
196	195	647.7724	0.6981	0.0128	------	647.0872	650.6000
No approach losses at node 199 because inverts and/or crowns are offset.							
198	196	650.1745	------	------	------	650.1745	652.8100
No approach losses at node 202 because inverts and/or crowns are offset.							
199	198	654.1528	------	------	------	654.1528	655.7400
No approach losses at node 203 because inverts and/or crowns are offset.							
202	199	656.7575	------	------	------	656.7575	656.7800
203	202	656.9681	0.1813	0.0013	------	656.7880	660.8800
204	203	659.0885	------	------	------	659.0885	661.8100
C-29	C-28	626.4532	--na--	--na--	--na--	626.4532	626.5600
C-154	C-29	629.8104	--na--	--na--	--na--	629.8104	631.0900
13	C-154	632.4430	0.3549	0.0030	------	632.0911	704.5900
234	13	634.8294	0.3549	0.0018	------	634.4762	639.0200
233	234	640.0358	0.3549	0.0015	------	639.6824	644.0300
232	233	646.3825	0.3549	0.0022	------	646.0298	648.8100
231	232	649.5536	------	------	------	649.5536	652.3000
No approach losses at node C-60 because inverts and/or crowns are offset.							
230	231	0.0000	------	------	------	0.0000	652.8900
C-60	230	0.0000	--na--	--na--	--na--	0.0000	663.8600
End 7	End 12	609.1115	--na--	--na--	--na--	609.1115	675.5700
93	End 7	611.4444	0.6096	0.1499	------	610.9847	613.7700
94	93	614.5429	0.6096	0.2616	------	612.2700	612.1700
99	94	616.3636	0.6096	0.2025	------	612.5300	612.4300
100	99	615.2534	0.6096	0.1069	------	613.1000	613.0000
101	100	614.7800	0.6096	0.2740	------	613.4700	613.3700
189	101	618.3140	0.6096	0.5344	------	618.2388	619.3100
191	189	627.1650	0.6096	0.0317	------	626.5871	627.8700
No approach losses at node 13 because inverts and/or crowns are offset.							
192	191	638.0279	------	------	------	638.0279	638.1700
205	192	663.4032	0.6570	0.0065	------	662.7527	665.5700
206	205	664.9268	0.2229	0.3018	------	665.0057	666.3000
72	206	665.9459	0.2229	0.0035	------	665.7266	666.6300
70	72	666.7015	------	------	------	666.7015	667.1300
11	End 12	608.8612	0.8208	0.8956	------	608.7000	608.6000

92	11	632.7628	0.8208	0.0094	------	631.9515	648.6200
ɔ approach losses at node 88 because inverts and/or crowns are offset.							
SDMH-10	92	647.3724	------	------	------	647.3724	648.3200
88	SDMH-10	651.0243	0.1368	0.1598	0.0666	648.4100	648.3100
90	88	650.6759	0.0767	0.0004	------	647.4000	647.3000
96	90	648.9946	0.0106	0.0001	------	645.9700	645.8700
97	96	646.1133	------	------	------	645.2700	645.1700
98	97	0.0000	------	------	------	0.0000	645.2600
85	88	650.0847	0.0414	0.1130	0.0140	648.7200	648.6200
74	85	648.8818	------	------	------	648.2300	648.1300
75	74	0.0000	------	------	------	0.0000	648.0700
84	85	649.0546	0.0414	0.0034	------	649.0166	649.8900
82	84	653.7591	0.2972	0.0150	------	653.4769	656.3400
81	82	657.6655	0.0834	0.0081	------	657.5902	660.2000
79	81	658.6603	0.0822	0.0013	------	658.5794	661.0700
78	79	660.1905	------	------	------	660.1906	662.0100

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Appended on: 10:57:17 Monday, May 18, 2009

Warning, History file is now 2.09 MB in size

UPSIZED PIPES

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [25 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
556	0.0000	0.0000	9.1421	0.00	0.0000	12" Diam	0.0000	11.6401	
434	0.0000	0.0000	152.52	0.00	0.0000	54" Diam	0.0000	9.5898	
528	0.0000	0.0000	138.50	0.00	0.0000	36" Diam	0.0000	19.5938	
403	0.2500	0.1669	3.4002	0.05	0.1006	8" Diam	5.0395	9.7409	G-1
404	0.2500	0.1669	3.3583	0.05	0.1012	8" Diam	4.9926	9.6207	
405	1.3600	0.6625	6.6312	0.10	0.2134	12" Diam	5.4013	8.4432	G-2
520	2.4700	1.1680	6.5824	0.18	0.2852	12" Diam	6.3248	8.3810	G-2
297	2.2500	1.5274	9.9040	0.15	0.2651	12" Diam	9.1582	12.6101	F-3
298	2.2500	1.5274	4.2542	0.36	0.4146	12" Diam	4.9646	5.4166	
299	2.2500	1.5274	6.9334	0.22	0.3188	12" Diam	7.0849	8.8279	
300	2.2500	1.5274	12.7869	0.12	0.2329	12" Diam	10.9951	16.2808	
301	3.2700	2.0802	8.4838	0.25	0.3374	12" Diam	8.9275	10.8019	F-4
566	3.9600	2.4881	10.0941	0.25	0.3384	12" Diam	10.6358	12.8522	F-5
565	4.6500	2.8960	10.6844	0.27	0.5336	18" Diam	5.1394	6.0461	F-5
302	2.3700	1.1480	6.0837	0.19	0.2944	12" Diam	5.9457	7.7460	F-2
303	3.7300	1.8526	7.5359	0.25	0.3374	12" Diam	7.9504	9.5950	F-1
0-B	3.7300	1.8526	11.3416	0.16	0.2729	12" Diam	10.6645	14.4405	
B-20	3.7300	1.8526	5.4731	0.34	0.4009	12" Diam	6.2963	6.9686	
564	4.9300	2.6454	22.5820	0.12	0.3468	18" Diam	8.5523	12.7788	F-6
563	9.5800	5.5415	19.7323	0.28	0.5438	18" Diam	9.5832	11.1662	

562	10.3300	6.0737	23.9859	0.25	0.5145	18" Diam	11.3262	13.5733	F-7
521	10.3300	6.0737	8.7829	0.69	0.6118	12" Diam	12.0612	11.1827	
323	0.0000	0.0000	7.8204	0.00	0.0000	12" Diam	0.0000	9.9572	
319	0.0000	0.0000	2.1267	0.00	0.0000	8" Diam	0.0000	6.0926	
318	1.5800	0.7584	3.9366	0.19	0.2974	12" Diam	3.8742	5.0122	D-1
320	1.5800	0.7584	4.0800	0.19	0.2925	12" Diam	3.9644	5.1948	
321	1.5800	0.7584	1.9567	0.39	0.4321	12" Diam	2.3333	2.4913	
322	1.5800	0.7584	2.2770	0.33	0.3975	12" Diam	2.6072	2.8991	
Pipe A	1.5800	0.7584	6.1793	0.12	0.2368	12" Diam	5.3321	7.8677	
Pipe B	1.5800	0.7584	6.6067	0.11	0.2290	12" Diam	5.5918	8.4120	
580	1.5800	0.7584	15.6160	0.05	0.2252	18" Diam	4.5562	8.8368	
581	1.5800	0.7584	16.2876	0.05	0.2201	18" Diam	4.7110	9.2169	
582	1.5800	0.7584	16.1366	0.05	0.2216	18" Diam	4.6658	9.1315	
612	0.0000	0.0000	2.7172	0.00	0.0000	6" Diam	0.0000	13.8388	
326	0.1600	0.1346	6.2619	0.02	0.1011	12" Diam	3.2416	7.9728	C-1
327	0.1600	0.1346	6.8887	0.02	0.0972	12" Diam	3.4347	8.7709	
328	0.1600	0.1346	8.1996	0.02	0.0894	12" Diam	3.8852	10.4401	
329	1.1800	0.6653	4.2534	0.16	0.1781	8" Diam	8.8837	12.1852	C-2
332	2.2000	1.3908	6.1364	0.23	0.3237	12" Diam	6.3174	7.8131	C-3
333	2.2000	1.3908	6.5605	0.21	0.3130	12" Diam	6.6183	8.3531	
447	2.2000	1.3908	10.4960	0.13	0.2456	12" Diam	9.2874	13.3639	
338	2.2000	1.3908	13.3659	0.10	0.2183	12" Diam	10.9792	17.0179	
339	2.2000	1.3908	7.0416	0.20	0.3013	12" Diam	6.9773	8.9656	
340	2.2000	1.3908	5.4983	0.25	0.3433	12" Diam	5.8298	7.0007	
						12"			

446	3.2100	2.0671	6.0132	0.34	0.4048	Diam	6.9351	7.6563	C-4
349	3.2100	2.0671	10.4508	0.20	0.3013	12" Diam	10.3701	13.3064	
354	8.4100	5.0602	10.0660	0.50	0.5015	12" Diam	12.8378	12.8165	C-5
356	8.4100	5.0602	12.1146	0.42	0.4507	12" Diam	14.7329	15.4248	
358	8.4100	5.0602	12.6392	0.40	0.4399	12" Diam	15.2056	16.0927	
555	9.5100	5.8020	19.7141	0.29	0.5577	18" Diam	9.6963	11.1559	C-6
305	0.0000	0.0000	9.3956	0.00	0.0000	12" Diam	0.0000	11.9628	
306	0.0000	0.0000	5.0756	0.00	0.0000	12" Diam	0.0000	6.4624	
307	27.3200	6.1280	13.8760	0.44	0.6976	18" Diam	7.6117	7.8522	E-1
308	27.3200	6.1280	23.6349	0.26	0.5211	18" Diam	11.2306	13.3746	
309	27.3200	6.1280	22.4156	0.27	0.5358	18" Diam	10.8146	12.6846	
310	27.3200	6.1280	20.9785	0.29	0.5555	18" Diam	10.2960	11.8714	
311	27.3200	6.1280	14.2476	0.43	0.6874	18" Diam	7.7595	8.0625	
DITCH C154-C29	27.3200	6.1280	56.7127	0.11	0.5746	Ditch	3.9156	-----	
312	27.3200	6.1280	19.3289	0.32	0.5804	18" Diam	9.7051	10.9379	
317	3.7400	2.3655	1.4149	1.67	-----	12" Diam	3.0119	1.8015	B-1
324	3.7400	2.3655	2.4601	0.96	0.7866	12" Diam	3.5693	3.1323	
325	3.7400	2.3655	4.8638	0.49	0.4917	12" Diam	6.1538	6.1928	
DITCH 205-192	3.7400	2.3655	51.1551	0.05	0.3871	Ditch	2.8276	-----	
337	6.1100	3.9243	12.2133	0.32	0.3901	12" Diam	13.8314	15.5504	B-2
341	6.1100	3.9243	11.4470	0.34	0.4038	12" Diam	13.2086	14.5747	
342	6.1100	3.9243	9.0884	0.43	0.4595	12" Diam	11.1418	11.5717	
343	6.1100	3.9243	8.5567	0.46	0.7130	18" Diam	4.7389	4.8421	
344	6.1100	3.9243	8.5382	0.46	0.7137	18" Diam	4.7326	4.8316	

345	6.1100	3.9243	8.2978	0.47	0.7262	18" Diam	4.6284	4.6956	
346	6.1100	3.9243	6.5145	0.60	0.8397	18" Diam	3.8556	3.6864	
347	6.1100	3.9243	7.9107	0.50	0.7467	18" Diam	4.4664	4.4765	
DITCH END7-11	6.1100	3.9243	16.4539	0.24	0.7943	Ditch	1.9086	-----	
398	0.0000	0.0000	1.2233	0.00	0.0000	8" Diam	0.0000	3.5044	
397	0.8100	0.5091	3.0360	0.17	0.4156	18" Diam	1.2752	1.7180	A-2-CB97
395	1.9500	1.3856	4.8587	0.29	0.5482	18" Diam	2.3702	2.7495	A-2-CB96
394	2.6400	1.8558	3.8895	0.48	0.7299	18" Diam	2.1747	2.2010	A-2-CB90
380	0.0000	0.0000	0.1979	0.00	0.0000	8" Diam	0.0000	0.5668	
382	0.9500	0.5096	1.2813	0.40	0.4385	12" Diam	1.5382	1.6314	A-4
389	0.9400	0.5096	2.0355	0.25	0.3413	12" Diam	2.1529	2.5917	A-1
388	0.9400	0.5096	2.0551	0.25	0.3394	12" Diam	2.1699	2.6166	
387	1.9500	1.0020	3.8024	0.26	0.3501	12" Diam	4.0886	4.8414	A-3
386	1.9500	1.0020	4.3878	0.23	0.3247	12" Diam	4.5326	5.5867	
384	1.9500	1.0020	3.2136	0.31	0.3833	12" Diam	3.6164	4.0917	
383	2.9000	1.5116	3.3984	0.44	0.4673	12" Diam	4.1989	4.3270	
392	6.0300	3.7107	9.8128	0.38	0.6390	18" Diam	5.1700	5.5529	A-2-CB88
376	7.5500	4.4951	4.2411	1.06	-----	12" Diam	5.7233	5.3999	A-5
377	7.5500	4.4951	14.3438	0.31	0.3843	12" Diam	16.1682	18.2631	
378	7.5500	4.4951	7.5325	0.60	0.5562	12" Diam	10.0172	9.5907	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							691.2500
B-556	E-556	0.0000	--na--	--na--	--na--	0.0000	704.5900
B-434	E-434	0.0000	--na--	--na--	--na--	0.0000	582.0000
B-528	E-528	0.0000	--na--	--na--	--na--	0.0000	704.5900
215	E-520	625.2804	0.4530	0.0029	------	624.8303	627.8900

No approach losses at node 213 because inverts and/or crowns are offset.							
214	215	628.3427	------	------	------	628.3427	630.8700
213	214	629.9846	0.3944	0.4715	------	630.0618	631.2700
1	213	637.6302	------	------	------	637.6302	639.6000
216	E-521	625.8561	0.1834	0.0261	------	625.6988	626.2300
508	216	647.9446	1.4260	1.6160	------	648.1346	704.5900
509	508	651.4690	0.4102	0.0068	0.2134	651.2790	652.4100
522	509	654.3103	1.7565	2.2643	------	654.8181	657.0000
226	522	659.3856	1.2376	0.0054	------	658.1534	661.1700
227	226	668.4173	1.8772	0.0187	------	666.5588	668.9400
223	227	685.2451	0.7794	1.0112	------	685.4769	692.6600
217	223	690.6437	0.3827	0.2295	------	690.4904	692.6600
218	217	692.0056	1.3024	0.5073	------	691.2104	693.2700
E-297	218	695.2994	--na--	--na--	--na--	695.2994	696.0000
20	509	653.7960	0.6156	0.8242	------	654.0046	657.0600
No approach losses at node 0 because inverts and/or crowns are offset.							
CB-B	20	654.6522	------	------	------	654.6522	656.9000
0	CB-B	663.3104	0.9815	0.0149	------	662.3438	665.9600
229	0	664.2444	0.5489	0.6741	------	664.3696	666.5900
228	229	669.6127	------	------	------	669.6127	671.0400
519	E-582	647.9531	0.3446	0.0478	------	647.6563	704.5900
518	519	650.6634	0.3223	0.0339	------	650.3749	656.5400
No approach losses at node CB-A because inverts and/or crowns are offset.							
516	518	653.0246	------	------	------	653.0247	661.0000
CB-A	516	660.5005	0.4415	0.1706	------	660.2296	664.0000
77	CB-A	664.6323	0.1056	0.1036	------	664.6303	668.0300
76	77	0.0000	------	------	------	0.0000	667.1100
64	77	665.3259	0.0845	0.0013	------	665.2427	667.4200
65	64	665.3872	0.2440	0.0316	------	665.1748	666.6700
66	65	665.6004	0.2331	0.0402	------	665.4075	666.9600
63	66	0.0000	------	------	------	0.0000	667.5300
62	66	667.0809	------	------	------	667.0809	704.5900
No approach losses at node 177 because inverts and/or crowns are offset.							
488	End 13	552.9663	------	------	------	552.9662	558.4800
517	488	0.0000	------	------	------	0.0000	660.5000
177	488	574.3695	0.6446	0.1022	------	573.8271	575.4100
179	177	585.3746	0.6446	0.1117	------	584.8417	586.7600
182	179	599.7224	0.1076	0.0702	------	599.6851	601.1100
185	182	609.6447	0.7468	0.5898	------	609.4877	611.7100
187	185	611.5433	0.5277	0.3041	------	611.3197	613.3300

No approach losses at node 190 because inverts and/or crowns are offset.							
188	187	614.1974	------	------	------	614.1974	617.3600
190	188	617.9798	1.8718	0.0348	------	616.1428	621.3000
No approach losses at node 195 because inverts and/or crowns are offset.							
194	190	634.2858	------	------	------	634.2858	638.7800
195	194	645.8987	0.6802	0.0078	------	645.2263	648.2900
196	195	647.6723	0.6197	0.0114	------	647.0640	650.6000
No approach losses at node 199 because inverts and/or crowns are offset.							
198	196	650.0745	------	------	------	650.0745	652.8100
No approach losses at node 202 because inverts and/or crowns are offset.							
199	198	654.0632	------	------	------	654.0632	655.7400
No approach losses at node 203 because inverts and/or crowns are offset.							
202	199	656.7354	------	------	------	656.7355	656.7800
203	202	656.9460	0.1632	0.0012	------	656.7841	660.8800
204	203	659.0665	------	------	------	659.0665	661.8100
C-29	C-28	626.0250	--na--	--na--	--na--	626.0250	626.5600
C-154	C-29	629.7078	--na--	--na--	--na--	629.7078	631.0900
13	C-154	632.0148	1.6461	0.0139	------	630.3827	704.5900
234	13	634.4012	1.8161	0.0090	------	632.5942	639.0200
233	234	639.6076	1.9585	0.0083	------	637.6575	644.0300
232	233	645.9544	0.8997	0.0055	------	645.0602	648.8100
231	232	649.1255	------	------	------	649.1255	652.3000
No approach losses at node C-60 because inverts and/or crowns are offset.							
230	231	0.0000	------	------	------	0.0000	652.8900
C-60	230	0.0000	--na--	--na--	--na--	0.0000	663.8600
End 7	End 12	609.0243	--na--	--na--	--na--	609.0243	675.5700
93	End 7	609.7604	0.2308	0.0568	------	609.5864	613.7700
94	93	610.3570	0.3326	0.1427	------	610.1671	612.1700
99	94	611.6306	0.3478	0.1155	------	611.3984	612.4300
100	99	612.3397	0.3487	0.0612	------	612.0521	613.0000
101	100	612.7597	1.9276	0.8665	------	611.6985	613.3700
189	101	617.8967	0.3877	0.3399	------	617.8489	619.3100
191	189	626.7477	0.3877	0.0201	------	626.3801	627.8700
No approach losses at node 13 because inverts and/or crowns are offset.							
192	191	637.6106	------	------	------	637.6106	638.1700
205	192	663.3571	0.5880	0.0058	------	662.7748	665.5700
206	205	664.7388	0.1409	0.1907	------	664.7887	666.3000
72	206	665.3829	0.1409	0.0022	------	665.2443	666.6300
70	72	665.8604	------	------	------	665.8604	667.1300
11	End 12	608.2742	0.5086	0.5550	------	608.3206	608.6000

92	11	632.1759	0.5086	0.0058	------	631.6730	648.6200
No approach losses at node 88 because inverts and/or crowns are offset.							
SDMH-10	92	641.3524	------	------	------	641.3524	648.3200
88	SDMH-10	641.6581	0.0734	0.0858	0.0353	641.7058	648.3100
90	88	642.0629	0.0872	0.0005	------	641.9762	647.3000
96	90	643.1488	0.0253	0.0003	------	643.1238	645.8700
97	96	643.3147	------	------	------	643.3147	645.1700
98	97	0.0000	------	------	------	0.0000	645.2600
85	88	645.9818	0.2031	0.5536	0.0688	646.4012	648.6200
74	85	646.5011	------	------	------	646.5012	648.1300
75	74	0.0000	------	------	------	0.0000	648.0700
84	85	647.5980	0.3190	0.0263	------	647.3054	649.8900
82	84	653.6661	0.2596	0.0131	------	653.4196	656.3400
81	82	657.5725	0.0731	0.0071	------	657.5065	660.2000
79	81	658.5991	0.0720	0.0012	------	658.5283	661.0700
78	79	660.1291	------	------	------	660.1292	662.0100

Licensed to: Professional License

Downtown East

- 5th Ave
- Lawson Street
- 6th Ave

Appended on: 07:20:47 Tuesday, May 26, 2009

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [10 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
587	0.0000	0.0000	75.5158	0.00	0.0000	36" Diam	0.0000	10.6833	
586	0.0000	0.0000	69.7425	0.00	0.0000	36" Diam	0.0000	9.8665	
588	0.0000	0.0000	43.3034	0.00	0.0000	24" Diam	0.0000	13.7839	
373	0.0000	0.0000	140.55	0.00	0.0000	36" Diam	0.0000	19.8838	
584	0.0000	0.0000	74.7136	0.00	0.0000	36" Diam	0.0000	10.5698	
471	0.0000	0.0000	73.9363	0.00	0.0000	36" Diam	0.0000	10.4599	
472	0.0000	0.0000	73.9363	0.00	0.0000	36" Diam	0.0000	10.4599	
283	11.9400	3.9030	5.1444	0.76	0.8142	15" Diam	4.6111	4.1921	F-4
Ditch C122-C52	11.9400	3.9030	29.6796	0.13	0.6010	Ditch	2.9496	-----	
287	11.9400	3.9030	5.6992	0.68	0.7596	15" Diam	5.0006	4.6441	
Ditch C50-C51	11.9400	3.9030	13.3730	0.29	0.8712	Ditch	1.6336	-----	
286	11.9400	3.9030	9.3981	0.42	0.5618	15" Diam	7.2986	7.6582	
Ditch C49-C48	11.9400	3.9030	37.2027	0.10	0.5387	Ditch	3.4877	-----	
285	11.9400	3.9030	8.2659	0.47	0.6046	15" Diam	6.6374	6.7357	
Ditch C47-C138	11.9400	3.9030	25.3286	0.15	0.6478	Ditch	2.6244	-----	
284	11.9400	3.9030	7.0169	0.56	0.6662	15" Diam	5.8688	5.7179	
Ditch C139-CB61	11.9400	3.9030	24.5577	0.16	0.5760	Ditch	1.6318	-----	
CB61-C46	11.9400	3.9030	4.9963	0.78	0.6646	12" Diam	7.0423	6.3614	
263	3.2400	1.6456	9.7028	0.17	0.2788	12" Diam	9.1958	12.3540	F-2
264	3.2400	1.6456	3.7245	0.44	0.3102	8" Diam	10.3407	10.6699	
265	3.2400	1.6456	10.6214	0.15	0.2661	12" Diam	9.8159	13.5236	
270	3.2400	1.6456	7.6958	0.21	0.3140	12" Diam	7.7972	9.7986	
						12"			

257	12.7600	3.2741	7.9216	0.41	0.4478	Diam	9.6143	10.0860	F-1
Ditch C147-C146	12.7600	3.2741	100.71	0.03	0.3618	Ditch	3.3224	-----	
258	12.7600	3.2741	18.1883	0.18	0.3592	15" Diam	11.2266	14.8212	
259	12.7600	3.2741	16.1520	0.20	0.3818	15" Diam	10.3148	13.1618	
260	12.7600	3.2741	8.4292	0.39	0.4331	12" Diam	10.0432	10.7324	
261	12.7600	3.2741	9.9866	0.33	0.3940	12" Diam	11.3866	12.7154	
262	12.7600	3.2741	9.9807	0.33	0.3940	12" Diam	11.3866	12.7078	
266	12.7600	3.2741	9.5995	0.34	0.4028	12" Diam	11.0558	12.2225	
267	12.7600	3.2741	10.3111	0.32	0.3872	12" Diam	11.6571	13.1285	
268	12.7600	3.2741	9.7863	0.33	0.3979	12" Diam	11.2373	12.4603	
269	12.7600	3.2741	10.6598	0.31	0.3804	12" Diam	11.9397	13.5725	
271	20.9700	7.3610	56.4112	0.13	0.4878	24" Diam	12.4105	17.9562	F-3
Ditch C143-C46	20.9700	7.3610	56.1127	0.13	0.5475	Ditch	4.3442	-----	
473	33.1300	11.3789	27.6617	0.41	0.9976	Ditch	5.7034	-----	F-5
474	33.1300	11.3789	39.4475	0.29	0.7358	24" Diam	10.8507	12.5565	
Ditch C145-C45	33.1300	11.3789	162.92	0.07	0.3900	Ditch	10.4947	-----	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							533.0200
B-587	E-587	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-586	E-586	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-588	E-588	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-373	E-373	0.0000	--na--	--na--	--na--	0.0000	558.0000
B-584	E-584	0.0000	--na--	--na--	--na--	0.0000	560.5000
B-471	E-471	0.0000	--na--	--na--	--na--	0.0000	663.0000
C-44	C-45	0.0000	--na--	--na--	--na--	0.0000	662.9900
60	C-45	661.8116	1.8282	0.0629	------	660.0462	665.5100
C-144	60	664.2017	--na--	--na--	--na--	664.2017	668.8900
C-46	C-144	666.8915	--na--	--na--	--na--	666.8915	675.7100
No approach losses at node C-139 because inverts and/or crowns are offset.							
61	C-46	675.2628	------	------	------	675.2628	736.9900

C-139	61	678.3860	--na--	--na--	--na--	678.3860	679.3100
C-138	C-139	679.3967	--na--	--na--	--na--	679.3967	689.8600
C-47	C-138	679.9378	--na--	--na--	--na--	679.9378	691.6400
C-48	C-47	681.0725	--na--	--na--	--na--	681.0725	693.2400
C-49	C-48	682.1875	--na--	--na--	--na--	682.1875	693.2400
C-50	C-49	684.4495	--na--	--na--	--na--	684.4495	696.4800
C-51	C-50	684.4532	--na--	--na--	--na--	684.4532	684.7600
C-52	C-51	685.7163	--na--	--na--	--na--	685.7163	696.4800
C-122	C-52	687.0809	--na--	--na--	--na--	687.0809	687.1200
C-123	C-122	687.8114	--na--	--na--	--na--	687.8115	687.9800
C-143	C-46	673.6376	--na--	--na--	--na--	673.6376	693.2400
No approach losses at node 58 because inverts and/or crowns are offset.							
59	C-143	692.3396	------	------	------	692.3397	695.0500
No approach losses at node 54 because inverts and/or crowns are offset.							
57	59	697.3156	------	------	------	697.3156	700.6200
54	57	718.6834	0.3451	0.0183	------	718.3566	737.4500
53	54	728.7544	0.0682	0.0017	------	728.6879	751.5600
49	53	742.3219	------	------	------	742.3219	743.0500
58	59	697.5930	0.2699	0.0135	------	697.3366	714.9100
56	58	706.1199	0.2699	0.0024	------	705.8524	726.4000
55	56	717.6058	0.2699	0.0028	------	717.3388	718.7200
52	55	728.2013	0.2699	0.0133	------	727.9448	729.6300
51	52	736.8126	0.2699	0.0051	------	736.5478	751.6900
50	51	743.0126	0.2699	0.0074	------	742.7502	763.8200
40	50	755.0396	0.1105	0.0034	------	754.9324	767.2900
39	40	758.3571	1.9571	0.0367	------	756.4368	771.5400
C-146	39	762.5983	--na--	--na--	--na--	762.5983	763.2900
C-147	C-146	766.3214	--na--	--na--	--na--	766.3214	767.8200
C-148	C-147	770.0907	--na--	--na--	--na--	770.0907	770.2500

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Appended on: 07:21:10 Tuesday, May 26, 2009

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [25 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
587	0.0000	0.0000	75.5158	0.00	0.0000	36" Diam	0.0000	10.6833	
586	0.0000	0.0000	69.7425	0.00	0.0000	36" Diam	0.0000	9.8665	
588	0.0000	0.0000	43.3034	0.00	0.0000	24" Diam	0.0000	13.7839	
373	0.0000	0.0000	140.55	0.00	0.0000	36" Diam	0.0000	19.8838	
584	0.0000	0.0000	74.7136	0.00	0.0000	36" Diam	0.0000	10.5698	
471	0.0000	0.0000	73.9363	0.00	0.0000	36" Diam	0.0000	10.4599	
472	0.0000	0.0000	73.9363	0.00	0.0000	36" Diam	0.0000	10.4599	
283	11.9400	4.8238	5.1444	0.94	0.9610	15" Diam	4.7648	4.1921	F-4
Ditch C122-C52	11.9400	4.8238	29.6796	0.16	0.6643	Ditch	3.1183	-----	
287	11.9400	4.8238	5.6992	0.85	0.8823	15" Diam	5.2102	4.6441	
Ditch C50-C51	11.9400	4.8238	13.3730	0.36	0.9591	Ditch	1.7235	-----	
286	11.9400	4.8238	9.3981	0.51	0.6345	15" Diam	7.7129	7.6582	
Ditch C49-C48	11.9400	4.8238	37.2027	0.13	0.5966	Ditch	3.6870	-----	
285	11.9400	4.8238	8.2659	0.58	0.6857	15" Diam	6.9973	6.7357	
Ditch C47-C138	11.9400	4.8238	25.3286	0.19	0.7159	Ditch	2.7706	-----	
284	11.9400	4.8238	7.0169	0.69	0.7614	15" Diam	6.1627	5.7179	
Ditch C139-CB61	11.9400	4.8238	24.5577	0.20	0.6464	Ditch	1.7385	-----	
CB61-C46	11.9400	4.8238	4.9963	0.97	0.7905	12" Diam	7.2437	6.3614	
263	3.2400	1.9789	9.7028	0.20	0.3062	12" Diam	9.7088	12.3540	F-2
264	3.2400	1.9789	3.7245	0.53	0.3454	8" Diam	10.8396	10.6699	
265	3.2400	1.9789	10.6214	0.19	0.2925	12" Diam	10.3443	13.5236	
270	3.2400	1.9789	7.6958	0.26	0.3462	12" Diam	8.1992	9.7986	
						12"			

257	12.7600	3.9972	7.9216	0.50	0.5024	Diam	10.1159	10.0860	F-1
Ditch C147-C146	12.7600	3.9972	100.71	0.04	0.4038	Ditch	3.5257	-----	
258	12.7600	3.9972	18.1883	0.22	0.3983	15" Diam	11.8785	14.8212	
259	12.7600	3.9972	16.1520	0.25	0.4239	15" Diam	10.9031	13.1618	
260	12.7600	3.9972	8.4292	0.47	0.4849	12" Diam	10.5868	10.7324	
261	12.7600	3.9972	9.9866	0.40	0.4399	12" Diam	12.0113	12.7154	
262	12.7600	3.9972	9.9807	0.40	0.4399	12" Diam	12.0113	12.7078	
266	12.7600	3.9972	9.5995	0.42	0.4497	12" Diam	11.6710	12.2225	
267	12.7600	3.9972	10.3111	0.39	0.4321	12" Diam	12.2977	13.1285	
268	12.7600	3.9972	9.7863	0.41	0.4448	12" Diam	11.8388	12.4603	
269	12.7600	3.9972	10.6598	0.37	0.4243	12" Diam	12.5973	13.5725	
271	20.9700	8.8330	56.4112	0.16	0.5347	24" Diam	13.0878	17.9562	F-3
Ditch C143-C46	20.9700	8.8330	56.1127	0.16	0.6024	Ditch	4.5752	-----	
473	33.1300	13.7919	27.6617	0.50	1.1538	Ditch	5.9767	-----	F-5
474	33.1300	13.7919	39.4475	0.35	0.8159	24" Diam	11.4482	12.5565	
Ditch C145-C45	33.1300	13.7919	162.92	0.08	0.4332	Ditch	11.1062	-----	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							533.0200
B-587	E-587	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-586	E-586	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-588	E-588	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-373	E-373	0.0000	--na--	--na--	--na--	0.0000	558.0000
B-584	E-584	0.0000	--na--	--na--	--na--	0.0000	560.5000
B-471	E-471	0.0000	--na--	--na--	--na--	0.0000	663.0000
C-44	C-45	0.0000	--na--	--na--	--na--	0.0000	662.9900
60	C-45	661.8958	2.0351	0.0700	------	659.9307	665.5100
C-144	60	664.4731	--na--	--na--	--na--	664.4731	668.8900
C-46	C-144	667.0438	--na--	--na--	--na--	667.0438	675.7100
No approach losses at node C-139 because inverts and/or crowns are offset.							
61	C-46	675.6431	------	------	------	675.6431	736.9900

C-139	61	678.4564	--na--	--na--	--na--	678.4564	679.3100
C-138	C-139	679.6088	--na--	--na--	--na--	679.6088	689.8600
C-47	C-138	680.0059	--na--	--na--	--na--	680.0059	691.6400
C-48	C-47	681.2739	--na--	--na--	--na--	681.2739	693.2400
C-49	C-48	682.2505	--na--	--na--	--na--	682.2505	693.2400
C-50	C-49	684.6510	--na--	--na--	--na--	684.6509	696.4800
C-51	C-50	684.6536	--na--	--na--	--na--	684.6536	684.7600
C-52	C-51	685.1134	--na--	--na--	--na--	685.1134	696.4800
C-122	C-52	687.1443	--na--	--na--	--na--	687.2200	687.1200
C-123	C-122	688.3358	--na--	--na--	--na--	688.0800	687.9800
C-143	C-46	673.7020	--na--	--na--	--na--	673.7020	693.2400
No approach losses at node 58 because inverts and/or crowns are offset.							
59	C-143	692.5086	------	------	------	692.5086	695.0500
No approach losses at node 54 because inverts and/or crowns are offset.							
57	59	697.4175	------	------	------	697.4175	700.6200
54	57	718.7892	0.4990	0.0265	------	718.3167	737.4500
53	54	729.1490	0.0986	0.0024	------	729.0528	751.5600
49	53	742.4238	------	------	------	742.4238	743.0500
58	59	697.8418	0.4022	0.0201	------	697.4598	714.9100
56	58	706.3688	0.4022	0.0035	------	705.9701	726.4000
55	56	717.8547	0.4022	0.0042	------	717.4567	718.7200
52	55	728.4502	0.4022	0.0198	------	728.0678	729.6300
51	52	737.1518	0.4022	0.0075	------	736.7572	751.6900
50	51	743.3518	0.4022	0.0110	------	742.9607	763.8200
40	50	755.2885	0.1647	0.0050	------	755.1288	767.2900
39	40	758.5213	0.1647	0.0031	------	758.3596	771.5400
C-146	39	762.7624	--na--	--na--	--na--	762.7624	763.2900
C-147	C-146	766.3692	--na--	--na--	--na--	766.3692	767.8200
C-148	C-147	770.4299	--na--	--na--	--na--	770.3500	770.2500

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Appended on: 07:21:30 Tuesday, May 26, 2009

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [100 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
587	0.0000	0.0000	75.5158	0.00	0.0000	36" Diam	0.0000	10.6833	
586	0.0000	0.0000	69.7425	0.00	0.0000	36" Diam	0.0000	9.8665	
588	0.0000	0.0000	43.3034	0.00	0.0000	24" Diam	0.0000	13.7839	
373	0.0000	0.0000	140.55	0.00	0.0000	36" Diam	0.0000	19.8838	
584	0.0000	0.0000	74.7136	0.00	0.0000	36" Diam	0.0000	10.5698	
471	0.0000	0.0000	73.9363	0.00	0.0000	36" Diam	0.0000	10.4599	
472	0.0000	0.0000	73.9363	0.00	0.0000	36" Diam	0.0000	10.4599	
283	11.9400	6.3150	5.1444	1.23	-----	15" Diam	5.1459	4.1921	F-4
Ditch C122-C52	11.9400	6.3150	29.6796	0.21	0.7533	Ditch	3.3444	-----	
287	11.9400	6.3150	5.6992	1.11	-----	15" Diam	5.1459	4.6441	
Ditch C50-C51	11.9400	6.3150	13.3730	0.47	1.0822	Ditch	1.8442	-----	
286	11.9400	6.3150	9.3981	0.67	0.7498	15" Diam	8.2165	7.6582	
Ditch C49-C48	11.9400	6.3150	37.2027	0.17	0.6779	Ditch	3.9547	-----	
285	11.9400	6.3150	8.2659	0.76	0.8182	15" Diam	7.4192	6.7357	
Ditch C47-C138	11.9400	6.3150	25.3286	0.25	0.8112	Ditch	2.9688	-----	
284	11.9400	6.3150	7.0169	0.90	0.9268	15" Diam	6.4726	5.7179	
Ditch C139-CB61	11.9400	6.3150	24.5577	0.26	0.7474	Ditch	1.8797	-----	
CB61-C46	11.9400	6.3150	4.9963	1.26	-----	12" Diam	8.0405	6.3614	
263	3.2400	2.5110	9.7028	0.26	0.3472	12" Diam	10.3639	12.3540	F-2
264	3.2400	2.5110	3.7245	0.67	0.4007	8" Diam	11.4579	10.6699	
265	3.2400	2.5110	10.6214	0.24	0.3306	12" Diam	11.0827	13.5236	
270	3.2400	2.5110	7.6958	0.33	0.3931	12" Diam	8.7617	9.7986	
						12"			

257	12.7600	5.1632	7.9216	0.65	0.5884	Diam	10.7430	10.0860	F-1
Ditch C147-C146	12.7600	5.1632	100.71	0.05	0.4644	Ditch	3.7966	-----	
258	12.7600	5.1632	18.1883	0.28	0.4556	15" Diam	12.7646	14.8212	
259	12.7600	5.1632	16.1520	0.32	0.4855	15" Diam	11.7155	13.1618	
260	12.7600	5.1632	8.4292	0.61	0.5659	12" Diam	11.2630	10.7324	
261	12.7600	5.1632	9.9866	0.52	0.5103	12" Diam	12.8135	12.7154	
262	12.7600	5.1632	9.9807	0.52	0.5103	12" Diam	12.8135	12.7078	
266	12.7600	5.1632	9.5995	0.54	0.5220	12" Diam	12.4516	12.2225	
267	12.7600	5.1632	10.3111	0.50	0.5005	12" Diam	13.1318	13.1285	
268	12.7600	5.1632	9.7863	0.53	0.5161	12" Diam	12.6300	12.4603	
269	12.7600	5.1632	10.6598	0.48	0.4907	12" Diam	13.4662	13.5725	
271	20.9700	11.1943	56.4112	0.20	0.6040	24" Diam	13.9926	17.9562	F-3
Ditch C143-C46	20.9700	11.1943	56.1127	0.20	0.6815	Ditch	4.8841	-----	
473	33.1300	17.6766	27.6617	0.64	1.3979	Ditch	6.3223	-----	F-5
474	33.1300	17.6766	39.4475	0.45	0.9380	24" Diam	12.2173	12.5565	
Ditch C145-C45	33.1300	17.6766	162.92	0.11	0.4948	Ditch	11.9512	-----	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							533.0200
B-587	E-587	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-586	E-586	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-588	E-588	0.0000	--na--	--na--	--na--	0.0000	550.0000
B-373	E-373	0.0000	--na--	--na--	--na--	0.0000	558.0000
B-584	E-584	0.0000	--na--	--na--	--na--	0.0000	560.5000
B-471	E-471	0.0000	--na--	--na--	--na--	0.0000	663.0000
C-44	C-45	0.0000	--na--	--na--	--na--	0.0000	662.9900
60	C-45	662.0152	2.3177	0.0797	------	659.7772	665.5100
C-144	60	664.9542	--na--	--na--	--na--	664.9542	668.8900
C-46	C-144	667.2880	--na--	--na--	--na--	667.2880	675.7100
No approach losses at node C-139 because inverts and/or crowns are offset.							
61	C-46	676.6715	------	------	------	676.6714	736.9900

C-139	61	678.5574	--na--	--na--	--na--	678.5574	679.3100
C-138	C-139	680.0451	--na--	--na--	--na--	680.0451	689.8600
C-47	C-138	680.1011	--na--	--na--	--na--	680.1011	691.6400
C-48	C-47	681.5480	--na--	--na--	--na--	681.5480	693.2400
C-49	C-48	682.3384	--na--	--na--	--na--	682.3384	693.2400
C-50	C-49	684.9250	--na--	--na--	--na--	684.9250	696.4800
C-51	C-50	0.0000	--na--	--na--	--na--	684.8600	684.7600
C-52	C-51	685.6480	--na--	--na--	--na--	685.6480	696.4800
C-122	C-52	687.2333	--na--	--na--	--na--	687.2200	687.1200
C-123	C-122	689.1323	--na--	--na--	--na--	688.0800	687.9800
C-143	C-46	673.7950	--na--	--na--	--na--	673.7950	693.2400
No approach losses at node 58 because inverts and/or crowns are offset.							
59	C-143	692.7741	------	------	------	692.7741	695.0500
No approach losses at node 54 because inverts and/or crowns are offset.							
57	59	697.5792	------	------	------	697.5792	700.6200
54	57	718.9586	0.8035	0.0427	------	718.1978	737.4500
53	54	729.9293	0.1587	0.0039	------	729.7744	751.5600
49	53	742.5855	------	------	------	742.5855	743.0500
58	59	698.3475	0.6711	0.0336	------	697.7100	714.9100
56	58	706.8744	0.6711	0.0059	------	706.2092	726.4000
55	56	718.3603	0.6711	0.0071	------	717.6964	718.7200
52	55	728.9559	0.6711	0.0330	------	728.3177	729.6300
51	52	737.8410	0.6711	0.0126	------	737.1826	751.6900
50	51	744.0410	0.6711	0.0184	------	743.3884	763.8200
40	50	755.7941	0.2749	0.0084	------	755.5276	767.2900
39	40	758.7989	0.2749	0.0052	------	758.5292	771.5400
C-146	39	763.0400	--na--	--na--	--na--	763.0400	763.2900
C-147	C-146	766.4376	--na--	--na--	--na--	766.4376	767.8200
C-148	C-147	771.1191	--na--	--na--	--na--	770.3500	770.2500

Licensed to: Professional License

Morgan Creek Subdivision

- Kanasket Drive
- Cumberland Way
- Cumberland Place
- Palmer Place
- Selleck Place

Appended on: 07:30:15 Tuesday, May 26, 2009

Warning, History file is now 0.63 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [10 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
597	0.0000	0.0000	345.21	0.00	0.0000	8'0" x 4'2"	0.0000	13.1424	
17	0.0000	0.0000	7.4470	0.00	0.0000	12" Diam	0.0000	9.4818	
16	0.0000	0.0000	11.1160	0.00	0.0000	12" Diam	0.0000	14.1533	
32	0.0000	0.0000	9.5052	0.00	0.0000	12" Diam	0.0000	12.1024	
15	0.0000	0.0000	6.2703	0.00	0.0000	12" Diam	0.0000	7.9836	
6	0.0000	0.0000	3.3272	0.00	0.0000	12" Diam	0.0000	4.2364	
13	0.0000	0.0000	6.1971	0.00	0.0000	12" Diam	0.0000	7.8904	
4	0.0000	0.0000	3.4721	0.00	0.0000	12" Diam	0.0000	4.4208	
5	0.0000	0.0000	5.2617	0.00	0.0000	12" Diam	0.0000	6.6995	
7	0.0000	0.0000	4.3618	0.00	0.0000	12" Diam	0.0000	5.5537	
8	0.0000	0.0000	4.2010	0.00	0.0000	12" Diam	0.0000	5.3489	
9	0.0000	0.0000	9.2774	0.00	0.0000	12" Diam	0.0000	11.8123	
10	2.4200	1.2194	10.4887	0.12	0.2300	12" Diam	8.9366	13.3546	I
11	2.4200	1.2194	10.0994	0.12	0.2349	12" Diam	8.6744	12.8589	
12	2.4200	1.2194	6.7032	0.18	0.2886	12" Diam	6.4946	8.5348	
14	6.0700	2.8047	3.4751	0.81	0.6812	12" Diam	4.9223	4.4247	A
29	6.0700	2.8047	4.2115	0.67	0.5962	12" Diam	5.7440	5.3622	
24	0.0000	0.0000	10.7913	0.00	0.0000	12" Diam	0.0000	13.7398	
23	0.0000	0.0000	6.5335	0.00	0.0000	12" Diam	0.0000	8.3187	
22	0.0000	0.0000	4.6471	0.00	0.0000	12" Diam	0.0000	5.9169	
21	0.0000	0.0000	3.5152	0.00	0.0000	12" Diam	0.0000	4.4757	
25	1.3800	0.7675	3.4162	0.22	0.3218	12" Diam	3.5152	4.3497	F
26	1.3800	0.7675	3.7561	0.20	0.3071	12" Diam	3.7488	4.7824	
27	1.3800	0.7675	4.4724	0.17	0.2808	12" Diam	4.2471	5.6944	
28	6.5900	3.3994	1.0319	3.29	-----	12" Diam	4.3283	1.3138	G
34	0.0000	0.0000	7.0952	0.00	0.0000	12" Diam	0.0000	9.0339	
36	0.0000	0.0000	8.1726	0.00	0.0000	12" Diam	0.0000	10.4057	
38	0.0000	0.0000	8.3852	0.00	0.0000	12" Diam	0.0000	10.6764	
40	0.0000	0.0000	7.6591	0.00	0.0000	12" Diam	0.0000	9.7519	
42	0.0000	0.0000	7.2403	0.00	0.0000	12" Diam	0.0000	9.2186	
44	0.0000	0.0000	7.9523	0.00	0.0000	12" Diam	0.0000	10.1252	
46	0.0000	0.0000	6.1868	0.00	0.0000	12" Diam	0.0000	7.8772	
45	3.4700	1.7833	7.3040	0.24	0.3364	12" Diam	7.6836	9.2997	D
43	3.4700	1.7833	4.0095	0.44	0.4673	12" Diam	4.9535	5.1050	
41	3.4700	1.7833	4.1802	0.43	0.4565	12" Diam	5.1054	5.3224	

39	7.0900	3.6896	5.6879	0.65	0.5864	12" Diam	7.7076	7.2420	E
37	7.0900	3.6896	7.9682	0.46	0.4780	12" Diam	9.9520	10.1454	
35	7.0900	3.6896	9.9254	0.37	0.4224	12" Diam	11.6989	12.6374	
33	7.0900	3.6896	11.0540	0.33	0.3979	12" Diam	12.6632	14.0744	
30	13.6800	7.0890	7.1002	1.00	0.8179	12" Diam	10.3094	9.0402	
20	19.7500	9.8937	11.2951	0.88	1.0880	18" Diam	7.2066	6.3917	
19	23.4000	11.4791	6.0774	1.89	-----	18" Diam	6.4958	3.4391	A
18	23.4000	11.4791	10.8655	1.06	-----	18" Diam	6.4958	6.1486	
527	23.4000	11.4791	21.9905	0.52	0.7694	18" Diam	12.5773	12.4441	
1	0.0000	0.0000	10.0412	0.00	0.0000	12" Diam	0.0000	12.7848	
192	0.0000	0.0000	6.5335	0.00	0.0000	12" Diam	0.0000	8.3187	
62	0.0000	0.0000	4.1967	0.00	0.0000	12" Diam	0.0000	5.3434	
60	0.0000	0.0000	4.1802	0.00	0.0000	12" Diam	0.0000	5.3224	
56	0.0000	0.0000	5.9418	0.00	0.0000	12" Diam	0.0000	7.5653	
55	0.0000	0.0000	5.5486	0.00	0.0000	12" Diam	0.0000	7.0647	
57	0.0000	0.0000	6.4657	0.00	0.0000	12" Diam	0.0000	8.2324	
58	3.2900	1.4995	2.8326	0.53	0.5171	12" Diam	3.6593	3.6066	B
53	0.0000	0.0000	8.1333	0.00	0.0000	12" Diam	0.0000	10.3557	
51	0.0000	0.0000	7.2263	0.00	0.0000	12" Diam	0.0000	9.2008	
48	0.0000	0.0000	3.7053	0.00	0.0000	12" Diam	0.0000	4.7178	
47	3.6500	1.5854	3.1030	0.51	0.5063	12" Diam	3.9729	3.9508	A
49	3.6500	1.5854	7.6624	0.21	0.3091	12" Diam	7.6763	9.7561	
50	3.6500	1.5854	9.6677	0.16	0.2739	12" Diam	9.0808	12.3093	
52	3.6500	1.5854	9.3768	0.17	0.2778	12" Diam	8.9028	11.9390	
54	3.6500	1.5854	5.9011	0.27	0.3540	12" Diam	6.3719	7.5135	
59	6.9400	3.0849	3.9892	0.77	0.6606	12" Diam	5.6034	5.0792	
61	9.9600	4.6611	5.7651	0.81	0.6821	12" Diam	8.1671	7.3403	C
0	9.9600	4.6611	6.6665	0.70	0.7700	15" Diam	5.8767	5.4323	
3	9.9600	4.6611	7.9290	0.59	0.6888	15" Diam	6.7242	6.4611	
2	9.9600	4.6611	8.4495	0.55	0.6625	15" Diam	7.0571	6.8853	
248 Outlet	9.9600	4.6611	22.5730	0.21	0.3854	15" Diam	14.4916	18.3941	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							628.8800
B-597	E-597	0.0000	--na--	--na--	--na--	0.0000	639.0000
292	E-527	643.8743	0.6552	1.1361	------	644.3552	647.8900
290	292	646.3354	0.6552	0.0027	------	645.6829	647.0700
291	290	0.0000	------	------	------	0.0000	647.1100
288	290	647.8958	0.4867	0.0080	------	647.4171	648.8600
289	288	0.0000	------	------	------	0.0000	648.8200

No approach losses at node 286 because inverts and/or crowns are offset.							
284	288	649.4969	------	------	------	649.4969	652.2500
287	284	0.0000	------	------	------	0.0000	653.4600
282	284	650.3331	0.1980	0.0285	------	650.1635	650.9290
283	282	0.0000	------	------	------	0.0000	650.9400
481	282	651.5668	0.0374	0.1067	------	651.6360	652.8600
238	481	0.0000	------	------	------	0.0000	652.1900
237	481	0.0000	------	------	------	0.0000	652.3900
245	481	0.0000	------	------	------	0.0000	655.7600
246	245	0.0000	------	------	------	0.0000	669.1800
239	481	651.7167	0.0374	0.0218	------	253.0100	252.9100
240	239	656.9402	1.2401	0.3113	------	656.0114	660.0000
242	240	665.2975	------	------	------	665.2974	668.3600
241	242	0.0000	------	------	------	0.0000	668.4000
243	242	0.0000	------	------	------	0.0000	676.5000
244	243	0.0000	------	------	------	0.0000	677.1600
No approach losses at node 281 because inverts and/or crowns are offset.							
286	284	652.3902	------	------	------	652.0900	651.9900
No approach losses at node 296 because inverts and/or crowns are offset.							
294	286	654.0666	------	------	------	654.0666	656.3100
293	294	0.0000	------	------	------	0.0000	655.9300
296	294	654.5317	0.2182	0.0125	------	654.3260	658.0300
295	296	0.0000	------	------	------	0.0000	658.0700
297	296	655.9437	0.1919	0.0019	------	655.7538	659.5300
298	297	0.0000	------	------	------	0.0000	659.6700
300	297	657.2145	------	------	------	657.2145	660.9800
299	300	0.0000	------	------	------	0.0000	660.9100
281	286	663.6136	0.3427	0.2652	------	663.5361	666.5400
280	281	0.0000	------	------	------	0.0000	666.5700
279	281	676.4915	0.3427	0.0127	------	676.1615	679.2000
278	279	0.0000	------	------	------	0.0000	679.1900
276	279	682.3532	0.3427	0.0125	------	682.0229	685.0900
277	276	0.0000	------	------	------	0.0000	685.2000
275	276	685.7436	0.0801	0.0004	------	685.6639	688.6100
272	275	0.0000	------	------	------	0.0000	688.5600
274	275	687.0152	0.3810	0.0086	------	686.6428	690.1200
271	274	0.0000	------	------	------	0.0000	690.0000
273	274	688.7358	0.9167	0.0380	------	687.8571	691.9200
270	273	0.0000	------	------	------	0.0000	691.9800
269	273	699.2633	------	------	------	699.2633	701.7600

268	269	0.0000	------	------	------	0.0000	701.7700
248	E-248	657.6036	0.2240	0.0141	------	657.3936	661.2400
247	248	658.2392	0.2240	0.1547	------	658.1699	661.3200
249	247	660.5602	0.2240	0.0074	------	660.3436	666.3800
250	249	0.0000	------	------	------	0.0000	666.3900
258	249	662.3726	0.5469	0.6704	------	662.4961	668.9800
259	258	0.0000	------	------	------	0.0000	668.0200
475	259	0.0000	------	------	------	0.0000	667.9200
256	258	665.2874	0.2396	0.0074	------	665.0552	667.4300
257	256	0.0000	------	------	------	0.0000	667.4800
255	256	666.3252	0.0633	0.0015	0.0337	666.2971	669.1900
254	255	666.4491	------	------	------	666.4491	668.7400
253	254	0.0000	------	------	------	0.0000	668.9100
No approach losses at node 252 because inverts and/or crowns are offset.							
251	254	0.0000	------	------	------	0.0000	671.7800
252	251	0.0000	------	------	------	0.0000	671.8100
260	255	670.7285	1.2307	0.0600	------	669.5577	673.9300
261	260	0.0000	------	------	------	0.0000	673.9500
262	260	688.4108	1.2805	0.0078	------	687.1382	691.6300
263	262	0.0000	------	------	------	0.0000	691.6400
264	262	698.0389	0.9150	0.3415	------	697.4655	701.0500
No approach losses at node 267 because inverts and/or crowns are offset.							
265	264	703.1705	------	------	------	703.1705	705.8100
266	265	0.0000	------	------	------	0.0000	705.7100
267	265	704.9070	------	------	------	704.9070	706.2300

Appended on: 07:32:26 Tuesday, May 26, 2009

Warning, History file is now 0.66 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [25 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
597	0.0000	0.0000	345.21	0.00	0.0000	8'0" x 4'2"	0.0000	13.1424	
17	0.0000	0.0000	7.4470	0.00	0.0000	12" Diam	0.0000	9.4818	
16	0.0000	0.0000	11.1160	0.00	0.0000	12" Diam	0.0000	14.1533	
32	0.0000	0.0000	9.5052	0.00	0.0000	12" Diam	0.0000	12.1024	
15	0.0000	0.0000	6.2703	0.00	0.0000	12" Diam	0.0000	7.9836	
6	0.0000	0.0000	3.3272	0.00	0.0000	12" Diam	0.0000	4.2364	
13	0.0000	0.0000	6.1971	0.00	0.0000	12" Diam	0.0000	7.8904	
4	0.0000	0.0000	3.4721	0.00	0.0000	12" Diam	0.0000	4.4208	
5	0.0000	0.0000	5.2617	0.00	0.0000	12" Diam	0.0000	6.6995	
7	0.0000	0.0000	4.3618	0.00	0.0000	12" Diam	0.0000	5.5537	
8	0.0000	0.0000	4.2010	0.00	0.0000	12" Diam	0.0000	5.3489	
9	0.0000	0.0000	9.2774	0.00	0.0000	12" Diam	0.0000	11.8123	
10	2.4200	1.4656	10.4887	0.14	0.2524	12" Diam	9.4150	13.3546	I
11	2.4200	1.4656	10.0994	0.15	0.2573	12" Diam	9.1645	12.8589	
12	2.4200	1.4656	6.7032	0.22	0.3179	12" Diam	6.8267	8.5348	
14	6.0700	3.4217	3.4751	0.98	0.8062	12" Diam	5.0432	4.4247	A
29	6.0700	3.4217	4.2115	0.81	0.6841	12" Diam	5.9764	5.3622	
24	0.0000	0.0000	10.7913	0.00	0.0000	12" Diam	0.0000	13.7398	
23	0.0000	0.0000	6.5335	0.00	0.0000	12" Diam	0.0000	8.3187	
22	0.0000	0.0000	4.6471	0.00	0.0000	12" Diam	0.0000	5.9169	
21	0.0000	0.0000	3.5152	0.00	0.0000	12" Diam	0.0000	4.4757	
25	1.3800	0.9084	3.4162	0.27	0.3521	12" Diam	3.6785	4.3497	F
26	1.3800	0.9084	3.7561	0.24	0.3345	12" Diam	3.9452	4.7824	
27	1.3800	0.9084	4.4724	0.20	0.3062	12" Diam	4.4566	5.6944	
28	6.5900	4.0767	1.0319	3.95	-----	12" Diam	5.1906	1.3138	G
34	0.0000	0.0000	7.0952	0.00	0.0000	12" Diam	0.0000	9.0339	
36	0.0000	0.0000	8.1726	0.00	0.0000	12" Diam	0.0000	10.4057	
38	0.0000	0.0000	8.3852	0.00	0.0000	12" Diam	0.0000	10.6764	
40	0.0000	0.0000	7.6591	0.00	0.0000	12" Diam	0.0000	9.7519	
42	0.0000	0.0000	7.2403	0.00	0.0000	12" Diam	0.0000	9.2186	
44	0.0000	0.0000	7.9523	0.00	0.0000	12" Diam	0.0000	10.1252	
46	0.0000	0.0000	6.1868	0.00	0.0000	12" Diam	0.0000	7.8772	
45	3.4700	2.1409	7.3040	0.29	0.3706	12" Diam	8.0862	9.2997	D
43	3.4700	2.1409	4.0095	0.53	0.5200	12" Diam	5.1875	5.1050	
41	3.4700	2.1409	4.1802	0.51	0.5073	12" Diam	5.3520	5.3224	

39	7.0900	4.4194	5.6879	0.78	0.6626	12" Diam	8.0005	7.2420	E
37	7.0900	4.4194	7.9682	0.55	0.5317	12" Diam	10.4128	10.1454	
35	7.0900	4.4194	9.9254	0.45	0.4673	12" Diam	12.2758	12.6374	
33	7.0900	4.4194	11.0540	0.40	0.4399	12" Diam	13.2799	14.0744	
30	13.6800	8.4961	7.1002	1.20	-----	12" Diam	10.8175	9.0402	
20	19.7500	11.9177	11.2951	1.06	-----	18" Diam	6.7441	6.3917	
19	23.4000	13.8738	6.0774	2.28	-----	18" Diam	7.8510	3.4391	A
18	23.4000	13.8738	10.8655	1.28	-----	18" Diam	7.8510	6.1486	
527	23.4000	13.8738	21.9905	0.63	0.8646	18" Diam	13.1526	12.4441	
1	0.0000	0.0000	10.0412	0.00	0.0000	12" Diam	0.0000	12.7848	
192	0.0000	0.0000	6.5335	0.00	0.0000	12" Diam	0.0000	8.3187	
62	0.0000	0.0000	4.1967	0.00	0.0000	12" Diam	0.0000	5.3434	
60	0.0000	0.0000	4.1802	0.00	0.0000	12" Diam	0.0000	5.3224	
56	0.0000	0.0000	5.9418	0.00	0.0000	12" Diam	0.0000	7.5653	
55	0.0000	0.0000	5.5486	0.00	0.0000	12" Diam	0.0000	7.0647	
57	0.0000	0.0000	6.4657	0.00	0.0000	12" Diam	0.0000	8.2324	
58	3.2900	1.8362	2.8326	0.65	0.5864	12" Diam	3.8358	3.6066	B
53	0.0000	0.0000	8.1333	0.00	0.0000	12" Diam	0.0000	10.3557	
51	0.0000	0.0000	7.2263	0.00	0.0000	12" Diam	0.0000	9.2008	
48	0.0000	0.0000	3.7053	0.00	0.0000	12" Diam	0.0000	4.7178	
47	3.6500	1.9561	3.1030	0.63	0.5757	12" Diam	4.1789	3.9508	A
49	3.6500	1.9561	7.6624	0.26	0.3442	12" Diam	8.1676	9.7561	
50	3.6500	1.9561	9.6677	0.20	0.3052	12" Diam	9.6396	12.3093	
52	3.6500	1.9561	9.3768	0.21	0.3101	12" Diam	9.4302	11.9390	
54	3.6500	1.9561	5.9011	0.33	0.3960	12" Diam	6.7580	7.5135	
59	6.9400	3.7923	3.9892	0.95	0.7788	12" Diam	5.7783	5.0792	
61	9.9600	5.6791	5.7651	0.99	0.8062	12" Diam	8.3705	7.3403	C
0	9.9600	5.6791	6.6665	0.85	0.8865	15" Diam	6.1020	5.4323	
3	9.9600	5.6791	7.9290	0.72	0.7828	15" Diam	7.0226	6.4611	
2	9.9600	5.6791	8.4495	0.67	0.7504	15" Diam	7.3820	6.8853	
248 Outlet	9.9600	5.6791	22.5730	0.25	0.4276	15" Diam	15.3097	18.3941	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							628.8800
B-597	E-597	0.0000	--na--	--na--	--na--	0.0000	639.0000
292	E-527	644.4420	0.9571	1.6596	------	645.1445	647.8900
290	292	648.0371	0.9571	0.0040	------	647.1700	647.0700
291	290	0.0000	------	------	------	0.0000	647.1100
288	290	650.4025	0.7062	0.0116	------	648.9600	648.8600
289	288	0.0000	------	------	------	0.0000	648.8200

No approach losses at node 286 because inverts and/or crowns are offset.							
284	288	651.9778	------	------	------	651.9778	652.2500
287	284	0.0000	------	------	------	0.0000	653.4600
282	284	653.2223	0.2947	0.0423	------	651.0290	650.9290
283	282	0.0000	------	------	------	0.0000	650.9400
481	282	653.1176	0.0541	0.1541	------	652.9600	652.8600
238	481	0.0000	------	------	------	0.0000	652.1900
237	481	0.0000	------	------	------	0.0000	652.3900
245	481	0.0000	------	------	------	0.0000	655.7600
246	245	0.0000	------	------	------	0.0000	669.1800
239	481	653.0765	0.0541	0.0314	------	253.0100	252.9100
240	239	657.0187	1.3764	0.3455	------	655.9878	660.0000
242	240	665.3760	------	------	------	665.3760	668.3600
241	242	0.0000	------	------	------	0.0000	668.4000
243	242	0.0000	------	------	------	0.0000	676.5000
244	243	0.0000	------	------	------	0.0000	677.1600
No approach losses at node 281 because inverts and/or crowns are offset.							
286	284	656.1337	------	------	------	652.0900	651.9900
No approach losses at node 296 because inverts and/or crowns are offset.							
294	286	654.9327	------	------	------	654.9327	656.3100
293	294	0.0000	------	------	------	0.0000	655.9300
296	294	655.0430	0.0208	0.0012	------	655.0234	658.0300
295	296	0.0000	------	------	------	0.0000	658.0700
297	296	655.9946	0.2101	0.0021	------	655.7866	659.5300
298	297	0.0000	------	------	------	0.0000	659.6700
300	297	657.2654	------	------	------	657.2654	660.9800
299	300	0.0000	------	------	------	0.0000	660.9100
281	286	663.8938	0.4916	0.3805	------	663.7826	666.5400
280	281	0.0000	------	------	------	0.0000	666.5700
279	281	676.7717	0.4916	0.0182	------	676.2982	679.2000
278	279	0.0000	------	------	------	0.0000	679.1900
276	279	682.6333	0.4916	0.0179	------	682.1595	685.0900
277	276	0.0000	------	------	------	0.0000	685.2000
275	276	686.0237	0.1154	0.0005	------	685.9089	688.6100
272	275	0.0000	------	------	------	0.0000	688.5600
274	275	687.1240	0.4179	0.0094	------	686.7156	690.1200
271	274	0.0000	------	------	------	0.0000	690.0000
273	274	688.8446	0.1154	0.0048	------	688.7339	691.9200
270	273	0.0000	------	------	------	0.0000	691.9800
269	273	699.3721	------	------	------	699.3721	701.7600

268	269	0.0000	------	------	------	0.0000	701.7700
248	E-248	657.7657	0.3326	0.0209	------	657.4540	661.2400
247	248	658.4013	0.3326	0.2297	------	658.2985	661.3200
249	247	660.7223	0.3326	0.0110	------	660.4008	666.3800
250	249	0.0000	------	------	------	0.0000	666.3900
258	249	662.5347	0.8119	0.9952	------	662.7180	668.9800
259	258	0.0000	------	------	------	0.0000	668.0200
475	259	0.0000	------	------	------	0.0000	667.9200
256	258	665.7857	0.3620	0.0112	------	665.4348	667.4300
257	256	0.0000	------	------	------	0.0000	667.4800
255	256	666.5055	0.0963	0.0023	0.0510	666.4626	669.1900
254	255	666.6905	------	------	------	666.6904	668.7400
253	254	0.0000	------	------	------	0.0000	668.9100
No approach losses at node 252 because inverts and/or crowns are offset.							
251	254	0.0000	------	------	------	0.0000	671.7800
252	251	0.0000	------	------	------	0.0000	671.8100
260	255	670.8421	1.3809	0.0673	------	669.5286	673.9300
261	260	0.0000	------	------	------	0.0000	673.9500
262	260	688.5244	1.4429	0.0088	------	687.0903	691.6300
263	262	0.0000	------	------	------	0.0000	691.6400
264	262	698.1525	1.0359	0.3866	------	697.5033	701.0500
No approach losses at node 267 because inverts and/or crowns are offset.							
265	264	703.2841	------	------	------	703.2841	705.8100
266	265	0.0000	------	------	------	0.0000	705.7100
267	265	705.0206	------	------	------	705.0206	706.2300

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Appended on: 07:32:48 Tuesday, May 26, 2009

Warning, History file is now 0.69 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [100 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
597	0.0000	0.0000	345.21	0.00	0.0000	8'0" x 4'2"	0.0000	13.1424	
17	0.0000	0.0000	7.4470	0.00	0.0000	12" Diam	0.0000	9.4818	
16	0.0000	0.0000	11.1160	0.00	0.0000	12" Diam	0.0000	14.1533	
32	0.0000	0.0000	9.5052	0.00	0.0000	12" Diam	0.0000	12.1024	
15	0.0000	0.0000	6.2703	0.00	0.0000	12" Diam	0.0000	7.9836	
6	0.0000	0.0000	3.3272	0.00	0.0000	12" Diam	0.0000	4.2364	
13	0.0000	0.0000	6.1971	0.00	0.0000	12" Diam	0.0000	7.8904	
4	0.0000	0.0000	3.4721	0.00	0.0000	12" Diam	0.0000	4.4208	
5	0.0000	0.0000	5.2617	0.00	0.0000	12" Diam	0.0000	6.6995	
7	0.0000	0.0000	4.3618	0.00	0.0000	12" Diam	0.0000	5.5537	
8	0.0000	0.0000	4.2010	0.00	0.0000	12" Diam	0.0000	5.3489	
9	0.0000	0.0000	9.2774	0.00	0.0000	12" Diam	0.0000	11.8123	
10	2.4200	1.8585	10.4887	0.18	0.2847	12" Diam	10.0886	13.3546	I
11	2.4200	1.8585	10.0994	0.18	0.2905	12" Diam	9.8063	12.8589	
12	2.4200	1.8585	6.7032	0.28	0.3599	12" Diam	7.3051	8.5348	
14	6.0700	4.4140	3.4751	1.27	-----	12" Diam	5.6201	4.4247	A
29	6.0700	4.4140	4.2115	1.05	-----	12" Diam	5.6201	5.3622	
24	0.0000	0.0000	10.7913	0.00	0.0000	12" Diam	0.0000	13.7398	
23	0.0000	0.0000	6.5335	0.00	0.0000	12" Diam	0.0000	8.3187	
22	0.0000	0.0000	4.6471	0.00	0.0000	12" Diam	0.0000	5.9169	
21	0.0000	0.0000	3.5152	0.00	0.0000	12" Diam	0.0000	4.4757	
25	1.3800	1.1324	3.4162	0.33	0.3960	12" Diam	3.9123	4.3497	F
26	1.3800	1.1324	3.7561	0.30	0.3765	12" Diam	4.1874	4.7824	
27	1.3800	1.1324	4.4724	0.25	0.3433	12" Diam	4.7467	5.6944	
28	6.5900	5.1573	1.0319	5.00	-----	12" Diam	6.5665	1.3138	G
34	0.0000	0.0000	7.0952	0.00	0.0000	12" Diam	0.0000	9.0339	
36	0.0000	0.0000	8.1726	0.00	0.0000	12" Diam	0.0000	10.4057	
38	0.0000	0.0000	8.3852	0.00	0.0000	12" Diam	0.0000	10.6764	
40	0.0000	0.0000	7.6591	0.00	0.0000	12" Diam	0.0000	9.7519	
42	0.0000	0.0000	7.2403	0.00	0.0000	12" Diam	0.0000	9.2186	
44	0.0000	0.0000	7.9523	0.00	0.0000	12" Diam	0.0000	10.1252	
46	0.0000	0.0000	6.1868	0.00	0.0000	12" Diam	0.0000	7.8772	
45	3.4700	2.7116	7.3040	0.37	0.4224	12" Diam	8.5979	9.2997	D
43	3.4700	2.7116	4.0095	0.68	0.6030	12" Diam	5.4780	5.1050	
41	3.4700	2.7116	4.1802	0.65	0.5864	12" Diam	5.6645	5.3224	

39	7.0900	5.5830	5.6879	0.98	0.8032	12" Diam	8.2570	7.2420	E
37	7.0900	5.5830	7.9682	0.70	0.6167	12" Diam	10.9829	10.1454	
35	7.0900	5.5830	9.9254	0.56	0.5366	12" Diam	13.0052	12.6374	
33	7.0900	5.5830	11.0540	0.51	0.5034	12" Diam	14.0942	14.0744	
30	13.6800	10.7403	7.1002	1.51	-----	12" Diam	13.6750	9.0402	
20	19.7500	15.1543	11.2951	1.34	-----	18" Diam	8.5756	6.3917	
19	23.4000	17.7098	6.0774	2.91	-----	18" Diam	10.0217	3.4391	A
18	23.4000	17.7098	10.8655	1.63	-----	18" Diam	10.0217	6.1486	
527	23.4000	17.7098	21.9905	0.81	1.0199	18" Diam	13.8412	12.4441	
1	0.0000	0.0000	10.0412	0.00	0.0000	12" Diam	0.0000	12.7848	
192	0.0000	0.0000	6.5335	0.00	0.0000	12" Diam	0.0000	8.3187	
62	0.0000	0.0000	4.1967	0.00	0.0000	12" Diam	0.0000	5.3434	
60	0.0000	0.0000	4.1802	0.00	0.0000	12" Diam	0.0000	5.3224	
56	0.0000	0.0000	5.9418	0.00	0.0000	12" Diam	0.0000	7.5653	
55	0.0000	0.0000	5.5486	0.00	0.0000	12" Diam	0.0000	7.0647	
57	0.0000	0.0000	6.4657	0.00	0.0000	12" Diam	0.0000	8.2324	
58	3.2900	2.3782	2.8326	0.84	0.7017	12" Diam	4.0393	3.6066	B
53	0.0000	0.0000	8.1333	0.00	0.0000	12" Diam	0.0000	10.3557	
51	0.0000	0.0000	7.2263	0.00	0.0000	12" Diam	0.0000	9.2008	
48	0.0000	0.0000	3.7053	0.00	0.0000	12" Diam	0.0000	4.7178	
47	3.6500	2.5555	3.1030	0.82	0.6909	12" Diam	4.4146	3.9508	A
49	3.6500	2.5555	7.6624	0.33	0.3979	12" Diam	8.7709	9.7561	
50	3.6500	2.5555	9.6677	0.26	0.3511	12" Diam	10.3880	12.3093	
52	3.6500	2.5555	9.3768	0.27	0.3569	12" Diam	10.1566	11.9390	
54	3.6500	2.5555	5.9011	0.43	0.4604	12" Diam	7.2355	7.5135	
59	6.9400	4.9337	3.9892	1.24	-----	12" Diam	6.2817	5.0792	
61	9.9600	7.3157	5.7651	1.27	-----	12" Diam	9.3146	7.3403	C
0	9.9600	7.3157	6.6665	1.10	-----	15" Diam	5.9614	5.4323	
3	9.9600	7.3157	7.9290	0.92	0.9470	15" Diam	7.3343	6.4611	
2	9.9600	7.3157	8.4495	0.87	0.8981	15" Diam	7.7513	6.8853	
248 Outlet	9.9600	7.3157	22.5730	0.32	0.4892	15" Diam	16.4329	18.3941	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							628.8800
B-597	E-597	0.0000	--na--	--na--	--na--	0.0000	639.0000
292	E-527	645.5749	1.5595	2.7042	------	646.7195	647.8900
290	292	651.4328	1.5595	0.0065	------	647.1700	647.0700
291	290	0.0000	------	------	------	0.0000	647.1100
288	290	652.4372	1.1419	0.0187	------	648.9600	648.8600
289	288	0.0000	------	------	------	0.0000	648.8200

No approach losses at node 286 because inverts and/or crowns are offset.							
284	288	653.8396	------	------	------	652.3500	652.2500
287	284	0.0000	------	------	------	0.0000	653.4600
282	284	654.4211	0.4905	0.0705	------	651.0290	650.9290
283	282	0.0000	------	------	------	0.0000	650.9400
481	282	654.5047	0.0870	0.2478	------	652.9600	652.8600
238	481	0.0000	------	------	------	0.0000	652.1900
237	481	0.0000	------	------	------	0.0000	652.3900
245	481	0.0000	------	------	------	0.0000	655.7600
246	245	0.0000	------	------	------	0.0000	669.1800
239	481	653.1473	0.0870	0.0506	------	253.0100	252.9100
240	239	657.1400	1.5804	0.3967	------	655.9562	660.0000
242	240	665.4973	------	------	------	665.4973	668.3600
241	242	0.0000	------	------	------	0.0000	668.4000
243	242	0.0000	------	------	------	0.0000	676.5000
244	243	0.0000	------	------	------	0.0000	677.1600
No approach losses at node 281 because inverts and/or crowns are offset.							
286	284	658.9914	------	------	------	652.0900	651.9900
No approach losses at node 296 because inverts and/or crowns are offset.							
294	286	656.6395	------	------	------	656.4100	656.3100
293	294	0.0000	------	------	------	0.0000	655.9300
296	294	656.5814	0.0323	0.0018	------	656.5510	658.0300
295	296	0.0000	------	------	------	0.0000	658.0700
297	296	656.7224	0.0323	0.0003	------	656.6904	659.5300
298	297	0.0000	------	------	------	0.0000	659.6700
300	297	657.3418	------	------	------	657.3418	660.9800
299	300	0.0000	------	------	------	0.0000	660.9100
281	286	664.4447	0.7846	0.6072	------	664.2672	666.5400
280	281	0.0000	------	------	------	0.0000	666.5700
279	281	677.3226	0.7846	0.0291	------	676.5670	679.2000
278	279	0.0000	------	------	------	0.0000	679.1900
276	279	683.1843	0.7846	0.0285	------	682.4282	685.0900
277	276	0.0000	------	------	------	0.0000	685.2000
275	276	686.5747	0.1851	0.0009	------	686.3904	688.6100
272	275	0.0000	------	------	------	0.0000	688.5600
274	275	687.2981	0.1851	0.0042	------	687.1172	690.1200
271	274	0.0000	------	------	------	0.0000	690.0000
273	274	689.0186	0.1851	0.0077	------	688.8412	691.9200
270	273	0.0000	------	------	------	0.0000	691.9800
269	273	699.5462	------	------	------	699.5461	701.7600

268	269	0.0000	------	------	------	0.0000	701.7700
248	E-248	658.1780	0.5518	0.0346	------	657.6608	661.2400
247	248	658.8136	0.5518	0.3812	------	658.6430	661.3200
249	247	661.1347	0.5518	0.0183	------	660.6012	666.3800
250	249	0.0000	------	------	------	0.0000	666.3900
258	249	663.3824	1.3472	1.6514	------	663.6866	668.9800
259	258	0.0000	------	------	------	0.0000	668.0200
475	259	0.0000	------	------	------	0.0000	667.9200
256	258	669.0542	0.6127	0.0189	------	667.5300	667.4300
257	256	0.0000	------	------	------	0.0000	667.4800
255	256	670.3449	0.1644	0.0040	0.0866	669.2900	669.1900
254	255	669.6722	------	------	------	668.8400	668.7400
253	254	0.0000	------	------	------	0.0000	668.9100
No approach losses at node 252 because inverts and/or crowns are offset.							
251	254	0.0000	------	------	------	0.0000	671.7800
252	251	0.0000	------	------	------	0.0000	671.8100
260	255	671.0244	0.1644	0.0080	------	670.8680	673.9300
261	260	0.0000	------	------	------	0.0000	673.9500
262	260	688.7066	0.1644	0.0010	------	688.5433	691.6300
263	262	0.0000	------	------	------	0.0000	691.6400
264	262	698.3348	1.1945	0.4458	------	697.5861	701.0500
No approach losses at node 267 because inverts and/or crowns are offset.							
265	264	703.4664	------	------	------	703.4664	705.8100
266	265	0.0000	------	------	------	0.0000	705.7100
267	265	705.1838	------	------	------	705.1838	706.2300

Lake Sawyer East

- 225th Ave SE
- 233rd Ave SE
- 234th Ave SE
- 289th Street
- 291st Street
- 293rd Street

Appended on: 07:28:40 Tuesday, May 26, 2009

'arning, History file is now 0.80 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [10 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
537	0.0000	0.0000	54.5962	0.00	0.0000	72" Diam	0.0000	1.9309	
538	0.0000	0.0000	----	0.00	0.0000	72" Diam	0.0000	0.0000	
539	0.0000	0.0000	207.90	0.00	0.0000	72" Diam	0.0000	7.3528	
542	0.0000	0.0000	104.33	0.00	0.0000	48" Diam	0.0000	8.3026	
543	0.0000	0.0000	44.6618	0.00	0.0000	48" Diam	0.0000	3.5541	
144	5.6900	1.3927	6.5114	0.21	0.3140	12" Diam	6.5989	8.2906	B
152	3.6300	0.3554	4.3247	0.08	0.1938	12" Diam	3.3235	5.5063	C
150	3.6300	0.3554	5.2626	0.07	0.1763	12" Diam	3.8099	6.7005	
147	6.1800	0.4699	5.1140	0.09	0.2046	12" Diam	4.0682	6.5114	A
149	6.1800	0.4699	4.4142	0.11	0.2202	12" Diam	3.6629	5.6204	
143	15.5000	2.1288	5.4562	0.39	0.4341	12" Diam	6.5106	6.9471	
141	15.5000	2.1288	4.7060	0.45	0.4722	12" Diam	5.8342	5.9919	
140	15.5000	2.1288	5.2341	0.41	0.5551	15" Diam	4.0439	4.2651	
156	2.0000	0.2921	5.6288	0.05	0.1548	12" Diam	3.7782	7.1668	E
159	0.0000	0.0000	2.9595	0.00	0.0000	12" Diam	0.0000	3.7682	
158	0.0000	0.0000	2.8659	0.00	0.0000	12" Diam	0.0000	3.6490	
157	0.0000	0.0000	2.7366	0.00	0.0000	12" Diam	0.0000	3.4843	
154	5.0500	0.9754	2.6092	0.37	0.4233	12" Diam	3.0832	3.3222	F
124	17.3400	2.1903	2.6515	0.83	0.6929	12" Diam	3.7721	3.3760	D
126	17.3400	2.1903	2.5643	0.85	0.7109	12" Diam	3.6677	3.2649	
128	17.3400	2.1903	3.0089	0.73	0.6333	12" Diam	4.1768	3.8311	
130	17.3400	2.1903	5.6136	0.39	0.5423	15" Diam	4.2904	4.5743	
132	17.3400	2.1903	4.6748	0.47	0.6015	15" Diam	3.7491	3.8094	
133	17.3400	2.1903	4.9071	0.45	0.5850	15" Diam	3.8860	3.9987	
135	17.3400	2.1903	5.3669	0.41	0.5563	15" Diam	4.1489	4.3734	
137	17.3400	2.1903	4.7935	0.46	0.5930	15" Diam	3.8189	3.9061	
138	17.3400	2.1903	7.0447	0.31	0.4788	15" Diam	5.0638	5.7406	
200	32.8400	4.3191	18.2531	0.24	0.4138	15" Diam	12.1759	14.8739	
167	0.0000	0.0000	10.4206	0.00	0.0000	15" Diam	0.0000	8.4915	
169	0.0000	0.0000	15.6485	0.00	0.0000	15" Diam	0.0000	12.7515	
170	0.0000	0.0000	9.3933	0.00	0.0000	15" Diam	0.0000	7.6543	
172	0.0000	0.0000	5.6547	0.00	0.0000	15" Diam	0.0000	4.6079	
174	0.0000	0.0000	8.6940	0.00	0.0000	15" Diam	0.0000	7.0845	
160	3.7900	0.0307	3.8308	0.01	0.0635	12" Diam	1.4664	4.8775	H
161	7.8500	0.0538	7.3330	0.01	0.0763	15" Diam	1.7458	5.9754	G

163	13.6400	0.6388	9.0985	0.07	0.2692	18" Diam	2.9662	5.1487	I
175	13.6400	0.6388	2.6436	0.24	0.4184	15" Diam	1.7737	2.1542	
176	13.6400	0.6388	3.7660	0.17	0.3482	15" Diam	2.2872	3.0688	
177	20.8900	0.7785	3.4752	0.22	0.4019	15" Diam	2.2844	2.8319	J
178	20.8900	0.7785	4.7308	0.16	0.3427	15" Diam	2.8503	3.8550	
186	0.0000	0.0000	5.4731	0.00	0.0000	12" Diam	0.0000	6.9686	
187	0.5200	0.0568	5.4405	0.01	0.0718	12" Diam	2.2657	6.9270	M
185	4.9700	0.3892	5.1537	0.08	0.1860	12" Diam	3.8614	6.5619	L
183	25.8600	1.1677	3.8923	0.30	0.4697	15" Diam	2.7708	3.1717	
182	25.8600	1.1677	4.5627	0.26	0.4312	15" Diam	3.1114	3.7181	
180	27.7400	1.3568	3.6613	0.37	0.5270	15" Diam	2.7597	2.9835	K
179	27.7400	1.3568	22.1101	0.06	0.2103	15" Diam	9.9584	18.0170	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							517.6700
B-537	E-537	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-538	E-538	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-539	E-539	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-542	E-542	0.0000	--na--	--na--	--na--	0.0000	527.0000
B-543	E-543	0.0000	--na--	--na--	--na--	0.0000	527.0000
423	E-200	539.3258	0.3982	0.3187	0.2159	539.4623	541.3000
No approach losses at node 416 because inverts and/or crowns are offset.							
418	423	539.7325	------	------	------	539.7325	542.8000
416	418	541.9035	0.1141	0.0101	------	541.7995	555.9200
415	416	545.0609	0.6762	0.8656	0.2580	545.5083	548.4800
409	415	546.6320	------	------	------	546.6320	549.9000
414	415	545.5175	0.1715	0.0007	------	545.3467	548.7400
422	414	547.7388	------	------	------	547.7388	551.9500
412	415	545.7827	0.2570	0.0041	------	545.5298	548.5800
420	412	548.0605	------	------	------	548.0604	552.3000
425	423	540.2443	0.2265	0.0084	------	540.0262	542.6100
426	425	540.9533	0.2673	0.0027	------	540.6887	545.8000
429	426	541.9970	0.2345	0.0221	------	541.7847	550.0700
430	429	542.6375	0.2183	0.0678	------	542.4871	552.4000
431	430	543.5782	0.2858	0.0163	------	543.3087	551.1900
434	431	544.7166	0.2709	0.0032	------	544.4490	549.2900
435	434	545.7192	0.1208	0.0011	------	545.5995	547.9800
438	435	546.4255	0.1208	0.0004	------	546.3052	550.6700
441	438	547.1143	0.0239	0.0002	------	547.0906	553.6600
No approach losses at node 439 because inverts and/or crowns are offset.							

442	441	547.3345	------	------	------	547.3345	554.6600
439	442	552.2914	------	------	------	552.2914	556.3500
444	442	0.0000	------	------	------	0.0000	553.2400
443	444	0.0000	------	------	------	0.0000	553.3100
446	443	0.0000	------	------	------	0.0000	551.4700
466	E-179	537.4202	0.1183	0.0715	------	537.3734	542.5000
468	466	538.0645	0.1503	0.0760	------	537.9902	547.4300
470	468	538.6464	0.1192	0.0355	------	538.5627	550.5800
471	470	539.0685	0.1261	0.1317	0.0422	539.1163	553.2200
465	471	539.7900	0.0810	0.0016	------	539.7105	550.2000
464	465	540.2832	0.0812	0.0024	------	540.2044	547.0200
No approach losses at node 460 because inverts and/or crowns are offset.							
463	464	540.8001	------	------	------	540.8000	550.7800
460	463	0.0000	------	------	------	0.0000	551.3800
459	460	0.0000	------	------	------	0.0000	548.5800
457	459	0.0000	------	------	------	0.0000	564.6400
456	457	0.0000	------	------	------	0.0000	568.8200
453	456	0.0000	------	------	------	0.0000	562.4800
462	463	541.5623	0.1366	0.0048	------	541.4305	552.1400
450	462	542.5665	0.0473	0.0011	------	542.5203	551.1200
448	450	543.0655	0.0334	0.0493	------	543.0814	552.1500
447	448	544.7536	------	------	------	544.7536	548.3600
473	471	544.1928	0.0797	0.0266	------	544.1398	548.9200
472	473	0.0000	------	------	------	0.0000	548.9600
474	473	545.0314	------	------	------	545.0314	548.3800

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Appended on: 07:36:19 Tuesday, May 26, 2009

Warning, History file is now 0.80 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [25 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
537	0.0000	0.0000	54.5962	0.00	0.0000	72" Diam	0.0000	1.9309	
538	0.0000	0.0000	----	0.00	0.0000	72" Diam	0.0000	0.0000	
539	0.0000	0.0000	207.90	0.00	0.0000	72" Diam	0.0000	7.3528	
542	0.0000	0.0000	104.33	0.00	0.0000	48" Diam	0.0000	8.3026	
543	0.0000	0.0000	44.6618	0.00	0.0000	48" Diam	0.0000	3.5541	
144	5.6900	1.9198	6.5114	0.29	0.3716	12" Diam	7.2251	8.2906	B
152	3.6300	0.5635	4.3247	0.13	0.2437	12" Diam	3.8054	5.5063	C
150	3.6300	0.5635	5.2626	0.11	0.2212	12" Diam	4.3646	6.7005	
147	6.1800	0.7652	5.1140	0.15	0.2612	12" Diam	4.6844	6.5114	A
149	6.1800	0.7652	4.4142	0.17	0.2817	12" Diam	4.2139	5.6204	
143	15.5000	3.1847	5.4562	0.58	0.5488	12" Diam	7.2141	6.9471	
141	15.5000	3.1847	4.7060	0.68	0.6030	12" Diam	6.4338	5.9919	
140	15.5000	3.1847	5.2341	0.61	0.7040	15" Diam	4.4720	4.2651	
156	2.0000	0.4350	5.6288	0.08	0.1880	12" Diam	4.2515	7.1668	E
159	0.0000	0.0000	2.9595	0.00	0.0000	12" Diam	0.0000	3.7682	
158	0.0000	0.0000	2.8659	0.00	0.0000	12" Diam	0.0000	3.6490	
157	0.0000	0.0000	2.7366	0.00	0.0000	12" Diam	0.0000	3.4843	
154	5.0500	1.3610	2.6092	0.52	0.5127	12" Diam	3.3572	3.3222	F
124	17.3400	3.3759	2.6515	1.27	-----	12" Diam	4.2984	3.3760	D
126	17.3400	3.3759	2.5643	1.32	-----	12" Diam	4.2984	3.2649	
128	17.3400	3.3759	3.0089	1.12	-----	12" Diam	4.2984	3.8311	
130	17.3400	3.3759	5.6136	0.60	0.6989	15" Diam	4.7839	4.5743	
132	17.3400	3.3759	4.6748	0.72	0.7870	15" Diam	4.1481	3.8094	
133	17.3400	3.3759	4.9071	0.69	0.7620	15" Diam	4.3089	3.9987	
135	17.3400	3.3759	5.3669	0.63	0.7187	15" Diam	4.6229	4.3734	
137	17.3400	3.3759	4.7935	0.70	0.7736	15" Diam	4.2326	3.9061	
138	17.3400	3.3759	7.0447	0.48	0.6094	15" Diam	5.6821	5.7406	
200	32.8400	6.5606	18.2531	0.36	0.5179	15" Diam	13.6578	14.8739	
167	0.0000	0.0000	10.4206	0.00	0.0000	15" Diam	0.0000	8.4915	
169	0.0000	0.0000	15.6485	0.00	0.0000	15" Diam	0.0000	12.7515	
170	0.0000	0.0000	9.3933	0.00	0.0000	15" Diam	0.0000	7.6543	
172	0.0000	0.0000	5.6547	0.00	0.0000	15" Diam	0.0000	4.6079	
174	0.0000	0.0000	8.6940	0.00	0.0000	15" Diam	0.0000	7.0845	
160	3.7900	0.0606	3.8308	0.02	0.0874	12" Diam	1.8073	4.8775	H
161	7.8500	0.1135	7.3330	0.02	0.1083	15" Diam	2.1940	5.9754	G

163	13.6400	1.0164	9.0985	0.11	0.3387	18" Diam	3.3973	5.1487	I
175	13.6400	1.0164	2.6436	0.38	0.5380	15" Diam	2.0118	2.1542	
176	13.6400	1.0164	3.7660	0.27	0.4434	15" Diam	2.6071	3.0688	
177	20.8900	1.3397	3.4752	0.39	0.5386	15" Diam	2.6478	2.8319	J
178	20.8900	1.3397	4.7308	0.28	0.4550	15" Diam	3.3181	3.8550	
186	0.0000	0.0000	5.4731	0.00	0.0000	12" Diam	0.0000	6.9686	
187	0.5200	0.0873	5.4405	0.02	0.0884	12" Diam	2.5615	6.9270	M
185	4.9700	0.6423	5.1537	0.12	0.2388	12" Diam	4.4638	6.5619	L
183	25.8600	1.9821	3.8923	0.51	0.6320	15" Diam	3.1847	3.1717	
182	25.8600	1.9821	4.5627	0.43	0.5759	15" Diam	3.5891	3.7181	
180	27.7400	2.2701	3.6613	0.62	0.7126	15" Diam	3.1410	2.9835	K
179	27.7400	2.2701	22.1101	0.10	0.2707	15" Diam	11.5981	18.0170	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							517.6700
B-537	E-537	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-538	E-538	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-539	E-539	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-542	E-542	0.0000	--na--	--na--	--na--	0.0000	527.0000
B-543	E-543	0.0000	--na--	--na--	--na--	0.0000	527.0000
423	E-200	539.9627	0.1175	0.0941	0.0625	540.0018	541.3000
No approach losses at node 416 because inverts and/or crowns are offset.							
418	423	540.4325	------	------	------	540.4325	542.8000
416	418	542.2670	0.2553	0.0226	------	542.0342	555.9200
415	416	545.4244	0.0928	0.1188	0.0397	545.4901	548.4800
409	415	546.8005	------	------	------	546.8005	549.9000
414	415	545.5133	0.2249	0.0009	------	545.2894	548.7400
422	414	547.8334	------	------	------	547.8334	551.9500
412	415	545.9030	0.3407	0.0054	------	545.5676	548.5800
420	412	548.1807	------	------	------	548.1807	552.3000
425	423	540.5171	0.2782	0.0103	------	540.2491	542.6100
426	425	541.2114	0.3319	0.0034	------	540.8829	545.8000
429	426	542.2698	0.2883	0.0272	------	542.0087	550.0700
430	429	542.9847	0.2672	0.0830	------	542.8005	552.4000
431	430	543.8374	0.3554	0.0203	------	543.5023	551.1900
434	431	544.9894	0.2869	0.0034	------	544.7059	549.2900
435	434	546.3257	0.2869	0.0027	------	546.0415	547.9800
438	435	547.7195	0.2869	0.0010	------	547.4335	550.6700
441	438	548.9822	0.0466	0.0004	------	548.9359	553.6600
No approach losses at node 439 because inverts and/or crowns are offset.							

442	441	549.0875	------	------	------	549.0875	554.6600
439	442	552.3627	------	------	------	552.3627	556.3500
444	442	0.0000	------	------	------	0.0000	553.2400
443	444	0.0000	------	------	------	0.0000	553.3100
446	443	0.0000	------	------	------	0.0000	551.4700
466	E-179	537.6474	0.1532	0.0926	------	537.5868	542.5000
468	466	538.3028	0.2000	0.1012	------	538.2039	547.4300
470	468	538.8655	0.1575	0.0469	------	538.7549	550.5800
471	470	539.2882	0.1710	0.1785	0.0553	539.3510	553.2200
465	471	539.9548	0.1089	0.0022	------	539.8481	550.2000
464	465	540.4615	0.1055	0.0032	------	540.3592	547.0200
No approach losses at node 460 because inverts and/or crowns are offset.							
463	464	540.9317	------	------	------	540.9318	550.7800
460	463	0.0000	------	------	------	0.0000	551.3800
459	460	0.0000	------	------	------	0.0000	548.5800
457	459	0.0000	------	------	------	0.0000	564.6400
456	457	0.0000	------	------	------	0.0000	568.8200
453	456	0.0000	------	------	------	0.0000	562.4800
462	463	541.7027	0.1792	0.0064	------	541.5298	552.1400
450	462	542.6778	0.0747	0.0018	------	542.6049	551.1200
448	450	543.1177	0.0507	0.0749	------	543.1419	552.1500
447	448	544.8035	------	------	------	544.8035	548.3600
473	471	544.3030	0.1019	0.0340	------	544.2351	548.9200
472	473	0.0000	------	------	------	0.0000	548.9600
474	473	544.9921	------	------	------	544.9921	548.3800

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'arning, History file is now 0.82 MB in size

ROUTEHYD [] THRU [Untitled] USING TYPE1A AND [100 year] NOTZERO RELATIVE SCS/SBUH

Reach ID	Area (ac)	Flow (cfs)	Full Q (cfs)	Full ratio	nDepth (ft)	Size	nVel (ft/s)	fVel (ft/s)	CBasin / Hyd
537	0.0000	0.0000	54.5962	0.00	0.0000	72" Diam	0.0000	1.9309	
538	0.0000	0.0000	----	0.00	0.0000	72" Diam	0.0000	0.0000	
539	0.0000	0.0000	207.90	0.00	0.0000	72" Diam	0.0000	7.3528	
542	0.0000	0.0000	104.33	0.00	0.0000	48" Diam	0.0000	8.3026	
543	0.0000	0.0000	44.6618	0.00	0.0000	48" Diam	0.0000	3.5541	
144	5.6900	2.4504	6.5114	0.38	0.4253	12" Diam	7.6990	8.2906	B
152	3.6300	0.8003	4.3247	0.19	0.2915	12" Diam	4.2030	5.5063	C
150	3.6300	0.8003	5.2626	0.15	0.2632	12" Diam	4.8486	6.7005	
147	6.1800	1.0886	5.1140	0.21	0.3130	12" Diam	5.1802	6.5114	A
149	6.1800	1.0886	4.4142	0.25	0.3384	12" Diam	4.6533	5.6204	
143	15.5000	4.2905	5.4562	0.79	0.6685	12" Diam	7.6903	6.9471	
141	15.5000	4.2905	4.7060	0.91	0.7495	12" Diam	6.7950	5.9919	
140	15.5000	4.2905	5.2341	0.82	0.8609	15" Diam	4.7603	4.2651	
156	2.0000	0.5835	5.6288	0.10	0.2173	12" Diam	4.6360	7.1668	E
159	0.0000	0.0000	2.9595	0.00	0.0000	12" Diam	0.0000	3.7682	
158	0.0000	0.0000	2.8659	0.00	0.0000	12" Diam	0.0000	3.6490	
157	0.0000	0.0000	2.7366	0.00	0.0000	12" Diam	0.0000	3.4843	
154	5.0500	1.7520	2.6092	0.67	0.6001	12" Diam	3.5601	3.3222	F
124	17.3400	4.6241	2.6515	1.74	-----	12" Diam	5.8876	3.3760	D
126	17.3400	4.6241	2.5643	1.80	-----	12" Diam	5.8876	3.2649	
128	17.3400	4.6241	3.0089	1.54	-----	12" Diam	5.8876	3.8311	
130	17.3400	4.6241	5.6136	0.82	0.8646	15" Diam	5.1064	4.5743	
132	17.3400	4.6241	4.6748	0.99	1.0123	15" Diam	4.3434	3.8094	
133	17.3400	4.6241	4.9071	0.94	0.9653	15" Diam	4.5474	3.9987	
135	17.3400	4.6241	5.3669	0.86	0.8945	15" Diam	4.9209	4.3734	
137	17.3400	4.6241	4.7935	0.96	0.9869	15" Diam	4.4493	3.9061	
138	17.3400	4.6241	7.0447	0.66	0.7388	15" Diam	6.1239	5.7406	
200	32.8400	8.9146	18.2531	0.49	0.6161	15" Diam	14.7953	14.8739	
167	0.0000	0.0000	10.4206	0.00	0.0000	15" Diam	0.0000	8.4915	
169	0.0000	0.0000	15.6485	0.00	0.0000	15" Diam	0.0000	12.7515	
170	0.0000	0.0000	9.3933	0.00	0.0000	15" Diam	0.0000	7.6543	
172	0.0000	0.0000	5.6547	0.00	0.0000	15" Diam	0.0000	4.6079	
174	0.0000	0.0000	8.6940	0.00	0.0000	15" Diam	0.0000	7.0845	
160	3.7900	0.0935	3.8308	0.02	0.1079	12" Diam	2.0452	4.8775	H
161	7.8500	0.1795	7.3330	0.02	0.1349	15" Diam	2.5141	5.9754	G

163	13.6400	1.4238	9.0985	0.16	0.4010	18" Diam	3.7504	5.1487	I
175	13.6400	1.4238	2.6436	0.54	0.6534	15" Diam	2.1936	2.1542	
176	13.6400	1.4238	3.7660	0.38	0.5325	15" Diam	2.8566	3.0688	
177	20.8900	1.9925	3.4752	0.57	0.6784	15" Diam	2.9289	2.8319	J
178	20.8900	1.9925	4.7308	0.42	0.5661	15" Diam	3.6892	3.8550	
186	0.0000	0.0000	5.4731	0.00	0.0000	12" Diam	0.0000	6.9686	
187	0.5200	0.1198	5.4405	0.02	0.1025	12" Diam	2.8239	6.9270	M
185	4.9700	0.9226	5.1537	0.18	0.2866	12" Diam	4.9604	6.5619	L
183	25.8600	2.9150	3.8923	0.75	0.8069	15" Diam	3.4798	3.1717	
182	25.8600	2.9150	4.5627	0.64	0.7260	15" Diam	3.9429	3.7181	
180	27.7400	3.3110	3.6613	0.90	0.9311	15" Diam	3.3775	2.9835	K
179	27.7400	3.3110	22.1101	0.15	0.3268	15" Diam	12.9559	18.0170	

From Node	To Node	Rch Loss (ft)	App (ft)	Bend (ft)	Junct Loss (ft)	HW Loss Elev (ft)	Max El (ft)
							517.6700
B-537	E-537	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-538	E-538	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-539	E-539	0.0000	--na--	--na--	--na--	0.0000	528.0000
B-542	E-542	0.0000	--na--	--na--	--na--	0.0000	527.0000
B-543	E-543	0.0000	--na--	--na--	--na--	0.0000	527.0000
423	E-200	540.9255	0.2205	0.1765	0.1159	540.9974	541.3000
No approach losses at node 416 because inverts and/or crowns are offset.							
418	423	541.7792	------	------	------	541.7792	542.8000
416	418	542.8004	0.4634	0.0410	------	542.3779	555.9200
415	416	545.9578	0.1511	0.1935	0.0700	546.0701	548.4800
409	415	546.9692	------	------	------	546.9692	549.9000
414	415	546.1169	0.0161	0.0001	------	546.1008	548.7400
422	414	547.9263	------	------	------	547.9263	551.9500
412	415	546.1963	0.4167	0.0066	------	545.7862	548.5800
420	412	548.2962	------	------	------	548.2961	552.3000
425	423	541.8751	0.2205	0.0081	------	541.6628	542.6100
426	425	542.6447	0.2205	0.0022	------	542.4265	545.8000
429	426	543.6254	0.2205	0.0208	------	543.4258	550.0700
430	429	544.3513	0.2205	0.0685	------	544.1993	552.4000
431	430	545.3418	0.2205	0.0126	------	545.1339	551.1900
434	431	546.3329	0.5382	0.0064	------	545.8011	549.2900
435	434	548.5209	0.5382	0.0051	------	548.0800	547.9800
438	435	551.2280	0.5382	0.0018	------	550.7700	550.6700
441	438	553.6753	0.0773	0.0006	------	553.5987	553.6600
No approach losses at node 439 because inverts and/or crowns are offset.							

442	441	553.8498	------	------	------	553.8498	554.6600
439	442	553.9040	------	------	------	553.9040	556.3500
444	442	0.0000	------	------	------	0.0000	553.2400
443	444	0.0000	------	------	------	0.0000	553.3100
446	443	0.0000	------	------	------	0.0000	551.4700
466	E-179	537.8866	0.1771	0.1070	------	537.8165	542.5000
468	466	538.5630	0.2414	0.1221	------	538.4437	547.4300
470	468	539.0777	0.1880	0.0560	------	538.9457	550.5800
471	470	539.5283	0.2113	0.2207	0.0665	539.6041	553.2200
465	471	540.2023	0.1332	0.0026	------	540.0717	550.2000
464	465	540.6373	0.1267	0.0038	------	540.5144	547.0200
No approach losses at node 460 because inverts and/or crowns are offset.							
463	464	541.0526	------	------	------	541.0526	550.7800
460	463	0.0000	------	------	------	0.0000	551.3800
459	460	0.0000	------	------	------	0.0000	548.5800
457	459	0.0000	------	------	------	0.0000	564.6400
456	457	0.0000	------	------	------	0.0000	568.8200
453	456	0.0000	------	------	------	0.0000	562.4800
462	463	541.8359	0.2184	0.0077	------	541.6252	552.1400
450	462	542.7798	0.0981	0.0024	------	542.6841	551.1200
448	450	543.1629	0.0649	0.0959	------	543.1939	552.1500
447	448	544.8025	------	------	------	544.8025	548.3600
473	471	544.4082	0.1238	0.0413	------	544.3257	548.9200
472	473	0.0000	------	------	------	0.0000	548.9600
474	473	545.0202	------	------	------	545.0202	548.3800

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APPENDIX G – Water Quality Technical Report

PacWest Engineering LLC

A.C. Kindig & Co.
ENVIRONMENTAL CONSULTING

LAWSON HILLS MPD
WATER QUALITY TECHNICAL REPORT

SUPPLEMENTAL MEMORANDUM

Prepared for:

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Prepared by:

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425-638-0358

October 6, 2008
Project No. 310

1.0 INTRODUCTION

This supplemental memorandum to the A.C. Kindig & Co. May 5, 2008 *Lawson Hills MDP Water Quality Technical Report* (*Water Quality Report*) is prepared as a result of two subsequent requests summarized in Table 1 from the City of Black Diamond (City) to BD Lawson Partners, LP (Applicant).

Table 1. Supplemental Memorandum Content Summary

Issue	City Requests	Supplemental Memorandum Content
Stormwater Pond Configuration & Flow Management	The City asked for consideration of a new stormwater pond configuration (named Option 2) and a new flow control management option (named Option 3) in addition to the pond and flow control configuration evaluated in the May 2008 report (named Option 1).	The potential for differences in water quality impacts under pond configuration Option 2 and flow control Option 3 are evaluated relative to the Option 1 configuration with flow control evaluated in May 2008.
Storm Pond Temperature	The City's EIS consultant, Parametrix Inc., asked for additional details supporting the pond water temperature analysis in the May 2008 report (Section 3.2.2.8, pages 3-21 to 3-22).	Thermal monitoring data results summarized in the May 2008 report are provided in more detail.

2.0 STORMWATER POND CONFIGURATION OPTIONS 1 AND 2, AND FLOW MANAGEMENT OPTION 3

Stormwater pond configuration Option 1 with flow control was previously described and analyzed in the May 2008 *Water Quality Technical Report.* Figure 3-1 in the *Water Quality Report* shows the drainage basins A through D under the Option 1 pond configuration.

One new stormwater pond configuration named Option 2 with flow control is under consideration by the City, along with a flow control management Option 3. Both are described in the *Lawson Hills Stormwater Concept Memorandum* prepared by Triad Associates on October 3, 2008. The evaluation in this memorandum is based on those conceptual descriptions.

2.1 *Option 2*

Under Option 2, a single offsite pond, possibly located east of Jones Lake and adjacent to SR-169, would be constructed as an alternative to the four onsite ponds serving Basins A, B and C under Option 1. The Basin D pond would be constructed under both Options 1 and 2. There would be no difference to storm management for the North Triangle. Onsite rooftop runoff or treated stormwater would be routed to Lawson Creek,

Mud Lake, the Unnamed Creek, and onsite wetlands as needed to maintain existing flow conditions, just as under Option 1. The specific siting of the single offsite pond and its potential for environmental impacts would be subject to future environmental review.

There are no differences in stormwater quality pollution generating sources, treatment type (wet pond) or combined project discharge impacts on Rock Creek downstream of the Ginder Creek confluence, or Lake Sawyer further downstream, because at this point and downstream all stormwater influences from the Lawson Hills project are combined. There would be some differences between routing of stormwater after treatment and discharge between Option 2 relative to Option 1 as follows:

1. ***Basin A*** treated stormwater discharge to Lawson Creek would be nearly the same under both Option 1 and Option 2, because Option 1 included a bypass to Lawson Creek to maintain existing hydrology in Lawson Creek and avoid erosive impact to the steeply incised portion of the creek upstream of SR-169, as described previously. The impacts to Lawson Creek under Option 2 would be as described previously for Option 1 (see Table 3-12 in the *Water Quality Report).*

   Depending on siting for the Option 2 offsite ponds, construction impacts may differ somewhat from those for the ponds under Option 1 because of differences in soils, slopes, or proximity of natural watercourses. However, it is reasonably expected that construction best management practices and mitigation described in the *Water Quality Report* would be sufficient to minimize or avoid impacts to the same degree under both options.

2. ***Basin B*** treated stormwater discharge to Mud Lake would not occur under Option 2 as under Option 2, except as needed to maintain existing hydrology in Mud Lake, Mud Lake Creek, and Ginder Creek downstream. Therefore, potential impacts to Mud Lake, Mud Lake Creek, and Ginder Creek would be reduced under Option 2 relative to Option 1. However, no adverse impacts to water quality were forecast by the water quality model to any of these water bodies, so there would be no meaningful change in conclusions for water quality impact to these waters under Option 2 relative to Option 1 for drainage from Basin B (see Table 3-14 in the *Water Quality Report* for a forecast of treated discharge quality from Basin B.

3. ***Basin C*** treated stormwater discharge to Unnamed Creek would not occur under Option 2 as under Option 2, except as needed to maintain existing hydrology in Unnamed Creek. However, no adverse impacts to water quality were forecast by the water quality model to unnamed Creek, so there would be no meaningful change in conclusions for water quality under Option 2 relative to Option 1 for drainage from Basin C (see Table 3-13 in the *Water Quality Report* for a forecast of treated discharge quality from Basin C.

4. ***Combined discharges from Basins A through C*** to Lawson Creek at Jones Lake under Option 2 would only differ from Option 1 with regard to Basin B contributions. Under both Options 1 and 2, Basin A and Basin C treated storm discharges would combine at this point; under Option 2 Basin B discharges are added as well. This would increase the potential for water quality impact to lower Lawson Creek at Jones Lake, in Jones Lake, and in Rock Creek downstream to the Ginder Creek confluence. Basin B influences reach Rock Creek at the

Ginder Creek confluence under Option 1, but are moved higher in the Rock Creek watershed under Option 2.

The effect of combined Basin A and C discharges on Jones Lake is shown in Table 3-18 and described in the *Water Quality Report*. Under Option 2, influences of Basin B treated discharge (shown in Table 3-14 in the *Water Quality Report*) would be added. Qualitatively, these tables show that the Basin B and Basins A and C discharge quality is very similar, with no important differences in any of the constituents analyzed. Therefore, constituent concentrations of combined stormwater from the Lawson Hills project at the point of discharge from the offsite Option 2 pond would be similar to those already analyzed for impacts in the Water Quality Report for Option 1 to lower Lawson Creek, Jones Lake and upper Rock Creek.

2.2 *Option 3*

Under Option 3 being considered by the City, the City would apply for and obtain a Basin/Watershed Plan for the Jones Lake and Rock Creek basins. This could potentially allow the City to alter flow control requirements from those required under the 2005 Ecology *Stormwater Management Manual for Western Washington.* Under Option 3, the City would explore the potential to provide flow control within the Jones Lake and Rock Creek wetland complex rather than provide stormwater detention onsite. Water quality treatment would still be required in wet ponds, which could be placed onsite (as under Option 1) or offsite (as under Option 2). The impacts of Option 3 would be subject to future environmental review. Baseflow requirements for onsite streams and wetlands would be provided by rooftop drainage and treated stormwater as under Options 1 and 2.

Option 3 pertains only to flow control, not to stormwater quality treatment. Therefore, none of the Option 1 stormwater quality analysis in the *Water Quality Report* pertaining to the quality of pond discharge or its impacts would be changed. Baseflow protections would be the same under Option 3 as under Options 1 and 2, so no water quality differences that pertain to changes in base flow, such as temperature or dissolved oxygen, would occur under the different options. No significant differences in construction discharge or best management practices would be expected under Option 3 relative to Options 1 or 2.

Under Option 3, it is unknown if erosion in Rock Creek could increase under high flow conditions, unless the flow control afforded by the natural wetlands attenuated stream energy enough to prevent these impacts. If stream erosion was increased, there could be increased phosphorus loading to Lake Sawyer because of the natural phosphorus content in soil. Since Lake Sawyer is a phosphorus sensitive lake, this would increase potential for eutrophic impact. The degree of flow control that could be provided by the Jones Lake and Rock Creek wetland complex, and the degree of mitigating flow control that may be necessary to avoid water level fluctuation or flow impacts on the wetland/lake/stream complex or further waterbodies downstream is unknown and subject to future environmental review.

3.0 STORM POND TEMPERATURE

Section 3.2.2.8 of the *Water Quality Report* explained why wet ponds for stormwater treatment are not expected to increase water temperatures in receiving waters. This section used continuous temperature recording data to examine water inflow, pond water, and pond outflow during spring, summer and late summer conditions in the Puget Lowlands. The analysis was focused on storm discharges during July through early September, which is the hottest period in the Puget Sound lowlands and the period during which receiving waters would have the greatest susceptibility to thermal impact. It is important to keep in mind that thermal inputs are not conservative in nature; that is, temperature in water will always tend towards thermal equilibrium. The cooler the ambient condition, the faster thermal equilibrium to ambient conditions will occur. Even with continuous thermal inputs to streams during the warmest time of the year, thermal impacts of forest clearing, for example, were found to extend no more than about 2,000 feet downstream before returning to the ambient temperature in non-harvested forests.[1] Storm ponds do not discharge coincident with warmest temperatures. Therefore, there is no possibility that any Lawson Hills pond, whether onsite under Option 1 or offsite under Option 2, could extend thermal impact very far down stream, including to Rock Creek or Lake Sawyer, before equilibrium was reached. The analysis in the Water Quality Report was intended to address the potential for localized temperature impacts at the points of discharge during the warm summer season.

The City's consultant Parametrix Inc. expressed concern that any stormwater pond may be a source of thermal impact to receiving waters, and that the larger regional wet pond that would be constructed offsite under Option 2, relative to Option 1, may exacerbate any thermal impact. This section of the memorandum addresses that concern by expanding on the discussion and elaborating on the source data for the previous analysis.

Urban runoff from summer storms is often thought to be warm because of the influence of impervious surfaces and wet ponds which warm from sunlight and warm air temperatures. However, measurement of air and wet pond temperatures during the summer demonstrates that storm runoff in western Washington rarely coincides with warmer weather. In the Puget Lowlands, most storms and the vast majority of runoff volume occurs during the cooler weather seasons (late fall through early spring). A temperature monitoring study was conducted by A.C. Kindig & Co. at Trossachs, a residential development in the City of Sammamish, Washington in the Puget Lowlands. Continuous gages measured stormwater and air temperatures from May 2000 through September 2000. Temperature gages were installed at inflow to the combined wet detention pond, in the wet pond, at the wet pond outflow (which was inflow to a sand filter), and at the sand filter outflow[2] (A.C. Kindig 2000). An ambient air temperature gage was installed out of direct sunlight at the site. From July through early September, the period of greatest susceptibility of receiving water impacts from temperature change, runoff from summer storms never overcame evaporative losses in the wet pond to cause discharge to occur (Figures 1 through 3). From May through September 2000 storm runoff entered the wet pond at temperatures consistently below 62 °F (16.7°C) due to

[1] J.E. Caldwell, K. Doughty, and K. Sullivan. 1991. Evaluation of Downstream Temperature Effects of Type 4/5 Waters.

[2] A.C. Kindig & Co. 2000. Unpublished runoff data from Trossachs Residential Development inflow, wet pond and sand filter. Issaquah, Washington.

evaporative cooling, and because of the cooler air temperatures measured during all storms (A.C. Kindig 2000). Water within the wet pond cooled rapidly during all storms in 2000, both because of cooler air temperatures and because of mixing with the cooler inflow water. Pond discharge occurred in 2000 for the first time after several days of rain between September 5th and September 11th. The series of storms that resulted in pond outflow followed periodic storms and cooler weather starting in late August. When pond outflow began, the pond temperature had dropped to about 60 to 61°F (15.6 to 16.1°C), and continued to drop as the storm and discharge continued. The peak water temperature expected in discharge from wet ponds in late summer is therefore under or around 16°C.

These peak summer discharge temperatures are within the range of water quality standard criteria. More importantly, storm discharge does not occur during the hottest ambient conditions when surface receiving waters would be warmest and therefore most susceptible to thermal impact. When storm discharge does occur, ambient conditions are cooler, receiving water temperatures would be cooler, and thermal equilibrium mechanisms would be stronger, preventing thermal impacts from storm discharge.

For these reasons, the *Water Quality Report* concluded no adverse impacts from storm ponds, regardless of location. Pond size would make no difference, since the surface to volume ratio tends to increase for larger ponds (because they can only be constructed within a narrow wet pond storage depth range), which makes thermal equilibrium to cooler storm temperatures just as fast as in smaller ponds.

Figure 1 Trossachs Wet Pond and Sand Filter Continuous Temperature Record
and Daily Rainfall May 25 through June 30, 2000

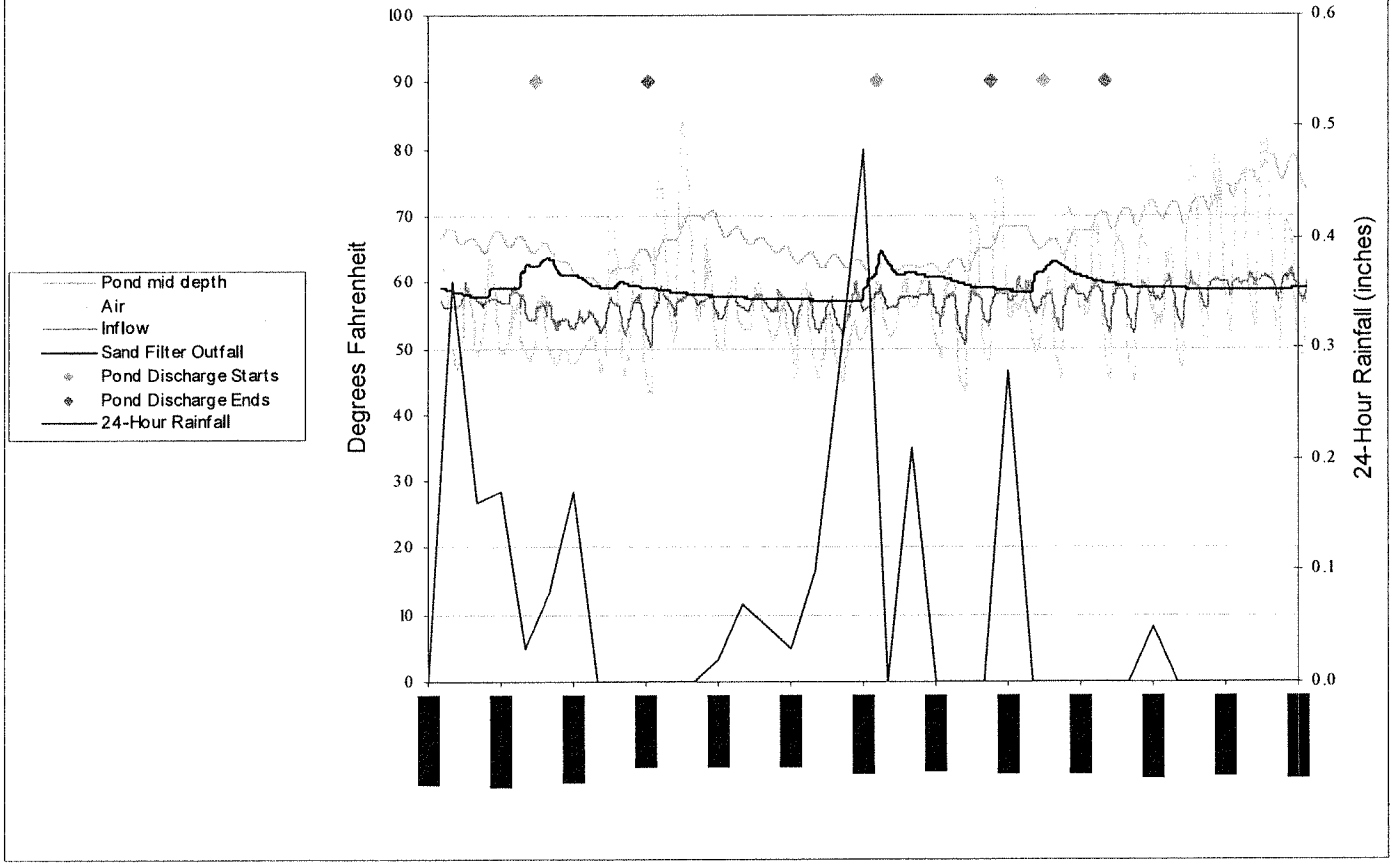


Figure 2 Trossachs Wet Pond and Sand Filter Continuous Temperature Record
and Daily Rainfall July 1 through August 14, 2000

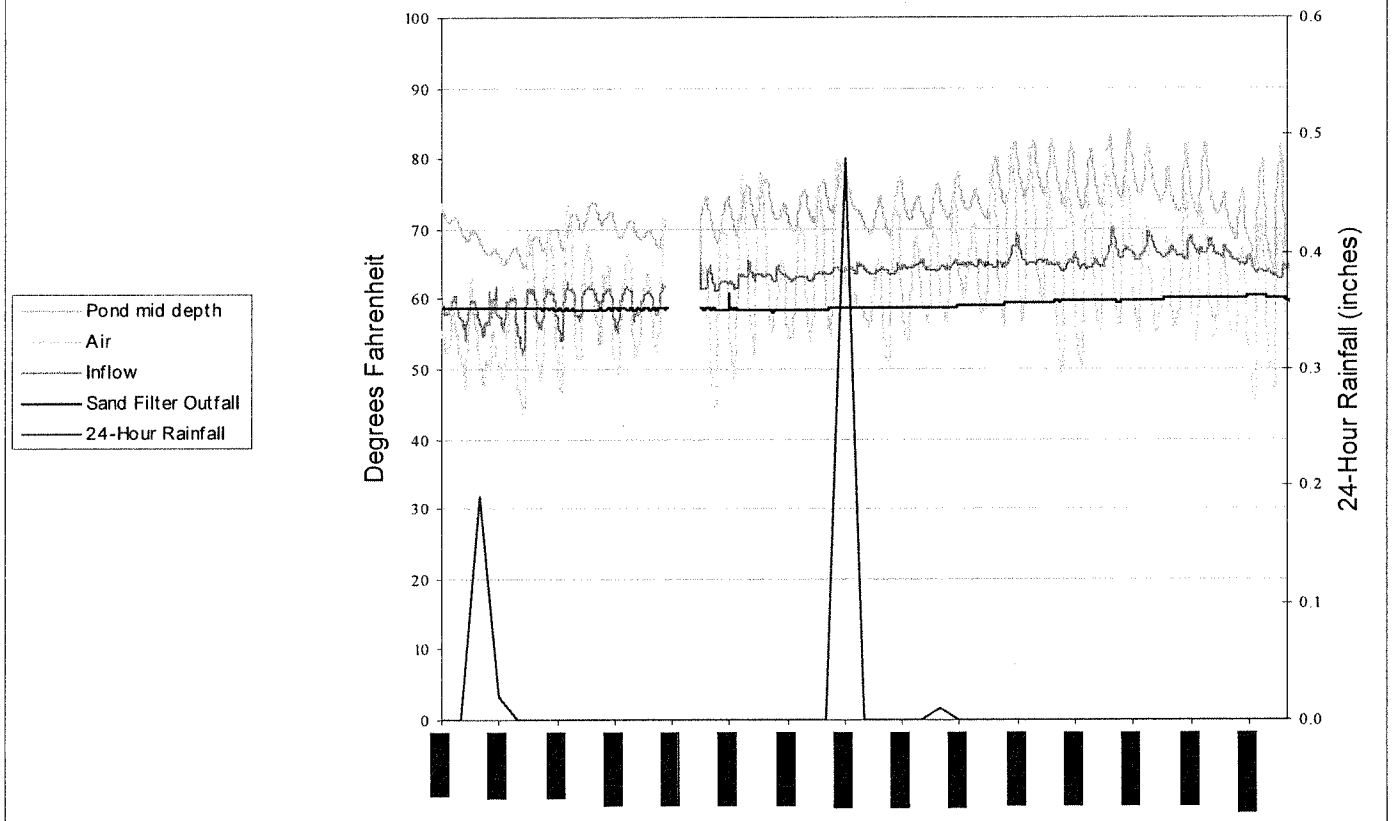
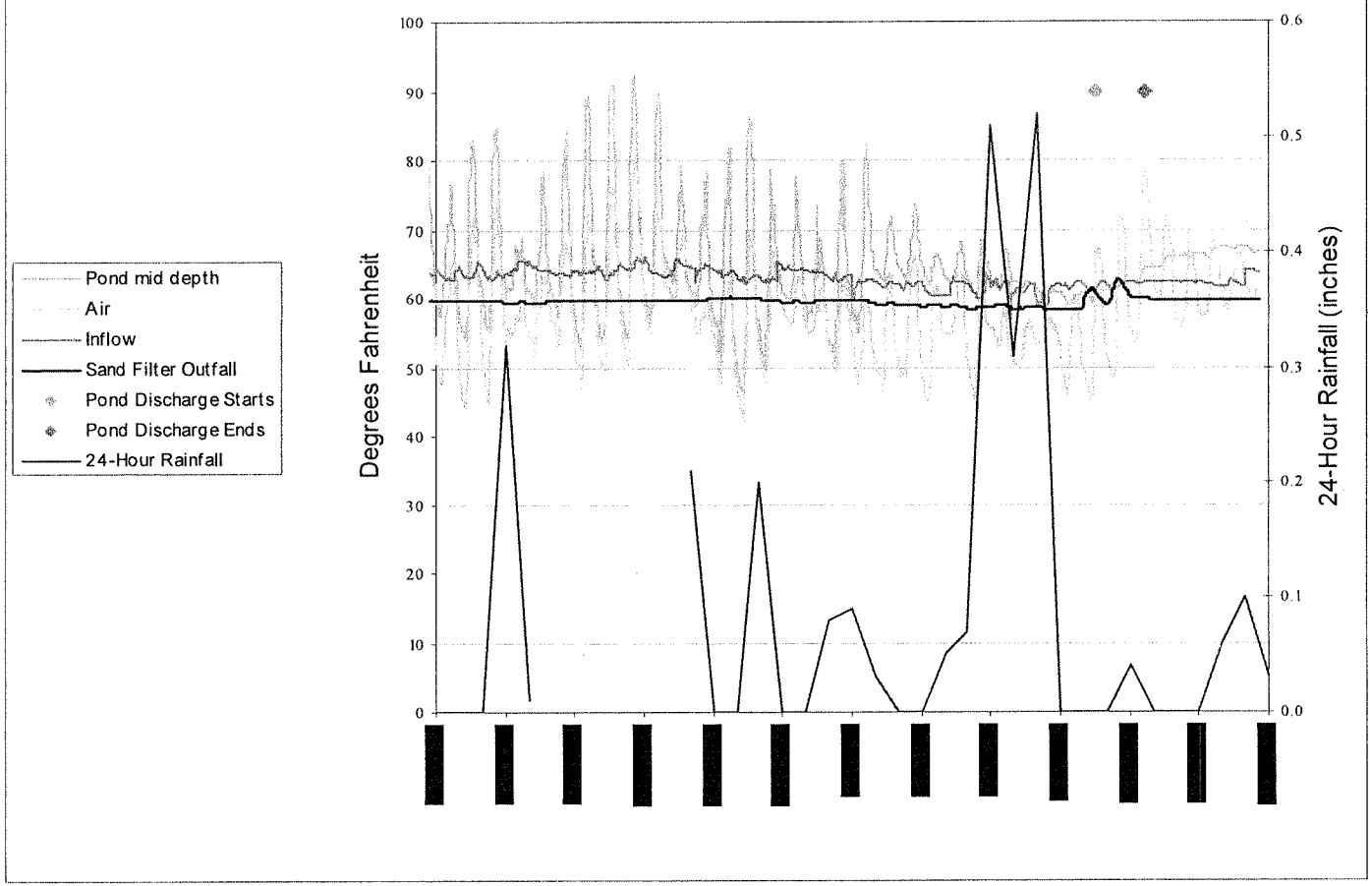


Figure 3 Trossachs Wet Pond and Sand Filter Continuous Temperature Record and Daily Rainfall August 15 through September 20, 2000



CEDAROCK CONSULTANTS, INC.
Environmental Consulting

FISHERIES TECHNICAL REPORT

THE VILLAGES
MASTER PLANNED DEVELOPMENT

Black Diamond, Washington

Prepared for:
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September 29, 2008

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1.0 INTRODUCTION

1.1 Report Scope

A proposed action that would result in development of a mixed-use Master Planned Community on an approximately 1,190-acre site is evaluated for potential impacts to fisheries resources. The Black Diamond Villages (Villages) Project site consists of the approximately 1,108-acre Main Property generally located south and west of the City of Black Diamond, and the approximately 82-acre North Property located on the northern edge of the City. This report analyzes the Proposed Master Planned Development (MPD) and a No Action Alternative.

Existing fisheries conditions on the site and in the vicinity are described based on site-specific field reconnaissance, a review of existing documents, and interviews with regional experts. The data are used to describe existing conditions, to assess potential impacts of proposed development activities to fisheries resources and aquatic habitat, and to evaluate and discuss mitigation measures proposed to avoid and/or minimize impacts. Where appropriate, additional conservation and mitigation measures are recommended.

1.2 Proposed Action

Development of the Villages MPD is expected to commence in 2009. Full buildout is anticipated to occur by 2025. Under the Proposed MPD, the Villages site (including both the Main Property and the North Property) would be developed with a mix of uses, including residential, retail/commercial, office, educational and recreational uses, and open space. Development would be clustered to avoid environmentally sensitive areas (i.e., wetlands, streams and steep slope areas and their buffers).

1.3 No Action Alternative

The No Action Alternative is defined by what would be most likely to happen if the Villages MPD did not occur. Logging activities could continue to take place onsite in the future. The individual tax parcels that comprise the Main Property and North Property could be sold to individuals or small developers and developed in the future in accordance with the City's zoning and other applicable regulations. Sensitive areas' buffers would be protected as required under the code, but there would be no coordinated opportunities to protect larger parcels as public open space.

2.0 AFFECTED ENVIRONMENT

2.1 Site Description

The project site consists of approximately 1,190 acres located on multiple parcels (known as B, C, D, E, BDA and F) within portions of Sections 11, 15, 22, 23 and 27, Township 21 North, Range 6 East in the City of Black Diamond, King County, Washington. Parcels C, D, E, BDA and F are contiguous and located along the south boundary of the City of Black Diamond. Parcel B is located west of SR 169 near the City's north boundary. Existing development on the site consists primarily of native surface logging roads and a small gravel pit on Parcel D.

The main portion of the project site (Parcels C, D, E, BDA and F) consists of approximately 1,110 acres of flat to moderately sloped forestland and scrub-shrub habitat. Site elevations range from approximately 510 feet to around 710 feet. The site straddles a north-south divide with about half of the site draining north to Rock Creek and Lake Sawyer. The rest of the site drains southwest to the Green River. Most of the land consists of managed young coniferous forest. Some of the site was historically mined for gravel and virtually all was commercially logged at one time or another. There is no existing residential development on the site.

Several natural watercourses are found on the site ranging from salmon-bearing Rock Creek to a number of intermittent non-fish-bearing streams (Figure 1). Manmade ditches dug during logging operations and to drain roads are also present but do not meet the definition of watercourses under the City of Black Diamond Code. The entire site was walked by fisheries, wetland, and geologic scientists to identify sensitive areas.

Parcel B (approximately 80-acres) is located near the northern tip of Black Diamond adjacent to the west side of SR 169. The Parcel B Property consists of two relatively flat terraces separated by an average 45-foot high slope. The land is primarily forested with young mixed coniferous-deciduous trees, and has no structures. One short, isolated watercourse (S2) connects two wetlands on the upper and lower terrace within the site. A number of long linear watercourses were examined and found to most closely fit the City's CAO wetland definition rather than the stream definition and are further described by Wetland Resources (2008).

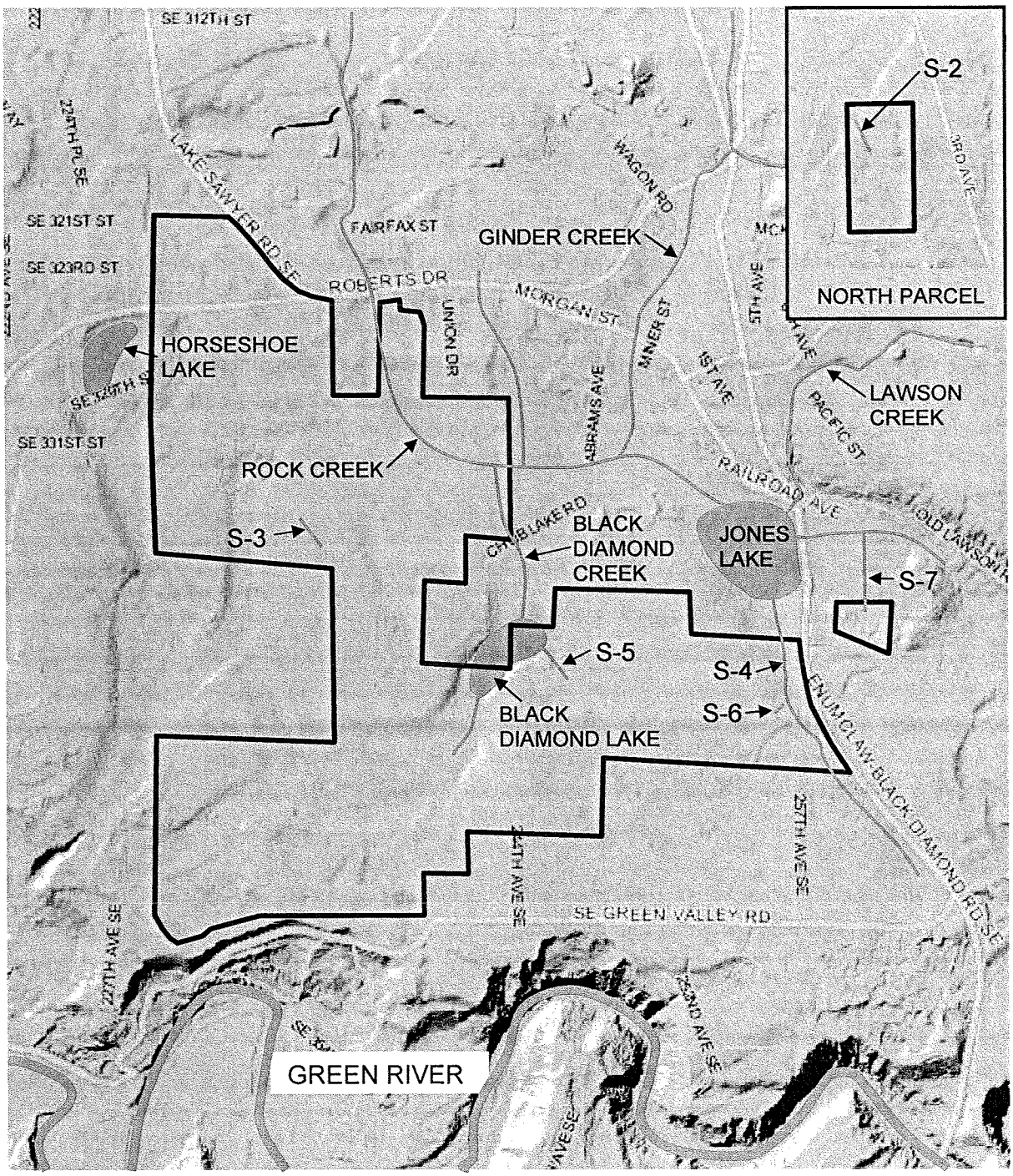

Figure 1. Watercourses on and in the vicinity of the Villages MPD site.

2.2 Surface Water Drainage Setting

The site is entirely within the Green River drainage basin (WRIA 9). All surface water drainage eventually ends up in the Green River (WRIA 09-0001). The majority of the main site (52%) drains in a northwesterly direction via various watercourses that eventually collect in Rock Creek (09-0085). Rock Creek drains via Lake Sawyer, Covington Creek (09-0083), and Big Soos Creek (09-0072) to the Green River near river mile (RM) 33.6. All drainage on Parcel B infiltrates to groundwater which eventually reaches Ravensdale Creek (Associated Earth Sciences, Inc [AESI] 2008). Ravensdale Creek drains directly to Lake Sawyer. A minority of the site (48%) slopes towards the Green River. Rainfall in this part of the site infiltrates or is collected in wetlands that extend off-site to the south. There are no watercourses on the site that drain directly to the Green River.

2.3 City of Black Diamond Watercourse Definitions

The draft City of Black Diamond Zoning Code (January 22, 2008 draft) defines streams according to WAC 222-16-030. Streams are classified based on fish use, size, and flow characteristics as summarized below:

Type S Water means all waters, within their bankfull width, as inventoried as shorelines of the state.

Type F Water means segments of natural waters other than Type S Waters, which are within the bankfull widths of defined channels and periodically inundated areas of their associated wetlands, or within lakes, ponds, or impoundments having a surface area of 0.5 acre or greater at seasonal low water and which in any case contain fish habitat.

Type Np Water means all segments of natural waters within the bankfull width of defined channels that are perennial nonfish habitat streams. Perennial streams are waters that do not go dry any time of a year of normal rainfall.

Type Ns Water means all segments of natural waters within the bankfull width of the defined channels that are not Type S, F, or Np Waters. These are seasonal, nonfish habitat streams in which surface flow is not present for at least some portion of a year of normal rainfall.

2.4 Aquatic Habitat Quality: Onsite Waterbodies

Physical habitat attributes of onsite waterbodies are described in this section. Results are summarized in Table 1. Information about existing conditions was gathered from survey work completed by the applicant for this project and in existing documents (City of Black Diamond 1996, Kerwin and Nelson 2000, WDFW 2008a, 2008b).

Habitat surveys to evaluate existing conditions were completed during the summer of 2007, winter of 2007/2008, and spring of 2008. Onsite channels were walked in their entirety. Affected off-site channels were spot checked.

Only five natural watercourses (Rock Creek and streams S2, S4, S5, and S7) and Black Diamond Lake were identified on the project site. Two other watercourses, (S3 and S6) were dug or created during past road building activities but contain flow from natural sources and therefore are described in this report. A number of roadside ditches and natural wetlands are also present. Neither S3, S6, or any of the roadside ditches show any evidence (based on topography and soil types) of having replaced previously existing natural watercourses. They all appear to have been constructed solely for draining road surface runoff or diverting seepage back to a topographic low point. Evidence of the passage of water was observed in some of the wetlands but the physical features more closely resembled wetlands (aquatic plants, vegetated substrates, hydric soils, etc.) than streams so were classified as such. Wetlands are described in detail by Wetland Resources Inc. (2008).

Table 1
Watercourses and Lakes, Habitat Attributes, and Fish Use on the Villages Site

Watercourse Name	Type of Water	Black Diamond Type	Fish Use	Avg. Slope	Dominant Substrate	Flow
S2	Stream	Ns	None; onsite channel goes dry and is isolated	15%	Silt	Seasonal
S3 (manmade)	Ditch	None	None; onsite channel goes dry and is isolated	7%	Sand	Seasonal
S4	Stream	F	Presumed resident trout; possible coho juvenile	3%	Gravel	Perennial
S5	Stream	F	Presumed resident trout; possible coho juvenile	10%	Gravel	Perennial
S6 (culvert discharge)	Stream	Ns	None, poor access and no habitat	7%	Silt	Seasonal
S7	Stream	F	Presumed resident trout; possible coho juvenile	10%	Silt	Seasonal
Black Diamond Lake	Lake	F	Resident trout; coho juvenile	—	—	Perennial
Rock Creek	Stream	F	Resident trout and coho spawning and rearing	1%	Silt	Perennial

Several unclassified stream channels are identified on maps prepared by the Department of Natural Resources (DNR). Field review found that mapped channels shown throughout Section

15 and in the NW ¼ of Section 22 do not actually exist on the site. It is likely the channels were plotted based on interpretation of topographic data and extrapolation from known watercourses.

2.4.1 Watercourse S2

A single isolated stream (S2) is located on Parcel B. The entire watercourse is approximately 800 feet long and only exists on the steep slope between the upper and lower terraces. Headwaters are located in onsite wetlands on the upper terrace to the east. As Stream S2 reaches the lower terrace, all flow quickly infiltrates into recessional outwash (Qvr, AESI 2008). This effect was observed even during a very wet period in January 2007. The water from Stream S2 ultimately provides baseflow to Ravensdale Creek.

The S2 stream channel is isolated and does not connect with any other surface waterbody. The channel is intermittent, non-fish-bearing, and does not significantly influence water quality downstream with the possible exception of water temperature. The channel would be classified as a Type Ns water.

Wetland 6B is a linear wetland located just south of Stream S2 that has some stream-like characteristics but is dominated by emergent vegetation and organic soils. Because the wetland contains open water during the winter it was walked downstream to identify any possible connection with fish-bearing waters. Much like other watercourses in this area, all flow was found to rapidly infiltrate into the recessional outwash soils once it reached the lower plateau. No surface connection to offsite fish-bearing waterbodies was found for any of the water features in Parcel B.

2.4.2 Ditch S3

Ditch S3 is located on the south half of Parcel D. This is a manmade ditch that was likely dug to during past logging operations. Flow from a wetland through which an old logging road passes currently runs north and west down the road bed before infiltrating when the road reaches the recessional outwash soils near the toe of the slope. There is no evidence of a natural channel nor does the local topography give any indication a natural channel may have existed at this location prior to the road being constructed. The ditch contains a natural source of water but is isolated, seasonal, and non-fish-bearing. This artificial conveyance would not be defined as a watercourse under the proposed Black Diamond CAO (BDMC 19.10.090). About half of the channel has been identified as wetland and will be preserved as such.

2.4.3 Watercourse S4

This watercourse is located on the extreme eastern edge of Parcel F and parallels 257th Avenue SE before discharging to Jones Lake off-site. The stream is headwatered off-site to the south in a large wetland complex in the area bounded by 257th Avenue SE to the west, SE Green Valley Road to the south, and SR 169 to the east. Flow travels north through a broad wetland near the toe of the SR 169 fill slope and enters the site. Flow then crosses under 257th Avenue SE in a small (approximately 8-inch) culvert and continues northwest through the site in a well-defined channel through densely vegetated young forest. The well defined channel in this area is small (2 to 5 feet wide), shallow (approximately 3 to 12 inches at Ordinary High Water), and of

moderate gradient 3 to 5 percent. Substrate is dominated by gravel and small cobble with sand sub-dominant. Cobbles larger than about 2-inches are generally moss covered indicating a lack of frequent high flows. Instream habitat consists primarily of riffle with a few small pools. Large woody debris (LWD) frequency is low.

No natural barriers to fish migration were noted between Jones Lake and the southern property boundary. Given the presence of suitable fish habitat, the entire watercourse through the site is presumed to be fish-bearing (Type F).

2.4.4 Watercourse S5

Watercourse S5 is located near the northwest corner of Parcel F. It is a natural 800-foot long creek draining onsite wetlands directly to Black Diamond Lake. Much of the middle and lower portion of the channel is deeply embedded in Himalayan blackberry making a detailed survey of the channel difficult. However, the channel averages more than 2-feet wide with a gradient of about 10 percent and is presumed fish-bearing throughout its length (Type F). No natural fish barriers were observed in the portion of channel that was observed and topographic conditions appear to preclude the presence of a natural barrier.

2.4.5 Watercourse S6

S6 is a manmade watercourse located near the east boundary of Parcel F that begins as drainage from a 15-inch culvert under an old logging road. The road crosses the eastern tip of Wetland Q. Discharge from the wetland at this location is seasonal and Watercourse S6 is relatively poorly defined, so it is not clear if the watercourse was present at this location before the road was installed or replaced a previously existing watercourse at this or some other location. Flow has created a small poorly defined channel that persists part of the way down the slope towards Watercourse S4. However, there is no evidence flow ever reaches Watercourse S4 on the surface. While it is possible there is a surface connection between Wetland Q and Watercourse S4 under some conditions, there is no evidence of the passage of surface water between the two, so fish use of S6 is not believed possible. The intermittent, non-fish-bearing channel would be classified as a Type Ns watercourse under the draft BDMC.

2.4.6 Watercourse S7

Watercourse S7 is located east of SR 169 on the isolated parcel of land east of Jones Lake. It begins as groundwater seepage on a steep hillside before coalescing into a defined channel and discharging to a ditched watercourse on the Jones Lake floodplain off site. The ditch heads due north and connects to Unnamed Creek a short distance upstream of Jones Lake. The Unnamed Creek system in this area is fish-bearing and no natural barriers are known to exist downstream of the site. It is unknown whether the channel contains perennial flows. The watercourse upstream on to the site would be classified as a Type F stream until the point at which the channel is no longer defined. This point was not flagged in the field as no development was proposed in this area.

2.4.7 Black Diamond Lake

Black Diamond Lake and associated wetlands cover an area of approximately 40 acres in a watershed of approximately 700 acres (City of Black Diamond 1996). The open water portion of the lake is about 10 acres. The mean depth is 6 feet and the maximum depth is 8 feet. A large wetland system extending to the southwest includes some open water during parts of the year. A survey in June 2000 found a channel approximately 5 feet wide at the OHWM with an average water depth of approximately 0.2 feet. Channel gradient was less than 1 percent and water was slow moving. Substrate was organic muck and silt.

The lake is unique in that it contains a bog component. Bogs require special water quality conditions such as a low pH and low flows that are not always conducive to fish use. However, Black Diamond Lake has been stocked with native and non-native fish species on a number of occasions and upstream access from Rock Creek was improved when the intervening channel was cleared and cleaned a number of years ago (see Section 2.6.2). Fishing for both warmwater species and salmonids still occurs at the lake. The lake would be classified as a Type F waterbody, but is also classified as a Category 1 wetland (Wetland Resources, Inc. 2008).

2.4.8 Rock Creek

Rock Creek (WRIA 09-0085) is part of an extensive wetland system that extends from Jones Lake downstream to Lake Sawyer. The active channel averages 10 feet wide at the OHWM. Average water depth ranges from about 0.5 feet to over a foot in places. Channel gradient is approximately 1 percent. Substrate is dominated by silts and organics with some graveled and cobbled reaches present. Channel type is primarily glide or riffle. Very little large woody debris is present. Riparian vegetation is comprised of red alder, bigleaf maple, salmonberry, Indian plum, red elderberry, and skunk cabbage.

Fish rearing habitat in Rock Creek is good. There are abundant on- and off-channel refuge locations, deep pools, and overhanging vegetation. With a few exceptions, riparian buffers are generally large and well vegetated. Water quality issues in Rock Creek in the past include low dissolved oxygen (DO), high temperatures, and other issues (A.C. Kindig & Co. 2008). Rock Creek is known to be used by coho salmon and resident cutthroat trout (Williams et al. 1975, City of Black Diamond 1996, Kerwin and Nelson 2000, WDFW 2008a, 2008b).

2.5 Aquatic Habitat Quality: Off-site Waterbodies

This section provides a description of the physical habitat attributes of off-site waterbodies receiving flow from the project site.

2.5.1 Jones Lake

Jones Lake is located in the southern part of Black Diamond just west of SR169 and is generally considered the headwater of Rock Creek. The lake is approximately 23 acres in size and has a total watershed area of 742 acres (Williams et al. 1975). The mean depth is approximately 4 feet, and the maximum depth is 7 feet (City of Black Diamond 1996). Jones Lake has been characterized as exhibiting high concentrations of acidic organic materials, as well as having

bottom deposits consisting of unrated organic material that accumulates as peat. Jones Lake provides good overwintering habitat potential for salmonids utilizing the Rock Creek drainage, including coho and cutthroat trout. Anecdotal evidence suggests rainbow trout historically stocked in Jones Lake persist in the drainage and some continued use by trout is expected. Warmwater fishes also utilize the lake and may prey on juvenile salmonids.

2.5.2 Black Diamond Lake Creek

This tributary to Rock Creek (09-0085A) exits Black Diamond Lake at the northern end, flows through a wetland with beaver dams, under Abrams Avenue, and then through part of a wetland complex previously utilized by the Black Diamond Wastewater Treatment Plant known as the "Black Diamond Lagoon" (Ecology 1987). Black Diamond Lake Creek combines with Rock Creek downstream of the wetland.

The channel downstream of Black Diamond Lake ranges from about 5 to 6 feet wide at the OHWM. Average water depth is approximately 0.5 feet. Substrate is comprised of silt and organic material. The riparian vegetation is dominated by Douglas' spirea, willow, rushes, sedges, and reed canarygrass. Channel type consists primarily of a glide or run. Downstream of the culvert crossing at Abrams Avenue the channel splits and diffuses into an extensive wetland complex before emptying to Rock Creek.

Salmonid habitat suitability of the creek is generally poor. No gravels suitable for spawning by resident trout or anadromous salmonids were observed. No LWD, pools, or other habitat features of value to salmonid habitat were noted. However, some salmonid use is possible and this system is utilized as rearing habitat for coho and by resident salmonids, especially during the winter when flows are higher (Kerwin and Nelson 2000). The cool summer water temperatures may also provide a summer refuge for fish.

2.5.3 Horseshoe Lake

Horseshoe Lake is located west of the project site off Black Diamond Road. Horseshoe Lake is located in a topographic depression and has no outlet. Water levels in the lake are sensitive to the effects of both overland runoff and ground water inflows (Tetra Tech/KCM, Inc. et al. 1999, AESI 2008).

Horseshoe Lake is generally unsuitable for salmonids. Historical stocking records indicate rainbow trout were stocked in the past for recreational angling. However, the isolated lake is not believed to contain habitat suitable for spawning. No reproductive population of salmonids is expected. In addition, water temperatures are not conducive to salmonid use and a one-time water quality sampling found low oxygen (AESI 2000). Habitat is suitable for warm-water fish species and there are reports of bass, sunfish, and catfish being caught in the lake (AESI 2000).

2.5.4 Ravensdale Creek

Ravensdale Creek has its headwaters in Ravensdale Lake approximately 1.4 miles east of the site. The channel flows through commercial forestland approximately 3 river miles to Lake Sawyer. Ravensdale Creek passes within a few hundred feet of Parcel B at its closest location

but is not within the project boundaries. No surface water drains from the site to Ravensdale Creek, but water infiltrating into the recessional outwash on the lower portion of the site (including flow from Stream S2) ultimately provides baseflow to Ravensdale Creek.

Ravensdale Creek is a major salmon-bearing stream recognized for very high fish use (Williams et al. 1975, City of Black Diamond 1996, Kerwin and Nelson 2000, WDFW 2008).

2.5.5 Lake Sawyer

Lake Sawyer is the forth largest lake in King County with a surface area of approximately 280 acres (Tetra Tech/KCM 1999). Rock Creek and Ravensdale Creek both discharge to Lake Sawyer near the south end. Lake Sawyer drains via Covington Creek (09-0083) eventually reaching the Green River (09-0001) approximately 11 miles downstream of the project site. Lake Sawyer is utilized as a migration corridor and for rearing by coho salmon. The lake also contains native cutthroat trout, stocked rainbow trout, and a warmwater fishery.

2.5.6 Crisp Creek

Crisp Creek (WRIA 09-0113), also known as Keta Creek or Keta Springs, is generally regarded as one of the most important small streams draining into the Green River within this area of the Green River Watershed (Williams et al. 1975). Crisp Creek is 3.5 miles long and enters the Green River at approximately RM 40.1. The Crisp Creek Basin drains an area of approximately 5.0 square miles both within and outside of the Project Area.

Crisp Creek is located approximately three-quarters of a mile west of the project site at its closest point and does not receive any surface water runoff from the site. However, groundwater that infiltrates on portions of the site travels south and west to feed springs that discharge to Crisp Creek (AESI 2008). The Keta Creek Hatchery operated by the Muckleshoot Indian Tribe is located near RM 1.1. Crisp Creek is the primary water supply for the hatchery and the former WDFW rearing ponds located nearby (Carlson 1994). Crisp Creek is dominated by ground water recharge which enters the creek as springs approximately one-half mile upstream of the hatchery and state rearing ponds (Carlson 1994).

Crisp Creek supports runs of coho, Chinook, and chum salmon and winter steelhead (Kerwin and Nelson 2000). Resident and anadromous cutthroats have also been observed.

2.5.7 Green River Spring

The Green River Spring is located near the extreme southwest corner of the Project site (Parcel BDA, northwest corner of Section 27). Source flow for the spring is described by AESI (2008). Flow from the spring enters into the Green River at approximately RM 40. Little is known about salmonid use of the stream emanating from the spring. A very steep chute runs downhill from near the spring to the Green River floodplain. It is likely that fish make use of the stream on the floodplain and the spring influences water quality in the Green River itself.

2.5.8 Green River

The Green River begins in the Cascade Mountains approximately 30 miles northeast of Mount Rainier and flows west and northwest over 93 miles to Puget Sound where it enters at Elliot Bay near Seattle. Instream flows and sediment transport characteristics of the lower Green/Duwamish River system are influenced by Howard Hanson Dam operations and water withdrawal at the Tacoma Headworks. The dam is operated to control flooding downstream and, since its construction in 1961, has eliminated most high flows above the 2-year event. The 2002/2004 Water Quality 303(d) List cites the Green River between RM 11 and RM 42.3 as limited for DO, fecal coliform bacteria, mercury, and temperature (Ecology 2005).

2.6 Fish Use: Onsite

Local, county, state, and federal reports and databases were reviewed to identify any known or presumed fish use of onsite stream channels. These references included Williams et al. 1975, King County 1990, WDFW and WWTIT 1994, City of Black Diamond 1996, WDFW 1998, Kerwin and Nelson 2000, King County 2000, NMFS 2005, USFWS 2005, King County 2007, WDFW 2008a, WDFW 2008b.

Resident cutthroat trout and coho salmon are the dominant native species found in on-site fish-bearing waters discussed above in Section 2.5. These waters are Streams S4, S5, S7, Rock Creek and Black Diamond Lake. Numerous non-naturally occurring fish species in this area have been stocked by WDFW and others. Stocked species include rainbow trout, largemouth and smallmouth bass, yellow perch, eastern brook trout, kokanee, crappie, and bullhead.

The only federally listed fish species known to occur within the project site is a winter run of steelhead salmon (WDFW 2008). Steelhead have been reported in Rock Creek and could be present in the other fish-bearing streams.

Only coho salmon, steelhead, and cutthroat trout are known to occur above the outlet of Lake Sawyer (Covington Creek). Coho salmon and cutthroat trout have been reported upstream as far as Jones Lake in Rock Creek (Kerwin and Nelson 2000). Steelhead move up a mile or two past Lake Sawyer into Rock Creek but have not been reported as far upstream as coho or cutthroat. Coho and cutthroat trout have been reported in Ravensdale Creek (WDFW 2008). Life histories of these three native species are described in more detail below.

Coho Salmon

Coho salmon adults within the Green/Duwamish River system are generally 3-year-olds, having spent approximately 18 months in fresh water and 18 months in salt water. In the Green River, coho salmon begin entering the system in August and spawn from late September to mid-January. The Lake Sawyer run is a late run which moves into the lake in late December with most fish spawning in Ravensdale Creek (City of Black Diamond 1996). In general, earlier migrating fish spawn farther upstream within a basin than later migrating fish, which enter rivers in a more advanced state of sexual maturity (Sandercock 1991). Coho often move upstream into the smaller streams and tributaries to spawn. Coho spawn in all available tributaries and in the mainstem Green River. Mainstem spawning is heaviest in areas between Burns Creek (RM 38.0)

and the Tacoma Headworks dam (RM 61.0) (USFWS and NMFS 2000). Coho fry begin hatching in late winter and typically rear 1 year in freshwater prior to migrating to Puget Sound the following spring. Juvenile coho salmon are found rearing in mainstem sections of the Green River below Howard Hanson Dam and in all tributaries that are accessible to adult spawners. Peak outmigration of juvenile coho generally occurs in May. These fish migrate relatively quickly out to the open ocean, where they overwinter before returning the following summer.

Green River coho salmon are part of the greater Puget Sound/Strait of Georgia ESU considered by NMFS to be a candidate for listing under the ESA. Coho salmon of the Green River system are divided into the Soos and Newaukum Creek stocks. Both stocks are of mixed origin and contain both native and non-native coho. The Newaukum Creek stock is considered depressed, and the Soos Creek stock is currently considered healthy (WDFW and WWTIT 1994).

Steelhead

Steelhead and rainbow trout represent different life histories of the same species of salmonid. Steelhead migrate to salt water after spawning in fresh water (anadromous), but rainbow trout spend their entire lives in fresh water. Two major run types, winter and summer steelhead, are found in the Green/Duwamish river basin. Winter steelhead adults begin river entry in December and generally spawn from February through May. The winter steelhead run is native to the Green River (WDFW and WWTIT 1994). The Green/Duwamish river basin also supports a non-native origin summer steelhead run. Summer-run steelhead generally enter the river from May through October and spawn from February through April. Winter steelhead spawn in the Green River from approximately RM 26.0 to RM 61.0 (USFWS and NMFS 2000). Summer steelhead principally spawn in the mainstream and lower tributary areas from the Tacoma Headworks (RM 61.0) downstream to the upper Green River Gorge (RM 58.0). The resultant fry typically outmigrate between April and June after spending at least one complete year and up to three years in fresh water.

Resident rainbow trout spend their entire lives in freshwater wherever deep, cool water with high oxygen content can be found. Rainbow trout spawning also occurs during the spring, with the juveniles occupying available habitat within the natal stream.

Green/Duwamish River steelhead are part of the Puget Sound ESU. The Puget Sound steelhead stock is considered by NMFS to be at risk of becoming endangered and was therefore listed as threatened under the federal Endangered Species Act (72 FR 26722). Both the summer and winter Green/Duwamish River steelhead stocks were listed as healthy by the WDFW based on meeting escapement goals in the early 1990s (WDFW and WWTIT 1994).

Cutthroat Trout

Resident cutthroat trout are present throughout all perennial reaches of the Green River drainage (WDFW 2000). Anadromous fish are believed present through all accessible reaches of the system (USFWS and NMFS 2000). Anadromous cutthroat enter the river from July through February and spawn from March into early May. Resident trout spawn into June. Spawning occurs throughout the system where medium to coarse gravel is found. The fry emerge from late March to mid-July depending on spawning location and timing. Anadromous cutthroat trout fry

may rear in fresh water for up to several years before migrating to the sea which usually occurs in the spring, peaking during May. They typically spend less than a year in the ocean before returning to spawn. Cutthroat may spawn several times during their lifespan.

The population of coastal cutthroat trout in the Green/Duwamish River system is small and not well studied (USFWS and NMFS 2000). Less than 50 are caught by anglers each year (WDFW 2000). It is considered to be native and the population is maintained through wild production (WDFW 2000). The stock status is labeled unknown by WDFW due to insufficient data. The Green/Duwamish River coastal cutthroat trout population is part of the Puget Sound ESU. The Puget Sound ESU does not warrant listing under the federal ESA, as populations have been fairly stable over the past 10 to 15 years (64 FR 16397).

2.7 Fish Use: Off-site

This section describes fish use in off-site watercourses potentially affected by project actions.

Chinook, coho, chum, pink, and sockeye salmon; steelhead; and coastal cutthroat trout are currently found at various times of the year in the Green/Duwamish River System downstream of the project site (Table 2). Native char (bull trout and Dolly Varden) may be present though this is not considered likely (WDFW 1998, Kerwin and Nelson 2000, USFWS 2005). Native resident salmonids in the WRIA include rainbow and cutthroat trout and mountain whitefish. Other native resident fish species are also present, including lamprey and various minnow, sculpin, and sucker species.

Other listed species found downstream of Lake Sawyer and elsewhere in the Green River watershed include Chinook salmon and bull trout.

Chinook Salmon

Chinook salmon within the Green/Duwamish River basin originate from both native and hatchery fish. The stock is of mixed origin, as natural production is currently supplemented by hatchery releases from the Green River Hatchery located on Soos Creek. Most Chinook salmon in the Green River system are summer/fall run fish (WDFW and WWTIT 1994, Ruggerone and Weitkamp 2004). Adult summer/fall Chinook return to the Green River from late June through September and spawn from early September into mid-November (USFWS and NMFS 2000). The Duwamish/Green stock spawns primarily in the main river channel from Kent (RM 24.0) to the Tacoma Headworks diversion (RM 61.0). The Newaukum Chinook stock spawn in Newaukum Creek (RM 40.7). Fry emergence is usually complete by February with most summer/fall run fish outmigrating within 2 to 3 months of emergence.

Chinook in the Green River are part of the Puget Sound Evolutionarily Significant Unit (ESU) currently listed by the National Marine Fisheries Service (NMFS) as threatened under the Endangered Species Act (ESA). Both Green River Chinook stocks are listed as healthy by the Washington Department of Fish and Wildlife (WDFW) based on stable escapement levels.

Table 2
Green/Duwamish River Salmonid Temporal Distribution

Stock	Lifestage	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Chinook [a]	Adult Migration												
	Spawning												
	Incubation/Rearing												
	Outmigration												
Coho [b]	Adult Migration												
	Spawning												
	Incubation/Rearing												
	Outmigration												
Chum [c]	Adult Migration												
	Spawning												
	Incubation/Rearing												
	Outmigration												
Pink [d]	Adult Migration												
	Spawning												
	Incubation/Rearing												
	Outmigration												
Steelhead	Adult Migration												
	Spawning												
	Incubation/Rearing												
	Outmigration												
Cutthroat	Adult Migration												
	Spawning												
	Incubation/Rearing												
	Outmigration												
Char [e]	Adult Migration												
	Spawning												
	Incubation/Rearing												
	Outmigration												

(Adapted from: Williams et al. 1975, WDFW and WWTIT 1994, USFWS and NMFS 2000, WDFW 2007)
[a] Includes both Green/Duwamish and Newaukum Creek summer/fall Chinook stocks.
[b] Includes both Green/Soos (healthy) and Newaukum Creek (depressed) coho stocks.
[c] Includes both Green/Duwamish (unknown) and Crisp Creek (healthy) chum stocks.
[d] Pink salmon spawn only in odd years. Periodicity is based on regional averages. Status not listed by WDFW.
[e] Native char include both bull trout and Dolly Varden. Periodicity based on general/regional information.

Chum Salmon

Chum salmon adults return to the Green River from early September through December. Spawning takes place from early November through mid-January and is concentrated in and downstream of Burns Creek (RM 38.0). Incubation takes between 90 and 150 days depending on water temperature, with fry emergence occurring from February through July. Chum fry usually remain in fresh water for only a few days before beginning their downstream migration to estuarine habitat in the lower Duwamish River and Elliot Bay. Migration takes place at night.

Two chum salmon stocks are recognized in the Green River system (WDFW and WWTIT 1994). The Green/Duwamish stock may be a remnant native stock, but its status is considered unknown by WDFW due to insufficient data. The Crisp Creek fall chum stock originated from releases of Quilcene and Hood Canal stocks in the early 1980s and is considered healthy by WDFW.

Pink Salmon

Not much is known about the distribution of pink salmon in the Green River (USFWS and NMFS 2000). Pink salmon return to the Duwamish and lower Green River every other year (odd years) in the fall and probably spawn between August and October. Pink salmon typically experience a 2-year life span. Females dig redds in riffles or runs with small- to medium-sized gravels. Pink fry begin hatching between February and May and almost immediately begin their migration to Puget Sound. Juveniles form large schools in estuarine areas during the summer where they feed mostly on various species of zooplankton. After several months, the fish move out to the ocean, typically running in the shallower areas nearshore.

The Puget Sound pink salmon stock is considered by NMFS to be healthy and not at risk of extinction based on escapement near historic levels (60 FR 51928). No Duwamish/Green River pink salmon stock is recognized by WDFW (WDFW and WWTIT 1994).

Sockeye Salmon

Sockeye salmon exhibit a variety of life-history types including freshwater (kokanee), lacustrine sockeye, and river-type sockeye. Lake-rearing stocks represent the most common and typical life history. Sockeye that rear in rivers for 1 to 2 years (river-type sockeye) are less common and little is known about them. The Green River possesses river-type sockeye in very low numbers (USFWS and NMFS 2000). Only between 100 and 400 are reported annually near the Headworks Dam (Kerwin and Nelson 2000). Sockeye salmon enter most Puget Sound rivers from mid-June through August. Spawning takes place from late September to late December and occasionally into January. Peak emergence for similar river systems occurs from early March to mid-May.

The origin of adult sockeye observed spawning in the Green/Duwamish river basin is not known. It is hypothesized that the fish may either be strays from other populations, a riverine form of sockeye, or some combination of both (Kerwin and Nelson 2000).

Native Char

Bull trout and Dolly Varden are native char, typically found in high mountain streams or near cold perennial springs, although individual fish can occur downstream throughout larger river systems (Rieman and McIntyre 1993, Buchanan and Gregory 1997). Water temperature above 15°C is believed to limit bull trout distribution, which partially explains the generally patchy distribution within a watershed (Fraley and Shepard 1989; Rieman and McIntyre 1995). Preferred spawning habitat consists of low-gradient streams with loose, clean gravel (Fraley and Shepard 1989) and water temperatures of 5°C to 9°C in late summer to early fall (Goetz 1989). Bull trout generally live in fresh water their entire lives, although a small component of the Puget Sound run is anadromous. Dolly Varden are generally anadromous. Self-sustaining bull trout populations in the Green/Duwamish River Basin have not been documented, although individual fish have been observed (WDFW 1998, Kerwin and Nelson 2000).

Bull trout were historically found in the lower Green River but have not been recently documented. Their presence is considered "possible but not likely" (Kerwin and Nelson 2000). Any bull trout found in the Green/Duwamish River are part of the Puget Sound bull trout

Distinct Population Segment (DPS) identified by the United States Fish and Wildlife Service (USFWS). All bull trout in the coterminous United States were listed by the USFWS as threatened under the ESA (64 FR 58910). Dolly Varden are proposed for listing as threatened due to their similarity of appearance to bull trout (66 FR 1628). The stock status is labeled unknown according to WDFW (1998) due to insufficient data. The mainstem of the Green River, but not any of the tributaries, has been listed as Critical Habitat for bull trout (USFWS 2005).

2.8 Barriers to Fish Migration

The water surface level of Lake Sawyer is controlled by a concrete weir which was constructed at the head of Covington Creek in 1952. A fish ladder at this location allows upstream fish passage when sufficient flow is present. According to Patrick Trotter, a consulting fisheries biologist, the lake level naturally draws down during the summer which exposes the fish ladder built at the weir (AESI 2000). Mr. Trotter believes a beaver dam was originally at the outlet of Lake Sawyer to Covington Creek and the late winter run of coho unique life history timing is a product of the natural drawdown of Lake Sawyer and a long history of a natural barrier at the outlet. Because flows leaving the lake are low in the summer when adult Chinook would normally return, no Chinook have been reported upstream of the head of Covington Creek.

Beaver dams and other partial natural barriers may prevent fish from moving upstream into Black Diamond Lake at certain flow levels. A culvert off-site near the north property boundary may prevent upstream fish passage in Stream S4. An on-site culvert under a logging road near the headwaters of Stream S5 may prevent upstream fish migration at this point. However, the culvert is in a steep section of stream and it is not known if any fish are present at this location. Fish habitat upstream of this point is minimal.

2.9 Federally Protected Fish Species

Three fish species listed as threatened under the federal ESA and one fish species proposed for listing could potentially be directly or indirectly affected by the Proposed Action and Alternatives. The listed species are Chinook salmon, steelhead, and bull trout. The Dolly Varden is proposed for listing because of its similarity of appearance to bull trout. In addition, Chinook, coho, and pink salmon habitat has been designated Essential Fish Habitat (EFH) by the Pacific Fisheries Management Council. Descriptions of the life history and occurrence of these fish species in the project area are provided in Section 2.8.

3.0 IMPACTS ANALYSIS

Impacts and mitigation measures for the Proposed Action and the No Action Alternative are presented in this section. Evaluation of impacts was based on the level of quantification provided in supporting documents prepared by other EIS consultants, in particular the water quality analysis prepared by A.C. Kindig & Co. (2008), surface hydrologic analysis prepared by Triad (2008), and geology, soils, and ground water analysis prepared by AESI (2008).

The capacity of fresh water streams to support a population of salmonid fishes is a function of the quality and quantity of habitat conditions for various life history stages of existing or potentially existing species. Factors related to land development that influence habitat conditions are generally associated with:

- Physical loss or degradation of habitat features resulting from structures being built within or over the active channel, adjacent riparian area, or potential channel migration zone;
- The change in delivery of fine and coarse sediments to the stream channel;
- Impacts to the functions and values provided by riparian zones;
- Effects on water quality; and
- Changes in surface and ground water quantity.

The influence of each of these factors on fish habitat and existing site conditions is discussed below for the construction and post-construction (developed) phases of the project.

3.1 Construction Impacts Analysis

3.1.1 Proposed Action

Construction activity under the Proposed Action would include new road and utility stream crossings of Streams S-2, S-4 and S-5, installation of one new stormwater outfall to Stream S-4, clearing and grading of several hundred acres of the site, and filling of approximately 0.6 acres of wetland associated with streams.

Direct Impacts

Direct impacts to fish habitat are most likely to occur when construction activities take place at or below the ordinary high water mark (OHWM) of a fish-bearing stream, side-channel, or associated open water wetland. Construction within flowing wetlands or streams greatly increases the chance of erosion and sediment transport, and makes it more difficult to protect water quality from other potential construction effects such as contaminant spills. Construction within or near both fish-bearing and non-fish-bearing streams can eliminate nutrient input,

primary productivity, and macro-invertebrate production which contribute to the productivity of local fish populations.

Onsite development under the Proposed Action includes three tasks where construction in, near or over a waterbody could directly impact fish-bearing streams:

- Installation of a new stormwater discharge outfall to Stream S-4;
- A new stream crossing of Stream S-4; and
- A new stream crossing of Stream S-5.

The new Stream S-4 outfall would be constructed on the west bank of the channel just upstream (south) of the northern property boundary. Under standard Best Management Practices (BMP) the new outfall would be created in uplands near the creek. A short channel from the new outfall to the existing channel would then be provided to convey storm water releases. This minimizes construction activity in the natural channel because virtually all work on the outfall and new channel can be kept isolated from the natural channel by leaving the bank at the future confluence undisturbed. The final construction action would be to remove the bank between the new outfall channel and the natural channel and cover disturbed substrate with a stream gravel mix. Stream S-4 in this area provides moderate quality fish rearing and migration habitat and some care would be required in siting the actual outfall. But there are no steep slopes that might be disturbed or unusually valuable habitat. No significant adverse effects are expected.

The Stream S-4 and S-5 crossings are over stream reaches believed to be used by salmonids. The Stream S-4 crossing would consist of a full span bridge or bottomless arch-culvert covering a stream length of approximately 50 feet. The structure would meet all regulatory requirements for passage of flow and debris and little to no work below OHW would be required. The Stream S-5 crossing would occur at or near an existing logging road crossing and would replace the crossing. Suitable mitigation could include removal of the existing crossing and restoration of the riparian corridor once the new crossing is serviceable. A full span bridge or bottomless arch-culvert covering a stream length of approximately 50 feet would be used with all utilities contained in the crossing. If the Stream S-5 crossing occurs at the existing crossing location, instream work would be required to remove the existing culvert and create a new fish-passable stream channel. BMPs require work be completed when the stream is either naturally dry or by bypassing all instream flow around the work area. Because the Stream S-5 channel is small and contains little if any flow during the summer, common TESC measures are expected to provide adequate protection of downstream habitat. If the Stream S-5 crossing occurs at a new crossing location, no instream work would be required. However, mitigation could include removal of the existing crossing which would require the same instream effort described above. Because of the small channel size, absence of significant habitat, and minor flow volumes, neither situation is expected to result in significant adverse effects to fish or aquatic habitat.

Several tasks are proposed near non-fish-bearing streams and wetlands that could indirectly affect fish habitat downstream:

- A crossing of Stream S-2 is proposed. This watercourse is non-fish-bearing with all flow infiltrating to ground water. Thus, any work near this watercourse has a very low risk of affecting fish.
- A number of non-fish-bearing wetlands would be impacted by some minor filling (Wetland Resources Inc. 2008). Of the wetlands that would be impacted, only Wetland S-18 is directly tributary to a fish-bearing creek (Stream S-4). Wetland S-18 consists of fringe wetlands running in a narrow band along both sides of Stream S-4 and supported by flows in the creek. Thus, the minor impacts (less than 0.05 acres of wetland disturbance) caused by the road crossing and outfall placement are not expected to have a significant effect on fish habitat.

Off-site road improvements could include paving and shoulder work along portions of the Auburn-Black Diamond Road. Work near the existing Rock Creek crossing and one or two small tributaries to Rock Creek may be necessary. While no specific plans are available, it is assumed that any work would consist of minor road improvements with possible short extensions to existing crossings. Culvert or bridge extensions would require Hydraulic Project Approval from WDFW and possibly federal permits if wetlands were affected. Maintenance or enhancement of fish passage would be required and mitigation typically includes riparian enhancement. These minor off-site improvements are not expected to have a significant adverse effect on fish or fish habitat.

Stream (ditch) S-3 contains a natural source of water but is isolated, seasonal, and non-fish-bearing. The ditch was formed when a logging road passed through a wetland. Flow from the wetland runs down an old logging road before infiltrating when the road reaches the recessional outwash soils near the toe of the slope. The portion of ditch not conveyed within the wetland is proposed to be filled to help protect wetland hydrology. Because the channel is isolated and non-fish-bearing, no impacts to fish are possible.

The conceptual design shows a total of approximately 0.6 acres over 9 wetlands would be filled for the project (Wetlands Resources Inc. 2008). None of the wetlands would be filled in their entirety. Impacted wetlands are for the most part well removed from fish-bearing waters and do not provide habitat for fish. Some minor loss of hydrologic function could be expected. However, mitigation to include wetland replacement, buffer enhancement, and hydrologic supplementation, along with the relatively miniscule effect within each contributing basin precludes overall impacts to fisheries resources from being significant.

With proposed Temporary Erosion and Sediment Control (TESC) BMPs (A.C. Kindig & Co. 2008) it is unlikely that any significant direct adverse effects on fisheries resources would result from construction under the Proposed Action.

Impacts to Fine Sediment Recruitment

The greatest risk to fish habitat resulting from land development construction activities is the potential for fine sediments to be mobilized from newly exposed soils by rainfall or stormwater

runoff. Fine sediments less than 0.85 mm in diameter (fine sand and smaller) can impair water quality and degrade salmonid spawning habitat and spawning success if heavy sedimentation of gravels occurs during spawning and incubation (Chapman 1988, Tappel and Bjornn 1983). Fine sediments in large volumes can reduce summer and winter rearing capacities by filling pools, embedding stream substrates, and decreasing food production (Peterson et al. 1992, Lisle and Hilton 1992).

Very fine sediments, which elevate turbidity for a sustained period, can directly affect fish behavior and physiology, or indirectly decrease food supply, habitat availability, or the ability of fish to find prey. Turbidity can also exacerbate existing problems, such as poor DO levels or high temperatures, and lower fish tolerance to other water quality parameters. Behavioral modifications include cessation of feeding and outmigration. Physical reactions include excessive mucus secretion, excretory interference and respiratory complications resulting in possible suffocation (Redding et al. 1987).

The impact of any fine sediment transported to fish habitat depends in part on the time of year, watercourse gradient, and habitat type. If TESC measures failed, sediment would be transported to fish-bearing waters primarily during the winter when there would be sufficient stream energy available to mobilize and transport the material. Fine sediments are deposited in low-gradient streams (those with less than approximately 1 percent slope), which means that Black Diamond Lake, Black Diamond Creek, Rock Creek, and Streams S-4 and the lower part of Stream S-5 are potentially vulnerable.

Spawning habitat used or potentially used by anadromous salmon and/or resident trout is present on the project site in Rock Creek, Stream S-4, and Stream S-5. None of these streams contain regionally significant spawning habitat but may be important in maintaining local resident populations and contributing to the larger basin production for migratory species (Kerwin and Nelson 2000, USFWS and NMFS 2000, Williams et al. 1975, WDFW and WWTIT 1994). Thus, the highly vulnerable incubation stage of the salmonid lifecycle is potentially at risk of being affected by construction under the Proposed Action.

A National Pollutant Discharge Elimination System (NPDES) Permit is required for this project from the Washington State Department of Ecology (Ecology) for discharge of stormwater. The NPDES permit requires preparation of a stormwater pollution prevention plan (SWPPP). TESC BMPs would be implemented and maintained in accordance with the SWPPP. Clearing and grading for construction exposes erodible soils and increases the rate of surface water runoff from storms because of soil compaction and removal of vegetation. The most significant increase in erosion potential would be during the early construction phase when earthwork activities near onsite watercourses commence. BMPs described by A.C. Kindig & Co. (2008) would be implemented to prevent or minimize impacts to water quality from grading and construction work.

A.C. Kindig & Co. (2008) evaluated the risk of erosion due to construction activities considering site-specific conditions and assuming BMPs required under an NPDES permit and the King County Surface Water Design Manual (SWDM) were implemented. The TESC BMPs are

described in Section 3.1 of the water quality analysis (A.C. Kindig & Co. 2008). With the use of BMPs, proper site inspection, and implementation of the SWPPP, Hydraulic Permit Approval (HPA), and Section 404 and 401 permit conditions, impacts due to sediment releases are unlikely to cause significant adverse effect to aquatic habitat (A.C. Kindig & Co. 2008). Thus, the potential for adverse effects on fish is not considered significant.

Impacts to Coarse Sediment Recruitment

Coarse sediments enter the stream network naturally through bank erosion, mass wasting events, and catastrophic landscape events such as dam-break floods and debris torrents. Land use changes can influence delivery of coarse sediments to streams by altering natural rates of bank erosion, mass wasting, and catastrophic events. The most notable practices are generally related to disturbances of steep slopes and bank protection to shield project features from floods. Whereas fish habitat is to a large extent dependent on sufficient coarse sediment in streams (spawning gravels, deformable bed thickness capable of creating deep pools, etc.), too much coarse sediment can reduce the fish production capacity of a stream. Sediments can fill pools or deposit amounts that change bed elevations and alter stream courses. Dry reaches can result where summer low flows are inadequate to fill increased interstitial spaces in deposits of coarse sediment. Coarse sediment volumes deposited in thickness greater than the height of channel obstructions (large woody debris, boulders, etc.) would reduce the hydrologic value of the obstructions. Such deposits are considered too great a volume to benefit fish habitat.

Under existing conditions, there are no significant deposits of coarse sediments found on the project site that adjacent streams are capable of transporting. Rather, coarse sediment is recruited at low levels from channel banks throughout the system. Only Stream S-5 is steep enough to mobilize and carry coarse sediment. But this creek drains directly to Black Diamond Lake were any larger particles would deposit without further movement. The very large wetlands that form the headwaters of Stream S-4 provide an unusually stable stream flow in this channel and buffer the stream from larger storm events. An examination of substrate in this channel found that most particles larger than an inch in diameter were moss or algae covered indicating a lack of transport (AESI 2008). Any sediment that did move downstream through Stream S-4 would deposit in Jones Lake. Thus, it is unlikely that construction of the new stream crossings or outfalls would interrupt any significant supply of coarse sediment from the site.

Landslide hazard areas were described and ranked by AESI (2008 - see Section 4.4.2). High hazard areas that could potentially deliver sediment to waterbodies are present near Black Diamond Lake and Black Diamond Creek, as well as in the Green River Valley. The risk of initiating landslides in these area during construction was evaluated by AESI (2008 – see Section 6.3). AESI determined that the stability of slopes potentially contributing mass quantities of sediments would not be affected by development of the Proposed Action or No Action alternatives. This was based on the proposed design which avoids work near steep slopes and keeps stormwater away from high hazard slopes and streams, as well as from uplands where infiltration could lead to increased groundwater or spring discharge onto or near steep slopes.

Impacts to Water Quality

Water quality components that are critical to fish habitat and most often affected by land development include water temperature, turbidity, toxic chemicals, metals, DO, nutrients, and pH. Construction measures designed to protect water quality and their expected efficacy are described by A.C. Kindig & Co. (2008 – See Section 3.1). The analysis reached a conclusion that with proper control of stormwater drainage, BMPs defined for culvert work below the OHWM, and good accidental spill response planning, adverse impacts from fine sediment, alkaline (high) pH, and construction-related accidental hazardous material spills would be reasonably expected to be avoided or limited to small short-term and mainly onsite occurrences with no lasting adverse effects. Some minor introductions of fine sediments to stormwater leaving the site during heavy rainstorms may occur from time to time, but stringent implementation of SWPPP measures and countermeasures required by federal, state, and City of Black Diamond permits should identify and rapidly correct such occurrences so that they would not adversely affect habitat through water quality impacts. Therefore, no significant adverse construction-related water quality impacts to fish or fish habitat are expected.

Impacts to Listed Species

No listed fish species are found on the project site. Indirect (off-site) impacts were evaluated above. Construction impacts described in Section 3.1 are not likely to result in adverse effects to listed species or their habitat due to the provision of water quality and water quantity mitigation; the reasonable likelihood that proposed mitigation measures would adequately protect aquatic habitat; and the absence of spawning habitat for listed species within, adjacent to, or within a reasonable distance downstream of the project site. Thus, no significant construction-related adverse impacts to listed species are expected.

3.1.2 No Action Alternative

The No Action Alternative is defined by what would be most likely to happen if the Villages MPD did not occur. Logging activities could continue to take place onsite in the future and some of the area could be developed as individual or small clusters of parcels. Sensitive area buffers would be protected the same as with the other alternatives, but the larger open space parcels adjacent to sensitive areas and elsewhere would not be created. There would be no coordinated opportunity to deal with stormwater treatment and detention, so much of the area would be dealt with on a lot-by-lot basis.

Development of the No-Action Alternative has less potential for impact to water quality than construction under the Proposed Action because of the absence of large-scale grading and the staggered timing of potential impacts. However, separate ownership and isolated development of parcels could lead to a less cohesively planned roadway and driveway layout and the lack of an integrated drainage and erosion control plan. Roadway or driveway access could cross or drain to wetlands and/or streams and cause localized sediment introduction or turbidity. If the roadways or driveways are unpaved, sediment introduction, though minor, could be chronic where such impacts occurred.

The No-Action Alternative could have a slightly greater risk to fisheries resources due to the less-coordinated approach to stream and buffer protection during construction. However, the risk of large scale impacts due to a catastrophic rainfall event is less, as less overall grading would occur. Therefore, construction effects on water quality, if any, would most likely be relatively small.

3.2 Post-construction Impacts Analysis

This section evaluates long-term impacts on fisheries resources of the developed project (post-construction) for the Proposed Action and No Action Alternatives. Direct and indirect effects of the altered landscape and land use are examined. Impacts related to water quality, water quantity, and sediment input are summarized from other reports or other portions of the EIS.

The following text compares aquatic habitat-related functions and values of onsite and off-site watercourses under both existing and proposed conditions utilizing best available science.

3.2.1 Proposed Action

Under the post-development condition, all infrastructure and mass grading would have been completed and major disturbed areas would have been stabilized and revegetated. It is expected that individual site development and onsite road construction could continue for many additional years but this would occur with only minor localized grading in upland areas and using established stormwater controls. The stormwater system would be fully constructed and would be managed consistent with the Ecology 2005 Manual as described by Triad (2008).

Direct Impacts

No major direct changes (e.g., channel moving) to any regional streams are anticipated under either alternative. Two new or upgraded stream crossings (Streams S-4 and S-5) and one new stormwater outfall (Stream S-4) are the only projects proposed that would require work within or above a stream channel (Figure 2).

Both new stream crossings are over reaches believed to be used by salmonids. Due to the small stream sizes, fish use is likely by resident trout only, or could possibly include juvenile coho use in Stream S-4. Both crossings would consist of full span bridges or bottomless arch-culverts covering a stream length of around 50 feet. The structures would meet all regulatory requirements for passage of fish, flow, and debris. The bridges would reduce habitat quality over the covered section of each stream. Neither affected stream reach provides a regionally significant resource or contains unusually rare or sensitive habitat or species. As such, the impacts are not expected to be significant on a regional scale.

The stormwater outfall would be built away from the channel in an upland area and then connected to Stream S-4 with a new channel. Some minor hydrologic effects on Stream S-4 in the vicinity of the outfall channel connection are possible. The addition of a second flow source at this location could influence habitat type and quality in the connection area. However, habitat in this channel consists almost entirely of riffle or run morphologies and is fairly stable based on

the moss and algae covered substrates. Hydraulic changes given the minor overall change in flow are expected to be minor (AESI 2008).

Increased development in the region would also bring additional people in closer contact with local rivers and streams. Angling in streams draining the site is against state law, though poaching and legal angling pressure on regional fisheries would be expected to increase. Increased human activity near the streams can also add stress to fish populations and result in significant degradation to the banks, stream channels, and riparian vegetation. No individual lots would be directly adjacent to fish-bearing stream riparian corridors so homeowners can not extend landscaping and other disturbances into these buffers to the detriment of fish habitat. New trail systems would be designed to focus human activity in locations away from streams to help avoid unregulated use of the riparian corridors.

No significant direct adverse effects to streams or fisheries resources are expected as a result of the proposed action. Mitigation measures suggested in Section 4.2 would further reduce any minor long-term effects.

Impacts to Fine Sediment Recruitment

Most of the existing roads on the project site were built for past forest management activities. The road bases consist of native material or native material overlain with gravel. Past traffic on these roads including heavy trucks, bicycles, horses, and off-road vehicles has accelerated the production and transportation of fine sediments. Drainage ditches collect the fine material and transport it during rain events to natural surface drainages. These roads would be eliminated as the surrounding portions of the site were developed. This would reduce the recruitment of fine material to area rivers, especially where existing dirt roads are within 200 feet of surface drainages (Burroughs and King 1989).

The risk of long-term erosion under a post-development scenario is likely to decrease for a site with the long-term disturbance history that occurred due to logging. Under existing conditions, there are many miles of dirt road and areas with poorly vegetated slopes. Once buildings and roadways are completed and landscaping and other vegetative cover established, the risk of erosion is expected to be similar to or less than existing conditions. Groundwater fed spring flows and instream flows are not expected to change significantly, thus instream erosion and sediment transport would not be affected (AESI 2008).

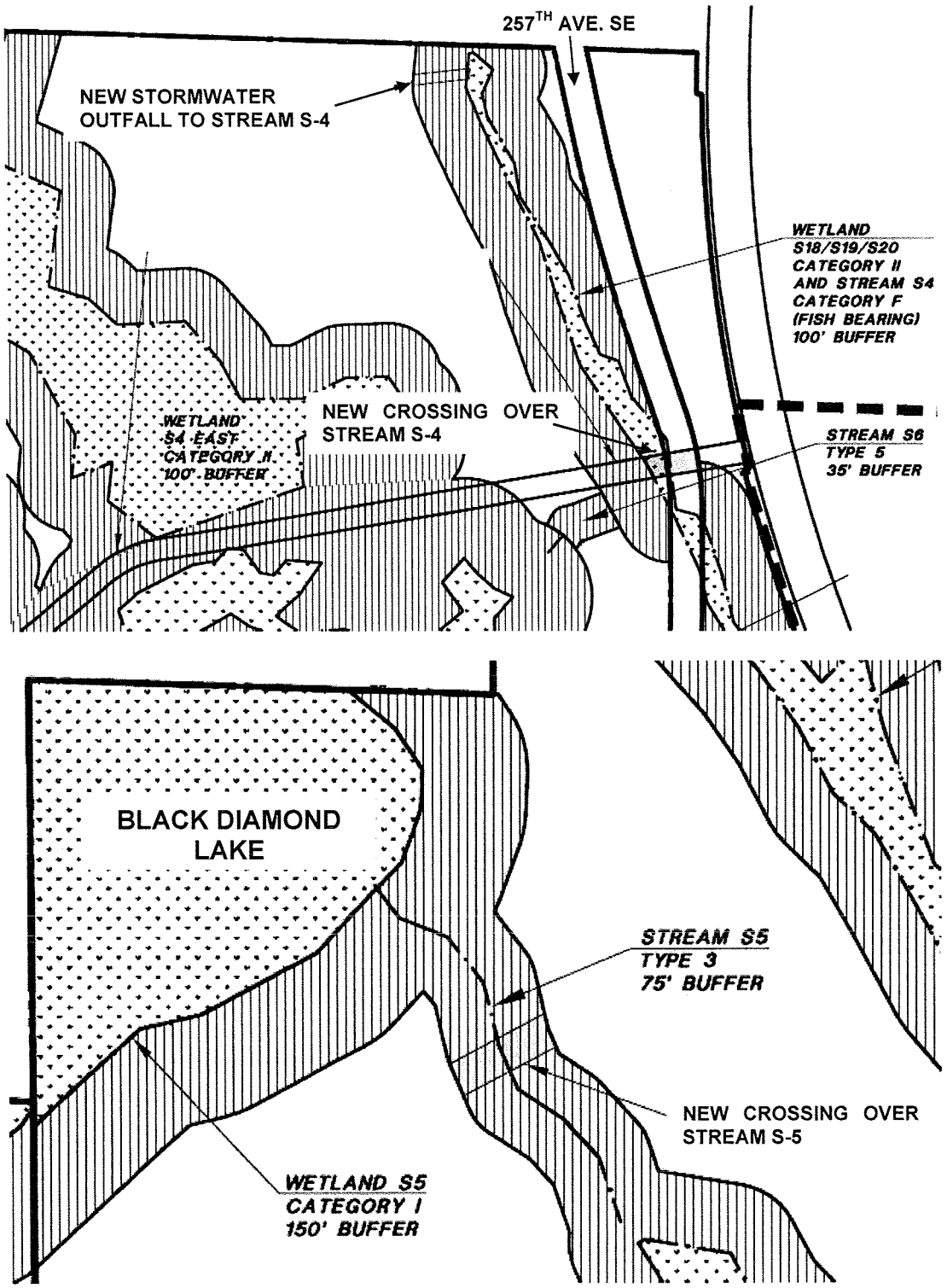

Figure 2. Proposed stream impact locations.

Impacts to Coarse Sediment Recruitment

As discussed in Section 3.1, there are no onsite channels with the capacity to transport coarse sediment to areas with regionally important salmonid habitat (e.g. Rock, Crisp, and Covington Creeks). Coarse sediment supply to these creeks and fluvial transport mechanisms are not expected to be affected for the following reasons:

- There are no significant sources of potential coarse sediment recruitment on the site.
- Lakes that would intercept coarse sediment and prevent further downstream transport are found downstream of channels with some capacity to transport coarse sediments (e.g. Black Diamond Lake, Jones Lake).
- AESI (2008) reviewed areas of potentially unstable slopes near waterbodies and found that stability is not expected to change with development.
- Large buffers would be maintained adjacent to high landslide hazard areas thereby maintaining slope stability on the banks and steep slopes near waterbodies.
- Although minor changes to instream flows are predicted, flows would not change sufficiently to affect sediment transport characteristics.

Thus, development-related changes to the watercourses are not expected to have a significant impact on coarse sediment recruitment.

Impacts to Riparian Functions

Riparian buffers perform many functions essential to fish survival and productivity. Vegetation in riparian areas shades streams and maintains cool water temperatures needed by most fish native to the Pacific Northwest. Plant roots stabilize stream banks and help control erosion and sedimentation. Adjacent vegetation creates overhanging cover for fish. Riparian habitat contributes leaves, twigs, and insects to streams, thereby providing basic food and nutrients that support fish and aquatic wildlife. Large trees that fall into streams create pools, riffles, backwater, small dams, and off-channel habitat that are needed by fish for cover, spawning, rearing, and protection from predators. Pools help maintain riffles, where gravel essential for spawning accumulates. Riparian vegetation, litter layers, and soils filter incoming sediments and pollutants, thereby assisting in the maintenance of high water quality needed for healthy fish populations. Riparian habitat moderates stream volumes by reducing peak flows during flooding periods and by storing and slowly releasing water into streams during low flows (Knutson and Naef 1997).

The proposed riparian corridors and buffer widths adjacent to onsite streams have been designed to accommodate the proposed development and maintain significant functionality based on Best Available Science (Table 3). Most of the proposed buffer widths are a minimum but under developed conditions would actually exceed that value. For example, Rock Creek, which is the largest fish-bearing stream onsite, is surrounded by wetlands between the channel and proposed

development activities. The proposed 150-foot buffer would begin from the edge of the fringing wetlands. The actual channel ranges around 200 feet to almost 1,000 feet away from the wetland edge. So in reality, the Rock Creek buffer would be between 350 feet and 1,150 feet. The second largest fish-bearing watercourse is Stream S-4. Development is proposed along only one side of about half of the length of the onsite channel. Therefore, for about 25 percent of the Stream S-4 channel length, the minimum buffer would be 100-feet. For 75 percent of the channel length the buffer would remain untouched for a distance up to 2,000 feet.

The following discussion provides a brief analysis of the science that went into the evaluation of impacts to changes in riparian functions and values.

- Large Woody Debris

Large woody debris consists of downed tree stems and branches and is a functionally important structural component of stream channels in the Pacific Northwest (Fetherston et al. 1995, Naiman and Beechie 1992). Once large woody debris reaches a stream it may remain in place or migrate downstream depending on the size of the wood and stream energy. Large woody debris can have a major effect on the quality of fish habitat within a stream, as it influences the routing of water and sediment, helps trap and stabilize coarse gravel deposits, plays a role in the development of channel morphology, is an important source of overhead and velocity cover for fish, and acts as a surface for biological activity (which contributes to the productivity of a stream system) (Bisson et al. 1987, Beschta et al. 1987, Sullivan et al. 1987, Bilby and Ward 1991).

Table 3
Proposed Stream Buffers

Waterbody	Proposed Buffer	Comments
Stream S-2	50 feet	All surface water infiltrates before reaching fish-bearing waters
Stream S-4	100+ feet	Fish-bearing; no development proposed along most of this channel
Stream S-5	75+ feet	Fish-bearing; located within high landslide hazard area; no development proposed along most of this channel
Stream S-6	50+ feet	No development proposed along most of this channel
Stream S-7	--	No development proposed in this basin
Rock Creek	150+ feet	Fish-bearing; channel surrounded by Category 1 wetlands
Black Diamond Lake	150+ feet	Fish-bearing; fringing wetlands expand buffer in some locations

The probability that a falling tree will reach a creek is a function of its distance from the creek, tree size, ground slope near the stream, and predominant wind direction. In a mature coniferous forest, the majority (70 to 90 percent) of large woody debris in a stream comes from within 50 feet of the stream; 90 to 99 percent comes from within 100 feet; and virtually all large woody debris contributing to streams in a typical Puget Sound lowland forested region comes from within a distance equal to approximately 150 feet (Murphy and Koski 1989, McDade et al. 1990, Robison and Beschta 1990, Federal Ecosystem Management Assessment Team [FEMAT] 1993, Fetherston et al. 1995). As a forested riparian stand ages and trees get taller, proportionally more of the large woody debris contribution comes from farther away (Fetherston et al. 1995).

The average buffer for Rock Creek, Black Diamond Lake and Stream S-4 would exceed 150 feet so the proposed development would have no measurable adverse effect on future woody debris recruitment in these fish-bearing waters. The proposed buffer on Stream S-5 could be as little as 75-feet in places though it is expected to average more than that as needed to protect steep slopes. This very small stream does not have the power to transport large woody debris but the material would function locally to provide fish habitat. The proposed development could have a small adverse effect on woody debris recruitment to this creek.

- Temperature and Shade

Riparian vegetation can affect water temperature by blocking solar radiation (Beschta et al. 1987, Sullivan et al. 1990). Overhanging vegetation shades streams until the channels become so broad that, like lakes, most of the water surface is exposed to the sun. By intercepting solar radiation, vegetation prevents heat energy from reaching streams, maintaining cooler water. Because salmonids are cold-blooded, stream temperature is an extremely important factor affecting production, metabolism, growth, survival, behavior, and habitat utilization. Shade benefits of streamside vegetation vary with season, channel orientation, and forest structure among other things. Of primary concern to fisheries resources are the potential increases in water temperature that typically occur during the late summer (August-September) low-flow/peak temperature period. Solar radiation is strongest during this period.

Although there is a considerable amount of variability in research results based on topographic elevation, adjacent land uses, vegetation type, and numerous other factors, most studies found up to 100 percent temperature moderation function within 100 feet of the stream under forested conditions (Brazier and Brown 1973, Barton et al. 1985, Beschta et al. 1987, Johnson and Ryba 1992, FEMAT 1993). Pollock and Kennard (1998) believe that 50 percent shade function requires 50 feet of forest shade.

Riparian buffers adjacent to most onsite streams are moderately to well densely vegetated with a predominately mixed deciduous-coniferous tree canopy with some native understory. Only Stream S-5 contains a significant proportion of exotic plants where Himalayan blackberry makes up a considerable portion of the stream cover in places.

Proposed buffers adjacent to all fish-bearing waters are wide enough to be fully protective of stream temperatures. While narrower buffers are proposed near Streams S-2 and S-6, infiltration

of all flow in Stream S-2 means ground temperatures are reached before discharge to fish-bearing waters, and Stream S-6 is dry during the warmer summer months so temperature is not an issue.

- Beneficial Nutrient Contribution

Vegetation and plant material falling into streams form an important component of the aquatic ecosystem food chain. Particulate matter delivered by the adjacent riparian area provides nutrients for organisms that eventually are consumed by fish. Insects living in the vegetation are also eaten by fish.

Little research has been done examining particulate contribution from riparian zones (FEMAT 1993). However, it is likely that the majority of material comes from directly over, or within a very short distance of the stream. FEMAT (1993) suggests that most leaf material is contributed by trees located within approximately 50 feet. Other studies have shown that benthic invertebrate communities in streams with riparian buffers greater than 100 feet are indistinguishable from those in streams in unlogged watersheds (Ermann et al. 1977).

Existing riparian buffers contain a good assortment of different plant types, thus both vegetative litter and insect population abundance and diversity are likely of good quality. Proposed buffers adjacent to all fish-bearing waters with the exception of Stream S-5 are wide enough to protect existing nutrient contributions. Stream S-5 has a riparian buffer dominated by Himalayan blackberry so may have a lower existing function. With the proposed 75 foot buffer, existing functions are likely to remain low for this small tributary. However, no significant adverse effects to fish habitat are expected.

- Sediment and Pollutant Control

Buffer widths ranging from 30 to 100 feet are described in the literature as satisfactory for removing the majority of sediment and pollutants from surface water (summarized in Knutson and Naef 1997). The majority of pollutants are typically removed in the first 30 to 60 feet; complete removal requires more than 100 feet. Up to about ninety percent of sediment removal occurs within 100 feet; larger distances are required for steeper slopes, very heavy loadings, and poorly vegetated areas.

The proposed development alternative would eliminate natural infiltration pathways to streams by changing the hydrologic flow paths to piped drainage systems. These systems would bypass the riparian water quality function in favor of engineered facilities. Much of the natural buffer functions for hydrologic and water quality functions (peak flow attenuation, base flow releases, and water quality treatment) would be removed from riparian buffer control by storm drain systems. Stormwater detention and water quality treatment requirements are regulated under City and State codes without reliance on riparian buffer function. For these areas, the natural sediment and pollution control functions would be provided at up to 100 percent of their natural function by the proposed treatment facilities.

The exception is found within the riparian buffer to onsite streams. Rain falling in these areas would still reach the creek via natural flow paths. Under existing conditions, runoff from native surface roads in this area contributes fine sediment and any petroleum drippings from vehicles. This would be reduced under the developed scenario as the existing roads are eliminated. With the relatively large remaining buffers, treatment and infiltration of most stormwater runoff, and elimination of native surfaced roads, the Proposed Action is expected to provide nearly 100 percent of the natural water quality function of fully intact buffers.

- Bank Stability

Roots from vegetation growing along the streambank help stabilize soils and reduce erosion. Overhanging roots also provide habitat for fish where streams undercut the root balls. The soil stabilizing benefits of root structures is greatest within one-half of the crown diameter of the vegetation growing along the bank (Burroughs and Thomas 1977). Assuming that the largest plants growing along stream banks are trees, and the maximum crown diameter of a mature fir tree is approximately 80 feet, root strength benefits would be low beyond 40 feet from the channel. Smaller vegetation growing near the creek also strongly influences bank stability at distances nearer than 40 feet.

All onsite channels would be permanently protected with buffers in excess of 50-feet so increased channel erosion due to bank disturbance is not expected to be an issue. Stormwater discharge would be regulated at rates designed to avoid increases in channel erosion (Triad 2008). An evaluation of channel stability in Stream S-4 showed that the minor increase in some predicted flow rates is not expected to affect bed stability under the developed condition for the Proposed Action (AESI 2008). Possible channel stability concerns were identified for the steep slopes downgradient of springs discharging from the pre-Olympia aquifer. These springs discharge to Crisp Creek and to small tributaries on the northern Green River Valley wall. With infiltration of excess stormwater to this aquifer, a slight rise in spring discharge was predicted (AESI 2008). The predicted increase in volume represents approximately 0.4 to 0.7 percent of the total volume of the aquifer so spring discharge increase is not expected to be large. A change in flow rates of less than 1 percent is unlikely to change channel erosion rates in Crisp Creek or the other Green River tributaries.

Impacts to Water Quality

Treated stormwater quality post-construction was quantitatively estimated for the Proposed Action and No Action Alternative after buildout by A.C. Kindig & Co. (2008). A complete description of the stormwater treatment system, methods used for the water quality evaluation, and results are described in the Water Quality Technical Analysis (A.C. Kindig & Co. 2008). The following section summarizes the results of the analyses.

Stormwater quality discharge to all receiving waters would comply with state water quality standards prior to any mixing or dilution, with some possible exceptions for fecal coliforms. Most discharge parameters would be less than or near background water quality averages for the receiving waters for most of the stormwater outlets, except for total suspended solids, fecal coliforms, and total phosphorus, which would have slightly higher concentrations in most

discharges. However, none of the parameters are expected to rise to levels that would degrade aquatic habitat or adversely affect regional fish populations.

Fecal coliforms originate from wildlife, including bird droppings, and thus occur wherever storm runoff is generated from impervious surfaces. Pet waste exacerbates fecal coliform concentrations when it is left to run off with stormwater in residential areas. Although predicted fecal coliform levels could exceed the state standard during peak storm runoff periods, fecal coliform bacteria do not represent a threat to fish or fish habitat value (Snohomish County 2000, Teel 1998). Their presence may indicate other problems such as low DO or high toxic (unionized ammonia) loadings (Brown and Caldwell 1999). The Department of Ecology recognizes fecal coliform contamination only as an impairment to recreational use and not as affecting salmonid habitat quality. Thus, the periodic storm-related peaks in fecal coliform levels as a result of the project would not pose a threat to salmonids or salmonid habitat.

Phosphorus occurs in stormwater runoff from roadways, from fertilizers used in landscaping, from exterior use of detergents, and from sediment erosion. Phosphorous is not directly harmful to fish in itself but can lead to increased algal growth under the right conditions, which in turn can degrade aquatic habitat due to decreased DO levels. This is commonly observed in lakes subject to increased nutrient loads from underperforming septic drainfields. Impacts of increased phosphorus loading on Jones Lake and Lake Sawyer are evaluated by A.C. Kindig & Co. (2008). They concluded that while phosphorus loading increases are expected with future development, including The Villages, the source control and phosphorus removal measures proposed would maintain those increases to levels the Lake Sawyer Management Plan (King County 2000) expects to maintain the current lake condition and beneficial uses, including fish habitat.

Impacts to Groundwater Quantity

Development of this site has the potential to change the amount of groundwater recharge. Replacing forestland with impervious surfaces (such as streets, parking lots, and buildings) reduces evapotranspiration and has the potential to reduce groundwater recharge and increase stormwater runoff. Maintaining groundwater flow quantities is important in the protection of fish habitat, especially during the summer low-flow period when much of the flow in local streams is derived from aquifer discharge. Reduced groundwater flows could lead to increases in summer water temperatures, with possible reductions in DO levels.

Crisp Creek and Green River in particular are highly dependant on spring flow to maintain summer baseflow levels and cool water temperatures. Smaller onsite streams are more dependant on interflow and shallow aquifer contributions.

AESI (2008) spent considerable effort evaluating existing groundwater conditions and potential effects of the development on this site. Section 7 of AESI (2008) provides a detailed analysis of expected impacts and mitigation measures. Extensive coordination between the resource analysts (fisheries and wetlands), project engineers/designers, and AESI helped ensure that potentially sensitive resources, possible impacts, and suitable mitigation were identified and provided. Mitigation designed to protect aquatic resources includes the following:

- The stormwater management plan developed for the site (Triad 2008) calls for extensive infiltration of stormwater runoff from the site using several small shallow dispersed LID infiltration facilities and several sites where excess stormwater would infiltrate to the deeper pre-Olympic aquifer. The only instances where stormwater would not be infiltrated occur where wetland hydrology balance must be maintained (roof water delivered to level spreaders within wetland buffers) and the single outfall to Steam S-4.
- Wetland and stream buffers would be largely avoided by the proposed development.
- Road designs would include provisions, where necessary, to maintain natural subsurface drainage pathways (interflow). This could include modified road prisms and use of free-draining sands as fill material.

The water balance analysis completed by AESI (2008) showed that the mitigated developed condition recharge into the shallower aquifers (Qvr and Qvic) would closely match pre-developed condition recharge. This results in no probable significant impacts to the shallower aquifers from development under the Proposed Action.

Excess runoff from throughout the site would be routed to large infiltration facilities in Basin 3 and to a site west of the Main Property. The excess stormwater infiltrated in this area would recharge the pre-Olympia aquifer. The mitigated developed condition recharge in the pre-Olympia aquifer would increase about 650 acre-feet/year. This volume amounts to approximately 0.4 to 0.7 percent of the total volume of the pre-Olympia aquifer tributary to the Crisp Creek springs and to a number of springs along the northern Green River valley slope. This small increase (less than 1 percent) is not expected to result in a significant impact to any downstream waterbody (AESI 2008).

Under the Proposed Action for the North Property, runoff collected in the storm water collection system would be discharged back into onsite wetland buffers to maintain wetland hydrology and routed to infiltration systems for infiltration into coarse-grained Vashon recessional outwash sediment. Recharge eventually contributes to Ravensdale Creek baseflow and/or to Lake Sawyer. Water balance results for this area indicates that an overall insignificant increase in the amount of water delivered to the aquifer would occur as a result of development (AESI 2008). No probable significant impacts to downgradient watercourses are expected.

Impacts to Surface Water Quantity

Stormwater management and drainage facilities planning are summarized in the Technical Information Report (Triad 2008). In general, flow release from detention ponds would be as allowed by the Ecology 2005 Manual and per Black Diamond Code (Triad 2008). Releases from the detention ponds would match flows from half of the 2-year flow to the 50-year flow.

Stormwater falling onto most of the site currently infiltrates near the contact point or after a short period of transport if the initial contact was onto till-mantled areas. Only small areas of the site that drain on the surface to Streams S-4 and S-5, and the areas that contain Black Diamond Lake

and Rock Creek and their associated wetlands are known to contribute surface flow to these watercourses. No development is proposed in any of these areas.

As described above, the vast majority of stormwater collected from new impervious surfaces of the project would be treated and then infiltrated. Clean roof water would also be used to maintain water balances to wetlands. Some treated water would be released via level spreaders into the large wetland buffers adjacent to Rock Creek. The only new surface water discharge (other than wetlands) would occur from a small (9.4 acre) portion of the site near the eastern boundary (Basin 6). Water would be treated and detained before release to Stream S-4 near the northeastern property corner.

Stormwater control standards are designed primarily to protect channel stability from peak storm flows. Fish habitat quality is also dependent on the more commonly experienced flows (e.g., base flow) which affect day-to-day habitat conditions about 90 percent of the time. For this analysis, we looked at both storm flows and base flows where data support an analysis. Because there is no existing stream flow information available for Stream S-4, much of the impacts analysis depended on modeled flows which were based on contributing basin area and condition, along with regional rainfall patterns.

Triad Associates, Inc. (Triad) conducted hydrologic modeling to calculate future instream flows from Basin 6 under pre- and post-development conditions (Triad 2008). Further refinements to the onsite drainage facilities would occur with site-specific engineering design of the stormwater system; thus, these figures may not be final. However, the rates shown in Table 4 reflect an advanced state of analysis, and no significant changes are expected.

Where possible, the 90 percent, 50 percent, and 10 percent exceedence flows (as measured at the discharge location for each sub-basin) are selected to evaluate the most common base flow rates contributed from a project site. The 90 percent exceedence flow represents the flow rate that is exceeded 90 percent of the time (flows are below this rate only 10 percent of the time). The 90 percent exceedence flow is often looked at as the summer low flow. Because Stream S-6 has a relatively small contributory basin, it experiences very low flows, especially during the dry season. As such, it was not possible to calculate or predict either the 90 or 50 percent exceedence flows. The 10 percent exceedence flow is a fairly normal winter flow rate, such as might be experienced during a typical period of average rainfall.

Table 4
Instream Flow Analysis for Basin 6 (Surface Discharge to Stream S-4)

Return Period	Existing (cfs)	Future (cfs)	Change
90% Exceedence [a]	<0.1 [a]	<0.1 [a]	--
50% Exceedence	<0.2 [a]	<0.2 [a]	--
10% Exceedence	0.84	0.91	8%
2-year	8.00	7.76	- 3%
10-year	12.90	12.90	0%
25-year	15.32	14.95	-2%
100-year	22.22	22.08	-1%

[a] Flows are too low to model accurately with available information

The instream flow analysis for Basin 6 (Table 4) show that excess water volumes created by new development would be released at very low flow levels thereby increasing flows rates slightly throughout non-storm event periods (<10% exceedence). In its analysis of potential channel geomorphologic changes, AESI (2008) predicted that these small changes in rates would have no adverse effect on the physical structure of Stream S-4 (see *Impacts to Channel Erosion and Sedimentation Processes* below). Once this flow increase reached Jones Lake and the greater Rock Creek system it would be immeasurable.

Surface release of flows would occur elsewhere on the site as needed to maintain wetland hydrology. Water would be released via level spreaders to wetland buffers throughout the site including wetlands associated with Rock Creek, Black Diamond Lake, and small tributaries draining south towards the Green River. All water would be released at rates needed to maintain wetland hydrology at or near existing conditions. With attenuation provided by flow through the buffers and wetlands, no measurable change in flow rates leaving the wetlands is expected.

As discussed under Impacts to Groundwater Quantity above, AESI (2008) predicted only a very small increase (0.4 to 0.7 percent) in flows to the Crisp Creek and northern Green River valley slope springs. This small increase (less than 1 percent) is not expected to result in a significant impact to any downstream waterbody.

Impacts to Stream Baseflows

AESI (2008) evaluated the potential for added impervious surfaces under the Proposed Action to reduce groundwater recharge that could affect base flows in local streams. The assessment concluded that no reduction in base flow contribution to Rock Creek, Ravensdale Creek, Stream 4, Horseshoe Lake, Black Diamond Lake, Crisp Creek or the Green River would occur as a

result of the Proposed Action. Recharge to Black Diamond Lake and Horseshoe Lake would be balanced by design of the stormwater system to avoid increasing inflow to those waterbodies.

Impacts to Channel Erosion and Sedimentation Processes

A stream erosion and sedimentation analysis was conducted by AESI (2008 – Section 6.2.1) for surface water drainages potentially affected by development of the project. The purpose of this analysis was to identify existing erosion, landslide, and sediment transport hazards in drainage channels that originate on the site with the goal of protecting aquatic habitat. AESI (2008) evaluated hydraulic and geomorphic conditions in potentially susceptible stream channels, and determined erosion thresholds for existing and proposed conditions. Their analysis is summarized below.

Streams S-2, S-5, S-6, S-7 and Rock Creek are either buffered or located within wetland buffers/Sensitive Area Tracts. The streams are either formed by wetland discharge (S-2, S-5, S-6 and S-7) or flow through a large wetland complex onsite (Rock Creek), but could be susceptible to erosion from uncontrolled storm water discharge. Existing condition wetland hydrology would be maintained as discussed in Wetland Resources (2008) and Triad (2008). No direct discharge is planned to Stream S-2, S-5, S-6, S-7 and Rock Creek. Therefore, no stream erosion impacts are anticipated.

Stream S-4 was found to be relatively stable along the channel length between onsite wetlands and the southern property boundary. Under the proposed stormwater plan (Triad 2008), peak flows within Stream S-4 would remain unchanged or somewhat decreased. In most cases, a stream that is at equilibrium could experience channel aggradation by a decrease in peak flow. Because the headwaters for Stream S-4 are located in on and off-site wetlands, much of the natural hydrology would remained unchanged. The likely decrease in peak flows as allowed by code is not considered to be an adverse impact to stream erosion (AESI 2008).

Crisp Creek and spring-fed tributaries to the Green River do not receive any direct surface water runoff under existing conditions from The Villages; however, both receive ground water contributions to baseflow from the pre-Olympia aquifer proposed to receive stormwater infiltration (AESI 2008). Crisp Creek is relatively stable in the upper portion of the channel. Downstream of the pre-Olympia aquifer spring discharge zone at approximately elevation 370 to 400 feet mean sea level (fmsl), several landslides and other erosion features are present. The channel is susceptible to stream incision, sidebank destabilization, and channel degradation as a result of significant increases in baseflow from elevated spring flow.

Under the Proposed Action for The Villages, a portion of the stormwater runoff from Basins 1-4 would be treated and infiltrated. This infiltrated water would flow vertically downward to the pre-Olymipa aquifer water table, and eventually re-emerge as spring flow within Crisp Creek and unnamed tributaries to the Green River (see AESI 2008, Figure 4). While a 0.4 to 0.7 percent increase of the total volume of the pre-Olympia aquifer is expected, attenuation due to (1) the distance between the nearest infiltration point and the spring discharge zones, and (2) the vertical and lateral ground water flow components, would make any measurable change in Crisp Creek

or unnamed tributary spring flow unlikely. Therefore, no probable significant impacts to erosion within Crisp Creek and the unnamed tributaries to the Green River have been identified.

Impacts to Listed Species

No listed fish species are found on the project site. Indirect impacts were evaluated above. Post-construction impacts described in Section 3.2 are not likely to result in adverse effects to listed species or their habitat due to the protection measures being implemented for both the quantity and quality of water leaving the site. The proposal to use the most current stormwater protection measures, including extensive infiltration, should adequately protect aquatic habitat downstream. Given the absence of habitat used by listed species within, adjacent to, or within more than one mile downstream of the project site, no significant post-construction-related adverse impacts to listed species are expected.

3.2.2 No Action Alternative

Under the No Action Alternative, development would occur under standard City sensitive areas regulations, but under a less coordinated approach than for the two development alternatives. Individual lot development could include more wetland filling, more stream crossings, continued logging, development closer to the streams, and continued use of native surface roads in places. It is assumed that existing road and wetland crossings would be utilized where appropriate, and new crossings would be created where allowed by law. Sensitive area buffers would be protected as required under the code, but there would be no coordinated opportunities to protect larger parcels as public open space. Less open space would be provided than under the MPD requirements.

Stormwater would be dealt with on a lot-by-lot basis without the requirement for a regional protection treatment and detention facilities or implementation of LID measures. This could result in adverse effects on the quantity and quality of flow in regional streams as each lot owner deals with stormwater runoff independently (A.C. Kindig & Co. 2008).

Piecemeal applications for development of the parcels could result in more overall direct aquatic resource impacts at wetland or wetland buffer crossings than a design under the MPD.

Overall, it is likely that the developed condition under the No Action Alternative would have a higher potential for impacts to fish and aquatic habitat than for the Proposed Action.

3.3 Basinwide and Cumulative Effects

The correlation between watershed development and the aquatic habitat condition has been investigated for over two decades (Booth and Jackson 1997). It is well substantiated that stream and wetland ecosystem impairment begins when total impervious area (TIA) in a basin exceeds about 10 percent (Horner et al. 1997). These impacts have been largely the result of unmitigated modifications to the land surface that alter both the magnitude and type of runoff processes. The cumulative effects of these alterations produce an instream habitat significantly different from

that in which salmonids and other aquatic organisms have evolved. Some of these impacts include the alteration of peak and base flow conditions and the duration of flow attenuation.

The Villages Project site and proposed development actions are significantly different from the projects evaluated in earlier studies. First, entire drainage basins were evaluated, not individual projects. Second, most of the projects reviewed by those authors were developed during the 1980s and earlier and contained no water quality or water quantity protection features. As a result, this style of land development resulted in large-scale impacts to instream habitat and significant channel degradation.

The Villages Project would not contain any new unmitigated impervious surface. Unusually wide riparian buffers, along with the use of stringent stormwater detention and treatment measures, would help ensure that regional waterbodies continue to function in a manner consistent with a relatively natural hydrological flow regime. As a result, the Villages Project is not expected to contribute to the adverse basin effects of the type created by development prior to 1990.

Cumulative effects on fish habitat are possible with additional development proposed in the Black Diamond area. The rapidly developing area would include the proposed Lawson Hills Project. The Lawson Hills Project would deliver flow to both Rock Creek and Ravensdale Creek. Treatment and detention requirements have been designed to meet all current standards and should be fully protective of aquatic habitat (A.C. Kindig & Co. 2008). The Lawson Hills Project would also consist of a coordinated approach to dealing with potential development effects on the natural environment. This approach generally provides greater protection than piecemeal lot-by-lot development. Assuming both developments occur under Master Planned Community programs as currently proposed, no significant adverse cumulative effects on fish habitat are expected.

4.0 MITIGATION MEASURES

4.1 Construction

- All areas that are to remain undisturbed during site clearing and grading (e.g., sensitive areas and their buffers) would be delineated and fenced with highly visible material prior to construction.
- The stream crossing over Stream S-5 would be constructed (if practicable) at the location of the existing crossing structure. If this is not practical, the existing crossing and portions of dirt road outside the future road alignment but within the riparian buffer would be removed as mitigation.
- Stream crossings over Stream S-4 and S-5 should be full span structures designed to be fish passable, and with a capacity to pass 100-year storm flows and expected debris.

- The new outfall to Stream S-4 would be sited after consideration of potential disturbance to adjacent wetlands, unstable slopes, significant trees, and instream habitat.
- All construction at or below the OHWM of any waterbody, (as needed to install the new outfall on Stream S-4 and new stream crossings) would observe the following conditions:
  - Work would take place during the summer low flow season or as otherwise allowed by the WDFW under conditions of an Hydraulic Project Approval (HPA) permit.
  - Measures would be implemented to control sediment introduction by bypassing flow around the work site or by completing all work before allowing flow to contact the work area. Where necessary, fish would be removed from the work site before work begins.
  - If work is completed in a fish-bearing stream, all fish would first be removed from the instream work area prior to commencing the work and moved to a non-impacted area. Fish removal methods would follow standard WDFW protocols. Captured fish would be transported in coolers to an area outside of the work area (as specified by WDFW) and released back into suitable habitat.
  - Flow would be diverted around the work site and measures conducted as needed to contain all expected flows.
  - Instream work shall be conducted by equipment positioned on the bank. No equipment (with the exception of clean excavator buckets) shall work below the OHWM.
  - The excavator bucket and boom shall be first thoroughly cleaned of all visible petroleum products and a floating oil boom placed downstream of the work area.
  - Excess material shall be end-hauled off-site to an upland location.
  - Temporary and permanent ground cover measures shall be provided in a timely manner to protect disturbed areas. Cover methods shall include mulch, erosion control blankets, plastic covering, sodding, hydroseeding, jute matting, and clear plastic sheeting where necessary and if inclement weather conditions threaten exposed soils.
  - All areas of affected streambank would be revegetated with native species and maintained as required by City ordinance.
- No surface water runoff from construction areas would be discharged directly to onsite or off-site waterbodies without first being treated.
- Additional mitigation measures provided in A.C. Kindig & Co. (2008), AESI (2008), Wetland Resources (2008), and Triad (2008) to protect water quality, water quantity, stream channel stability, riparian buffers, and wetland attributes during construction are also relevant and incorporated herein by reference.
- New stormwater outfalls would be designed to minimize potential impacts to existing aquatic habitat. New outfalls would be sited and designed to avoid sensitive instream habitat and riparian buffers.

- Wetland and stream buffers would avoided to the greatest extant practicable by the proposed development.
- Road designs would include provisions, where necessary, to maintain natural subsurface drainage pathways (interflow). This could include modified road prisms and use of free-draining sands as fill material.

4.2 Post-Construction

- The project would employ extensive infiltration of stormwater runoff from the site using several small shallow dispersed LID infiltration facilities and several sites where excess stormwater would infiltrate to the deeper pre-Olympic aquifer. Wetland hydrology balance would be maintained using roof water delivered to level spreaders within wetland buffers.
- Mitigation measures provided in A.C. Kindig & Co. (2008), AESI (2008), Wetland Resources (2008), and Triad (2008) to provide long-term protection of water quality and water quantity are also relevant to the protection of fisheries resources and are incorporated herein by reference.

5.0 UNAVOIDABLE SIGNIFICANT ADVERSE IMPACTS

The Proposed Action is not likely to result in significant adverse effects to fish habitat for the following reasons:

- Only two fish-bearing stream crossings would occur. Both would be full span structures designed to avoid impacts to the creek channel below.
- Few fish-bearing watercourses exist on the site. No listed fish species are found on or within more than one mile of the site.
- A high level of stormwater detention and treatment would be provided. The project would infiltrate most of the excess stormwater to large aquifers under the site. Infiltration provides the highest level of fish protection possible for a development and is the preferred method to protect aquatic habitat where conditions are suitable.
- The project design includes stream buffers much larger than are normally provided adjacent to watercourses. Most stream reaches on the site would contain buffers in excess of widths recommended by WDFW for the protection of aquatic habitat (Knutson and Naef 1997).

This analysis relies heavily on the analyses and conclusions of the water quality, hydrologic, erosion control, and geotechnical experts as to how the project might affect the quantity and quality of water delivered to off-site streams. No unavoidable significant adverse impacts were identified during their analyses of the Proposed Action.

In summary, development of the Villages Project under the Proposed Action is not expected to result in any significant unavoidable adverse impacts to fisheries resources.

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APPENDIX H – "The Villages" Stormwater Management

PACWEST ENGINEERING LLC

Stormwater Management

Overview

The purpose of this plan is to describe the overall stormwater goals for the site, describe the stormwater concept for the entire site, and provide standards for stormwater management at the development parcel level to ensure that the overall goals are met.

Stormwater for The Villages MPD is managed through collection, treatment and release into groundwater or surface water bodies. Large areas of The Villages site are suitable for infiltration of stormwater to groundwater (aquifers) using Low Impact Development (LID) techniques, so infiltration is a key component of the stormwater management plan. Where feasible, stormwater is proposed to be infiltrated to shallow outwash soils (Qvr) that form a shallow aquifer or to deeper outwash deposits (Qpog) that form a deep aquifer underlying the site. Since some areas are sensitive to changes in water volumes or are not suitable for infiltration, more traditional stormwater management techniques are also necessary. Thus, the components of the stormwater management plan for the site include infiltration of stormwater into the shallow aquifer (Qvr) through LID, infiltration into the deep aquifer (Qpog) through infiltration facilities, conventional ponds, wetland recharge, water quality treatment facilities and two regional stormwater management facilities.

Facilities to serve the entire development have been planned and approximate locations determined (See Figure 5-1). There will be two regional stormwater facilities on the site which will infiltrate into the deeper outwash deposits (Qpog). One of the regional stormwater facilities will be used to treat the excess stormwater created by the need for water balance to Horseshoe Lake. The second facility will treat and infiltrate the excess stormwater created by the need for water balance to the aquifer above the steep slopes south of the site, Black Diamond Lake, and the wetlands on the southern portion of the site. These two facilities may be replaced with a single large offsite facility.

In addition to these regional facilities, additional facilities will be needed to manage stormwater for each development parcel. These facilities will be designed with the construction plans for each implementing plat consistent with the standards provided in this plan. Since stormwater management needs, treatment options, and discharge options vary across the site, the site has been divided into stormwater management zones based on groundwater flow paths, soil types, topography, and surface water features. Each zone has stormwater requirements specific to its unique conditions. Each development parcel will be required to manage stormwater consistent with the standards for the stormwater management zone within which it is located.

Stormwater Management Goals

The overall goals of this stormwater management plan are as follows:

- Maintain surface water and groundwater quality and quantities consistent with the requirements of the Department of Ecology's 2005 Stormwater Manual for Western Washington;
- Avoid impacts to Horseshoe Lake water levels by ensuring that the volume of stormwater infiltrated into the shallow outwash upgradient of Horseshoe Lake is approximately he same as that which infiltrates under predeveloped conditions;
- Avoid impacts to water quality in Lake Sawyer by providing stormwater treatment that treats for phosphorus removal for those basins that drain to Lake Sawyer;
- Maintain hydrology for Black Diamond Lake and wetlands on the site by recharging them with approximately the same volume of stormwater as would occur under predeveloped conditions;
- Maintain pH levels and water quality in Black Diamond Lake;
- Avoid impacts to steep slopes by routing excess stormwater away from slopes to a stormwater management facility;
- Recharge groundwater with stormwater infiltrated using Low Impact Development techniques and infiltration facilities
- Provide a menu of stormwater treatment options ranging from ponds to rain gardens

2005 Stormwater Manual for Western Washington

This stormwater management plan has been prepared to meet the requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual). This plan assumes that the City of Black Diamond will adopt the 2005 DOE Manual. The DOE Manual requires the following:

- The duration of stormwater discharge in the developed condition must match predeveloped durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow (Minimum Requirement #7: Flow Control);
- Basic water quality treatment for stormwater generated by residential development;
- Enhanced water quality treatment for stormwater generated from commercial development, multi-family development and roads with Annual Average Daily Traffic (AADT) above 7,500, except when that stormwater is infiltrated to groundwater more than ¼ mile upstream of fish-bearing waters; and
- Phosphorus treatment for stormwater released to surface waters that ultimately drain to Lake Sawyer

Key Stormwater Management Issues

The following issues have been identified as important and addressed through the stormwater management plan and design of the overall stormwater system for the project.

Horseshoe Lake

Horseshoe Lake lies directly west of The Villages site and under existing conditions has occasional flooding problems. Based on groundwater studies completed for the project, these flooding problems appear to be the result of high ground water levels within the shallow aquifer that feeds the lake. The groundwater recharge area for this aquifer and Horseshoe Lake extends under a portion of The Villages site.

Development of The Villages site and the conversion of ground cover from existing forested conditions to impervious surfaces will result in an increase in the volume of stormwater produced. Typically, on a site which can accommodate infiltration, the DOE Manual allows for all stormwater to be infiltrated, even though an increase in volume occurs. Since an increase in volumes over existing volumes could exacerbate

Horseshoe Lake flooding, this plan requires infiltrated volumes to approximately match volumes under existing conditions.

Specifically, the stormwater management standards require that the volume of stormwater infiltrated within the groundwater recharge area tributary to Horseshoe Lake match volumes under existing conditions. Excess volume is proposed to be conveyed to a regional stormwater facility which infiltrates to the deep outwash aquifer, bypassing Horseshoe Lake. Stormwater still needs to be infiltrated into the shallow aquifer to maintain existing hydrology of Horseshoe Lake and thus maintain existing lake levels. The bypass of the excess volume will mitigate impacts of development to the Lake's existing flooding problems.

Steep Slopes and Down Gradient Wells

The Villages site contains a portion of the recharge zone for the ground water table that is the source for down gradient wells and slopes south of the site. A portion of the stormwater will be infiltrated in this recharge zone in order to maintain subsurface flow to these existing wells. Stormwater in excess of the water balance necessary to maintain the down gradient wells will be conveyed to a regional stormwater facility to avoid impacts to the steep slopes south of the site.

Black Diamond Lake

A portion of The Villages site is tributary to Black Diamond Lake. Black Diamond Lake lies within the boundary of The Villages site and has been identified as a bog which can be adversely impacted by fluctuations in water levels, changes in nutrient loading, and changes in pH. Typically, under the DOE Manual, the development of a basin tributary to an open body of water would be mitigated using a detention facility combined with a water quality facility. Due to the sensitive nature of bogs, the stormwater management approach for Black Diamond Lake will not follow the typical DOE Manual approach.

The existing tributary basin to Black Diamond Lake has been identified for water balance calculations to match the existing stormwater volume conveyed to Black Diamond Lake. Rooftop runoff is proposed to be used to match the existing volume to maintain the hydrology of Black Diamond Lake. Rooftop runoff is specifically being used to ensure clean stormwater is being conveyed to Black Diamond Lake, minimizing the potential for changes in nutrient loading and pH. All non-rooftop generated runoff from within the basin tributary to Black Diamond Lake will be conveyed to a regional stormwater facility where it will be infiltrated into the deep outwash deposits.

Rock Creek, Ravensdale Creek, Jones Lake and Lake Sawyer

There are three basins within The Villages site that drain to water bodies, which are tributary to Lake Sawyer. One of these basins drains to Rock Creek, one towards Ravensdale Creek, while the other drains to Jones Lake. All these basins are tributary to Lake Sawyer (Rock Creek flows from Jones Lake to Lake Sawyer and Ravensdale

Creek flows directly into Lake Sawyer). All basins will provide flow control per the DOE Manual and must meet the DOE Manual requirement for phosphorous treatment.

Wetland Recharge

There are many wetland complexes throughout The Villages site. To maintain wetland hydrology, the areas to be developed which are tributary to wetlands have been identified. Runoff from rooftops and or yards will be used to match the existing stormwater volume that these areas contribute to each of the wetlands. Excess stormwater in areas originally tributary to a wetland will be routed to a regional stormwater facility which infiltrates into the deep outwash deposits.

Ownership and Maintenance

All stormwater facilities, except stormwater vaults serving commercial property, are proposed to be owned and maintained by the City of Black Diamond.

Stormwater Management Zones and Standards

The Villages MPD has been divided into stormwater management zones. Each stormwater management zone has a unique set of specific stormwater requirements that were used to develop the stormwater concept. Developable area, areas of impervious and pervious surface, area of rooftops, the amount of stormwater that can be infiltrated into the shallow outwash (Qvr) and the amount of recharge required for wetlands and Black Diamond Lake must be determined for ultimate stormwater balance calculations. Water balance calculations will need to be performed based on actual developed conditions to ensure water balance goals are met.

Individual developments are required to meet the overall requirements as well as the stormwater requirements unique to the stormwater zone in which each is located. Each development must provide calculations of the amount of stormwater conveyed to wetland recharge, Black Diamond Lake, the shallow aquifer tributary to Horseshoe Lake etc. The City of Black Diamond will maintain a running tally and will manage the water balance requirements for each zone to ensure that the water balance goals are met.

Requirements Applicable to All Stormwater Zones

- Stormwater facilities shall be designed to meet the requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual).

- Stormwater from rooftops does not require water quality treatment prior to infiltration or discharge unless combined with stormwater from pollution-generating surfaces.

- Stormwater from pervious surfaces that is collected is required to meet the water quality requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual).

- All treatment options allowed under the 2005 DOE Manual such as ponds, vaults, media filter strips, biodetention and rain gardens are allowed without preference for any one type of facility.

Stormwater Management Zone 1

Stormwater Management Zone 1 consists of the north portion of The Villages site. Under existing conditions, all stormwater infiltrates in the outwash soils present within Stormwater Management Zone 1. The main constraint for Stormwater Management Zone 1 is Horseshoe Lake, which lies directly to the west of The Villages site. Horseshoe Lake has a history of flooding problems and may be sensitive to groundwater fluctuations but requires flows to maintain summer use. To address this issue, stormwater infiltration to the shallow outwash soils tributary to Horseshoe Lake is proposed to meet the predeveloped infiltration volume. By matching this volume, impacts to both the low flows and high flows are mitigated. Remaining stormwater will be infiltrated into the deeper outwash soils which bypass Horseshoe Lake through the use of a regional water quality and infiltration facility.

Stormwater Management Zone 1 has been split into three sections. The sections have been divided based on the stormwater management requirements. Stormwater Management Zones 1A and 1B are tributary to Horseshoe Lake while Stormwater Zone 1C is cross gradient from Horseshoe Lake. To ensure that the predeveloped volume of water conveyed to Horseshoe Lake is matched, an accounting of the infiltrated water volume (based on pervious area, rooftop area and impervious area infiltrated) within this zone must be maintained through build out.

Stormwater conveyed to Horseshoe Lake via the shallow outwash soils will include:

- All stormwater in SMZ 1A from areas underlain by outwash soils. The rooftops will be infiltrated directly while the remaining stormwater will be treated to the water quality requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual) before infiltration.

- All stormwater from SMZ 1A conveyed to the local pond located in the southwest corner of Parcel C.

- All Stormwater from SMZ 1B until the predeveloped average annual infiltrated volume is met. The rooftops will be infiltrated directly while the remaining stormwater will be treated for basic water quality before infiltration.

- Stormwater from rooftops and pervious surfaces used to recharge wetlands.

Stormwater conveyed to the deeper outwash deposits (Qpog) will include:

- All remaining stormwater within SMZ 1.

The stormwater management requirements for each section of Stormwater Management Zone 1 are as follows:

Stormwater Management Zone 1A

- All stormwater shall be infiltrated into the shallow aquifer (Qvr) unless underlying soils are till (including till fill area), provided the avg. annual volume to be infiltrated has not yet been met.
    - Surfaces requiring basic water quality treatment per the 2005 DOE Manual can be infiltrated in SMZ 1A after basic water quality treatment.
    - Surfaces requiring enhanced water quality treatment per the 2005 DOE Manual can be infiltrated in SMZ 1A after enhanced water quality treatment or can be infiltrated in SMZ 1B after basic water quality treatment.
- All stormwater that cannot be infiltrated based upon the underlying soil, will be routed to the regional stormwater facility located in the southern portion of SMZ 1C.
- All stormwater that cannot be infiltrated based upon the underlying soil and cannot be routed to the regional stormwater facility located in the southern portion of SMZ 1C based on elevation will be routed to the local stormwater facility located in the southwest corner of Parcel C.

Stormwater Management Zone 1B

- Stormwater from rooftops and pervious surfaces shall be used to recharge wetlands where required. All remaining stormwater shall be infiltrated to the shallow aquifer (Qvr) provided that the predeveloped average annual volume to be infiltrated has not yet been met.

- Stormwater from pollution generating surfaces (roads, parking lots, driveways etc.) shall be treated for basic water quality and infiltrated, provided the predeveloped average annual volume to be infiltrated has not yet been met. Once the predeveloped average annual volume has been met, all remaining stormwater shall be conveyed to the stormwater facility located in the southern portion of Zone 1C.

Stormwater Management Zone 1C

- Stormwater from rooftops and pervious surfaces shall be used to recharge wetlands where required. All other runoff will be conveyed to the regional stormwater facility within this drainage zone (Figure 5-1) unless the runoff is needed to meet the water balance needs to Horseshoe Lake.

Stormwater Management Zone 2

Drainage Zone 2 consists of the eastern portion of The Villages site which drains directly to Rock Creek. All stormwater runoff flows to Rock Creek which flows into Lake Sawyer. Lake Sawyer is a phosphorous sensitive lake which is located approximately three quarters of a mile north of the site. In addition to basic water quality treatment requirements per the DOE Manual, phosphorous treatment is required to be provided for all basins that drain towards Lake Sawyer. A detention/water quality pond will be used to manage stormwater for this zone. A large wet pond is proposed to provide basic and phosphorus treatment for this zone.

Runoff from rooftops shall be used to recharge wetlands and maintain wetland hydrology. All other runoff will be conveyed to the detention/water quality pond in this drainage zone. (Figure X-X)

Stormwater Management Zone 3

Stormwater Management Zone 3 consists of the southern portion of The Villages site. A large portion of Stormwater Management Zone 3 is tributary to Black Diamond Lake. A portion along the southwest border of Stormwater Management Zone 3 is underlain with outwash soils, where stormwater runoff infiltrates under existing conditions. The remainder or Stormwater Management Zone 3 is underlain with till soils, with stormwater runoff flowing to wetlands throughout the zone. There are several constraints within Stormwater Management Zone 3. Black Diamond Lake is a bog and as such could be adversely impacted by changes to hydrology. In order to maintain hydrology and mitigate the effects of development, only runoff from rooftops will be used to recharge Black Diamond Lake. Predeveloped stormwater volumes will be provided to Black Diamond Lake with rooftop runoff. In the existing conditions, stormwater infiltrating in the outwash soils along the south boundary daylights along steep slopes. In order to minimize potential erosion, the predeveloped infiltration volume for this area will be matched. Finally, many of the wetlands within Stormwater Management Zone 3 discharge to steeply sloping areas. To minimize erosion potential, the existing volume conveyed to each wetland will be matched to maintain wetland hydrology. Remaining stormwater will be infiltrated into the deeper outwash soils through the use of a regional water quality and infiltration facility.

Stormwater Management Zone 3 has been split into four sections. The sections have been divided based on the stormwater management requirements. To ensure that the predeveloped volumes of water conveyed to Black Diamond Lake, onsite wetlands, and the outwash soils are matched, an accounting of the water volumes conveyed to each (based on pervious area, rooftop area and impervious area) within this zone must be maintained through build out.

Stormwater conveyed to Black Diamond Lake will include:

- Stormwater runoff from rooftops only.

Stormwater infiltrated in the outwash soils along the south boundary will include:

- All Stormwater from SMZ 3C until the predeveloped average annual infiltrated volume is met. The rooftops will be infiltrated directly while the remaining stormwater will be treated for basic water quality before infiltration.

Stormwater conveyed to deeper outwash deposits (Qpog) will include:

- All other stormwater not needed for shallow aquifer recharge, Black Diamond Lake recharge or wetland recharge.

Stormwater Management

The stormwater management requirements for each section of Stormwater Management Zone 3 are as follows:

Stormwater Management Zone 3A

- Stormwater from rooftops shall be used for wetland recharge and recharge to Black Diamond Lake to match predeveloped volumes
- Stormwater from backyards may also be used for wetland recharge if needed but CANNOT be used for recharge to Black Diamond Lake.
- All stormwater from pollution generating surfaces shall be conveyed to the large infiltration facility to the west (Figure 5-1).
- Once the wetland recharge and Black Diamond Lake recharge requirements have been met, all other stormwater will be taken to the regional stormwater facility to the west.

Stormwater Management Zone 3B

- Stormwater from rooftops and/or backyard will be used for wetland recharge. All other stormwater not required for wetland recharge will be conveyed to the regional stormwater facility to the west (Figure 5-1).

Stormwater Management Zone 3C

- Stormwater from rooftops and pervious surfaces shall be infiltrated to the shallow aquifer (Qvr) provided that the predeveloped average annual volume to be infiltrated has not yet been met.
- Stormwater from pollution generating surfaces (roads, parking lots, driveways etc.) shall be treated for basic water quality and infiltrated, provided the predeveloped average annual volume to be infiltrated has not yet been met. Once the predeveloped average annual volume has been met, all remaining stormwater shall be conveyed to the regional stormwater facility located to the west (Figure 5-1).

Stormwater Management Zone 3D

- If Black Diamond Lake requires more recharge volume after the build out of Stormwater Management Zone 3A, runoff from rooftops will be conveyed to Black Diamond Lake to provide the remainder of the volume required.

- Stormwater from rooftops and backyards will be used for wetland recharge.

- All remaining stormwater will be conveyed to the regional stormwater facility located to the west (Figure 5-1).

Stormwater Management Zone 4

Stormwater Management Zone 4 consists of the eastern portion of The Villages site which drains directly to Jones Lake. All stormwater runoff flows to Jones Lake which flows into Lake Sawyer via Rock Creek. In addition to basic water quality treatment requirements, phosphorous treatment is required to be provided for all basins that drain towards Lake Sawyer. A detention/water quality pond will be used to manage stormwater. A large wet pond is proposed to provide basic and phosphorus treatment.

All stormwater will be conveyed to the detention/water quality pond in this Stormwater Management Zone.

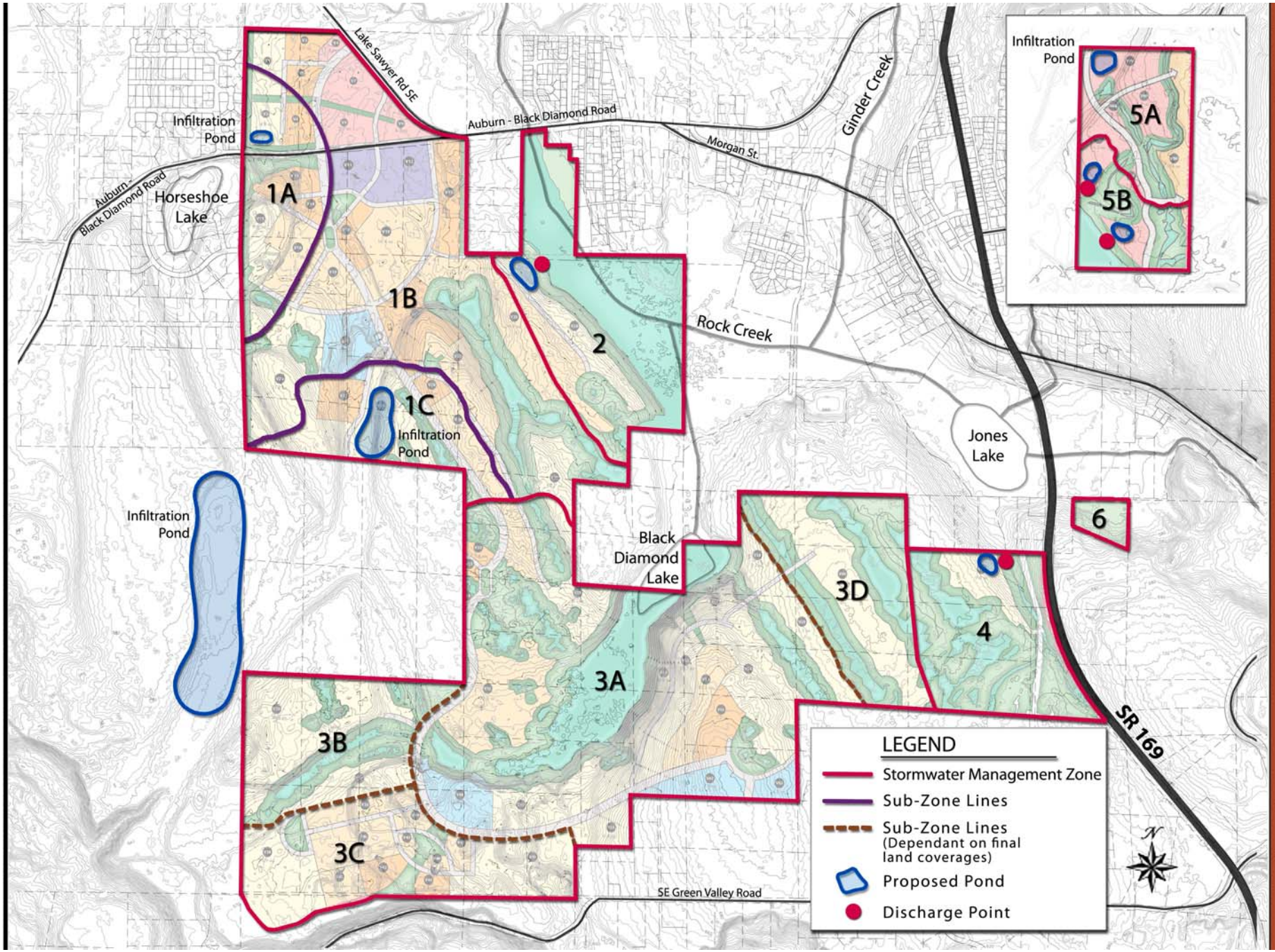
Stormwater Management Zone 5

Stormwater Management Zone 5 consists of Parcel B of The Villages project. The northwest corner of Stormwater Management Zone 5 is located on outwash soils with good infiltration rates. The remainder of Stormwater Management Zone 5 (approximately two-thirds of the basin) is located on till soils. Stormwater runoff from the northern portion of Stormwater Management Zone 5 drains to the north and northwest overland and through a series of wetlands and a stream to the outwash soils in the northwest corner where it infiltrates. The infiltrated stormwater flows towards Ravensdale Creek. In addition to the till portions of the site, runoff from adjacent offsite parcels to the east also drains to the wetlands and stream on the till portion of the site and infiltrates into the outwash soils in the northwest corner of the site. The existing volume tributary to each of the wetlands will be matched in developed condition with runoff from rooftops to maintain wetland hydrology. Runoff from the remaining rooftops and other non pollution generating surfaces are proposed to be infiltrated directly. All remaining stormwater runoff will be directed to an infiltration and water quality facility located in the outwash in the northwest corner of Stormwater Management Zone 5. Based on available soils information the existing soils do not meet DOE soil requirements for water quality treatment. Due to this fact, the stormwater from the northern portion of Stormwater Management Zone 5 requires treatment for phosphorous removal and enhanced water quality treatment based on the currently proposed land use. The options available for water quality treatment from pollution generating surfaces prior to infiltration include; large sand filter, amended sand filter, stormwater treatment wetland followed by sand filter, compost amended filter strips or two facility treatment trains.

Stormwater runoff from the southern portion of Stormwater Management Zone 5 drains to the south and southwest where it enters an existing wetland, located along the south and southwest boundaries of the site, and eventually infiltrates. There are several wetlands within this portion of the site. The existing volume conveyed to each of the wetlands will be matched in developed condition with runoff from rooftops to maintain wetland hydrology. The remaining stormwater runoff will be conveyed to two stormwater facilities which will provide detention, phosphorous treatment, and basic water quality treatment.

Stormwater Management Zone 6

Stormwater Management Zone 6 will remain the same in both the existing and developed conditions.



The Villages

Black Diamond, WA

MPD Stormwater Concept

12-19-08
TRIAD ASSOCIATES

FIGURE 5-1

APPENDIX I – "Lawson Hills" Stormwater Management

OVERVIEW

The purpose of this plan is to describe the overall stormwater goals for the site, describe the stormwater concept for the entire site, and provide standards for stormwater management at the development parcel level to ensure that the overall goals are met.

Stormwater for the Lawson Hills MPD is managed through collection, treatment, and release to surface water bodies. The components of the stormwater management plan for the site include conventional detention ponds, wetland recharge, and water quality facilities. Facilities to serve the entire development have been planned and approximate locations determined (See Figure 5-1).

The site has been divided into stormwater basins based on natural discharge location, mitigation of potential impacts and topography. Each development parcel will be required to manage stormwater consistent with the standards for the basin within which it is located.

STORMWATER MANAGEMENT GOALS

The overall goals of this stormwater management plan are as follows:

- Maintain surface water and groundwater quality and quantities consistent with the requirements of the Department of Ecology's 2005 Stormwater Manual for Western Washington;
- Avoid impacts to water quality in Lake Sawyer by providing stormwater treatment that removes phosphorus for those basins that drain to Lake Sawyer;
- Avoid impacts to Lawson Creek, which shows signs of erosion, by limiting the volume of additional stormwater discharged to the creek;
- Avoid impacts to steep slopes by routing excess stormwater away from slopes to a stormwater management facility;
- Maintain hydrology for wetlands on the site by recharging them with the same volume of stormwater as would occur under pre-developed conditions;

2005 STORMWATER MANUAL FOR WESTERN WASHINGTON

This stormwater management plan has been prepared to meet the requirements of the the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual). This plan assumes that the City of Black Diamond will adopt the 2005 DOE Manual. The DOE Manual requires the following:

- The duration of stormwater discharge in the developed condition must match predeveloped durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow (Minimum Requirement #7: Flow Control);
- Basic water quality treatment for stormwater generated by residential development;
- Enhanced water quality treatment for stormwater generated from commercial development, multi-family development and roads with Annual Average Daily Traffic (AADT) above 7,500, except when that stormwater from land uses requiring enhanced treatment constitutes less than 50% of the total stormwater volume within a threshold discharge; and
- Phosphorus treatment for stormwater released to surface waters (Ginder Creek, Lawson Creek, the unnamed creek, and Jones Lake) that ultimately drain to Lake Sawyer

KEY STORMWATER MANAGEMENT ISSUES

The following issues have been identified as important and addressed through the stormwater management plan and design of the overall stormwater system for the project.

Lake Sawyer

All Basins within the site drain to water bodies that ultimately drain to Lake Sawyer. As such, all basins will provide flow control per the DOE Manual, in the form of a detention pond or vault and must meet the DOE Manual requirement for phosphorous treatment.

Lawson Creek

Downstream of the site, Lawson Creek shows signs of erosion. In order to minimize the impacts of the project on Lawson Creek, a portion of the stormwater within the basin tributary to Lawson Creek will be conveyed directly to Jones Lake, bypassing Lawson Creek.

Steep Slopes and Down Gradient Wells

Steep slopes exist to the southwest of the site above an unnamed creek. No drainage flow paths were found above the steep slopes. Any stormwater discharges along these steep slopes would likely cause erosion problems. To minimize erosion impacts, stormwater in areas tributary to these steep slopes will be routed to facilities within the Lawson Creek Basin.

Wetland Recharge

There are many wetland complexes throughout the Lawson Hills site. To maintain wetland hydrology, the areas to be developed which are tributary to wetlands have been identified. Runoff from rooftops and or yards will be used to match the existing stormwater volume that these areas contribute to each of the wetlands. Excess stormwater in areas originally tributary to a wetland will be routed to stormwater facilities within the basin.

STORMWATER BASINS AND STANDARDS

The Lawson Hills MPD has been divided into stormwater management zones. Individual developments are required to meet the overall requirements as well as the stormwater requirements unique to the stormwater basin in which each is located.

Requirements Applicable to All Stormwater Zones

- Stormwater facilities shall be designed to meet the requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual)

- Stormwater from roof-tops does not require water quality treatment prior to discharge unless combined with stormwater from pollution-generating surfaces.

- Where wetland recharge is needed, runoff from roof-tops and pervious areas will be used to match the predeveloped volume of stormwater tributary to each wetland.

Stormwater Basin A

Stormwater Basin A consists of the central portion of the main Lawson Hills project site. Basin A is underlined with till soils and shallow bedrock. In the predeveloped condition, all stormwater runoff from Basin A flows into Lawson Creek.

Stormwater in Basin A will be managed through the use of two approximately equal sized detention ponds combined with large wetponds for phosphorous removal and water quality treatment (Pond A South and Pond A North). In addition to the stormwater runoff from Basin A, these ponds will also detain and treat stormwater from a portion of Basin C to mitigate possible steep slope disturbance along the southwest side of the site.

Downstream of the Lawson Hills site, Lawson Creek shows signs of erosion. To minimize the erosion impact from the Lawson Hills project, one of the Basin A ponds (approximately half of the stormwater) will be conveyed directly to Jones Lake in a pipeline, bypassing Lawson Creek. The other pond will discharge to Lawson Creek to maintain flows. There are two possible routes for this bypass pipeline. The southern route begins at Pond A South and heads south down the slopes until it reaches the railroad grade. The pipe will continue west along the railroad grade, across Lawson Creek and turn south along SR 169. A flow splitter is proposed to convey half of the flows each to Lawson Creek and the unnamed creek near Jones Lake. In this option, the discharge from Pond A North will be directly to Lawson Creek. The northern option begins at Pond A North, heads west along Lawson Street and turns south at SR 169. This system also proposes to use a flow splitter to provide half of the flows to each creek near Jones Lake. In this option, the discharge from Pond A South will be directly to Lawson Creek. Manholes are proposed to be set over the existing discharge pipes under SR 169 to reduce impacts on the streams.

Stormwater Basin B

Stormwater Basin B consists of the northeastern portion of the main Lawson Hills project site. Basin B is within the same threshold discharge area as Basin D. Basin B is underlined with till soils and shallow bedrock. In the predeveloped condition, stormwater runoff from Basin B flows to Mud Lake which lies to the north of the Lawson Hills project.

In the developed condition, stormwater runoff from Basin B will be routed to a detention pond combined with a large wetpond to provide phosphorous removal and water quality treatment. A portion of Basin B may be too low in elevation to drain to this pond and will be routed to the Basin D stormwater facilities.

Stormwater Basin C

Stormwater Basin C consists of the southern portion of the main Lawson Hills project area. In the existing condition, Basin C consists of approximately the south 74 acres of the Lawson Hills project site. Basin C is underlined with till soils and shallow bedrock. In the predeveloped condition, all drainage from Basin C flows to the unnamed creek to the south of the project site and ultimately to Jones Lake. Basin C can be broken into three sub-basin which are the west, central and east sub-basins of Basin C. The three sub-basins drain in three different directions but combine less than a quarter mile downstream from the site at unnamed creek. Along the southern edge of the west and central sub-basins of Basin C there are steep slopes. Above these slopes, no flow channels are present. Any discharge from stormwater facilities above these steep slopes could cause potential erosion problems.

In order to minimize the erosion potential of these steep slopes, stormwater runoff from the west and central sub-basins of Basin C will be routed to the stormwater facilities in Basin A. See the Basin A discussion above for routing of Basin A discharges to Jones Lake. The eastern portion of Basin C will be routed to a detention pond combined with a large wetpond for phosphorous removal and water quality treatment located near the southeast corner of the Lawson Hills site. The discharge from this pond will be located in an area where a more obvious flow path is present and proposes to use a level spreader to disperse discharged flows. The pond will discharge stormwater at rates matching the predeveloped rates from the area tributary to the pond. Stormwater from this pond will provide water to the unnamed creek and associated wetlands.

Stormwater Basin D

Stormwater Basin D consists of the western portion of the main Lawson Hills project site. Basin D is underlined with till soils and shallow bedrock. In the predeveloped condition, stormwater runoff from Basin D eventually flows to Ginder Creek.

Depending on the land usage and traffic loading within Basin D, enhanced water quality treatment may be required. In the developed condition, stormwater runoff will be routed to detention and water quality facilities. These facilities will contain a combination of detention ponds, detention vaults, wetponds, wetvaults and sand filters depending on the water quality requirements for the land use of actual build out.

Stormwater Basin E

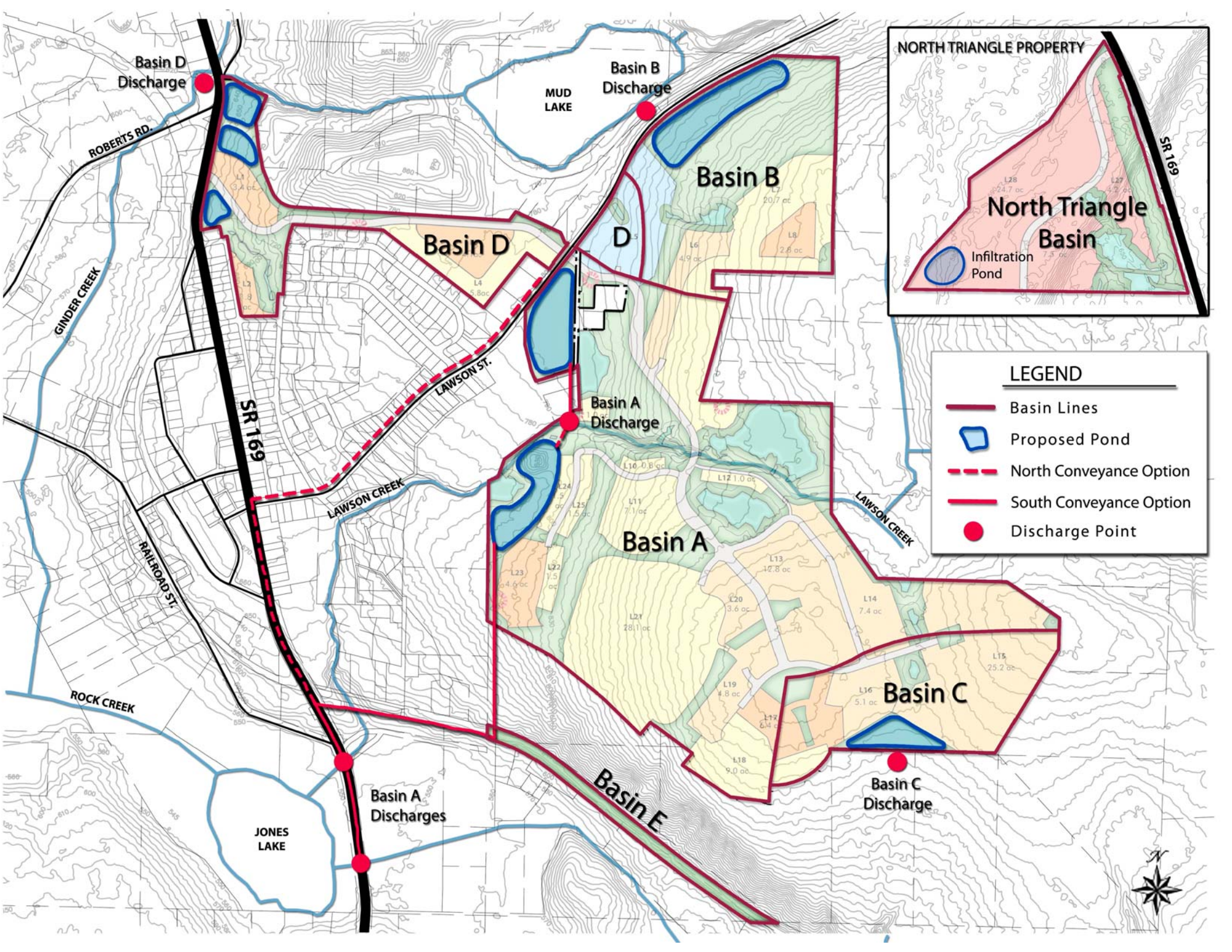
Stormwater Basin E consists of a strip of the railroad grade south of the main Lawson Hills project site. Basin E will be left unchanged in the developed condition.

North Triangle Stormwater Basin

The North Triangle Stormwater Basin consists of all areas within the North Triangle Property of the Lawson Hills project which lies to the northwest of the main portion of the Lawson Hills project site. The North Triangle Basin is underlain with a mix of till and outwash soils. Stormwater runoff from the southeast third of the North Triangle (which is underlined with till soils) flows to the northwest, where it infiltrates in the outwash soils covering the remaining two-thirds of the basin. The infiltrated stormwater eventually flows into Ravensdale Creek.

In the developed condition, stormwater runoff from the North Triangle development will be infiltrated in the lower portion of the site along with runoff from offsite that currently infiltrates on the lower portion of the North Triangle. Runoff from roof tops and other non pollution generating surfaces do not require water quality treatment prior to infiltration and are proposed to be infiltrated directly.

The North Triangle is proposed to be developed with commercial and office space and will require enhanced water quality treatment. In addition, the outwash soils between the site and Ravensdale Creek do not provide sufficient treatment to allow for phosphorous treatment credits to be applied to the basin, therefore, phosphorous removal will be required onsite. The options available for water quality treatment of runoff from pollution generating surfaces prior to infiltration include; large sand filter, amended sand filter, stormwater treatment wetland, compost amended filter strip and two facility treatment trains. Where possible sand filters are proposed to co-exist with landscaping and then to infiltrate below the sand filter. In addition to infiltrating runoff from the North Triangle, a combination of LID measures are proposed for the North Triangle consisting of one or more of the following; reduced street widths, use of native or adapted plants in landscaping and porous pavements.


NORTH TRIANGLE PROPERTY
SR 169
North Triangle Basin
Infiltration Pond
LEGEND
Basin Lines
Proposed Pond
North Conveyance Option
South Conveyance Option
Discharge Point
Basin D Discharge
Basin B Discharge
MUD LAKE
ROBERTS RD.
GINDER CREEK
SR 169
LAWSON ST.
LAWSON CREEK
Basin A Discharge
Basin B
Basin D
D
Basin A
Basin C
Basin E
RAILROAD ST.
ROCK CREEK
Basin A Discharges
JONES LAKE
Basin C Discharge

APPENDIX J – CIP Map

APPENDIX K – Project Cost Estimates

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PWE # **08-534**

224th Street Covington Creek Culvert Replacements
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Culvert Removal	LS	1	$ 15,000	$ 15,000
Roadway Restoration	SF	10,000	8.00	80,000
Traffic control	HR	300	45.00	13,500
Culvert Replacement	LF	225	300.00	67,500
Mobilization and Cleanup	LS	1	15,500.00	15,500
			Sub-total	**$ 191,500**
			Sales Tax (8.9%)	**17,044**
			Sub-total Including Sales Tax	**$ 208,544**
			Contingency (15%)	**$ 31,282**
			Sub-Total	**$ 239,825**
			Engineering, Overhead, and Administration (25%)	**$ 59,956**
			Grand Total	**$ 300,000**

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PWE # **08-534**

Roberts Drive - Ginder Creek Culvert Replacement
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Culvert Removal	LS	1	$ 15,000	$ 15,000
Roadway Restoration	SF	1,500	10.00	15,000
Traffic control	HR	120	50.00	6,000
Culvert Replacement	LF	60	200.00	12,000
Mobilization and Cleanup	LS	1	6,000.00	6,000
			Sub-total	**$ 54,000**
			Sales Tax (8.9%)	**4,806**
			Sub-total Including Sales Tax	**$ 58,806**
			Contingency (15%)	**$ 8,821**
			Sub-Total	**$ 67,627**
			Engineering, Overhead, and Administration (25%)	**$ 16,907**
			Grand Total	**$ 85,000**

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PWE # **08-534**

Lake Sawyer Park Culvert Replacements
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Culvert Removal	LS	1	$ 3,000	$ 3,000
Trail Restoration	SF	3,200	4.25	13,600
Traffic control	HR	0	50.00	-
Culvert Replacement	LF	225	120.00	27,000
Mobilization and Cleanup	LS	1	4,500.00	4,500
			Sub-total	**$ 48,100**
			Sales Tax (8.9%)	**4,281**
			Sub-total Including Sales Tax	**$ 52,381**
			Contingency (15%)	**$ 7,857**
			Sub-Total	**$ 60,238**
			Engineering, Overhead, and Administration (25%)	**$ 15,060**
			Grand Total	**$ 75,000**

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PWE # **08-534**

3rd Ave (SR-169) - Ginder Creek Culvert Replacement
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Culvert Removal	LS	1	$ 15,000	$ 15,000
Roadway Restoration	SF	2,000	10.00	20,000
Traffic control	HR	240	50.00	12,000
Culvert Replacement	LF	250	100.00	25,000
Mobilization and Cleanup	LS	1	8,000.00	8,000
			Sub-total	**$ 80,000**
			Sales Tax (8.9%)	**7,120**
			Sub-total Including Sales Tax	**$ 87,120**
			Contingency (15%)	**$ 13,068**
			Sub-Total	**$ 100,188**
			Engineering, Overhead, and Administration (25%)	**$ 25,047**
			Grand Total	**$ 125,000**

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PWE # **08-534**

3rd Ave (SR-169) - Mud Lake Creek Culvert Replacement
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Culvert Removal	LS	1	$ 15,000	$ 15,000
Roadway Restoration	SF	4,500	8.00	36,000
Traffic control	HR	400	40.00	16,000
Culvert Replacement	LF	135	120.00	16,200
Mobilization and Cleanup	LS	1	9,500.00	9,500
			Sub-total	**$ 92,700**
			Sales Tax (8.9%)	**8,250**
			Sub-total Including Sales Tax	**$ 100,950**
			Contingency (15%)	**$ 15,143**
			Sub-Total	**$ 116,093**
			Engineering, Overhead, and Administration (25%)	**$ 29,023**
			Grand Total	**$ 145,000**

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PWE # **08-534**

3rd Ave (SR-169) Culvert Replacement at Old Lawson Road
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Culvert Removal	LS	1	$ 5,000	$ 5,000
Roadway Restoration	SF	1,800	10.00	18,000
Traffic control	HR	240	40.00	9,600
Culvert Replacement	LF	110	100.00	11,000
Mobilization and Cleanup	LS	1	4,500.00	4,500
			Sub-total	**$ 48,100**
			Sales Tax (8.9%)	**4,281**
			Sub-total Including Sales Tax	**$ 52,381**
			Contingency (15%)	**$ 7,857**
			Sub-Total	**$ 60,238**
			Engineering, Overhead, and Administration (25%)	**$ 15,060**
			Grand Total	**$ 75,000**

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PWE # **08-534**

Ginder Creek Culvert Replacement at Morgan Street
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Culvert Removal	LS	1	$ 5,000	$ 5,000
Roadway Restoration	SF	1,800	10.00	18,000
Traffic control	HR	240	40.00	9,600
Culvert Replacement	LF	50	200.00	10,000
Mobilization and Cleanup	LS	1	5,000.00	5,000
			Sub-total	**$ 47,600**
			Sales Tax (8.9%)	**4,236**
			Sub-total Including Sales Tax	**$ 51,836**
			Contingency (15%)	**$ 7,775**
			Sub-Total	**$ 59,612**
			Engineering, Overhead, and Administration (25%)	**$ 14,903**
			Grand Total	**$ 75,000**

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PWE # **08-534**

Rock Creek Wetlands Basin Study
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Basin Study and Hyrologic Analysis	LS	1	$ 52,000	$ 52,000
Wetlands Consulting	LS	1	18,000	18,000
Other Consulting	LS	1	9,000	9,000
			Sub-total	**$ 79,000**
			Contingency (15%)	**$ 11,850**
			Sub-Total	**$ 90,850**
			Overhead, and Administration (10%)	**$ 9,085**
			Grand Total	**$ 100,000**

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PWE # **08-534**

North Downtown/Ginder Creek Stormwater Facility
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Piped Conveyance	LS	1	$ 26,000	$ 26,000
Pond Construction	LS	1	150,000.00	150,000
Mobilization and Cleanup	LS	1	15,500.00	15,500
			Sub-total	**$ 191,500**
			Sales Tax (8.9%)	**17,044**
			Sub-total Including Sales Tax	**$ 208,544**
			Contingency (15%)	**$ 31,282**
			Sub-Total	**$ 239,825**
			Engineering, Overhead, and Administration (25%)	**$ 59,956**
			Grand Total	**$ 300,000**

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PWE # **08-534**

South Downtown/Jones Lake Stormwater Facility Study
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
Basin Study and Hyrologic Analysis	LS	1	$ 29,000	$ 29,000
Wetlands Consulting	LS	1	8,000	8,000
Other Consulting	LS	1	2,500	2,500
			Sub-total	**$ 39,500**
			Contingency (15%)	**$ 5,925**
			Sub-Total	**$ 45,425**
			Overhead, and Administration (10%)	**$ 4,543**
			Grand Total	**$ 50,000**

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PWE # **08-534**

5th Ave Storm Drain Improvements
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
15-inch Storm	LF	175	$40.00	$ 7,000
Ditch Improvement	LF	400	2.00	800
Driveway Repairs	EA	5	750.00	3,750
Traffic control	HR	80	50.00	4,000
Mobilization and Cleanup	LS	1	2,500.00	2,500
			Sub-total	**$ 18,050**
			Sales Tax (8.9%)	**1,606**
			Sub-total Including Sales Tax	**$ 19,656**
			Contingency (15%)	**$ 2,948**
			Sub-Total	**$ 22,605**
			Engineering, Overhead, and Administration (25%)	**$ 5,651**
			Grand Total	**$ 28,000**

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PWE # **08-534**

Railroad Ave Storm Drainage Improvements
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
18-inch Storm	LF	750	$50.00	$ 37,500
Catch Basins Type-2	EA	6	$2,500.00	$ 15,000
Traffic control	HR	120	40.00	4,800
Mobilization and Cleanup	LS	1	6,500.00	6,500
			Sub-total	**$ 63,800**
			Sales Tax (8.9%)	**5,678**
			Sub-total Including Sales Tax	**$ 69,478**
			Contingency (15%)	**$ 10,422**
			Sub-Total	**$ 79,900**
			Engineering, Overhead, and Administration (25%)	**$ 19,975**
			Grand Total	**$ 100,000**

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PWE # **08-534**

1st Ave Storm Drainage Improvements
Opinion of Probable Project Costs
April 1, 2009

Item	Unit	Quantity	Unit Price	Amount
15-inch Storm	LF	500	$40.00	$ 20,000
Catch Basins Type-1	EA	2	$750.00	$ 1,500
Catch Basins Type-2	EA	3	$2,500.00	$ 7,500
Traffic control	HR	90	50.00	4,500
Mobilization and Cleanup	LS	1	5,000.00	5,000
			Sub-total	**$ 38,500**
			Sales Tax (8.9%)	**3,427**
			Sub-total Including Sales Tax	**$ 41,927**
			Contingency (15%)	**$ 6,289**
			Sub-Total	**$ 48,215**
			Engineering, Overhead, and Administration (25%)	**$ 12,054**
			Grand Total	**$ 60,000**

APPENDIX L – Maintenance Standards

4.6 Maintenance Standards for Drainage Facilities

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedence of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table 4.5 – Maintenance Standards

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	~~No contaminants or pollutants present.~~
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See “Side Slopes of Pond”	

No. 2 – Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1)
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

No. 3 – Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See “Catch Basins” (No. 5)	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).

No. 4 – Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See “Closed Detention Systems” (No. 3).	See “Closed Detention Systems” (No. 3).	See “Closed Detention Systems” (No. 3).
Catch Basin	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).	See “Catch Basins” (No. 5).

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

No. 7 – Energy Dissipaters

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

No. 8 – Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

No. 9 – Wet Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	See "Detention Ponds" (No. 1).	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

No. 10 – Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

No. 11 – Wetponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Accumulation that exceeds 1 CF per 1000-SF of pond area.	Trash and debris removed from pond.
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

No. 12 – Wetvaults

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

No. 13 – Sand Filters (above ground/open)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Above Ground (open sand filter)	Sediment Accumulation on top layer	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
	Trash and Debris Accumulations	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
	Sediment/ Debris in Clean-Outs	When the clean-outs become full or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
	Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow through the overflow pipes occurs frequently.	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
	Short Circuiting	When flows become concentrated over one section of the sand filter rather than dispersed.	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.
	Erosion Damage to Slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

No. 14 –Sand Filters (below ground/enclosed)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault.	Sediment Accumulation on Sand Media Section	Sediment depth exceeds 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	Ventilation	Ventilation area blocked or plugged	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles/Internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.

No. 14 –Sand Filters (below ground/enclosed)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

No. 15 – Stormfilter™ (leaf compost filter)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault	Sediment Accumulation on Media.	Sediment depth exceeds 0.25-inches.	No sediment deposits which would impede permeability of the compost media.
	Sediment Accumulation in Vault	Sediment depth exceeds 6-inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash/Debris Accumulation	Trash and debris accumulated on compost filter bed.	Trash and debris removed from the compost filter bed.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Compost Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

No. 16 – Baffle Oil/Water Separators (API Type)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	See “Catch Basins” (No. 5)	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

No. 17 – Coalescing Plate Oil/Water Separators

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

No. 18 – Catchbasin Inserts

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Normal Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

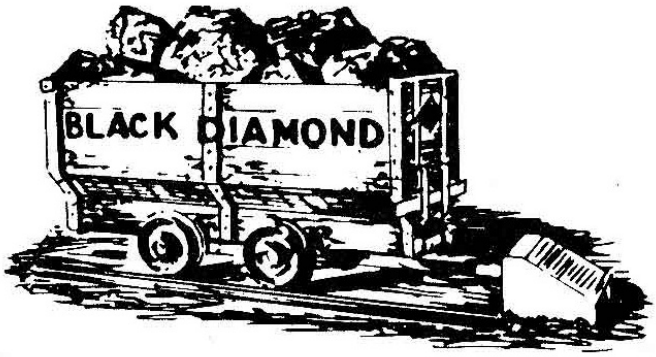
APPENDIX M – LID Map

APPENDIX N – LID Standards

CITY OF BLACK DIAMOND

LOW IMPACT DEVELOPMENT GUIDELINES

2009



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CHAPTER 1 - INTRODUCTION

Low impact development (LID) is a term generally used to describe a land use development strategy that emphasizes protection and use of on-site natural features integrated with engineered, small-scale hydrologic controls at the parcel and subdivision scale to manage stormwater and more closely mimic predevelopment watershed hydrologic functions. LID techniques are increasingly being looked to as an alternative to traditional, structural stormwater management solutions. In addition, individual LID best management practices (BMPs) as outlined in this volume can play an integral role in meeting the minimum requirements applicable to any stormwater design, even if the overall project is not entirely an LID project.

1.1 INTENT

The purpose of these guidelines is two-fold. First, these guidelines provide strategies to utilize an alternative method of stormwater management referred to as low impact development. LID strategies meet multiple objectives such as open space, critical area, and habitat protection while still meeting the standards and requirements set forth under the City's National Pollutant Discharge Elimination System (NPDES) permit and growth management act (GMA) density requirements. Second, this volume presents design guidelines for several LID BMPs that can be integrated into any stormwater design – LID or traditional.

Use of these guidelines does not alleviate the design engineer from using sound professional engineering practices. Special conditions may require more stringent requirements than those outlined herein. All storm drainage improvements should be designed and constructed in conformance with the "Stormwater Management Manual for Western Washington", as published by the Department of Ecology (referred to in this document as the "DOE Manual") and as modified by the City of Black Diamond Engineering and Construction Standards.

These guidelines outline the performance goals, objectives, and standards necessary to evaluate the application of LID methods as an effective stormwater management tools.

1.2 APPLICABILITY

The primary focus for application of LID approaches is new development (residential, commercial, and industrial) that occurs within urban growth management areas. However, this methodology can also be applied to development within the rural setting and in redevelopment of highly urbanized areas.

At this time the LID approaches and BMPs outlined herein are encouraged for all private development, however until these guidelines are finalized and adopted by City Code, proposed LID approaches require prior approval by the City.

Though encouraged, the use of the LID design approach or individual LID BMPs in these guidelines should be considered voluntary by the applicant, unless it is mandated through a City planning process or other implementing ordinances or regulations. Low

impact development can be applied to a variety of zoning and physical land classifications to protect water resources, and specifically should be considered for the following:

- Sites located in a pothole subbasin (i.e., draining to a closed depression)
- Sites that contain or are located adjacent to wetlands, riparian areas (such as rivers, streams, creeks, or swales), fish or wildlife habitat areas, or subbasins tributary to these areas if changes in the land use will result in any negative impacts caused by the increase in volume or rate of surface water leaving or arriving to these areas
- Sites that are underlain by a critical aquifer recharge area
- Sites located within a designated open space area
- Subbasins where preservation of trees is recommended by the City.

1.3 SUBMITTAL RECOMMENDATIONS

LID design proposals should comply with the submittal requirements outlined in The City of Black Diamond Engineering and Construction Standards. In addition, it is recommended that submittal for a land use which has proposed an LID design should also include a site inventory (see section 2.2.1), and preliminary street and stormwater design calculations to assure that the design of stormwater treatment for the site has been adequately considered during the lot and open space layout process. Finally, LID design proposals should also meet any applicable maintenance, management, or ownership submittal requirements outlined in Section 4 of these guidelines.

1.4 PERFORMANCE GOAL AND OBJECTIVES

This section outlines the performance goal and objectives that should guide any proposed LID design approach.

The goal of low impact development is to manage stormwater generated from new development and redevelopment to limit negative impacts to adjacent and/or downstream property owners, and degradation to groundwater or surface waters (such as but not limited to streams, ravines, wetlands, potholes, and rivers).

The LID site design goal can be achieved through the following objectives:

- Minimize the impacts of increased stormwater runoff from new impervious surfaces and land cover conversions by maintaining peak flow frequencies and durations of the site's undisturbed hydrologic condition. This objective, in concert with other objectives, is meant to closely mimic a natural Pacific Northwest minimal surface runoff condition. To provide a quantifiable and measurable standard for flow control on LID projects, Minimum Requirement #7 outlined in

Volume I of the DOE Manual should be adhered to in addition to meeting the other objectives listed below.

- Retain or restore a high percentage of the residential site's native soils and vegetation (~65 percent for residential development and ~25 percent for commercial, as a goal) and set aside these areas into permanent open space areas such as within a natural resource protection area, a conservation easement, or tract/easement for the stormwater drainage system.

- Limit the effective impervious area of the site. The site layout and combined use of LID BMPs should demonstrate that attempts were made to reduce effective impervious area within the site over conventional site layouts.

- Retain and incorporate natural site features that promote infiltration of stormwater on a developed site. Utilize LID BMPs as outlined in Chapter 3 of these guidelines and minimize the use of traditional conveyance and pond technologies to manage stormwater quality and quantity.

- Manage stormwater as close to the origin as possible.

CHAPTER 2 - LOW IMPACT DEVELOPMENT STRATEGIES AND APPLICATIONS

2.1 INTRODUCTION

Low impact development design concepts include a variety of strategies and techniques to address the impacts associated with stormwater runoff. The following sections provide an overview of each LID strategy and, where appropriate, establish targets for achieving the LID site design recommended goals and objectives set forth in Chapter 1. It is important to note that LID design is an iterative process, which encourages ingenuity in the site layout and use of LID techniques to tailor a design to each individual site.

2.2 CONDUCT A SITE ANALYSIS PRIOR TO DESIGNING AN LID PROJECT

The site analysis is a method of evaluating the topography, soils, vegetation, and water features to determine how the site currently processes stormwater. This evaluation provides information essential for developing strategies to configure lots, determine where best to locate natural resource protection areas, and align street networks in a way that retains and restores natural hydrologic function.

2.2.1 SITE INVENTORY PROCESS

A site inventory is a recommended component of an LID design and should be submitted with the application for the project. Environmental features should be inventoried on the proposed development site prior to the site planning process. In addition, important site characteristics on adjacent properties should be assessed to identify how the project will impact or be influenced by the surrounding area. The functions of these environmental features should be assessed for performance at both the site scale and at the watershed scale, where applicable, to determine potential impacts (see Figure 2.1).

An inventory of the environmental features can be used to produce an LID site plan that identifies natural resource protection areas (e.g., riparian areas, wetlands, steep slopes, and other critical areas; significant wildlife habitat areas and their associated buffers; tree conservation areas; and permeable soils offering the best available infiltration potential) as well as areas to direct development. At a minimum, it is recommended that the following process for identifying natural resource protection areas be applied:

- Identify critical areas and associated buffers as set forth in the Black Diamond Municipal Code.
- Identify any tree conservation areas as set forth in the Black Diamond Municipal Code. This should include the tree species, seral stage, diameter breast height, canopy cover, and condition of groundcover and shrub layer.

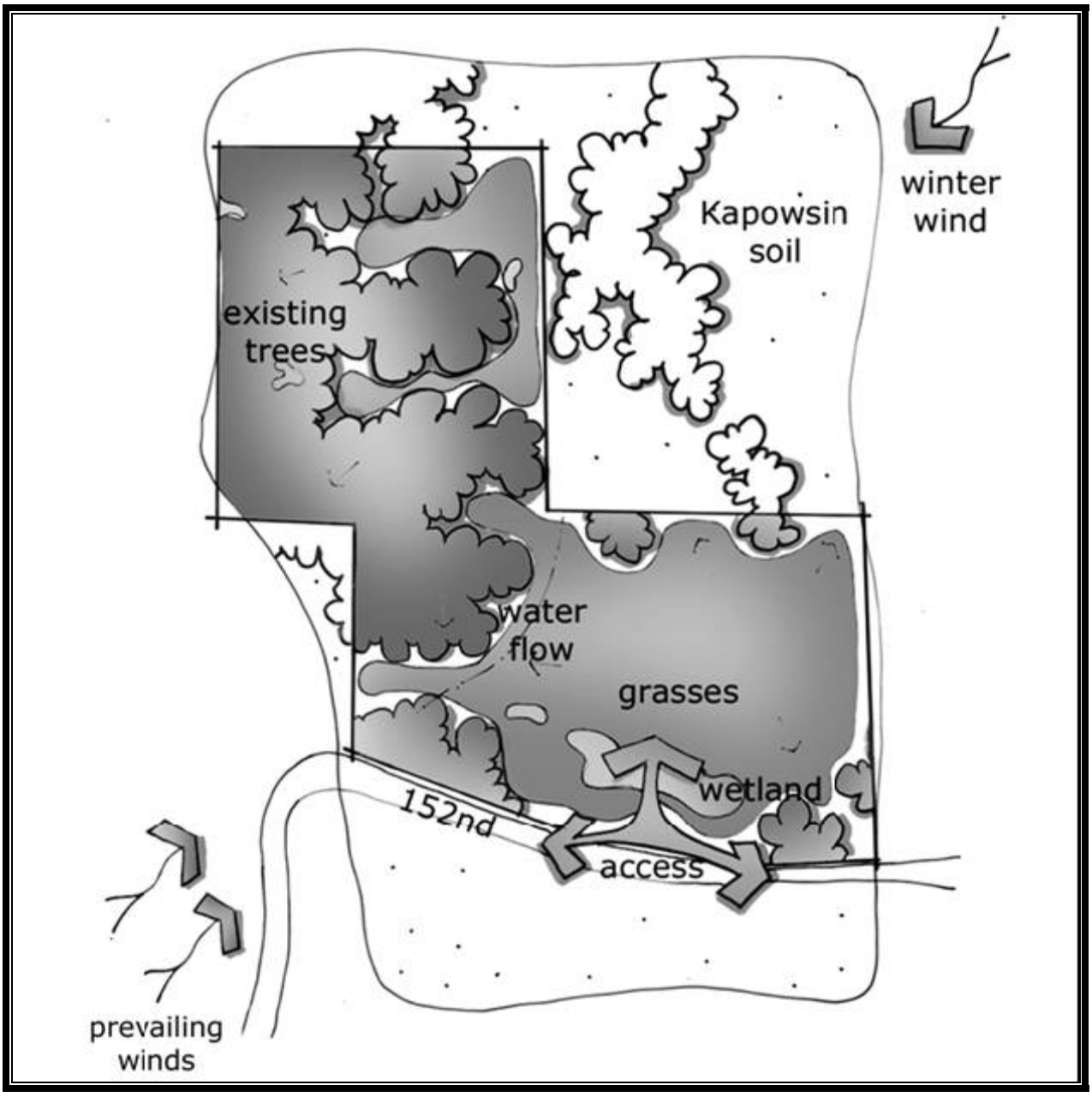

Figure 2.1. Sample Site Inventory.

- Identify underlying soils on the site utilizing soil pits and soil grain analysis to assess infiltration capability on site. (Note: frequency and distribution of soil pits should be adequate to direct placement of the streets and structures away from soils that can most effectively infiltrate stormwater.)

- Identify topographic features that may act as natural stormwater storage/conveyance and underlying soils that provide opportunities for storage and whole or partial infiltration.

- Identify potential wildlife movement corridors.

2.2.2 SITE DESIGN PROCESS

The initial inventory process outlined in Section 2.2.1 will provide the baseline information necessary for the site design. Development areas should be located outside of the natural resource protection areas and within designated buildable areas to minimize soil and vegetation disturbance and take advantage of a site's natural ability to store and infiltrate stormwater (see Figure 2.2). Guidelines for the LID site design process include:

- To the maximum extent practicable, retain a high percent of the site in vegetated open space or natural resource protection areas preferably in contiguous blocks or linear corridors, for the protection of the best stormwater management features identified in the site analysis process. The open space layout should be situated in a location that will have the most success at providing a buffer next to impervious surfaces. See Section 2.3 for related recommendations, and Chapter 3 for BMPs recommended to mitigate a reduction in vegetated open space.

- Limit effective impervious for both residential and commercial developments. Techniques to reduce the amount of effective impervious areas via streets, walkways, and roofs are provided in Section 2.4. Additional mitigation BMPs are provided in Chapter 3.

- Orient residential lots to minimize site disturbance; maximize the benefits of minimal excavation foundation systems; facilitate sheet flow into natural resource protection areas and bioretention facilities; and promote community aesthetics, livability, and privacy.

- Eliminate stream crossings with streets and conveyance systems whenever possible.

- Minimize impervious surfaces by reducing building footprints, street length and width, parking areas, and driveways.

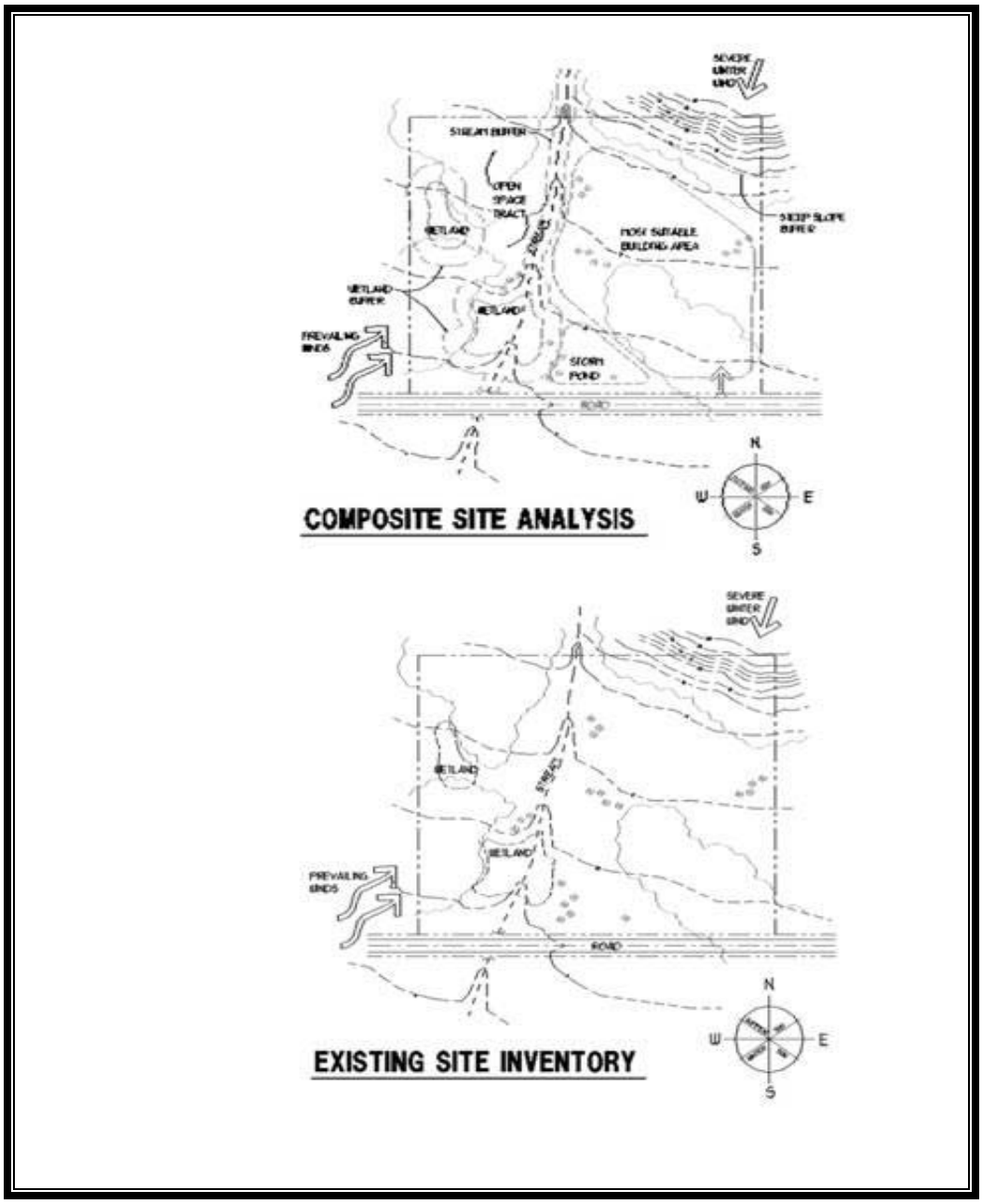

Figure 2.2. Sample Composite Site Inventory.

- Eliminate effective impervious areas by directing stormwater from impervious areas in swales or as low velocity sheet flow to adjacent undisturbed open space areas or bioretention areas.

- Integrate small, dispersed bioretention areas to capture, store, and infiltrate stormwater on site.

- Maintain predevelopment flow path lengths in natural drainage patterns whenever possible.

- Layout streets, lots, and other proposed site features to follow topographic contours to minimize soil and vegetation disturbance and loss of topsoil or organic duff layer.

- Utilize pervious paving surfaces such as porous pavement and pavers for streets, driveways, parking lots, or other types of drivable or walkable coverage.

- Direct rooftop runoff to infiltration areas, full dispersion systems, or to rainfall reuse systems for non-potable reuse, or utilize vegetated roof systems to evaporate and transpire stormwater.

- Limit development within natural resource protection areas to:

    - Passive, confined recreation (i.e., walking and biking trails) constructed from pervious surfaces.

    - Platforms for viewing streams, lakes, and wetlands constructed with techniques to minimize disturbance to soils and vegetation.

    - Small dispersed bioretention and other LID stormwater dispersion areas. These should ne avoided in riparian areas or wetlands and their associated buffers.

    (See Figures 2.3, 2.4, and 2.5.)

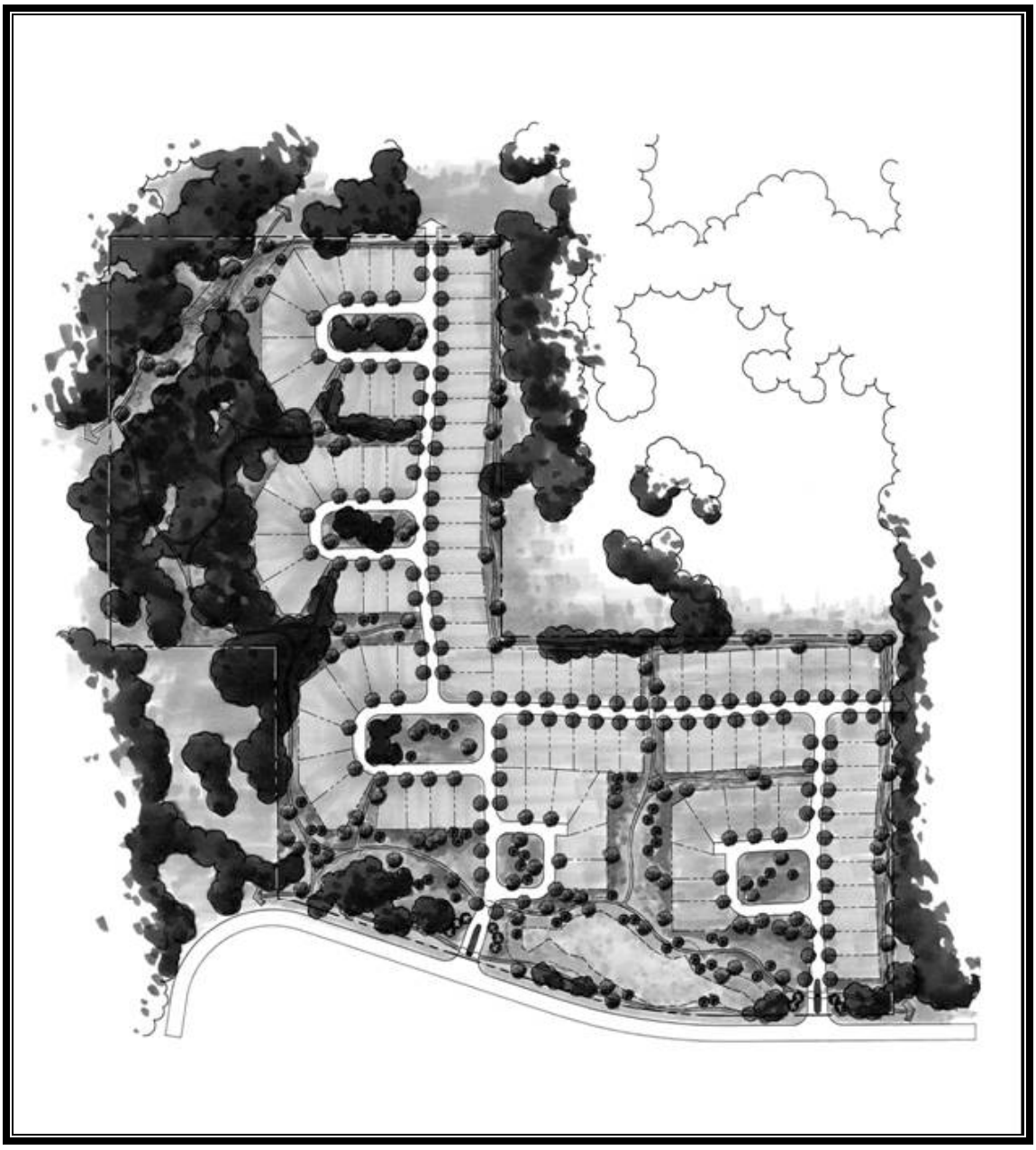

Figure 2.3. Sample LID Subdivision Design.

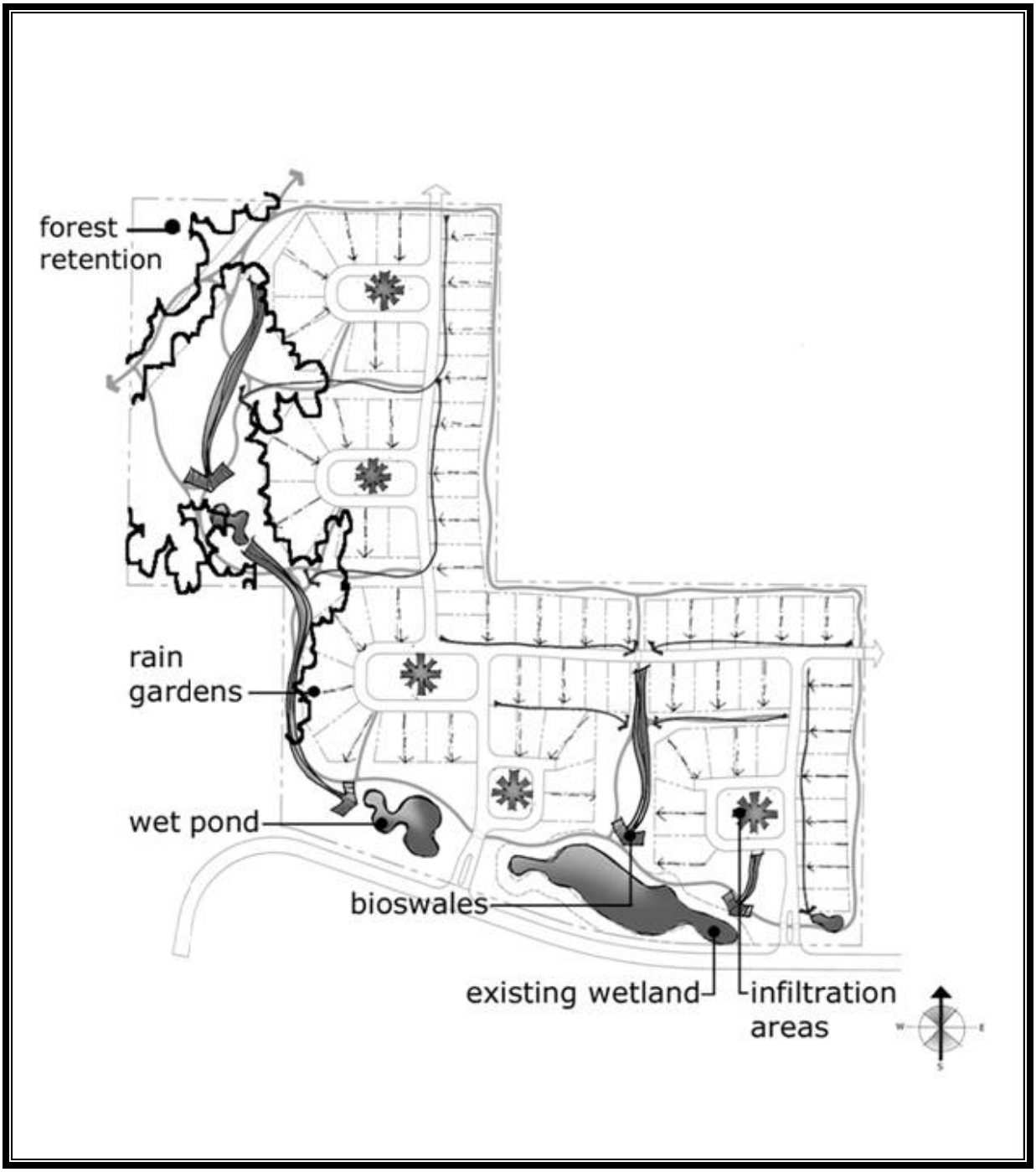

Figure 2.4. LID Storm Drainage Concept.

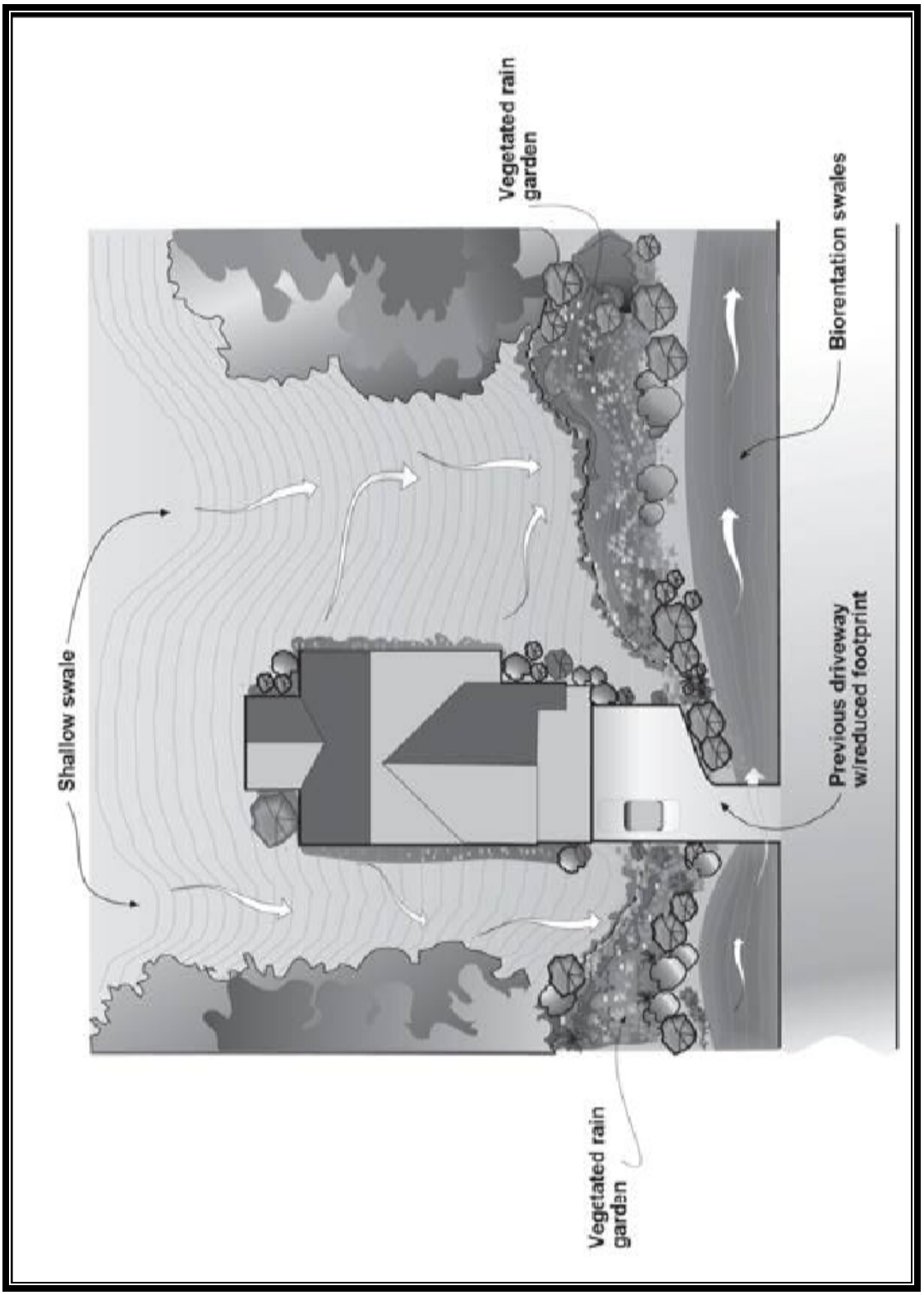

Figure 2.5. Sample LID Large Lot Design.

2.3 RETAIN NATIVE VEGETATION, AND PROVIDE REFORESTATION WHERE APPLICABLE

The following sections outline specific strategies to support the comprehensive LID design approach. Strategies discussed include:

- Vegetation retention
- Reforestation
- Minimizing impacts during site clearing and grading.

2.3.1 VEGETATION RETENTION

The primary goal is to retain large, connected tracts of native vegetation areas, either through a cluster design or on individual lots, to maintain the natural hydrologic function and provide infiltration areas for overland flows generated in developed portions of the site. Tree areas not directly adjacent to structures (or located where they may potentially impact a structure) should be protected or restored to follow natural successional patterns and develop diverse multilayer canopy structure, snags, large woody debris, understory vegetation, and forest duff. In addition to meeting the primary objective of stormwater management, these large, connected tracts of native vegetation can be used to meet secondary objectives such as the creation of open space corridors and critical area and habitat protection.

Applicability – Native Vegetation Retention Recommendations

Assessment of natural resources outlined in Section 2.2.1 will identify critical areas and native soils and vegetation offering the best available stormwater benefit. Retaining a high percentage of native vegetation is the objective; however, it is recognized that achieving this percentage may be difficult given each site's unique characteristics while trying to obtain urban level densities. In these cases, the combined use of other LID strategies will help determine the amount of vegetation retention necessary to maintain a site's natural hydrologic cycle.

The following recommendations can be applied in designated urban areas (i.e., within the City's urban growth management area [UGA]), when retention of large areas of native vegetation cannot be achieved:

- Residential LID projects should attempt to retain as much of the site for native soil/vegetation protection areas as possible and provide the following additional BMPs (as well as other LID BMPs described in Chapter 3):

    - Soil amendments should be applied to areas which are being set aside as non-buildable areas (open space or natural resource protection areas) and are in need of rehabilitation because of past land use disturbances such as clearing and intrusion of invasive species. The purpose is to enhance and accelerate the rehabilitation of the soil structure. The application should be nondestructive to the existing vegetation that is retained by taking care to taper depths of soil amendment near the surface roots. The soil amendment procedures should be the similar to the recommended rates for lawn areas as specified in Section 3.14, *Option 1 – Amend*

Existing Soils in Place. However, removal of surface woody debris and rocks larger than 1-inch diameter is not required.

- Natural resource protection areas should be reforested to the extent possible.

- Trees should be replanted throughout the buildable areas of the site. A recommended number of trees will be two per lot spaced adjacent to the public right-of-way near the lot.

- Commercial and industrial LID projects should attempt to retain a minimum of approximately 25 percent native soil/vegetation protection areas and provide the following additional BMPs:

    - Utilize shared parking (refer to Section 2.4.2), multi-storied parking, or parking facilities located under the structure

    - Any outdoor parking areas should be designed with bioretention facilities that are interspersed throughout the parking lot area to receive stormwater runoff from the impervious surfaces.

Design Recommendations

Vegetation Protection During the Construction Phase
The following steps should be taken to protect vegetation during construction:

- Map natural resource protection areas on all plans and delineate these areas on the site with silt, construction, or other appropriate fencing to protect soils and vegetation from construction damage.

- Meet and walk property with equipment operators to clarify construction boundaries and limits of disturbance.

- Protect drainage areas during construction. If an area has any type of channel/drainage swale that provides a hydrologic connection to vegetation protection area(s), then the channel should also be protected throughout the construction phase by fencing and use of erosion control measures to prevent untreated runoff from the construction site to flow into the channel.

- Install signs and fences to identify and protect natural resource protection areas.

- Protect trees and tree root systems utilizing the following methods:

    - Reduce soil compaction during the construction phase by protecting critical tree root zones that may extend to or beyond the trees canopy or drip line. The critical root zone should be identified by the project arborist.

- Reduce soil compaction during the construction phase by protecting critical tree root zones that may extend to or beyond the trees canopy or drip line.

- Limit any excavation within the critical tree root zone.

- Limit the stockpiling or disposal of excavated or construction materials in the vegetation retention areas to prevent contaminants from damaging vegetation and soils.

- Avoid excavation or changing the grade near trees that have been designated for protection. If the grade level around a tree is to be raised, a dry rock wall or rock well should be constructed around the tree.

- Restrict trenching in critical tree root zone areas.

- Prevent wounds to tree trunks and limbs during the construction phase.

- Limit the installation of any impervious surfaces in critical root zone areas. Where street or sidewalk surfaces are needed under a tree canopy, unmortared porous pavers or flagstone (rather than concrete or asphalt) or bridging techniques can be used (see Figure 2.6).

- Prep tree conservation areas to better withstand the stresses of the construction phase by fertilizing, pruning, and mulching around them well in advance of construction activities.

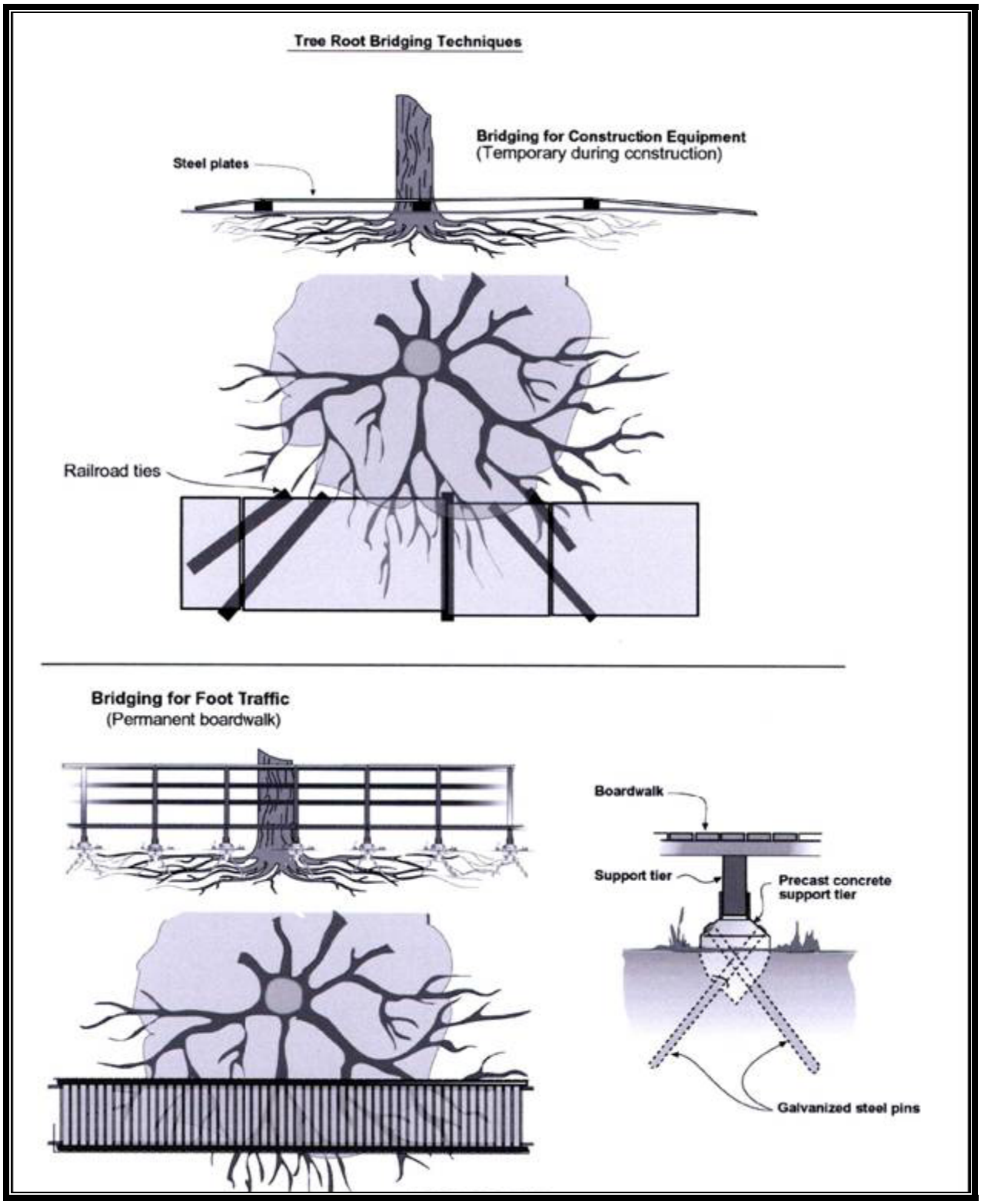

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Figure 2.6. Root Bridge.

Vegetation Protection Post-construction
The following steps should be taken to protect vegetation after construction:

- Mechanisms should be put in place to assure long-term protection of vegetation retention areas. Mechanisms to protect conservation areas include setting aside conservation areas into separate tracts, permanent easements; homeowner covenants, maintenance agreements, and education (see Sections 4.2.1 through 4.2.3 for specifics on these topics).

- Signs should be installed indicating that removal of trees or vegetation is prohibited within the native vegetation retention areas (see Figure 2.7).

- Permanent fencing is recommended around the limits of the vegetation retention areas. Recommended construction should be in such a manner as to not impede the movement of wildlife within the vegetation retention areas.

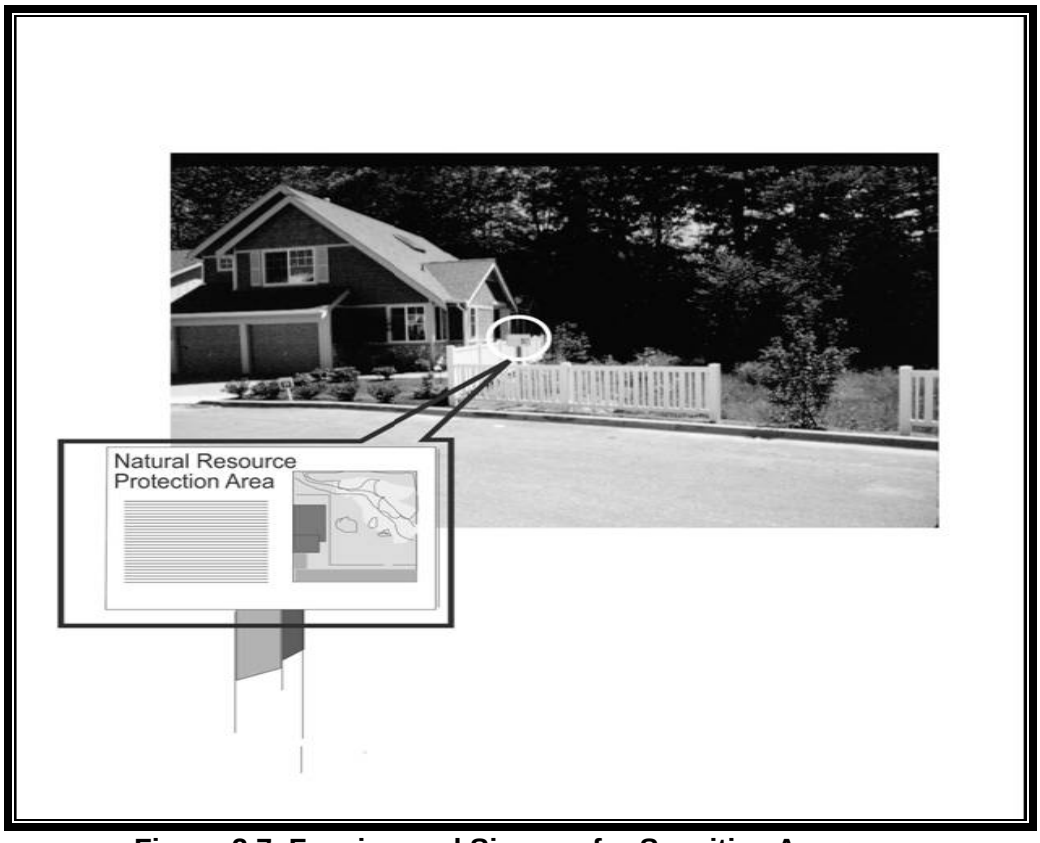

Figure 2.7. Fencing and Signage for Sensitive Areas.

2.3.2 REFORESTATION RECOMMENDATIONS

Natural resource protection areas that have been disturbed may need to be (or may be required to be) replanted with native trees and vegetation in order to achieve the full hydrologic benefits of a native, forested site. Vegetation restoration/planting methods should conform to published standards as appropriate to the type of natural resource protection area. The following guidance documents are provided as an example:

- Restoring the Watershed A Citizen's Guide to Riparian Restoration in Western Washington, Washington State Department of Fish and Wildlife, 1995

- Streamside Planting Guide for Western Washington, Cowlitz County Soil and Water Conservation District

- Plant It Right: Restoring Our Streams, WSU Cooperative Extension, 2002

- Integrated Streambank Protection Guidelines, Washington State Department of Fish and Wildlife, 2000

- Surface Water and Groundwater on Coastal Bluffs: A Guide for Puget Sound Property Owners, Washington State Department of Ecology, Shorelands and Coastal Zone Management Program Publication No. 95-107, 1995

- Vegetation Management: A Guide for Puget Sound Bluff Property Owners, Washington State Department of Ecology, Shorelands and Coastal Zone Management Program Publication No. 93-31, 1993.

In those situations where it is not feasible to retain existing trees of sufficient size and quantity to achieve the recommended or required amount of tree cover, additional tree cover can be provided through supplemental tree plantings. Additionally, on those sites where tree cover does not exist due to previous removal, tree cover can be reestablished (reforestation). The following standards should be utilized:

- Tree conservation areas not adjacent to or potentially impacting structures should be protected or restored to follow natural successional patterns and develop diverse multilayer canopy structure, snags, large woody debris, understory vegetation, and forest duff.

- Trees selected for replacement purposes should be free from injury, pests, diseases, and nutritional disorders. Trees should be fully branched and have a healthy root system. Proper size and species will be determined by the project arborist.

- Avoid the use of a single species of tree for replacement purposes. As a recommended guideline; no individual species of replacement tree should exceed 50 percent of the total nor should any individual species be less than 10 percent of the total.

- Ongoing maintenance should include weeding and watering so as to achieve a recommended minimum 80 percent survival of all planted vegetation after 2 years. If during the 2-year period survival of planted vegetation falls below 80 percent, additional vegetation should be installed as necessary to achieve the recommended survival percentage. Additionally, the likely cause of the high rate of plant mortality should be determined and corrective actions should be taken as needed to ensure plant survival. If it is determined that the original plant choices are not well suited to site conditions, these plants can be replaced with plant species that are better suited to the site.

- Developments should use native trees for replacement purposes in areas that are separate from either residential lots or storm drainage areas adjacent to streets or parking lots (i.e., locate native trees within natural resource protection areas). The native tree species selected should be based on the underlying soils and the historic, native indigenous plant community type for the site and the recommendations of the project arborist.

2.3.3 RECOMMENDATIONS TO MINIMIZE IMPACTS DURING SITE CLEARING AND GRADING ACTIVITIES

Prepare a Detailed Soils Analysis
A detailed soils analysis that identifies soil types and associated infiltration capabilities should be conducted prior to any clearing and grading activities on the site (see Section 2.2.1 for specifics on inventory and assessment of soils).

Minimize Clearing and Grading
Grading should be kept to a minimum by incorporating natural topography into the development and limiting the amount of cut and fill on those portions of the site with permeable soils. The following recommended standards should be utilized:

- Any portion of the site with permeable soils should be closely considered for preservation to promote infiltration of stormwater runoff

- Areas of rich topsoil should either be left in place or, if excavated in construction areas, utilized elsewhere on the site to amend areas with sparse or nutrient deficient topsoil

- Direct runoff to areas of permeable soils or natural depression areas to promote infiltration

- Distances for overland flow should be kept short to promote sheet flow and minimize concentration of runoff

- Grading should not increase steep, continuous slopes

- Limit clearing to street, utility, building pad, lawn areas, and the minimum amount of extra land necessary to maneuver machinery. All other land outside these areas should be protected with construction fencing to prevent intrusion and compaction by construction equipment or other types of vehicles.

Erosion Control Techniques

In addition to the erosion and sediment control requirements specified in DOE Manual and Black Diamond Engineering and Construction Standards, the following standards are recommended for use on LID sites:

- Limit secondary excavations and heavy equipment use by shaping final lot grades and topographic features at the site development stage.

- Utilize effective revegetation methods to reduce erosion including:

    - Establish vegetation quickly, particularly during the seasons that have the heaviest rainfall

    - Use native plant species adapted to the local environment

    - Plant during seasons that provide best opportunity for survival of vegetation (usually late fall, winter, or early spring months)

    - Control excess surface water runoff to prevent erosion

    - Utilize proper seedbed preparation

    - Fertilize and mulch to protect germinating plants

    - Protect areas designated for revegetation from soils compaction by restricting heavy equipment

    - Provide proper soil amendments where necessary (refer to Section 3.14).

- Protect native topsoil during the construction phase. Native topsoil has a high organic content and native seed sources, which are excellent for reestablishing permanent vegetation:

    - If at all possible, topsoil or other material should not be relocated or stockpiled on critical areas where they can cover critical root zones, suffocate vegetation, and erode into adjacent streams

    - To prevent erosion, small stockpiles may be covered with weed barrier material that sheds moisture yet allows air transmission. Large stockpiles may need to be seeded and/or mulched.

- Minimize the amount and time that graded areas are left exposed by completing construction and erosion control in one section of the site before beginning operation on the next.

- Limit clearing and grading during heavy rainfall seasons. Construction activities should begin during the season of lowest precipitation and end when conditions are favorable for the establishment of vegetation.

- Reduce the number and width of construction access streets. These access streets should be located in areas where future streets and utility corridors will be placed whenever possible.

- Stockpile materials in areas designated for clearing and grading (such as parking areas and future streets).

- Perform preconstruction, routine, and post-construction inspections:

    - Conduct a preconstruction inspection to determine that adequate barriers have been placed around vegetation retention areas and structural controls are implemented properly

    - Routine inspections should be conducted to verify that structural controls are being maintained and operating effectively throughout construction

    - Conduct a final inspection to verify that revegetation areas are stabilized and that stormwater management systems are in place and functioning properly.

2.4 REDUCE EFFECTIVE IMPERVIOUS AREAS ASSOCIATED WITH STREETS, ALLEYS, SIDEWALKS, DRIVEWAYS, AND PARKING AREAS

Streets, alleys, sidewalks, driveways, and parking areas create a substantial portion of total urban impervious area and usually have highly efficient drainage systems. Reducing the amount of effective impervious area associated with streets, alleys, sidewalks, driveways, and parking areas is a key concept of LID site designs. The following sections contain strategies for reducing the impacts of impervious surfaces associated with transportation related networks. Note: Existing applicable street standards still apply. Should the City choose to adopt any LID guidelines regarding streets and access they would need to be incorporated into the City's Transportation Standards.

2.4.1 STREET DESIGN

Street design refers to the layout of the street system within a development. The objective for the street system design is to reduce the amount of effective impervious area associated with the street network. This may be achieved by examining alternative

street layouts and determining the best option for increasing the number of homes per unit length of street. Strategies for reducing the amount of effective impervious area associated with the street network include:

- Design street layout to follow the existing topographic contours to minimize cuts and fills. This is also beneficial for creating vegetated open channels along the street that have gentle slopes.
- Design the street layout to avoid crossing natural resource protection areas.
- Natural resource protection areas or bioretention areas should be located down-gradient of streets, alleys, or other impervious surfaces when feasible.
- Streets should be designed to service clusters of development located within the buildable portions of the site (i.e., cluster housing) and avoid entering into the natural resource protection areas, thereby reducing the overall length of the street network and minimizing the disruption of sheet flow within these areas.
- An example street design using LID features is shown in Figure 2.8.

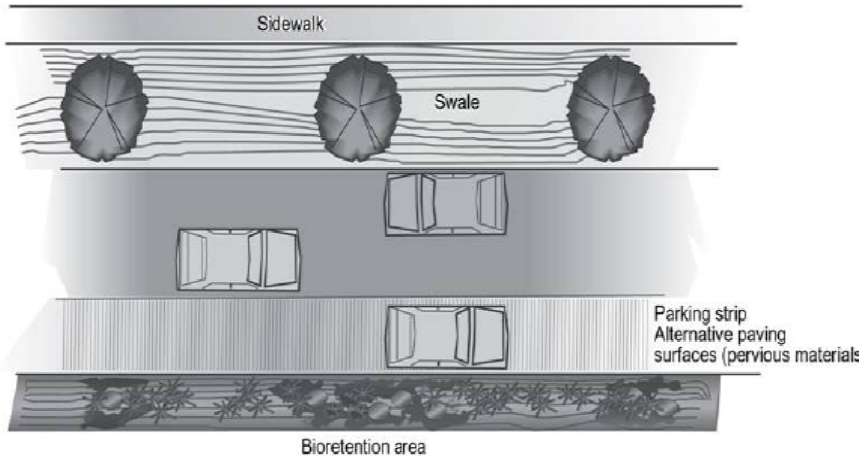

Figure 2.8. Sample LID Street Design.

Street Layout
One type of street layout cannot be used in all situations, so it is advantageous for a designer to explore different strategies and decide which ones will work best for the existing site. The following types of layouts should be considered:

- Grid layouts – Grid patterns provide multiple access routes to each parcel and may include alleyways between blocks with garages located at the back of the house. It should be noted that the use of alleys may increase the total street network and associated impervious surface. Pervious pavements may be utilized to reduce this effect.

- Cul-de-sacs – In those instances where cul-de-sacs are used, techniques should be used to reduce or disconnect the impervious area. This can be accomplished by increasing the diameter of the cul-de-sac, but including a pervious or bioretention landscaped area in the center where stormwater can be directed. See Figures 2.9 an example schematic.

Street Cross Sections
The objective of modifying street cross sections is to reduce the street width to the minimum amount of impervious surface necessary, while still accommodating project traffic, and emergency vehicle access, and utilizing pervious pavements where most applicable. Note: Existing applicable street standards still apply. Should the City choose to adopt any LID guidelines regarding streets and access they would need to be incorporated into the City's Transportation Standards:

- Sample LID streets are provided in Figures 2.9 through 2.11. They incorporate a narrower paved section of street, use of alternative paving surfaces, and promotion of sheet flow into vegetated open channels. An example of an LID street layout using a standard street section is shown in Figure 2.10.

- Paving surfaces for LID street designs may utilize alternative paving surfaces, as outlined in Section 3.16 with City approval. Porous paving surfaces adjacent to the traveled lane (e.g., in pull out parking, shoulders, or for sidewalks) is a recommended alternative provided the subgrade of the traveled lane will not become saturated by infiltrating runoff through the porous surfaces.

- Cement/concrete pavement strips (2-foot-wide strips of concrete that act as a transition between the traveled lane and porous pavement surfaces adjacent to the traveled way) may be utilized to delineate the traveled lane areas.

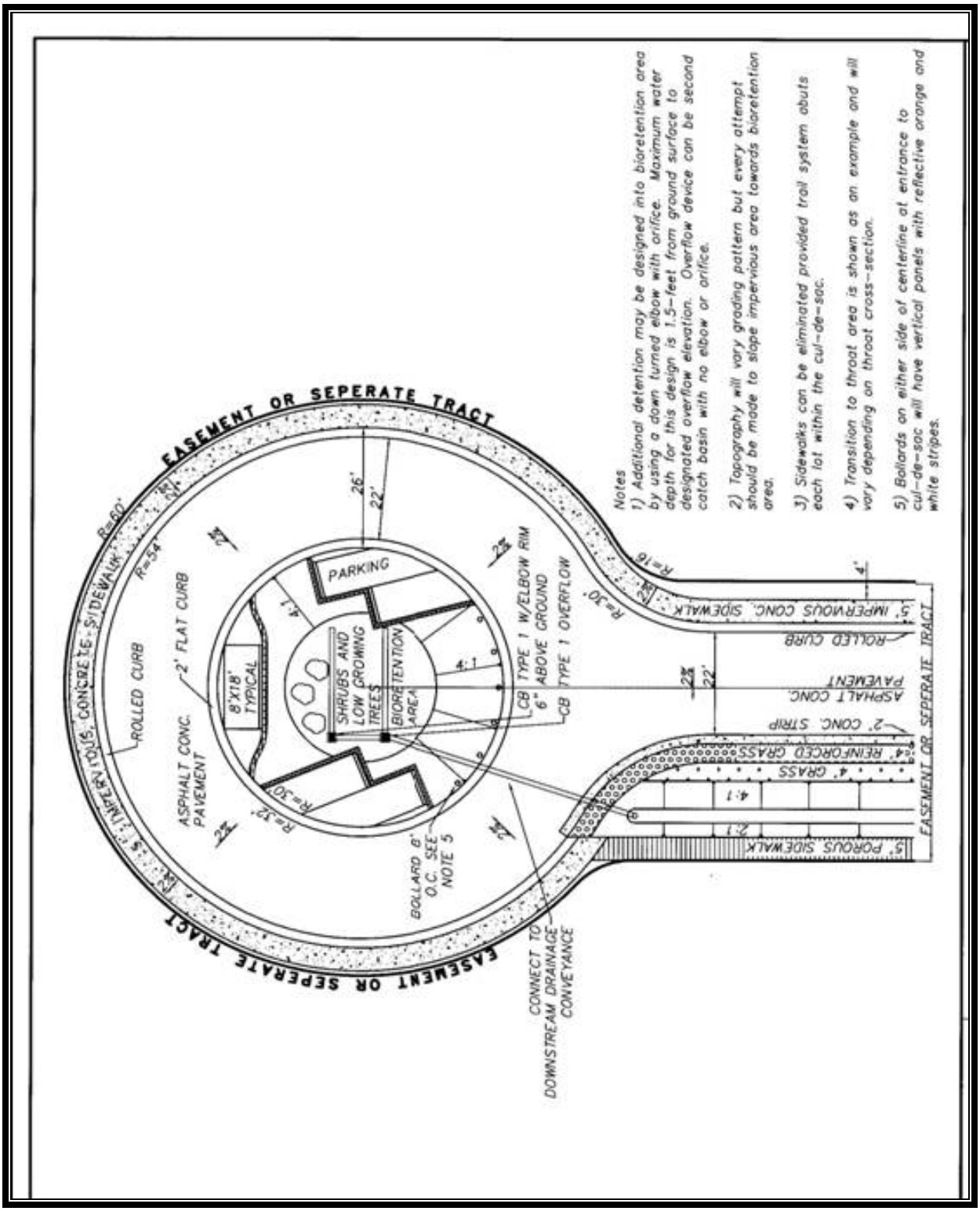

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Figure 2.9. Sample Cul-de-Sac Design with Bioretention.

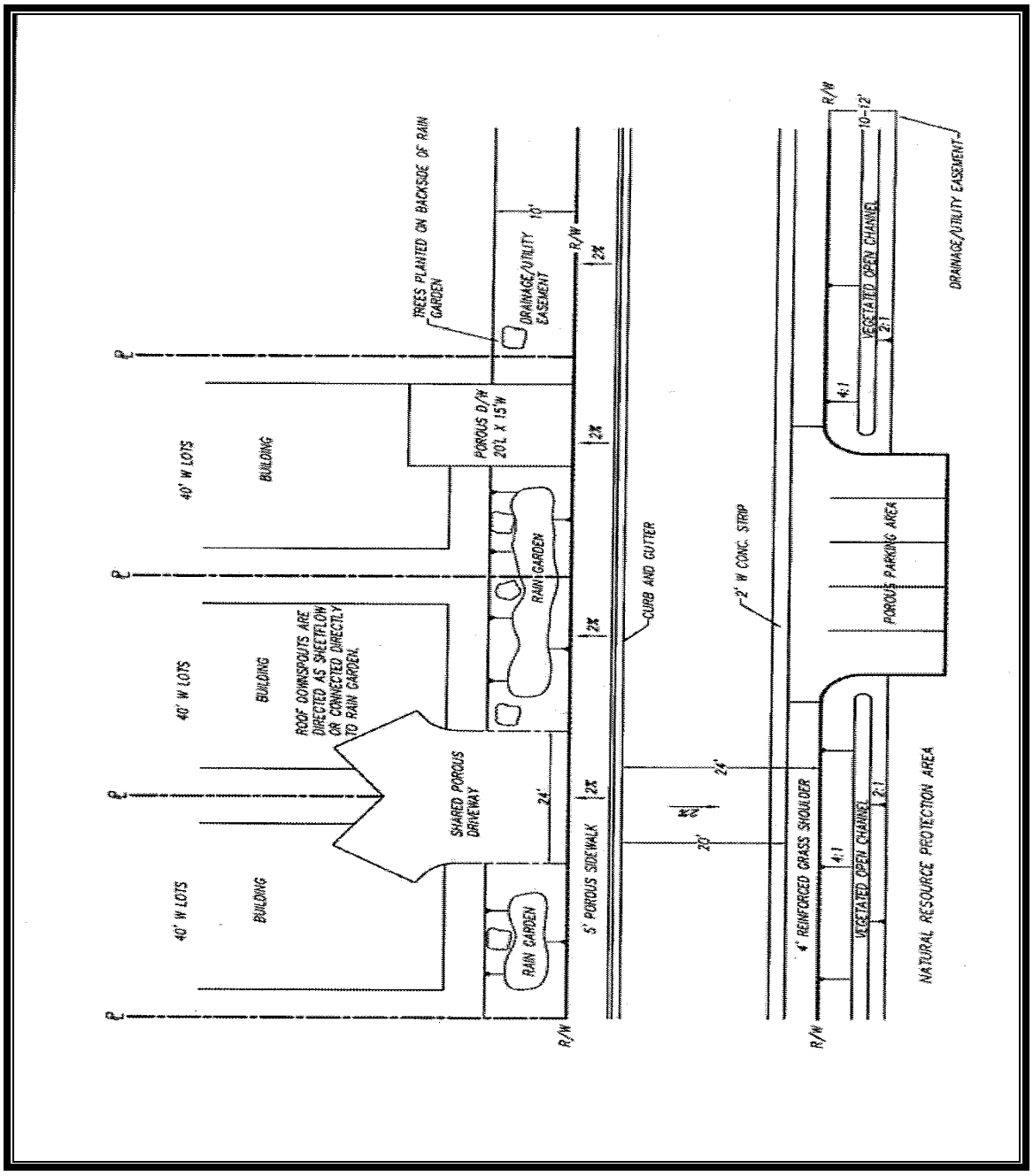

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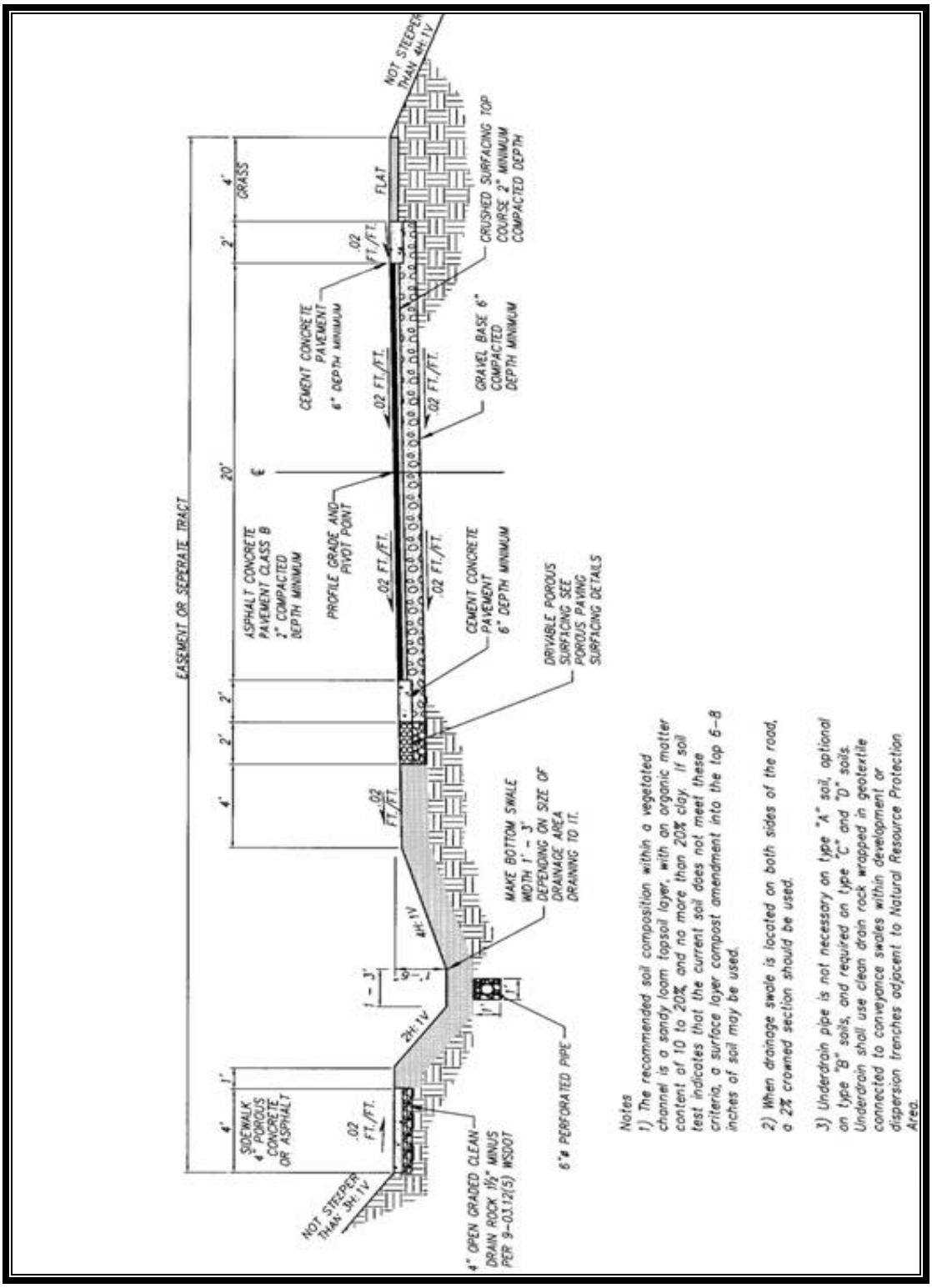
Figure 2.10. Sample Street – Lots on One Side of Street Only.



Not to Scale

Figure 2.11. Sample Street Open Drainage with Porous Shoulder & Detached Sidewalk.

- Curbs and gutters systems in conjunction with catch basins and pipes are discouraged for use as stormwater collection in LID projects. Where there is a legitimate need for constructing a curb and gutter system, Section 2.4.5 provides guidance for designing curb and gutter alternatives. The following general recommendations apply to curb and gutter applications in street designs for LID projects:

    - Curbs should be utilized when the sidewalk is adjacent and connected to the traveled way provided they are used only on one side of the street and the street cross slope is away from the curb or if curb cuts are utilized, as shown in Figure 2.12, and drain to a vegetated open channel or bioretention area behind the curb.

    - Attempts should be made to disconnect sidewalks and trails from the traveled way portion of the street, to the greatest extent possible. Although sidewalks should not be required on both sides of the street, every lot should have pedestrian access to an abutting trail or to a sidewalk located on at least one side of the street. Sidewalks may be separated from the street by placement of a vegetated open channel or bioretention area between the sidewalk and the street.

- Sidewalks and trails should be constructed of porous materials where feasible. Porous materials for sidewalks and trails which abut lots, in lieu of a street side sidewalk, should be Americans with Disabilities Act (ADA) compliant. An example sidewalk design is provided in Figure 2.13.

- The use of additional pullout parking spaces can be used in LID street designs to compensate for narrower street widths which restrict street-side parking. An example design is provided in Figure 2.14. Parking stalls should be provided at an adequate rate to meet the parking needs of the development. These rates may be determined by the City when LID street cross-sections are requested.

- On street parking stalls should be located within 150 feet of each lot being served.

- Signage that prohibits on-street parking is recommended for streets that provide less than the standard width needed for emergency vehicle access.

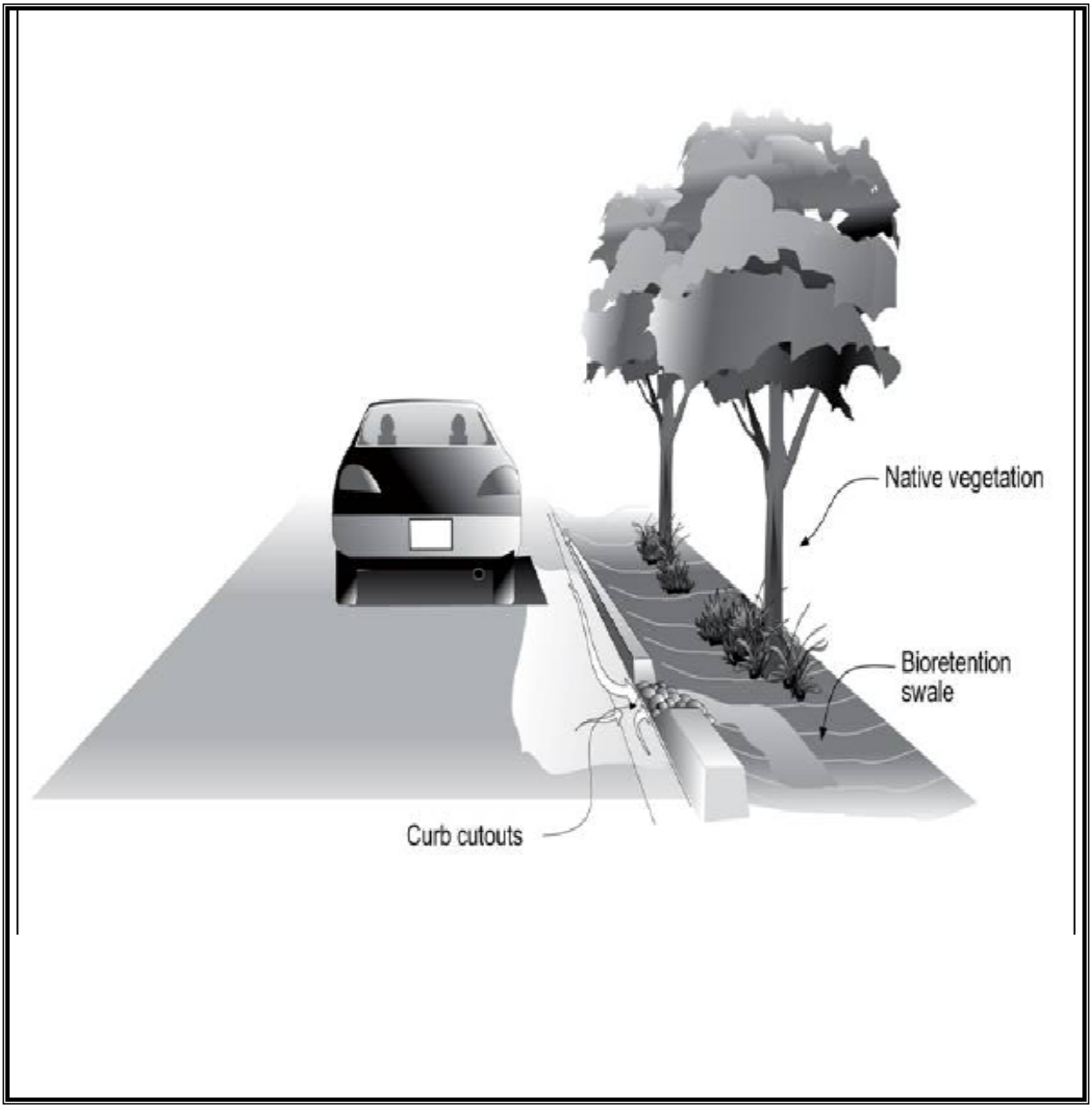
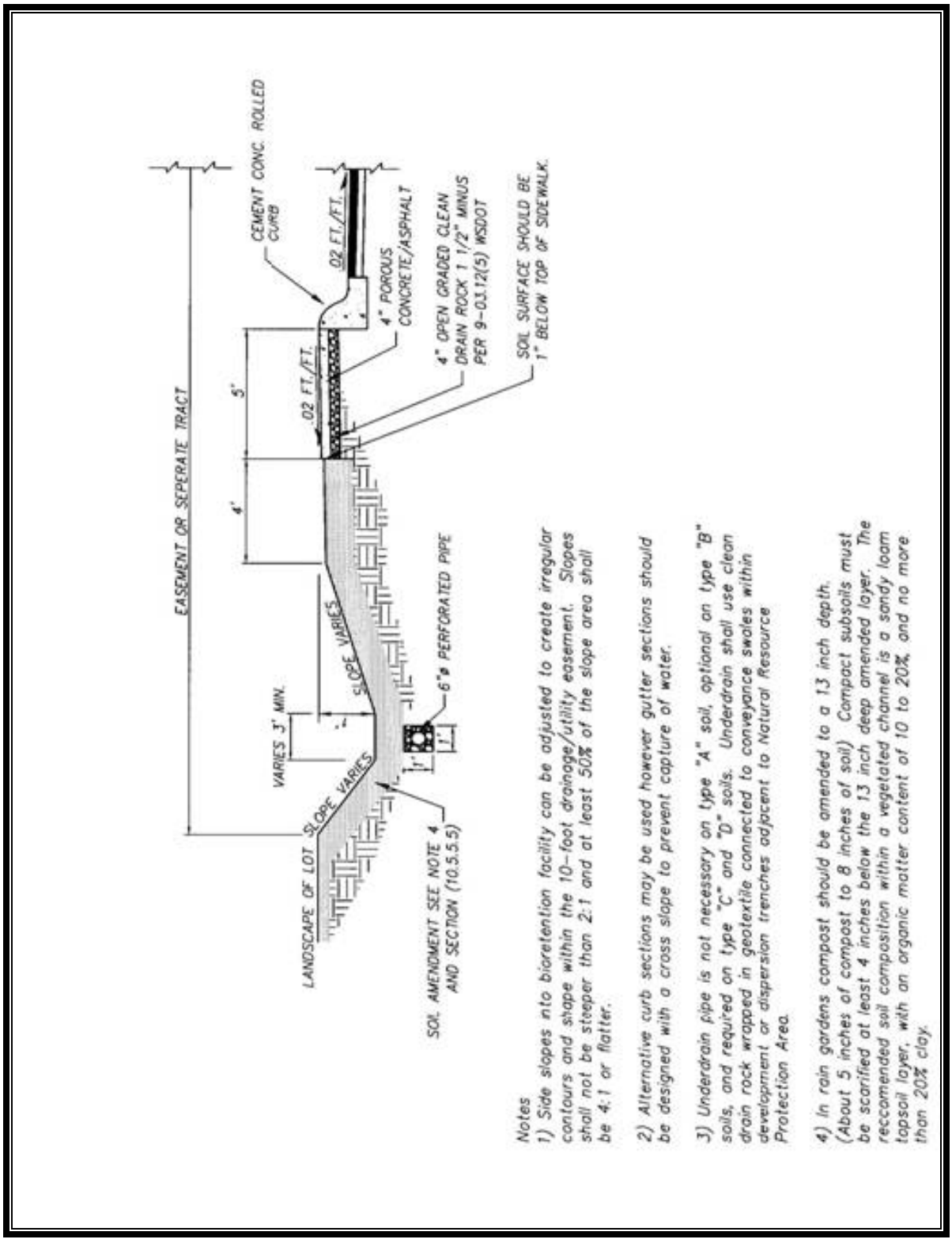


Figure 2.12. Curb and Gutter Cutouts.



Not to Scale

Figure 2.13. Alternate Sidewalk Design with Rain Garden Behind Porous Sidewalk.

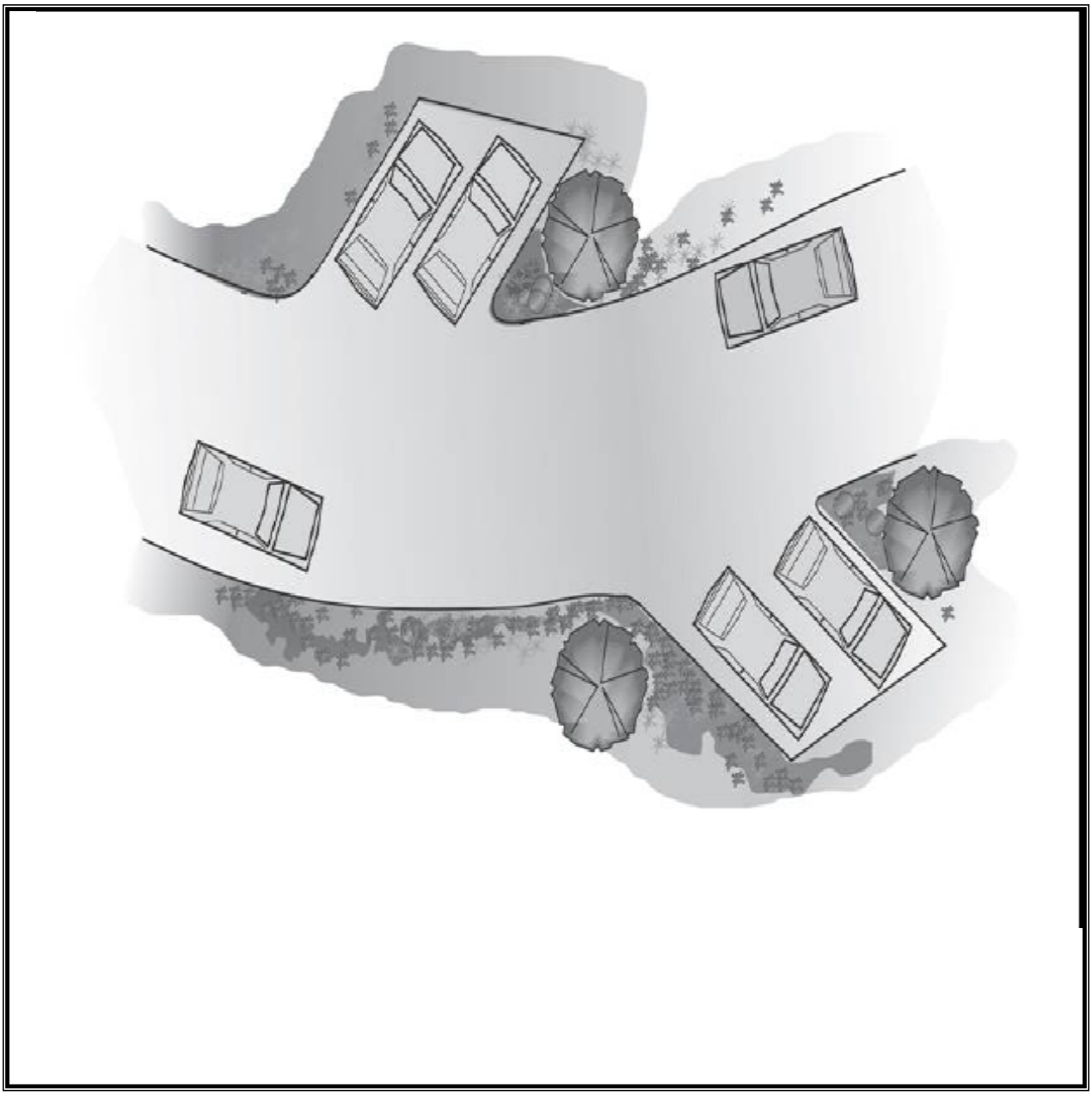


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Figure 2.14. Alternative Parking.

2.4.2 PARKING LOTS

The objective of alternative parking lot designs is to eliminate excessive impervious areas and/or reduce the effective impervious area of the lot, while still providing adequate parking for the intended land use(s).

Parking Lot Recommendations

- Utilize the minimum off-street parking requirements outlined City's Code for non-residential uses. If the total amount of parking spaces exceeds the minimums outlined in the City's code, it is recommended that any parking lot space above the minimum amount be constructed of pervious materials or accommodated in a multi-storied or underground parking structure.

- It is recommended that the designer should incorporate alternative paving surfaces as discussed in Section 3.16 into the parking lot to promote infiltration of the runoff without the need for conventional catch basins and pipe systems.

- Bioretention areas can be used in concert with alternative paving surfaces to maximize the attenuation of runoff. Spacing and layout of the bioretention area should be designed so runoff is maintained as sheet flow from the driving surfaces into the bioretention area.

- Compact vehicle parking should be maximized to the extent allowed by City Code.

Shared Parking

The total amount of impervious area can be reduced by utilizing shared parking. This strategy is appropriate for land uses with non-competing hours of operation, such as a church and a school or office. Recommendations for proposals with shared parking are as follows:

- The peak parking demand for the two uses should occur at different times of the day or week

- Properties should be in close proximity to each other

- Each establishment should have long term, consistent parking needs

- It is recommended that property owners enter into a legally binding agreement that outlines the terms of shared parking arrangements to avoid future conflicts.

2.4.3 ALLEYS

Alleyways with garages located at the rear of lots provide more visually appealing streetscapes, effectively taking vehicle access emphasis from the front of homes. However, the use of alleys may increase the overall amount of impervious surface on the site. The following recommendations apply to alleys:

- Alleys should not be used in-lieu of streets due to access needs of emergency vehicles

- Construct alleys with pervious materials whenever feasible.

- Alleys should be constructed without curb, gutter, or sidewalks

- Alleys should be designed to direct sheet flow to vegetated stormwater facilities or infiltration systems.

- Alleys should be limited in size where feasible based on either one-way or two-way traffic needs.

2.4.4 DRIVEWAYS

Driveways are typically constructed with impervious surfaces and as such should be considered in the total stormwater runoff reduction strategy. The following are recommended methods to reduce the amount of effective impervious surface associated with driveways:

- Driveways serving up to two single family residences should be limited to a maximum of 18 feet in width or 24 feet for a three car garage bay.

- Driveway length should be reduced as much as possible. This may be achieved by locating the house closer to the street or by using alley access directly into a garage. However, driveway length should be designed to accommodate the entire length of an average sized passenger vehicle (e.g., SUVs, pick-up trucks, sedans, vans) for parking.

- When possible, design clusters of homes to utilize shared driveways. On lots that accommodate multiple family dwellings, such as townhouses, a courtyard between garages and the stem of the driveway can be shared space.

- Driveways should be constructed using pervious materials where possible, and graded in such a manner to prevent stormwater runoff from saturating the subgrade of the traveled lane portion of the street. Surface and subsurface (e.g., discharge from the pervious material) stormwater runoff should drain to vegetated infiltration areas such as soil amended lawns, vegetated open channels, or bioretention areas wherever feasible.

2.4.5 CURB AND GUTTER ALTERNATIVES

Because of the effect they have on concentrating runoff flows, the use of curb and gutter systems is not recommended for an LID project. The discussion below is intended to give guidance for appropriate LID methods of designing curb and gutter alternatives in situations where there is a legitimate need for constructing a curb and gutter system.

Applicability

- Legitimate needs where use of curb and gutter may be considered are:

    - Incorporation of or tie into a street with a high functional classification of Street, or in an ultra urban setting.

    - Where specific community design standards require the use of curb and gutters in all or part of the street network, alternative designs (discussed below) should be considered that will still meet the functional requirements.

Design Recommendations

- Where curb and gutters are required in a community to provide a means of separation between the pedestrians and the motorized traffic, an alternative design using placement of a vegetated channel between the sidewalk and the streets should be considered. In addition, a 2-foot wide concrete strip along the edge of the pavement at the same surface elevation of the pavement may be utilized as a visual barrier for the motorist. This concrete strip gives drivers a visual cue of the edge of the driving surface and can help protect the vegetated channel from tire ruts.

- Another alternative is to provide cuts in the curb at appropriately designed spacing to allow runoff to enter adjacent vegetated systems or other LID BMPs.

- Parking lots that incorporate bioretention into the landscaped portions of the parking lot should use slotted wheel stops to protect the bioretention area from traffic intrusion while allowing the parking lot runoff to flow somewhat unobstructed to the bioretention system. Figure 2.15 provides an example schematic with LID features incorporated into the parking lot design.

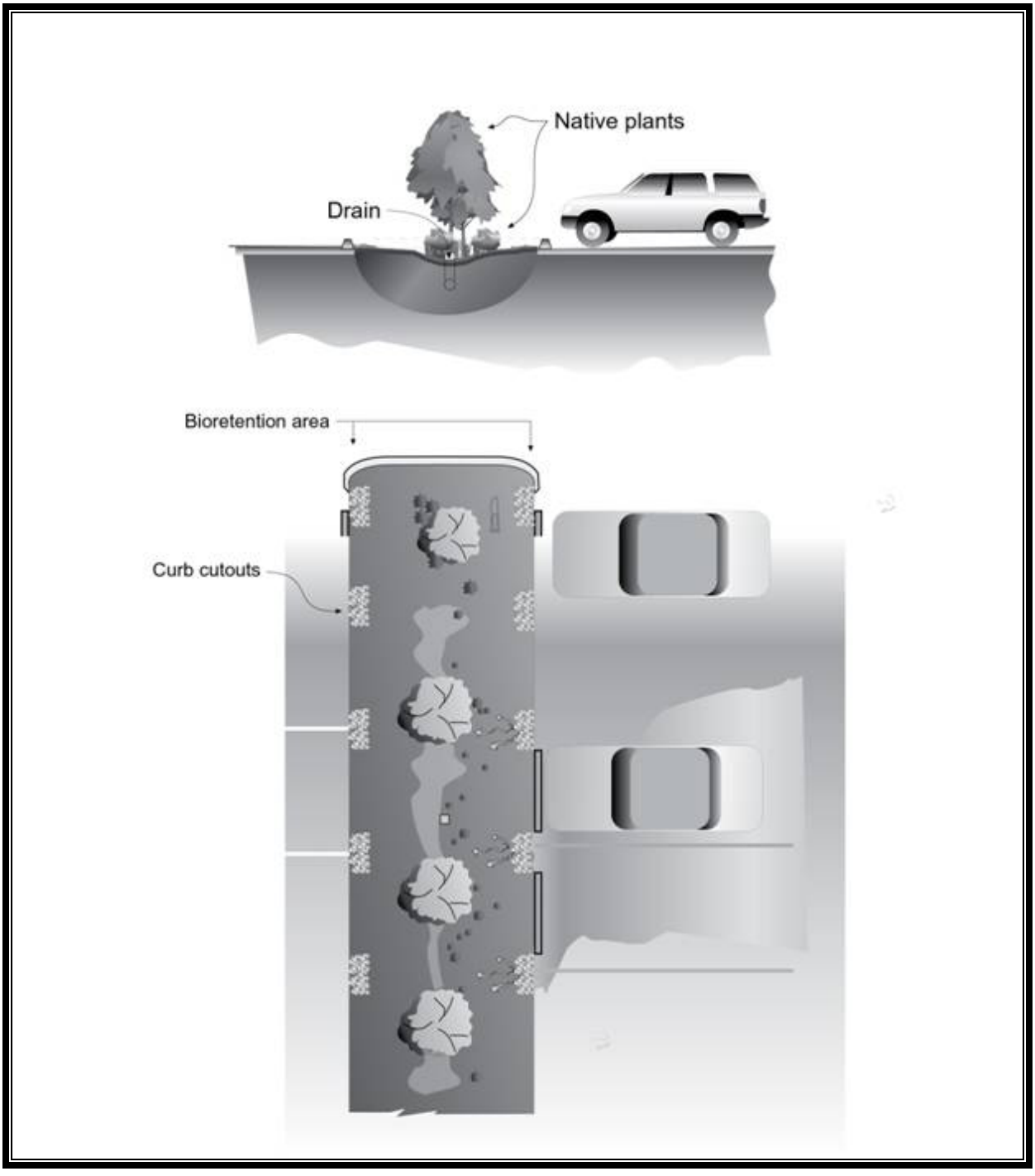


Figure 2.15. Direct Parking Lot Runoff to Bioretention Areas.

CHAPTER 3 - LOW IMPACT DEVELOPMENT BEST MANAGEMENT PRACTICES

Low impact development BMPs focus on infiltrating, dispersing, evaporating, in some cases reusing, and as a last resort, detaining and discharging stormwater. In contrast to conventional BMPs that typically collect and convey runoff to one location on the site, LID applications treat stormwater in small-scale, dispersed facilities located as close to the source of the runoff as possible. Due to the many different factors affecting both stormwater quantity and quality, there is no one technique that will work in all situations.

This section presents the list of individual LID BMPs that can be considered either to meet applicable flow control and/or water quality minimum requirements, or to support a comprehensive LID site design approach.

3.1 APPLICABILITY

The BMPs listed in this section are intended to mitigate the impacts associated with surface water runoff generated from streets, driveways, rooftops, and other forms of impervious surfaces. The following sections provide recommendations and outline the order of preference for choosing LID BMPs when designing an LID project; specifically, to:

1) Minimize the impacts of increased stormwater runoff from new impervious surfaces and land cover conversions by mimicking peak flow frequencies and durations of the site's predeveloped hydrologic condition and;

2) Achieve a low effective impervious area within a site or portions of a site.

In addition, the LID BMPs outlined in this section should be used to help meet applicable flow control and/or water quality treatment requirements specified in Volume I of the DOE Manual.

3.2 GENERAL DESIGN GUIDELINES

Knowing how the site processed stormwater historically is important in determining appropriate BMPs. The site analysis described in Section 2 provides information on how the site and the surrounding areas process stormwater, both currently and historically before any land use changes had altered those processes. This information will aid the designer in determining the best site layout and in deciding what appropriate BMPs will either maintain or restore this natural predeveloped stormwater process. The following items from the site analysis can be used to determine appropriate site layouts and LID BMPs:

- Location and quantity of offsite drainage entering and onsite drainage leaving the site, if any, and the location

- Slopes throughout the site

- Locations of existing vegetation (trees and shrubs) that may help retain upper soil profiles for stormwater processing

- Small depressions on site that retain stormwater runoff

- Depths and conditions of upper soil profile (the A and B horizons) along with the identification of the deeper soil types.

3.3 ORDER OF PREFERENCE FOR LID BMP SELECTION

The following is the recommended order of preference for LID BMP selection for managing stormwater runoff from streets, driveways, buildings, and other impervious surfaces within the buildable portions of the site. It is intended that BMP selection occurs after all efforts to reduce impervious surfaces and other hydrologic modifications have been utilized in order to achieve the full benefits of LID:

- Infiltrate where Type A and B soils exist that readily infiltrate (coarse sands and cobbles to medium sands). The surface water infiltration should be dispersed throughout the site and not in one "end of the pipe" system whenever feasible. Surface infiltration systems in the form of bioretention areas (rain gardens) or vegetated channels designed for infiltration are typically easier to maintain than subsurface systems. These BMPs require soil amendments for maximum soil absorption, porosity, and plant growth.

- Where full infiltration is not feasible, such as where less permeable Type C and D soils exists, bioretention areas (rain gardens) or vegetated channels designed with surface detention should be the second preference.

- Where adequate flow paths are available, dispersion techniques for roof runoff (outlined in Section 3.11) are recommended after bioretention considerations.

- Dispersion of street runoff may be recommended and even preferred when sheet flow can be maintained and directed into adjacent vegetated areas and/or natural resource protection areas with adequate flow path lengths to absorb the flow (see the dispersion specifications in Sections 3.12 and 3.13 for additional recommendations).

- Pervious pavements outside the traveled lane, within driveways, and within parking stalls should be utilized to the greatest extent possible to attenuate flows and recharge groundwater.

Where none of the above listed methods are feasible the designer may choose to utilize more conventional collection, conveyance, and detention methods. When using this type of system every effort should be made to promote groundwater recharge and reduction of runoff volumes by constructing conveyance in vegetated open channels

(see Section 3.15) and limiting the size of the drainage area serviced by the detention facility.

LID Site Example:

A site with moderate slopes of 2 to 5 percent is underlain with a nearly impermeable cemented till soil (Type C or D) but has an upper soil horizon consisting of 2 to 5 feet of organic topsoil material. The site receives no offsite runoff but there are very loosely defined channeled areas on the downhill side of the property that appear to convey excess surface runoff offsite during extreme storm events.

Infiltration through the cemented till has historically not occurred except in small amounts, so the focus should be to preserve the upper soil horizon to allow continued retention and allow uninterrupted pathways for stormwater movement as interflow through the upper soil horizon. With the addition of the impervious areas on the site, the remaining exposed soil may be required to process more stormwater than prior to development, so additional detention will likely be needed using bioretention areas and vegetated channels. The downhill side of the property should be retained as a natural resource protection area and restored with trees and shrubs if necessary to enhance natural evaporation/transpiration processes. Stormwater conveyed to this area through overflow channels from bioretention areas should be dispersed before entering the protection area.

3.4 SPECIALIZED BMP SELECTION

Certain BMPs are somewhat specialized such as vegetated roofs and stormwater runoff reuse systems. These BMPs are probably most applicable in highly urban environments or commercial centers where larger buildings or multi-story parking facilities encompass a large majority of the area. Design recommendations for these BMPs are also included below, but the application of these BMPs will be on a case-by-case basis.

3.5 MAINTENANCE RECOMMENDATIONS

Adequate operation and maintenance (O&M) should be provided for in the design, installation, and operation of all LID BMPs. See Minimum Requirement #10 in Volume I of the DOE Manual for additional information on maintenance requirements. In addition, maintenance considerations and recommendations specific to LID site designs are outlined in Section 4.2.

3.6 PRESERVATION OF UPPER SOIL STRUCTURE (NATIVE TOPSOIL)

Preservation of the existing upper soil horizon is of primary importance to the success of LID developments ability to maintain natural stormwater processes on the site.

3.6.1 APPLICABILITY

- On sites that are underlain by cemented till layers, which are nearly impermeable, the upper soil horizon (native topsoil) processes the majority of

stormwater on the site. Therefore, it is important to preserve the existing depth of the upper soil horizon by either leaving it in place or removing, stockpiling and replacing it during the grading process. For soils removed and replaced on site, the soil amendment recommendations outlined in Section 3.14 should also be considered.

- On sites which are underlain by outwash soils the existing topsoil is not usually as deep but is still beneficial for preservation to provide water quality treatment of runoff before infiltration into the outwash soils.

3.6.2 SOIL STRUCTURE DESIGN RECOMMENDATIONS

- In buildable areas where minimal excavation foundation systems are proposed, existing top soils should be left in place to the greatest extent feasible and shaped or feathered with small tracked grading equipment whenever. Where some re-grading is required, re-compaction of placed materials, which may include topsoils free of vegetated matter, should be limited to the minimum densities required for the use of that portion of the site.

- In buildable areas of the site, where conventional grading is required, it is recommended that the areas requiring cuts have the upper native topsoil removed and stockpiled for replacement to areas of the development utilized for LID stormwater management (yards, bioretention areas, interflow pathways, vegetated channels, or degraded natural resource protection areas).

- The recommended depth of upper native topsoil to be stockpiled and replaced should be the entire depth of the native topsoil horizon as determined by the project soils professional.

- Over-excavation of cut sections may be necessary if the cut is in a location that will be utilized for LID stormwater management. A cut depth that will allow replacement of stockpiled native topsoil to the entire depth that was on the pre-developed site or is needed for the individual BMP design is recommended.

- Cut sections where native topsoil replacement is proposed should rip of any cemented till layers to a depth of approximately 6 inches depending on soil conditions. Subsequently the replacement of stockpiled topsoil should be thoroughly mixed into the ripped till to provide a gradual transition between the cemented till layer and the topsoil.

- Stockpiled topsoil should be replaced in lifts no greater than 1 foot deep and compacted by rolling to a density that matches existing conditions as closely as possible.

- Also soil amendment recommendations outlined in Section 3.14.

3.7 ROOFTOP RUNOFF AND MINIMAL EXCAVATION FOUNDATION SYSTEMS

Minimal excavation foundation systems are those techniques that minimize disturbance to the natural soil profile within the footprint of a proposed structure. This preserves most of the hydrologic properties of the native soil. Pin foundations are an example of a minimal excavation foundation.

3.7.1 APPLICABILITY

- Downspout infiltration systems are recommended where outwash type soils (i.e., those meeting U.S. Department of Agriculture (USDA) soil texture classes ranging from coarse sand and cobbles to medium sand, Hydrologic Soil Group Classification A or B) exist on the lot. Infiltration systems should also be considered for other soil types based on recommendations from the project soils professional. Where soils with slower percolation rates exist, bioretention or dispersion techniques may be considered.

- As an alternative to the above infiltration systems, minimal excavation foundation systems may be considered to provide partial rooftop runoff infiltration on sites with less permeable soils. Where minimal excavation foundation systems are used some runoff credit may be available in the hydrologic analysis per the DOE Manual.

3.7.2 DESIGN RECOMMENDATIONS

- Minimal excavation foundation systems utilize a pin anchoring system (see Figure 3.1) or a piling/pier foundation which secures the foundation without complete removal and compaction of the surface soil beneath the house. This allows the interflow pathways of runoff under the building structure to be maintained.

- To maximize the benefit of minimal excavation foundation systems, the roof runoff should be dispersed up-gradient of the structure when possible. Passive systems are preferred, but active systems (pump mechanism) may be employed.

- Where runoff cannot be dispersed up-gradient of the structure, the contributing downspout areas should be dispersed in accordance with the recommendations of Section 3.11, including the flow path and vegetated cover requirements.

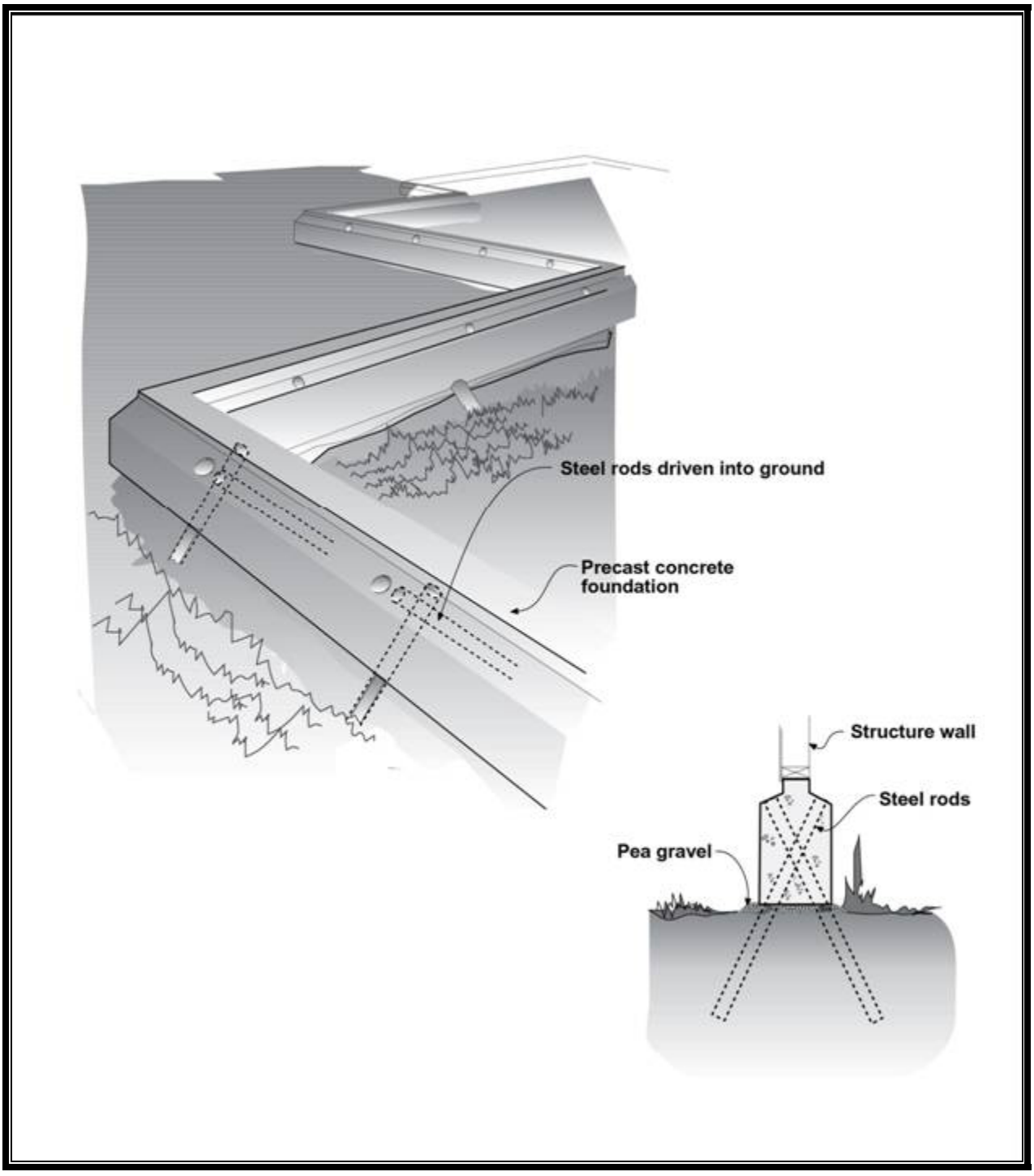


Figure 3.1. Pin Foundation Example.

3.8 BIORETENTION FACILITIES AND RAIN GARDENS

Bioretention areas and rain gardens are shallow stormwater retention systems that are designed to mimic forested systems by controlling stormwater through detention, infiltration, and evapotranspiration. Bioretention areas and rain gardens also provide water quality treatment through sedimentation, filtration, adsorption, and phytoremediation.

In contrast to traditional stormwater pond designs, these facilities are typically smaller-scale and are integrated into the landscape to better mimic natural hydrologic systems. In the context of these guidelines, the term “rain garden” refers to an on-lot facility that receives only runoff from that lot. “Bioretention” refers to a larger scale facility which receives runoff from a combination of the development’s impervious and pervious areas or larger buildings.

Figure 3.2 provides an example illustration of a bioretention system.

3.8.1 APPLICABILITY

- Rain gardens may be utilized as on-lot retention facilities, even in areas where underlying soils may not be conducive to rapid infiltration (such as an underlying glacial till), but where the area does have a surface soil cover that allows the migration of stormwater through the upper soil horizon as interflow.

- Rain gardens should be used to receive rooftop runoff in areas where infiltration facilities are not feasible and in preference to dispersing runoff, and may be integrated into the landscaped areas of the lot.

- Bioretention facilities and rain gardens are particularly effective where soils provide moderate to high infiltration rates.

- Separation between the lowest elevation of the bioretention soil, or any underlying gravel layer, and the seasonal high groundwater elevation or other impermeable layer should be established as a part of the design. The project soils professional should make recommendations on this separation based on the application of the BMP. A minimum of one foot of separation is recommended, but may be increased base on the application.

- Bioretention facilities are applicable in parking lots as concaved landscaped areas (i.e., situated lower than the height of the parking lot surface so that stormwater runoff is directed as sheet flow into the bioretention area.). This application, in concert with porous surfaces in the parking lot, can greatly attenuate stormwater runoff.

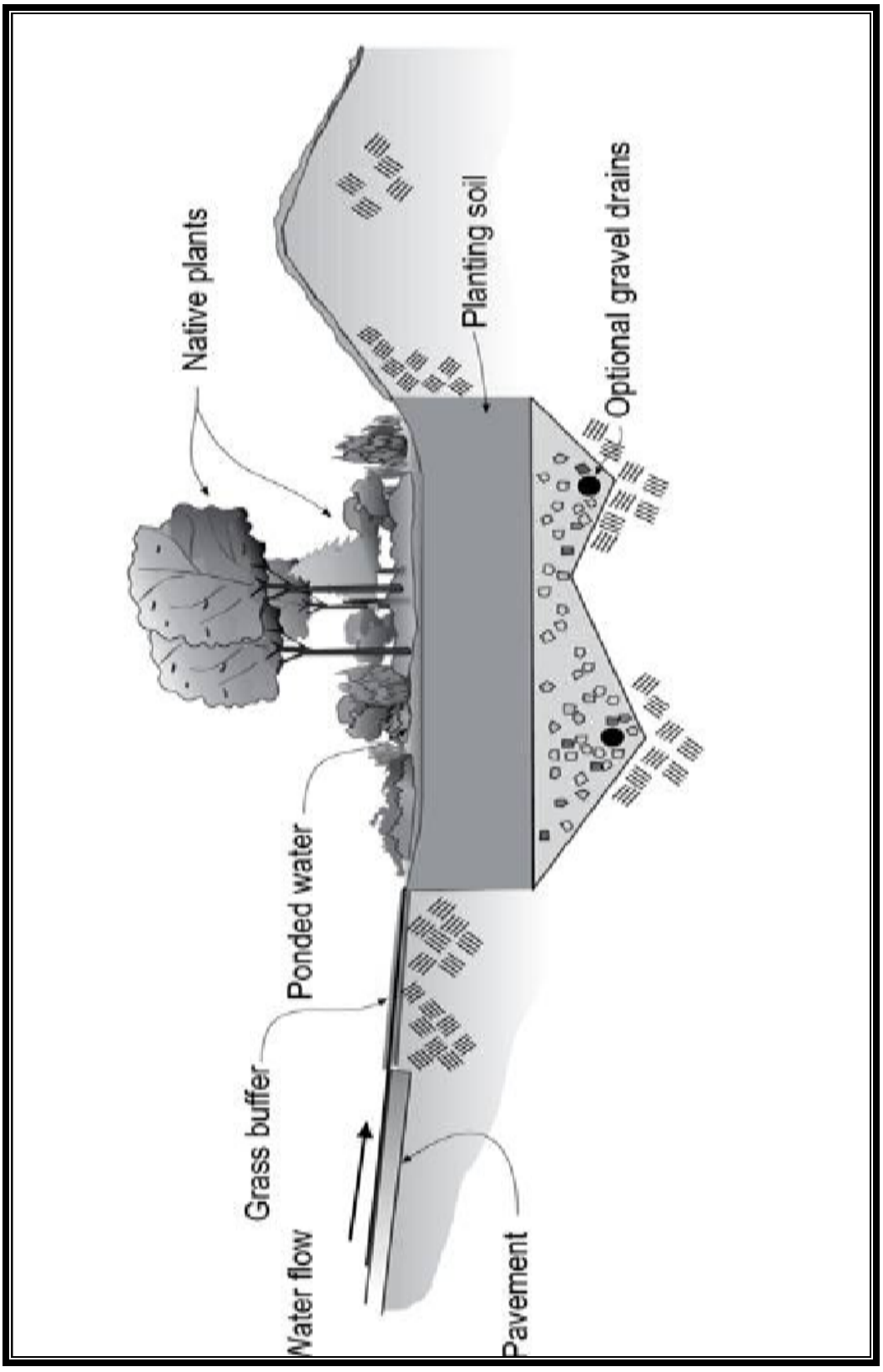


Figure 3.2. Sample Bioretention Area

- Bioretention and rain garden facilities may meet the requirements for basic and enhanced treatment per the DOE Manual when the bioretention soil is designed in accordance with the treatment soil requirements outlined in the design recommendations below, It is the responsibility of the design engineer to demonstrate compliance for quality and flow control for this BMP.

3.8.2 BIORETENTION FACILITY DESIGN RECOMMENDATIONS

The following provides a description and recommendations for the components of bioretention and rain garden facilities. Some or all of the components may be used for a given application depending on the site characteristics and restrictions, pollutant loading, and design objectives. Submittal for facility review is recommended to include documentation of the following elements, discussed in detail below:

- Setbacks and Site Constraints
- Flow entrance / presettling
- Cell ponding area
- Overflow
- Soils
- Underdrains (if included)
- Plantings
- Mulch layer
- Modeling and sizing

Setbacks and Site Constraints

- Bioretention facilities and rain gardens rely on water movement through the surface soils as infiltration and interflow. Therefore, it is important to always consider the pathway of interflow and assure that the pathway is maintained in an unobstructed and uncompacted state. This is true during the construction phase as well as the post-construction condition.

- Minimizing compaction of the base and sidewalls of the bioretention or rain garden area is critical. Excavation, soil placement, or soil amendment is not recommended during wet or saturated conditions. Excavation should be performed by machinery operating adjacent to the facility. Heavy equipment tracking on the bottom of the facility should be avoided to the extent possible. If machinery must operate in the facility for excavation, light weight, low ground-contact pressure equipment should be used and the base should be scarified at completion to refracture soil to a depth as recommended by the project soils professional.

- All bioretention facilities and rain gardens overflows or discharges should be oriented away from any down gradient structure or property line to the extent possible. A recommended setback would be five to ten feet depending on gradient and soil conditions.

- Bioretention facilities and rain gardens should be set back from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical analysis should be prepared addressing the potential impact of the facility on the slope. The geotechnical report should recommend a setback based on the gradient and vertical height of the slope.

- Bioretention facilities and rain gardens should be discouraged near any active landslide hazard area unless the slope stability impacts of such systems have been analyzed by a geotechnical professional, and appropriate analysis indicates that the impacts are negligible and/or recommended setbacks are proposed.

- In the event that the downstream pathway of infiltration and interflow can't be maintained, and/or the infiltration capacity is insufficient to handle the contributing area flows (e.g., a facility enclosed in a loop street system or a landscape island within a parking lot), an underdrain system can be incorporated into the facility. The underdrain system can then be conveyed to a nearby vegetated channel, another stormwater facility, or dispersed into a natural protection area. See the underdrain section below for additional information.

Flow Entrance/Presettling

The design of flow entrance to a bioretention or rain garden facility will depend upon topography, flow velocities, flow volume, and site constraints. Flows entering a facility should be relatively slow to minimize erosion potential. Vegetated buffer strips are the preferred entrance type because they slow incoming flows and provide initial settling of particulates.

Four primary types of flow entrances should be considered for use in bioretention facilities and rain gardens:

- Dispersed, low velocity flow across a grass or landscape area – this is the preferred method of delivering flows to the facility and can provide initial settling of particulates

- Dispersed flow across pavement or gravel and past wheel stops for parking areas

- Drainage curb cuts for driveway or parking lot areas – curb cuts should include rock or other erosion protection material in the channel entrance to dissipate energy

- Pipe flow entrance – piped entrances should include rock or other erosion protection material in the facility entrance to dissipate energy and/or provide flow dispersion.

Woody plants should not be placed directly in the entrance flow path as they can restrict or concentrate flows and can be damaged by erosion around the root ball.

Minimum recommendations associated with the flow entrance/presettling design include the following:

- If concentrated flows are entering the facility, engineered flow dissipation (e.g., rock pad or flow dispersion weir) should be incorporated.

- A minimum 1-inch grade change between the edge of a contributing impervious surface and the vegetated flow entrance is recommended.

- Until the upstream catchment area is thoroughly stabilized, flow diversion and erosion control measures should be installed to protect the bioretention area from sedimentation.

- If the catchment area is large, a pre-settling facility (e.g., filter strip, pre-settling basin, or vault) may be recommended.

Cell Ponding Area
The ponding area provides surface storage for storm flows, particulate settling, and the first stages of pollutant treatment within the facility.

Ponding depth and draw-down rate recommendations are to provide surface storage, adequate infiltration capability, and soil moisture conditions that allow for a range of appropriate plant species. Soils should be allowed to dry out periodically in order to:

1) Restore hydraulic capacity of system,
2) Maintain infiltration rates,
3) Maintain adequate soil oxygen levels for healthy soil biota and vegetation,
4) Provide proper soil conditions for biodegradation and retention of pollutants, and
5) Prevent conditions supportive of mosquito breeding.

Minimum recommendations associated with the facility ponding area design include the following:

- The recommended ponding depth is maximum of 6 inches (see alternative design under the overflow section below)

- The surface pool drawdown time should be a maximum of 48 hours or as recommend by the landscape architect base on selected plantings.

- The recommended maximum planted side slope should be 4H:1V

- The recommended minimum bottom width should be no less than 2 feet

- The recommended minimum freeboard measured from the invert of the overflow pipe or earthen channel to facility overtopping elevation should be 2 inches for

drainage areas less than 1,000 square feet and 6 inches for drainage areas 1,000 square feet of greater

- If berms are used to achieve the minimum top elevation needed to meet the recommended ponding depth and freeboard, the recommended maximum slope on the berm should be 4H:1V, and recommended minimum top width of design berm should be 1 foot.

Overflow
Unless designed for full infiltration, it is recommended that bioretention and rain garden facilities include an overflow. Facility overflow can be provided by a drain pipe installed at the designed maximum ponding elevation and connected to a downstream BMP or other appropriate discharge point.

Overflows should be designed to convey the 100-year recurrence interval flow. The design should provide controlled discharge directly into the downstream conveyance system or another acceptable discharge point.

It is possible to design additional detention storage above the 6-inch design water surface (to a maximum of 30 inches total) but recommend to including an orifice control system within the overflow structure to help attenuate the flows. For example, a catch basin with removable down-turned elbow (using properly designed orifices) could be used. This would allow the bioretention facility to dewater in a reasonable timeframe. If using this design it is recommended that the plant selection reflect the additional proposed storage depth. Care must be taken to blend these larger and deeper facilities in with the surrounding landscape.

Soils
Bioretention facilities may meet the requirements for basic and enhanced treatment, and may need to meet the same soil infiltration treatment requirements for basins, trenches, and swales discussed in Volumes III and V of the DOE Manual (i.e., soil and site suitability criteria). For flows requiring basic or enhanced treatment, the following soil design recommendations apply:

- The bioretention soil mix should meet the recommendations of Section 3.14 of this volume.

- The minimum recommended depth of treatment soil is 12 inches or as designed by the project engineer and/or soils professional.

- Soil depths of 22 inches and greater should be considered to provide improved removal of nutrients as needed, including phosphorus. Metals uptake has been shown to be greater at 22 inches than 10 inches (with no additional improvement in deeper soils); however most significant metal uptake occurs in the mulch layer.

- A soils report, prepared and by a soils professional, is recommended to address the following for each bioretention or rain garden facility:

- At least one soil log or test pit is recommended at each facility location.

- The soil log should extend a minimum of 3 feet below the bottom of the subgrade (which is the lowest point of excavation where soil is to be amended).

- The soil log should describe the USDA textural class of the soil horizon(s) through the depth of the log and note any evidence of high groundwater level, such as mottling.

- A primary pathway for stormwater discharge from a bioretention facility with less permeable (ie. Type C) soils can be through interflow in the upper soil structure. The soil investigation should include a detailed description of the condition of the upper soil structure, including the pathway the discharged stormwater will take.

- The report should include recommendations on the degree of soil amendment (see Section 3.14) necessary to reestablish an upper soil profile similar to an undisturbed forested condition that will allow interflow through the upper soil structure.

- Where the native soils do not meet the desired soil conditions, the soil should be improved by amending the soil as discussed in Section 3.14. The depth of the soil amendment should be determined by the designer with deeper amendments, allowing a smaller foot print for amended areas. The bottom depth should also be kept above the seasonal high groundwater level or other impermeable layer as noted previously.

- Infiltration rates of the native soil (i.e., the undisturbed soil below the imported and/or amended facility soil) must be used when sizing and modeling bioretention facilities. The native infiltration rate should be determined using the methods outlined in the DOE Manual.

Underdrains (Optional)

The area above an underdrain pipe in a bioretention or rain garden provides attenuation and pollutant filtering. Underdrain systems should be installed only if the bioretention or rain garden is:

- Located where infiltration is not feasible.

- In soils with infiltration rates that are not adequate to meet maximum pool drawdown time.

The underdrain pipe diameter will depend on hydraulic capacity required (4 to 8 inches is common). The underdrain can be connected to a downstream BMP such as another

bioretention/rain garden facility as part of a connected system, or to an appropriate discharge point. A geotextile fabric is recommended to be used between the soil layer and underdrain to prevent clogging.

Plantings

The design intent for bioretention and rain garden plantings is to replicate, to the extent possible, the hydrologic function of a mature forest including succession plants and groundcover. Plant roots aid in the physical and chemical bonding of soil particles that is necessary to form stable aggregates, improve soil structure, and increase infiltration capacity. The primary design considerations for plant selection include:

- Soil moisture conditions – plants should be tolerant of summer drought, ponding fluctuations, and saturated soil conditions for the lengths of time anticipated by the facility design.

- Above and below ground infrastructure in and near the facility –plant size and wind firmness should be considered within the context of the surrounding infrastructure. Rooting depths should be selected to not damage underground utilities if present. Tree locations are recommended to be 5 feet minimum from slotted or perforated pipe and all side sewer pipes.

- Adjacent plant communities and potential invasive species control – if adjacent to invasive species, consider planting fast growing, hearty species. Shrubs may be used to help shade-out invasive weeds.

- Aesthetics – These facilities should be designed to blend into the surrounding landscaping, which will provide a more aesthetically pleasing stormwater facility. In addition, visually pleasing plant designs add value to the property and encourage community and homeowner acceptance.

In general, the predominant plant material utilized in bioretention and rain garden facilities are facultative species adapted to stresses associated with wet and dry conditions. Soil moisture conditions will vary within the facility from saturated (bottom of facility) to relatively dry (rim of facility).

Accordingly, wetland plants may be used in the lower areas, if saturated soil conditions exist for appropriate periods, and drought-tolerant species planted on the perimeter of the facility or on mounded areas. Native plant species, placed appropriately, tolerate local climate and biological stresses and usually require no nutrient or pesticide application in properly designed soil mixes. Natives can be used as the exclusive material in a bioretention or rain garden facility, or in combination with hardy cultivars that are not invasive and do not require chemical inputs.

To increase survival rates and ensure quality of plant material, the following guidelines are suggested:

- As a general guideline, a minimum of three trees, three shrubs, and three herbaceous species should be incorporated to protect against facility failure due to disease and insect infestations of a single species. Grass coverage alone is not recommended. The planting arrangement should be designed to create a dense coverage of plants, shrubs, and trees.

- Plants should conform to the standards of the current edition of American Standard for Nursery Stock as approved by the American Standards Institute, Inc., or the 2005 Puget Sound Action Team Low Impact Development Technical Guidance Manual for Puget Sound (PSAT 2005). All plant grades should be those established in the current edition of American Standards for Nursery Stock.

- All plant materials should have normal, well-developed branches and root systems, and be free from physical defects, plant diseases, and insect pests.

- Plant size – small plant material provides several advantages and is recommended. Specifically, small plant material requires less careful handling, less initial irrigation, experiences less transplant shock, is less expensive, adapts more quickly to a site, and transplants more successfully than larger material. Small trees and shrubs are generally supplied in pots of 3 gallons or less.

- Optimum planting time is typically early fall. Winter planting is acceptable; however, extended freezing temperatures shortly after installation can increase plant mortality. Spring is also acceptable, but requires more summer watering than fall plantings. Summer planting is the least desirable and requires regular watering for the dry months immediately following installation.

A permanent irrigation system may be used, but an alternative means of irrigation, such as air conditioning condensate or another readily available non-potable source should be considered to maximize efficient use of resources. Any non-potable sources must be analyzed to ensure that they do not contain chemicals that might harm or kill the vegetation.

Mulch Layer

Bioretention and rain garden facilities should be designed with a mulch layer or a dense groundcover. Research indicates that most attenuation of heavy metals in bioretention cells occurs in the first 1 to 2 inches of the mulch layer. That layer can be easily removed or added to as part of a standard and periodic landscape maintenance procedure. Properly selected mulch material also reduces weed establishment, regulates soil temperatures and moisture, and adds organic matter to soil. Mulch recommendations are as follows:

- Compost in the bottom of the facilities (compost is less likely to float than wood chip mulch and is a better source for organic materials)

- Wood chip mulch composed of shredded or chipped hardwood or softwood on cell slopes

- Mulch free of weed seeds, soil, roots and other material that is not trunk or branch wood and bark

- A recommended maximum of 3 inches thick for compost or 4 inches thick for wood chips (thicker applications can inhibit proper oxygen and carbon dioxide cycling between the soil and atmosphere).

It is recommended that mulch not include grass clippings (decomposing grass clippings are a source of nitrogen and are not recommended for mulch in bioretention areas), mineral aggregate, or pure bark (bark is essentially sterile and inhibits plant establishment).

As an alternative to mulch, a dense groundcover may be used. Mulch is recommended in conjunction with the groundcover until groundcover is established.

Modeling and Sizing

- Sizing of a small **rain garden** (lot-scale facility), can be done by use of the *King County Surface Water Design Manual Appendix C Section C.2.5 Rain Garden* method. This same method of sizing can also be used for rain gardens receiving driveway runoff provided that the soils meet the water quality treatment requirements outlined in the DOE Manual, or the runoff passes through a basic treatment facility before reaching the rain garden. Other design methods may also be acceptable and will be reviewed on a case by case basis as proposed by the project engineer.

- **Bioretention facilities** (i.e., facilities managing larger areas or greater than one lot) receiving runoff from streets or a combination of streets and other impervious/pervious surfaces will be larger than rain gardens. Sizing is recommended to be determined by using an approved continuous simulation model and treating the facility as an infiltration facility with appropriate stage-storage and overflow/ outflow rates.

At the time of publication of this volume, the professional version of WWHM includes a bioretention module that can be used to size the cell with or without an underdrain as a function of tributary area, land use type, native soil infiltration rate, side slopes, etc. It is anticipated that other modeling programs will develop similar modules to represent bioretention cells in the future.

3.9 ROOF DOWNSPOUT CONTROLS

Roof downspout controls are simple pre-engineered designs for infiltrating and/or dispersing runoff from roof areas for the purposes of increasing opportunities for groundwater recharge and reduction of runoff volumes from new developments. Roof downspout controls are required as part of Minimum Requirement #5, if applicable (see Volume I, Chapter 2 of the DOE Manual). This section presents an overview of the types and applications of roof downspout controls. Additional details on specific BMPs are provided in subsequent sections.

3.9.1 SELECTION OF ROOF DOWNSPOUT CONTROLS

Large lots in rural areas typically have enough area to infiltrate or disperse roof runoff. Lots created in urban areas will typically be smaller and have a limited amount of area in which to incorporate infiltration or dispersion trenches.

Downspout infiltration should be used in those soils that readily infiltrate (coarse sands and cobbles to medium sands). This clean runoff does not require pretreatment prior to the storage/discharge facility provided that it is not mixed with other contaminated runoff. Dispersion BMPs should be used in areas with less permeable soils where infiltration is not feasible.

Where dispersion is not feasible or where downspout disconnection or dispersion could cause downstream flooding or erosion concerns, downspouts should be connected to a City approved discharge point (e.g., stormwater management facility and/or conveyance system).

The feasibility or applicability of downspout infiltration and dispersion should be evaluated for all subdivision single-family lots in an LID project. Single family subdivision projects subject to Minimum Requirement #5 and/or #7 of the DOE Manual should provide for individual downspout infiltration or dispersion systems where practicable.

3.9.2 APPLICABILITY

Where roof downspout controls are required or planned, the following two types should be considered in order of preference:

- Downspout infiltration systems (Section 3.10)
- Downspout dispersion systems (Section 3.11).

Other innovative downspout control BMPs such as rain barrels, ornamental ponds, downspout cisterns, or other downspout water storage devices may also be used with prior approval by the City. Any alternative methods proposed are recommended to meet the performance criteria of all applicable minimum requirements, particularly Minimum Requirements #5 or #7 of Volume I of the DOE Manual.

Downspout disconnection or dispersion is not recommended in situations where the disconnection could cause erosion or flooding problems, either on site or on adjacent lots. The design engineer should demonstrate that the proposed release rate will not have an adverse downstream impact. The City should review each proposal on a case-by-case basis due to the uniqueness of each site condition.

In rural densities of one dwelling unit per acre or less, gutters and downspouts can, in some cases, be eliminated to allow rooftop stormwater to drip from the roof edge into vegetation planted at the drip line when designed in conformance with applicable City and building code requirements.

3.10 DOWNSPOUT INFILTRATION SYSTEMS

Downspout infiltration systems are trench or drywell designs intended only for use in infiltrating runoff from roof downspout drains. They are not designed to directly infiltrate runoff from pollutant-generating impervious surfaces.

Infiltration of roof runoff should be considered before dispersion and bioretention techniques.

3.10.1 FLOW CREDIT FOR ROOF DOWNSPOUT INFILTRATION

If roof runoff is infiltrated according to the requirements of the DOE Manual, the roof area may be discounted from the project area used for sizing stormwater facilities. This is done by clicking on the "Credit" button in WWHM software and entering the percent of roof area that is being infiltrated.

3.10.2 RECOMMENDED PROCEDURE FOR EVALUATING SOILS FEASIBILITY

- A soils report should be prepared by a professional soil scientist, a locally licensed onsite sewage designer, or by a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington to determine if soils suitable for infiltration are present on the site. The report should reference a sufficient number of soils logs to establish the type and limits of soils at the proposed trench locations. The report should, at a minimum, identify the limits of any *outwash type soils* (i.e., those meeting USDA soil texture classes ranging from coarse sand and cobbles to medium sand) versus other soil types and include an inventory of topsoil depth.

- For projects using the sizing criteria presented in Volume III, Section 3.1.1 of the DOE Manual, individual lot or site tests should consist of at least one soils log at the location of the infiltration system, a minimum of 4 feet in depth (from proposed grade), identifying the Natural Resources Conservations Service (NRCS – formerly the SCS) series of the soil and the USDA textural class of the soil horizon through the depth of the log, and noting any evidence of high groundwater level, such as mottling.

- Site-specific tests should indicate 18 inches or more of permeable soil from the proposed final grade to the seasonal high groundwater table.

- For sites that do not use the sizing tables presented in Volume III, Section 3.1.1 of the DOE Manual, the facility should be sized by a professional engineer.

3.10.3 DESIGN RECOMMENDATIONS FOR INFILTRATION TRENCHES

Figure 3.3 provides a typical downspout infiltration trench system. These systems are designed as specified below.

The following standardized design criteria are recommended to guide the applicant in providing an acceptable design for an individual downspout infiltration system. A professional engineer should not be required to design an individual downspout infiltration system provided that: 1) the proposed site development does not result in a net increase in impervious surfaces of 5,000 square feet or more, 2) the project has prepared a soils report as outlined above, 3) the system is sized according Volume III, Section 3.1.1 of the DOE Manual and the general guidelines below, and 4) the system is to be constructed according to the standard design shown in Figure 3.3. Any deviation in design or construction from the DOE Manual criteria detailed and it is recommended that the individual downspout infiltration be designed by a professional engineer.

Volume III, Section 3.1.1 of the DOE Manual outlines an approved prescriptive design for downspout infiltration trenches that meet recommended flow control requirements. It is recommended that trenches be constructed according to the standard design shown in Figure 3.3 or an equivalent design approved by the City. Note that for roof areas that fall between the areas represented, the required trench footprint area may be interpolated. However, for infiltration rates that fall between the rates represented in each table, the designer should use the more conservative (i.e., lower) infiltration rate in their design. It is recommended that all sites have the option to do their own engineered design for infiltration trenches in lieu of using the simple DOE method described above, subject to approval by the City. In addition to the sizing requirements outlined in the tables, the following are design recommendations:

- Maximum length of trench should not exceed 100 feet from the inlet sump.
- Minimum spacing between distribution pipe centerlines should be 6 feet.
- The aggregate material for the infiltration trench should consist of clean washed drain rock.
- Geotextile filter fabric should be wrapped entirely around trench drain rock prior to backfilling.
- Infiltration trenches can be placed in fill material if the fill is placed and compacted under the direct supervision of a geotechnical engineer or professional civil engineer.

- Infiltration trenches should be set back from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical analysis should be prepared addressing the potential impact of the facility on the slope. The geotechnical report should recommend a setback based on the gradient and vertical height of the slope.

- All trenches should be oriented away from any down gradient structure or property line to the extent possible. A recommended setback would be five to ten feet depending on gradient and soil conditions.

- A drainage structure with a sump should be located upstream of the trench, which provides a recommended 12 inches of depth below the outlet riser. The outlet riser pipe bottom should be designed so as to be submerged at all times, and a screening material should be installed on the pipe outlet.

- Trenches can be located under pavement if designed by a professional engineer. Trenches should include an overflow below the pavement section, and in a location which can accommodate the overflow without creating a significant adverse impact to downhill properties or drainage systems. This is intended to prevent saturation of the pavement section in the event of system failure.

- Prior to approval of an individual downspout infiltration system, a site plan should be submitted showing the location of the proposed infiltration system together with adjacent buildings, structures, wells, septic drainfields, and property lines. Prior to final approval of construction, an as-built (record) drawing should be submitted to the City that includes the site plan together with the actual constructed square footage of the infiltration system.

- See Volume III, Section 3.1.1 of the DOE Manual, for additional recommendation and requirements for downspout infiltration facilities.

3.10.4 DESIGN RECOMMENDATIONS FOR INFILTRATION DRYWELL SYSTEMS

Figure 3.4 provides a typical downspout infiltration drywell system. The drywell should include a settling chamber as shown, or its equivalent upstream of the drywell for particulate removal. These systems are recommended to be designed as specified below:

- Drywell bottoms should be a minimum of 1 foot above seasonal high groundwater level or impermeable soil layers.

- Soils in the proposed location should not be silty clay loam, clay loam, clay, or any other soil having percolation rates slower than 1 inch per hour.

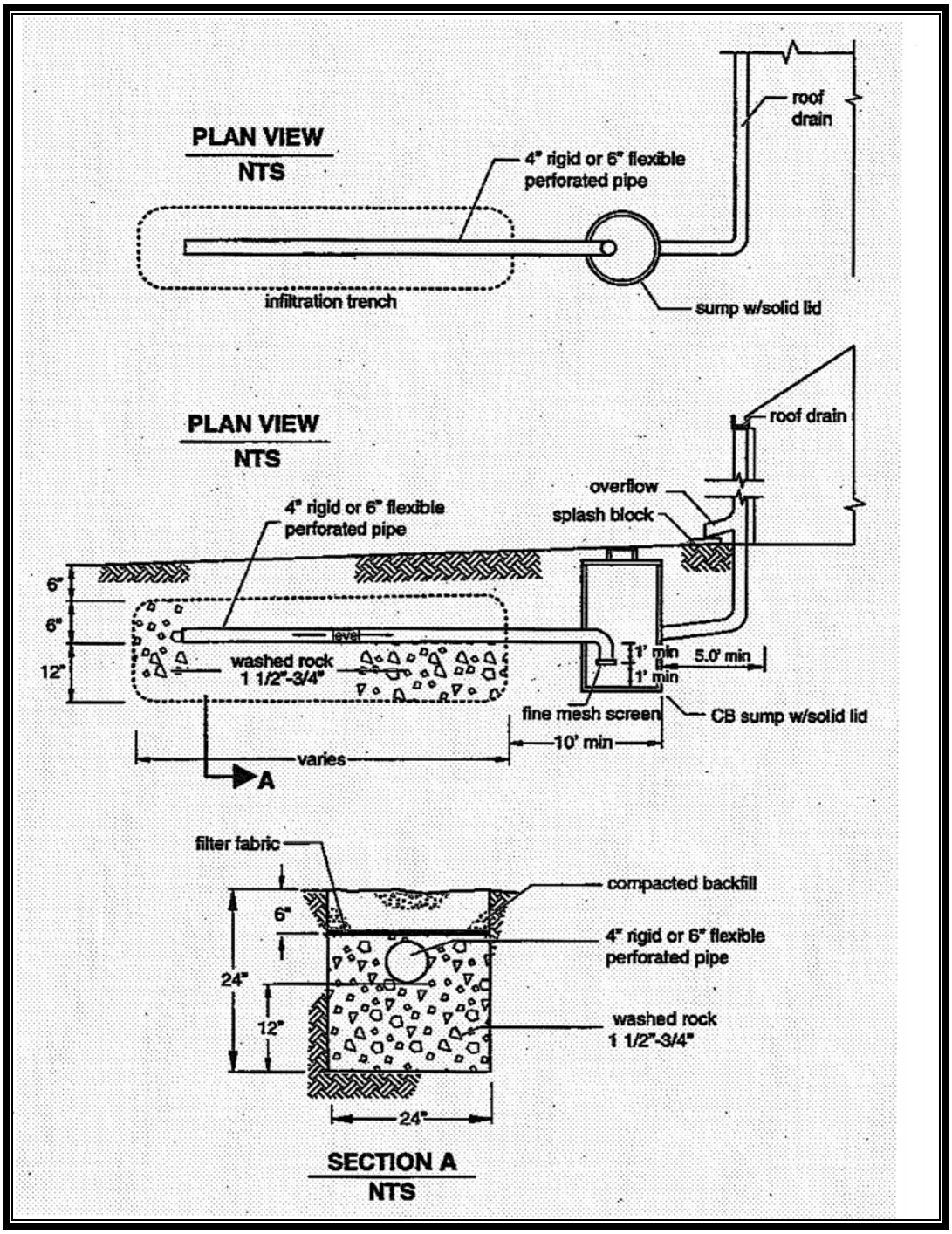


Figure 3.3. Typical Downspout Infiltration Trench
(Source: King County)

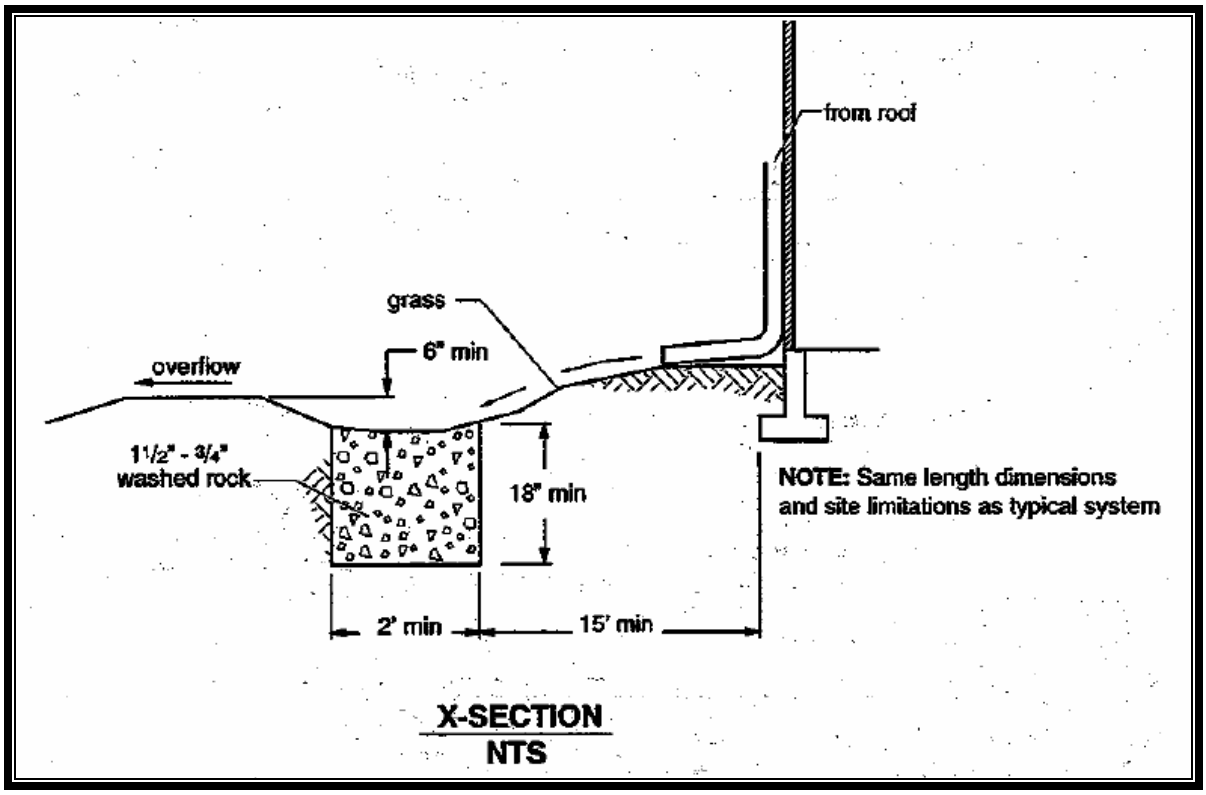


Figure 3.4. Typical Downspout Infiltration Drywell
(Source: King County)

- If using drywells, size the facilities according to the area and depth recommendations outlined for infiltration trenches.

- Typically drywells are 48 inches in diameter (minimum) and have a depth of 5 feet (4 feet of gravel and 1 foot of suitable cover material).

- Filter fabric (geotextile) should be placed on top of the drain rock and on trench or drywell sides prior to backfilling.

- Spacing between drywells should be a minimum of 4 feet.

- It is recommended that downspout infiltration drywells not be built on slopes greater than 25 percent (4:1). Drywells should not be placed on or above an active landslide hazard area or slopes greater than 15 percent without evaluation by a professional engineer with geotechnical expertise or a licensed geologist, hydrogeologist, or engineering geologist, and with jurisdiction approval.

- See Volume III, Section 3.1.1 of the DOE Manual, for additional recommendation and requirements for downspout infiltration facilities.

3.11 DOWNSPOUT DISPERSION SYSTEMS

Downspout dispersion systems are gravel-filled trenches or splash blocks, which serve to spread roof runoff over vegetated pervious areas. Dispersion attenuates peak flows by slowing entry of the runoff into the conveyance system, allows for some infiltration, and provides some water quality benefits. The general recommended applicability of downspout dispersion is as follows:

- Dispersing roof runoff should be considered after infiltration and bioretention techniques have been determined infeasible due to soil types or high groundwater.

- Natural resource protection areas adjacent to and down gradient of individual lots can provide opportunities to disperse runoff into the natural resource protection area.

3.11.1 FLOW CREDIT FOR ROOF DOWNSPOUT DISPERSION

See the Volume III, Section 3.1.2 of the DOE Manual for specific flow credit available through the use of roof downspout dispersion techniques.

3.11.2 DOWNSPOUT DISPERSION DESIGN RECOMMENDATIONS

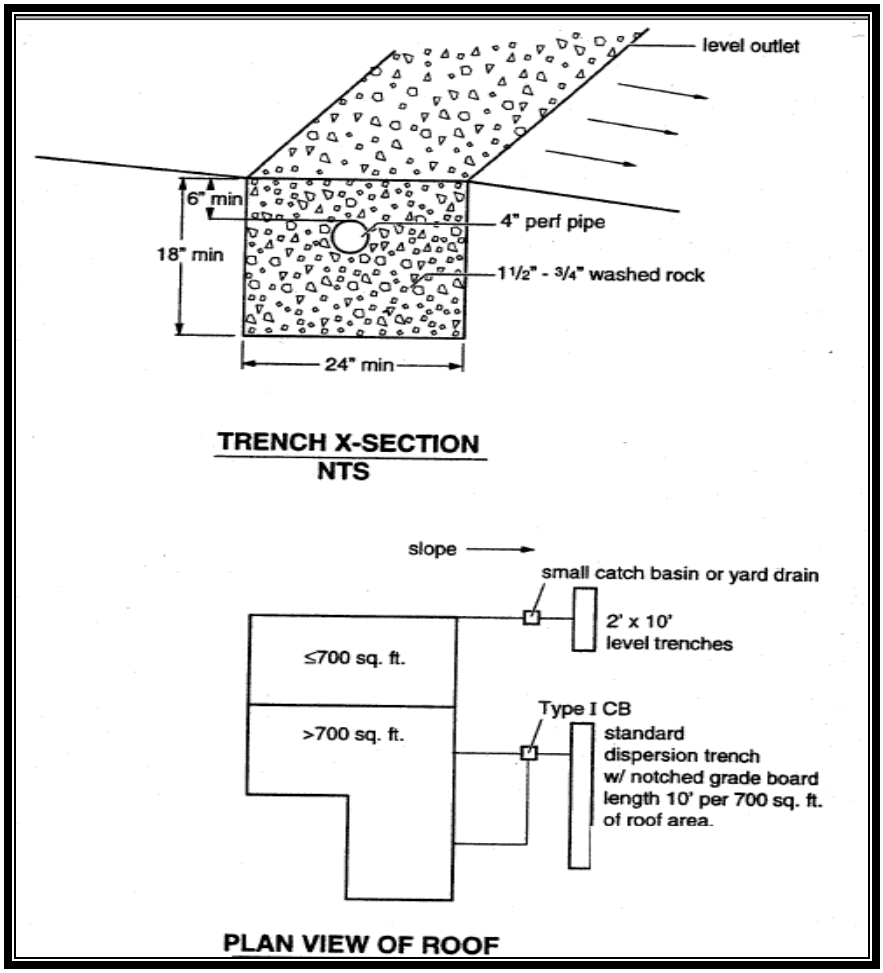
This section provides design recommendations for both dispersion trenches and splash blocks:

- Dispersion trenches are recommended to be designed shown in Figure 3.5 (or an approved alternative).

- Splash blocks should be designed as shown in Figure 3.6 (or an approved alternative).

- A vegetated flowpath of at least 25 feet in length is recommended to be maintained between the outlet of a trench and any property line; structure; critical area (i.e., stream, wetland), or impervious surface. Natural resource protection areas and critical area buffers may count towards flowpath lengths. This does not include steep slopes.

- Trenches serving up to 700 square feet of roof area may be simple 10-foot long by 2-foot wide gravel filled trenches as shown in Figure 3.5. For roof areas larger than 700 square feet, a dispersion trench with notched grade board or other design as approved by the City should be used. The total length of this design should not exceed 50 feet and should provide at least 10 feet of trench per 700 square feet of roof area. Splash blocks shown in Figure 3.6 may be used for downspouts discharging to a vegetated flow path at least a recommended 10 feet in width and 50 feet in length as measured from the downspout to the downstream property line; structure; critical areas (i.e., stream, wetland), or other impervious surface. Flow path measurement may traverse a property line into an adjacent natural resource protection area or critical area buffer. This **does not** include steep slopes. See steep slope setbacks below



Not to Scale (source: King County)

Figure 3.5 Typical Downspout Dispersion Trench

- A maximum of 700 square feet of roof area is recommended to drain to each splash block.

- Care should be taken by the designer so no erosion or flooding of downstream properties results.

- For both trenches and splashblocks, the vegetated flowpath should be covered with well-established vegetation to prevent erosion and promote partial infiltration.

- For sites with septic systems, the discharge point should be down slope of the primary and reserve drainfield areas. This requirement may be waived if site topography clearly prohibits flows from intersecting the drainfield.

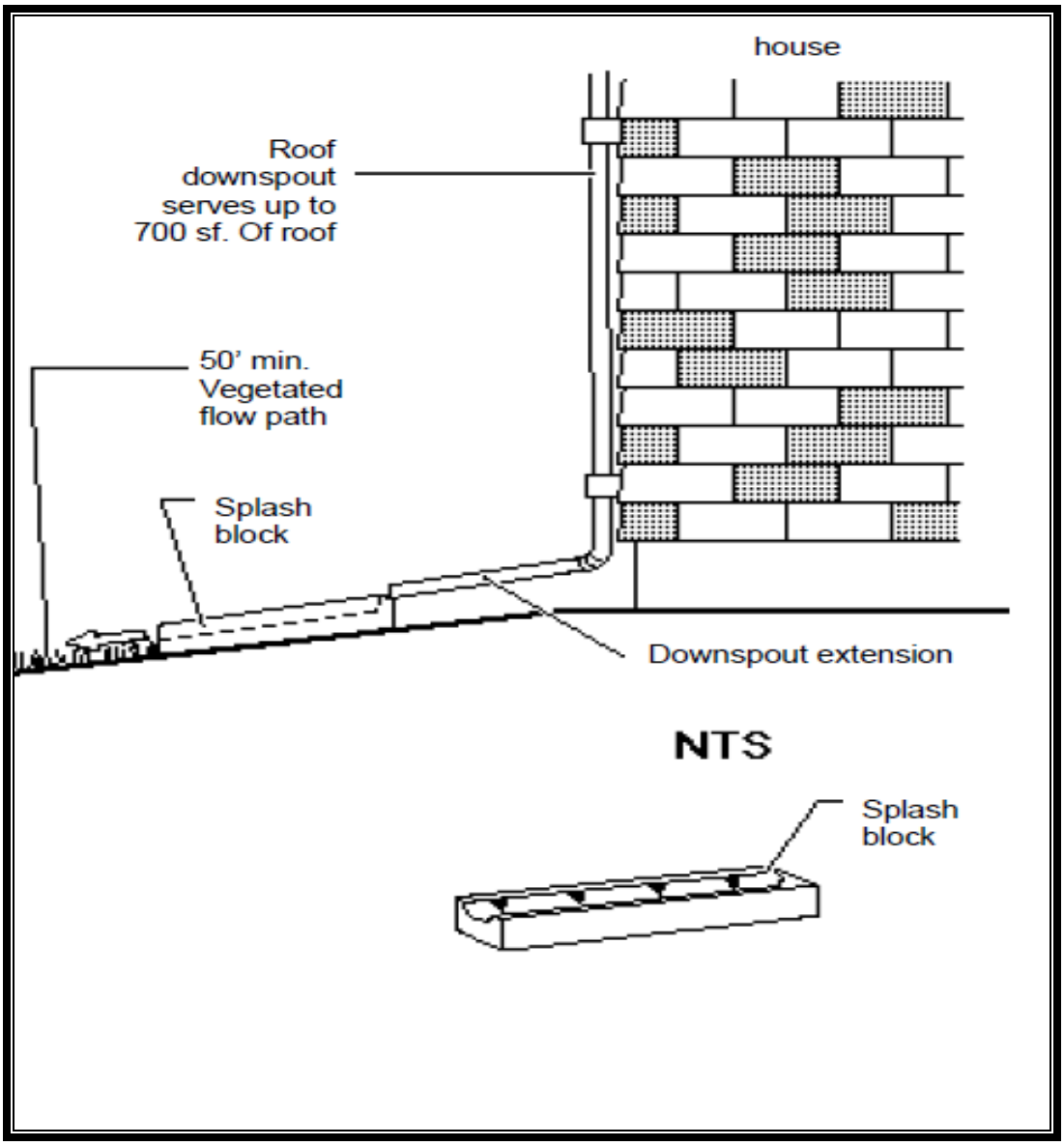


Figure 3.6. Typical Downspout Splashblock Dispersion

- Dispersion systems should be set back at least 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high. This setback may be reduced to 15 feet based on geotechnical evaluation, but should not be less than the buffer width.

- See Volume III, Section 3.1.2 of the DOE Manual, for additional recommendation and requirements for downspout dispersion systems.

3.12 CONCENTRATED FLOW DISPERSION

Dispersion of concentrated flows from driveways or other pavement through a vegetated pervious area attenuates peak flows by slowing entry of the runoff into the conveyance system, allows for some infiltration, and provides some water quality benefits.

3.12.1 APPLICABILITY

- Any situation where concentrated flow can be dispersed through vegetation.

- Dispersion for driveways will generally only be effective for single-family residences on large lots and in rural short plats, but may be applied where the recommendations from this section can be met.

- Figure 3.7 shows two possible ways of spreading flows from driveways.

3.12.2 CONCENTRATED FLOW DISPERSION DESIGN RECOMMENDATIONS

- A vegetated flowpath of at least 50 feet should be maintained between the discharge point and any structure, steep slope, stream, lake, wetland, lake, or other impervious surface.

- Care should be taken by the designer so no erosion or flooding of downstream properties results.

- It is recommended that a maximum of 700 square feet of impervious area drain to each concentrated flow dispersion BMP.

- A pad of crushed rock (2 feet wide by 3 feet long by 6 inches deep) should be placed at each discharge point.

- No erosion or flooding of downstream properties should result from installation of these systems.

- Runoff discharged towards active landslide hazard areas and on-site septic systems should employ the same recommendations as downspout dispersion systems.

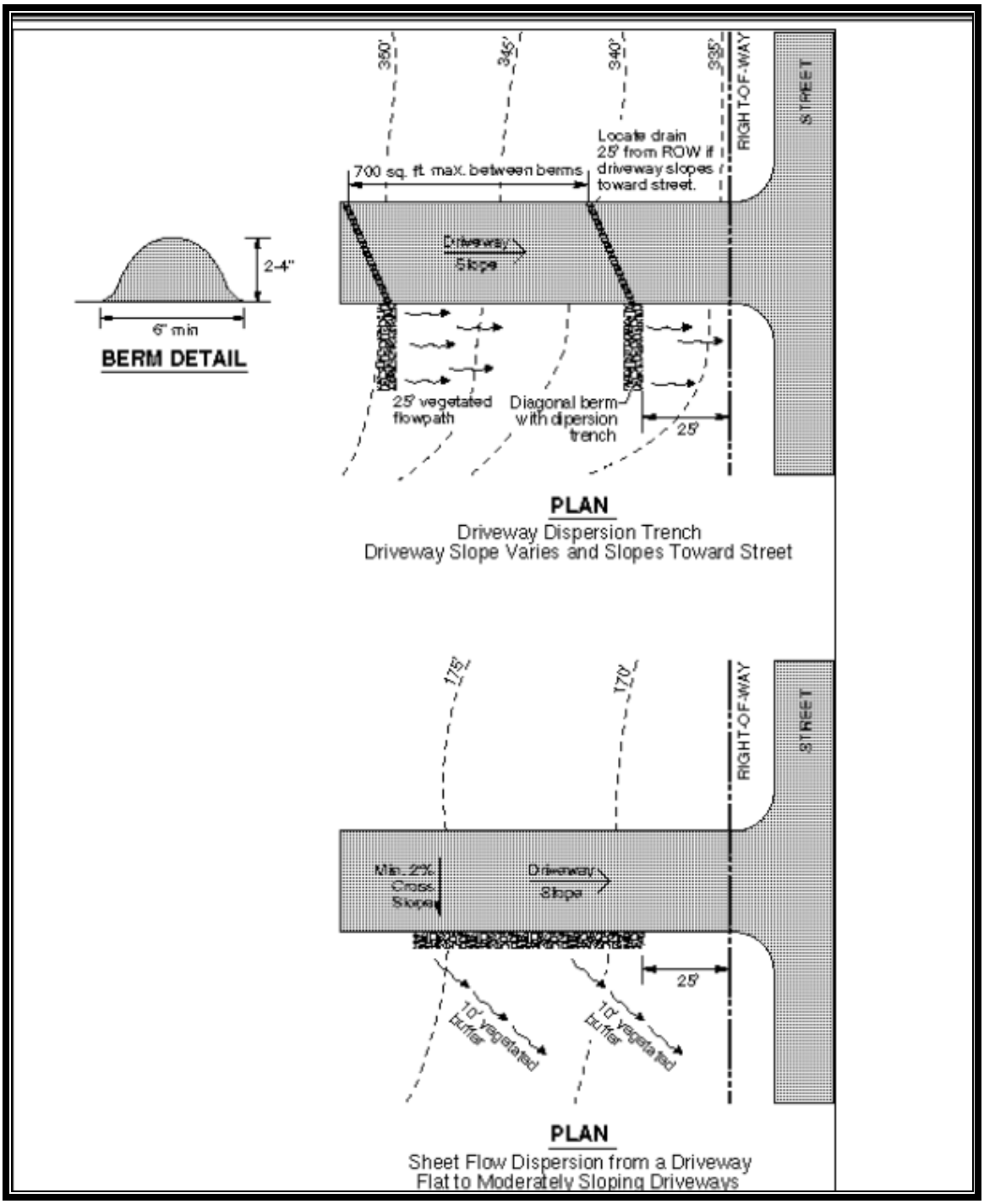


Figure 3.7. Typical Concentrated Flow Dispersion for Driveways

3.13 SHEET FLOW DISPERSION

Sheet flow dispersion is the simplest method of runoff control. This BMP can be used for any impervious or pervious surface that is graded so as to avoid concentrating flows. Because flows are already dispersed as they leave the surface, they need only traverse a narrow band of adjacent vegetation for effective attenuation and treatment.

3.13.1 APPLICABILITY

This BMP is recommended for flat or moderately sloping (less than 15 percent slope) impervious surfaces such as driveways, sport courts, patios, and roofs without gutters; sloping cleared areas that are comprised of bare soil, non-native landscaping, lawn, and/or pasture; or any situation where concentration of flows can be avoided.

3.13.2 SHEET FLOW DISPERSION DESIGN RECOMMENDATIONS

- See Figure 3.7 for flow dispersion for driveways, but similar applications can be employed for other impervious surfaces as well.

- A 2-foot-wide transition zone to discourage channeling should be provided between the edge of the driveway pavement and the down slope vegetation, or under building eaves. This may be an extension of subgrade material (crushed rock), modular pavement, drain rock, or other material approved by the City.

- A vegetated buffer width of 10 feet of vegetation should be provided for up to 20 feet of width of paved or impervious surface. An additional 5 feet of width should be added for each additional 20 feet of width or fraction thereof.

- A vegetated buffer width of 25 feet of vegetation should be provided for up to 150 feet of contributing cleared area (i.e., bare soil, nonnative landscaping, lawn, and/or pasture). Slopes within the 25-foot minimum flowpath through vegetation should be no steeper than 8 percent. If this criterion cannot be met due to site constraints, the 25-foot flowpath length should be increased 1.5 feet for each percent increase in slope above 8 percent.

- No erosion or flooding of downstream properties should result from the installation of these systems.

- Runoff discharged towards active landslide hazard areas and on-site septic systems should employ the same recommendations as downspout dispersion systems.

3.14 SOIL AMENDMENTS

Traditional grass yards attenuate stormwater runoff more affectively than native forest or prairie. Amending soils is a method of regaining some of the absorption and infiltration capability of the soil, and increasing a yard's ability to retain runoff and filter pollutants. This can be especially important if runoff from adjacent impervious surfaces, such as roofs or driveways, is dispersed over the yard. Within both LID projects and

traditional development projects, the soil and landscape system should be viewed as tools for at least partial stormwater infiltration, water conservation, and pollution control.

3.14.1 APPLICABILITY

- Soil amendments are recommended for the disturbed areas of LID sites subject to Minimum Requirement #5, as outlined in Volume I of the DOE Manual

- For sites where Minimum Requirement #5 does not apply, and the site is acceptable for traditional lawn installation, then a compost amended soil lawn is recommended. A compost-amended lawn will drain equally well, while providing the incidental stormwater retention and detention benefits.

- If the site being considered for turf establishment already does not drain well, an alternative to planting a lawn can be considered. If the site is not freely draining, and turf replacement is still being attempted, compost amendment will still provide stormwater benefits but should be incorporated into the soil at a reduced ratio as determined by an engineer or landscape architect. This reduced ratio is suggested in the Pacific Northwest because regions extended saturated winter conditions may create water logging of the lawn. The landscape professional should also provide a drainage route or subsurface collection system.

- Soil amendments should be used in areas that are to be incorporated into the stormwater drainage system such as vegetated channels, rain gardens, and bioretention areas and also into the lawn and landscape areas of the development.

- Soil amendments may also be used to improve permeability of soils graded and/or partially compacted in preparation for use of minimal excavation foundation systems.

3.14.2 LIMITATIONS

- There is the potential that increasing the moisture content within the soil could also increase soil instability in areas with steep slopes. However, the Washington State Department of Transportation (WSDOT) has been incorporating compost amendment in almost all of its vegetated sites since 1992 and has not experienced problems, even on the steepest sites (33 percent slope), as a result of the increased moisture holding capacity within the soils. (Note: See design recommendations below for application of steep slope soil amendment.)

3.14.3 DESIGN RECOMMENDATIONS

- As a first priority, native soils with robust native landscapes should be protected from disturbance whenever possible, especially in natural resource protection areas where post-construction soil rehabilitation is not planned. See Section 2.3.1 Vegetation Retention, Vegetation Protection during Construction Phase of

these guidelines for protection recommendations of natural resource protection areas during construction.

- The designer can typically choose from several options for creating the appropriate soil quality and depth. There are different desired soil quality and depths depending on the function at the location being amended (e.g., either a part of the stormwater drainage system, landscaped area, or lawn). Follow the option that works best with your site for estimating soil depth and height changes when applying soil amendments.

- Note: information on recommended compost composition and quality is provided at the end of this section.

OPTION 1 – Amend Existing Soils in Place
Scarify or till existing subgrade to 4 inches depth (or to depth needed to achieve a total depth of 12 inches of uncompacted soil after calculated amount of amendment is added). Entire surface should be disturbed by scarification. It is not recommended to scarify within drip line of existing trees to be retained.

Within *Stormwater Drainage System* locations or *Landscaped Areas (10 percent organic content)* – Place and rototill 3 inches of composted material into 5 inches of soil (a total depth of about 9.5 inches, for a settled depth of 8 inches). As noted previously, subsoils below this layer should be scarified at least 4 inches, for a finished minimum depth of 12 inches of uncompacted soil. Rake beds to smooth and remove rocks larger than 2 inches diameter. Mulch areas with 2 inches of organic mulch.

Within *Lawn Areas (5 percent organic content)* – Place and rototill 1.75-inches of composted material into 6.25 inches of soil (a total mended depth of about 9.5 inches, for a settled depth of 8 inches). As noted previously, subsoils below this layer should be scarified at least4 inches, for a finished minimum depth of 12 inches of uncompacted soil. Water or roll to compact soil to 85 percent of maximum. Rake to level, and remove surface woody debris and rocks larger than 1 inch in diameter.

OPTION 2 – Stockpile Site Topsoils Prior to Grading for Reapplication
If placed topsoil plus compost or other organic material will amount to less than 12 inches: scarify or till subgrade to depth needed to achieve 12 inches of loosened soil after topsoil and amendment are placed. Entire surface should be disturbed by scarification. Do not scarify within drip line of existing trees to be retained.

Stockpile and cover soil with weed barrier material that sheds moisture yet allows air transmission prior to grading.

Replace stockpiled topsoil prior to planting.

Within *Stormwater Drainage System* locations or *Landscaped Areas (10 percent organic content)* – Place and rototill 3 inches of compost material into 5 inches of replaced soil (a total depth of about 9.5 inches, for a settled depth of 8 inches).

Subsoils below this layer should be scarified at least 4 inches, for a finished minimum depth of 12 inches of uncompacted soil. Rake beds to smooth and remove rocks larger than 2 inches in diameter. Mulch areas with 2 inches of organic mulch or stockpiled duff.

Within *Lawn Areas (5 percent organic content)* – Place and rototill 1.75 inches of composted material into 6.25 inches of replaced soil (a total amended depth of about 9.5 inches, for a settled depth of 8 inches). Subsoils below this layer should be scarified at least 4 inches, for a finished minimum depth of 12 inches of uncompacted soil. Water or roll to compact soil to 85 percent of maximum. Rake to level, and remove surface woody debris and rocks larger than 1 inch in diameter.

OPTION 3 – Import Topsoil Meeting Organic Matter Content
Scarify or till subgrade in two directions to 6 inches depth. Entire surface should be disturbed by scarification. Do not scarify within drip line of existing trees to be retained.

Within *Stormwater Drainage System* locations or *Landscaped Areas (10 percent organic content)* – Use imported topsoil mix containing 10 percent organic matter (typically around 40 percent compost). Soil portion should be sand or sandy loam as defined by the USDA. Place 3 inches of imported topsoil mix on surface and till into 2 inches of soil. Place 3 inches of topsoil mix on the surface. Rake smooth and remove surface rocks over 2 inches diameter. Mulch planting beds with 2 inches of organic mulch.

Within *Lawn Areas (5 percent organic content)* – Use imported topsoil mix containing 5 percent organic matter (typically around 25 percent compost). Soil portion should be sand or sandy loam as defined by the USDA. Place 3 inches of imported topsoil mix on surface and till into 2 inches of soil. Water or roll to compact soil to 85 percent maximum. Rake to level, and remove surface rocks larger than 1 inch in diameter.

Additional Information on Soil Depth
After determining the elevation to which a site should be graded estimation of the changes in soil depth and height need to be calculated. A final grade of the soil should range between one-half inch and 2 inches below the elevation of sidewalks, driveways, and other impervious surfaces on the site.

The difference in volume of the dense verses the loose soil condition is determined by the “fluff factor” of the soil. The fluff factor of compacted subsoils in the Puget Sound Area is typically between 1.3 and 1.4 depending on soil type. Rototilling typically penetrates the upper 6 to 8 inches of the existing soil. Assuming only a 6-inch depth is achieved; this depth adjusted by the fluff factor will correspond to a 7.8- to 8.4-inch depth of loose soil. This loose volume would then be amended at a 2:1 ratio of loose soil to compost, corresponding to an imported amendment depth of approximately 4 inches for this example. In the loose state, both the soil and compost have a high percentage of pore spaces (volume of total soil not occupied by solids). The resulting change in elevation should account for compost settling into void spaces of the loose soil (assume 15 percent of the soils’ void spaces become occupied by compost

particles). After compost incorporation, the amended site will undergo some degree of compaction by the rolling procedure and the weight of the soil itself. Assume a compression factor of 1.15 for soils with a 1.3 fluff factor and 1.2 for soils with a 1.4 fluff factor (15 to 20 percent of the soils' void spaces will become occupied by compost particles.) The resulting change in elevation for a site amended to a 6-inch depth will be approximately 3 inches.

Note: These options for soil amendments are recommendations and site specific designs are encouraged for each individual project. Designs will be reviewed based on local site conditions use for the amendments.

Compost Quality Recommendations

- Compost should be prepared by the controlled decomposition of organic materials. Acceptable feedstocks include, but are not limited to, yard debris, wood waste, land-clearing debris, brush, branches, manure, biosolids, food residuals, and forest byproducts. The product should have a uniform, dark, soil-like appearance and an earthy loam-like odor. No ammonia or putrid smells should be present. Minimum organic matter should be 35 percent (dry-weight basis). Particles should be 100 percent passing the 1-inch sieve. pH range should be between 6.0 and 8.5 for wetlands and streamside locations, and 6.0 and 8.0 for other locations. Foreign material should be no more than 2 percent on a dry-weight or volume basis whichever provides the least foreign material.

  Compost for the approved rates listed above should be Class A compost per Washington State Department of Ecology (Ecology) interim Compost Quality Guidelines ("composted materials" defined in Washington Administrative Code (WAC) Chapter 173-350 Section 220) or topsoil manufactured from these composts plus sand or sandy soil. Products should meet additional requirements for organic matter content and a carbon to nitrogen ratio below 25:1. The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound region.

- It is recommended that alternatives to straw mulch, such as composted mulch or wood-based mulch be utilized for construction erosion and sediment control.

- Compost is recommended on slopes instead of hydromulch.

- Soils amendments should be installed post-construction, prior to installation of landscaping and turf, unless used as a step in the lot preparation process involving minimal excavation foundation systems.

Steep Slope Area Recommendations

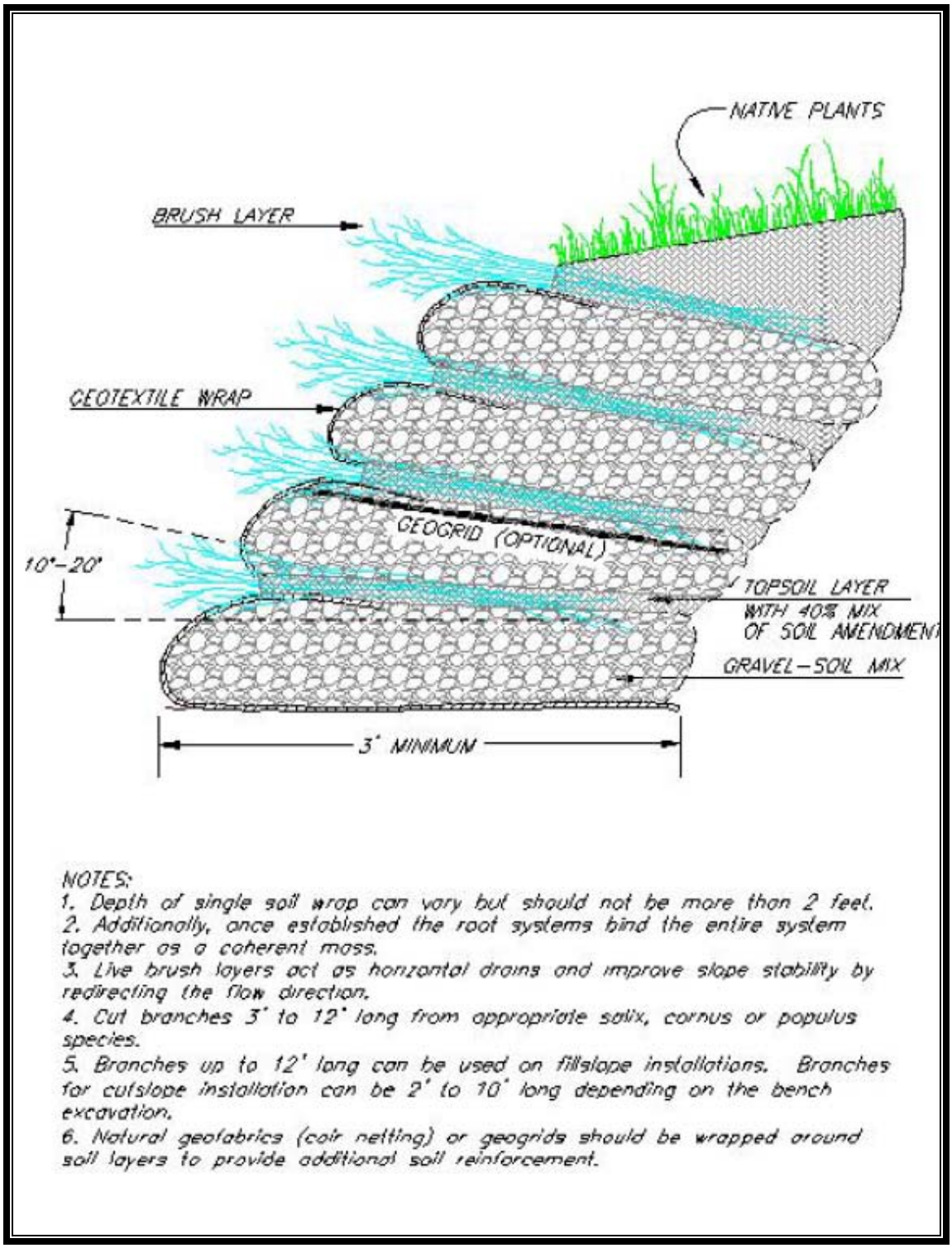
Existing Steep Slope Areas – On-site steep slope areas, which have native soils with robust native landscapes, should be protected from disturbance as a preference to re-grading and augmenting the disturbed soil with soil amendment.

Steep slopes that remain on site which are not constructed as part of the development AND where native soils and vegetation is sparse can be amended by planting deep rooting vegetation to improve stormwater attenuation.

Constructed Steep Slopes – In lawn and landscaped areas, the slope angle should be minimized to the greatest extent possible for both stability and lawn maintenance concerns. Terracing is recommended to minimize steep slope angles. A recommended method of interim slope stabilization for slopes steeper than 40 percent is brush layering with geotextile soil wrap (see Figure 3.8). Brush layering can be used on fill slopes and on cut slopes that are over-excavated and rebuilt with the soil wraps. Other plant species may be substituted which meet the requirement of rapid establishment of deep root systems.

Adequate drainage systems should be installed on steep slope areas where it is determined that retained runoff may cause instability. To provide adequate drainage, a professional engineer should determine the drainage pattern of the slope and design/install controlled drainage at the outfall of these areas. A subsurface collection system should be installed at the base of each terrace to redirect water away from any retaining structures. Subsurface collection systems may also be necessary in low depressions of a non-uniform site, although it is recommended that these areas be left undisturbed so as to serve as natural stormwater retention areas. An appropriate receiving area for the water collected and concentrated by the subsurface drainage system should be provided.

Additional guidelines for this BMP can be found in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in Ecology Stormwater Management Manual for Western Washington*, which is available at www.soilsforsalmon.org under the “How-To” section, or at <www.buildingsoil.org>.



Not to Scale

Figure 3.8. Brush Layering with Geotextile Soil Wrap.

3.15 VEGETATED OPEN CHANNELS

The order of preference for stormwater treatment on LID developments uses BMPs for infiltration and dispersion to the greatest extent possible before collection and conveyance techniques are utilized. There are still instances, due to site and layout constraints, where conveyance will be required. In these cases vegetated open channels should be used, where possible, in lieu of piped conveyance systems. Along with conveying stormwater, vegetated open channels provide opportunities for groundwater recharge in smaller storm events and provide greater storage capacity and attenuation of peak flows than piped systems.

Vegetated open channels are meant to be very different than a typical street side ditch, with shallower depths and gentler side slopes. Where street side ditches usually convey runoff from large areas and grow continually deeper as their length increases, the vegetated open channels are meant to drain only small scale drainage areas and convey the water only short distances.

3.15.1 APPLICABILITY

- Vegetated open channels are most applicable adjacent to the streets where the linear nature of the street often makes it difficult to provide enough area within the right-of-way for treatment by infiltration or dispersion. Street side vegetated channels can be used to seamlessly blend into the adjacent lot landscaping or act as a buffer between the and the sidewalk.

- Depending on the site conditions, vegetated open channels can be designed to provide retention within the channel. They can promote infiltration of a majority of the stormwater while releasing stormwater along the channel only during major storm events.

- Vegetated channels spaced strategically throughout the development can act as interceptor points along the identified interflow pathways from rain gardens and bioretention areas. With the elevation of the vegetated channel bottom set below the upper soil profile, it will be possible for interflow to seep from the side slopes of the channel during heavily saturated conditions. This allows some alleviation from excess saturation of the upper soil structure and also can pick up overflows from the bioretention facilities.

- Vegetated channels should have termination points in either bioretention areas, stormwater ponds, or in dispersion trenches sheet flowing into natural resource protection areas.

3.15.2 FLOW CREDIT FOR VEGETATED OPEN CHANNELS

Vegetated open channels are generally preferred for site conveyance, but may not always receive additional flow control or water quality credit. Designers who wish to use vegetated open channels to meet either the flow control and/or water quality minimum requirements outlined in Volume I of the DOE Manual will have to demonstrate that the facility will perform comparatively to other approved flow control and treatment BMPs.

Given the variety of performance functions of vegetated open channels (e.g., filtration, infiltration, and detention), the design approach required to meet the applicable minimum requirements may vary.

In general, vegetated open channels intended to meet water quality requirements should meet the design criteria outlined for biofiltration swales, filter strips, bioretention, or bioinfiltration swales. Vegetated open channels intended to meet flow control requirements should meet the design criteria outlined for infiltration facilities, or bioretention facilities (as designed for flow control specifically). Note that these flow control facilities can also be modified to provide water quality treatment.

Designers who wish to use vegetated open channels for conveyance, but without credit for flow control or treatment should follow the design recommendations in Section 3.15.3. Incidental flow control or treatment credit may be warranted if the designer engineer can demonstrate how some or all of the applicable flow control or water quality treatment requirements will be met.

3.15.3 VEGETATED OPEN CHANNEL DESIGN RECOMMENDATIONS

- The geometry of vegetated channels is meant to blend into the surrounding landscape as seamlessly as possible. Vegetated channels can be various shapes but it is recommended they have side slopes of 4:1 or greater but no case should be steeper than 2H:1V. Sharp corners in the transition with the adjacent landscaping should be avoided. Sizing of the channel width should depend on the contributing area but the bottom width of the channel should be at least 1-foot wide and widths larger than 3 feet should incorporate some sort of structural measures such as logs or spreader boards to maintain sheet flow. Recommended longitudinal slopes should be in the range of 2 to 4 percent.

- Vegetated channels should have dense vegetated cover of grass or shrubs. When the vegetated channel is located along the street, vegetation over 18 inches in height located within the City right-of-way for a local street should be placed far enough away from the traveled way to avoid interference with sight-lines or clear zones.

- A Manning's roughness coefficient (n) value of 0.20 is recommended for vegetated channels with grass cover that are routinely mowed. Select grass species that produce a uniform cover of fine-hardy vegetation that can withstand the prevailing moisture condition. Wetland adapted species such as Juncus and Scirpus can be utilized if drainage is poor.

- Trees: Trees placed within the bottom and sides of the vegetated channels can help intercept rainfall with their canopy, withdraw water out of the soils, and provide a visual break between the sidewalk and the street. Maintenance to remove fallen leaves and prevent clogging pervious soils or killing grass may increase as a result of incorporating trees in the design.

- Water Table: Designers should determine the level of the seasonal high water table. If the water table is within a foot of the bottom of the swale, it may be advisable to select water tolerant plant species.

- Additional detention can be designed within the channel by expanding the cross-section of the vegetated channel. Expanding the cross-section should benefit the efforts to blend into the surrounding landscape by flattening the side slopes and providing a gentler transition into the surrounding landscape.

- Infiltration can be promoted for smaller storm events within the vegetated channel by elevating the outlet of the channel by 2 to 6 inches. When infiltration is designed into the vegetated channel the bottom of the channel should be amended with compost.

- Another approach to design infiltration into the vegetated channel is to install an underdrain system beneath the channel bottom. This design is similar to the bioretention areas, in that the outlet to the channel is through the collection of runoff in the underdrain system except when the channel is in overflow. Overflow can be through a designated surface flow path or by elevating a catch basin rim with a bee hive grate. The outlet or the underdrain system can be to another stormwater facility, dispersed into a natural resource protection area, or other appropriate discharge location.

- Where vegetated channels cross driveways, the conveyance under the driveway can be by traditional mechanisms such as culverts or by open graded rock pads placed under the driveway surfacing. Geotextile fabric should be placed under the rock pad to prevent movement of the rock into the subgrade. To keep the rock pad from clogging with silt during the stabilization of the vegetated channel the fabric should be installed longer on each side of the driveway and temporarily flipped up over the end of the rock to trap any silt before it can enter into the rock pad. Once the vegetation is established and the site stabilized these ends can be cut off. Rock pads can work well with the subgrade designs of alternative paving surfaces for driveways which incorporate open graded gravels to promote runoff movement through the subgrade.

3.16 ALTERNATIVE PAVING SURFACES

Alternative paving surfaces include porous asphalt pavement; porous concrete; grid or lattice rigid plastic or paving blocks where the holes are filled with soil, sand, or gravel; and cast-in-place paver systems. Porous surfaces are designed to accommodate pedestrian, bicycle, and auto traffic while allowing infiltration and storage of stormwater.

3.16.1 APPLICABILITY

- Appropriate applications for alternative porous surfaces include parking overflow areas, parking stalls, low volume residential streets, alleys, driveways, sidewalks/pathways, and patios.

- Porous paving surfaces can provide some attenuation and uptake of stormwater runoff even on cemented till soils while still providing the structural integrity required for a street surface to support heavy truck loads.

- Recent research of porous paving surfaces has shown that although there is a drop off in infiltration rates over time, the long-term infiltration rate is still substantial enough to provide significant reductions in runoff.

3.16.2 LIMITATIONS

- Because of water quality concerns related to stormwater with high concentrations of oils or other contaminants infiltrating through the surface and contaminating groundwater, pervious pavement surfaces are not recommended for land uses that generate heavy loadings of these pollutants. These include land uses which include but are not limited to gas stations, small mini marts, commercial fueling stations, autobody shops, automobile repair services, and automobile wash services.

- An apparent limitation of porous paving surfaces is the increased potential for clogging when runoff generated from other surfaces (i.e., run-on) is directed onto the porous paving surface, especially as a point discharge, thereby potentially conveying sediment onto the porous paving surface (see the Maintenance Recommendations below for measure to prevent clogging). The potential sediment loading for each application should be considered when determining if the application is appropriate for an alternative paving surface.

- To reduce the potential of clogging it is not recommended that runoff generated from lawns or other pervious surfaces be directed onto a porous pavement surface. Point discharges should not be directed onto porous pavement surfaces. Runoff as sheet flow from a paved surface may be directed onto a porous pavement surface (as with a paved travel lane sheet flowing onto adjacent porous parking stalls) provided that the porous pavement is designed to take that discharge.

3.16.3 POROUS PAVING SURFACE DESIGN RECOMMENDATIONS

- Recommended maximum slopes for alternative paving surfaces are 5 percent (porous asphalt), 6 percent (porous concrete), 10 percent (interlocking pavers), and 5 to 6 percent (grid and lattice systems).

- Modeling of runoff from areas of porous pavement surfaces designed in accordance with this volume should conform to requirements of the 2005 Ecology Stormwater Management Manual for Western Washington, Volume III, Appendix C; the modeling methods provided in an Ecology and Black Diamond-approved continuous simulation model; or subsequent approved technical documentation.

- Where individual porous paving surfaces have multiple design configurations approved by the manufacturer, the designer should choose the design configuration with the maximum porosity. Base materials of porous pavement systems can be designed to infiltrate vertically into outwash soils or move runoff laterally along the subgrade for release by seepage into vegetated channels. Manufacturer's recommendations on design, installation, and maintenance should be followed for each application.

- Per the DOE Manual, subgrade infiltration rates less than 2.4 inches per hour and a cation exchange capacity of 5 milliequivalents CEC/100 grams dry soil (or greater) will provide water quality treatment, satisfying applicable Minimum Requirement #5 requirements.

- Typical cross-sections of porous paving systems consist of a top layer (pervious wearing course) with either porous asphalt; porous concrete; concrete block pavers; or a plastic grid paver filled with sand, topsoil, or gravel. Supporting the top layer is an aggregate subbase with larger rock at the bottom and smaller rock directly under the top surface (e.g., a gradient from 2 to 5/8 inch). The aggregate subbase has minimal fines and is compacted to support the traffic load while allowing for the design infiltration rate and storage. Open-celled paving grids and concrete block pavers, a leveling course consisting of finer aggregate is also included. Between the underlying soil layer and the base layer of stone is a geo-textile fabric which allows water to infiltrate but restricts movement of other particles into the gravel. See Figures 3.9 and 3.10 for example illustrations and details.

- Structural designs for porous surfaces should be per the manufacturer's specifications and designed by a professional engineer.

- Where cemented till layers of soil exist under a parking lot, a pervious pavement system can still be effective to attenuate peak flows. In small area applications, the subgrade of the parking lot can be built up with porous base material and graded to direct runoff through this material to an eventual outfall, such as bioretention areas. In larger areas, an underdrain system should be installed to collect and convey runoff to bioretention areas or open space. In this manner, stormwater is stored and metered out slowly, similar to the way the existing topsoil on a site captures and slowly releases runoff.

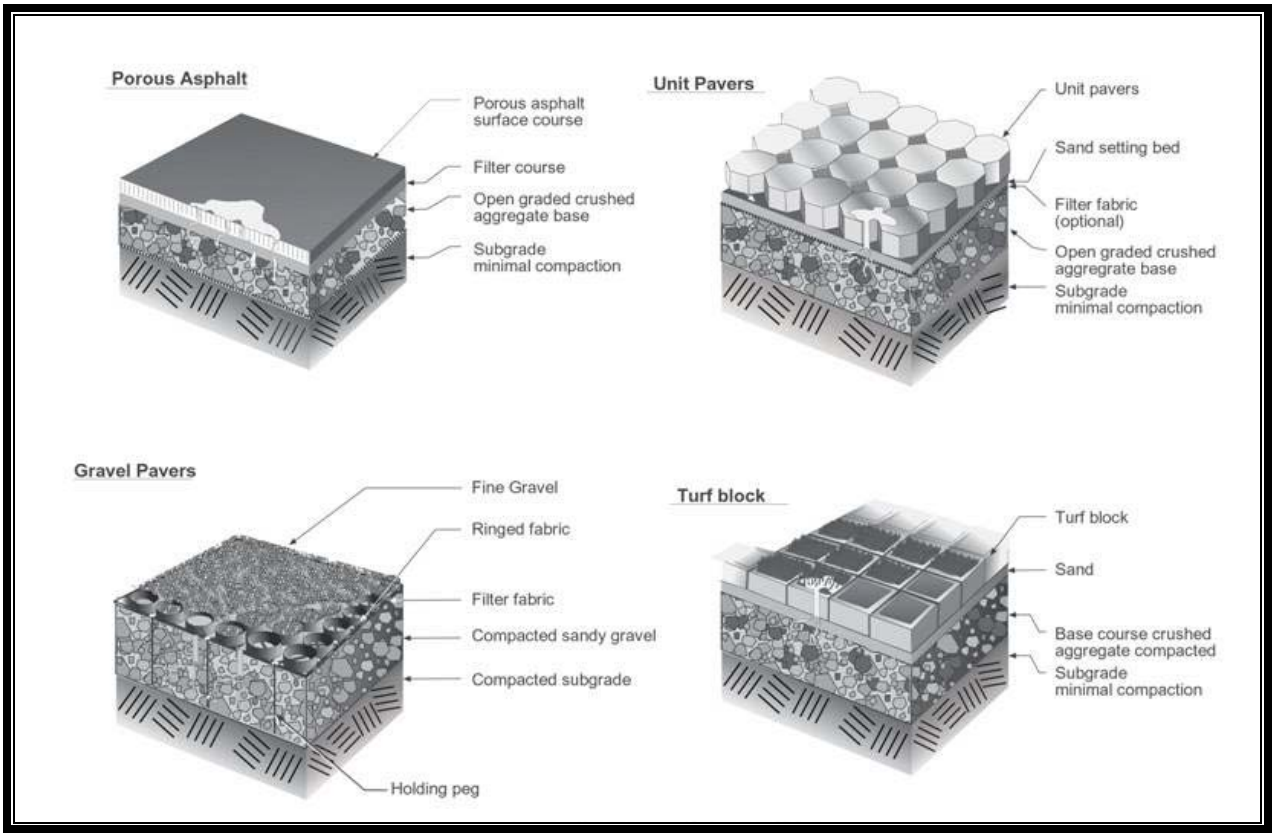


Figure 3.9. Alternative Paving Surfaces.

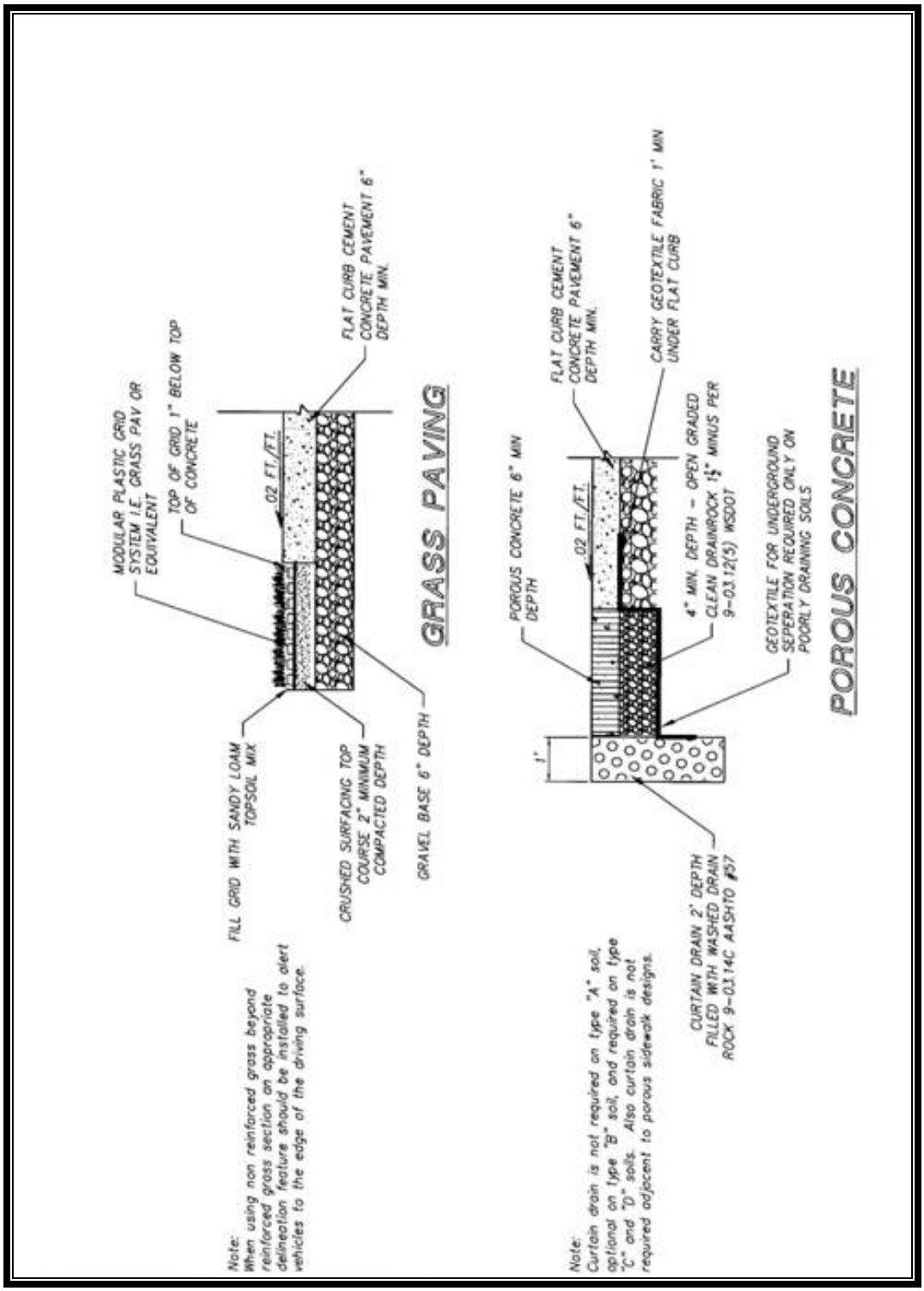


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Figure 3.10. Sample Porous Paving Surfacing Details.

- Both gravel and soil with vegetation can be used to fill the openings in paver and rigid grid systems and manufacturer recommendations should be followed to apply the appropriate material for each application.

- Porous systems that utilize pavers should be confined with a rigid edge system to prevent gradual movement of the paving stones.

- ADA compliance should be requested from the manufacturer considered in determining where to use alternative paving surfaces.

Pervious Wearing Course
The wearing course or surface layer of the alternative paving surface may consist of permeable asphalt, permeable concrete, interlocking concrete pavers, or open-celled paving grid with vegetation or gravel. The wearing course should provide adequate porosity for stormwater infiltration.

- Positive surface drainage should be provided to eliminate risk of ponding on pavement surface (recommended minimum surface slope of 1 percent)

- For a vegetated open-celled paving grid, topsoil should have a minimum 4 percent organic matter by dry weight. If receiving run-on from other surfaces, it should be demonstrated that run-on is infiltrated through the pervious wearing course to the storage reservoir without ponding.

Leveling Course
Depending upon the type of permeable pavement installation, a leveling course (also called a bedding or choker course) may be required (per manufacturer recommendations). A leveling course is often required for open-celled paving grids and interlocking concrete pavers. This course is a layer of aggregate that provides a more uniform surface for laying pavement or pavers and consists of crushed aggregate smaller in size than the underlying aggregate subbase. Course thickness will vary with permeable pavement type and application.

Aggregate Subbase
The aggregate subbase in an alternative paving surface serves as the street, parking, or pedestrian area's support base and should be sufficiently thick to support the expected loads and be free draining. The subbase should meet the following recommendations:

- A 2-inch minimum depth of aggregate subbase is recommended under the pervious wearing course and leveling course (if any)

- Aggregate subbase should consist of larger rock at the bottom and smaller rock directly under the top surface (e.g., a gradient from 2 to five-eighths inch)

- The bottom and sides of the aggregate subbase should be contained by a nonwoven geotextile.

Nonwoven Geotextile
As part of the pavement section design, the designer should review the existing native soil or subbase characteristics and determine if a nonwoven geotextile is needed for separation of subbase from underlying soils.

3.16.4 INSTALLATION RECOMMENDATIONS

- Proper installation is one of the key components to ensure the success of porous paving surfaces. As with any pavement system, porous pavement systems require careful preparation of the subgrade and base course to ensure success in terms of strength and permeability. The compressive strength of a permeable paver system relies in large part on the strength of the underlying soils, particularly in the case of modular or plastic units where the pavement itself lacks rigidity. Design and installation of alternative paving surfaces should be according to the recommendations of the manufacturer and project engineer.

- Install appropriate source and erosion control BMPs to prevent sediment transport from construction activities onto the base material or top course when the porous surface is applied prior to the completion of construction and stabilization of the entire site.

- If possible, temporary roads should be used during project construction especially during final construction of the base material and porous surfacing.

3.16.5 MAINTENANCE RECOMMENDATIONS

- See Minimum Requirement #10 in Volume I; Section 2.5.10; of the DOE Manual for additional information on maintenance requirements.

- Clogging is the primary mechanism that degrades infiltration rates. However, as discussed above, the surface design can have a significant influence on clogging of void space.

- Studies have indicated that infiltration rates on moderately degraded porous asphalts and concrete can be partially restored by suctioning and sweeping of the surface. It is recommended that highly degraded porous asphalts and concrete have periodic high pressure washing with suction performed for maintenance of infiltration.

- Maintenance frequencies of suctioning and sweeping should be specified in the operation and maintenance plans (Section 4.2) for each individual project.

- Porous pavement systems designed with pavers have advantages of ease of disassembly when repairs or utility work is necessary. However, it is important to note that the paver removal area should be no greater than the area that can be

replaced prior to reopening of the access to vehicular traffic. If an area of pavers is removed, leaving remaining edges unconfined, it is likely that loading in nearby areas will create movement of the remaining pavers thereby unraveling significantly more area than intended.

3.17 RAINFALL REUSE SYSTEMS

Rainfall reuse systems are systems designed to collect stormwater runoff from non-polluting surfaces, such as roofs, and to make use of the collected water. Reuse of the runoff can be for irrigation, potable, and non-potable uses but would require different levels of storage and water quality treatment depending on the intended use. Although sophisticated rainfall reuse systems have not been widely used throughout the Northwest, there have been systems designed and installed by a growing group of professionals such as “Northwest Water Source” located in Friday Harbor. The most abundant use of water reuse systems in the Northwest has been on some of the island communities where potable water has limited availability. In these cases the systems have been sized and designed to capture all rooftop runoff with adequate treatment for reuse as a potable water source. Rainfall reuse systems are also coined under the terminology “Rainfall Catchment” and “Rainwater Harvesting.”

3.17.1 APPLICABILITY

- Highly developed areas or commercial centers where larger buildings, especially multistory buildings, encompass nearly all of the area are suitable for water reuse systems. In these areas, stormwater management can be expensive due to the high cost of land and therefore the cost of a water reuse system could be more competitive. Multistory buildings require a more constant and larger demand for non-potable water and therefore the required storage of rooftop runoff won’t be as large, potentially reducing the costs of these systems.

- Rainfall reuse systems have the additional benefit of decreasing demands on the treated potable water supply

- Approval of a water reuse system as a potable source would require approval of the appropriate state and local agencies as required for any water right.

3.17.2 LIMITATIONS

- Although use of rain barrels for capturing rainfall can be beneficial for providing a small amount of irrigation and also provide an educational aspect to the benefits of water reuse, they generally do not provide enough storage of seasonal runoff to be considered to meet the performance goals of Minimum Requirement #5 or #7 in the DOE Manual. The burden to show how these systems meet the minimum requirements would be on the applicant for the project.

3.17.3 GENERAL RAINFALL REUSE DESIGN RECOMMENDATIONS

- Because of the complicated nature of storage and treatment any rainfall reuse system should be designed by a qualified designer.

- The cistern can be designed as part of the foundation to fit under the house (adding about 1 foot in height), or can be placed next to the house, either above or below ground. When the storage of runoff is incorporated into the building design it should be approved as part of the building permit. Figure 3.11 provides an illustration of an example cistern installation.

- Rainfall reuse systems that supply non-potable water should be designed to augment the supply of treated water and therefore should be designed to use the stored rainfall runoff first and use the treated water supply when the rainfall runoff is depleted.

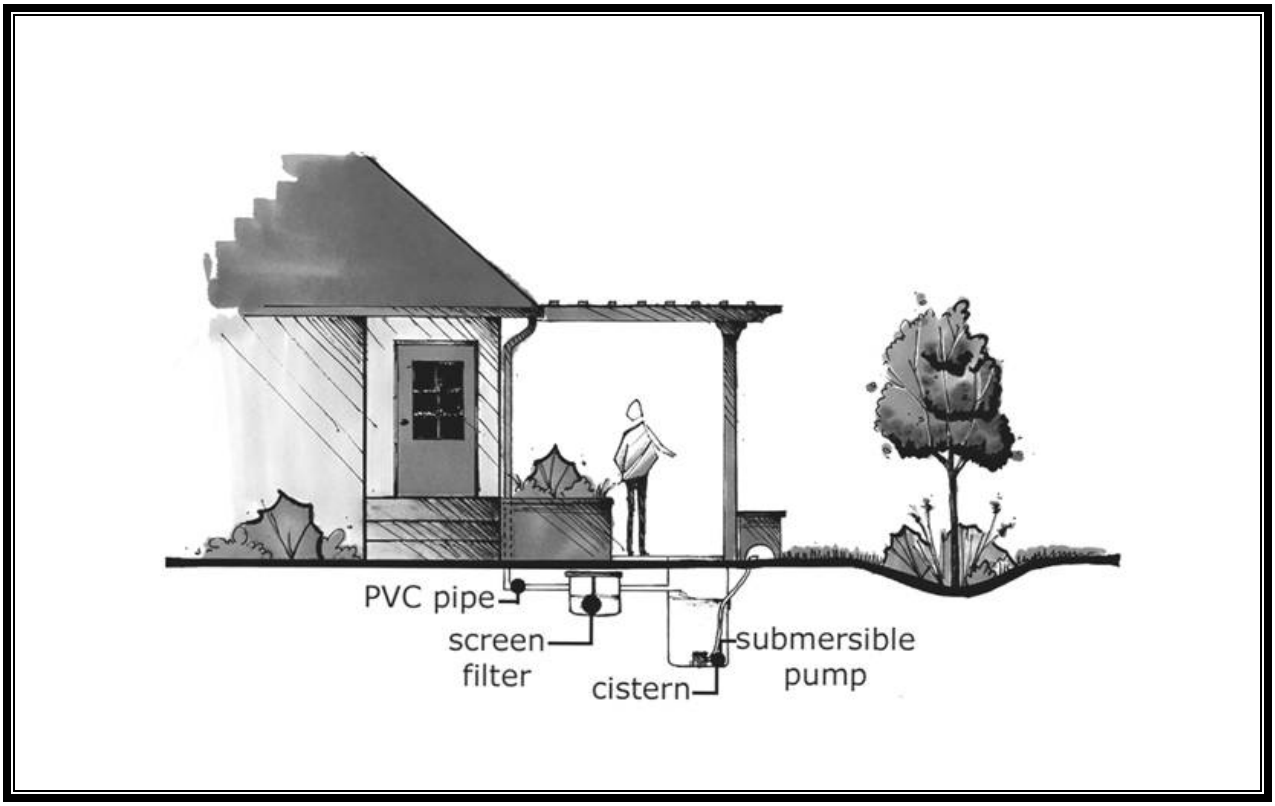

Figure 3.11. Sample Cistern.

- Cisterns should be sized according to roof area, monthly rainfall patterns, and anticipated water usage of connected plumbing facilities. To estimate the storage volume required for non-potable uses, the volume of rainfall off the roof surface should be plotted over time against curves showing the amount of water used inside the house. Rainwater collection systems have losses due to roofing material texture, evaporation, and inefficiencies in the collection process, which can account for up to a 25 percent loss of annual rainfall.

3.17.4 MAINTENANCE RECOMMENDATIONS

- It is recommended that rainfall reuse have a maintenance agreement in the same manner as other types of stormwater BMPs.

- Maintenance agreements should provide for annual inspections of systems to assure pumps and filters are working properly and the design level of water quality is being maintained.

3.18 VEGETATED ROOFS

Vegetated roofs are areas of living vegetation installed on top of buildings to provide flow control via detention, attenuation, soil storage, and losses to interception, evaporation, and transpiration. Vegetated roofs are also known as eco-roofs, green roofs, and roof gardens. Vegetated roofs have the additional benefits of providing relaxing green space, reducing temperature within urban centers, and have a longer life span than traditional roofing materials.

A vegetated roof consists of a system in which several materials are layered to achieve the desired vegetative cover and drainage characteristics (see Figure 3.12). Design components vary depending on the vegetated roof type and site constraints, but typically include a waterproofing material, a drain system, a drainage layer, a separation fabric, a growth medium (soil), and vegetation.

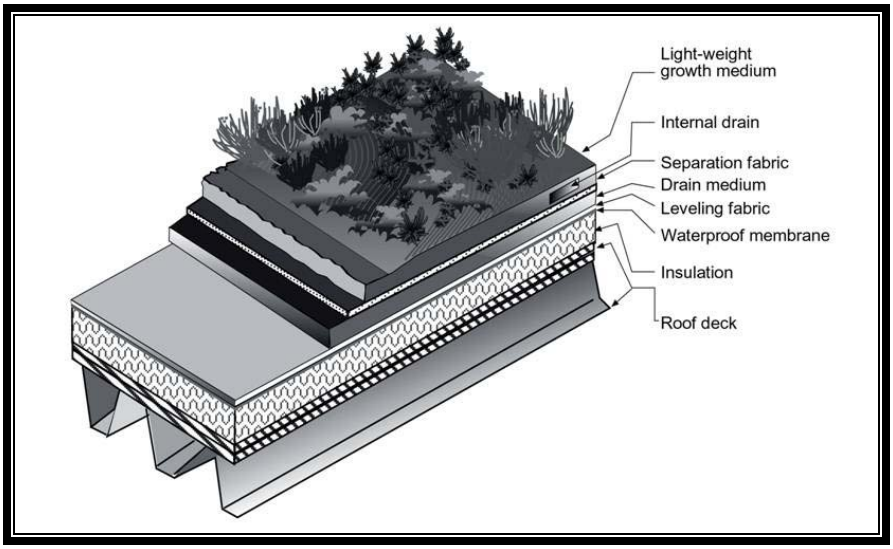

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Figure 3.12. Sample Vegetated Roof.

Vegetated roofs are categorized by the depth and the courses used in their construction. Deeper installations, referred to as “intensive” roofs, are comprised of at least 6 inches of growth media and are planted with groundcovers, grasses, shrubs, and sometimes trees. These systems require regular landscape maintenance. Shallower installations, referred to as “extensive” roofs, are comprised of less than 6 inches of growth media and use a planting palette of drought-tolerant, low maintenance groundcovers. Extensive systems are further divided into “single-course” systems

which consist of a single media designed to be freely draining and support plant growth, and “multi-course” systems that include both a growth media layer and a separate, underlying drainage layer. Extensive vegetated roofs typically have the lowest weight and are the most suitable for placement on existing structures.

3.18.1 APPLICABILITY

The use of vegetated roofs should be evaluated on a case-by-case basis.

- Vegetated roofs, like rainfall reuse systems, are very applicable in highly developed environments where other LID practices of forest retention or infiltration may not be feasible. Vegetated roofs have the additional benefits of providing relaxing green space, reducing temperature within urban centers, and a longer life span than traditional roofing materials.

- Vegetated roofs can be applied to a range of rooftop slopes. However, steeper slopes, such as those on single family residences, may result in reduced flow control performance and may trigger additional design requirements (e.g., underlying drainage layer and lateral support measures. These guidelines do not preclude the use of vegetated roofs on steeper slopes, but it will be up to the designer to demonstrate that these applications still have the effectiveness of eliminating runoff from the smaller storm events and attenuating runoff from larger storms.

3.18.2 VEGETATED ROOF DESIGN RECOMMENDATIONS

This section focuses on the guidelines and recommendations that should be included in vegetated roof designs to achieve effective stormwater management. Additional loading, structural, waterproofing, fire resistance, and horticultural considerations will apply and should be adhered to when incorporating vegetated roof systems. While some of these issues are noted, related design methods and requirements are not included. Vegetated roofs should also require approval from the local Fire Marshal to demonstrate adequate ventilation or ability to ventilate in cases of a fire. The design team should include qualified professionals to address all design considerations.

Vegetated roofs typically consist of the following components,

- Waterproof membrane
- Root barrier
- Drainage layer
- Separation fabric (for multi-course systems)
- Growth medium (soil)
- Vegetation
- Irrigation plan
- Drain system.

Waterproof Membrane
Waterproof membranes are made of various materials, including reinforced polyvinyl chloride (PVC), synthetic rubber (EPDM), thermoplastic polyolefins, high-density polyethylene (HDPE), modified asphalts (bitumens), and hypalon (CPSE). Some waterproofing materials come in sheets or rolls and some are available in liquid form. Each material has different strengths and functional characteristics.

Root Barrier
To discourage roots from damaging the waterproofing membrane, a physical root barrier may be required. The need for a root barrier depends primarily on the particular waterproof membrane selected. Some waterproofing membranes have root barrier capabilities intrinsic to the material. Modified asphalts usually require a root barrier, while EPDM and reinforced PVC typically do not. The manufacturer should be consulted to determine whether a root barrier is recommended for a particular product.

During installation, treatment to prevent root penetration should not be restricted to parts of the roof that will be covered with vegetation, as the roots will extend beyond the areas in which vegetation shows at the surface. Care should be taken to fully treat the areas at joints, borders, and seams.

The root barrier should not contain leachable water quality contaminants (e.g., herbicides, copper, and zinc).

Drainage Layer
For intensive and extensive multi-course vegetated roof systems, a drainage layer should underlie the growth medium. The drainage layer is a multipurpose layer designed to provide void spaces to hold a portion of the water that passes through the growth medium and to channel the water to the roof drain system. The drainage layer can consist of a layer of aggregate or a manufactured mat or board that provides an open free-draining area or other material as designed. Many manufactured products include “egg carton” shaped depressions that retain a portion of the water for eventual evapotranspiration. Some studies have shown that aggregate drainage layers may provide the better flow control.

Separation Fabric
A nonwoven geotextile should be installed between the growth medium (soil) and the drainage layer to prevent fine soil and substrate components from being washed out of the growth medium into the drainage layer (note that this does not apply to single-course extensive vegetated roofs). The fabric should be pervious to allow water to percolate into the drainage layer. If a manufactured drainage layer is used, the separation fabric is typically included.

The separation fabric should be installed between the growth medium and the drainage layer and between the growth medium and all surrounding areas, roof edges, penetrations, and structures. The fabric also should have average opening size sufficient to retain media.

Growth Medium (Soil)
Vegetated roofs typically use a light-weight growth medium with adequate fertility and drainage capacity to support plants and allow infiltration and storage of water. Growth medium composition (fines content and water holding capacity) is important to flow control performance.

The growth medium typically has a high ratio of mineral to organic material content and can be a mixture of various components including gravel, sand, compost, soil, or light weight aggregate material. Due to their excessive weight, particularly when wet, native soils are typically not acceptable substrates for vegetated roofs.

The growth medium should be submitted on a case by case basin and will vary based on its intended application.

Growth medium depth and characteristics should support growth for selected plant species.

Vegetated roofs should not be subject to any use that will significantly compact the growth medium. Unless designed for foot traffic, vegetated roof areas that are accessible to the public should be protected (e.g., signs, railing, and fencing).

Measures to control erosion of growth media (ie. mulch mat) are recommended to be maintained until 90 percent vegetation coverage is achieved.

Vegetation
Vegetation used on extensive vegetated roofs should be drought tolerant, self-sustaining, low maintenance, and perennial or self-sowing. Appropriate plants should also be able to withstand heat, cold, periodic inundation and high winds. Vegetation with these attributes typically includes succulents, grasses, herbs, and wildflowers that are adapted to harsh conditions.

Plants can be installed as vegetation mats, individual plugs, cuttings, spread as seeds, or other installation methods on a case by case basis.

- *Vegetation mats* – vegetation mats are sod-like, pre-germinated mats that achieve immediate full plant coverage. They provide immediate erosion control, do not need mulch, provide the most rapid establishment for sedums, and minimize weed intrusion. They also need minimal maintenance during the establishment period and little ongoing watering and weeding.

- *Plugs or potted plants* – plugs or potted plants may provide more design flexibility than mats. However, they take longer to achieve full coverage, are more prone to erosion, need more watering during establishment, require mulching, and require more weeding. Birds sometimes pull out plugs, in which case netting may be needed until they are fully rooted.

- *Cuttings* – while cuttings may be used, they become established more slowly than mats and plugs and have a higher mortality rate.

- *Seeds* – seeds can be either hand broadcast or applied by hydroseeding. Seed plantings require more weeding, erosion control, and watering than mats and plugs.

In the long term, the generation of warm and cold air currents resulting from heating and air-conditioning vents on the rooftop can cause frost and drought damage to plants. Exhaust gases such as sulfur dioxide or grease from chimneys and exhausts can result in direct damage to vegetation, depending on the species. Therefore, areas that are affected by warm air, variable air currents, and exhaust gasses need to be checked carefully to determine whether they are suitable areas for planting and to identify the type of vegetation that is best suited to the particular conditions.

An additional consideration is the effect of providing a vegetated roof habitat. Habitat may be enhanced by using diverse planting and including some larger plants. Some projects sites may not want to encourage wildlife (e.g., birds near air fields).

Plant spacing and plant size should be designed by a certified landscape architect. Turf grasses are not recommended for vegetated roof application because of the dangers of longer grasses growth dying, drying out, and becoming a fire danger. Ideal plants for this application should not require fertilizer, pesticides, or herbicides after 2-year establishment period. Vegetated roof designs should specify that vegetation coverage of selected plants should achieve 90 percent coverage within 2 years or additional plantings should be provided until this coverage requirement is met.

Irrigation

Provisions should be made for supplemental irrigation during the first two dry seasons after installation to improve plant survival depending on plan selection. Subsurface irrigation methods are ideal. If surface irrigation is the only method available, drip irrigation is the preferred method to deliver water to the base of the plant. At a minimum, a water tap should be available on the roof for manual watering.

A permanent irrigation system using potable water may be used, but an alternative means of irrigation, such as air conditioning condensate or another readily available non-potable source can be considered to maximize efficient use of resources. Any non-potable sources should be analyzed to ensure that they do not contain chemicals that might harm or kill the vegetation.

It is recommended that sufficient irrigation be provided to achieve and maintain 90 percent plant coverage after 2 years following installation.

Drain System

Vegetated roof drainage facilities should be capable of collecting subsurface and surface drainage and conveying it safely to an appropriate discharge point. To facilitate

subsurface drainage, interceptor drains should be installed at an appropriate spacing to prevent excessive moisture build up in the media and convey water to the roof drain.

The roof outlets at vegetated roof sites should be protected from the invasion of plant growth and the entry of loose gravel. Accessibility for maintenance to the drains should also be considered in the design. Overflow grates tied into the roof downspouts are also recommended to be provided set at the height of the soil.

3.18.3 MAINTENANCE RECOMMENDATIONS

Vegetated roofs should be designed to need very little maintenance and if designed correctly should have a longer lifespan than traditional roofs because of the protective nature of the soil structure. Inspections still should be performed regularly to identify any leakage of the membrane system or blockages of the overflow system.

CHAPTER 4 - SUPPLEMENTAL INFORMATION

4.1 HYDROLOGIC ANALYSIS

Hydrologic modeling for LID site designs should conform to all applicable minimum requirements outlined in the DOE Manual Volume I. In particular the following minimum requirements:

- Minimum Requirement #4: Preservation of Natural Drainage System and Outfalls
- Minimum Requirement #5: Onsite Stormwater Management
- and Minimum Requirement #7: Flow Control (including the applicable predeveloped land-cover assumptions used in hydrologic modeling).

The field of low impact development is rapidly evolving, and the City of Black Diamond may choose to accept or adopt revised LID modeling and hydrologic analysis methods as they are refined and as approved by Ecology, after the publication date of these guidelines.

4.2 MANAGEMENT, MAINTENANCE, EDUCATION, AND ENFORCEMENT

In order to assure that the LID techniques that have been employed in the project continue to function over time, long-term management and maintenance strategies need to be addressed. The goal is to ensure successful management and maintenance of the vegetation retention areas, open space tracts, and BMPs through proper transition to subsequent owners and/or organizations that have long-term responsibility and vested interest. In addition to the O&M requirements for individual BMPs required under Volume I, Minimum Requirement #10 of the DOE Manual; the following is recommended specifically for LID site developments.

4.2.1 DEDICATED TRACTS AND CONSERVATION EASEMENTS

- Any vegetation retention, open space areas, bioretention areas, bio-swales, or any other feature utilized for stormwater purposes should be adequately protected through the application of dedicated tracts and, where applicable, conservation easements, so that these elements will remain in such capacity in perpetuity.
- Large open space areas adjacent to riparian areas, wetlands, or critical fish and wildlife habitat areas may be transferred to local land trusts for long-term management and stewardship or managed by homeowners/building associations with specific maintenance covenants.
- Onsite stormwater controls such as bioretention areas or bio-swales should be managed by the homeowners/building association with specific maintenance covenants

- Stewardship and management plans that address long-term protection and maintenance should be developed for these sites by the applicant.

4.2.2 HOMEOWNERS/BUILDING COVENANTS

Homeowners/building agreements/covenants should be considered for projects utilizing LID design approaches to ensure that the stormwater management applications continue to function as designed. These instruments will vary based on the project. The covenants, as needed, should specifically address and/or append the requirements and responsibilities for long-term management and maintenance of any bioretention areas, natural resource protection areas, open space tracts, tree and other vegetation retention areas, or other BMPs.

4.2.3 MANAGEMENT PLANS AND MAINTENANCE AGREEMENTS

Management plans and maintenance agreements for vegetation retention areas, open space tracts, and BMPs should address the recommendations in Section 2 of these guidelines and adhere to any applicable City codes.

It is recommended that management plans and maintenance agreements address the following as applicable:

- Identification of all stormwater management facilities such as but not limited to bioretention areas, bioswales, open space areas, detention or retention ponds, rain gardens, water reuse systems, etc.

- Soil and erosion control management practices.

- Pest and disease management practices.

- Pruning requirements.

- Irrigation requirements.

- Fertilization requirements.

- Fire fuel management practices.

- BMP inspection (monitoring) and maintenance needed to assure continued performance of the intended function.

- Water quality sampling criteria, if required.

- Fencing and signage around natural resource protection areas.

- Other aspects of the project may need to be included on a project by project basis.

4.2.4 EDUCATION

Homeowner education measures describing the functions of conservation areas and LID BMPs should be implemented during sale of the home sites or buildings/land, and periodically during ownership. Some recommendations for inclusion in brochures or homeowner guides are as follows:

- An overview describing the function and need for natural resource protection, vegetation retention areas, and LID BMPs
- A description of the tree/plant species located within the vegetation retention areas and guidelines for protection of the vegetation
- Operation and maintenance requirements
- Contacts for questions on maintenance needs and enforcement.

4.2.5 ENFORCEMENT

At this time this document is considered only guidelines for Low Impact Development in the City of Black Diamond. Enforcement of these standards would need to conform to provisions established by the City of Black Diamond Municipal Code.