1994 Edition

Drainage Design and Erosion Control MANUAL for Thurston County

FOREWORD

This MANUAL is implemented by Thurston County Roads and Transportation Services Department which provides development-specific stormwater information to applicants and reviews Drainage and Erosion Control Plans for minimum requirements. The Director of the Department of Water and Waste Management or designee is ADMINISTRATOR of this MANUAL.

THURSTON COUNTY
WASHINGTON
SINCE 1852

COUNTY COMMISSIONERS
Judy Wilson
District One
Diane Oberquell
District Two
Dick Nichols
District Three

DEPARTMENT OF WATER
AND WASTE MANAGEMENT

Daniel F. Durig, Director

May 1, 1994

Dear Drainage Design and Erosion Control Manual Owner:

The Thurston County Board of Commissioners on April 11, 1994 has adopted revisions to the drainage ordinance. There are approximately 200 proposed changes to the Drainage Design and Erosion Control Manual many of them made in response to your comments on the 1991 ordinance. Seventy-five percent of the changes are clarifications and/or corrections of typographical errors. Another twenty-five percent of the changes are design detail changes or modifications in procedures.

Five major changes are:

1. Doubling the minimum required storage volumes and halving the maximum allowed release rates (Chapter 4, soil dependent);

2. Adjustments to what new development activities trigger an upgrade of stormwater facilities on a developed site (Chapter 2, Table 2.1);

3. Revisions to technical designs to reflect recent research (Chapter 8, mostly wet ponds and constructed wetlands);

4. Revisions to soil reporting requirements (Chapter 3 and 4); and

5. Addition of new requirements for single-family residences, including a section on managing single-family roof runoff and runoff from other clean impervious surfaces, and a standard erosion control plan to be required for single-family sites (Section 8.5.13).

For the most part the County's manual is identical to Olympia and Lacey's version. However there are a few differences as follows:

1. Olympia only sections (Section 1.3.1.1, Appendix O) deleted.

Lakes Management, Solid Waste Management, Storm & Surface Water Management
Utilities (Water & Sewer) Operations and Develpment
Building #1, 2000 Lakeridge Drive SW, Olympia, Washington 98502-6045 (206) 786-5485

2. Section 2.2, restore exemption for private and public road widening projects exempt from SEPA requirements.

3. Glossary definition for "Clean Impervious Surfaces"; add "where hazardous materials will not be handled".

4. Marine bluff section 2.1.3 under certain circumstances allows an Abbreviated Plan instead of an engineered plan.

5. The threshold for remodel projects to come up to current standards for the entire site has been modified to include projects which are currently causing a water quality or quantity problem.

As with any new ordinance there will be questions, comments, and suggestions for improvement. Please call with your thoughts and they will be considered for future amendments of the ordinance.

Sincerely,

Thomas W. Holz

Thomas W. Holz, PE
Administrator, Thurston County

TH:lp\dm94\manowner.let

ORDINANCE NO. 10610

AN ORDINANCE amending development standards relating to stormwater drainage and management and adding a new section 15.05.070, Thurston County Code; amending sections 15.05.010, 18.24.010, 20.31.030, and 20.44.050, Thurston County Code.

WHEREAS, in 1991 the Board of County Commissioners directed staff to monitor the administration of the Drainage Design and Erosion Control Manual adopted by Ordinance 9589, and to bring to them suggested amendments after a sufficient trial period; and

WHEREAS, several basin plans have been adopted since 1991 which have recommended revisions to the Manual; and

WHEREAS, the development standards and procedures amended by this Ordinance are a major and necessary part of the reduction and ultimate solution of erosion and runoff problems and are necessary to serve the public health, safety and welfare;

NOW, THEREFORE, BE IT ORDAINED BY THE BOARD OF COUNTY COMMISSIONERS OF THURSTON COUNTY as follows:

Section 1. Section 15.05.010 of the Thurston County Code entitled "Drainage and Erosion Control Manual for Thurston County and the Cities of Lacey, Olympia, and Tunwater, Washington" is amended as shown in Exhibits 1 and 2, attached to this Ordinance, and as follows:

> Section 15.05.010. Drainage Design and Erosion Control Manual for Thurston County and the Cities of Lacey, Olympia, and Tumwater, Washington--Adopted by reference. This section consists of the Drainage Design and Erosion Control Manual on file in the Water and Waste Management Department as amended.

Section 2. A new section 15.05.070 is added to the Thurston County Code to read as follows:

> Section 15.05.070. The Administrator of the Drainage Design and Erosion Control Manual for Thurston County shall be the Director of Water and Waste Management or designee.

Section 3. Section 18.24.010, Thurston County Code, is hereby amended to read as follows:

> Section 18.24.010 Agreement in lieu of completion of improvements--Agreement to assure successful operation of improvements.

(1) Before final approval is given for any division of land pursuant to Title 18, Thurston County Code:

(a) The developer shall install required improvements and replace or repair any such improvements which are damaged in the development of the subdivision; or

(b) In lieu of installation of all required improvements, the developer may execute and file with the county an agreement guaranteeing completion of such improvements together with any needed replacements or repairs within a specified time. Such agreement

1. Shall provide the period of time within which all work required shall be completed which shall not exceed one year from the date of approval. Such agreement may provide for reasonable extensions of time for completion of work. Extensions must be requested, approved by the board of county commissioners and properly secured as provided herein in advance of the required initial completion date;
2. Shall provide that the developer shall notify the County Engineer or designee promptly upon completion of all required improvements and that the County Engineer or designee will give notice of approval or disapproval of installation within a reasonable time after receiving notice of completion;
3. Shall be secured by a bond or such other method of financial security permitted by Section 18.24.020;
4. Shall provide that if the developer fails to complete all required work within the period specified, including any approved extensions of time, the county may take steps to demand performance of the developer's obligations within a reasonable time not to exceed ninety days from the date of demand. If the required improvements are not substantially completed within that time, the county may take action to forfeit the financial security. The county shall be entitled to recover all costs of such action including a reasonable attorney's fee. Following recovery of the proceeds of the financial security, they shall be used to complete the required improvements and pay the costs incurred. Should the proceeds of the financial security be insufficient for completion of the work and payment of the costs, the county shall be entitled to recover the deficiency from the developer;

5. May, with the agreement of the county, provide for construction of improvements in units.

(2) Regardless of whether all required improvements are completed prior to final approval of any division of land pursuant to Title 18, Thurston County Code, as a condition of such approval, the developer shall execute an agreement to assure successful operation of said improvements.

(a) As security for assurance of successful operation, the developer

1. Shall post a bond or such other method of financial security permitted by Section 18.24.020 to secure successful operation of all required improvements and full performance of the developer's maintenance obligation. Such financial security shall be effective for a two-year period following approval of installation of all required improvements.

(b) Such agreement and security shall not relieve the developer of liability for the defective condition of any required improvements discovered following the effective term of the security given.

(c) If the county agrees, by action of the board of county commissioners, to accept and perform maintenance of the improvements, then the developer's obligation to perform maintenance functions shall terminate.

Section 4. Section 20.31.030, Thurston County Code, is hereby amended to read as follows:

20.31.030 Mobile home parks--Performance regulations. In granting site plan review permits for mobile home parks, the following regulations shall apply, except as specifically modified by the hearings examiner.

1. Evidence of Water and Sewer Facilities. The developer shall present evidence to indicate the following:

a. That the proposed development will meet the water and sewage disposal requirements of the Thurston County health code;

b. That the proposed mobile home park will be served by a fire protection system meeting the requirements of the Thurston County fire marshal;

Such system may be combined with the domestic water supply system required above;

2. Flood Hazard. Mobile home park sites shall not be approved if the site is located within a designated fifty-year or one hundred-year floodplain.

3. Circulation System.

a. All interior mobile home park roads shall be private roads.

b. Off-street guest parking shall be provided at the ratio of one parking space for each four mobile home pads and shall be provided by separate parking areas. Clubhouse and community building parking facilities may account for up to fifty percent of this requirement.

c. All off-street parking spaces shall have a minimum dimension of ten by twenty feet.

6. Open Space. All mobile home parks shall allocate a minimum of ten percent of the site area for open space when:

   a. The land to be developed equals ten acres or more and is located wholly or in part in the following county zoning classifications: RR 2/1, SR 4/1, RR 1-2/1, MDR 1-6/1, MDR 2-8/1, MDR 4-8/1, HDR 4-16/1; or

   b. The land to be developed will result in a density greater than one unit per acre and is located in the Unmapped Use District.

   Such allocation shall conform to the standards of Chapter 20.32 of this title, except that dedication to a property owners' association or other private entity is not required.

7. Lighting. Adequate lighting shall be provided to illuminate streets, driveways and walkways for the safe movement of pedestrians and vehicles.

8. Utilities. All water, sewer, electrical and communication service lines shall be underground and shall be approved by the agency or jurisdiction providing the service.

9. Storm Drainage. Sites shall be constructed in compliance with the storm drainage provisions of this title, Chapter 15.05 of this code, and other applicable ordinances.

10. Minimum Lot Sizes.

    a. Single wide: 2,400 square feet;
    b. Double wide: 3,600 square feet;
    c. Triple wide: 4,800 square feet.

Section 5. Section 20.44.050, Thurston County Code, is hereby amended to read as follows:

20.44.050 Design Requirements for Off-Street Parking. Whenever off-street parking is required, the parking area and space shall be designed, constructed and maintained in accordance with the following minimum provisions and standards:

1. When more than two spaces are required, the following standards and provisions, in addition to those provided in Sections 20.44.020 and 20.44.030, shall apply:

Angle of Parking Space in Degrees	Aisle Width	Total Width of One Tier of Parking Plus Aisle	Total Width of Two Tiers of Parking Plus Aisle
90°	22 feet	42 feet	62 feet
80--89	21	42	62
75--79	19	41	61
70--74	18	40	62
65--69	17	40	62
60--64	16	37	58
55--59	15	36	56
50--54	14	34	53
45--49	13	32	50
40--44	12	30	47
35--39	11	28	44
30--34	11	27	42
1--29	10	24	38
Parallel		24 one-way	33 one-way
Parallel		29 two-way	38 two-way

2. For hard surface parking areas paint, paving bricks, or similar devices shall be used to delineate parking spaces. Areas paved with lattice block pavement, gravel, or grass parking areas shall use wood or concrete wheel guards or wheel stops at the end of parking spaces or paving bricks, concrete strips or similar devices on the sides of spaces to delineate parking spaces. When parking spaces are arranged so that cars will park bumper to bumper in rows, a minimum of six feet clear space between wheel stops will be lined with vegetation and will provide drainage for the parking spaces substantially in accordance with Figure A2 in the Drainage and Erosion Control Manual, Thurston County Code Section 15.05.010.
3. All parking spaces shall be designed to prevent egress by backing out onto any state highway, collector or arterial street.
4. Bumper stops, curbing or wheel chocks shall be provided to prevent any vehicle from damaging or encroaching upon any sidewalk or upon any building adjacent to the parking area.
5. All parking spaces shall be nine (9) feet in width and twenty (20) feet in length. At the developers option, twenty-five (25%) percent may be marked "compact only" with a dimension of seven and one-half (7½) feet by fifteen (15) feet.
6. Parallel parking spaces shall be twenty (20) feet in length and eight (8) feet in width, with maneuvering space of three (3) feet for every two (2) vehicles. Driveways and other spaces not occupied by parking may be used to obtain the required maneuvering space.
7. Within the long-term urban growth boundary as shown on Map M-15 of the Thurston County Comprehensive Plan, required parking areas shall be surfaced with lattice

b. All interior mobile home park roads shall be constructed within a right-of-way which shall extend at least two feet beyond the paved surface but which shall, in no case, be less than thirty feet in width.

c. Park roads shall have widths and surfacing as follows:

   (1) Park roads shall have a minimum paved width of twenty feet. One-way roads shall have a minimum twelve-foot travel lane and an eight-foot parking lane. Two-way roads shall have a minimum of two ten-foot travel lanes and may have eight-foot parking lane(s).

   (2) Park roads shall have surfacing depths as proposed by a licensed engineer and approved by the County Engineer or designee.

d. Cul-de-sac turnarounds shall have a minimum pavement width of twenty feet and a minimum diameter of seventy feet, exclusive of any parking lanes or areas.

e. Points of ingress and egress with county rights-of-way shall be in accordance with the public works department's standards.

4. Bulk Requirements.

a. Setbacks. All mobile homes, together with their additions and appurtenant structures, accessory structures and other structures on the site (excluding fences), shall observe the following setbacks (excluding any hitch or towing fixture) which supersede the standards of the underlying district:

   (1) Park roads: Fifteen feet from centerline of right-of-way, but in no case less than five feet from the paved surfaced edge;

   (2) Exterior site boundary, not abutting an off-site public right-of-way: ten feet from property line;

   (3) Exterior site boundary, abutting an off-site public or private right-of-way: fifty feet from centerline of right-of-way, sixty feet on arterial;

   (4) Exterior site boundary, abutting an off-site public or private right-of-way sixty feet or more in width: one-half right-of-way plus twenty feet measured from centerline.

b. Structure Separations. A minimum ten-foot separation shall be maintained between all mobile homes, together with their habitable additions and accessory structures, and other mobile homes.

5. Parking Requirements.

a. Two off-street parking spaces, located adjacent to each respective mobile home pad, shall be provided for each unit and shall be surfaced.

block pavement, asphalt concrete or portland cement concrete, except that the County Engineer or designee may require a surface of grass reinforced with geotextiles in parking areas which are used lightly enough to allow the survival of such a surface.

8. Outside such long-term urban growth boundary required parking areas shall be surfaced with lattice block pavement, asphalt concrete, portland cement concrete or compacted gravel, except that the County Engineer or designee may require a surface of grass reinforced with geotextiles in parking areas which are used lightly enough to allow the survival of such a surface.

Section 6. If any provision of this Ordinance or its application to any person or property is held to be invalid, the remainder of the Ordinance and its application to other persons or circumstances is not affected.

Section 7. This Ordinance shall take effect immediately.

ADOPTED: April 11, 1994.

BOARD OF COUNTY COMMISSIONERS
Thurston County, Washington

ATTEST:

LaBonita I. Bowman
Clerk of the Board

Chairman

APPROVED AS TO FORM:

Commissioner

PATRICK D. SUTHERLAND
PROSECUTING ATTORNEY

Commissioner

By: M Dooris
Millie Dooris
Deputy Prosecuting Attorney

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GLOSSARY

ABBREVIATED PLAN - A drainage and erosion control plan, as specified in the MANUAL, having considerably fewer requirements for submittals than that for a Drainage and Erosion Control Plan.

ADMINISTRATOR - That person (or agent) designated by the jurisdiction as having authority for interpreting and administering this MANUAL.

ALLOWABLE DISCHARGE - The rate at which runoff may be released from a project.

AS-BUILT DRAWINGS - Engineering plans that document changes made to a project during construction.

ASSESSED VALUE - The value of the existing improvements excluding land as listed in current records at the Thurston County Assessor's Office. Alternately, the Proponent may provide current appraisal information and request that it be substituted for the Assessor's records.

BASIN - An area from which surface runoff is concentrated usually to a single point such as the mouth of a stream.

BASIN PLAN - A plan adopted by the jurisdiction which specifies capital improvements, regulations, and policies for managing drainage in a basin.

BEST MANAGEMENT PRACTICE - Structures, conservation practices, or regulations that improve quality of runoff or reduce the impact of development on quantity of runoff.

BIOFILTER - A plane, vegetated surface over which runoff traverses at uniform depth and velocity. Biofilters perform best when vegetation has a thick mat of roots, leaves, and stems at the soil interface (such as grass).

BIOFILTRATION - The process through which pollutant concentrations in runoff are reduced by filtering through vegetation.

BMP - Best Management Practice.

BUFFER - The zone which protects aquatic resources by providing:

- o protection of slope stability,
- o attenuation of runoff,
- o reduction of landslide hazards,
- o an integral part of a stream or wetland ecosystem,
- o shading, input of organic debris, and coarse sediments to streams,
- o room for variation in stream or wetland boundaries,
- o habitat for wildlife and protection from harmful intrusion.

CAPITAL IMPROVEMENT PROGRAM - A list of prioritized and scheduled construction projects and their costs.

CHECK STRUCTURE - A dam (e.g., rock, earthen, log) used in channels to reduce water velocities, promote sediment deposition, and/or enhance infiltration.

CLASS OR HYDROLOGIC GROUP A, B, C, D SOILS - Refers to US Soil Conservation Service soil classification by hydrologic characteristics. Class A and B soils have high and moderate infiltration rates when wet, and transmit water well. Class C soils have slow infiltration rates when wet, due mainly to a layer that impedes downward movement of water. Surface intake of water on these soils can be good, but downward movement is slow. Class D soils have very slow infiltration rates when wet. These soils transmit water poorly as they are often clays, have high water tables, or shallow impervious layers.

CLEAN IMPERVIOUS SURFACE - Impervious surface where the frequency or probability of contamination from motor vehicles or from the routine handling of hazardous materials is minimal. Such surfaces may include, but shall not be limited to, roofs, sidewalks, dedicated play areas, and emergency fire lanes.

CLEARING - Removing of all or most trees from an area.

CLOSED BASIN - A basin for which there is no surface water outlet.

CONSTRUCTION COST - As used in Table 2.1, construction cost, including sales tax, shall mean the estimated cost of the redevelopment calculated using current Uniform Building Code methods, bid estimates, or best available information.

CONVEYANCE - A mechanism or device for transporting water including pipes, channels (natural and man-made), culverts, gutters, manholes, etc.

CRITICAL AREA - As defined by ordinance or resolution by the jurisdiction.

CRITICAL HABITAT - Habitat necessary for survival of endangered, threatened, rare, sensitive, or monitor species.

CULVERT - A conveyance device (e.g., concrete box, pipe) which conveys water under (usually across) a roadway or embankment.

DEAD STORAGE - The volume of storage in a facility below an outlet (which does not drain after a storm event).

DESIGN ENGINEER - The Project Engineer.

DESIGN EVENT - A precipitation event (storm) represented by the jurisdiction's designated hyetograph for use in designing a drainage facility.

DETENTION FACILITY - A facility (e.g., pond, vault, pipe) in which surface and storm water is temporarily stored.

DETENTION POND - A detention facility in the form of an open pond.

DEVELOPMENT - For purposes of this manual, any project that requires a Drainage and Erosion Control Plan.

DISTURBED AREA - An area inside project boundaries which is not protected from alteration from its natural state .

DRAINAGE BASIN - See BASIN.

DRAINAGE AND EROSION CONTROL PLAN - A plan which identifies existing drainage conditions and provides plans, specifications, calculations, and text for the construction of drainage facilities for the proposed project as specified in THE MANUAL. Such facilities will include conveyance, detention, infiltration, monitoring, treatment, and erosion control facilities and any other feature, device, or notation that the jurisdiction may require.

DRAINAGE SYSTEM - The combination of Best Management Practices, conveyances, treatment, retention, detention, and outfall features or structures on a project.

DROP STRUCTURE - A structure for dropping water to a lower elevation and/or dissipating energy. A drop may be vertical or inclined.

DRY POND - A detention facility which drains dry after a storm.

EASEMENT - A right afforded a person to make limited use of another's real property. All easements granted pursuant to the MANUAL shall be legally recorded with the County Auditor's office.

ENVIRONMENTALLY SENSITIVE AREA - As defined by ordinance or resolution by the jurisdiction.

EROSION CONTROL PLAN - An element of the Drainage and Erosion Control Plan. A plan for a proposed project for facilities, devices, procedures, etc., to prevent erosion.

FEMA - Federal Emergency Management Agency.

FIELD-SATURATED PERCOLATION RATE - The overall infiltration/permeability rate of the soil column at a site or facility under saturated soil conditions with air trapped in the soil column. This rate is approximated through evaluation of infiltration tests and in situ soils.

FLOOD HAZARD AREA - Flood Plain.

FLOOD PLAIN - The total area subject to inundation by the base flood including the flood fringe and floodway.

FLOODWAY - The zone within a Flood Plain such that if flood waters were contained within it (e.g., with a dike) base flood stage would not rise more than one-foot.

FLOW CONTROL MANHOLE - A manhole with a flow regulating device or system within (e.g., weirs, orifice plates).

FREEBOARD - Is the vertical distance between the design water surface elevation and the elevation of the top of the structure (for example, the top of channel bank).

GEOTECHNICAL ENGINEER - Means a person licensed as a Civil Engineer in the State of Washington who has at least four years of professional experience as an engineer specializing in engineering geology and slope stability evaluation.

HAZARDOUS MATERIALS - Defined in Section 20.23.025 of Thurston County Code.

HYDROGRAPH - A graph of discharge over time at a single point.

HYDROGRAPHIC METHOD - A method of estimating a hydrograph using a mathematical simulation of precipitation, evaporation, infiltration, runoff, and other hydrologic processes.

HYETOGRAPH - A graph of rainfall intensity (often in inches per hour) over time at a single point.

IMPERVIOUS SURFACE - Pavement (compacted gravel and concrete), roofs, revetments, or any other man-made surface which substantially impedes the infiltration of precipitation.

IMPROVED PROPERTY - Land from which runoff has been permanently increased through the actions of man.

INFILTRATION - The flow of water through the soil surface usually under very slight head.

INFILTRATION FACILITY (OR STRUCTURE) - A retention facility.

INTERCEPTION - The trapping and holding of precipitation by foliage.

INTERFLOW - That portion of rainfall that infiltrates into the soil and moves laterally along a restrictive layer through the upper soil horizons to a surface outlet as a spring or seep.

JUNCTION - Point where two or more drainage pipes or channels converge (e.g., a manhole).

JURISDICTION - For purposes of this MANUAL, a governmental body which has adopted this MANUAL.

LANDSCAPE PLAN - A plan showing the form and species of plants and procedures for planting to stabilize and beautify earthwork or to increase the functionality of a drainage structure.

LATTICE BLOCK PAVEMENT - A pavement, either cast in place or interlocking paving bricks, with interstices allowing infiltration and the growing of vegetation.

LINED POND, CONVEYANCE - A lined pond or conveyance system is one in which the bottom and sides of the facility have been made impervious to the transmission of liquids.

LIVE STORAGE - The amount of storage in a detention facility that is intended to completely drain after a storm event.

MANUAL, THE - This drainage and erosion control manual, its adopting ordinance, and all documents included by reference.

NATURAL CHANNEL - Stream, creek, river, lake, wetland, estuary, gully, swale, ravine, or any open conduit where water will concentrate and flow intermittently or continuously.

NEPA - National Environmental Policy Act, a federal law.

NEW IMPERVIOUS SURFACE - Impervious surface created on or added to a site or structural development including construction, installation, or expansion of a building or other structure. New impervious surface may also include existing impervious surface that is removed and replaced. To be considered new, the removal and replacement activity must result in significant changes in impervious surface locations, grades, and/or drainage system features, and/or must involve construction, installation, or expansion of a building or structure after complete or substantial intentional demolition thereof by or for the benefit of the Proponent.

OIL WATER SEPARATOR - A structure or device used to remove oil and greasy solids from water. They operate by using gravity separation of liquids that have different densities.

OUTFALL - The point where water flows from a manmade conduit, channel, or drain into a water body or other natural drainage feature.

PARAMETERS - Constants or variables that are terms of an equation.

PERSON - Any individual, partnership, corporation, association, organization, cooperative, public or municipal corporation, agency of the state, or local government unit, however designated.

POST-DEVELOPMENT CONDITIONS - The condition of site after the project has been constructed.

POTHOLE - A closed basin.

PREDEVELOPMENT CONDITIONS - The state of land before any development; that is, the pristine state.

PROJECT - The proposed action of a permit application which requires a Drainage and Erosion Control Plan. The proposed action may occur on two or more adjacent parcels and still be considered one project.

PROJECT ENGINEER - The engineer who is responsible for the design of drainage facilities and who will affix his/her seal on project Drainage and Erosion Control Plans.

PROPONENT - The person or legal entity who holds title to the property or has a sufficient interest in the property to propose the project. The proponent of the project.

RAVINE - A narrow gorge normally containing steep slopes and deeper than 10 vertical feet as measured from the centerline of the ravine to the top of the slope.

REACH - A length of channel with uniform characteristics.

RETENTION/DETENTION FACILITY - 1) A facility with an outlet to surface water and which is intended to discharge partially to groundwater and partially to surface water, OR 2) either a retention or a detention facility.

RETENTION FACILITY - A facility with no outlet to surface water and which is intended to discharge to groundwater.

RETENTION POND - A retention facility that is an open pond.

RETENTION FACILITY PERMEABILITY - Average field-saturated percolation rate of an infiltration facility after construction as determined by field and/or laboratory work conducted by a Soils Professional.

REVETMENTS - Facing used to sustain an embankment.

RIP RAP - Broken rock, cobbles, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream for protection against the action of water; also applied to brush or pole mattresses, or brush and stone, or other similar materials used for soil erosion control.

RIPARIAN - A term pertaining to the banks of streams, wetlands, lakes or tidewater.

RUNOFF - Stormwater.

SEPA - State Environmental Policy Act, Chapter 43.21C RCW, as amended.

SITE - One or more parcels on which the Project is proposed to be built or on which a project exists which is proposed to be expanded.

SITE PERMEABILITY - Average field-saturated percolation rate of a site in its pre-development condition as determined by field and/or laboratory work conducted by a Soils Professional. If the site being assessed shows signs of disturbance (e.g., fill, compaction), this value shall be adjusted upward to approximate its pre-development value.

SOILS PROFESSIONAL - A person who demonstrates proficiency in the practice of the science of soils, including their origin, character, and utilization for stormwater treatment and disposal. This proficiency shall be demonstrated through the soils professional's ability to complete the Soils Evaluation Report forms (provided in Chapter 3 of this MANUAL) in a precise and accurate manner.

STANDARD PLANS - The most recent edition of *Standard Plans for Road, Bridge, and Municipal Construction* by Washington State Department of Transportation in cooperation with the American Public Works Association.

STANDARD SPECIFICATIONS - The most recent edition of *Standard Specifications for Road and Bridge and Municipal Construction* by Washington State Department of Transportation in cooperation with the American Public Works Association.

STORMWATER - That portion of precipitation that falls on property and that does not naturally percolate into the ground or evaporate, but flows via overland flow, channels or pipes into a defined surface water channel, or a constructed infiltration facility. Stormwater includes washdown water and other waste that enters the drainage system.

SUBBASIN - A drainage area which drains to a point contained within a larger basin.

SWALE - A shallow drainage conveyance with relatively gentle side slopes, generally with flow depths less then one foot.

THURSTON REGION - The area within the boundaries of those jurisdictions which have adopted this MANUAL.

TOP OF SLOPE - Means a distinct topographic break in slope which separates slopes inclined less than the reference percentage (15 percent or 40 percent as applicable) from steeper slopes. Where no distinct break in slope exists this point shall be the uppermost limit of the area where the ground surface increases by ten feet or more vertically within a horizontal distance of sixty-seven or twenty-five feet, as applicable.

TRANSMISSION RATE (Of Soils) - See "Field-saturated percolation."

UNINTERRUPTABLE SERVICES - Those services to the public which the jurisdiction has identified as important enough to merit a higher standard of protection against flooding such as hospitals, police, and fire stations.

UNDISTURBED AREA - Property in the pristine state.

WATER QUALITY INLET - A catch basin or manhole with an oil water separator within.

WATER QUALITY SWALE - A channel designed to convey runoff for a design event while providing for biofiltration by passing water through vegetation at a specified maximum velocity and depth.

WATERSHED - A basin.

WET POND - A stormwater treatment pond designed to maintain a continuous or seasonal static water level below the pond outlet elevation.

WETLAND - Land which is inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

WETLANDS CONSULTANT - A person whose livelihood is obtained primarily from practice in the fields of freshwater or wetland biology, ecology, or equivalent.

CHAPTER 1 - INTRODUCTION

It is the goal of the jurisdiction to improve the quality of life for its citizens. To that end this MANUAL is intended to help in protecting our water resources and in preserving and enhancing surface and groundwater quality. It is the intent of this MANUAL to protect the uses of our water and the pleasure that it provides us and to guard the livelihoods that it supports.

1.1 Intent of this Document

This document defines policies, minimum requirements, minimum standards, and procedures for the design, construction, and maintenance of drainage facilities and for the control of erosion on construction sites. Where structures are necessary to treat runoff and to control flow, it is intended that this MANUAL will promote the construction of multiple use drainage facilities that will provide recreational opportunities and be pleasing to the eye as well as functional.

It also provides standard procedures for estimating flow from and establishes allowable runoff criteria for developed property. In addition, it provides design standards and specifications for construction of stormwater conveyance, detention, retention, and infiltration facilities for jurisdictions in Thurston County. The purposes of these facilities are:

- To treat stormwater
- To mitigate the impacts of increased runoff due to urbanization.
- To maximize infiltration on and minimize runoff from developed property.
- To facilitate groundwater recharge such that stream/wetland baseflows can be adequately maintained year-round.

1.2 Interpretation of Design Guides -- Minimum Requirements

This MANUAL presents minimum standards for achieving the jurisdiction's goals. The Administrator has authority to increase requirements to protect the public interest, on the basis of reports on threatened water quality, erosion problems, habitat destruction, protection of uninterruptable services, endangerment to property, etc. Alternatives to standard plans, specifications, and design details found in the MANUAL will be accepted if they meet or exceed the performance of the standards. Engineers are encouraged to be innovative.

Where requirements in this document are also covered in any other law, ordinance, resolution, rule, or regulation of any kind, the more restrictive shall govern.

1.3 Basin Plan Supersedes MANUAL

If a proposed Project is located in a basin or subbasin for which the jurisdiction has an adopted basin plan, stormwater requirements specifically identified in the basin plan shall take precedence over those provided in this MANUAL. However, all other elements detailed in this MANUAL shall continue to apply to such projects.

1.3.1 Fees-in-Lieu of Onsite Stormwater Management

The Administrator or designee may allow Projects under certain limited circumstances to substitute a cash payment for required onsite stormwater management. Use of this alternate approach shall generally be limited to sites where it would be impossible or extraordinarily difficult to provide onsite controls, or where a regional stormwater management system can provide the Project's required storage, treatment, and conveyance at an offsite location. Specific requirements regarding fees-in-lieu shall be set by the jurisdiction.

1.4 Variances From These Standards

Variances from these standards may be allowed at the discretion of the Administrator or designee provided that the Proponent will substantially meet flow control and water quality goals established by or implicit in these standards. Compliance with Manual requirements shall normally occur within the project area, but may be performed as offsite mitigation in certain situations. Examples of cases when variances may be approved include, but are not limited to, the following:

- That special conditions and circumstances exist which are peculiar to the land, such as size, shape, topography, or location, and that literal interpretation of these standards would deprive the property owner of rights commonly enjoyed by other properties similarly situated; OR

- That the site is being remodeled and certain site investigations would be destructive to existing structures; OR

- That remodels of existing projects which are either so small or so configured that in the Administrator or designee's opinion some requirements of the manual cannot practically be met; OR

- That public works or private sector projects are in an existing road right-of-way which is not of adequate size to install preferred BMPs and for which right-of-way cannot be expanded because of encroaching structures or setbacks for existing structures.

All requests for variances must be submitted in writing to the Administrator or designee, and must clearly state the specific Section(s) of the MANUAL from which a variance is requested and why.

1.5 Interpretations and Appeals

Any person who disagrees with any decision of a jurisdiction regarding application of this Manual may request an interpretation. The request for an interpretation shall be submitted in writing to that jurisdiction's Administrator or designee as defined herein. The Administrator or designee shall respond to that person in a timely manner. If the person is not satisfied with the response, he/she may request, in writing, a joint interpretation from the Administrators or designees of all four jurisdictions. The Administrators or designees, as a group, shall respond to that person in a timely manner. A copy of the response shall also be provided to the affected jurisdiction. The Administrators' or designees' interpretation shall be advisory in nature and shall not bind the affected jurisdiction to modify its interpretation.

Appeals from an Administrative decision may be taken to the Hearings Examiner by any aggrieved person or by an officer, department, board, or commission of the jurisdiction affected by any order, requirement, permit, decision, or determination made by the Administrator or designee in the administration or enforcement of this MANUAL or any amendment made thereto. Appeals procedure shall be identical to that in the jurisdiction's zoning ordinance or in accordance with the jurisdiction's normal appeals procedures.

1.6 Severability

If any provisions of this MANUAL or their application to any person or property are amended or held to be invalid, the remainder of the provisions in this MANUAL in their application to other persons or circumstances shall not be affected.

CHAPTER 2 - GENERAL REQUIREMENTS

2.1 Projects and Activities Requiring Plan Submittal

2.1.1 Drainage and Erosion Control Plans

Proponents of projects which could cause significant excess runoff, erosion, water quality or quantity impacts, and/or sediment transport problems must submit Drainage and Erosion Control Plans as specified in Chapter 3. All such Plans, excepting Abbreviated Plans, shall be developed by a civil engineer licensed to practice in the State of Washington (hereinafter referred to as the "Project Engineer"). Thresholds for projects requiring Drainage and Erosion Control Plans are shown in Table 2.1. (For purposes of estimating impervious surface in plats refer to Section 5.6.) Projects falling below thresholds shown in Table 2.1 will require Abbreviated Plans unless exempted from all submittal requirements per Section 2.2.

2.1.2 Abbreviated Plans

Applicants for projects which fall below the thresholds shown in Table 2.1 shall submit to the Administrator or designee for approval an Abbreviated Plan as specified in Chapter 3, Section 3.4 unless exempted from all submittal requirements in Section 2.2.

Abbreviated Plans need not be stamped with the seal of a licensed Professional Engineer.

The Administrator or designee will attach conditions on the project as necessary to control erosion and runoff which shall include but not be limited to:

- An evaluation of the need for french drains (drywells) or other onsite facilities for disposal of runoff from roofs and other impervious surfaces. Size of facilities shall be determined through application of requirements specified in Section 8.5.13.

- Routing for storm drainage as necessary and appropriate for the size of project.

- Erosion control devices (e.g., construction entrances, filter fabric fences, stockpile protection, buffers for Critical Areas, and other measures as appropriate to meet the intent of this MANUAL).

TABLE 2.1 PROJECTS FOR WHICH DRAINAGE AND EROSION CONTROL PLANS ARE REQUIRED

ACTIVITY or PROJECTS REQUIRING PERMIT	THRESHOLD (See Note)
○ Preliminary Plat	1
○ Short Plat	1
○ Cluster Subdivisions	5
○ Large Lot Subdivisions	5
○ Public Facilities Construction (e.g., roads, parks, structures, utilities)	1, 4, and 5
○ Private Utility Projects	1 and 4
○ Commercial Building Permit	1, 4, and 6
○ Residential Building Permit	6
○ Building Permits - Duplex on a single tax lot	6
○ Building Permits - Multi-family Dwelling Units	1 and 4
○ Projects Subject to Marine Bluff Review	7
○ Planned Residential Development	1
○ Mobile Home Parks	1
○ Shoreline Substantial Development Permit	1
○ Projects in Special Flood Hazard Zone	1
○ Special Use Permit	1
○ Clearing (Vegetation Protection)	2
○ Class 4 General Forest Practices Approval	2
○ Grading	3
○ Projects Subject to Zoning Site Plan Review	1 and 4

NOTES:

1. Drainage and Erosion Control Plans will be required for projects on which 5000 square feet or more will be made impervious. For subdivisions, impervious surface is to be calculated according to Section 5.7.

2. Drainage and Erosion Control Plans will be required for permit for clearing of 20 acres or greater sites where slopes are an average of five percent or greater. All others shall be subject to an Abbreviated Plan.

3. Drainage and Erosion Control Plans will be required for projects where over 5000 cubic yards of material will be moved.

4. For additions to and/or remodels of an existing developed site on a parcel (and on adjacent parcels if they are part of the project), the entire site will require Drainage and Erosion Control Plans and will be brought up to current drainage standards if:

TABLE 2.1 CONTINUED

- ○ the proposed project will result in the addition of new impervious surface amounting to 25 percent or more of existing impervious surface, providing that the area of the new impervious surface is at least 5000 square feet, OR

- ○ the construction cost of the addition and/or remodel is 25 percent or more of the assessed value excluding land value, providing that the construction cost of the addition and/or remodel is at least $300,000.

- ○ The Administrator determines that an existing water quality, flooding, or erosion problem can be attributed to the developed site. The Administrator shall base the determination on:

  - Results of basin planning for the basin in which the project is located.
  - Historic water quality data.
  - Historic flooding, erosion, or habitat degradation in receiving waters.

The cumulative costs and increase in impervious surface of all additions or remodels for which permits were issued by the jurisdiction during the previous five years (but not before September 9, 1991) shall apply toward the thresholds indicated in this subsection.

5. Drainage and Erosion Control Plans shall be required for Large Lot Subdivisions that require engineered design plans and profiles for roads. Drainage and Erosion Control Plans shall not be required for Large Lot Subdivisions or for cluster subdivisions on which building lots will be clustered on a maximum of 40 percent of the site (the rest to be permanently protected open space) providing that there is no substantial discharge to surface water or public drainage systems. Abbreviated Plans shall be submitted as described in Section 2.1.2.

6. Drainage and erosion control plans shall not be required for:

   - ○ single-family residence,
   - ○ duplex on a single-tax lot,
   - ○ commercial building permits for structures in plats (if the jurisdiction has already approved a drainage and erosion control plan for the plat).

   However, Abbreviated Plans shall be required as described in Section 2.1.2.

7. Projects subject to marine bluff review shall be exempt from the requirements of a drainage and erosion control plan but shall be subject to Section 2.1.3.

CONTINUED FROM PAGE 2-1

- Easements and setbacks as required to ensure maintenance access, buffers, proper drainage, or other functions cited in this MANUAL.

In most Abbreviated Plans, the jurisdiction shall require that drainage from impervious surfaces be managed (detained, treated, infiltrated) in a manner similar to that which would be required for a standard Drainage and Erosion Control Plan. Relatively simple practices such as those discussed in Section 8.5.13 shall be utilized. The Administrator or designee may increase plan submission and runoff control requirements for projects expected to have a significant impact on sensitive natural resources or projects that could exacerbate existing flooding or water quality problems.

The plot plan and the Administrator's or designee's conditions will comprise the Abbreviated Plan. The plan shall be kept on the project site during construction and made available to the jurisdiction's inspectors on demand.

2.1.3 Drainage Plans for Projects on Marine Bluffs

A plan must be prepared to convey runoff from the property away from the bluff, if possible, or safely conveyed over the bluff in a pipe.

The plan may be prepared as an Abbreviated Plan as described in Section 2.1.2 unless the Administrator determines that the plan shall be prepared by a licensed Civil Engineer. Preparation of an Engineered Plan is preferred but not required unless:

- The proposed project is within the 2:1 area of the bluff, or the applicant proposes stormwater infiltration as described in the Critical Areas Ordinance, Section 17.15.620

- Offsite drainage may cross the property to the bluff which would require engineering calculations of run-off for the build-out condition.

- The Abbreviated Plan prepared by the applicant does not meet the minimum requirements

If an engineered plan is required, the plan will be called an Engineered Plan described as:

Engineered Plan. The plan must take into consideration, for the 100 year, 15 minute design storm:

- Provision of adequate slope of surfaces toward drains,

- Sizing of catch basins, drains and ditches,
- Bedding or anchoring of conveyances,
- Safe routing of runoff away from or over the bluff,
- Other factors pertinent to safely convey runoff.

The plan shall include drawings of facilities and specifications sufficient for construction. In addition, the plan shall include submittals of Abbreviated Plan as described in Section 2.1.2.

The Administrator may waive any or all plan requirements if the proposal meets the criteria described in the Critical Areas Ordinance, Section 17.15.630.

2.1.4 Department of Ecology Permit Requirements

The U.S. Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) permit regulations for stormwater became effective on November 16, 1990. The Washington Department of Ecology (DOE) implements these regulations on EPA's behalf. Two areas of activity that are affected by this MANUAL or other jurisdictional programs are also regulated by DOE's NPDES program. These are:

- Most industries that discharge stormwater associated with industrial activities or storage of raw materials, and
- Construction sites that will disturb five acres or more.

DOE will regulate construction sites with a General Permit. Developers must file a Notice of Intent and an erosion control plan with DOE <u>prior</u> to beginning construction. It is the responsibility of the Proponent to contact DOE to determine if these, or other, requirements apply to their project.

2.2 <u>Exemptions From Submittal Requirements</u>

The Administrator or designee shall exempt from submittal requirements for a Drainage and Erosion Control Plan or an Abbreviated Plan the following types of projects:

- Emergency projects which if not performed immediately would substantially endanger life or property.
- Public works and private sector road projects completely within the right-of-way which do not add impervious surface.

- Public works and private sector road widening projects which are categorically exempted from filing requirements of SEPA and for which no change in the type of conveyance system (ie, from open channel to piped system) is proposed.

- Providing that no runoff or sediment discharge to adjoining property or to waters of the United States is probable, projects for which impervious area to be added or modified results in total impervious surface of less than five percent of the parcel (such as outbuildings on a farm).

- Routine agricultural practices such as discing, harrowing, plowing, etc.

- Grading of land for agricultural purposes, provided that environmentally sensitive areas are not significantly affected.

- Grading projects for which no grading permit is required per current Uniform Building Code requirements.

2.3 All Governmental Entities Must Comply

All utilities, port, irrigation, drainage and flood control districts, cities, towns, counties, and other local, state, and federal government entities shall file Drainage and Erosion Control Plans according to requirements stated herein and in every way comply with the MANUAL. The requirements of this MANUAL apply to all unincorporated areas of the County. The MANUAL is valid in incorporated areas only upon adoption through ordinance.

2.4 Project Completion Criteria

2.4.1 Preliminary Approval

Until the Administrator or designee approves a Drainage and Erosion Control Plan or an Abbreviated Plan per Section 2.1 and erosion control devices are in place as per the plan, the jurisdiction will not:

- Grant any development, building, or other related permit except as needed to install erosion and sediment control facilities.

- Allow project clearing, earthwork, demolition, site work, or construction to begin.

A pre-construction meeting with jurisdiction staff is required to discuss sequencing of construction of erosion control and infiltration facilities, inspection, and other matters.

2.4.2 Approval to Place Concrete

No approval to construct footings for structures will be granted unless erosion control devices are in place and functional.

2.4.3 Final Project Approval

The jurisdiction will not approve plats, grant certificates of occupancy, release financial securities related to drainage and erosion control, or accept final construction until the following have been completed:

For those filing Drainage and Erosion Control Plans:

- Completed Drainage and Erosion Control Plan (Chapter 3).
- Construction Inspection Report and As-built Drawings (Sections 2.6 and 2.7 below).
- Special requirements on the cover sheet of a plat, such as drywell or surface retention pond sizes (for each lot where required), and a general easement for protection and maintenance.
- Filing of covenants on lots, property owners association articles, maintenance easements, agreements with adjacent property owners, conservation easements, and similar documents as required in the Drainage and Erosion Control Plan.
- Conditions of approval fulfilled.
- Site permanently stabilized and restored, and temporary erosion control measures are removed.

For those filing Abbreviated Plans projects:

- Conditions of the Abbreviated Plan must be met except that replanting may be delayed as provided for in Chapter 9, Section 9.12.

2.5 Other Submittals Must be Concurrent With Drainage and Erosion Control Plan Submittal

Drainage and Erosion Control Plans must be submitted to the Administrator or designee concurrently with other plans for the Project such as vegetation removal/clearing, final grading, landscaping, water and sewer, community onsite sanitary waste disposal system, roads, utilities plans, and other relevant site work. Incomplete Drainage and Erosion Control Plans will be returned to Proponent without being reviewed. The jurisdiction shall specify the number of copies of the plan to be submitted.

Abbreviated Plans must be submitted concurrently with the application for permit or preliminary project approval.

2.6 Inspection Report - Drainage and Erosion Control Plans

For Drainage and Erosion Control Plans, in addition to inspection performed by the jurisdiction, the Proponent must retain a licensed Civil Engineer to inspect or oversee inspection of the project as directed by the Drainage and Erosion Control Plan and/or the Administrator or designee. (See inspection reporting requirements, Chapter 3, Section 3.1.2.) The Engineer must file with the jurisdiction a construction inspection report as shown in Appendix F before the project is made final. The report will consist of a completed form and sufficient additional text to describe all factors relating to the construction and operation of the system to meet treatment, erosion control, detention/retention, flow control, and conveyance requirements.

The Engineer or his/her designee shall keep records of inspections of drainage and erosion control facilities. Records of inspection shall be submitted to the jurisdiction upon request at any time during the course of the project.

2.7 As-Built Submittal - Drainage and Erosion Control Plans

For Drainage and Erosion Control Plans, the Project Engineer shall submit as-built drawings bearing the Project Engineer's seal showing all final locations and elevations, materials, and changes substantially different from the design. Note that changes from the approved plan will be reviewed by the jurisdiction and may be subject to action by the Administrator or designee.

2.8 Phased Projects Submittals - Drainage and Erosion Control Plans

A plan showing the overall project, clearly delineating phase boundaries, and estimating dates of construction, shall be part of any initial submittal. Phased projects shall be completed in accordance with approved plans and in accordance with standard phased development requirements for the jurisdiction.

2.9 Qualifications of Project Engineers

The Project Engineer responsible for completion of Drainage and Erosion Control Plans as described herein shall be a Civil Engineer with a current state of Washington Professional Engineer's license. All plans and specifications, calculations, construction inspection reports, and all other submittals which will become part of the permanent record of the Project must bear the Project Engineer's official seal.

2.10 Review and Acceptance Does Not Confer Responsibility

The jurisdiction will review all drainage related submittals for general compliance with these specific criteria. An acceptance by the jurisdiction does not relieve the Proponent or Project Engineer from responsibility for ensuring that all facilities are safe and that calculations, plans, specifications, construction, and as-built drawings comply with normal engineering standards, this MANUAL, and applicable federal, state, and local laws and codes.

2.11 Time Limitations of Approval for Plans

Drainage and Erosion Control Plans and Abbreviated Plans shall expire with the expiration of approval for the permitted activity (e.g., preliminary plat, clearing, grading, building permit). After expiration, a new Drainage and Erosion Control Plan must be performed subject to conditions and requirements then currently applicable.

2.12 Drainage Plans Must Include Aesthetics Consideration and Informational Signs

Drainage facilities shall be made attractive features of the urban environment. To this end, engineers are encouraged to be creative in shaping and landscaping facilities and to consider aesthetics when choosing alternatives for parking lot paving, conveyance systems, detention facilities, weirs, check structures, etc. Contact the jurisdiction for open space and landscaping criteria.

The Proponent shall provide an informational sign for all above-ground or tract-located stormwater facilities. The sign shall be constructed and worded as specified in Appendix Q.

2.13 Drainage Plans For Environmentally Sensitive Areas

2.13.1 Development in an Environmentally Sensitive Area

Where buffer zones have been established by the jurisdiction to restrict development near an environmentally sensitive area, obtain the jurisdiction's regulations regarding buffer zones.

2.13.2 Acceptance of Dedication of Buffers

Buffers for natural drainage features can provide water quality benefits. Consult the jurisdiction regarding policy on acceptance of buffers.

2.14 Easements, Setbacks, and Access

2.14.1 Easements for Natural Channels and Stormwater Facilities

All man-made drainage facilities and conveyances and all natural channels (including swales, stream channels, lake shores, wetlands, potholes, estuaries, gullies, ravines, etc.) shall be located within easements. Easements shall contain the natural features and facilities and shall allow jurisdiction access to them for purposes of inspection, maintenance, flood control, water quality monitoring, and other activities permitted by law.

2.14.1.1 Easements for Access

A minimum 15-foot wide access easement shall be provided to drainage facilities from a public street or right-of-way. Access easements shall be surfaced with a minimum 12-foot width of lattice block pavement, crushed rock, or other approved surface to allow year-round equipment access to the facility.

2.14.1.2 Easements for Conveyance Systems

Easements as shown in Table 2.2 are minimums for drainage facilities.

TABLE 2.2 MINIMUM EASEMENT WIDTHS FOR CONVEYANCE SYSTEMS FOR ACCESS, INSPECTION, AND MAINTENANCE

CONVEYANCE WIDTH	EASEMENT WIDTH
Channels < 30' wide	Channel + 15' from top, one side
Channels > 30' wide	Channel + 15' from top, both sides
Pipes/Outfalls < or = 60"	20' centered on pipe
Pipes/Outfalls > 60"	30' + pipe width, centered on pipe

2.14.2 Setbacks from Infiltration Facilities and Other Site Features

Setbacks from various site features shall be required. Contact the jurisdiction regarding applicable standards in zoning, development, health, critical areas, or environmentally sensitive areas ordinances. In the absence of other applicable standards, the values listed in Table 2.3 shall apply.

If any other law, regulation, or ordinance also provides for setbacks, the more restrictive shall apply. Contact the jurisdiction.

2.15 <u>Responsibility for Maintenance of Drainage Facilities</u>

If the project is a subdivision, the Proponent shall form a property owners' association. The document creating the Property Owners' Association shall at a minimum make provision for the following:

- Members of the Property Owners' Association shall be responsible for maintenance of storm drainage facilities as described in Maintenance Plan (See Section 3.3).

- Inclusion by reference of the maintenance manual prepared by the Project Engineer in accordance with Section 3.3.

- Power to assess fees to maintain storm drainage facilities.

- Sanctions in the event that jurisdiction takes action to maintain facilities. Refer to Appendix E, Section E.2 for sample language.

A maintenance covenant will be filed on the plat and recorded against each lot within the subdivision. (A model covenant may be found in Appendix E, Section E.1.)

If the Project is other than a plat, the Proponent will describe the organization or persons that will maintain the facility and show how maintenance will be financed.

If the jurisdiction elects to maintain the facility, then covenants requiring maintenance by property owners association shall be excluded.

TABLE 2.3 MINIMUM SETBACKS FROM INFILTRATION FACILITIES[1]

SITE FEATURE	ENGINEERED INFILTRATION FACILITY	DRYWELLS FOR SINGLE-FAMILY RESIDENCES
ONSITE/SEPTIC SYSTEM	30 TO 100 FEET[2]	30 FEET/10 FEET
WATER SUPPLY WELL[3]	100 FEET	30 FEET/10 FEET
BUILDING FOUNDATION OR BASEMENT[4]	100 FEET/20 FEET	50 FEET/10 FEET
SLOPES OVER 15 PERCENT[5]	50 FEET	25 FEET

[1]Where two setback distances are specified, the higher value is for infiltration facilities located upgradient from the site feature of concern, and the lower value is for facilities located downgradient. If no discernible gradient exists, use lower setback value.

[2]Setback varies depending on Hydrologic Group of soil present onsite. The following setbacks should provide good protection: Group A--30 feet, Group B--75 feet, Groups C and D--100 feet.

[3]In wellhead areas, for the siting of "high risk" activities as defined through implementation of the *Northern Thurston County Ground Water Management Plan*, recommendation HM-14, pp. 5-88, 5-97, and 5-98, the Administrator may require the proponent to supply geohydrologic analysis and to calculate acceptable separation distances between the activity and the well.

[4]The Project Engineer shall perform calculations to ensure that the line of saturation, measured from the design storm elevation in the facility, at a gradient acceptable to the Administrator or designee, falls a minimum of one foot below the lowest floor elevation. Setbacks shall be increased as necessary to allow for saturation effects.

[5]The Administrator or designee may require a geotechnical report to evaluate whether a slope exceeding 15 percent is a landslide hazard area. Increased setbacks or prohibition of infiltration facilities may result from this report.

CHAPTER 3 - DRAINAGE AND EROSION CONTROL PLAN COMPONENTS

Drainage and Erosion Control Plans shall have the following components:

- Report (3.1 below)
- Drawings and Specifications (3.2 below)
- Maintenance Plan (3.3 below)

For projects which the Administrator or designee has exempted from the requirement to submit a Drainage and Erosion Control Plan, the Proponent shall submit an Abbreviated Plan as described in Section 3.4 unless otherwise exempted in Section 2.2.

The Administrator or designee may require the Proponent to participate in a meeting early in the project to outline the conceptual approach for stormwater management on the development site. To the extent possible, the contents and level-of-detail of the Drainage and Erosion Control Plan shall be outlined and agreed upon at this meeting.

3.1 Drainage and Erosion Control Plan Report

The report shall be bound and on 8½ x 11-inch size unless the jurisdiction approves another submittal format.

All reports shall contain the following elements:

- Cover Sheet. A Drainage and Erosion Control Plan will have a cover sheet with the Project name, Proponent's name, address, and telephone number, Project Engineer, date of submittal, contact's name, address, and telephone number.

- Project Engineer's Certification. A page with the Project Engineer's seal with the following words:

  > "I hereby certify that this Drainage and Erosion Control Plan for ________________________(name of project) has been prepared by me or under my supervision and meets minimum standards of ____________________ (jurisdiction) and normal standards of engineering practice. I understand that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me."

- Table of Contents. Show the number of pages in each section of the report for which the Project Engineer is responsible. Show page numbers for appendices.

- Facility Summary Form (see example in Appendix G).

- Bond Quantities Worksheet (use jurisdiction's format).

3.1.1 Drainage Plan Contents

All drainage plans shall have each of the following section titles (if sections do not apply, mark NA):

- **Drainage Report Section 1 - Proposed Project Description**

  Describe type of permit for which the Proponent is applying, address and legal description of property, parcel number, property zoning, etc. Describe other permits required (e.g., hydraulic permits, 404 permit, marine bluff, etc.).

  Provide a brief description of the development project (type, size, location, and for additions/remodels only, current assessed value and cost of improvements excluding land value) and the stormwater features to be installed for storage, treatment, conveyance, and disposal/discharge (types, sizes, and locations). Summarize calculations for all facilities. Include a tabulation of the current and proposed impervious, disturbed pervious, and undisturbed areas. In this table, indicate any additions of impervious surface, and the value of any additions or remodels completed, during the last five years. **Complete calculations, including hydrologic modeling analyses where required, must be included with the report. It is recommended that these be placed in appendices and be referenced where appropriate.**

  Use the same nomenclature for facilities in the report as in the Facility Summary form (Appendix G).

  Describe "best management practices" (BMPs) used including innovative paving materials such as grass/paver systems, square feet of vegetated (biofiltration) swales incorporated into the design, other conveyance systems. Describe detention system, outlet works, spillways. Discuss vegetation establishment and management plan for conveyance and detention systems.

- **Drainage Report Section 2 - Existing Conditions**

  Describe existing conditions including relevant hydrological conditions including but not limited to the following:

  - Offsite drainage to the property.

  - Creeks, lakes, ponds, wetlands, ravines, gullies, steep slopes, springs, and other environmentally sensitive areas on or down gradient of the property.

- Is the project located in an aquifer sensitive area or wellhead protection area as defined by the *Northern Thurston County Ground Water Management Plan* or by the jurisdiction? Cite reports.

- Drains, channels, and swales, within the project site and immediately adjacent.

- Points of exit for existing drainage from the property.

Include references to relevant reports such as basin plans, flood studies, groundwater studies, wetland designation, sensitive area designation, environmental impact statements, lake restoration plans, water quality reports, etc. Where such reports impose additional conditions on the Proponent, state these conditions.

- **Drainage Report Section 3 - Infiltration Rates/Soils Report**

A soils report by a Soils Professional (see Section 4.4.1 for qualifications and Appendix R for report forms) will be required to establish soils types on the proposed project site and to establish field-saturated percolation rates for the stormwater facility and the overall site. Refer to procedure described in Chapter 4, Section 4.4.3.

The soils report shall include evaluation of one or more soil test locations (yielding an overall site assessment) and, if an infiltration facility will be part of the drainage system for the project, infiltration tests at the facility site as described in Chapter 4, Section 4.4.2.

The Soils Professional shall provide to the Project Engineer, soil log sheets that include all required information as shown in Appendix R.

- **Drainage Report Section 4 - Wells and Septic Systems**

The Project Engineer shall make a diligent search to identify wells and septic systems both "of record" and others on the site and on adjacent property within the setback distance for stormwater retention/detention facilities identified in Section 2.14.2. The Project Engineer shall inquire with Thurston County Health Department and neighboring property owners as necessary to obtain location of wells and septic systems that are not "of record." Wells and septic systems thus found, both active and abandoned, shall also be called out on the plans or as-builts (if found during construction).

The proper abandonment of wells is a matter regulated by state law (WAC 173-160). If a well on the site has not been properly sealed, the Proponent shall be responsible for contacting the jurisdiction and State Department of Ecology. DOE's procedure shall be followed for sealing the well. Proof of proper abandonment (e.g., copies of the well log and invoice from a firm qualified to perform such work) shall be supplied to the jurisdiction at or prior to the time of final project approval. If no wells or septic systems were found, indicate so.

- **Drainage Report Section 5 - Fuel Tanks**

  The Project Engineer shall report after making a diligent search of records and project site the existence of fuel tanks, in-use or abandoned. Fuel tanks shall be shown on the plans or as-builts (if found during construction). If fuel tanks will be abandoned, contact the jurisdiction for specific instructions. If no fuel tanks were found, indicate so.

- **Drainage Report Section 6 - Sub-Basin Description**

  Describe offsite drainage tributary to the Project.

  Describe the drainage system between the site and the receiving surface waters (or pothole, regional detention facility, etc). Describe emergency services located along the flow path (e.g., fire/police stations, hospitals). Describe environmentally sensitive areas, etc.

  If it can be determined that hazardous materials are or will be handled or transported in the area (on or off-site) tributary to detention/retention facilities proposed for this project, describe the materials and the frequency that such materials may be found in the tributary area.

- **Drainage Report Section 7 - Analysis of the 100-Year Flood**

  If the project contains or abuts a stream, show the 100-year flood hazard zone on the plans. If the zone has not been established (or the Administrator or designee determines that it is in error), the jurisdiction may require the Proponent to establish the 100-year flood plain for the proposed Project to be submitted with the Drainage and Erosion Control Plan. Analysis will be for the 100-year flood for build out at maximum density allowed by zoning (making reasonable assumptions regarding future stormwater management). The Project Engineer shall use HEC 2 program for backwater analysis or another on approval of the Administrator or designee.

- **Drainage Report Section 8 - Aesthetic Considerations for Facilities**

  Describe the effort made to make the facilities aesthetically pleasing, how facilities will provide usable open space, and how the facilities will fit into the landscaping plan for the property. See policy for aesthetically acceptable drainage facilities in Chapter 2, Section 2.12.

- **Drainage Report Section 9 - Facility Sizing and Downstream Analysis**

  The Project Engineer shall provide calculations for the project's stormwater storage, treatment, and conveyance system components. Regardless whether the calculations are made using computer software or by hand, all relevant work shall be submitted for jurisdictional review. All calculations shall be keyed to features shown on the work map as described in Section 3.2.1.

  A downstream analysis of the project is required. If hydrologic modeling is required (see Section 4.12), the Project Engineer shall state methods, assumptions, model parameters, data sources, and all other relevant information to the analysis. If model parameters are used that are outside the recommended ranges discussed in Chapter 5 or if parameters are different than those discussed in Chapter 5, justify parameters. At the jurisdiction's request, include a copy of the computer model data file in ASCII format on floppy disk.

  Include copies of all calculations for capacity of channels, culverts, drains, gutters, etc. If used, include nomographs and tables indicating how they were used. Show headwater and tailwater analysis for culverts when necessary. Provide details on references and sources of information used.

  Describe capacities, design flows, and velocities in each link. Describe required materials or specifications for the design (e.g., rock lining for channels when velocity is exceeded; high density polyethylene pipe needed for steep slope).

- **Drainage Report Section 10 - Covenants, Dedications, Easements**

  Describe instruments needed to guarantee preservation of drainage system and access for maintenance purposes. (Attach copies.) Describe the organization which will be responsible for operation and maintenance of storm drainage facilities.

- **Drainage Report Section 11 - Property Owners Association Articles of Incorporation**

  Attach a copy of the Articles of Incorporation, if applicable.

3.1.2 Erosion Control Plan Format and Contents

The erosion control plan shall consist of the report described below and the drawings described in Section 3.2.1.

The report shall address methods to contain silt and soil within Project boundaries during construction and permanent erosion control afterwards, including the following:

- **Erosion Control Report Section 1 - Construction Sequence and Procedure**

  State which construction elements are contingent upon completion of erosion control facilities. Sequence must be in specifications or on plans. See especially Chapter 8, Section 8.5.5.

- **Erosion Control Report Section 2 - Trapping Sediment**

  Describe methods and procedures for trapping sediment before it reaches the storm drainage detention system, adjoining property, or natural channels.

  Describe how loss of soil due to vehicles tracking it away from the site will be prevented. Describe clean-up methods both on and off site.

  Describe procedures for stabilizing exposed soil in or near environmentally sensitive areas.

- **Erosion Control Report Section 3 - Permanent Erosion Control and Site Restoration**

  Describe retaining walls, revetments, training walls, energy dissipaters, geotextiles, paving or bank reinforcement, landscaping, and other permanent site features.

- **Erosion Control Report Section 4 - Geotechnical Analysis and Report**

  If a retention/detention facility is near the top of a slope that is regulated through local ordinance (see also Setbacks, Table 2.3), then a geotechnical report addressing effects of seepage and the potential for slope failure during any precipitation event through the 100-year 24-hour event may be required as part of the Drainage and Erosion Control Plan.

- **Erosion Control Report Section 5 - Inspection Sequence**

  Refer to Section 2.6. The Project Engineer shall state which facilities will be inspected and at what point in construction they will be inspected to ensure that facilities will operate as designed. At a minimum, specify inspection of construction entrances, sediment traps, and silt fences before construction. See also Chapter 9, Section 9.8.

If an infiltration facility will be constructed as part of the project, minimum inspection shall include steps as described in Chapter 8, Section 8.5.6.

At minimum, a final inspection will be performed to determine final grades, settings of control structures, and all necessary findings to complete as-built drawings and to fulfill requirements of certification (Appendix F).

- **Erosion Control Report Section 6 - Control of Pollutants Other Than Sediments**

  Describe how pollutants other than sediments are to be controlled on the work site. Develop a plan of action that includes elements such as centralized areas for equipment and concrete truck washing, and for temporary storage of debris and other stockpiled materials. Detailed guidance on control of non-sediment pollutants is available in the *Stormwater Management Manual for the Puget Sound Basin*, Department of Ecology, February 1992, Section II-3.

3.2 Drawings and Specifications

It is the responsibility of the Project Engineer to ensure that engineering plans supporting the drainage and erosion control report shall be sufficiently clear to construct the Project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill intent of drainage laws and ordinances and these design guidelines.

3.2.1 Number of Sheets - Content

Plans will include sheets adequate to clearly display the following:

- **Vicinity Map**. Show Project boundaries, sub-basin boundaries, and off-site area tributary to the project. Show contours, major drainage features (such as channels and detention facilities and floodways), and flow path to receiving waters.

- **Site Map**. On a topographic map, show existing conditions and the proposed Project including (as applicable) but not limited to:

  - Existing topography for the site and at least 50 feet beyond site boundaries.
  - Finished grades.
  - Existing structures within 100 feet of project boundaries.
  - Utilities.

- Easements both existing and proposed.
- Environmentally sensitive areas (e.g., gullies, ravines, swales, wetlands, steep slopes, estuaries, springs, wetlands, creeks, lakes, etc). For natural drainage features show direction of flow.
- 100-year flood plain boundary (if applicable).
- Existing and proposed wells onsite and on adjacent properties (both "of record" and not "of record") within setbacks as specified in Table 2.3.
- Existing and proposed fuel tanks.
- Existing and proposed onsite sanitary systems within setbacks as specified in Table 2.3.
- Proposed structures including roads, parking surfaces.
- Lot dimensions and areas.
- Proposed drainage facilities and sufficient cross sections and details to build.
- Standard stormwater plan notes. Example notes are found in Appendix S. Provide only those notes that apply.

Contour intervals on site plan must be as follows:

Slope (%)	Contour Interval (feet)
0 - 15	2
16 - 40	5
> 40	10

Topography must be field verified for drainage easements and conveyance systems. Contours shall extend 50 feet beyond property lines.

- **Schedule of Catch Basins**. Show the following information:

  - Catch Basin/Manhole Identifier
  - Street Name
  - Cross Street
  - Stationing
  - Street side
  - Catch Basin diameter or size
  - Invert in/out
  - Pipe Diameter in/out

Plans or worksheets of open channel systems shall show water surface elevation for the design storm, invert elevations at breaks in grade, design discharge, design velocity, and such other data which facilitates plan review.

- **Work Map (or maps)**. On a contour topographic map at the same scale as site map, show:

    - Unit areas as contributing to a reach of swale or to a catchbasin including off-site area. Identify areas contributing to retention/detention facilities. Show the following on the work map (or on a schedule) for unit areas: area, percent impervious, average slope, and estimated ultimate infiltration rate.
    - Conveyance data, identifier (for reference to model output), length, slope, inverts up and down.
    - Overland flow paths and distances.
    - Soil types.
    - Locations of soil pits and infiltration tests.
    - Spot water surface elevations discharges and velocities for the Design Event.

- **Erosion Control Plan Drawing**. Drawing shall show:

    - Construction entrance detail.
    - Silt fences and traps.
    - Mulching and vegetation plan.
    - Clearing and grubbing limits.
    - Existing and finished grade.
    - Standard erosion control plan notes. Example notes are found in Appendix T. Provide only those notes that apply.

3.2.2 Required Drawing Size

Required sheet size is 24x36 inches.

3.2.3 Required Drawing Protocol

All sheets will have a north arrow, scale, a benchmark reference, and at least two coordinates matching the utilities coordinate system. Each set of drawings shall have legend to define map symbols.

3.2.4 Plans and Specifications

The most recent editions of Standard Specifications and Standard Plans (see Glossary) shall be the standards for all design and construction of drainage facilities not explicitly described herein. In the event of a conflict between the Standard Specifications, Standard Plans, and this MANUAL, this MANUAL shall prevail.

3.3 <u>Maintenance Plan</u>

3.3.1 Contents of Plan

The Project Engineer will prepare a maintenance plan describing required type and frequency of long-term maintenance of drainage facilities and identification of the responsible maintenance organization. Frequency of sediment removal, cleaning of catch basins, vegetation control, etc., shall be described. An estimate of the average annual cost of maintenance will be included. See jurisdiction's maintenance specifications and Appendix K for guidance.

3.3.2 Identify Organization Responsible for Maintenance

If it is the jurisdiction's policy that the property owner(s) shall maintain storm drainage facilities, the maintenance plan shall be prepared to jurisdiction's specifications and included by reference in the articles of the property owners association. See Chapter 2 for required easements and covenants.

3.3.3 Vegetation Management Plan

The effectiveness of many stormwater facilities will depend on the species planted in them and their proper maintenance. Consult the jurisdiction regarding proper species for the design condition and for their requirements for maintenance. Specifications and requirements shall be incorporated into the maintenance plan.

3.3.4 Pollution Source Control

Pollution source control is the application of pollution prevention practices on a developed site to reduce contamination of stormwater runoff **at its source.** Best management practices (BMPs) and resource management systems are designed to reduce the amount of contaminants used or discharged to the environment.

All maintenance plans shall contain language regarding pollution source control that is specifically developed for the type of site covered by the plan. The pollution source control section of the plan shall incorporate the relevant information found in Volume IV of the *Stormwater Management Manual for the Puget Sound Basin*, February 1992, unless otherwise approved by the Administrator or designee.

3.4 Small Projects Abbreviated Plan Format and Content

Applicants for projects that do not exceed thresholds described in Section 2.1 and not exempted in Section 2.2 shall submit an Abbreviated Plan. They shall submit a plot plan containing the following information:

- Name, address, and telephone of the applicant.

- Name, address, and telephone of the person preparing the plot plan.
- Parcel number(s).
- Scale and north arrow.
- Legend if symbols are used.
- Vicinity map of sufficient clarity to locate the property and the receiving water body.
- Property boundaries, dimensions, and area.
- Contour lines from the best available source (specify datum used).
- Adjoining street names.
- Existing and proposed structures and other impervious surfaces such as driveways, patios, green houses, barns, etc.
- Location of waste treatment systems.
- Utility easements.
- Established buffers, significant trees, and natural vegetation easements.
- Natural drainage channels, wetlands, canyons, gullies, water bodies, etc.
- Clearing limits.
- Areas to be graded, filled, excavated, or otherwise disturbed.
- Location of known wells, underground storage tanks, septic tanks.
- The location and type of erosion and sediment control measures.

Lines shall be drawn with a straight edge and features shall be to scale. Drawing shall be sufficiently clear to see footprint of structures and other features described above.
The Administrator or designee may impose the requirements of Section 8.5.13 and the guidance in Appendix O in its review and approval of the Abbreviated Plan.

CHAPTER 4 - STORAGE AND DISCHARGE REQUIREMENTS

This chapter describes:

- minimum storage volumes,
- minimum volumes to be infiltrated,
- maximum discharge rates , and
- some conditions under which storage, infiltration, and release standards will change.

Retention and detention facilities may be sized:

- using standard methods described herein OR
- using hydrologic methods described in Chapter 5 provided that minimum storage volumes and maximum release rates are met.

The Project Engineer shall determine if:

- the proposed project will endanger downstream property, AND
- the more rigorous storage and release requirements of Sections 4.5 through 4.13 shall be used instead of the minimums.

This determination shall be reported in the "Downstream Analysis" section of the required Drainage Report. (See Section 3.1.1.)

Treatment of runoff is required before discharge to groundwater or surface water; allowable flow path for facilities is discussed in Chapter 7, Section 7.1.

Roof and clean impervious surface runoff (surfaces not subject to vehicular traffic or the routine handling of hazardous materials) may be managed separately from other runoff.[2] This approach enables the Project Engineer to limit the size of required stormwater treatment facilities. Drywells, infiltration trenches, and storage ponds for such projects shall be designed in accordance with this chapter and Section 8.5.13.

4.1 <u>Release Rate to Surface Water and Storage Volumes</u>

[2]For the purpose of this MANUAL, the importance of air pollution and roof maintenance chemicals have been discounted. However, at some future date these may need to be dealt with through stormwater treatment prior to release to surface or ground waters.

For project sites where estimated infiltration is 0.5 inches per hour or greater, retention and in most cases detention must be provided. The volume to be infiltrated may not be less than, nor may release rates from detention facilities be greater than those given in this section.

4.1.1 Estimating Maximum Release Rates to Surface Water

The Project Engineer shall estimate maximum allowable release rates by the following method:

1. Maximum standard unit release rates before adjustment for site specific soils are:

   Maximum Release, Two-year event = 0.04 cfs/disturbed acre

   Maximum Release, 100-year event = 0.35 cfs/disturbed acre

2. To estimate the unit release rate for a specific project, multiply the maximum standard unit release rates by the reduction factor from Figure 4.1. (Enter Figure 4.1 with the estimated project site infiltration rate; see Section 4.4.3.) It is anticipated that there will be slight errors in reading charts. The Administrator or designee will accept values two or three percent different from his/her estimate.

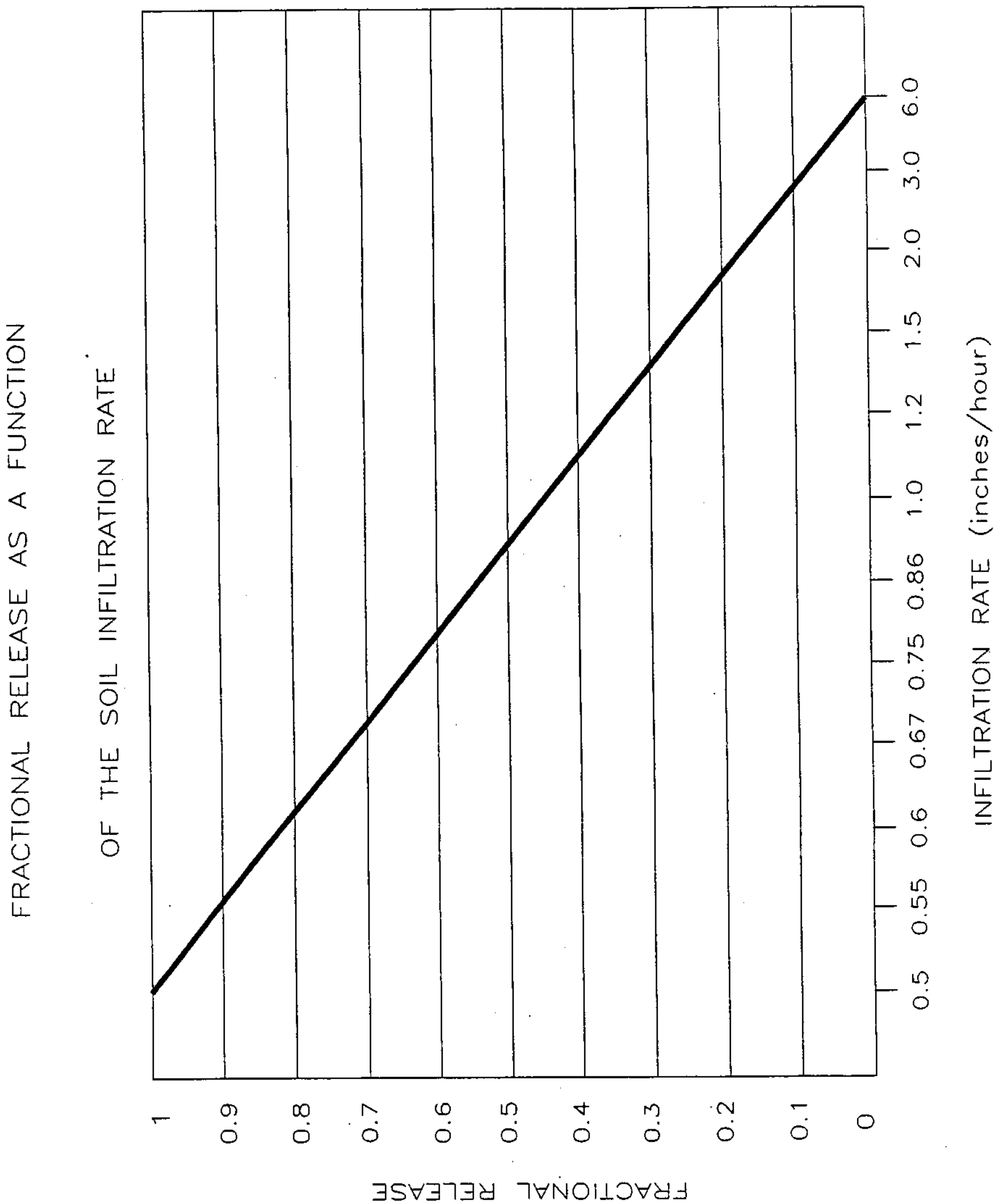
3. Example: if estimated project site infiltration rate is one-inch per hour, then, from Figure 4.1, the reduction factor is 0.43. Thus, project specific maximum release rates are:

   Q_2 = 0.04 * 0.43 = 0.0172 cfs/disturbed acre

   Q_{100} = 0.35 * 0.43 = 0.15 cfs/disturbed acre

These calculations will yield the maximum release rate for the developing site. However, as the intent of this MANUAL includes maximizing infiltration, minimizing runoff, recharging groundwater, and maintaining stream baseflows in the summer, the Administrator or designee may direct the Project Engineer to route stormwater to

STORM DRAINAGE DESIGN MANUAL | FIG 4.1



DATE:
OCT 1990

RELEASE RATE REDUCTION ESTIMATION

project site soils with infiltration rates better than the project site average where the routing is facilitated by gravity flow. This routing results in a reduction in the maximum release rate for the project site. If the Project Engineer chooses not to route stormwater to the better soils, the stormwater facility may be located elsewhere, provided that it is upsized to allow for the recalculated (reduced) release rate.

4.1.2 Minimum Storage Volume of Retention/Detention Facility; Storage Volume Based Upon Soils Conditions

Live storage volume for disturbed pervious and impervious surfaces shall be provided in accordance with Table 4.1.

Reductions from the minimums may be allowed only in the following instances:

- Use of semi-pervious pavement materials as described in Section 6.8.1.

- Use of gravel or other loose pervious material as may be allowed by some jurisdictions in place of pavement[3]. Such areas meeting the jurisdiction's design standards (e.g., clean, non-compacting, low fines) shall be considered "disturbed pervious" for the purposes of calculating required minimum storage volume. Such graveled areas may also be used for stormwater storage, but a liner may be required on Class A soils if vehicle use is significant (if a liner is required, these areas shall be considered as impervious surface for the purpose of calculating storage). All stormwater from these areas subject to significant vehicular traffic shall receive approved treatment prior to discharge to surface or ground waters.

For the purpose of calculating impervious cover in a subdivision where the amount of impervious cover on one or more lots is indeterminate at the time of stormwater facility design, the Project Engineer shall calculate and specify stormwater storage for the subdivision as if all lots were developed at the maximum density allowed by the zoning. The amount of storage required in the subdivision facility may be reduced by the Administrator or designee if requirements that limit impervious coverage to less than allowed by zoning, or require on-lot stormwater facilities such as drywells for each lot, are recorded on the face of the plat.

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[3]Standard designs developed as part of the "Impervious Surface Reduction Study" should satisfy the intent of this section.

TABLE 4.1 MINIMUM STORAGE VOLUMES AS A FUNCTION OF PROJECT SITE INFILTRATION RATE

Project Site Infiltration Rate (inches per hour)	Minimum Storage Volume Required (cubic feet per acre of disturbed pervious)	Minimum Storage Volume Required (cubic feet per acre of impervious)
0.0	4000	12000
0.5	4000	12000
1.0	3818	11455
1.5	3636	10909
2.0	3455	10364
2.5	3273	9818
3.0	3091	9273
3.5	2909	8727
4.0	2727	8182
4.5	2545	7636
5.0	2364	7091
5.5	2182	6545
6.0	2000	6000
7.0	1929	5786
8.0	1857	5571
9.0	1786	5357
10.0	1714	5143
11.0	1643	4929
12.0	1571	4714
13.0	1500	4500
14.0	1429	4286
15.0	1357	4071
16.0	1286	3857
17.0	1214	3643
18.0	1143	3429
19.0	1071	3214
20.0	1000	3000

4.1.3 Retention Design Event/Minimum Volume to Be Infiltrated

All projects on sites that infiltrate at 0.5 inches per hour or greater must provide a facility that will discharge a portion of runoff to groundwater. Project and stormwater facility sites with infiltration rates of six inches per hour or more must infiltrate 100 percent of the 100-year storm volume. This volume must be infiltrated provided that a suitable site for infiltration may be found per Chapter 8, Section 8.5 (e.g., allowing for minimum clearance to groundwater, maximum slope). Greater infiltration volumes may be required for some sites (e.g., draining to potholes); the Design Event for these sites is described in Sections 4.5 and 4.6.

The Project Engineer shall calculate the required minimum infiltration volume using the method outlined below and detailed in Appendix D, and shall verify through hydrologic modeling that this minimum volume is infiltrated during the allowed 48-hour drawdown period following the design storm.

The engineer may determine the minimum volume to be infiltrated by:

- Estimating the SCS curve number for the completed proposed project (refer to Appendix D), and
- Estimating the SCS curve number for the pre-developed (undisturbed) site, and
- Using the procedure in Appendix D to determine the minimum volume to be infiltrated.

4.2 Retention/Detention Facility Design

Infiltration facilities shall be sized to provide the volume calculated according to Sections 4.1.2 and 4.1.3.

4.2.1 Retention/Detention Facility Orifice Configuration

The retention/detention facility shall be provided with two orifices, one at the bottom of live storage and one at 70 percent of the live storage capacity of the facility. The lower orifice shall be sized so that the 2-year allowable release will not be exceeded when the pond is filled to 70 percent capacity. At pond (or trench) full, discharge from both orifices acting in concert shall not exceed the 100-year allowable release rate.

For some facilities the bottom orifice may be an underdrain filter as described in Chapter 8, Section 8.3.1. The Administrator or designee may approve slotted weirs or other outlet devices that within five percent approximate these release rates.

4.2.2 Calculation of Retention/Detention Facility Size

The following provides an example calculation for design of an infiltration facility with surface discharge.

Given a ten-acre project. Proposed six acres impervious; three acres landscaped; one acre designated "undisturbed." From a series of soil textural and infiltration analyses performed by a Soils Professional, it has been determined that the facility site has an average saturated "perc" rate of 1.10-inch per hour. The weighted average infiltration rate for the rest of the project site was measured as 1.00 inches per hour. SCS curve numbers for the site are 98 for the impervious areas, 90 for the landscaped areas, and 76 for the undisturbed areas.

The Project Engineer determines that the assumptions for use of Table 4.1 to size the facility are met by his/her proposed design. That is, the proposed design for the combined retention and detention facility contemplates a pond that will drain completely within 48 hours after the design storm event; and the area tributary to the facility infiltrates at less than or equal the rate of the facility site (i.e., 1.00 < 1.10). Therefore:

<u>Step 1</u>. To determine the size of the required retention/detention facility, the Project Engineer calculates the minimum volume for the retention/detention facility using Table 4.1 (interpolating for 1.1 inches per hour):

6 acres impervious	*	11,000 cu ft/impervious acre	=	66,000 cu ft
3 acres grass	*	3600 cu ft/disturbed acre	=	10,800 cu ft
Total minimum				76,800 cu ft

Use total minimum of 76,800 cu ft <-------------- answer from Step 1.

<u>Step 2</u>. Estimate maximum release rates for the two-year and 100-year events:

With the weighted average infiltration rate for the site of 1.0 inches per hour, enter Figure 4.1 to determine the fractional release rate = 0.43. Then:

Q_2 = 0.04 * 0.43 = 0.0172 cfs/disturbed acre
= 0.0172 * 9 acres
= 0.1548 cfs

Q_{100} = 0.35 * 0.43 = 0.15 cfs/disturbed acre
= 0.15 * 9 acres
= 1.35 cfs

The Project Engineer shows an orifice at the bottom of the detention/retention facility that will discharge at 0.1548 cfs when the pond is at 70 percent capacity:

0.7 * 76,800 = 53,760 cubic feet

At the elevation at which the pond contains 53,760 cubic feet, the Project Engineer shall show another orifice such that when the pond reaches capacity for the 100-year event both orifices together will discharge at 1.35 cfs.

<u>Step 3</u>. Using a hydrologic model, verify that the storage facility will infiltrate at least the required minimum infiltration volume (see Appendix D) and will be completely drained within 48 hours after the design storm.

First, calculate the required minimum infiltration volume. For this 10-acre site with an undisturbed site curve number of 76, the predevelopment runoff is:

3.49/12 * 10 acres * 43,560 sf/acre = 126,687 cubic feet.

The post-development runoff is the sum of runoff from the impervious, landscaped, and undisturbed areas, as follows:

[3.49/12 * 1 acre * 43,560 sf/acre] + [5.00/12 * 3 acres * 43,560 sf/acre] + [5.92/12 * 6 acres * 43,560 sf/acre] = 12,668 + 54,450 + 128,938 = 196,056 cubic feet.

The minimum required infiltration volume is the difference between the two totals, or 69,369 cubic feet.

Second, complete the hydrologic modeling for the storage facility. Route the hydrograph for the 100-year storm through the 76,800 cu ft facility designed in Step 1, using the release rates calculated in Step 2 (or other release rates proposed by the Project Engineer if less than those calculated) and the infiltration flow rate through the facility bottom.

Third, verify that the facility drains completely within 48 hours after the end of the 100-year storm. Most hydrologic models produce an overflow hydrograph that provides this information. If the facility does not satisfy this requirement, increase storage capacity and recalculate the hydrologic model until the requirement is satisfied.

Fourth, verify that 69,369 cubic feet of water is infiltrated in the pond during and after the 100-year storm. Some hydrologic models calculate the amount infiltrated, or the Project Engineer can approximate the quantity by multiplying the facility infiltration flow rate (cfs) by the time from the start of the storm until the facility drains completely. See the following example.

Assume the Project Engineer proposes a pond with 3:1 side slopes, four feet of storage, and a bottom area 185 feet by 85 feet (volume of 77,000 cubic feet exceeds the minimum requirement of 76,800 cubic feet). The infiltration flow rate for this facility with 1.1-inch per hour soil is between 0.40 cfs and 0.58 cfs (the lower rate includes only the bottom are; the higher rate allows for infiltration through the pond sides when the pond is full). Averaging these two rates (0.49 cfs), check the time needed to infiltrate the minimum required volume of 69,369 cubic feet by dividing this volume by the flow rate. The result, 36.4 hours, is then compared with the time from storm start to complete drain. If complete drain takes more than 36.4 hours (but less than the maximum 72 hours from storm start/48 hours from storm end), no change is needed. If it is less than 36.4 hours, the facility design will need to be adjusted (by adding storage, increasing bottom area, and/or reducing surface release rate) to allow more water to infiltrate.

4.3 Limitations for Infiltration Sites

Infiltration surface must be provided for disturbed area on a project providing a site(s) can be selected that will not violate design criteria (e.g., minimum depth to groundwater, maximum slope) specified in Chapter 8, Section 8.5. If the Project Engineer determines that a site that meets design criteria in Chapter 8 is not available to infiltrate runoff from the entire site, then a site(s) shall be selected in which the largest possible fraction of the project runoff can be infiltrated.

If the Project Engineer determines (and the Administrator or designee agrees) that some or all of the minimum required infiltration capacity cannot be provided, then the Project Engineer shall, in a memo to be co-signed by the Administrator or designee, state the physical limitations of the site which are the basis for partially or wholly waiving the requirement for infiltration.

4.4 Determining Soils Infiltration Characteristics

A soils evaluation shall be prepared for all projects for which a Drainage and Erosion Control Plan is required. The results of this evaluation shall be recorded on the forms provided in Table 3.1.

4.4.1 Qualifications of Soils Professional

All soil evaluations shall be conducted by professionals with training and experience in soil science. Refer to the definition for "Soils Professional" in the Glossary. The Administrator or designee shall retain final authority to accept or reject a soils evaluation.

4.4.2 Procedures for Infiltration Testing

The Soils Professional or designee shall perform infiltration (percolation) tests for trench type infiltration facilities according to the procedure for falling head percolation tests described in EPA, 1980 (Appendix L).

The Soils Professional or designee shall perform tests for open pond infiltration facilities or other non-trench type facilities (e.g., systems under pavement) using concentric ring infiltrometers as described in ASTM 3385-88 "Standard Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometers." Locally fabricated infiltrometers shall be allowed subject to approval by the Administrator or designee.

Operators of equipment used to perform soils analysis shall minimize disturbance of an undeveloped site.

Infiltration tests shall be performed only on soils for which the particular test has demonstrated validity.

The Project Engineer may request that the Administrator or designee waive infiltration testing. This requires a showing by the Project Engineer and the Soils Professional of one or both of the following:

- Infiltration testing would not significantly improve the estimate (developed through other testing on the subject site or similar nearby sites) of field-saturated percolation rates used for stormwater facility design.

- Neither recommended infiltration test procedure has demonstrated validity on the type of soil present on the site.

4.4.3 Procedure for Estimating Project Site Infiltration

The Soils Professional or designee shall excavate a sufficient number of test pits on the project site to characterize the soils and permeability of the site (i.e., determine f_c, Figure 4.1).

The Soils Professional or his/her designee shall perform infiltration tests by methods described in Section 4.4.2 sufficient to characterize the transmissivity of soils on the site, or at minimum, as directed by the Administrator or designee. Tests shall be conducted below the root zone.

The Soils Professional shall determine the soil classes and estimate the field-saturated percolation rate of the project site in inches per hour using infiltration testing and test pit analysis.

The Project Engineer may omit the tasks described in this Section if he/she proposes to infiltrate 100 percent of stormwater generated on the project site (for any type of development), and drywells are not proposed for management of roof runoff.

4.4.4 Procedure for Estimating Facility Site Infiltration

A sufficient number of test pits shall be excavated to characterize site infiltration capacity, but:

- ○ no less than one pit for every 10,000 square feet of percolation surface, OR
- ○ no more than 100 feet apart,

whichever provides the closer spacing. Test pits shall be excavated to a minimum of six feet below the infiltration surface or to hardpan, whichever is less. Infiltration tests for the facility site shall be performed at the design infiltration surface.

The Soils Professional or designee shall complete a soils evaluation report for each test pit. The Soils Professional shall determine soil classes and weighted infiltration capacity of the facility site in inches per hour using infiltration testing and the soils textural analysis.

4.4.5 Infiltration Facility Soils Report

Report format is discussed in Chapter 3, Section 3.1. See especially Table 3.1 for report forms and instructions.

4.5 Closed Basin (Pothole) Triggers Higher Infiltration Standard

A closed basin (pothole, kettle) is a basin with no outlet for surface water discharge.

4.5.1 Procedure for Management of New Stormwater Discharges to Closed Basins

Stormwater from a developing site may be released to a closed basin (subject to the requirements of Section 4.1) provided that hydrologic analysis done in conjunction with soil and land survey information on the pothole shows that:

(a) For a pothole entirely on the subject property, or a pothole to which the Proponent has acquired a legal right to discharge, the peak water elevation for the 100-year 7-day storm does not reach the top elevation less two feet of freeboard, the pothole draws down completely in seven days, and no significant public health, safety and welfare, or property damage issues are present; or

(b) For a pothole shared with, or entirely on other properties, absent a legal agreement to the contrary, the peak water elevation for the 100-year 7-day storm for the tributary area under built-out conditions does not exceed:

(i) 0.1 feet above the bottom, if available information indicates the bottom to be dry at all times, or

(ii) 0.1 feet above the current peak water elevation, if this elevation can be clearly demonstrated.

Discharge to a closed basin shall be allowed only if the Project Engineer can satisfactorily demonstrate that no significant public health, safety, welfare, or property damage issues are present.

4.5.2 Basin Plan in Lieu of Section 4.5.1

In lieu of requirements to use the criteria in Section 4.5.1, the Project Engineer may elect to perform a basin plan to demonstrate capacity of a closed basin to accept higher flows. The property that may be impacted by the 7-day, 100-year Design Storm event at build-out for the area contributing to the closed basin shall be identified using the hydrologic method described in Chapter 5. Owners of the impacted property must provide proof that they will accept higher flows. Proof shall mean covenants, a conservation easement, dedication to the public, or other means acceptable to the Administrator or designee.

4.6 Discharge to Private Property

When the proposed project site discharges onto an adjacent property where no public drainage facility or no defined drainage course exists (e.g., a natural channel with a measurable annual discharge such as a Department of Natural Resources (DNR) Type 5 rated stream; see Appendix M) the Proponent shall obtain an easement from the adjacent property owner(s) to establish a drainage way to connect to a defined drainage system. In the absence of such an easement, the discharge from retention/detention facilities shall be distributed along the property line in approximately the same flow pattern as before development.

The Administrator or designee may, under highly unusual circumstances, excuse the Proponent from requirements of this section (e.g., adjacent property is a wetland and is not a closed basin, and discharge to the wetland would not significantly alter the hydrology, degrade wetland functions and values, or reduce the value of the property). See also Section 4.13.

4.7 Discharge from Roof Drains

Criteria for management of runoff from roofs and clean impervious surfaces is provided in Section 8.5.13.

4.8 Discharge to a Major Water Body

A "major water body" means one of the following:

- Saltwater body or streams tributary to saltwater bodies up to the limit of tidal influence

- Capitol Lake

- The Nisqually River from mouth to River Mile 10

Proponents of projects which discharge to a major water body are exempt from minimum storage, infiltration, and peak discharge flow control requirements. (Treatment of the Water Quality Design Event is still required as discussed in Chapter 7.)

Also exempt are Proponents of projects which discharge to a public drainage system (i.e., pipes, ditches, etc.) which discharge directly to a major water body if the Proponent shows to the satisfaction of the Administrator or designee that:

- No flooding of public systems will occur as a result of the design event under build-out conditions for the area tributary to the public system. (For design event for conveyance systems see Chapter 6.)

- All other users of the public system may enjoy the same exemption from storage requirements without flooding.

- No structural damage will occur to the outfall during the 100-year, 24-hour design event.

4.9 Discharge at the Natural Location

Runoff as a result of precipitation (or surface water entering a property from adjacent property) must discharge at the natural, predevelopment location unless a comprehensive Drainage and Erosion Control Plan is approved by the jurisdiction allowing other alternatives or an easement is granted by the downstream property owner(s). This regulation is intended to preserve downstream properties from runoff greater than (or less than) the runoff that existed before the proposed Project.

4.10 Exceptions to Storage Requirements

Possible exceptions to the minimum storage requirements described in Section 4.1.2 are those projects subject to regulations imposed by an adopted basin plan, those that drain to closed basins, those that discharge to major water bodies, and those which sheet-flow to adjacent private property. (Also see Chapter 2.)

4.11 Offsite Drainage Can Trigger Higher Storage Requirements

Offsite drainage is drainage from adjacent property that enters the proposed project site in other than a defined natural channel. The Proponent shall not interfere with flows in natural channels, and shall provide protection as specified in Section 2.14.1.

Development projects are required to handle offsite drainage in the same manner as exists in the predeveloped condition. In other words, after development, offsite flows shall be infiltrated within or passed-through the project site in the same proportion as occurred prior to development. The development's retention (infiltration) systems shall be sized to accommodate the correct proportion of offsite flows.

Offsite pass-through flows shall be routed separately across the development site. They shall not be routed through the project's conveyance, treatment, or retention/detention systems. No storage or treatment of offsite pass-through flows is required.

However, if the Project Engineer and the Administrator or designee agree that separate handling of offsite flows is impracticable, then offsite flows may be routed through the project's stormwater systems. Those systems affected by the offsite flows shall be sized as if the offsite flows were generated within the development project's boundaries.

4.12 Downstream Analysis May Trigger Additional Requirements

The Project Engineer shall provide a detailed qualitative analysis of the flow path of the discharge from the project site to the receiving water. This requirement shall apply to all projects where a Drainage and Erosion Control Plan is prepared, including those proposing retention facilities. This analysis shall include flow routing, and provide existing pipe and channel sizes and estimated capacities. In addition, the Project Engineer shall discuss any known or expected downstream erosion, flooding, or water quality problems, including those that may be caused by interflow from the proposed retention facility. The Administrator or designee shall have the discretion to specify the distance and level of detail to be provided by the Project Engineer. In making this determination, the Administrator or designee shall consider factors such as the relative size of the new development, availability of other hydrologic work for the drainage area, and the extent to which stormwater generated on the project site is to be infiltrated.

Based upon this analysis, the Project Engineer may determine or the Administrator or designee may require that a quantitative analysis of the conveyance system be performed both upstream and downstream of the project site as required in Section 3.1.1. A quantitative analysis will not be required for most projects that propose to infiltrate most or all stormwater. This analysis shall determine conveyance system performance for the appropriate design event(s) (see Chapter 6) both with and without the proposed development. The Administrator or designee shall have the discretion to specify the distance and level of detail to be provided by the Project Engineer. The Administrator or designee shall consider factors such as the relative size of the new development, availability of other hydrologic work for the drainage area, and results of the qualitative analysis, in making this determination.

The quantitative downstream analysis will include modeling the hydraulics of the proposed project and all other sources of runoff tributary to the receiving water body for the appropriate Design Event. The Project Engineer shall include an analysis of the impact of the 24-hour, 100-year event (in addition to "Design Event" analysis) for each component of the system including pond spillway.

The Administrator or designee may impose stricter discharge and/or detention standards if the discharge from the Project, evaluated in the context of other existing conditions in the drainage area, is reasonably expected to result in any of the following:

- Flooding
- Loss of aquatic habitat due either to high or low flows
- Property damage
- Water quality problems
- Erosion
- Or an unacceptable interruption of vital services.

If the Project Engineer (or Administrator or designee) determines that greater treatment, infiltration and/or storage volumes, lower release rates, or downstream improvements are needed, he/she shall specify project design criteria or other means to relieve the downstream problems (providing that such solution will not violate minimum standards established in this MANUAL). Other means might include increases in downstream flow capacity and/or offsite detention and infiltration facilities, plans and financing for which will be subject to the approval of the Administrator or designee.

4.13 Discharges to Wetlands

Stormwater discharges to wetlands shall maintain the wetland's natural hydroperiod and flows to the extent needed to preserve or enhance its existing functions and values. Prior to proposing discharge of higher volumes of stormwater to a wetland, alternative discharge, detention, and infiltration practices located in areas outside the wetland shall be evaluated and employed by the Project Engineer where feasible and practicable.

These requirements apply to existing natural wetlands and wetlands created as mitigation for loss of wetland acreage. Wetlands constructed and operated solely for use as stormwater treatment/ storage areas are exempt from these and most other restrictions that apply to natural wetlands. Constructed wetlands may lose this exemption if not operated and maintained as stormwater areas for three or more years. Other local, state, or federal wetland protection requirements may also apply.

CHAPTER 5 - HYDROLOGIC MODELING TO SIZE FACILITIES

This chapter describes methods acceptable to the Administrator or designee for calculating discharge, volume, and velocity of runoff for sizing and designing conveyance systems.

These methods may also be used to size infiltration and storage facilities when the Project Engineer or Administrator or designee determines that a downstream analysis is required, or when special discharge limitations are in effect as described in Chapter 1, Sections 1.1 and 1.3.

No less than minimum storage and infiltration volumes established in Chapter 4 will be allowed regardless of the results of hydrological analysis. For example, if from Appendix D it is determined that 50,000 cubic feet must be infiltrated for a site, then if the results of hydrologic analysis yield a facility design that infiltrates less than that volume, the facility must still be designed to infiltrate 50,000 cubic feet in a 48-hour period after the storm.

5.1 Flow Estimation Methods

For design of storm drainage facilities, several design storms may have to be used to adequately assess the downstream impact of proposed project. If the Administrator or designee so requests such an analysis, a **computer model must be used in flow calculations**.
Numerous hydrologic modeling software packages are available for use by the Project Engineer. Contact the Administrator or designee to determine those packages, versions (releases), and package modules that are being accepted. **Without exception, the Project Engineer must first verify that a particular modeling approach will be acceptable. Then, the Project Engineer must provide clear and complete information (e.g., input and output files, annotation of key outputs, and discussion of results) to enable the jurisdiction to conduct its review.**

5.2 Assumptions For Model Operation

Hydrographic models usually require an estimation of infiltration rates for each soil type encountered, an estimate of soil saturation for the design condition (reflecting antecedent rainfall), an estimate of interception by vegetation, and other surface storage. Sometimes an evaporation or evapotranspiration rate is a required input of the model. If so, set this value equal to zero. This section describes the rationale to be used in selecting these parameters and ranges of parameter values acceptable to the Administrator or designee.

Other model input includes information about conveyance systems such as channels, inlets, pipes, and storage facilities. Design criteria relating to these input parameters are found in later chapters.

5.2.1 Design Storm Hyetographs

When sizing facilities, the jurisdiction's design hyetographs must be used as input to hydrologic modeling of storm events. The SCS Type 1A hyetograph in 15 minute steps has been modified so that peak intensities are represented for periods from 30 minutes to two hours. These are available from the jurisdiction on magnetic media.

Volumes of typical storms used for design in Thurston region are shown in Appendix H.

5.3 Estimates of Interception

Interception (the volume of precipitation trapped on vegetation) is usually stated in terms of capacity after dry antecedent conditions. Because the beginning of a (design size) storm event in the northwest usually follows a wet period, a lower value of interception than that found in the literature is required. Table 5.1 provides guidance in selecting values of interception.

TABLE 5.1 INTERCEPTION VALUES FOR VARIOUS TYPES OF LAND COVER**

DESCRIPTION OF SURFACE	INTERCEPTION IN INCHES
Heavy Forest	.15
Light open Forest	.12
Pasture and shrubs	.10
Lawns	.05
Bare Ground	.03
Pavement	.02

** Values shown are about 1/2 of those for dry antecedent conditions found in references (e.g., HYDRA manual, 1985).

5.4 Estimates of Infiltration Rates for Various Soil Types

This section provides guidance in selection of infiltration rates. The methods described below may be used for estimating runoff from offsite tributary areas. Infiltration rates on the project site shall be determined using the field methods described in Chapter 4.

Adjustment of model parameters must be made so that ranges described below are not exceeded. Clearly justify selection of these parameters.

Figure 5.1 illustrates the relationship between infiltration and soil moisture storage. Table 5.2 shows hydrologic soils types in Thurston County.

5.4.1 Sources of Soil Infiltration Rates

SCS "Soil Survey Interpretations" provides background for estimating interstitial storage and provides qualitative estimates of infiltration capacity.

5.4.2 Infiltration Rate Ranges in the Thurston Region

Infiltration equations for the most part try to simulate the deterioration of the maximum infiltration rate (experienced when the soil is dry) to an ultimate (minimum) rate after the soil is saturated. Another algorithm will calculate for each time step the recovery of soil storage capacity after rainfall ceases. Maximum (moist soil) and minimum (soil saturated condition) infiltration rates for SCS hydrologic soils groups are given in Table 5.3. If the Project Engineer believes that another choice of parameters is applicable he/she shall justify the choice to the satisfaction of the Administrator or designee.

5.4.3 Modeling Infiltration of Imported Topsoil

Topsoil imported for landscaping lowers the infiltration of class A and B soils. If it can be reasonably predicted that landscaping will require importation of topsoil to cover Class A or B soils, that area shall be considered Class C for modeling purposes.

5.4.4 Time Required for Soil Saturation and Recovery

Saturation time for soils varies from hours to minutes. Justify parameters chosen.

EPA-SWMM manual estimates recovery time from saturation that ranges from a couple of days for coarse, well drained soil to seven to 14 days for heavier soils. A rough estimate can be made by dividing the moisture capacity of the soil (in inches) by the saturated soil infiltration rate (in/hr).

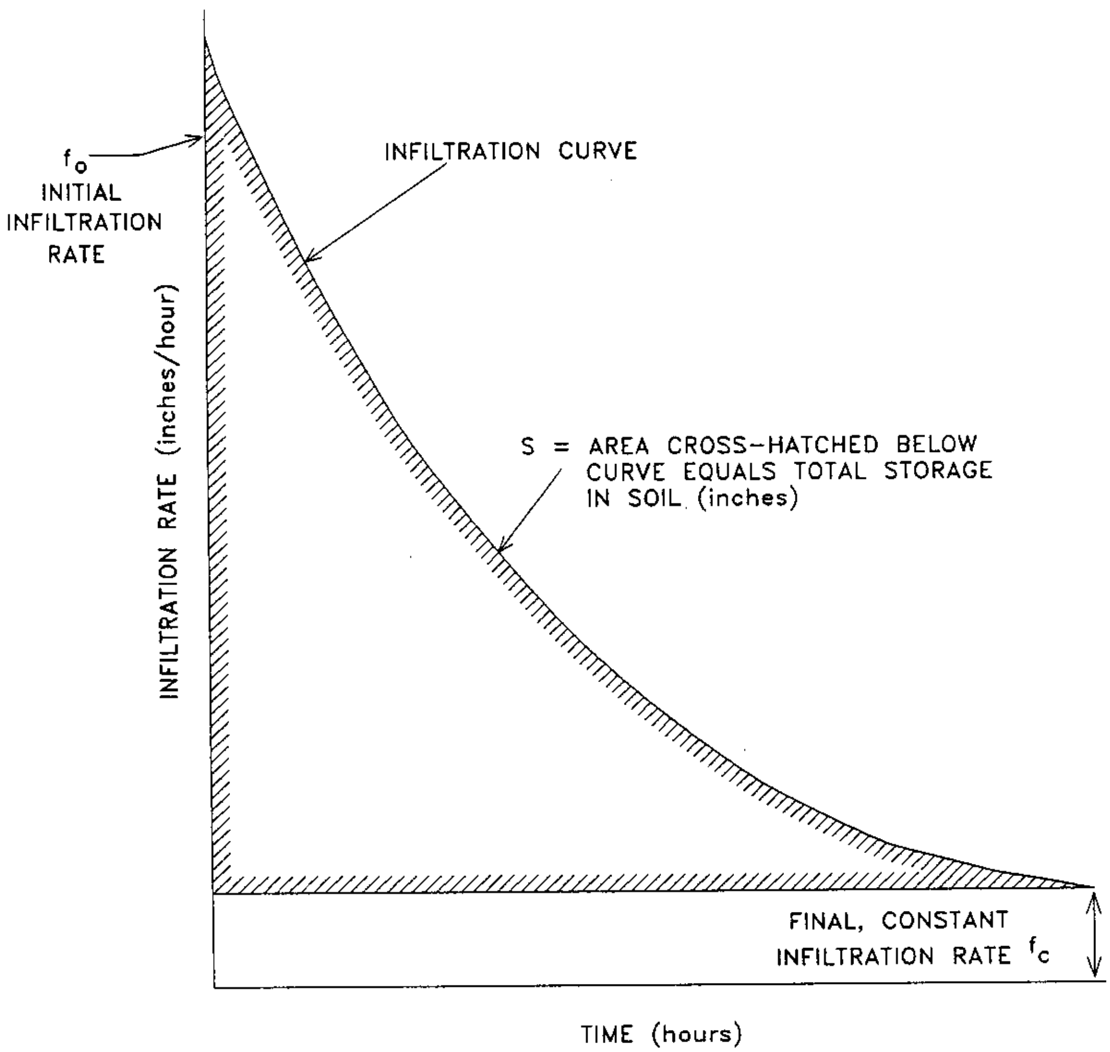

Diagram of infiltration curve and infiltration rates as related to storage in soil

REFERENCE:
"ILLUDAS" MANUAL

DATE:
JULY 1988

INFILTRATION RATE

TABLE 5.2 HYDROLOGICAL SOIL GROUP OF THE SOILS OF THURSTON COUNTY

SOIL GROUP	HYDROLOGIC GROUP	SOILS GROUP	HYDROLOGIC GROUP
Alderwood	C	Mukilteo	C or D
Baldhill	B	Newberg	B
Baumgard	B	Nisqually	B
Bellingham	C	Norma	D
Boistfort	B	Olympic	B
Bunker	B	Pheeney	C
Cagey	C	Pilchuck	C
Cathcart	B	Pits	*
Centralia	B	Prather	C
Chehalis	B	Puget	D
Delphi	B	Puyallup	B
Dupont	D	Rainier	C
Dystric Xerochrepts	C	Rock Outcrop	*
Eld	B	Raught	B
Everett	A	Riverwash	D
Everson	D	Salkum	B
Galvin	D	Scamman	D
Giles	B	Schneider	B
Godfrey	D	Semiahmoo	C
Grove	A	Shalcar	D
Hoogdal	C	Shalcar Variant	D
Hydraquents	D	Skipopa	D
Indianola	A	Spana	D
Jonas	B	Spanaway	B
Kapowsin	D	Sulton	C
Katula	C	Tacoma	D
Lates	C	Tenino	C
Mal	C	Tisch	D
Mashel	B	Vailton	B
Maytown	C	Wilkeson	B
McKenna	D	Xerorthents	C
Melbourne	B	Yelm	C

*See the description of map unit

Group A. Transmission Rate:	> 0.30 in/hour
Group B. Transmission Rate:	0.15 to 0.30 in/hour
Group C. Transmission Rate:	0.05 to 0.15 in/hour
Group D. Transmission Rate:	0.00 to 0.05 in/hour

Sources: Soil Survey of Thurston County, Washington, Soil Conservation Service, 1990, AND TR55 Model manual, 210-VI-TR55, Second Edition, June 1986.

TABLE 5.3 SCS SOILS GROUPS INFILTRATION RATE RANGES
(in inches/hour)

HYDROLOGIC SOIL GROUP	ULTIMATE (MINIMUM) INFILTRATION	INITIAL (MAXIMUM) INFILTRATION: MOIST SOILS LIGHT VEGETATION	INITIAL (MAXIMUM) INFILTRATION: MOIST SOILS DENSE VEGETATION
A	4.00 - 2.00	4.00	6.00
B	2.00 - 0.40	2.00	4.00
C	0.40 - 0.05	1.50	3.00
D	0.05 - 0.00	0.30	0.60

Reference: Stormwater Management Model (SWMM) User's Manual, EPA ERL, Athens, GA, 1988

(Example: If from SCS Soil Survey Interpretations, soil holds eight inches of water in the upper horizons and

$f_{infinite}$ = .05 in/hr then

recovery time = 8/.05 = 160 hours.)

The theory is that storage in the upper horizons is like a bucket and $f_{infinite}$, the rate at which the lower soil horizons drain, is like drainage from the hole in the bucket.

5.5 Estimates of Overland Flow Rates

In some models, overland flow rate is calculated on the basis of Manning's roughness coefficient. In this event, roughness coefficients found in Chapter 6, Section 6.2, for various types of channel linings may be used.

If the model uses some other algorithm to account for routing overland flow, justify the parameters chosen.

5.6 Estimates of Impervious Surface

Impervious surface for residential subdivisions may be estimated by calculating the impervious surface for roads and other features to be built during site development, and adding to that the impervious surface for each lot. The impervious surface estimates for lots must be estimated based on maximum lot coverage allowable by zoning code unless restricted to a lesser percentage by covenant. Alternately, the Project Engineer may estimate impervious surface area for residential subdivisions using Table D.2 in Appendix D.

Impervious area for commercial lots shall be estimated at the maximum percent impervious allowed by zoning code unless a lower percent impervious can be guaranteed through covenants, easements, and other such instruments.

CHAPTER 6 - CONVEYANCE SYSTEMS

This chapter describes methods and criteria for sizing of storm sewers, channels, revetments, and other drainage structures in the conveyance system. Setbacks and easements for conveyances are found in Chapter 2.

Grass-lined or otherwise vegetated open-channel surface drainage shall be required for the conveyance of stormwater, subject to the exceptions listed below. This requirement is consistent with the following hierarchy, which lists conveyance practices from most- to least-preferred.

1. Flow overland or through vegetated swales.
2. Flow through rock-armored or paved channels.
3. Flow through storm drains.

The Project Engineer must justify the use of any conveyance practice other than overland flow or flow through vegetated swales.

Factors that may be cited by the Project Engineer to justify the use of a less-preferred stormwater conveyance shall include but not be limited to:

- Road widening takes up all available land for open channels.
- Rolling terrain calls for deep cuts (swale/pipe combinations may be feasible in such cases, however).
- Traverse of an unstable or steep slope.
- High flow velocities and/or depths.
- Other factors that render open conveyance infeasible or impracticable from an engineering standpoint.
- Jurisdiction's street standard prohibits preferred conveyance.
- Lack of adequate space due to existing development coverage (usually only remodels and retrofits).

If in the Administrator or designee's opinion there is no practical alternative to the use of storm drains to convey runoff, then the Project Engineer shall, wherever possible, place catchbasins within grass islands (see Appendix A, Figure A2) in offstreet parking situations to provide some biofiltration before runoff enters the system. See Section 6.8.2. Vegetation surrounding catch basins must be protected from traffic.

6.1 Conveyance System Sizing Limitations and Methodology

6.1.1 Design Event

Conveyance systems (i.e., channels and pipes) shall be designed, at minimum, for the 10-year, 24-hour event except drains and culverts that pass under public roads and arterial streets; these must be sized for the 25-year, 24-hour event. Culverts for and bridges over natural channels must convey the 100-year, 24-hour event. The Administrator or designee may increase these standards as per Chapter 1, Section 1.2.

6.1.2 Methodology

For sizing onsite conveyances, the hydrographic methods described in Chapter 5 are preferred, but any standard engineering methodology is acceptable. However, if the Administrator or designee determines that special conditions require detailed hydrologic analysis (e.g., a downstream analysis required per Chapter 4, Section 4.12) then methods outlined in Chapter 5 shall be used.

6.1.3 Water Surface On Public Streets and Roads

In the urban area inside of the long-term urban growth management boundary (boundary information is depicted on current zoning maps available at the local jurisdictions) the outside driving lane of public roads and streets must not have water over more than 50 percent of the lane for a Design Event of a 25-year, 24-hour storm. In the area outside of the long-term urban growth boundary, the Design Event shall be the 100-year, 24-hour storm.

In areas where the Administrator or designee determines there is high risk of damage or vital service interruption (e.g., more than six inches of standing water in streets), the Administrator or designee may specify up to the 100-year, 24-hour event as the Design Event.

6.2 Design Criteria for Channels

6.2.1 Channel Lining

Channels shall be designed according to criteria in Table 6.1. Channels must be stabilized against erosion in compliance with minimum standards for erosion control set forth in Chapter 9.

6.2.2 Structural Integrity of Open Channels

Channels shall not suffer erosion or scour damage for the conveyance system Design Event (Section 6.1.1). Table 6.1 provides minimum criteria to prevent damage.

TABLE 6.1 DESIGN CRITERIA -- OPEN CHANNELS

Channel Lining	Maximum Design Velocity (fps)	Side Bank Maximum Design Slope H:V	Minimum Filter Blanket* (Inches)
Vegetation-Lined	5	3	NA
Geotextile-Armored	***	***	NA
Lattice Block Paving Systems	12	2	***
Quarry Spalls, 18" diameter	15**	2	4
Hand-Placed Rip Rap, 2' thick	12	2	4
Gabions	30	***	4
Concrete	30	Design	NA

* see Guide for determining gradation of sand and gravel filters, SMN-1, Soil Conservation Service, 1986

** see Riprap Design, Journal of Hydraulics, ASCE, July 7, 1989

*** manufacturer's instructions

6.2.3 Friction Factor

Friction factors for open channels are dependent upon the channel lining and condition. The Project Engineer may select the appropriate Mannings "n" value from Table 6.2.

Manning's Formula may be used to calculate friction losses in open channels. In one form it is expressed:

$$V = (1.486/n) * R^{0.67} * S^{0.5}$$

where

V = velocity, feet per second (fps)
n = friction factor
R = hydraulic radius (area/wetted perimeter)
S = channel slope, foot per foot

A discussion of friction factors may be found in Chow's *Open Channel Hydraulics*, 1959. Suggested friction factors for various channel conditions are found in Table 6.2.

TABLE 6.2 MANNING'S "n" VALUES FOR VARIOUS CHANNEL LININGS
(Channel Full)

Channel Lining	"n"
Concrete	0.012
Short grass	0.030
Stony bottom and weedy banks	0.035
Cobble bottom and grass banks	0.040
Dense weeds as high as flow	0.080
Dense woody brush high as flow	0.120
Biofiltration swale	0.150

6.2.4 Design of Biofiltration Swales

Biofiltration (Grass Lined) Swales shall be designed to meet criteria described in Chapter 7, Section 7.4.1.

6.3 Check Structures

Check structures for purposes of velocity control in ditches may be of rock construction as shown in Appendix B, Figure B15. The Project Engineer shall consider check structures, channel armor or other suitable means to protect channels from scour and erosion.

6.4 Culverts

Submit copies of nomographs and design aids if used in the calculation of culvert capacities. For the conveyance system Design Event for culverts passing under a public roadway see Section 6.1 above. See *Techniques of Water Resources Investigations of the USGS* or *Stormwater Management Manual for the Puget Sound Basin*, February 1992, Chapters III-2.3.3 and III-2.3.4 for information on culvert design and fish passage. Design criteria are given in the following sections.

Shallow fords may be substituted for culverts on residential driveway crossings of swales.

6.4.1 Fish Bearing Channels

Culverts for fish bearing channels must conform to Washington Department of Fisheries and Wildlife regulations.

6.4.2 Water Surface Elevation for the Design Event

Maximum design water surface elevation in the backwater behind culverts for the conveyance system Design Event (Section 6.1) shall be below top of channel. Maximum design water surface for culverts that convey streams shall be below the culvert crown.

6.4.3 Velocities Into and Out of Culverts

If velocity at design flow is greater than five feet per second, protect the channel and embankment from erosion as necessary.

6.4.4 Minimum Diameter

Minimum diameter culvert under public roads and streets is 12 inches. Check with the jurisdiction regarding minimum diameter culvert under private driveways. Culvert size shall be determined from hydrologic modeling results.

6.4.5 Materials

For acceptable materials see Section 6.9 below for materials and construction requirements.

6.5 Storm Sewers

6.5.1 Flow Analysis

The Design Event for storm sewers is given in 6.1 above. If the Administrator or designee determines that, as a result of the Project, runoff for any event through the 100-year, 24-hour event would cause damage or interrupt vital services, the Administrator or designee may require a computer backwater (pressure sewer) analysis. Submit results in tabular and graphic format showing hydraulic and energy gradient.

6.5.2 Design Friction Factors

Suggested values for friction factors using the Manning formula are shown in Table 6.3. If other factors are used, show justification.

TABLE 6.3 MANNING'S "n" FOR PIPES

Pipe Material	"n"
Concrete	0.013
Annular CMP or Pipe Arch	
2 2/3 x 1/2 corrugation	0.024
3 x 1 corrugation	0.027
6 x 2 corrugation	0.030
Helical	0.024
Spiral Rib	0.016
Ductile Iron (cement lined)	0.013
Plastic	0.010

Source: Chow's *Open Channel Hydraulics*, 1959 and others

6.5.3 Trash Racks

Where open channels or ponds discharge into storm drains, trash racks are required on all storm sewer system inlet pipes 18 inches and larger. Trash racks must be removable with ordinary hand tools.

6.5.4 Minimum Diameter, Slope, and Velocity

The minimum diameter for storm sewer on private property is four inches. The minimum diameter in the public right-of-way is 12 inches, except laterals connecting catch basins to main lines may be eight inches. The Administrator or designee may waive these minimums in cases where topography and existing drainage systems make it impractical to meet the standard. For culverts see Section 6.4.4.

6.5.5 Maximum Slopes and Velocities

Maximum slopes and velocities shall be as shown in Table 6.4. Anchor spacing shall be as shown in Table 6.5. Also see Appendix A, Figure A16. If velocities exceed 15 feet per second for the conveyance system Design Event (Section 6.1), provide anchors at bends and junctions.

TABLE 6.4 MAXIMUM PIPE SLOPES AND VELOCITIES

Pipe Material	Pipe Slope Above Which Pipe Anchors Required	Max Slope Allowed	Max Velocity at Full Flow
PVC	20%	30%	30 fps
CMP	20%	30%	30 fps
Concrete/Duct. Iron	20%	20%	30 fps
H D Polyethylene	20% None	None	

TABLE 6.5 PIPE ANCHOR SPACING

Slope Percent		
Greater Than	Less Than or Equal	Spacing Feet On Centers
20	35	36
36	50	24
50	100	16
100		Design

6.5.6 Cover Requirements, Trench Design, Pipe Strength

When calculating pipe loading for pipes over 24 inches in diameter or over 10 feet in depth, submit proof of pipe suitability for the design condition. Assume pipe trench will be opened at 45 degrees to the trench bottom unless trench configuration can be predicted with certainty.

6.5.7 Materials

See Section 6.9 below for construction and material requirements.

6.6 <u>Manholes and Catch Basins</u>

When design flow will be above 10 cubic feet per second (cfs), catch basin and manhole inlet capacities must be discussed in the Drainage and Erosion Control Plan and capacities must be shown on the work map. Inlet capacity limitations may be used to divide flow between channels or gutters and storm sewers.

See WSDOT "Standard Specifications" 7-05 for construction and material requirements for catch basins and manholes. Also, see WSDOT "Standard Plans" B-1 through B-12 for detailed diagrams.

6.6.1 Place Catch Basins in Parking Lots Within Grass Islands

See Section 6.8.2 for policy of placement of catch basins in off-street parking.

6.6.2 Anti-Dumping Message

Each catch basin or grated manhole must have a message cast into the catch basin cover. The message shall read as follows:

"DUMP NO WASTE
DRAINS TO (STREAM) (GROUNDWATER)"

In addition to casting the message into the catch basin cover or manhole grate, it must be depicted by one of the following means:

- Painted with pavement striping paint on pavement or curb. See Appendix A, Figure A15 for stencil print.

- Cast or embossed in the curb or pavement and painted with pavement striping paint.

- Press on vinyl letters.

- Other as permitted by the Administrator or designee.

6.6.3 Catch Basin/Manhole Sizing

Catch basin or manhole diameter shall be determined by the number and size of penetrations as described in Standard Specifications.

6.6.4 Flow Restrictor Manholes

Where flow restrictor manholes are to be used, they are to be designed in a manner similar to that shown in Appendix A, Figures A3 and A4. Manholes used to house flow restrictor assemblies shall have a minimum diameter of 54 inches. Assemblies shall be equipped with a chain-operated lift gate that can be opened in emergency situations. Flow restrictor devices may have multiple orifices as described in Chapter 4, or may use thin-plate slotted weirs in place of orifices.

For discharge through rectangular notches, thin-plate weirs may be calculated by the formula below (Kindsvater, 1957):

$$Q = C_e * L_e * (H_e)^{3/2}$$

Where

Q = discharge through weir, cfs

C_e,	reference King and Brater, 6th Edition, page 5-14, for sharp-crested weir with end contractions, dimensionless

$L_e = L + k_l$, feet

L = length of weir, feet

$k_l = .008$

$H_e = H + k_h$, feet

H = head over bottom of slot, feet

$k_h = .003$

6.6.5 Changes of Pipe Size or Direction

Pipe direction changes or size increases or decreases are allowed only at manholes and catch basins. (On private property, for four-inch and six-inch diameter pipe, clean-outs at junctions are permissible). Curvilinear pipe may be installed in strict accordance with manufactures instructions which shall be attached to the Drainage and Erosion Control Plan and shall be available on the job site.

6.6.6 Inlets

See Standard Plans and Standard Specifications for construction and material requirements and for detailed diagrams.

6.7 Outfalls

Outfalls are subject to hydraulic project requirements of the Washington Department of Fisheries and Wildlife which shall take precedence where more restrictive than those stated herein.

6.7.1 Design Storm Event

Outfalls shall be designed to pass the Design Event for conveyances (Section 6.1) and to suffer no structural damage or undercutting during the 100-year, 24-hour storm event. The Project Engineer shall present calculations showing the velocity, discharge, and flow path of the 100-year, 24-hour event.

6.7.2 Outfall Design

The standard for outfall design is as shown in Appendix A, Figure A5. This design is limited to slopes of 2:1 or flatter where native vegetation is well established or where slope armoring is engineered to the Administrator or designee's satisfaction.
For sites where the Project Engineer determines and the Administrator or designee agrees that the standard is impractical because of lack of space, danger of erosion, etc., see alternate outfall designs shown in Appendix A, Figures A6 and A7. Other outfall designs will be allowed upon approval of the Administrator or designee.

Outfalls with flow velocity under 12 feet per second and discharge under two cfs for the conveyance system Design Event (Section 6.1) are to be provided (at minimum) with a splash pad (e.g., rock, gabions, concrete).

Outfalls where flow is two cfs or greater or velocity is 12 feet per second or greater for the conveyance system Design Event (Section 6.1), an engineered energy dissipater is required. Examples are gabion splash blocks, stilling basins, drop pools, hydraulic jump pools, baffled aprons, bubble up structures, etc.

Outfalls must be protected against undercutting. Also consider scour, sedimentation, anchor damage, etc. Pipe and fittings materials shall be corrosion resistant such as aluminum, plastic, fiberglass, high density polyethylene, etc. Galvanized or coated steel will not be acceptable.

6.7.3 Outfalls on Steep Slopes

Outfall pipes on steep slopes (refer to Tables 6.4 and 6.5) must be anchored (see standard detail Appendix A, Figure A16) and must be fused or butt-welded or mechanically restrained. They may not be gasketed, slip fit, or banded.

On steep slopes, High Density Polyethylene (HDP) pipe may be laid on the surface or in a shallow trench, anchored, protected against sluicing, and hand compacted.

HDP outfall systems must be designed to address the material limitations as specified by the manufacturer, in particular thermal expansion and contraction. The coefficient of thermal expansion and contraction for HDP is on the order of 0.001-inch per foot per Fahrenheit degree. Sliding connections to address this thermal expansion and contraction must be located as close to the discharge end of the outfall system as is practical.

HDP systems longer than 100 feet must be secured at the upstream end and the downstream end placed in a four-foot section of the next larger pipe size. This sliding sleeve connection allows for high thermal expansion/contraction.

HDP shall comply with the requirements of Type III C5P34 as tabulated in ASTM D1248 and have the PPI recommended designation of PE3408 and have an ASTM D3350 cell classification of 345434C or 345534C. The pipe shall have a manufacturer's recommended hydrostatic design stress rating of 800 psi based on a material with a 1600 psi design basis determined in accordance with ASTM D2837-69. The pipe shall have a suggested design working pressure of 50 psi at 73.4 degrees F and SDR of 32.5.

6.7.4 Outfall Pipe Energy Dissipation

Outfall pipes that discharge directly into a channel or water body shall be provided at a minimum with a rock splash pad (see outfall detail Appendix A, Figure A6). See Table 6.6 for minimum rock protection at outfalls.

Due to HDP pipe's ability to transmit flows of very high energy, special consideration for energy dissipation must be made. A sample gabion mattress energy dissipater for this purpose has been provided as Appendix A, Figure A7. This mechanism may not be adequate to address flows of very high energy, therefore, a more engineered energy dissipater structure, as described above, may be warranted.

Mechanisms which reduce velocity prior to discharge from an outfall are encouraged. Examples are drop manholes and rapid expansion into pipes of much larger diameter.

TABLE 6.6 ROCK PROTECTION AT OUTFALLS

Velocity Max at Design Q (fps)	Type	Thickness (ft)	Width (ft)	Length (ft)	Height (ft)
5	8" Rock	1	Dia + 6	8	Crown + 1
12	Rip Rap	2	Dia + 6	12	Crown + 1
> 12	Design	-	-	-	-

Source: King County Drainage Manual

The Project Engineer shall also refer to Section III-2.3.5 of the *Stormwater Management Manual for the Puget Sound Basin* for additional specific design information.[4]

6.8 Off-Street Parking Design

6.8.1 Grass Pavers May Reduce Project Storage Requirements

The jurisdiction encourages for all off-street pavements the use of grass pavement combinations such as lattice blocks (see Appendix A, Figure A17), geotextiles, or other such semi-pervious pavements. Such systems will improve the quality of runoff, reduce the Proponent's investment in drainage systems, reduce the monthly utility rate payments, and improve the aesthetics of the development.

The jurisdiction will allow the Project Engineer to deduct from the required storage the volume stored in the interstices of the pavers, and the jurisdiction will allow the grass areas in the interstices to count as pervious provided that:

- topsoil or rock elevations in the interstices be constructed to a grade 3/4 inch or more below the driving surface, AND

- that a maintenance plan be provided to ensure that topsoil or rock elevations in the interstices shall be maintained 3/4-inch or more below the driving surface.

6.8.2 Use of Islands in Parking Lots/Preferred Conveyance

Islands in parking lots shall be used as vegetation lined conveyance and/or storage facilities whenever practical. Sheet flow over pavement is preferred in lieu of catch basins and pipes. The second preference is slotted drains or fords. When catch basins are unavoid-

[4]In case of conflicts, design criteria found in the MANUAL shall apply.

able it is preferred that they are placed in grass islands so that some biofiltration occurs before runoff enters the drain.

6.9 Conveyance Materials

All components of conveyance facilities including drains, manholes, catch basins, and outfalls, shall be as specified in Standard Specifications. Corrugated polyethylene shall meet AASHTO M294S.

Contact jurisdiction regarding preferences for or restrictions on the use of galvanized steel, PVC, high density polyethylene, double-walled (smooth interior) corrugated polyethylene, other plastic, or fiberglass pipe.

CHAPTER 7 - STORMWATER TREATMENT

7.1 <u>Stormwater Treatment is Required Before Discharge</u>

Runoff from the Disturbed Area (see Glossary) of a project must be treated before release from the site to surface or ground water (i.e., to infiltration systems). The objectives of providing stormwater treatment BMPs are, for both surface and ground waters, to protect the quality and quantity, to allow attainment of the designated uses, and to meet state standards promulgated under Chapter 173 of the Washington Administrative Code.

The retention/detention facilities sized using standard tables (Chapter 4) must be preceded by treatment. If retention and detention are performed in separate facilities then treatment may follow detention, but in most cases must precede retention facilities. Exceptions are as described in Chapter 4 (e.g., drainage from rooftops may be exempted under certain conditions). The following are acceptable flow paths for runoff:

1. Treatment -----> Retention/Detention -----> Surface Water (Standard, Chapter 4)

2. Treatment/Detention -----> Retention -----> Surface Water

3. Detention -----> Treatment -----> Retention -----> Surface Water

4. Detention -----> Treatment ----|----> Retention
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                                  |
                                  |----> Surface Water
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5. Treatment -----> Detention ----|----> Retention
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                                  |
                                  |----> Surface Water
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Other flow paths may be possible and will be accepted by the Administrator or designee provided that treatment always precedes discharge to surface or groundwater.

Effectiveness of various Best Management Practices (BMPs) is shown in Appendix J. Treatment is defined below for each type of BMP, device, or structure.

7.2 <u>Ponds Required in Hazardous Spill Risk Areas</u>

If there is a risk of spill of hazardous material in the tributary area for a pond (offsite and onsite), a vault or lined pond with live storage must be provided equal to the volume of maximum probable spill.

Areas of spill risk are defined as intersections of transportation systems (arterials, highways, railways) that regularly carry hazardous materials; and commercial/industrial areas in which hazardous material is handled and for which no other government agency requires spill trapping devices.

Pond lining is defined as a plastic or rubber material impervious to damage from petroleum products, at least six mils in thickness, designed for the purpose, and installed per manufactures instructions. Alternative liners may be accepted subject to the approval of the Administrator or designee provided that they satisfy the function of preventing discharge to groundwater over an acceptable design life.

All outlet devices for spill traps shall be equipped with valves to stop outflow from the facility. Valve locations shall be clearly marked and visible from the access road.

7.3 Hierarchy of Treatment

Treatment systems shall be selected according to the threshold criteria shown in Table 7.1. The Project Engineer shall select the highest-ranked treatment system that satisfies the criteria/threshold requirements. Under limited circumstances, the Project Engineer may, with the approval of the Administrator or designee, select a lower-ranked treatment system based on site-specific limitations which make the preferred treatment impracticable or infeasible. For example, a site with excessively well-drained soils and limited runoff, or with steep terrain, may not allow siting of a Constructed Wetland.

The Administrator or designee may direct the Project Engineer to select a higher-ranked treatment system and/or to increase the amount of treatment provided above the minimum required. Such an action on the part of the Administrator or designee may be triggered by:

- Water, sediment, or aquatic life data for a receiving water that indicate problems, such as violations of state water quality standards or non-attainment of designated uses.

- Action by the DOE, such as a wasteload allocation, that requires reduced nonpoint source loadings of pollutants to a receiving water.

- Actions specified in a jurisdiction-adopted drainage basin plan.

TABLE 7.1 HIERARCHY OF TREATMENT

Treatment		Criteria/Threshold
1.	Constructed Wetland	For sites with 12 acres or more of impervious surface.
2.	Wet Pond, Biofilter, or Sand Filter[1]	For sites with up to 12 acres of impervious surface.
3.	Wet Vaults	For sites with less than 2 acres of impervious surface.

The Administrator or designee may allow variance from the standards in this table if it can be shown that an alternative can be expected to provide an equal level of treatment.

[1]See Section 7.4.3 for conditions of use.

7.4 Sizing Criteria for Treatment Facilities

7.4.1 Biofilters

Biofilters shall be designed as specified below. A summary of design criteria is provided in Table 7.2. Additional information on biofilter design is provided in the *Stormwater Management Manual for the Puget Sound Basin*[5], Section III-6, as well as in Appendix A, Figure A1 of this MANUAL.

- Biofilters shall have a vegetated surface over which runoff shall flow at depths less than or equal to design depth.

- The minimum total surface area of the biofilter shall equal 2000 square feet per impervious acre draining to the biofilter except where the biofilter is placed after the detention facility, where a minimum total surface area of 500 square feet per impervious acre shall be provided.

[5]In case of conflicts, design criteria found in this MANUAL shall apply.

- If the biofilter is designed as a channel, the specified surface area shall be shaped as a trapezoidal cross-section with side slopes of 3:1 or less and a minimum length of 50 feet. Only the wetted perimeter area will be counted toward the minimum area requirement. Jurisdictions may require side slopes as flat as 5:1 in residential settings.

TABLE 7.2 SUMMARY OF BIOFILTER DESIGN CRITERIA

Design Element	Criterion
Biofilter surface area (for 6-month design storm)	Per impervious acre, 2000 square feet if inflow is undetained, 500 square feet if metered release.
Biofilter length	50-foot minimum for swales, 10-foot minimum for filter strips.
Biofilter width	2-foot minimum and 8-foot maximum for swales, no criteria for filter strips.
Design flow water depth	2-inch maximum
Design flow velocity	1.5 feet per second maximum
Flow line slope	1% minimum, 4% maximum
Side slopes	No steeper than 3:1, prefer 5:1

- If designed as a filter strip the minimum flow path shall be 25 feet except in cases where uniform sheet flow (no curb) can be assured across the strip, where 10 feet minimum shall be allowed; the surface contributing to the strip shall be sloped so as to ensure that the runoff is evenly distributed to the strip; curb cuts for tributary paved area shall have at least 12-inch openings and shall occur at least every 10 feet.

- Bottom width range = two feet to eight feet (above eight feet may be approved by Administrator or designee if uniform sheet flow in the swale can be assured through use of spreaders or special construction techniques).

- Design flow = peak flow from the six-month, 24-hour storm.

- Maximum design flow depth = two inches.

- Maximum design flow velocity = 1.5 fps.

- Mannings "n" = 0.15.

- Slope of biofilters shall be between one to four percent. The Administrator or designee may approve a steeper slope provided that check dams or other means to slow velocity are installed. Flatter slopes may be approved if the Project Engineer can demonstrate how the filter can be drained (e.g., via underdrains).

- Where the swale carries all storm flows, the swale must be able to carry the conveyance Design Event (see Section 6.1.1).

- In commercial developments the biofilter should to the maximum extent possible be integrated into the landscaping. See Chapter 8 and contact the jurisdiction for policy on qualifications for open space.

- Between April 1 and September 30 biofilters shall receive sod tolerant of seasonal saturation and drought conditions or be planted with a combination drought and wetness-tolerant vegetation seed mix approved by the jurisdiction (refer to Table III-6.1 in the *Stormwater Management Manual for the Puget Sound Basin* for seed recommendations). Between October 1 and March 30 sod tolerant of seasonal saturation and drought conditions must be placed. For seeded biofilters, sufficient armoring shall be placed to ensure that the seed bed will withstand the erosion control design event (see Section 9.3) without undue damage. (For example, stake down jute mat or straw mat according to manufacturer's recommendations for the device; use filter fences, hay bale check dams, etc., to reduce velocities.)

- Irrigation and other maintenance as necessary shall be provided to ensure that the vegetation remains viable and that a hardy root structure forms in the first year.

- Biofilters shall be lined according to the following schedule:

  - Where located over Hydrologic Group A soils (soils with a weighted average field-saturated percolation rate of six inches per hour or greater), the biofilter shall be lined with a minimum of six inches of topsoil. The topsoil shall be predominantly sandy loam, but must include small amounts (about 10 percent) of clay and organic matter to provide treatment of percolated water.

  - Where located in areas where hazardous materials spills may reasonably be expected to occur, information on when and how a biofilter shall be lined is provided in Section 7.2

7.4.2 Oil Water Separators, Filter Vaults, Coalescing Plate Filters

There are two basic types of oil/water separators: gravity and coalescing plate separators. The design criteria and maintenance for gravity oil/water separators is available through the Washington Department of Ecology, document WDOE 82-1.

Filter vaults must be used for high intensity vehicle use areas such as automobile service station pump aprons, bus barns, auto repair facilities, wrecking yards, etc. Oil water separators must be the best available and most appropriate for a particular situation. They shall treat the peak flow from the 6-month, 24-hour storm. They shall be in compliance with manufacturer's instructions for detention or detain liquid for 45 minutes whichever is greater. Example: If design flow into the separator is 20 gallons per minute then volume required is 20 x 45 or 900 gallons.

The jurisdiction encourages owners to roof over high intensity use areas and direct wash down effluent to filter vaults and from there to sanitary sewer systems in accordance with jurisdiction-specific requirements. If oil/water separators will discharge to surface or groundwater, effluent shall first be routed through water quality treatment facilities per Table 7.1.

The vault must be easily accessible by tank cleaning trucks. A maintenance manual must be included in the Drainage and Erosion Control Plan.

7.4.3 Sand Filtration

Sand filtration is appropriate for stormwater treatment in situations where all or most of the tributary area is paved. This practice is adaptable to tight spaces, and holds promise for use in new commercial settings, along existing road rights-of-way, and for retrofit of (treatment of runoff from) existing parking areas. Sand filters require more frequent maintenance than most other stormwater treatment practices. Project Engineers are expected to inform clients of this fact, and to reflect the enhanced maintenance requirements in the plan developed pursuant to Section 3.3.

Sand filtration practices shall be designed to capture and treat the 6-month storm. Practices may include basins or trenches (see Appendix A, Figure A12, for one example). Facilities shall be designed according to the guidelines in Chapter III-3.7.2 and III-3.7.3 of the *Stormwater Management Manual for the Puget Sound Basin*, February 1992.[6] All sand filtration areas shall be designed by the Project Engineer. Where the discharge from the sand filtration practice is routed to an infiltration system, the overall system shall be designed **in consultation with** the Soils Professional.

7.4.4 Treatment Ponds

Design details for detention facilities including treatment ponds are found in Chapter 8.

[6]In case of conflicts, design criteria found in this Manual shall apply.

CHAPTER 8 - DETENTION/RETENTION SYSTEM DESIGN

Ponds for purposes of this MANUAL are man-made detention or retention facilities which are open to the atmosphere and may serve as treatment and/or detention facilities.

Vaults are treatment and/or detention facilities located underground. Their use is limited as described in Chapter 7.

An infiltration facility (i.e., discharge of storm runoff to groundwater) is required for sites with certain soil characteristics as described in Chapter 4.

Ponds which will serve both as wet ponds (for water quality purposes) and detention ponds (for flood control purposes before discharge to surface water) may have dead and live storage in the same facility. This is a typical design for constructed wetlands and wet ponds.

8.1 Use of Retention/Detention/Treatment Facilities for Open Space

Residential "long" plats may provide recreation opportunities in conjunction with the detention/retention facilities. Recreation facilities shall mean active or passive recreation with improvements such as soccer fields, trails, play equipment, picnic facilities, or similar facilities to the satisfaction of the jurisdiction.

In lieu of providing recreation facilities, some jurisdictions may allow Proponents to contribute cash to the jurisdiction toward regional recreational facilities. The amount of cash will be determined by an adopted plan for such facilities.

Retention/detention facilities may be counted toward the jurisdictions open space requirements if facilities are made multiple use.

Multiple uses are:

- Recreational Facilities. Facilities are shaped in standard play areas (eg, soccer field) and are usable as such during portions of the year.

- Passive Open Space. Facilities are shaped aesthetically, wildlife habitat has been planned (e.g., nesting areas provided), and reasonable passive viewing facilities are provided (e.g., trails, picnic facilities).

The jurisdiction shall have final judgment on the facilities suitability or qualification for open space.

8.2 Design Criteria For Storage Devices

For constructed wetlands and all ponds, the Project Engineer shall also incorporate the general design criteria for ponds, Section 8.3, in engineered designs.

8.2.1 Constructed Wetlands

A constructed wetland is an artificial wetland intentionally constructed on a non-wetland site for the purpose of managing stormwater runoff. Constructed wetlands may provide treatment only (have a permanent pool with no live storage) or may provide both storage and treatment (have both a permanent pool and live storage).

8.2.1.1 Design Criteria

Constructed wetlands shall be designed to satisfy the general requirements of Section 8.3 of this MANUAL. The Project Engineer shall also refer to Chapter III-4.4.3 of the *Stormwater Management Manual of the Puget Sound Basin*, February 1992, for additional specific design information.[7] All constructed wetlands shall be designed by the Project Engineer **in conjunction with a Wetlands Consultant**.

The permanent pool storage volume must be equal or exceed the minimum volume that would be provided in the permanent pool of an equivalent wet pond (i.e., three feet deep times impervious surface in watershed times 0.025). The permanent pool surface area shall be allocated according to the following areal distribution: 60 percent at less than one foot deep, 20 percent at one to three feet deep, and 20 percent at greater than three feet deep (forebay area) unless otherwise approved by the Administrator or designee.

All constructed wetlands placed in soils with a field-saturated percolation rate greater than 0.5 inches per hour shall be lined. The recommended lining is four to six inches of silt loam, sandy clay loam, or organic muck. This lining serves to provide soil and retain moisture for the required vegetation, and to remove and slow the movement of contaminants that may enter the pond. An artificial liner may be substituted if the Project Engineer can demonstrate compatibility with specified vegetation and long-term maintenance requirements.

[7] In case of conflicts, design criteria found in this Manual shall apply.

8.2.1.2 Performance Criteria for Constructed Wetland Vegetation

The Wetlands Consultant shall monitor performance of the constructed wetland vegetation for a minimum of two years. Monitoring shall occur at least yearly during the summer months. Measures of success are as follows:

1. Minimum survival of plantings shall be 80 percent. Lesser survivals may be allowed if original planting density exceeded minimums. All plants lost shall be replaced by like species unless recommended otherwise by the Wetlands Consultant and approved by the Administrator or designee.

2. Minimum percent vegetated cover of constructed wetland bottom area, excluding exotic and invasive species, at two years shall be 50 percent. If constructed wetland cover is less than 50 percent, removal of exotic/invasive species and additional plantings may be required.

The jurisdiction may require a bond or other financial guarantee to ensure measures of success are attained.

8.2.1.3 Standard Planting Specifications

The jurisdiction may allow the Project Engineer to adapt the following planting plan for use on smaller constructed wetland projects. This would normally include sites with wetted areas of one acre or less. On larger areas, the constructed wetland design must be developed by the Project Engineer in consultation with a person with education and experience in freshwater or wetland biology, or equivalent.

The constructed wetland bottom and wetted side slopes shall be planted with nursery-grown plants and shrubs.[8] The constructed wetland bottom must have suitable soil type (loam, silt loam, silty clay loam, muck) and be tilled for planting and root establishment. If the native soil is unsuitable, the constructed wetland must be over-excavated by four to six inches and refilled with one of the listed soil types. All planting shall occur between the months of October and April unless otherwise approved by the Administrator or designee.

For each 1500 square feet of constructed wetland bottom, plant at least 100 open-water or emergent plants in homogeneous groups of 10 or more, on two-foot centers. In addition, plant at least 30 shrubs on five-foot centers, midway between the low and high-water level. Shrubs may be from cuttings or stakes if appropriate to the type of plant. Plantings used must be from the recommended list in Appendix N unless otherwise approved by the Administrator or designee.

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[8] Field-harvested (wild) plants may be used with approval of the Wetlands Consultant and the Administrator.

8.2.2 Wet Ponds

A wet pond is an open pond which provides mainly physical (settling) treatment of runoff using a permanent pool of water (dead storage). Wet ponds may be constructed to provide treatment only (have a permanent pool with no live storage) or to provide both storage and treatment (have both a permanent pool and live storage).

Wet ponds shall be designed to satisfy the general requirements of Section 8.3 of this MANUAL. The Project Engineer shall also refer to Chapters III-4.4.1 and 4.4.2 of the *Stormwater Management Manual of the Puget Sound Basin*, February 1992, for additional specific design information.[9]

No planting of areas below permanent pool storage water level shall be required. All pond slopes above the permanent pool storage water level shall be hydroseeded with appropriate wetness-tolerant seed and planted with screening vegetation (shrubbery). Shrubs shall be spaced in such a manner that within one year of planting adjacent plants will have grown together to form a screen.

A wet pond shall be designed using the following criteria:

- The permanent pool area of the pond shall equal 2.5 percent of the impervious surface[10] draining to the pond.

- Permanent pool depth shall be a minimum of three feet.

- Adhere to general design criteria for ponds, Section 8.3.

- All wet ponds placed in soils with a field-saturated percolation rate greater than 0.5 inches per hour shall be lined. The recommended lining is four to six inches of silt loam, sandy clay loam, or organic muck. This lining serves to provide soil and retain moisture for the vegetation, and to remove and slow the movement of contaminants that may enter the pond.

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[9] In case of conflicts, design criteria found in this Manual shall apply.

[10] Roofs and other clean impervious surfaces that do not require treatment may be routed directly to retention/detention facilities.

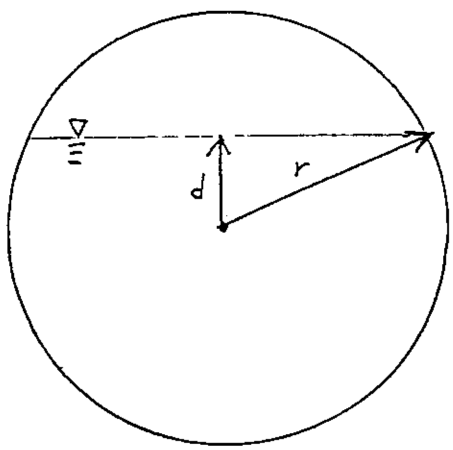
8.2.3 Wet Vaults

Refer to Appendix A, Figure A11. Wet vaults shall be designed using the following criteria:

- Drainage systems shall be designed so that the total amount of impervious surface draining to a wet vault does not exceed two acres.

- The bottom area of the vault shall equal 2.5 percent of the impervious surface draining to the vault (roof areas need not be routed through the wet vault subject to Section 4.7). The bottom area to be used is the horizontal or planar projection within and above which the water depth equals three feet when the permanent pool area is full, but just prior to discharge (see Figure 8.1). The formula for the area (in square feet) for round pipe is:

$$\sqrt{[(\text{Pipe radius})^2-(3 - \text{depth of water above center of pipe})^2]} * 2 * \text{pipe length}$$



Formula applies for all size pipe. If water depth above pipe center (d) exceeds 3 feet, area equals 2 * radius (r) * pipe length.

Figure 8.1 Determining Wet Vault Treatment Area

- Permanent pool depth shall be a minimum of three feet.

- The wet vault can also be used as a treatment and detention facility with the live storage placed on top of the permanent wet pool.

- The length to width ratio shall be as described in Section 8.3.5.

- General design criteria for all underground facilities are found in Section 8.4 See especially Section 8.4.2 for allowable materials.

8.3 Pond Design Criteria

8.3.1 Pond Outlets

Outlets for wet ponds must have a device for trapping floatable contaminants (eg, an inverted elbow).

Flow control outlets for dry ponds may be slotted weir, orifice plates, sutro weirs, notch weirs or other as approved by the jurisdiction.

Pond outlets for ponds with both live and dead storage may be sidewall underdrain systems as shown in Appendix A, Figures A8 to A10. A plastic butterfly valve or orifice plate on the underdrain outlet pipe will regulate the outflow to meet release requirements stated in Chapter 4 above.

8.3.1.1 Pond Outlets Underdrain Pipe

Underdrain pipe, other than AASHTO Designation M 36 Type III Class IV, shall be perforated. Pipe may be concrete, polyvinyl chloride (PVC), corrugated polyethylene (PE), or aluminum CMP.

Polyvinyl chloride pipe shall conform to the requirements of ASTM D 3034 SDR 35 or ASTM F 789. Fittings for PVC pipe shall be injection molded tees or factory solvent cemented saddle tees. Normally, all fittings shall be the same material as the pipe being connected except that fittings using other materials or constructed with more than one material may be used subject to the approval of the Administrator or designee. Fittings shall have sufficient strength to withstand handling and load stresses normally encountered.

8.3.1.2 Pond Outlets Butterfly Valves

All solid thermoplastic butterfly valves shall be of the lined body design and seal bubble tight with only the liner and disc as wetted parts. Butterfly valves shall be suitable for direct burial. The size of the butterfly valves shall be the same as that of the line on which they are located.

8.3.1.3 Pond Outlets Filter Fabric

Fabric tensile strength is based on standard engineering principles. When joints are necessary, filter cloth shall be spliced together with a minimum six-inch overlap.

Selection of a filter fabric is based on soil conditions at construction site (which effect Equivalent Opening Size (EOS) fabric specifications). Filter fabric shall prevent the soil found on a construction site from silting up filter media yet should have openings large enough to permit drainage. Table 8.1 shall be used as a guide in selecting filter fabric.

TABLE 8.1 SIZING OF FILTER FABRIC OPENINGS

Percent Soil By Weight	Soil Type	EOS
50 percent or less	Fine*	Equal to or smaller than sieve size that 85 percent of soil can pass through.
All Other	All Other	Max- no larger than U.S. standard sieve No. 70 [0.0083in. (0.21mm)]. Min- no smaller than U.S. standard sieve No. 100 [0.0059in. (0.15mm)].

* Fine particles smaller than U.S. standard sieve No. 200
Source: King County Drainage Manual

8.3.2 Pond Spillways

For all retention and detention facilities, a safe spillway must be provided which will pass the 100-year event without damage to the facility. The spillway will be designed assuming pond full at the beginning of the event. The spillway may be of any type (e.g., morning glory, broad crested weir, v-notch weir). The spillway shall be located at the elevation reached by runoff from the design storm event. If armoring of the spillway over the crest of the berm is necessary, grass/pavers may be used. If rock or gabions are used, cover the armoring with a minimum four-inch layer of topsoil and plant with suitable vegetation.

8.3.3 Pond Safety

Ponds shall have interior side slopes of three horizontal to one vertical or flatter unless:

- o the Project Engineer determines and the Administrator or designee agrees that site conditions make this impractical, OR

- the pond is located within an area where aesthetics are not an important consideration (e.g., an industrial site).

Facilities with side slopes steeper than three horizontal to one vertical must be provided with a barrier to entry of small children or others who may be incapable of climbing out of the facility. The barrier shall be at least a 10-foot-wide strip of thorny or otherwise impenetrable vegetation for the portion of the facility that has slopes in excess of 3:1. Vegetation type must be approved by the jurisdiction and must be in place within one growing season of pond excavation.

At the Administrator or designee's discretion, fencing may replace or supplement impenetrable vegetation. Fencing must be steel, pressure treated wood, or vinyl picket. Other materials may be accepted if they can be demonstrated to have a longevity equal to steel fencing. Fencing must be at least 42 inches high and must adequately restrict entry of small children or others who may be incapable of climbing out of the facility.

Anyone intending to construct or modify any dam or controlling works for the storage of 10 acre-feet or more of water shall submit plans and specifications to the Department of Ecology for approval as to safety, per RCW 90.03.350.

8.3.4 Pond Vegetation

All ponds shall be planted unless the Administrator or designee grants permission to use another type of lining. A landscaping plan shall be submitted describing suitable covering for the conditions expected. For wet ponds and constructed wetlands, vegetation must be suitable for varying depths, frequency, and duration of inundation found in various sectors of the pond. Refer to Sections 8.2.1 and 8.2.2 for detailed specifications on constructed wetland and wet pond plantings.

Ponds shall be planted as soon as practical after excavation and shall have well-established vegetation cover after one growing season. The Administrator or designee may approve a postponement of the planting for ponds that are to function initially as temporary sediment ponds. Proponent shall provide in the maintenance plan for the project a program of vegetation maintenance to ensure survival of plantings. The Administrator or designee shall also direct that a financial guarantee be provided to cover any required replacement of dead vegetation.

8.3.5 Treatment Pond Configuration

It is preferred that all ponds (including vaults) that are designed to treat runoff be at least five times longer than they are wide with outlet and inlet at opposite ends of the facility.

Treatment ponds whose length (distance between inlet and outlet) is less than three times its width are subject to short circuiting and shall be provided with means to prevent this such as berms (dividing the pond into cells), groins, baffles, islands, etc. See Appendix A, Figure A8.

A single pond may be replaced by a series of ponds provided that either all ponds are controlled by the same release structure or that pond routing is performed and calculations provided showing that volumes in all ponds acting in concert provide the necessary storage for design storm events.

8.3.6 Protection of Facilities from Flooding

Ponds and retention system bottoms shall be located at an elevation above the 100-year flood elevation of the nearest natural watercourse.

8.3.7 Pond Materials

Materials for ponds, if not specified in this chapter or on design drawings shown in the appendices, shall conform to materials for conveyance systems as described in Chapter 6, Section 6.9.

8.4 Underground Detention Systems (Vaults) Design Criteria

Underground facilities will be sized using criteria for treatment and detention as discussed above for open ponds. If in conformance with jurisdiction policy, vaults may be used for wet or dry pond design. See limitations described in Chapter 7. Use design shown in Appendix A, Figure A11 unless another is approved.

8.4.1 Minimum Vault Pipe Size

The minimum size allowed for a pipe vault is 36-inch diameter.

8.4.2 Materials

Materials for underground vaults shall conform to requirements for conveyance systems described in Section 6.9. Pipe material, joints, and construction procedures shall be in accordance with Standard Specifications except that materials shall be limited to:

- Aluminum spiral rib pipe
- Corrugated aluminum pipe and pipe arch
- Reinforced concrete pipe
- Corrugated high density polyethylene pipe (CPEP) - Smooth interior

No corrugated iron or steel pipe (galvanized or aluminized) will be allowed.

8.4.3 Structural Stability

All tanks shall meet structural requirements for overburden support and traffic loading if appropriate. HS-20 live loads must be accommodated for tanks lying under roadways or parking areas. Metal tank end plates must be designed for structural stability at maximum hydrostatic loading conditions. Flat end plates generally require thicker gage material than the pipe and/or require reinforcing ribs. Tanks shall be placed on native material with a suitable bedding. Tanks shall not be allowed in fill slopes.

8.4.4 Buoyancy

In moderately pervious soils where seasonal groundwater may induce flotation, buoyancy must be balanced by ballasting with either backfill or concrete backfill, providing concrete anchors, by increasing the total weight, or by providing subsurface drains to permanently lower the groundwater table.

8.4.5 Dimensions

The maximum depth to a vault invert shall be 20 feet. Spacing between access openings for tanks shall not exceed 100 feet. A 36-inch minimum diameter CMP riser-type manhole of the same gauge as the tank material may be used for access along the length of the tank. Access points must support expected wheel loads. Access must be provided to the upstream terminus of the tank if the tank is designed with a common inlet/outlet (e.g., a backup system rather than a flow through system). All tank access openings must be easily accessible by maintenance vehicles.

8.5 Retention Ponds and Trenches Design Criteria/Specifications

Sizing criteria for infiltration facilities may be found in Chapter 4. Tests for soil infiltration capacity shall be performed using procedures described in Chapter 4, Section 4.4.2. Infiltration facilities shall be designed according to the following criteria. The Project Engineer shall also refer to Chapters III-3.6.3 and III-3.6.5 of the *Stormwater Management Manual for the Puget Sound Basin*, February 1992 for additional design information.[11] All infiltration areas shall be designed by the Project Engineer **in consultation with** the Soils Professional.

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[11]In case of conflicts, design criteria found in this Manual shall apply.

8.5.1 Trenches Preferred; Open Ponds Have Limited Application

Preferred infiltration facilities shall be trenches (usually filled with a wall supporting media such as rock) excavated with a backhoe or other means which will not compact the percolation surface. (See Appendix A, Figure A13.)

Open infiltration ponds will be allowed only if the Project Engineer can ensure to the satisfaction of the Administrator or designee through specifications, notes on the plans, direction from the Soils Professional, and inspection during construction that the pond can be excavated without irreparably compacting the finished percolation surface. As a minimum, pond bottoms must be "ripped" (deep-tilled) using appropriate equipment prior to seeding.

Except where the Soils Professional certifies that soils at the infiltration facility are of Hydrologic Group A and lack significant stratification or any other features that may presently, or over time, impede drainage, infiltration pond bottoms shall be laced with trenches (see Section 8.5.11.1) to improve the contact of stormwater with underlying soils. Trenches shall be excavated a minimum of three feet below the grade of the pond bottom, or into a well-drained soil horizon where one is known to exist that can be exposed with standard excavation equipment. Trenches shall cover or underlie a minimum of 10 percent of the bottom.

8.5.2 Infiltration Facilities Under Off-Street Parking Lots

Observation wells must be placed no further than 100 feet apart. The maintenance manual for such systems must clearly state that the pavement may have to be removed for maintenance.

No infiltration facilities shall be allowed under streets or roads, public or private (if more than one parcel is served).

8.5.3 Elevation Above Groundwater

Infiltration facilities shall be sited such that their bottoms are located a minimum of three feet above seasonally high groundwater table as determined from soil logs. The Administrator or designee may approve facilities located at or below the water table where:

(a) Roof and clean impervious runoff only are being handled, or

(b) A portion of the trenches required pursuant to Section 8.5.1 are located below the water table (pond bottom must still meet clearance requirements), or

(c) In cases where "combination facilities" (retention/detention facilities following treatment with partial release to groundwater and partial surface discharge) are excavated into till or other impervious substrates. For case (c), the Soils

Professional must verify that the water table being accessed is both perched and seasonal (i.e., it is not the permanent water table), and the Project Engineer shall use only the wetted area of the downgradient sidewall in calculating the discharge in the infiltration analysis (see also Section 8.5.11.1).

8.5.4 Discharge to Interflow, Till Soils

Trench type infiltration facilities are preferred over ponds where an impervious layer (hardpan) underlies the upper soil layer (and the interflow zone is the target for infiltration))see Section 8.5.11.1).

8.5.5 Construction Sequence

To protect infiltration facilities from sedimentation, they shall be constructed after site work, roads, utilities, permanent erosion control measures, and landscaping are in place in the tributary area above the facility.

8.5.6 Inspection

The Project Engineer or his/her designee shall inspect infiltration facilities before, during, and after construction as necessary to ensure facilities are built to design specifications, that proper procedures are employed in construction, that the infiltration surface is not compacted, and that protection from sedimentation is in place.

The Soils Professional shall perform a sufficient number of infiltration tests and/or soil logs after construction to determine that the facility will operate as designed.

The Project Engineer shall report to the Administrator or designee as per Chapters 2 and 3.

8.5.7 Procedure for Start-Up

After the facility is constructed, the inlet into the system will remain plugged until the jurisdiction has verified that the tributary area has been stabilized and the Project Engineer or Soils Professional has performed a sufficient number of infiltration tests and/or soil logs as described in Chapter 4, to confirm to the satisfaction of the Administrator or designee that the site still percolates at the design rate.

8.5.8 Construction Procedures to Avoid Compaction

Project plans and specifications must describe construction procedures, barricades, etc that will positively prevent the crossing of heavy equipment over the finished area to be used for the infiltration facility.

8.5.9 Setbacks for Infiltration Facilities

Setbacks for infiltration facilities from structures, steep slopes, etc., are given in Table 2.3.

8.5.10 Maximum Slope for Location of Infiltration Facilities

Consult the jurisdiction's critical areas or environmentally sensitive areas ordinance for information on placement of infiltration facilities on (or setbacks from) steep slopes or landslide hazard areas. In the absence of applicable regulations, infiltration facilities shall be prohibited from all slopes exceeding 40 percent. Facilities may not be placed on slopes exceeding 15 percent or within 50 feet of top of slope, except where determined to be feasible by a geotechnical engineer and approved by the Administrator or designee.

8.5.11 Design Specifications

All retention facilities must be designed to drain dry within a 48-hour period after the Design Event.

8.5.11.1 Design Specifications for Infiltration Trenches

Refer to Appendix A, Figure A13.

- The bottom area of trenches and 25 percent of the sidewall may be counted in sizing the area required for infiltration unless the target for infiltration is the interflow zone (See Section 8.5.4). See Chapter 4, Section 4.4 for method to determine design infiltration rate.

- The media of the trench should be wrapped with filter fabric to prevent the sediment from reaching the percolation face. Clean, washed stone aggregate or other approved media shall be used. Part of the media may be replaced by perforated pipe (maximum diameter up to the width of the trench) to increase the effective storage volume.

- Trenches shall be covered the same day they are opened.

- Trenches shall be no wider than can be excavated by a backhoe straddling the trench.

- Parallel trenches shall be spaced no closer than 10 feet except that trenches whose target for discharge is the interflow zone. If hardpan is less than six feet below finished grade, or the trench is excavated to closer than three feet of hardpan (whatever the depth), then the target for infiltration is the interflow zone and:

    - Trenches must, as nearly as practical, follow a contour line.

- The facility must be designed to infiltrate only through the downslope sidewall.

- Parallel trenches shall be spaced no closer than 25 feet apart.

See also Sections 8.5.3 and 8.5.4 above.

8.5.11.2 Design Specifications Bottom Slope

All open pond type infiltration facility bottoms shall have zero slope to achieve even ponding over the percolation surface. Trench type infiltration facilities bottom slopes shall be less than five percent.

8.5.11.3 Other Specifications

For criteria for materials, spillways, ponds safety, vegetation refer to Section 8.3.

8.5.12 Operation and Maintenance of Infiltration Facilities

The Project Engineer shall prepare a maintenance manual for infiltration facilities and the associated pre-treatment facilities. It shall contain at a minimum the following elements:

- Heavy Equipment. In maintaining an infiltration facility, no heavy equipment (e.g., a truck, tractor, backhoe, bulldozer) may be driven over the finished infiltration area. Special maintenance procedures are required to ensure that the media does not become compacted and the infiltration facility continues to accept flow at the design rate.

- Loss of Capacity. Alternatives for restoring a failing facility shall be included. The following are examples:

    - If an open pond facility loses infiltration capacity the floor of the facility may be tilled and replanted.

    - For any type of infiltration facility, if too much fine or organic material has worked into the soil, infiltration capacity will continue to wane. Another alternative is using equipment that will not compact the infiltration surface, excavate several feet of soil from the bottom to remove the fine particles of silt and organic material clogging the facility.

    - In the event of irredeemable failure, the facility must be enlarged if space is available. If not, the system must be under-drained and partially discharged to surface water.

- Erosion in the Tributary Area. Eroded sediments can quickly clog an infiltration facility. Eroding or barren soils in the subbasin tributary to an infiltration facility shall be stabilized prior to completing excavation of the infiltration facility (for ponds), or routing stormwater to the infiltration facility (for trenches).

- Equipment Specifications. The Project Engineer shall describe types of equipment to be used, how it is to be used, and what types of equipment cannot be used. An estimate of the maintenance schedule, man-hours, and equipment hours shall be provided.

8.5.13 Management of Runoff from Single-Family Residential Roofs and Clean Impervious Surfaces

Runoff from roofs and clean impervious surfaces[12] must be infiltrated onsite where practicable. Depending upon site-specific factors, such as size, topography, and soils, this runoff shall be conveyed to a drywell, an available and adequately sized offsite retention/detention facility (such as for a subdivision), or an onsite retention/detention area. This runoff does not require pretreatment prior to the chosen storage/disposal practice provided that it is not mixed with other runoff that does require treatment.

8.5.13.1 Design Criteria

Roof runoff shall be handled to retain all runoff onsite where possible, and in any case to mitigate the impacts of runoff on adjoining properties. Acceptable methods are splashblocks, drywells, and small retention ponds. Designs shall be in compliance with the setback requirements shown in Table 2.3, as well as applicable Uniform Building Code specifications.

Splashblocks may be used only where runoff can be directed away from the structure and property lines onto a flat portion of the lot, and where the lot size is such that runoff would be expected to be contained onsite (use 10,000 square feet as a guideline).

Drywell design, where required, shall be based upon one or more soil tests done by a Soils Professional as defined in this MANUAL. The Soils Professional shall recommend the completion (bottom) depth of the drywell based upon soil texture and topographic factors. The controlling soil texture shall be used to determine the required drywell volume. The Administrator or designee may waive the soil test requirement if soils information available to the jurisdiction for the site is deemed to be adequate.

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[12]Clean impervious surfaces include those surfaces not intended for regular motor vehicle traffic, such as sidewalks, patios, tennis courts, and fire lanes.

Drywell sizes based on soil texture (per 1000 square feet of roof area) shall be provided according to Table 8.2. Use of drywells is not recommended for soils with field-saturated percolation rates less than two inches per hour (loam soil).

Where individual lot drywells are to be installed in a residential subdivision, the Project Engineer shall determine the required size using Table 8.2 for each lot or group of lots with similar soils. The Project Engineer shall then record these sizes as necessary to ensure that they become restrictions for future building applications (e.g., record written conditions for lots and/or dictate drywell size on the face of the final plat mylar, etc., see Section 2.4.3).

Onsite retention/detention ponds shall be sized in accordance with minimum MANUAL requirements for storage for impervious areas tributary to the pond (Section 4.1.2). Roof runoff shall be conveyed by pipe to the pond. Driveway runoff shall also be routed to the pond where feasible. General pond design criteria shall include the following:

- Locate pond adjacent to right-of-way or in such a manner as to facilitate homeowner maintenance and avoid impacts on adjoining property.

- Integrate ponds into lawn areas, with gentle side slopes, shallow depths, and wetness-tolerant grass throughout.

- Provide ponds with a flat bottom and a small area depressed on one side to allow overflow. Do not direct overflow across sidewalks.

- Show ponds on building applications so that property owners are made aware of the necessity to maintain ponds as designed.

Where roof runoff is to be routed to a subdivision's retention/detention facility, conveyance shall be such that runoff does not damage adjoining properties and is not directed across a sidewalk.

TABLE 8.2 ROOF DRYWELL SIZES BY SOIL HYDROLOGIC GROUP

Soil Hydrologic Group	Total Volume Required Per 1000 Square Feet of Roof[1]
A or B (Sand, loamy sand, sandy loam, loam)	125 cubic feet
C (Silt loam, sandy clay loam, "till" soils with Group A or B surface horizons)	250 cubic feet
D (Silts, clays, rock outcroppings, "till" soils with Group C or D surface horizons)[2]	750 cubic feet

[1]Volume includes rock backfill. Trench size may be reduced if pipe or other open structure replaces a portion of the rock backfill; contact the jurisdiction for guidance.

[2]Drywells are not recommended for Hydrologic Group D soils due to extremely slow percolation rates. Drywells should be used only if other reasonable alternatives are infeasible.

CHAPTER 9 - EROSION CONTROL STANDARDS AND POLICIES

This chapter is intended to cause structures to be built and Best Management Practices (BMPs) to be followed to prevent sediment from crossing a project's boundaries or entering water bodies. Standard structures and devices shown are commonly used to prevent erosion and/or trap sediment. However, there is no practical limit to the number, variations, and types of such devices. Nothing in this MANUAL is intended to limit the approaches to erosion control provided the Project Engineer demonstrates to the satisfaction of the Administrator or designee that they will meet the intention of this chapter.

While erosion control is effective at controlling sediment release from construction sites, other pollutants may still be flowing offsite. Careful storage and handling of construction materials such as paints, adhesives, and paving materials is important. The local jurisdictions can provide technical assistance to area engineers, developers, and other businesses on how to reduce pollution from construction sites.

9.1 Most Construction Projects Must Have Erosion Control

Erosion control measures shall reflect the site's soil conditions, topographic features, and hydrology. The Project Engineer shall evaluate both the proposed development site for susceptibility to erosion and downgradient areas for sensitivity to damage from eroded sediments. The applicant shall identify, to the best of their ability, and adequately provide for areas that may be prone to severe erosion (e.g., highly erodible soils and/or steep slopes) and areas, on and offsite, that are especially vulnerable to damage from erosion and/or sedimentation.

Erosion control techniques that prevent soil from eroding rather than treat runoff are preferred. The Project Engineer and Proponent shall take reasonable steps to phase projects such that the areal and time extent of disturbed and exposed soils is minimized. Erosion **prevention** practices that maintain soil integrity and stability, such as project phasing, runoff diversion, and the maintenance or establishment of vegetation or mulch cover, shall be emphasized over erosion **treatment** practices.

For projects requiring Drainage and Erosion Control Plans (see Chapter 2 for threshold; submittal requirements described in Chapter 3), a plan for protection during construction and for permanent protection of slopes and excavated surfaces must be submitted as part of the erosion control plan.

For projects requiring an Abbreviated Plan (see Chapter 2 for threshold; submittal requirements described in Chapter 3), exemption from submission of Drainage and Erosion Control Plans is conditioned upon the use of BMPs specified by the jurisdiction to ensure that no sediment will leave the site.

Temporary erosion control facilities shall not be removed before the site is stabilized to the satisfaction of the Administrator or designee. (See Chapter 2, Section 2.4).

9.2 Discharge of Sediment From the Site

Sediment from the construction must be trapped and prevented from leaving the project site or entering streams, drainage ways, wetlands, or other environmentally sensitive areas. Private and public property down gradient of the project site shall be protected against erosion during construction caused by excess runoff resulting from the Project.

9.3 Design Event for Construction of Erosion Control Facilities

Temporary erosion control facilities such as ponds, filters, traps, revetments, slope armoring, and other related facilities must be designed for the 2-year, 24-hour storm event unless otherwise specified in the design guidance.

9.4 Wet Season, Dry Season Requirements For Site Stabilization

9.4.1 Dry Season (May 1 to October 31)

Refer to Table 9.1. Unless the Administrator or designee approves otherwise, exposed soils shall be sodded, hand planted, hydroseeded, or otherwise stabilized within 30 days of reaching finished grade. Irrigation and other maintenance as needed shall be provided to ensure formation of a stable root structure.

Note that erosion control for conveyances and biofilters may be subject to different conditions. See Chapter 6, Section 6.2.2, and Chapter 7, Section 7.4.1.

9.4.2 Wet Season (November 1 to April 30)

Refer to Table 9.1. Unless the Administrator or designee approves otherwise, soil shall be stabilized within 48 hours after stop of work in any area that will remain unworked for 30 days or more.

Unless the Administrator or designee approves otherwise, stabilization of all exposed areas will be required within 48 hours after reaching finished grade. However, areas less than 5000 square feet and greater than 100 feet from a conveyance (e.g., pavement, inlet, drainage channel, stream) may be stabilized in up to seven days.

Unless the Administrator or designee approves otherwise, areas over 5000 square feet to be paved must be provided a crushed rock subbase or other approved armoring within a minimum of seven days after reaching grade.

TABLE 9.1 WET/DRY SEASON REQUIREMENTS FOR SITE STABILIZATION

Season	Area (Sq Ft)	Time Allowed to Stabilize	Remarks
Dry	All[1]	30 days	
Wet	All[1]	48 hours	If not to be worked 30 days
Wet	> 5000	48 hours	
Wet	< 5000	7 days	Unless close to conveyance
Wet	> 5000	7 days	Pave subgrade

[1] The Administrator or designee may, for a single-family residence, approve up to a six month delay for planting of permanent vegetation if temporary erosion controls are maintained and no special erosion concerns exist (e.g., steep site, near critical area).

Note that erosion control for conveyances and biofilters may be subject to different conditions. See Chapters 6 and 7.

9.5 Staking, Clearing, and Grading Limits

Notes on plans shall call out that clearing and grading limits shall be staked in the field before excavation. Trees to be saved must be fenced at the drip line or otherwise protected as directed by the Administrator or designee.

9.6 Erosion Control Facilities to be Built First

Sediment and erosion control measures as required in the Drainage and Erosion Control Plan or Abbreviated Plan shall be in place and functioning before clearing and grading begins.

9.7 Erosion Control at Shorelines

Erosion of cut and fill slopes at or near the shore of natural water bodies shall be prevented. No person shall dump or place earth into or in such proximity to water bodies, wetlands, or drainageways such that the material may reasonably be expected to slough, slide, or erode into them.

Exposed soil at stream crossings or near other natural water bodies which could slough into the water shall not be left at an angle steeper than two horizontal to one vertical unless it is engineered and reinforced to withstand sloughing and erosion. The toe of the exposed slope must not reach the shore of the natural water body. A silt fence (or other approved trapping device) shall be placed at the toe of the slope.

Exposed soil in the immediate tributary area to a water body (that is, too near the water body for sediment traps) must be stabilized on a daily basis. Examples of stabilization measures are: covering slope with plastic, straw mats, or geotextiles, or other means which will positively prevent erosion. Roads (and approaches as necessary) over culverts shall be stabilized with crushed rock (or other approved means) within 24 hours of reaching grade.

Hydraulic Project Approval permits (State of Washington Department of Fisheries and Wildlife) are required for work at stream crossings. Contact the jurisdiction regarding requirements of an "environmentally sensitive" or "critical" area ordinance.

9.8 Sediment Traps

Sediment traps are usually temporary ponds to trap sediment before it leaves a construction site. (See Appendix B, Figure B1.)

9.8.1 Use of Retention Facilities for Sediment Traps

A retention facility may not be used for temporary sediment and erosion control. The Administrator or designee may allow an exception to this requirement under the following conditions:

- Sediment trap is left at least two feet above finished grade for the infiltration facility.
- Sediment trap is completely lined with filter fabric or other device to prevent migration of sediment to the plane of infiltration.
- The Project Engineer or his/her designee is on the project site continuously during the hours of construction, inspecting the excavation and the placement of filter fabric and/or other protective devices.
- Other conditions necessary in the judgment of the Administrator or designee to protect the retention facility.

If a permanent stormwater detention facility will be used for a temporary sediment pond, describe how and when the sediment will be removed.

9.9 Erosion Control on Exposed Slopes

Concentrated flows that would cross an exposed slope shall, to the maximum extent practicable, be diverted or contained to prevent erosion, sedimentation, and undermining of slope stability. The slope's surface shall be contour plowed to retard the flow of stormwater and, where necessary, interceptors, check dams, cribbing, rip rap, or other appropriate measures shall be employed to minimize erosion and maintain slope stability. See also Section 9.14.9. See Uniform Building Code for height, terracing, toe drain, etc., requirements on cut or fill slopes.

9.10 Prevention of Soil Loss When Trenching

The construction of trenches (e.g., pipes, underground utility lines) shall be subject to the following criteria and notes on the plans or specifications shall require that:

- No more than 500 feet of trench on a downslope of more than five percent shall be opened at one time.
- Excavated material shall be placed on the uphill side of trenches.
- Trench dewatering devices shall be discharged in a manner that will not adversely affect flowing streams, drainage systems or offsite property. Sediment-laden water discharged from trench dewatering pumps shall be routed through a sediment pond or trap. Water pumped from building foundations shall, at a minimum, be routed through silt fence.

9.11 Best Management Practices During Construction

9.11.1 Protection for Storm Sewer Inlets

Refer to Appendix B, Figure B8. Storm sewer inlets receiving runoff from the project site during construction shall be protected so that sediment-laden water will be filtered before entering the conveyance system.

9.11.2 Dust Control

As necessary, or by order of the Administrator or designee, spray dry soil with water or approved dust palliative.

9.11.3 Stockpile Management

Soil stockpiles shall be set back at least 50 feet from down gradient drainage features (e.g., channels, catch basins, detention ponds, pavement, stream banks, environmentally sensitive areas).

Stockpiles must be completely covered with plastic (or otherwise stabilized) on the schedule described for areas greater than 5000 square feet in Section 9.4. Also see Section 9.14.17. If there is no practical alternative, the Administrator or designee may allow a stockpile within the 50-foot setback with the condition that it shall be stabilized daily.

No material shall be stockpiled on pavement without authorization from the Administrator or designee which will be conditional on implementation of a procedure to prevent sediment transport.

9.11.4 Construction Entrances

Construction site entrances are egress points for vehicles onto paved roadways. All projects which will have vehicular traffic shall have a means to prevent vehicles from tracking soil from the site. For example, the Project Engineer may specify stabilized construction entrance rock pad at every egress point (refer to Appendix B, Figure B16). The Proponent shall maintain the entrance(s) as necessary to ensure proper functioning of pad.

The Administrator or designee may require stabilization of interior roadways and car parks to keep sediment contained.

If sediment is tracked offsite, sediment shall, on a daily basis, be swept or shoveled from the paved surface before washing.

Runoff from construction entrances shall be directed to sediment ponds or traps where these have been otherwise provided on development sites.

9.11.5 Erosion Control Facilities Must Be Maintained

Erosion control facilities shall not be allowed to fall into disrepair. The Proponent or designee shall inspect facilities during and after rainfall events to ensure that they continue to function effectively. Repairs shall be made as soon as possible during rainfall events. The Project Engineer shall provide the Proponent (and include in the Drainage and Erosion Control Plan) an inspection schedule for the erosion control facilities. The schedule shall include a notation indicating the person responsible for implementation and shall be printed in the Standard Notes on the erosion control plan/blueline drawing for the development project.

9.12 Permanent Restoration

Temporary erosion control measures may not be removed until the site is permanently restored to the satisfaction of the Administrator or designee. For projects that expose more than 20,000 square feet of earth or contain or adjoin drainageways or environmentally sensitive areas, or occur on slopes over 15 percent, the Administrator or designee may require a restoration plan that shall consider vegetation types, mulching/armoring, and/or maintenance to affect the following:

- Erosion and sediment control
- Soil and slope stability
- Protection of drainageways and environmentally sensitive areas.

All temporary erosion control measures shall be removed within 30 days after final site stabilization has been achieved or after the measures are no longer needed. Sediment collected in traps, ponds, or silt fence shall be removed and disposed in an approved manner or stabilized on site. Disturbed soil areas resulting from sediment removal shall be permanently stabilized within seven days.

9.13 Limitations of Erosion Control Techniques

The Project Engineer shall design erosion control systems using practices that are appropriate to the site. Table 9.2 provides general guidance on usage for the most common erosion control practices. Additional detailed guidance on erosion control applications is available in the *Stormwater Management Manual for the Puget Sound Basin*, Department of Ecology, February 1992 (see especially pages II-2-2 and II-2-26). Other devices may be allowed with permission of the Administrator or designee if deemed suitable for the situation.

9.14 Design and Operational Standards

The following is design guidance for several of the most common sediment and erosion control practices. Additional, more detailed information is provided in Volume II of the *Stormwater Management Manual of the Puget Sound Basin*, February 1992, (see especially Chapter II-5, "Standards and Specifications for Best Management Practices for Erosion and Sediment Control)." This volume from the Department of Ecology manual provides detailed information on the purpose, conditions of use, advantages and disadvantages, design criteria, and maintenance for 30 of the most common erosion and sediment control practices.

The Project Engineer shall select those practices needed to prepare the Erosion Control Plan required per Section 3.1.2 of the MANUAL. The Project Engineer must demonstrate to the satisfaction of the Administrator or designee that the selected practices are designed (sized) correctly and combined in an appropriate manner to satisfy the conditions of use. The Administrator or designee may allow variations to the standard practices, or use of practices not contained in this MANUAL or the Department of Ecology manual, upon successful demonstration of effectiveness by the Project Engineer. The Project Engineer and Proponent shall be responsible for ensuring that the approved erosion control system is installed and maintained properly, and that the system provides satisfactory control for site runoff. Based on observed performance of the erosion control system, the Project Engineer, the Administrator or designee, or the jurisdiction's authorized site inspector shall have the authority to require that the Proponent and their contractors install additional erosion control measures where those specified in the Drainage and Erosion Control Plan are not fully effective.

TABLE 9.2 LIMITATIONS OF EROSION AND SEDIMENTATION CONTROL TECHNIQUES

Technique/ Device	Max. Drain. Area (acres)	Max. Velocity (fps)	Max. Discharge	Slope (H:V)	Comments
Sediment Pond, Trap	Dependent on load capacity of pond*	Dependent on settling vel. of particles	N/A	N/A	* See Ecology Manual for information on computing sediment load
Silt/Filter Fabric Fence	1	N/A	.05 to .1 cfs/sq ft	1:1	Selection of fence based on soil conditions
Straw or Hay Bale Barrier	0.25	N/A	0.01 cfs/sq ft	1:1	Not to be used in high sediment producing areas Length of slope should be less than 100 ft (50 ft if slope is greater than 10%)
Brush Bern	0.25	N/A	0.1 cfs/sq ft	N/A	
Sandbag Berm	5	N/A	N/A	N/A	
Rock Berm	5	N/A	1 cfs per 8 lin. ft. 0.1 cfs/sq ft	*	* Slope dependent on spacing of berms
Triangular Sediment Filter Dike	1	N/A	0.05 cfs/sq ft	N/A	
Perimeter Dike	5	N/A	N/A	*	* Dependent on spacing between dikes
Gravel Outlet Structure (temp.)	5	N/A	N/A	N/A	

REFERENCES:

- King County Surface Water Design Manual, draft, 1988
- City of Austin, Texas, Environmental Criteria Manual, 1988
- Henrico County Virginia Erosion and Control Handbook, 1979
- Stormwater Management Procedures and Methods, 1977, Snohomish County
- Puget Sound Stormwater Management section on Erosion and
- Sediment Control During Construction, draft 1988.

Construction drawings must list standard notes for each practice used. The notes provided in Appendix T (or equivalent) shall be used by the Project Engineer in developing erosion control designs and shall be placed on the construction drawings. The Project Engineer shall derive additional notes as needed to ensure that contractors have clear and complete instructions on installing and maintaining erosion control practices.

9.14.1 Filter Fabric Fences

Refer to Appendix B, Figure B2 and Appendix T for standard notes regarding this practice. In addition to limitations shown in Table 9.2, the Project Engineer shall adhere to the following guidelines:

- 100-foot maximum sheet or overland flow path length to the fence.
- No concentrated flows greater than 0.5 cfs.

9.14.2 Straw/Hay Bale Barriers

Refer to Appendix B, Figures B3 and B4 and Appendix T for standard notes regarding this practice. Straw/hay bale barriers consist of a row of entrenched and anchored straw or hay bales installed across the toe of a slope. These barriers are temporary and have a life expectancy of two months or less. Straw/hay bales may be used in conjunction with filter fabric in areas where fence posts cannot be driven.

The purpose of straw/hay bale barriers is to 1) intercept and detain small amounts of sediment from disturbed areas of limited extent in order to prevent sediment from leaving the site, and 2) decrease the velocity of sheet flows and low level channel flows. **For most applications, straw/hay bale barriers are not a substitute for filter fabric fences as they are short-lived and provide very little filtration of sediment.**

In addition to the limitations shown in Table 9.2, the Project Engineer shall adhere to the following standards:

- Straw and hay bales may be used below areas subject to sheet and rill erosion. The size of the drainage area is to be no greater than 0.25 acre and the length of the slope behind the barrier should be no greater than 100 feet. If the slope has a gradient greater than 10 percent, slope length should be no more than 50 feet.
- There shall be no concentration of water or possibility of a washout in a channel above the barrier.

See Appendix T for standard notes regarding this practice.

9.14.3 Brush Barrier

Refer to Appendix B, Figure B5, and Appendix T for standard notes regarding this practice. In addition to the limitations shown in Table 9.2, the Project Engineer shall adhere to the following standards:

- Minimum height = three feet
- Minimum width = five feet at its base.
- The jurisdiction may require a filter fence anchored over the brush berm to enhance the filtration ability of the barrier.

9.14.4 Gravel Filter Berm

Refer to Appendix B, Figure B5, and Appendix T for standard notes regarding this practice. Maximum area to be drained is five acres.

9.14.5 Sandbag Berm

Refer to Appendix B, Figure B6, and Appendix T for standard notes regarding this practice. A sandbag berm is a temporary berm constructed of stacked sandbags installed across a channel or right-of-way in a developed or disturbed area. Its purpose is to intercept sediment-laden water from disturbed areas, detain sediment, and release water in sheet flow.

9.14.6 Triangular Sediment Filter Dikes

Refer to Appendix B, Figure B7, and Appendix T for standard notes regarding this practice. Triangular sediment filter dikes are temporary barriers constructed of wire mesh and geotextile fabric, installed along a flat area or across the toe of a slope.

The purpose of a triangular sediment filter dike is to intercept and detain water-borne sediment from unprotected areas of limited extent.

They are to be used where there is no concentration of water in a channel or other drainageway above the barrier. If a concentrated flow does occur after installation, corrective action must be taken such as placing rock berms in the areas of concentrated flow.

9.14.7 Inlet Sediment Protection

Refer to Appendix B, Figures B8 and B9, and Appendix T for standard notes regarding these practices. Standard inlet protection techniques are intended for filtration of small amounts of sediment. They should be practiced only in areas where flooding of rights-of-way or private property when water backs up as a result of the practice is acceptable. **The placement of a length of filter fabric cloth under a catch basin grate is not an acceptable practice.**

Drop-in catch basin filters may be used in place of other standard inlet protection practices. In contrast to standard practices, this inlet protection technology can be used in situations where right-of-way flooding would be problematic. To maintain function, filters shall be removed and cleaned or replaced after each storm event. Contact the jurisdiction to determine its acceptance of specific filter products.

9.14.8 Pipe Slope Drains

Refer to Appendix B, Figure B10, and Appendix T for standard notes regarding this practice.

The entrance shall consist of a standard flared end section for culverts with a minimum six-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance shall be at least three percent.

9.14.9 Stair Stepping Cut Slopes And Grooving Slopes

Refer to Appendix B, Figure B11, and Appendix T for standard notes regarding this practice.

Graded areas with slopes greater than 3:1 but less than 2:1 shall be roughened before seeding. This can be accomplished in a variety of ways, including "trackwalking," or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours. Tread imprints trap seeds and encourage plants to become established.

Graded areas steeper than 2:1 shall be stair-stepped with benches as shown in Appendix B, Figure B11. The stair-stepping will help vegetation become established and also trap soil eroded from the slopes above.

9.14.10 Erosion Control Blankets

Refer to Appendix B, Figure B12, and Appendix T for standard notes regarding this practice.

Site Preparation - Before installing, all needed surface runoff control measures such as gradient terraces, interceptor dike/swales, level spreaders, and sediment basins shall be in place.

Erosion blankets (nets and mats) may be used on level areas, on slopes up to 2:1, and in waterways. Where soil is highly erodible, net shall only be used in conjunction with an organic mulch such as straw and wood fiber. Jute net shall be heavy, uniform cloth woven of single jute yarn, which if 36 to 48 inches wide shall weigh an average of 1.2 lbs/linear yard. It must be so applied that it is in complete contact with the soil. If it is not, erosion will occur beneath it. Netting shall be securely anchored to the soil with No. 11 gauge wire staples at least six inches long.

9.14.11 Temporary Interceptor Dikes and Swales

Refer to Appendix B, Figure B13 and Appendix T for standard notes regarding these practices.

9.14.11.1 Dikes and Swales Criteria

Interceptor dikes shall meet the following criteria:

Dimension	Criteria
Top Width	Two feet minimum
Height	18 inches minimum. Measured from upslope toe and at a compaction of 95 percent proctor (See Standard Specifications).
Side Slopes	2:1 or flatter
Grade	Topography dependent, except that dike shall be limited to grades between 0.5 and 1.0 percent.

Interceptor swales shall meet the following criteria:

Dimension	Criteria
Bottom Width	Two feet minimum; the bottom width shall be level
Depth	One-foot minimum
Side Slope	2:1 or flatter
Grade	One to three percent with a positive drainage to a suitable outlet (such as a sedimentation pond)

9.14.11.2 Dikes and Swales Spacing

Horizontal Spacing of Interceptor Dikes:

Slope	Spacing (feet)
< 5 percent	300
5-10 percent	200
10-40 percent	100

9.14.11.3 Dikes and Swales Stabilization Action

Slope	Action
< 5 percent	Seed and mulch applied within five days of dike construction (see vegetation).
5-40 percent	Dependent on runoff velocities and dike materials.

9.14.11.4 Dikes and Swales Outlet

The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment laden runoff must be released through a sediment trapping facility.

9.14.12 Temporary Gravel Outlet Structure

Refer to Appendix B, Figure B14, and Appendix T for standard notes regarding this practice.

A temporary gravel outlet is an auxiliary structure installed in conjunction with and as part of an interceptor dike or other structure designed to temporarily pond sediment-laden surface runoff. This provides a means of draining the storm runoff which is collected behind a structure while retaining the sediment.

Maximum drainage area is five acres.

Gravel shall be 5/8-inch minus washed rock. A layer of filter fabric shall be embedded in the gravel.

Minimum length in feet of the gravel outlet structure shall be equal to six times the number of acres of contributing drainage area. The invert of the gravel outlet shall not be less than six inches lower than the minimum elevation of the top of the dike.

Water shall be discharged from the gravel outlet onto an already stabilized area or into a stable watercourse.

The Proponent or designee shall inspect gravel outlet structure after each runoff-producing rain. The gravel must be replaced when the structure ceases to function as intended due to sediment accumulation among the gravel.

9.14.13 Check Dams

Refer to Appendix B, Figure B15, and Appendix T for standard notes regarding this practice.

Maximum area to be drained is 10 acres.

Check dams can be constructed of either rock or logs. The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

Rock check dams shall be constructed of two- to four-inch diameter rock. The rock must be placed by hand or mechanical placement (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.

Log check dams shall be constructed of four- to six-inch diameter logs. The logs shall be embedded into the soil at least 18 inches.

In the case of grass-lined ditches and swales, check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

Check dams shall be checked for sediment accumulation after each significant rainfall. Sediment shall be removed when it reaches one half of the original dam height or before.

9.14.14 Plastic Covering

Plastic covering may be used on bare slopes which require immediate protection from erosion.

Clear plastic may be used in areas which have been seeded during the period from November 1 to March 31. Clear plastic covering provides light to promote germination and growth of the seeds.

See Appendix T for standard notes regarding this practice.

9.14.15 Mulching

Mulch provides immediate protection to exposed soils during periods of short construction delays, steep slopes, or over winter months through the application of plant residues and other suitable materials.

Mulches shall be used in areas with slopes greater than 2:1.

Mulching shall be used immediately after seeding or in areas which cannot be seeded because of the season.

If clear plastic sheeting is not used, mulch may be applied to exposed surface soils, including stockpiles, which are not to be final graded within 15 days.

See Table 9.3 for guides to mulch materials, rates, and uses.

See Appendix T for standard notes regarding this practice.

9.14.16 Erosion Control Seeding

Erosion control seeding may be used where permanent structures are to be installed or extensive grading of the area will occur before the establishment of permanent vegetation. Seeding will reduce erosion and sedimentation by stabilizing exposed soils that will not be brought to final grading or permanent cover treatment or vegetation within 15 days of the exposure. Seed mixture shall be as shown in Table 9.4. For other seed mixtures, use local supplier recommendations and approval from jurisdiction.

The Project Engineer shall be guided by the following design criteria:

- Seed not to be used in areas subject to wear by construction traffic.
- Channels and biofilters have separate criteria for vegetative armoring. See Chapters 6 and 7.
- Practice may be applied in areas sloping up to 10 percent for 100 feet or less.

TABLE 9.3 GUIDE TO MULCH MATERIALS, RATES, AND USES

Mulch Material	Quality Standards	Application Rates: Per 1000 Sq Feet	Application Rates: Per Acre	Depth of Application	Remarks
Gravel, Crushed Stone, or Slag	Washed 3/4 to 1½-inch	9 CY		3 In	Good for short slope and around woody plants and ornaments. Use where subject to foot traffic
Hay or Straw	Air dry. Free from weed seed and coarse material.	75 to 100 pounds (Approx 2 In Thick)	1.5 to 2.5 Tons 90 to 120 Bales	Min 2 In	Use where needed for more than 3 mos. Subject to blowing))keep moist or tied down
Wood Fiber Cellulose (Partly digested wood fibers)	No growth organism inhibiting factors	20 to 30 pounds	1000 to 1500 pounds		When used on critical areas, double application rate. Apply with hydromulcher. No tie-down required.

TABLE 9.4 SEED MIXTURE FOR EROSION CONTROL

Name	Proportions by weight	Percent Purity	Percent Germination
Redtop (Agrostis alba)	10 percent	92	90
Annual rye (Lolium multiflorum)	40 percent	98	90
Chewings fescue (Festuca rubra commutata) (Jamestown, Banner, Shadow, or Koket)	40 percent	97	80
White dutch clover (Trifolium repens)	10 percent	96	90

- Apply the seed mixture shown in Table 9.4 to the prepared seed bed at a rate of 120 pounds per acre.

See Appendix T for standard notes regarding this practice.

9.14.17 Topsoiling

Topsoiling provides a suitable growth medium for final site stabilization with vegetation. Preservation or importation of topsoil is determined to be the most effective method of providing this growth medium.

Apply to areas with highly dense or impermeable soils, where mulch and fertilizer alone would not provide a suitable growth medium and where slopes do not exceed 3:1.

Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sand clay loam, clay loam).

Stripping shall be confined to the immediate construction area. A four- to six-inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place before stripping.

9.14.18 Stabilization With Sod

Sod stabilizes soil, reduces damage from sediment and runoff to downstream areas, and enhances natural beauty by establishing long-term stands of grass. Sod shall be used on sites which can be maintained with ground equipment (slopes not to exceed 2:1).

9.14.19 Construction Road Stabilization

Construction Road Stabilization is used wherever rock-based roads or parking areas are constructed, whether permanent or temporary, for use by construction traffic. This practice provides erosion protection to subdivision roads, parking areas, and other onsite vehicle transportation routes immediately after grading.

A six-inch depth of two-inch to four-inch crushed rock, gravel-base, or crushed surfacing base course shall be applied immediately after grading or the completion of utility installation within the right-of-way. A four-inch course of asphalt treated base (ATB) may be used in lieu of crushed rock.

Where feasible, alternative routes shall be made for construction traffic; one for use in dry conditions, the other for use in wet conditions.

Temporary roads shall follow the contour of the natural terrain to the extent possible. Slope shall not exceed 15 percent. Roadways shall be carefully graded to drain transversely. Drainage swales shall be provided on each side of the roadway in the case of a crowded section, or on one side in the case of a super elevated section.

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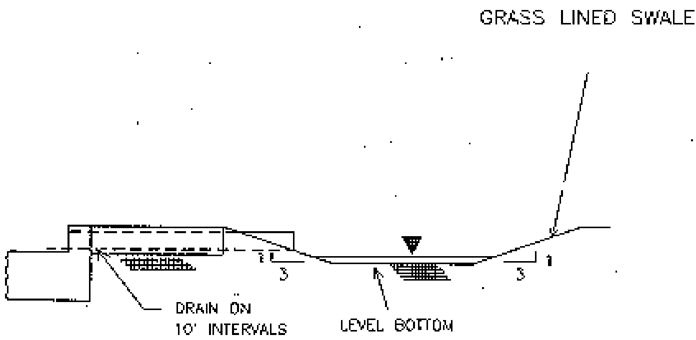
APPENDIX A

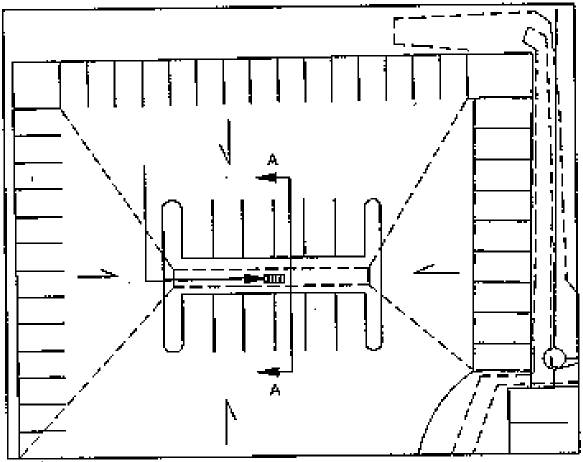
DRAINAGE DESIGN STANDARDS



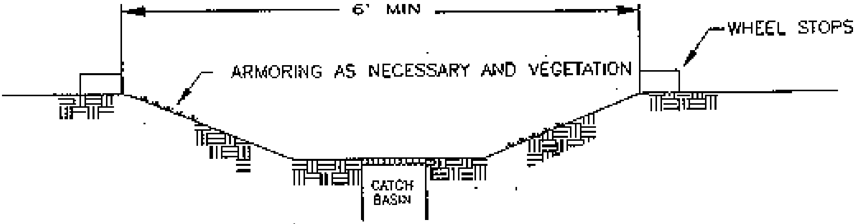
REFERENCE:

DATE:
JULY 1988

BIOFILTRATION SWALE



PLAN



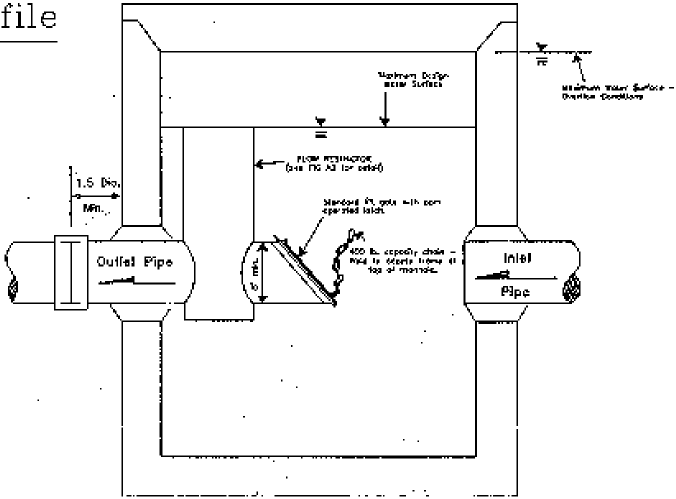
SECTION A – A

REFERENCE:

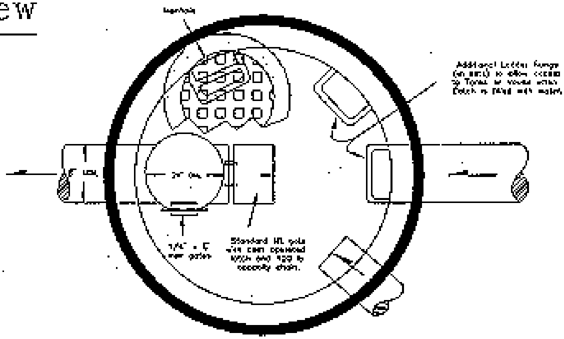
DATE: JAN. 1991

PARKING LOT CONVEYANCE SYSTEM

Profile



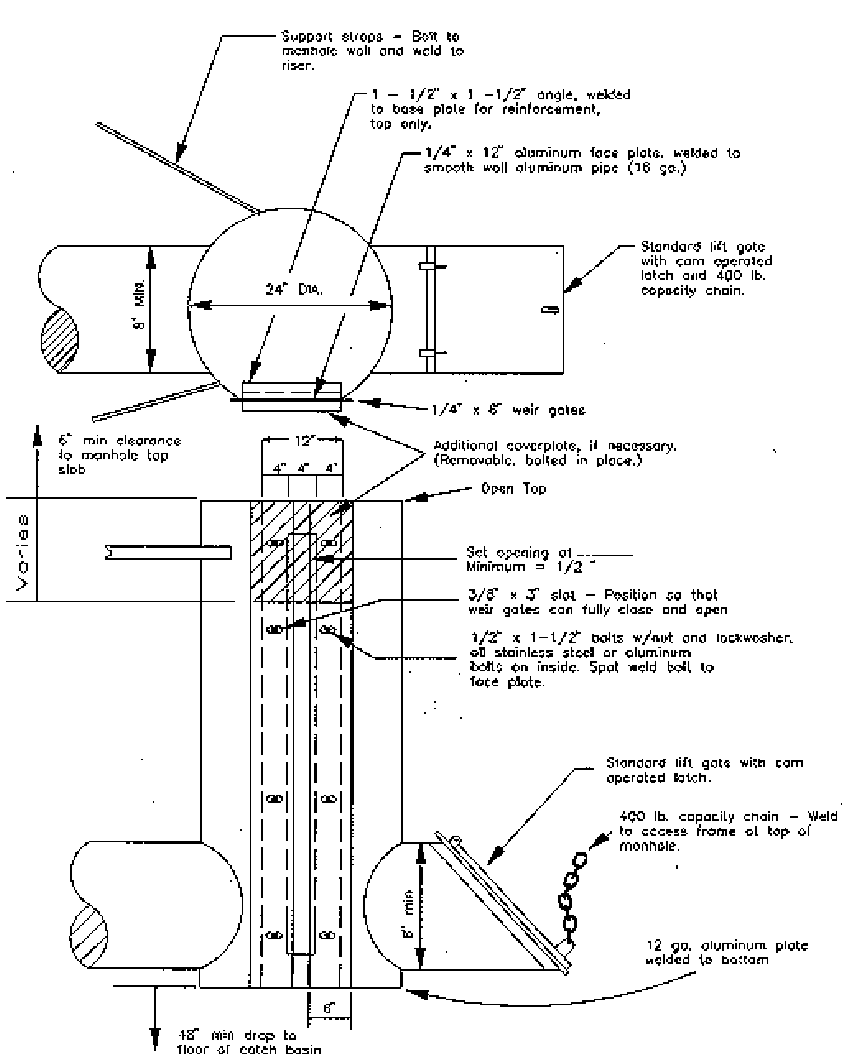
Plan View



REFERENCE:

DATE:
JAN. 1991

FLOW CONTROL MANHOLE



REFERENCE:
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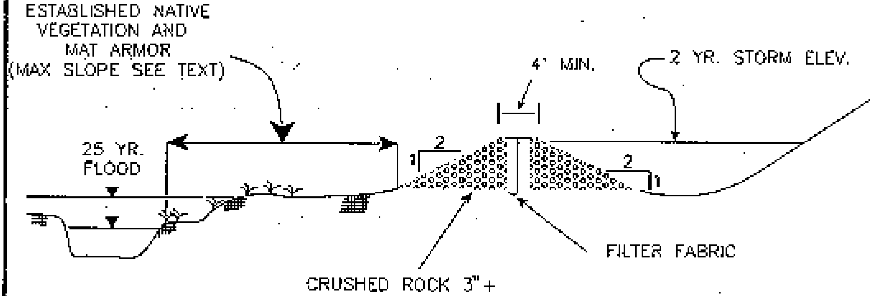
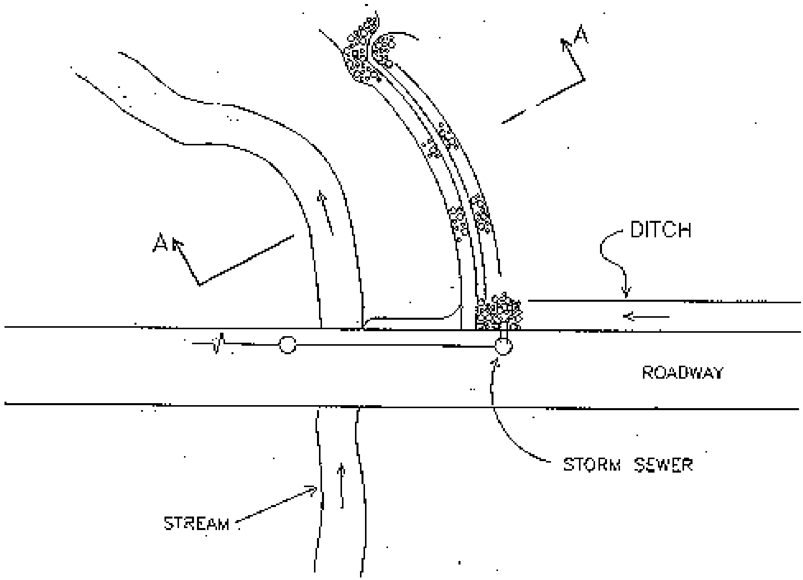
DATE:
JULY 1988

FLOW CONTROL MANHOLE DETAIL

NOTE: SHEET FLOW OVER WEIR
FOR DESIGN EVENT <1" DEEP.



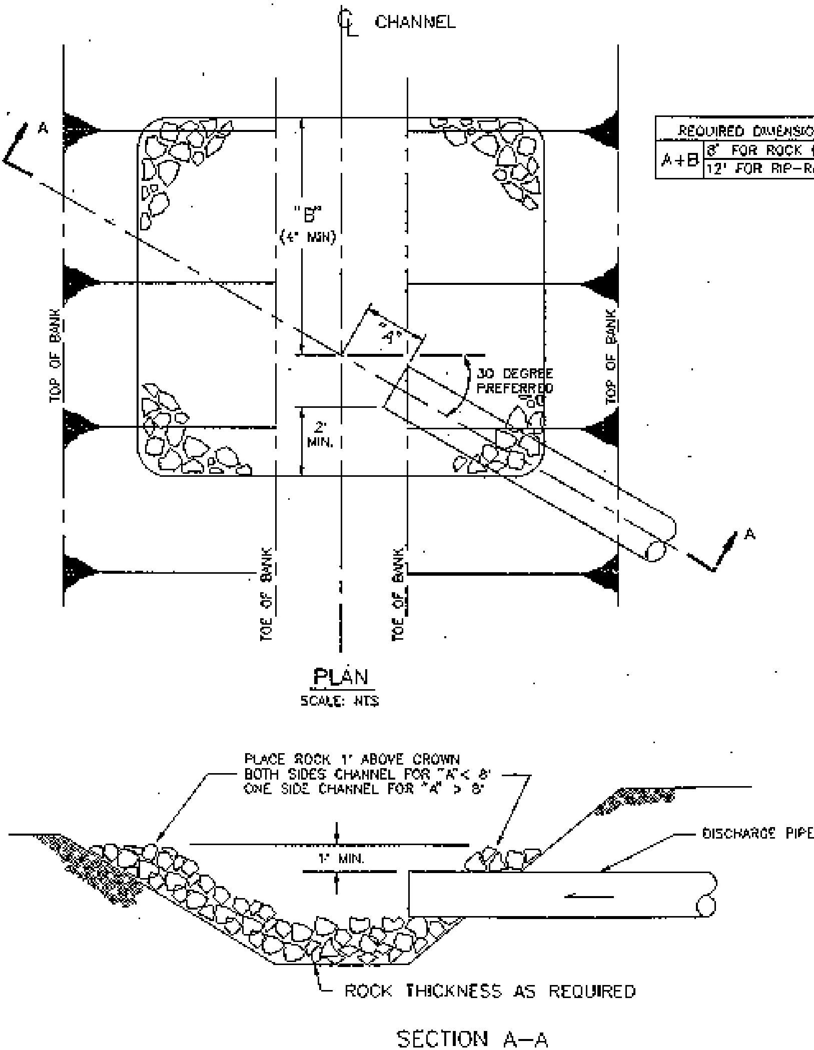
SECTION AA



REFERENCE:

DATE:
JULY 1988

STANDARD OUTFALL

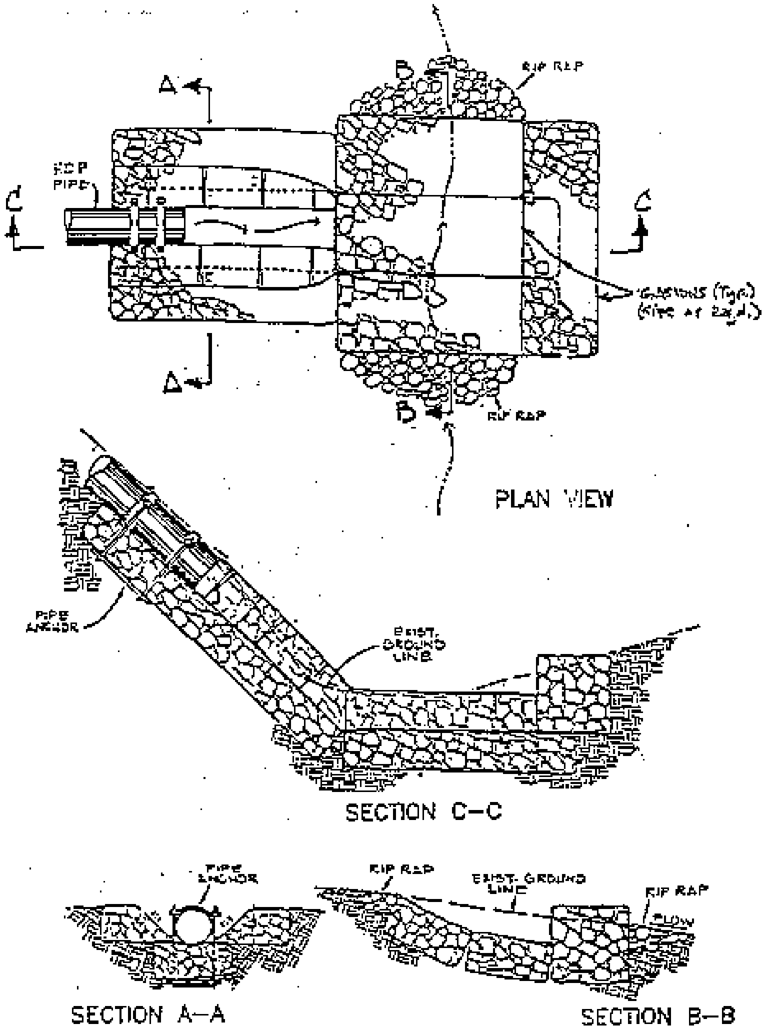


REQUIRED DIMENSIONS	
A+B	8' FOR ROCK LINING
	12' FOR RIP-RAP

REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JAN. 1991

ALTERNATE ROCK OUTFALL

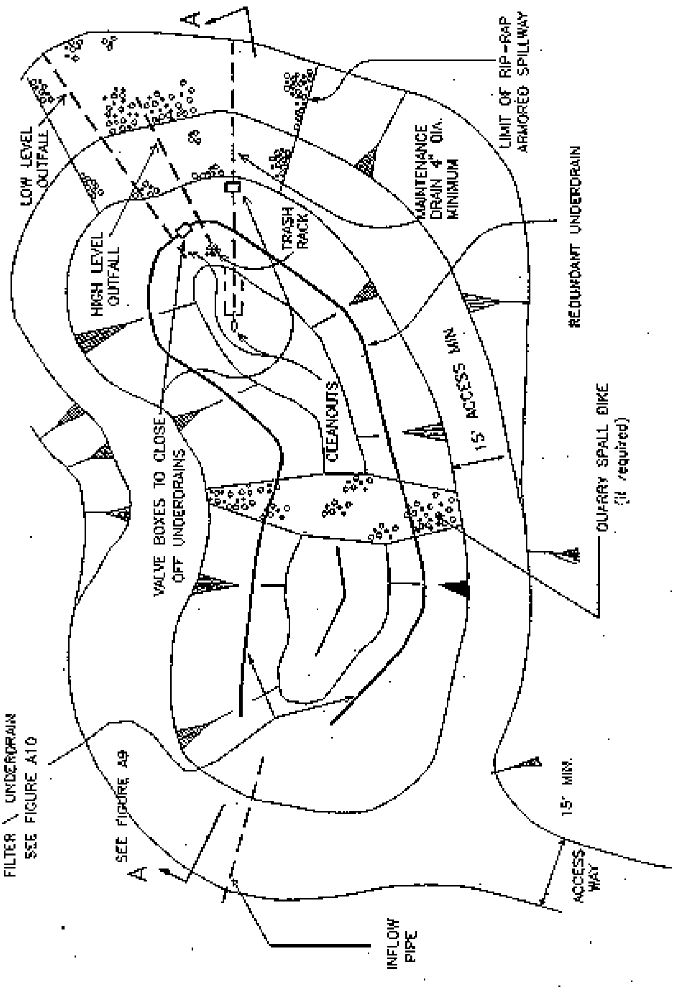


REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JAN. 1991

ALTERNATE GABION OUTFALL

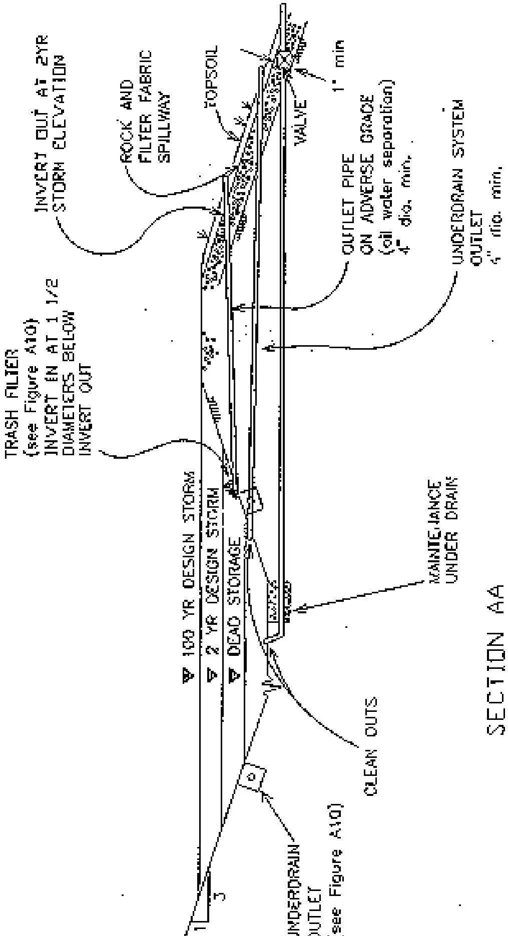
STORM DRAINAGE DESIGN MANUAL | FIG A8



REFERENCE:

DATE:
JAN. 1991

DETENTION/WET POND SCHEMATIC - PLAN VIEW

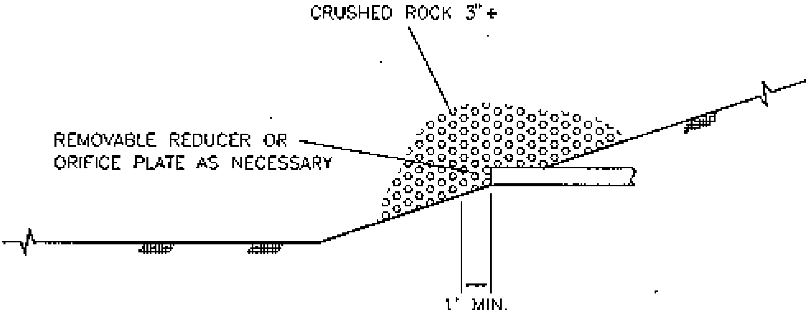


SECTION AA

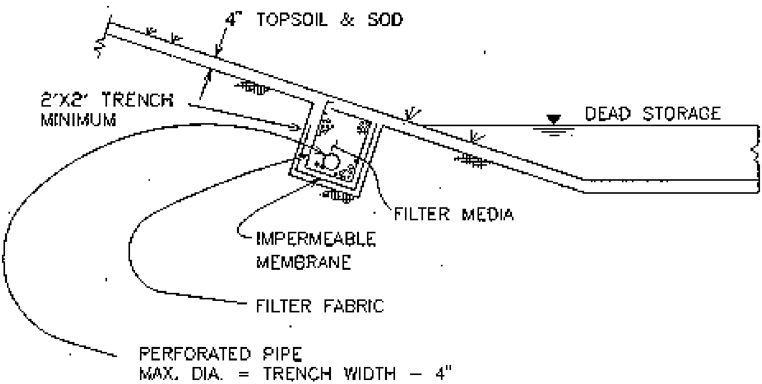
REFERENCE:

DATE:
JULY 1988

SECTION AA DETENTION/WET POND



OUTLET PIPE TRASH RACK DETAIL

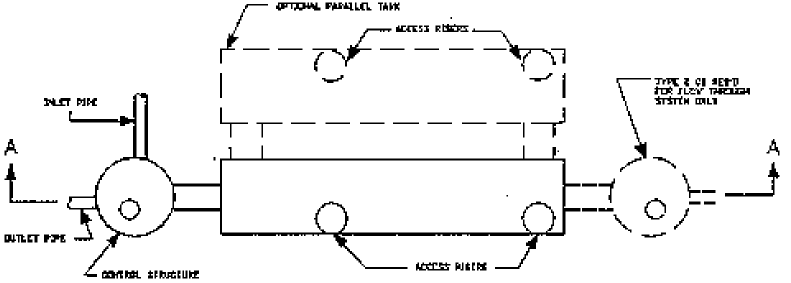


UNDERDRAIN FILTER OUTLET DETAIL

REFERENCE:

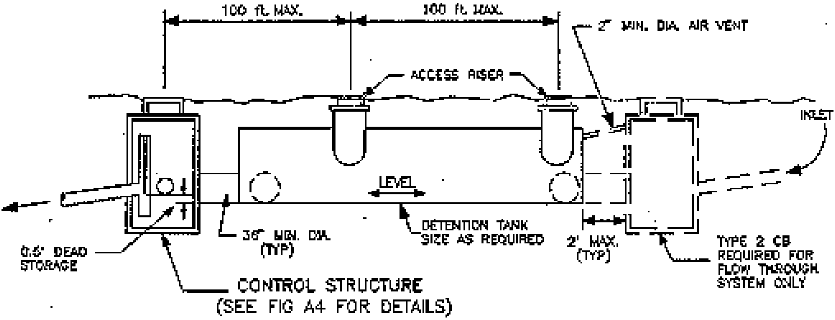
DATE:
JULY 1988

DETENTION/WET POND DETAIL

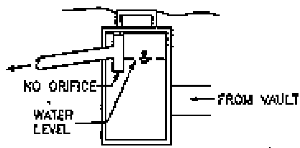


PLAN VIEW

"FLOW BACK UP" SYSTEM SHOWN
OPTIONAL DESIGNS FOR "FLOW TROUGH" SYSTEM AND PARALLEL TANKS SHOWN DASHED



SECTION A–A

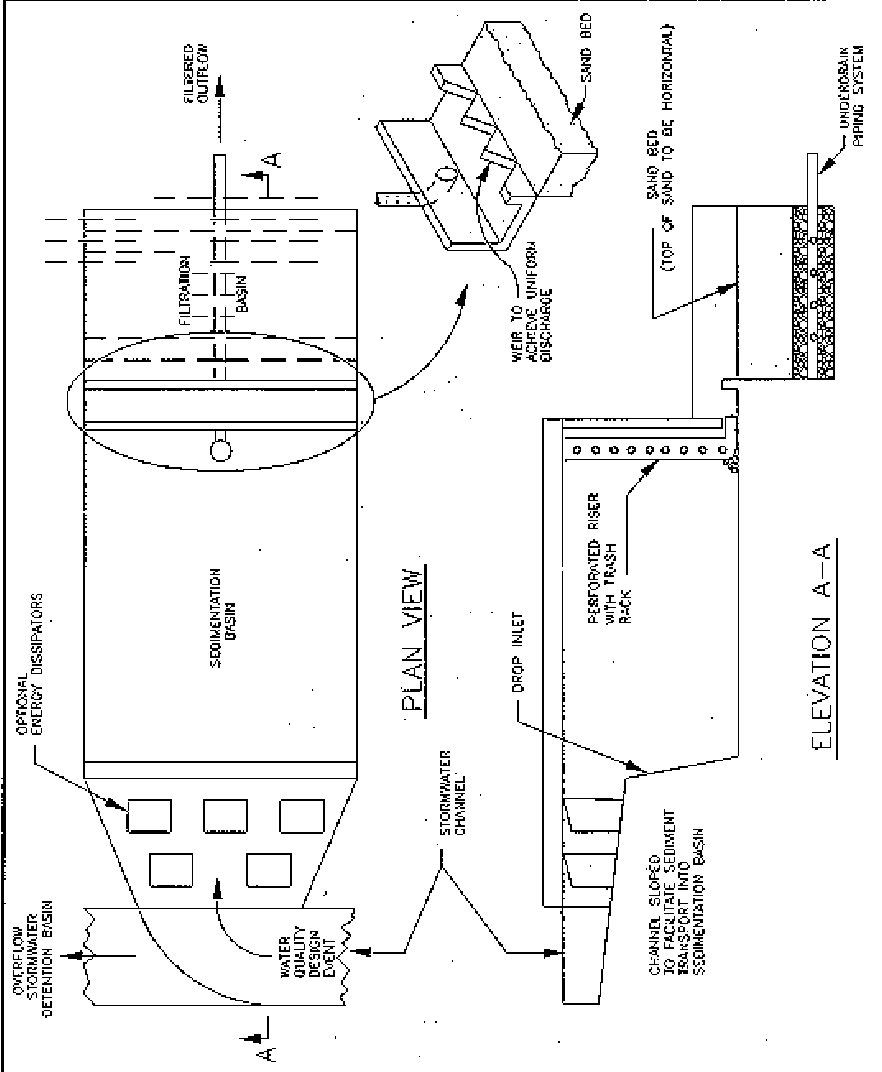


WET VAULT CONTROL STUCTURE

REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JUNE 1989

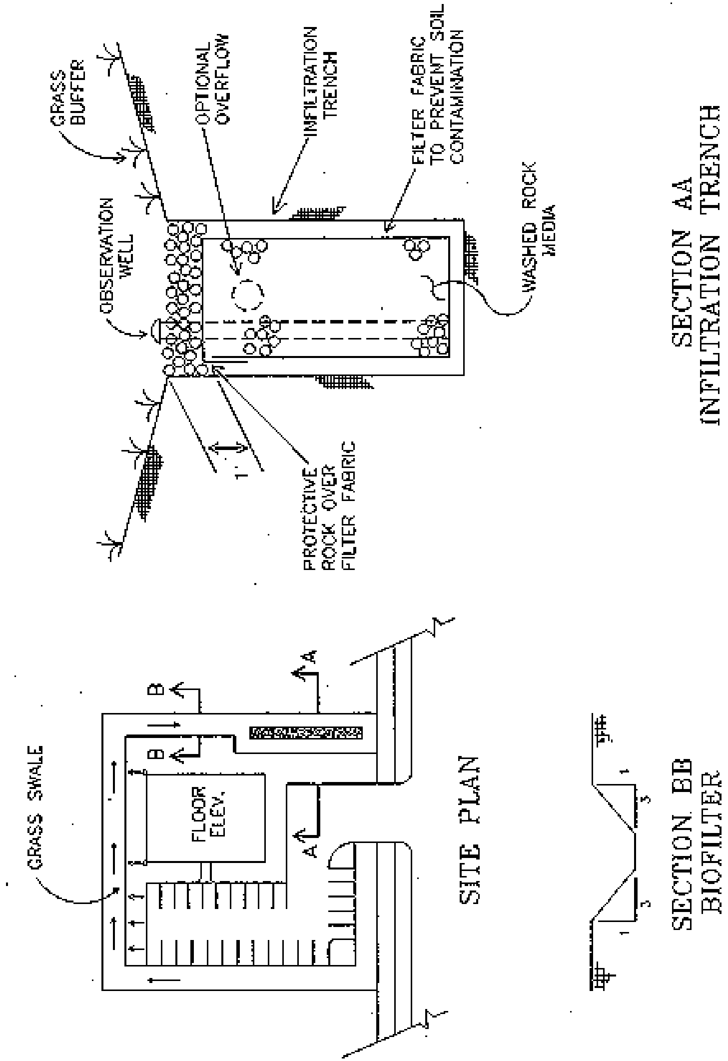
TYPICAL DETENTION TANK



REFERENCE:
CITY OF AUSTIN, TEXAS, AUSTIN DRAINAGE MANUAL

DATE:
JUNE 1989

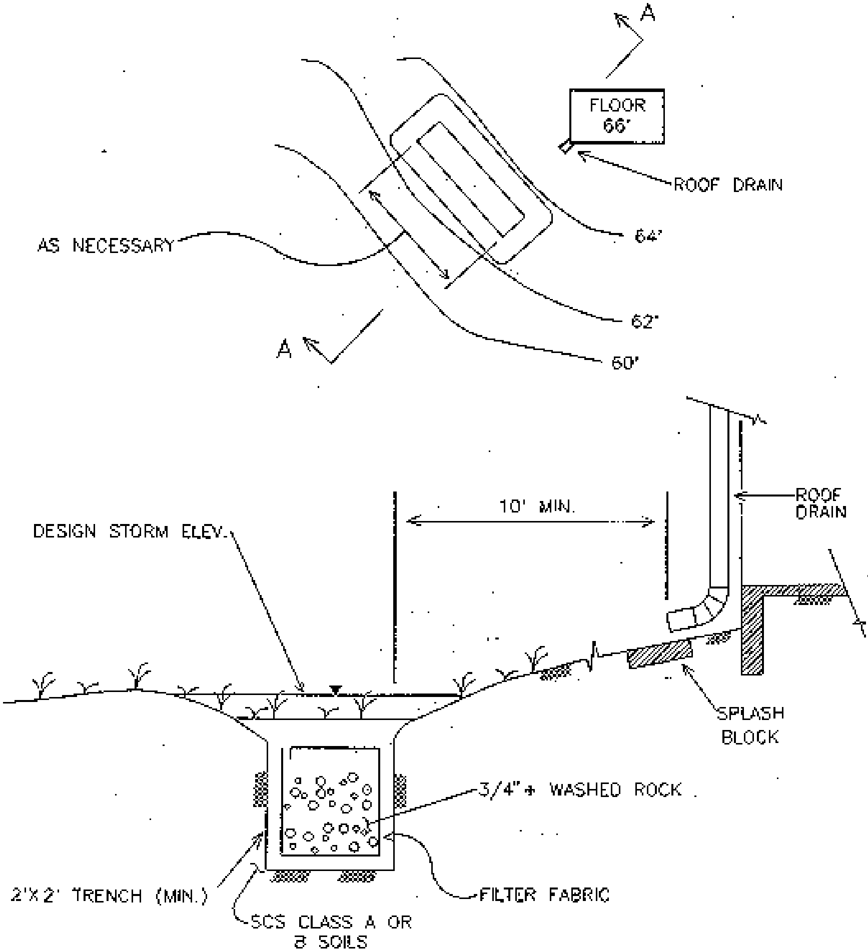
SAND FILTER



REFERENCE: "CONTROLLING URBAN RUNOFF" METRO COUNCIL OF GOVERNMENTS, WASHINGTON DC, 1987

DATE: JAN. 1991

INFILTRATION SYSTEM



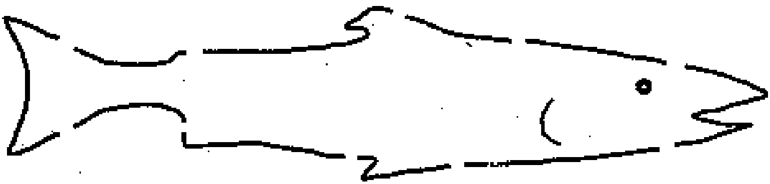
SECTION AA

REFERENCE:

DATE: JULY 1988

ROOF DRAIN DRYWELL EXAMPLE

DUMP NO WASTE

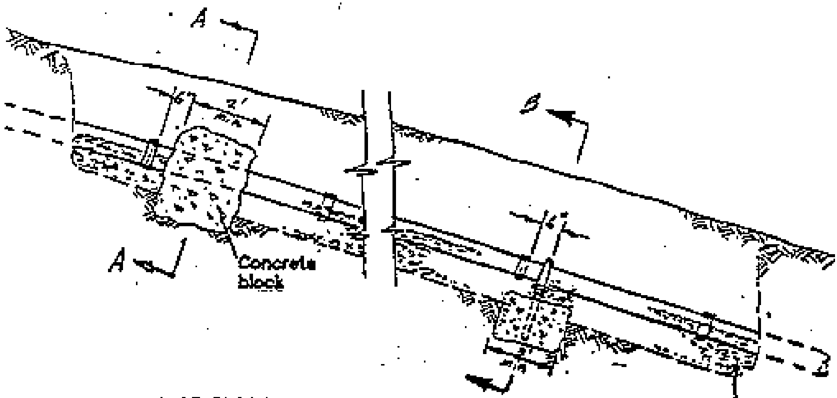


DRAINS TO STREAM

REFERENCE:

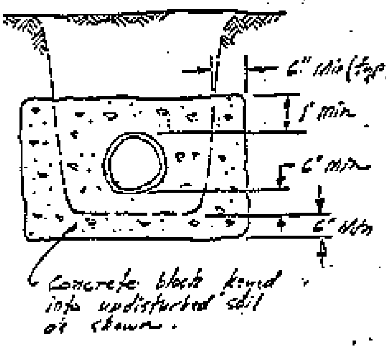
DATE:
JULY 1988

CATCH BASIN ANTI-DUMPING MESSAGE

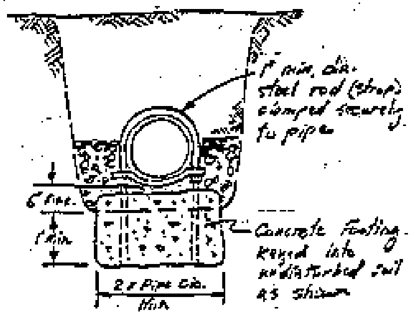


CONCRETE BLOCK ANCHOR

STRAP—FOOTING ANCHOR



SECTION A—A



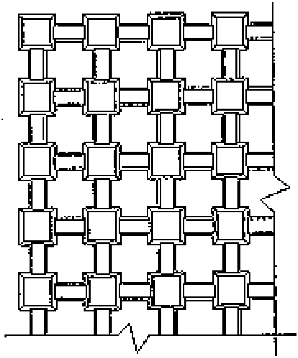
SECTION B—B

Note: Spacing for pipe anchors to be @ max. 20' intervals.

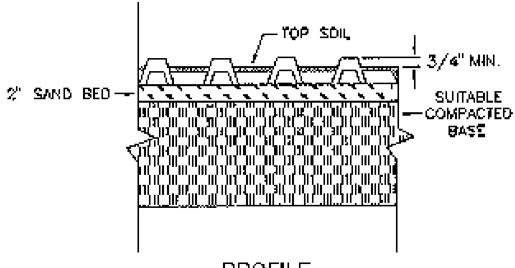
REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

PIPE ANCHOR DETAIL



PLAN

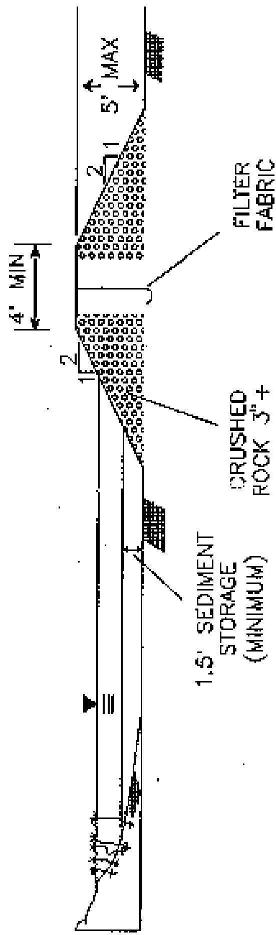


PROFILE

LATTICE BLOCK PAVING EXAMPLE

APPENDIX B

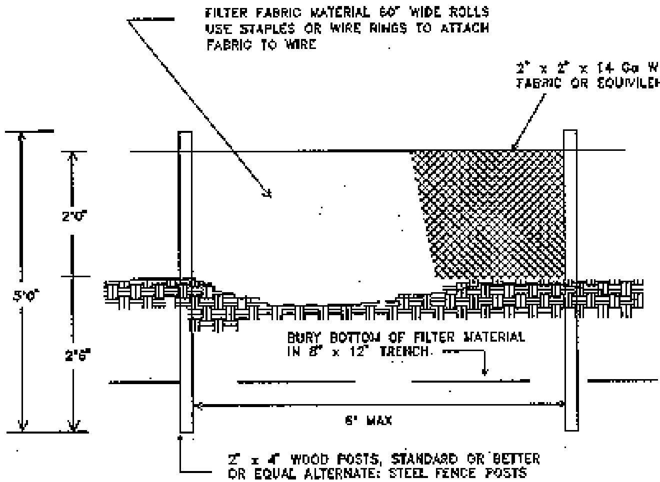
EROSION CONTROL STANDARDS

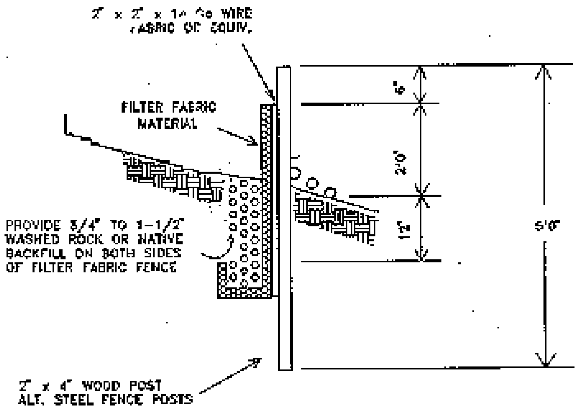


REFERENCE:
DOUGLAS COUNTY COLORADO DRAINAGE MANUAL, 1986

DATE:
FEB. 1991

SEDIMENT TRAP

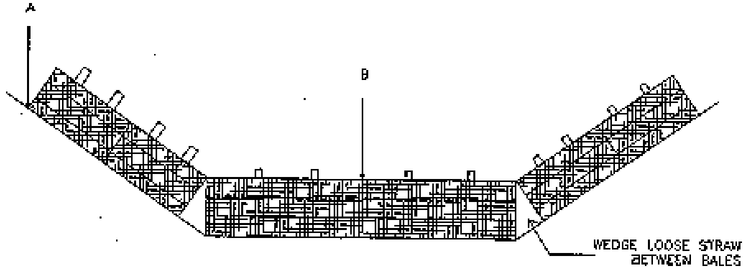




REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

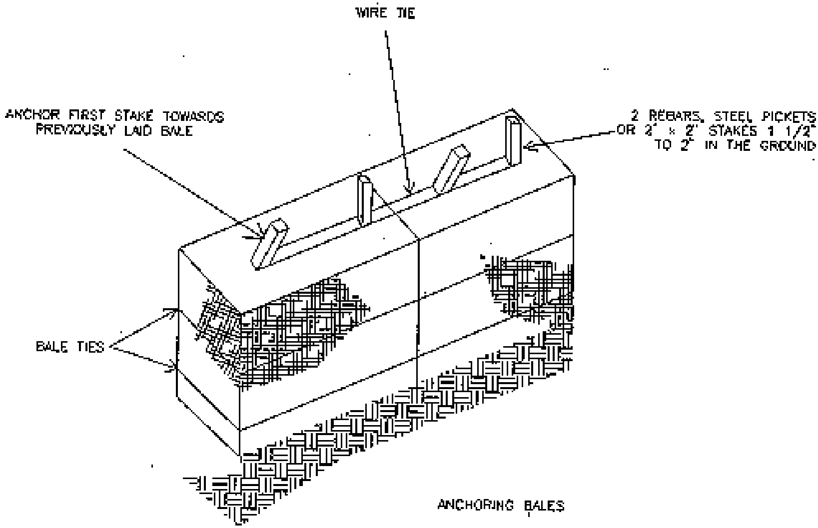
DATE:
FEB. 1991

FILTER FABRIC FENCE DETAIL



POINT A SHOULD BE HIGHER THAN POINT B

PROPER PLACEMENT OF STRAW BALE BARRIER IN DRAINAGE WAY

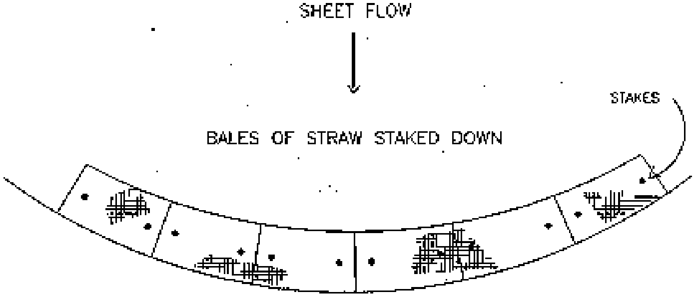


ANCHORING BALES

REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

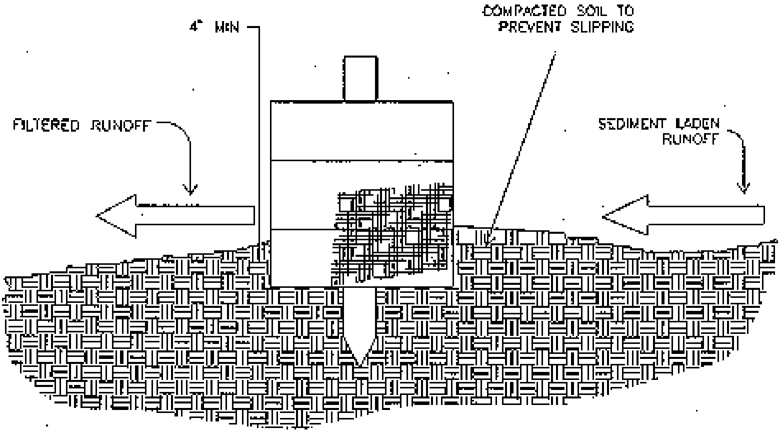
DATE:
JULY 1988

STRAW AND HAY BALE BARRIERS



PLAN

SINGLE ROW OF BALES OF STRAW TO BE
PLACED PRIOR TO THE START
OF ROUGH GRADING

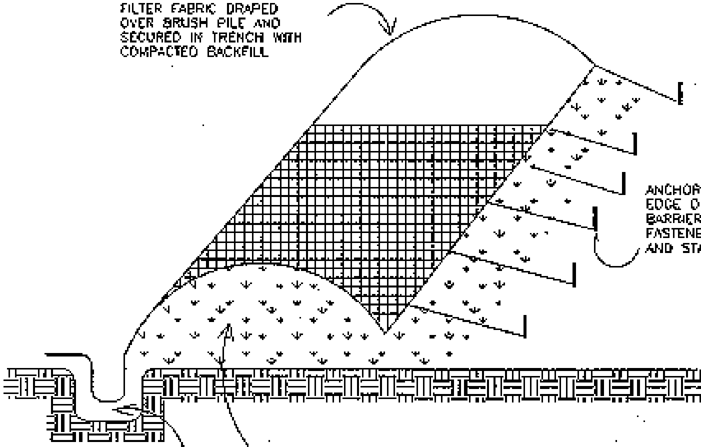


CROSS-SECTION OF A PROPERLY INSTALLED STRAW BALE

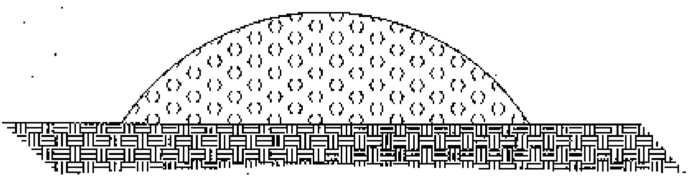
REFERENCE:
PUGET SOUND STORMWATER MANAGEMENT DRAFT

DATE:
JULY 1988

STRAW AND HAY BALE BARRIERS



BRUSH BARRIER

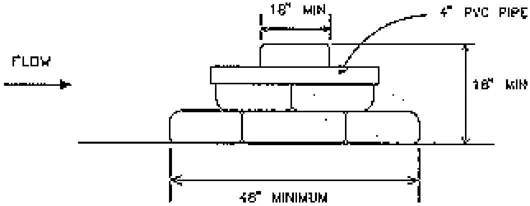


CROSS SECTION OF GRAVEL FILTER BERM

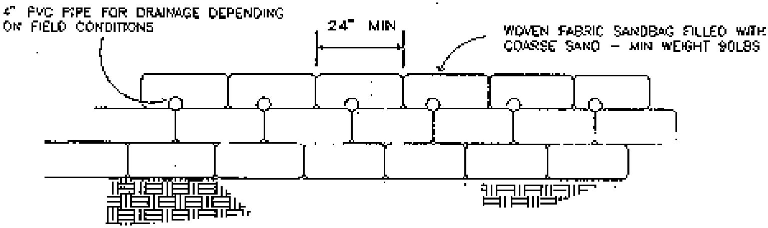
REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

BRUSH BARRIER AND GRAVEL FILTER BERM



CROSS SECTION



FRONT VIEW

1) WHEN A SANDBAG IS FILLED WITH MATERIAL, THE OPEN END OF THIS SANDBAG SHOULD BE STAPLED OR TIED WITH NYLON OR POLY CORD.

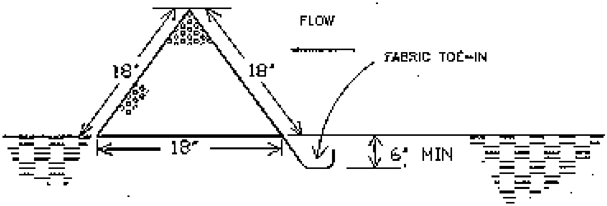
2) SANDBAGS SHOULD BE STACKED IN AT LEAST THREE ROWS ABUTTING EACH OTHER, AND IN STAGGERED ARRANGEMENT.

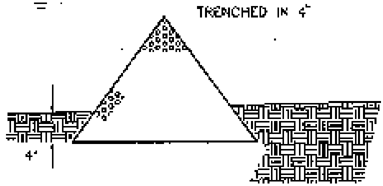
3) THE BASE OF THE BERM SHOULD HAVE AT LEAST 3 SANDBAGS AND CAN BE REDUCED TO 2 AND 1 BAG IN THE SECOND AND THIRD ROWS RESEPECTIVELY.

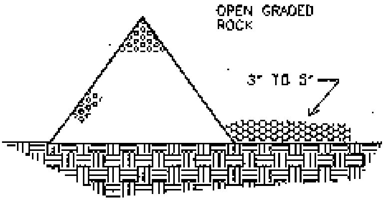
REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

SANDBAG BERM

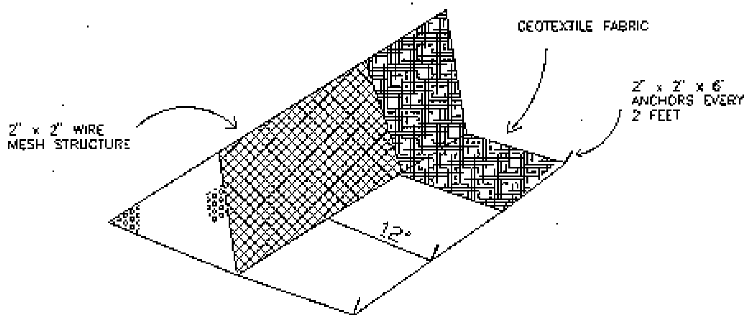






INSTALLATION DETAIL

OPTIONS
1) TOE-IN 6" MINIMUM
2) WEIGHTED WITH 3" TO 5" OPEN GRADED ROCK.
3) TRENCHED IN 4"

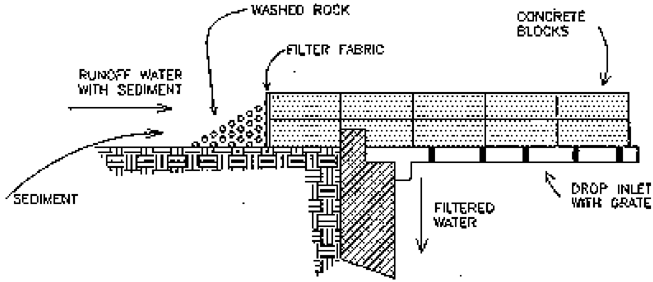


REFERENCE:
CITY OF AUSTIN TEXAS ENVIRONMENTAL CRITERIA MANUAL

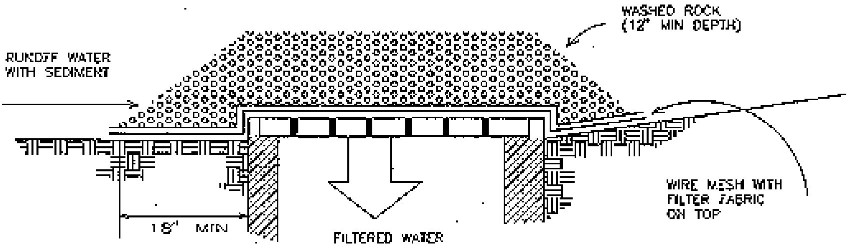
DATE:
JULY 1988

TRIANGULAR SEDIMENT DIKES

BLOCK AND GRAVEL FILTER



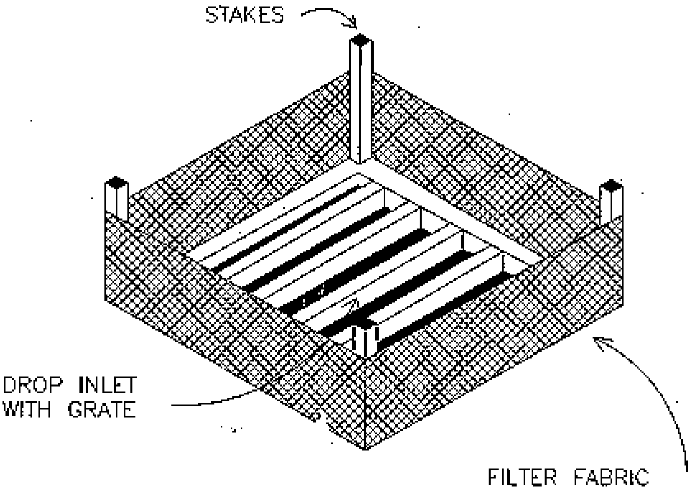
GRAVEL AND WIRE MESH FILTER

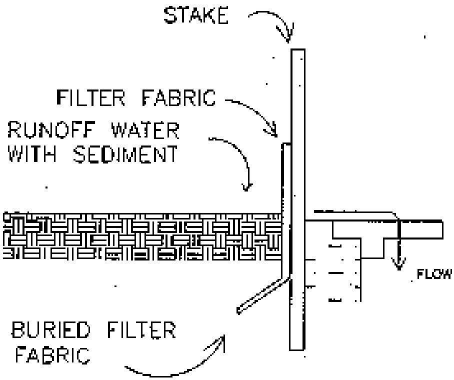


REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

INLET SEDIMENT PROTECTION



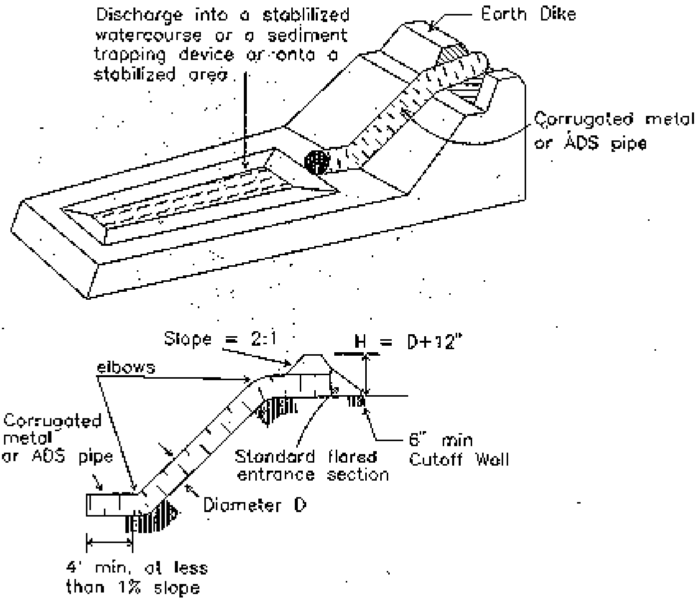


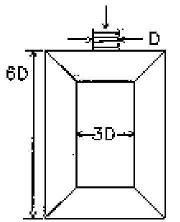
REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

FILTER FABRIC FENCE INLET FILTER

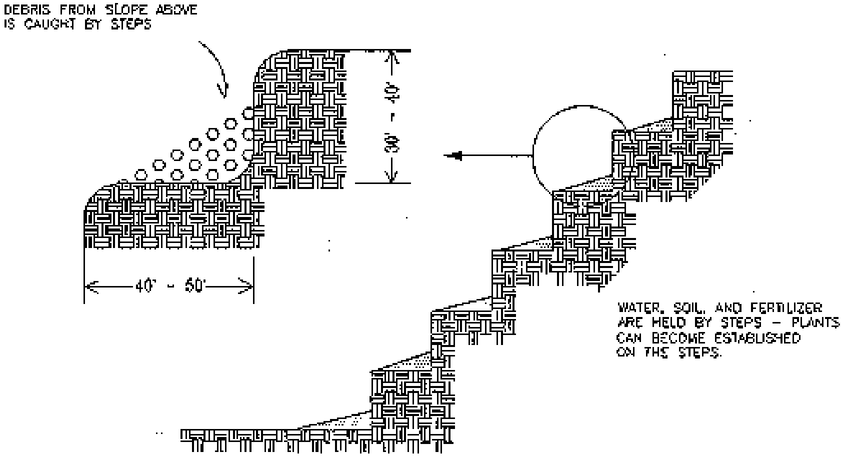
PIPE SLOPE DRAINS



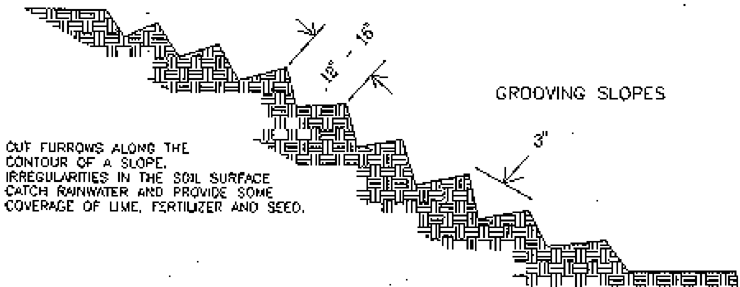


Riprap depth shall be equal to pipe diameter.

REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL



STAIR STEPPING CUT SLOPES



GROOVING SLOPES

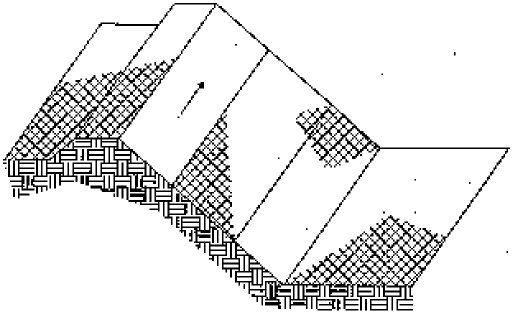
REFERENCE:

KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

STAIR STEPPING CUT AND GROOVING SLOPES

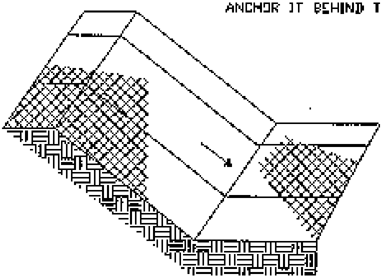
SHALLOW SLOPE



ON SHALLOW SLOPES, STRIPS OF NETTING MAY BE APPLIED ACROSS THE SLOPE.

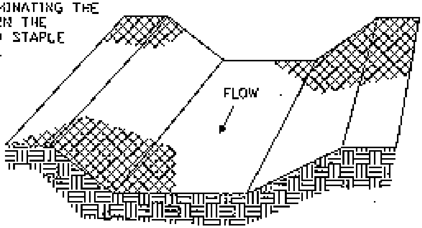
WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE NETTING OVER THE BERM AND ANCHOR IT BEHIND THE BERMLINE

STEEP SLOPE



ON STEEP SLOPES, APPLY STRIPS OF NETTING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY.

BRING NETTING DOWN TO A LEVEL AREA BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 6" AND STAPLE AT 12" INTERVALS.

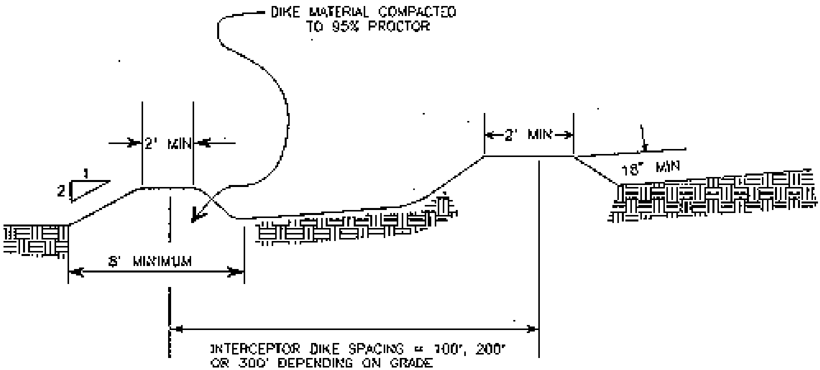


IN DITCHES, APPLY NETTING PARALLEL TO THE DIRECTION OF FLOW. USE CHECK SLOTS EVERY 15'. DO NOT JOIN STRIPS IN THE CENTER OF THE DITCH.

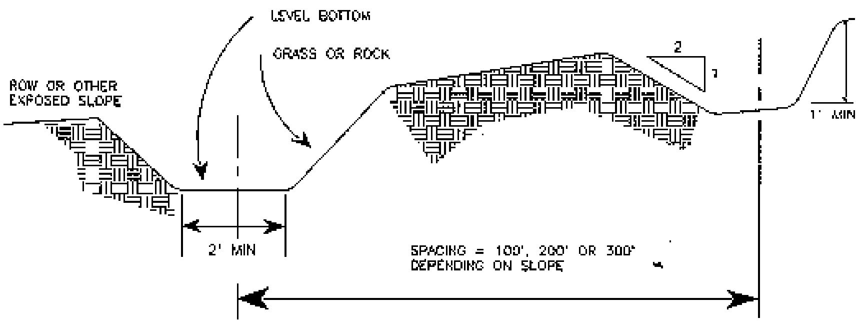
REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

EROSION CONTROL BLANKETS



INTERCEPTOR DIKES

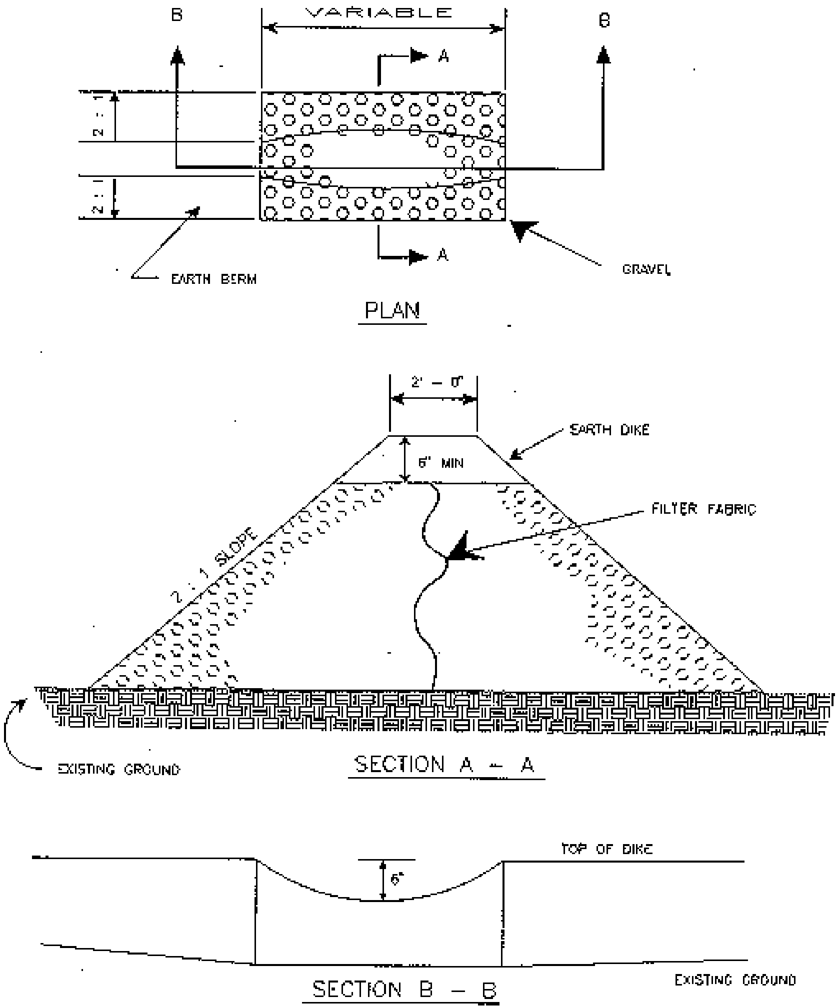


INTERCEPTOR SWALE

REFERENCE:
-KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

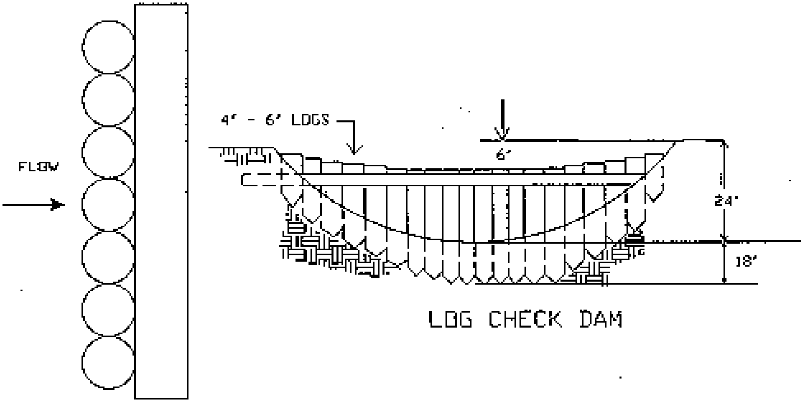
TEMPORARY SWALES AND DIKES

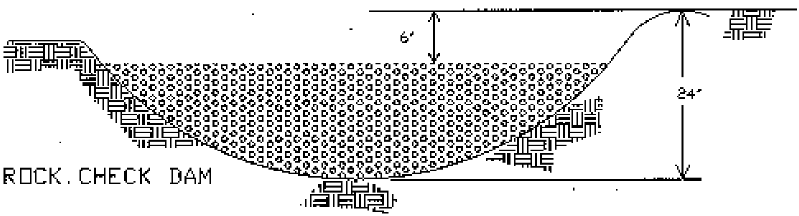


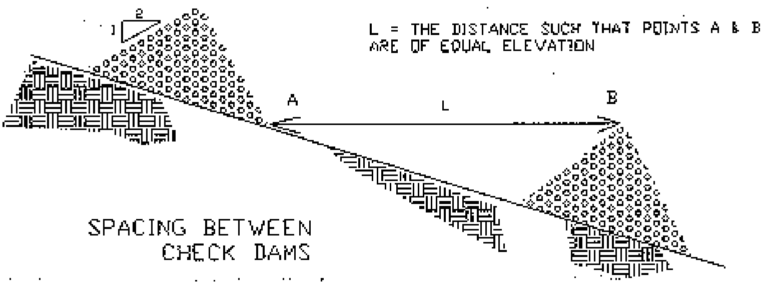
REFERENCE:
HENRICO COUNTY, VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK

DATE:
JULY 1988

TEMPORARY GRAVEL OUTLET STRUCTURE



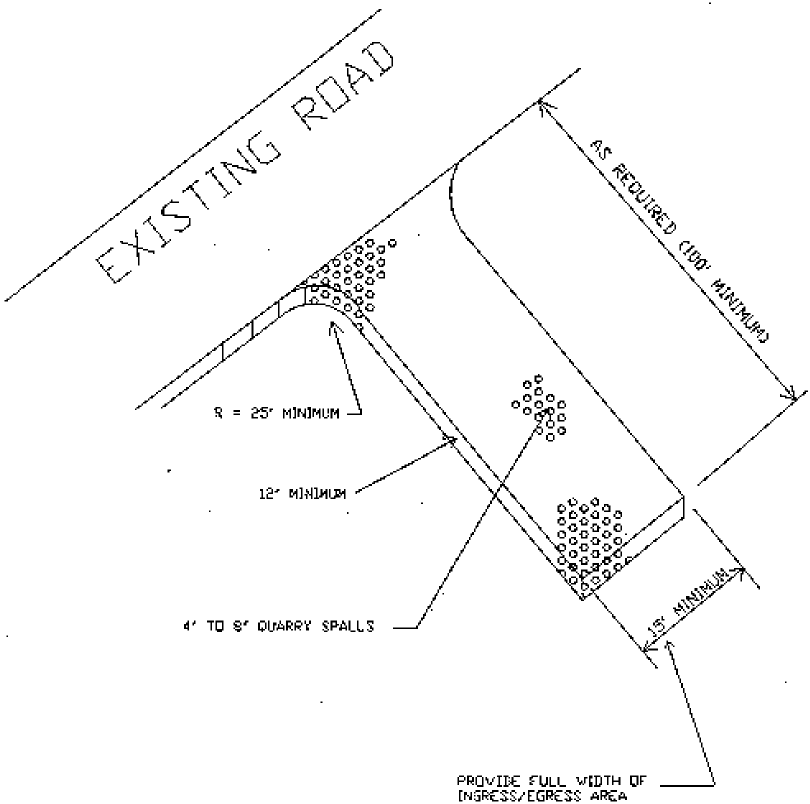




REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

CHECK DAMS



REFERENCE:
KING COUNTY, WASHINGTON, SURFACE WATER DESIGN MANUAL

DATE:
JULY 1988

STABILIZED CONSTRUCTION ENTRANCE

APPENDIX C

EXAMPLE DRAINAGE AND EROSION CONTROL PLAN

"Reserved"

APPENDIX D

REQUIRED INFILTRATION VOLUMES FOR PROJECTS

The table shown below may be used to determine the volume that must be infiltrated on any project. Enter the table with the "Curve Number" (SCS Methodology) for the site in the predevelopment state. In the Thurston Region this is always interpreted as the "forested" condition. Read the "predevelopment discharge" for the 100-year 24-hour event.

Then with the "Curve Number" for the site after construction of the proposed project enter the table and obtain the runoff for the "post- development" condition. The volume to be infiltrated is simply the difference of "predevelopment" runoff and "post-development" runoff in inches. Multiply by the project area to determine the volume to be infiltrated.

Example: A 10 acre site has a predevelopment "curve number" of 50. From Table D.1, runoff is 1.22 inches or

1.22/12 * 10 acres * 43,560 sf/acre = 44,286 cubic feet.

The post-development "curve number" is 88. Therefore by the same method the runoff is

4.77/12 * 10 acres * 43,560 sf/acre = 173,151 cubic feet.

The volume to be infiltrated on this project is 173,151 - 44,286 = 128,865 cubic feet.

TABLE D.1 VOLUMES OF RUNOFF FOR THE THURSTON REGION 100-YEAR, 24-HOUR STORM EVENT (USING SCS METHODOLOGY)

SCS CURVE NUMBER	INCHES OF RUNOFF
42	0.67
44	0.80
46	0.93
48	1.07
50	1.22
52	1.37
54	1.52
56	1.69
58	1.85
60	2.02
62	2.19
64	2.37
66	2.55
68	2.74
70	2.92
72	3.12
74	3.31
76	3.51
78	3.71
80	3.92
82	4.13
84	4.34
86	4.55
88	4.77
90	4.99
92	5.22
94	5.45
96	5.68
98	5.91
100	6.15

TABLE D.2 SCS WESTERN WASHINGTON RUNOFF CURVE NUMBERS
(Published by SCS in 1982)

Runoff curve numbers for selected agricultural, suburban and urban land use for Type 1a rainfall distribution, 24-hour storm duration.

LAND USE DESCRIPTION	CONDITION	Curve Numbers By Hydrologic Soils Group			
		A	B	C	D
Cultivated Land	Winter	86	91	94	95
Mountain open areas	Low brush/Grassland	74	82	89	92
Meadow/Pasture		65	78	85	89
Wood or Forest	Undisturbed	42	64	76	81
Wood or Forest	Young 2nd growth/brush	55	72	81	86
Orchard	With cover crop	81	88	92	94
Lawns, Parks, Golflinks, etc.	75% or more grass cover	68	80	86	90
Lawns, Parks, Golflinks, etc.	50% to 75% cover	77	85	90	92
Commercial	85% impervious	92	94	95	96
Industrial	75% impervious	88	92	94	95
Residential (1/8-acre lot)	65% impervious	86	90	93	95
Residential (1/4-acre lot)	38% impervious	77	85	90	92
Residential (1/3-acre lot)	30% impervious	75	84	89	91
Residential (1/2-acre lot)	25% impervious	73	83	88	91
Residential (1-acre lot)	20% impervious	71	82	88	90
Gravel Roads/Car Parks		76	85	89	91
Dirt Roads/Car Parks		72	82	87	89
Impervious Surfaces		98	98	98	98
Water Bodies		100	100	100	100

For more detailed information refer to the National Engineering Handbook, Chapter 9, Hydrology, SCS

APPENDIX E

COVENANTS

E.1 Maintenance Covenants

Whenever storm drainage facilities are to be maintained by a property owners' association within a subdivision, a covenant stating the property owners' specific maintenance responsibilities must be recorded on the plat and recorded against each lot in the subdivision. The covenant shall include the following or substantially similar language:

MAINTENANCE COVENANT

> Easements are hereby granted for the installation, inspection, and maintenance of utilities and drainage facilities as delineated on the plat for subdivision ____________. No encroachment will be placed within the easements shown on the plat which may damage or interfere with the installation, inspection, and maintenance of utilities. Maintenance and expense thereof of the utilities and drainage facilities shall be the responsibility of the property owners association as established by covenant recorded under Auditor's file number ___________________.

E.2 Sanctions for Failure to Maintain

If a property owners' association is to maintain drainage facilities, then the following or substantially similar words shall appear in the document creating the property owners' association:

> In the event Project Proponent (or successors or the Property Owners Association), in the judgment of the Jurisdiction, fails to maintain drainage facilities within the plat, or if the Proponent or successors willfully or accidentally reduces the capacity of the drainage system or renders any part of the drainage system unusable, the Proponent or successors agree to the following remedy: After 30 days notice by registered mail to the Proponent or successors, Jurisdiction may correct the problem or maintain facilities as necessary to restore the full design capacity of the drainage system. Jurisdiction will bill the Proponent or successors for all costs associated with the engineering and construction of the remedial work. Jurisdiction may charge interest as allowed by law from the date of completion of construction. Jurisdiction will place a lien on the property and/or on lots in the Property Owners Association for payments in arrears. Costs or fees incurred by the jurisdiction, should legal action be required to collect such payments, shall be borne by the Proponent or successors.

APPENDIX F

ENGINEER'S CONSTRUCTION INSPECTION REPORT FORM

Project Name: ______________________________

Project Number: ______________________________

Location (address, or other):

____

____

____

Pond Information:

1. Type: ______________________________

2(a). After pond construction, have infiltration tests and/or soil logs been completed?

____

2(b). Indicate test results and compare with design criteria (pre-construction soils information). Do the post-construction values indicate a need to modify system design? Explain.

____

3. Outlet Type ______________________________
Filter,
Oil Water Separator, Single orifice,
Oil Water Separator, Multiple orifice,
Slot,
V-notch,
Other

4. Outlet works at correct elevation(s), filter fabric installed properly (if needed), etc.

5. Spillway at correct elevation, slope, adequately armored, etc.

Conveyances:

1. Channels properly graded, sloped, planted, etc.

2. Sewers at proper grade, inlets as designed, trenches as designed, pipe bedding properly prepared, backfilling procedures correct, materials as specified, etc.

Roof Leaders:

1. Do roof leaders drain to infiltration trenches or as shown on the approved plans.

Erosion Control:

1. Erosion facilities in place at the specified time relative to other construction.

2. Construction entrance pad as specified.

3. Did facilities keep sediment, mud etc, out of water bodies, wetlands, and from crossing the property boundary.

____
____
____

4. Are permanent erosion control measures in place and as designed.

____
____
____

Signature and Seal:

I or someone under my direct supervision have adequately inspected the project during construction and to the best of my knowledge the project was built according to the approved plans and specifications except as noted above.

Signature/Date ____

APPENDIX G

EXAMPLE OF FACILITY SUMMARY FORM

The following summary form (or the jurisdiction's latest version) will be required for each proposed detention or retention facility (e.g., drywell, pond, coalescing plate filter, etc.). If more than one facility will be built on the project, complete parts six through eight of the summary form for each additional facility. Be sure that the name (e.g., Pond 1) and location (e.g., SW corner of plat) of each facility is included on the form.

THURSTON REGION
FACILITY SUMMARY FORM

Complete one (1) for each facility (detention/retention, coalescing plate filter, etc.) on the project site. Attach 8 1/2 x 11 sketch showing location of facility.

Proponent's Facility Name or Identifier (e.g., Pond A): ____________________

Name of Road or Street to Access Facility: ____________________

Hearings Examiner Case Number: ____________________

Development Rev. Project No./Bldg Permit No.: ____________________

Parcel Number: ____________________

Part 1 - Project Name and Proponent

To be completed by Utility Staff:

Utility Facility Number ________

Project Number (num) ________

Parcel Number Status, (num, 1ch) ________
0, Known; 1, Public; 2 Unknown; 3, Unassigned

Basin and Subbasin: (num, 6ch) ________
(2ch for basin, 2ch for subbasin, 2ch future)

Project Name:

Project Owner: ____________________

Project Contact: ____________________

Address: ____________________

Phone: ____________________

Project Proponent: (if different) ____________________

Address: ____________________

Phone: ____________________

Project Engineer: ____________________

Firm: ____________________ *Phone:* ____________________

Part 2 - Project Location

Section _________________

Township _________________

Range _________________

Names and Addresses of Adjacent Property Owners:

Part 3 - Type of Permit Application

Type of permit (e.g., Commercial Bldg):

Other Permits (circle)

DOF/W HPA	*COE 404*
COE Wetlands	*DOE Dam Safety*
FEMA	*Floodplain*
Shoreline Mgmt	*Rockery/Retaining Wall*
Encroachment	*Grading*
NPDES	

Other ______________________________________

Other Agencies (Federal, State, Local, etc.) that have had or will review this Drainage Erosion Control Plan:

Part 4 - Proposed Project Description

What stream basin is this project in (e.g., Percival, Woodland): ______________

Project Size, acres __________

Zoning: __________

Onsite:

Residential Subdivision:

Number of Lots: __________

Lot size (average), acres: __________

Building Permit/Commercial Plat:

Building(s) Footprint, acres: __________

Concrete Paving, acres: __________

Gravel Surface, acres: __________

Lattice Block Paving, acres: __________

Public Roads (including gravel shoulder), acres: __________

Private Roads (including gravel shoulder), acres: __________

Onsite Impervious Surface Total, acres: __________

Part 5 - Pre-Developed Project Site Characteristics

Stream through site, y/n: __________

Name: ____________________________________

DNR Type: ____________________________________

Type of feature this facility discharges to (i.e., lake, stream, intermittent stream, pothole, roadside ditch, sheetflow to adjacent private property, etc.):

____

Swales, Ravines, y/n: __________

Steep slopes, (steeper than 15%) y/n: __________

Erosion hazard, y/n: __________

100 yr. Floodplain, y/n: __________

Lakes or Wetlands, y/n: __________

Seeps/Springs, y/n: __________

High Groundwater Table, y/n: ___________

Wellhead Protection or Aquifer Sensitive Area, y/n: ___________

Other: ______________________________

Part 6 - Facility Description

Total Area Tributary to Facility Including Offsite (acres): ___________

Total Onsite Area Tributary to Facility (acres): ___________

Design Impervious Area Tributary to Facility (acres): ___________

Design Landscaped Area Tributary to Facility (acres): ___________

Design Total Tributary Area to Facility (acres): ___________

Enter a one (1) for the type of facility:

Wet pond detention ___________

Wet pond water surface area, acres ___________

Dry pond detention ___________

Underground detention ___________

Infiltration pond ___________

Dry well infiltration ___________

Coalescing plate separator ___________

Centrifuge separator ___________

Other ___________

Outlet type (Enter a one (1) for each type present)

Filter ___________

Oil water separator ___________

Single orifice ___________

Multiple orifice ___________

Weir ___________

Spillway ___________

Pump(s) ___________

Other __________

Part 7 - Release to Groundwater

Design Percolation Rate To Groundwater (if applicable) __________

Part 8 - Release to Surface Water (if applicable)

	Thurston County MSL Elevation (ft)	*Percent Design Full*	*Volume (cu ft)*	*Discharge to Surface Water (cfs)*
Empty:	__________	______0____	___0.0___	___0.0___
	__________	____25____	__________	__________
	__________	____50____	__________	__________
	__________	___100____	__________	__________

APPENDIX H

DESIGN STORMS FOR THURSTON REGION

Tables H.1 and H.2 are volumes and hyetographs for storms for design purposes in Thurston Region.

TABLE H.1 DESIGN STORM VOLUMES

RETURN FREQUENCY 24-HR STORM EVENT (years)	PRECIPITATION (inches)
0.5	1.79
2	2.80
5	3.75
10	4.35
25	5.10
50	5.65
100	6.15

The volume of the 7-day, 100-year storm is 12 inches.

TABLE H.2 DESIGN STORM HYETOGRAPHS

TIME STEP (15 MIN)	2-YEAR HYET-OGRAPH in/hr	10-YEAR HYET-OGRAPH in/hr	25-YEAR HYET-OGRAPh in/hr	50-YEAR HYET-OGRAPH in/hr	100-YEAR HYET-OGRAPH in/hr	'90 STM 100-YEAR HYET-OGRAPH in/hr	6-MONTH HYET-OGRAPH in/hr
-------	-------	--------	--------	--------	--------	--------	--------
1	0.015	0.103	0.110	0.082	0.091	0.15	0.01
2	0.015	0.103	0.110	0.082	0.091	0.04	0.01
3	0.015	0.103	0.110	0.082	0.091	0.04	0.01
4	0.015	0.103	0.110	0.082	0.091	0.15	0.01
5	0.015	0.103	0.110	0.082	0.091	0.31	0.01
6	0.015	0.103	0.122	0.096	0.091	0.31	0.01
7	0.018	0.120	0.143	0.112	0.106	0.31	0.01
8	0.022	0.120	0.143	0.112	0.123	0.35	0.01
9	0.027	0.120	0.143	0.112	0.123	0.31	0.02
10	0.027	0.120	0.143	0.128	0.123	0.20	0.02
11	0.035	0.155	0.184	0.164	0.159	0.11	0.02
12	0.046	0.155	0.202	0.185	0.159	0.27	0.03
13	0.058	0.155	0.202	0.185	0.159	0.35	0.04
14	0.058	0.155	0.202	0.185	0.159	0.27	0.04
15	0.064	0.172	0.224	0.205	0.176	0.27	0.04
16	0.077	0.172	0.224	0.205	0.202	0.27	0.05
17	0.081	0.181	0.236	0.215	0.212	0.31	0.05
18	0.081	0.181	0.236	0.215	0.212	0.23	0.05
19	0.090	0.201	0.263	0.240	0.236	0.27	0.06
20	0.090	0.201	0.263	0.240	0.236	0.23	0.06
21	0.094	0.212	0.276	0.261	0.248	0.27	0.06
22	0.094	0.212	0.276	0.280	0.279	0.27	0.06
23	0.104	0.234	0.277	0.310	0.308	0.31	0.06
24	0.122	0.234	0.277	0.310	0.308	0.35	0.08
25	0.128	0.245	0.291	0.325	0.323	0.23	0.08
26	0.128	0.245	0.291	0.325	0.323	0.27	0.08
27	0.232	0.312	0.370	0.290	0.412	0.23	0.15
28	0.121	0.312	0.370	0.290	0.412	0.20	0.08
29	0.316	0.297	0.302	0.282	0.373	0.24	0.20
30	0.455	0.705	0.793	0.563	0.373	0.23	0.29
31	1.181	1.824	2.052	0.878	0.971	0.24	0.76
32	0.103	0.375	0.487	2.281	2.514	0.23	0.06
33	0.287	0.308	0.183	0.327	0.553	0.15	0.18
34	0.287	0.316	0.366	0.511	0.367	0.16	0.18
35	0.198	0.256	0.316	0.346	0.508	0.24	0.13
36	0.192	0.427	0.348	0.318	0.391	0.20	0.13
37	0.304	0.227	0.345	0.406	0.389	0.24	0.19
38	0.237	0.227	0.242	0.482	0.539	0.27	0.15
39	0.169	0.227	0.215	0.503	0.579	0.28	0.11
40	0.135	0.227	0.215	0.241	0.333	0.28	0.09
41	0.237	0.272	0.215	0.241	0.449	0.23	0.15
42	0.169	0.295	0.215	0.361	0.466	0.20	0.11
43	0.193	0.180	0.237	0.317	0.292	0.11	0.12
44	0.148	0.200	0.284	0.354	0.292	0.28	0.09
45	0.138	0.186	0.220	0.222	0.272	0.20	0.09

(more)

TABLE H.2 DESIGN STORM HYETOGRAPHS (continued)

TIME STEP (15 MIN)	2-YEAR HYET-OGRAPH in/hr	10-YEAR HYET-OGRAPH in/hr	25-YEAR HYET-OGRAPH in/hr	50-YEAR HYET-OGRAPH in/hr	100-YEAR HYET-OGRAPH in/hr	'90 STM 100-YEAR HYET-OGRAPH in/hr	6-MONTH HYET-OGRAPH in/hr
-------	-------	--------	--------	--------	--------	--------	--------
46	0.138	0.186	0.240	0.246	0.272	0.24	0.09
47	0.124	0.186	0.242	0.271	0.272	0.27	0.09
48	0.124	0.186	0.242	0.295	0.272	0.24	0.08
49	0.124	0.204	0.242	0.320	0.272	0.24	0.08
50	0.124	0.204	0.286	0.320	0.272	0.24	0.08
51	0.155	0.192	0.247	0.276	0.234	0.24	0.08
52	0.155	0.208	0.247	0.276	0.234	0.20	0.10
53	0.153	0.191	0.227	0.253	0.215	0.24	0.10
54	0.153	0.191	0.227	0.253	0.237	0.28	0.10
55	0.153	0.191	0.227	0.253	0.241	0.24	0.10
56	0.142	0.191	0.227	0.292	0.259	0.2	0.10
57	0.131	0.191	0.227	0.234	0.259	0.20	0.09
58	0.120	0.191	0.227	0.214	0.259	0.24	0.08
59	0.131	0.176	0.144	0.179	0.237	0.24	0.08
60	0.100	0.176	0.144	0.179	0.237	0.28	0.08
61	0.096	0.146	0.138	0.171	0.227	0.24	0.06
62	0.096	0.142	0.138	0.171	0.227	0.24	0.06
63	0.096	0.142	0.138	0.171	0.208	0.28	0.06
64	0.096	0.142	0.138	0.171	0.189	0.32	0.06
65	0.096	0.142	0.138	0.171	0.189	0.36	0.06
66	0.086	0.142	0.138	0.171	0.189	0.28	0.06
67	0.075	0.112	0.119	0.148	0.164	0.32	0.06
68	0.075	0.101	0.119	0.148	0.164	0.32	0.05
69	0.069	0.083	0.110	0.137	0.151	0.28	0.05
70	0.069	0.072	0.110	0.137	0.151	0.36	0.04
71	0.069	0.072	0.110	0.137	0.151	0.32	0.04
72	0.069	0.072	0.110	0.137	0.151	0.28	0.04
73	0.069	0.072	0.110	0.137	0.151	0.28	0.04
74	0.069	0.072	0.110	0.137	0.151	0.28	0.04
75	0.069	0.072	0.110	0.137	0.151	0.32	0.04
76	0.069	0.072	0.110	0.137	0.151	0.32	0.04
77	0.069	0.072	0.110	0.137	0.151	0.28	0.04
78	0.069	0.072	0.110	0.137	0.151	0.24	0.04
79	0.069	0.072	0.110	0.123	0.151	0.36	0.04
80	0.069	0.072	0.110	0.123	0.151	0.32	0.04
81	0.069	0.072	0.110	0.123	0.151	0.28	0.04
82	0.061	0.072	0.110	0.116	0.151	0.28	0.04
83	0.061	0.072	0.110	0.109	0.151	0.28	0.04
84	0.061	0.072	0.110	0.109	0.151	0.32	0.04
85	0.061	0.072	0.110	0.109	0.151	0.32	0.04
86	0.061	0.072	0.110	0.109	0.151	0.44	0.04
87	0.061	0.072	0.110	0.109	0.151	0.40	0.04
88	0.061	0.062	0.110	0.109	0.151	0.40	0.04
89	0.061	0.062	0.110	0.109	0.151	0.36	0.04
90	0.061	0.086	0.098	0.109	0.136	0.36	0.04
91	0.061	0.083	0.098	0.109	0.136	0.20	0.04
92	0.061	0.083	0.098	0.109	0.136	0.24	0.04
93	0.061	0.083	0.098	0.109	0.121	0.28	0.04
94	0.061	0.083	0.098	0.109	0.121	0.28	0.04
95	0.061	0.083	0.098	0.109	0.121	0.20	0.04
96	0.061	0.083	0.098	0.109	0.121	0.12	0.04

APPENDIX I

TECHNICAL BASIS FOR REQUIRED STORMWATER DETENTION VOLUMES

Project No. : 65225
Date : November 4, 1993
Author : Tom Holz
File name : TM052.WP

THURSTON COUNTY STORM AND SURFACE WATER UTILITY TECHNICAL MEMORANDUM 52

JUSTIFICATION FOR DOUBLING STORAGE IN DRAINAGE ORDINANCE 9859

Introduction

In 1991 the Board of County Commissioners and the Councils of the Cities of Lacey, Olympia, and Tumwater adopted a common drainage ordinance. (In Thurston County it is titled Ordinance 9859). In this ordinance, minimum storage and maximum release rates for runoff from developed property were prescribed based on calculations using a limited, single-event hydrologic model (SCS Santa Barbara Unit Hydrograph). It was understood at the time that the model used probably was over-stating allowable discharge and that streams would not be adequately protected with the standard proposed; but it was the best available tool at the time.

It was also understood that better estimates of allowable discharge would come as a result of basin planning that was underway at the time. In the text of the ordinance (Chapter 1, Section 1.3) such changes were anticipated and it is clearly stated that limits on discharge determined through basin planning process superseded the manual.

Results of Basin Planning

To date basin plans using continuous flow modeling (HSPF) as the basis of estimating allowable discharge have been completed for Percival, Woodland, and Woodard basins. For all three basins it was estimated that peak discharges had greatly increased since the pristine condition. In all three plans it was shown that if the basins were built out to the densities allowed by zoning, peak discharges in the creeks would substantially increase again if the standards set in the 1991 ordinance were adhered to.

In Figure 1 below, it can be seen for the Percival Basin that existing peak flows have increased about 50% over those experienced during the forested condition and that development under 1991 standards will lead to nearly doubling of flows over the forested condition. By adopting discharge limits recommended in the Percival Basin Plan the increase of flows can be considerably reduced. Similar analyses were performed on Woodland and Woodard basins with parallel results.

In Figure 2, the analysis shows, for a subbasin in Woodland Creek with poorer soils, that proposed changes control more frequent storm events (up to the 2 year event) but have a less dramatic effect for less frequent events.

To further reduce the impact of development for the less frequent events, more storage could be provided by:

- Even higher standards for projects regulated by the proposed ordinance OR
- Construction of public projects in addition to facilities built by private developers under the proposed ordinance.

Impact on Habitat

Increases in flows in the three basins to date have led to the loss of habitat for fish. It was forecast for the Woodland Basin that if flows doubled fish habitat would be severely damaged to the point where juvenile salmonids might not be able to find refuge for flows in excess of the two year event. (Appendix L, Woodland / Woodard Basin Plan).

Because the pattern of increasing flows and commensurate loss of habitat is well established (eg, the subject of several papers at the March 1992, Salmon in the City Conference) results of the Woodland Creek analysis can reasonably be extrapolated to other basins.

Impact on Cost

If the proposed storage increase for poor soils were approved, financial analysis conducted in 1992 (City of Olympia Public Works, April 16, 1992, Andy Haub) indicates the following:

- Regional storage facilities cost about 47% more per acre foot of storage than on-site facilities principally because of expensive conveyance systems not needed for on-site facilities. Costs of regional facilities would be borne by rate payers. On-site facilities would be paid for developers / new home buyers.
- Additional cost to a prospective homeowner will be on the order of $640 per five acre home site. A cost reduction will be realized for lots on soils with good infiltration rates.

Because most of the county has high infiltration rates, the proposal will lead to lower costs in much of the county.

Conclusion

Adoption of non-structural flow control measures recommended in the three completed basin plans (ie, proposed revisions to the Drainage Ordinance) will reduce forecast flows. This change coupled with the projects and other non-structural measures recommended in the basin plans will deliver a level of service described as "preserve existing conditions".

This conclusion is predicated on implementation of the projects and non-structural recommendations in basin plans and on the assumption that no changes in land use policy are enacted which would invalidate the plans.

Figure 1

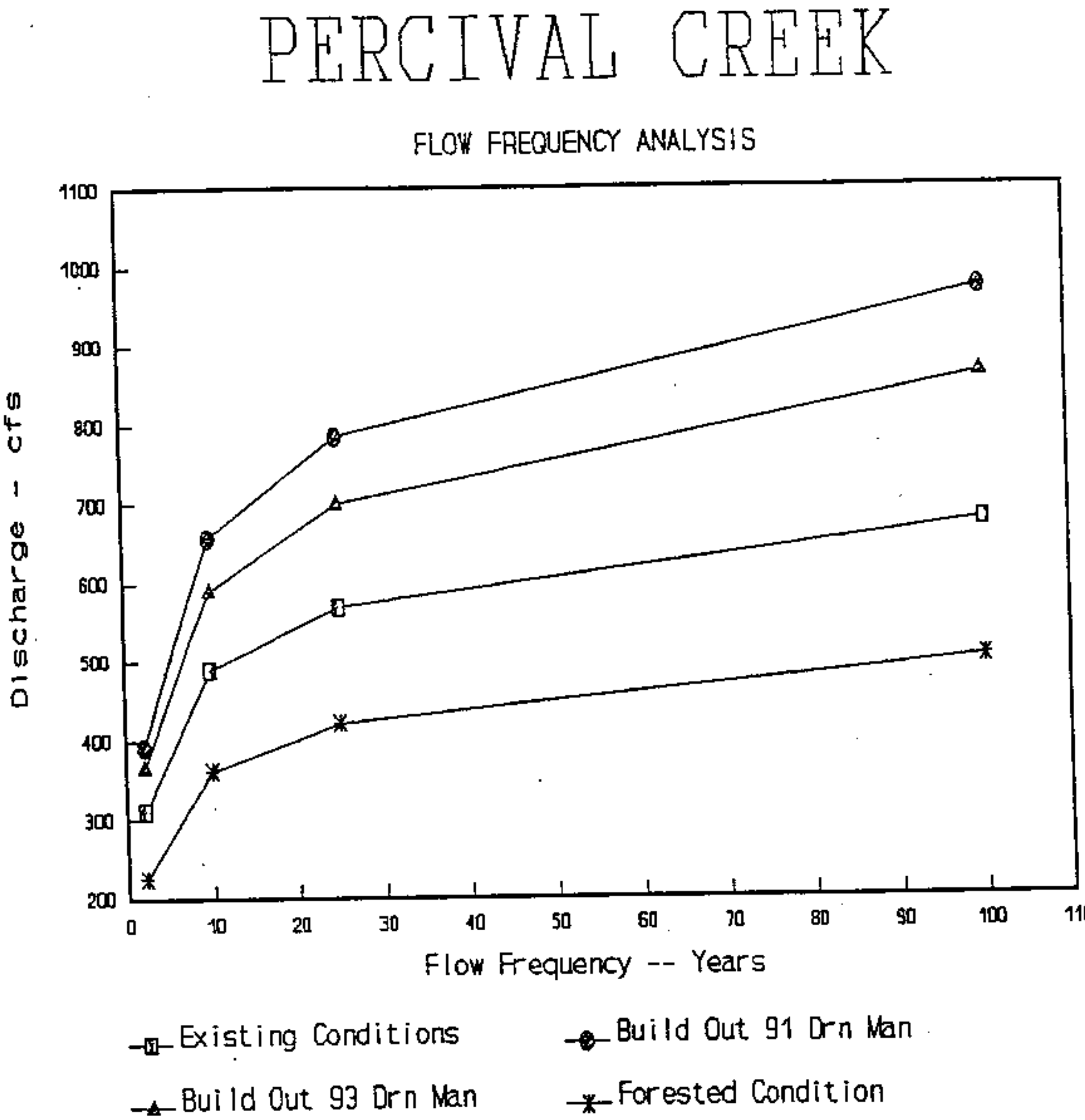
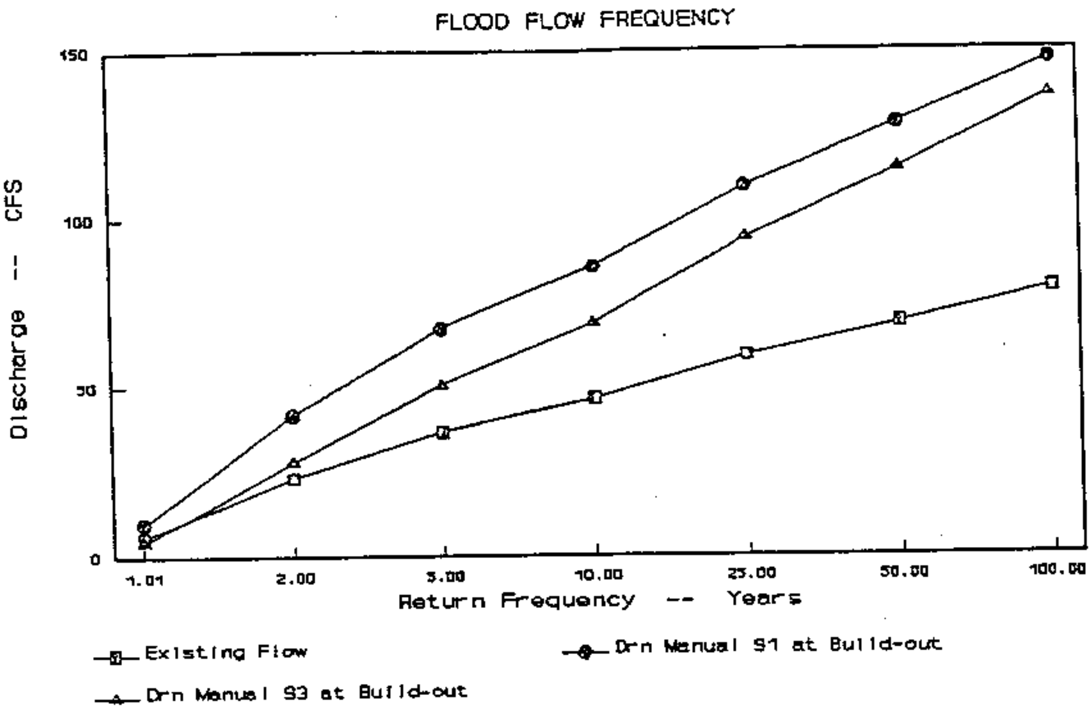

PERCIVAL CREEK
FLOW FREQUENCY ANALYSIS
Discharge - cfs
1100
1000
900
800
700
600
500
400
300
200
0
10
20
30
40
50
60
70
80
90
100
110
Flow Frequency -- Years
Existing Conditions
Build Out 91 Drn Man
Build Out 93 Drn Man
Forested Condition

Figure 2

SUBBASIN 25 OF WOODLAND CREEK



REFERENCES

1. Haub, Andy, Thomas W. Holz, *Proposed Drainage Manual Stormwater Storage and Release Rates*, (Memorandum), City of Olympia, March 4, 1992.

2. Haub, Andy, *Proposed Changes in Stormwater Management Requirements*, (Letter to Mr. Steve Hanson) City of Olympia, April 13, 1993.

3. Haub, Andy, *Private Costs of Basin Plan Implementation*, (Presentation to a joint meeting of Lacey, Olympia, Tumwater, and Thurston County Public Works Directors) April 16, 1992.

4. Leytham, Malcolm, *A Preliminary Evaluation of Hillslope Hydrologic Processes and Implications for Stormwater Control in Thurston County*, Northwest Hydraulics Consultants Inc, June, 1990.

5. Staff Report, *Effects of Development Density on Stormwater Management in Woodard Creek Basin, Thurston County*, Storm and Surface Water Program, ca 1992.

APPENDIX J

STORMWATER TREATMENT ALTERNATIVES

TABLE J-1 STORMWATER TREATMENT ALTERNATIVES

COMPARISON CRITERIA	TREATMENT							
	Wet Ponds (Mirror ponds)	Dry Ponds	Underground Vaults (wet/dry)	Filters (Ponds)	Grass Channels	(Water Quality Inlets)	Filter Vaults (Fram filter)	Sand Filters
% SEDIMENT REMOVAL (Toxins and metals assoc'd w/ sediment)	50-90% references 2,3,5	60% removal of tss reported (ref.3, p. 15) but indicate that sediment is resuspended with each new influx.	Same as ponds	Unknown but probably similar to sand filters	Up to 90.4-94.5% removal tss reported (ref 8,p22). Typically 60-70%.	None;"pollutant removal capacity has never been monitored in the field"(ref.2)..only moderate removal of coarse sediment, high removal of grease/oil."	Some removal but not primary function.	Removes 70% total suspended solids (ref. 1,5).
BIOFILTRATION? (Nutrient, Bacteria, Removal)	60-80% organic P and N removed during active growing season (ref.2).	Ranges from 0-30% reductin P and N (ref.3)	Whatever is associated with particulates.	Unknown but probably good removal.	99% removal N,P, andf BOD (ref. 4) during growing season.	None	Whatever is associated with particulates.	Removes 76% fecal coliform, 21% total N (ref.1).
APPLICABILITY	Best for high volume/low contamination areas >20 acres with reliable source of water. 10 acre watershed minimum. Pond surface 1/4 acre minimum.	High volume/low contamination. No limitations.	High volume/low contamination. Generally only used in commercial or industrial areas where no open land is available for surface detention (ref. 6,p.219).	Same as ponds	High volume/low contamination. Topographical limitations.	Low volume/high contamination. Requires outlet works for detention.	Low volume/high contamination. Parking lots, utilities, gas stations, vehicle repair and maintanance shops, truck stops, etc.	City of Austin standard design.
SUITABILITY FOR MULTI-USE	Excellent for passive recreation, stormwater management,pollutant removal, landscape/ habitat improvement.	Excellent for active recreation.	None	Not applicable	Open space amenity.	None.	None	None.

Table Page 2

TABLE J-1 STORMWATER TREATMENT ALTERNATIVES

COMPARISON CRITERIA	TREATMENT							
	Wet Ponds (Mirror ponds)	Dry Ponds	Underground Vaults (wet/dry)	Filters (Ponds)	Grass Channels	(Water Quality Inlets)	Filter Vaults (Fram filter)	Sand Filters
SUITABILITY FOR REGIONAL STORMWATER FACILITY	Excellent with correct design application and timing of individual releases.	Excellent with correct design.	Poor	Not applicable	None	None	None	None
RECEIVING WATER CONSIDERATIONS	Suitable for discharge to any water body. Best treatment for discharge to lakes.	Suitable for discharge to most water bodies except lakes.	No biofiltration. Not good for nutrient sensitive receiving waters.	Not designed for this purpose or should be used in conjunction with some other treatment.	Suitable for discharge to any water body. No volume control or spill trapping.	Not applicable.	Not designed for this purpose or should be used in conjunction with some other treatment.	Suitable for any receiving waters.
MAINTENANCE DIFFICULTY (Costly, Inexpensive)	Moderate. Mowing two times/year. Up to 14 times/year for aesthetics. Annual inspection in wet weather, nuisance control as needed. Sediment clean-out cycle every 10-20 years.	Moderate. Mowing 2 times/yr. to remove woody growth, up to 14/year for aesthetics.Outlets require inspection, cleaning.Sediment removal by mechanical means. (Ref. 9,p.373).	Costly, difficult.	Unknown	Moderate. Normal lawn-mowing activities only as necessary.	Costly. Monthly cleaning in winter, regular inspection, pump out of surface oil and sediments as needed.	Costly	Costly. Trash removal every six months, annual inspection and repair.
REMARKS					Swales need grading drainage permits. Side-slope max. gradient 8%. Use water and erosion tolerant grass. 200' removes 80% tss (ref. 5).	Unobtrusive, easy pretreatment,storm drain compatible. But limited pollutant removal, needs pump out and skimming.		

APPENDIX K

EXAMPLE MAINTENANCE SCHEDULE FOR DRAINAGE SYSTEMS

INSTRUCTIONS FOR PERSON ASSEMBLING
THE MAINTENANCE AGREEMENT

1. Select the correct type of Maintenance Agreement (residential or commercial).

2. Include the "Instruction for Person Maintaining Stormwater System" sheet.

3. Include the Attachment "A" cover sheet.

4. Include only those maintenance checklists that apply (e.g., if stormwater system includes a pond, provide pond checklist).

5. For residential projects, include a copy of "Residential Best Management Practices," from the *Stormwater Program Guidance Manual, Volume II*, Department of Ecology, July 1992. This provides source control.

6. For commercial/industrial projects, include the appropriate source control language from *Volume IV, Urban Land Use BMPs, Stormwater Management Manual for the Puget Sound*, Department of Ecology, February 1992.

RESIDENTIAL
AGREEMENT TO MAINTAIN
STORMWATER FACILITIES AND TO IMPLEMENT A
POLLUTION SOURCE CONTROL PLAN
BY AND BETWEEN

THEIR HEIRS, SUCCESSORS, OR ASSIGNS
(HEREINAFTER "____________")

The upkeep and maintenance of stormwater facilities and the implementation of pollution source control best management practices (BMPs) is essential to the protection of water resources. All property owners are expected to conduct business in a manner that promotes environmental protection. This Agreement contains specific provisions with respect to maintenance of stormwater facilities and use of pollution source control BMPs.

LEGAL DESCRIPTION:

Whereas, the ________________ have constructed improvements, including but not limited to, buildings, pavement, and stormwater facilities on the property described above. In order to further the goals of the Jurisdiction to ensure the protection and enhancement of water resources, the Jurisdiction and the _______________ hereby enter into this Agreement. The responsibilities of each party to this Agreement are identified below.

_________________ SHALL:

(1) Implement the stormwater facility maintenance program included herein as Attachment "A".

(2) Implement the pollution source control program included herein as Attachment "B".

(3) Maintain a record (in the form of a log book) of steps taken to implement the programs referenced in (1) and (2) above. The log book shall be available for inspection by appointment at ______________________________. The log book shall catalog the action taken, who took it, when it was done, how it was done, and any problems encountered or follow-on actions recommended. Maintenance items ("problems") listed in Attachment "A" shall be inspected as specified in the attached instructions or more often if necessary. The ___________ are encouraged to photocopy the individual checklists in

Attachment "A" and use them to complete its inspections. These completed checklists would then, in combination, comprise the log book.

(4) Submit an annual report to the Jurisdiction regarding implementation of the programs referenced in (1) and (2) above. The report must be submitted on or before May 15 of each calendar year and shall contain, at a minimum, the following:

(a) Name, address, and telephone number of the businesses, the persons, or the firms responsible for plan implementation, and the person completing the report.

(b) Time period covered by the report.

(c) A chronological summary of activities conducted to implement the programs referenced in (1) and (2) above. A photocopy of the applicable sections of the log book, with any additional explanation needed, shall normally suffice. For any activities conducted by paid parties, include a copy of the invoice for services.

(d) An outline of planned activities for the next year.

(5) Execute the following periodic major maintenance on the subdivision's stormwater facilities: sediment removal from ponds, managing vegetation in wet ponds, resetting orifice sizes and elevations, and adding baffles.

THE JURISDICTION SHALL:

(1) Maintain all stormwater system elements in the public rights-of-way, such as catch basins, oil-water separators, and pipes.

(2) Provide technical assistance to the _______________ in support of its operation and maintenance activities conducted pursuant to its maintenance and source control programs. Said assistance shall be provided upon request and as Jurisdiction time and resources permit.

(3) Review the annual report and conduct a minimum of one (1) site visit per year to discuss performance and problems with the _______________________.

(4) Review this agreement with the _______________________ and modify it as necessary at least once every three (3) years.

REMEDIES:

(1) If the Jurisdiction determines that maintenance or repair work is required to be done to the stormwater facilities located in the subdivision, the Jurisdiction shall give the _____________________ notice of the specific maintenance and/or repair required. The

Jurisdiction shall set a reasonable time in which such work is to be completed by the persons who were given notice. If the above required maintenance and/or repair is not completed within the time set by the Jurisdiction, written notice will be sent to the ________________ stating the Jurisdiction's intention to perform such maintenance and bill the ___________________ for all incurred expenses.

(2) If at any time the Jurisdiction determines that the existing system creates any imminent threat to public health or welfare, the Jurisdiction may take immediate measures to remedy said threat. No notice to the persons listed in Remedies (1), above, shall be required under such circumstances. All other ____________________ responsibilities shall remain in effect.

(3) The ______________________ grant unrestricted authority to the Jurisdiction for access to any and all stormwater system features for the purpose of performing maintenance or repair as may become necessary under Remedies (1) and/or (2).

(4) The ____________________ shall assume responsibility for the cost of maintenance and repairs to the stormwater facility, except for those maintenance actions explicitly assumed by the Jurisdiction in the preceding section. Such responsibility shall include reimbursement to the Jurisdiction within 90 days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the current legal rate for liquidated judgments. If legal action ensues, any costs or fees incurred by the Jurisdiction will be borne by the parties responsible for said reimbursements.

This Agreement is intended to protect the value and desirability of the real property described above and to benefit all the citizens of the Jurisdiction. It shall run with the land and be binding on all parties having or acquiring any right, title, or interest, or any part thereof, of real property in the subdivision. They shall inure to the benefit of each present or future successor in interest of said property or any part thereof, or interest therein, and to the benefit of all citizens of the Jurisdiction.

____

Owner

____

Owner

//

//

STATE OF WASHINGTON)
) ss
COUNTY OF THURSTON)

On this day and year above personally appeared before me, __________________ and ___________________________ known to be the individual(s) described, and who executed the foregoing instrument and acknowledge that they signed the same as their free and voluntary act and deed for the uses and purposes therein mentioned.

Given under my hand and official seal this ______ day of _____________, 199__.

____
Notary Public in and for the State of Washington, residing in ______________________
My commission expires ______________________

Dated at Olympia, Washington, this ______ day of _________________, 1991.

____

STATE OF WASHINGTON)
) ss
COUNTY OF THURSTON)

On this day and year above personally appeared before me, _____________________ ____, who executed the foregoing instrument and acknowledge the said instrument to be the free and voluntary act and deed of said Municipal Corporation for the uses and purposes therein mentioned and on oath states he is authorized to execute the said instrument.

Given under my hand and official seal this ______ day of _____________, 199__.

____
Notary Public in and for the
State of Washington, residing in
________________________________.

My commission expires ______________________

APPROVED AS TO FORM:

____

COMMERCIAL/INDUSTRIAL
AGREEMENT TO MAINTAIN
STORMWATER FACILITIES AND TO IMPLEMENT A
POLLUTION SOURCE CONTROL PLAN
BY AND BETWEEN

ITS HEIRS, SUCCESSORS, OR ASSIGNS
(HEREINAFTER "____________________")

The upkeep and maintenance of stormwater facilities and the implementation of pollution source control best management practices (BMPs) is essential to the protection of water resources. All property owners are expected to conduct business in a manner that promotes environmental protection. This Agreement contains specific provisions with respect to maintenance of stormwater facilities and use of pollution source control BMPs.

LEGAL DESCRIPTION:

Whereas, Business Name has constructed improvements, including but not limited to, buildings, pavement, and stormwater facilities on the property described above. In order to further the goals of the Jurisdiction to ensure the protection and enhancement of Jurisdiction's water resources, the Jurisdiction and Business Name hereby enter into this Agreement. The responsibilities of each party to this Agreement are identified below.

BUSINESS NAME SHALL:

(1) Implement the stormwater facility maintenance program included herein as Attachment "A".

(2) Implement the pollution source control program included herein as Attachment "B".

(3) Maintain a record (in the form of a log book) of steps taken to implement the programs referenced in (1) and (2) above. The log book shall be available for inspection by Jurisdiction staff at ______address_______ during normal business hours. The log book shall catalog the action taken, who took it, when it was done, how it was done, and any problems encountered or follow-on actions recommended. Maintenance items ("problems") listed in Attachment "A" shall be inspected on a monthly or more frequent basis as necessary. Business Name is encouraged to photocopy the individual checklists in

Attachment A and use them to complete its monthly inspections. These completed checklists would then, in combination, comprise the monthly log book.

(4) Submit an annual report to the Jurisdiction regarding implementation of the programs referenced in (1) and (2) above. The report must be submitted on or before May 15 of each calendar year and shall contain, at a minimum, the following:

(a) Name, address, and telephone number of the business, the person, or the firm responsible for plan implementation, and the person completing the report.

(b) Time period covered by the report.

(c) A chronological summary of activities conducted to implement the programs referenced in (1) and (2) above. A photocopy of the applicable sections of the log book, with any additional explanation needed, shall normally suffice. For any activities conducted by paid parties not affiliated with Business Name, include a copy of the invoice for services.

(d) An outline of planned activities for the next year.

THE JURISDICTION SHALL:

(1) Provide technical assistance to Business Name in support of its operation and maintenance activities conducted pursuant to its maintenance and source control programs. Said assistance shall be provided upon request, and as Jurisdiction time and resources permit, at no charge to Business Name.

(2) Review the annual report and conduct a minimum of one (1) site visit per year to discuss performance and problems with Business Name.

(3) Review this agreement with Business Name and modify it as necessary at least once every three (3) years.

REMEDIES:

(1) If the Jurisdiction determines that maintenance or repair work is required to be done to the stormwater facility existing on the Business Name property, the Jurisdiction shall give the owner of the property within which the drainage facility is located, and the person or agent in control of said property, notice of the specific maintenance and/or repair required. The Jurisdiction shall set a reasonable time in which such work is to be completed by the persons who were given notice. If the above required maintenance and/or repair is not completed within the time set by the Jurisdiction, written notice will be sent to the persons who were given notice stating the Jurisdiction's intention to perform such maintenance and bill the owner for all incurred expenses. The Jurisdiction may also revoke stormwater

utility rate credits for the quality component or invoke surcharges to the quantity component of the Business Name bill if required maintenance is not performed.

(2) If at any time the Jurisdiction determines that the existing system creates any imminent threat to public health or welfare, the Jurisdiction may take immediate measures to remedy said threat. No notice to the persons listed in (1), above, shall be required under such circumstances.

(3) The owner grants unrestricted authority to the Jurisdiction for access to any and all stormwater system features for the purpose of performing maintenance or repair as may become necessary under Remedies (1) and/or (2).

(4) The persons listed in (1), above, shall assume all responsibility for the cost of any maintenance and for repairs to the stormwater facility. Such responsibility shall include reimbursement to the Jurisdiction within 30 days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the current legal rate for liquidated judgments. If legal action ensues, any costs or fees incurred by the Jurisdiction will be borne by the parties responsible for said reimbursements.

(5) The owner hereby grants to the Jurisdiction a lien against the above-described property in an amount equal to the cost incurred by the Jurisdiction to perform the maintenance or repair work described herein.

This Agreement is intended to protect the value and desirability of the real property described above and to benefit all the citizens of the Jurisdiction. It shall run with the land and be binding on all parties having or acquiring from Business Name or their successors any right, title, or interest in the property or any part thereof, as well as their title, or interest in the property or any part thereof, as well as their heirs, successors, and assigns. They shall inure to the benefit of each present or future successor in interest of said property or any part thereof, or interest therein, and to the benefit of all citizens of the Jurisdiction.

____
Owner

____
Owner

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STATE OF WASHINGTON)
) ss
COUNTY OF THURSTON)

On this day and year above personally appeared before me, __________________ and __________________________ known to be the individual(s) described, and who executed the foregoing instrument and acknowledge that they signed the same as their free and voluntary act and deed for the uses and purposes therein mentioned.

Given under my hand and official seal this ______ day of _____________, 199__.

____
Notary Public in and for the
State of Washington, residing in
________________________________.

Dated at ___________, Washington, this ______ day of _________________, 199__.

____

STATE OF WASHINGTON)
) ss
COUNTY OF THURSTON)

On this day and year above personally appeared before me, ___________________ ____, who executed the foregoing instrument and acknowledge the said instrument to be the free and voluntary act and deed of said Municipal Corporation for the uses and purposes therein mentioned and on oath states he is authorized to execute the said instrument.

Given under my hand and official seal this ______ day of _____________, 199__.

____
Notary Public in and for the
State of Washington, residing in
________________________________.

APPROVED AS TO FORM:

NOTE: The following is an <u>example</u> of what the pollution source control program for a retail store would look like. You are required to <u>develop your own program</u>, tailored to your type of business, using the information available in Volume IV of the *Department of Ecology Stormwater Manual*.

POLLUTION SOURCE CONTROL PROGRAM

WHAT ARE POLLUTION SOURCE CONTROLS, AND WHY ARE THEY NEEDED?

Pollution source controls are actions taken by a person or business to reduce the amount of pollution reaching surface and ground waters. Controls, also called "best management practices" (BMPs), include:

- Altering the activity (e.g., substitute non-toxic products, recycle used oil, reroute floor drains to sanitary sewer from storm sewer)
- Enclosing or covering the activity (e.g., building a roof)
- Segregating the activity (e.g., diverting runoff away from an area that is contaminated)
- Routing runoff from the activity to a treatment alternative (e.g., to a wastewater treatment facility, sanitary sewer, or stormwater treatment area)

Pollution source controls are needed because of the contamination found in runoff from commercial areas and the effect of this contamination on aquatic life and human health. Research on urban runoff in the Puget Sound area and elsewhere has found oil and grease, nutrients, organic substances, toxic metals, bacteria, viruses, and sediments at unacceptable levels. Effects of contaminated runoff include closure of shellfish harvesting areas and swimming areas, mortality of young fish and other aquatic organisms, tumors on fish, and impairment of fish reproduction.

IV-2.3.4 RETAIL GENERAL MERCHANDISE

GENERAL DESCRIPTION: This group includes general merchandising stores such as department stores, shopping malls, variety stores, 24-hour convenience stores, and general retail stores that focus on a few product types such as clothing and shoes. It also includes furniture and appliance stores.

MATERIALS USED AND WASTES GENERATED: Of particular concern are the parking lots of shopping malls and 24-hour convenience stores. Because of heavy vehicle usage, the concentration of oil and grease in stormwater may exceed the Ecology guidelines of 10 mg/1. Although there are no local data to confirm this view, limited research in the San Francisco Bay area found the mean concentration of oil and grease in stormwater to exceed 10 mg/1. Larger stores may own delivery vehicles. It is likely that servicing these vehicles occurs elsewhere and is not done by the owner.

Furniture and appliance stores may provide repair services in which Dangerous Wastes may be produced. Department stores and shopping malls may have restaurants that generate waste food.

REQUIRED ACTIONS: The following actions shall be taken to ensure that pollution generated on site shall be minimized:

1. Warning signs (e.g., "Dump No Waste--Drains to Stream") shall be painted or embossed on or adjacent to all storm drain inlets. They shall be repainted as needed. Materials needed to undertake this task can be obtained at no cost from the Public Involvement Coordinator for the Department of Public Works.

2. Parking lots shall be swept when necessary to remove debris and, at a minimum, twice a year. Use of newer model high-velocity vacuum sweepers is recommended as they are more effective in removing the more harmful smaller particles from paved surfaces.

3. Sediment removed from detention vaults shall be disposed of in a proper manner. Contact the City for instruction prior to completing this task.

4. No activities shall be conducted on site that are likely to result in short-term high-concentration discharge of pollution to the stormwater system. Such activities may include, but are not limited to, vehicle washing, vehicle maintenance, and cleaning of equipment used in the periodic maintenance of buildings and paved surfaces.

5. Employees shall receive basic instruction regarding the control of pollution from commercial operations. Contact the Public Involvement Coordinator for the Department of Public Works for assistance in completing this task.

6. Retailers with high volume customer contacts have potential to influence individuals' water quality practices. Owners are encouraged to have informational brochures provided by the City available at counters.

INSTRUCTIONS

The following pages contain maintenance needs for most of the components that are part of your drainage system, as well as for some components that you may not have. Let us know if there are any components that are missing from these pages. Ignore the requirements that do not apply to your system. You should plan to complete a checklist for all system components on the following schedule:

(1) Monthly from November through April.
(2) Once in late summer (preferably September).
(3) After any major storm (use 1-inch in 24 hours as a guideline), items marked "S" only.

Using photocopies of these pages, check off the problems you looked for each time you did an inspection. Add comments on problems found and actions taken. Keep these "checked" sheets in your files, as they will be used to write your annual report (due in May). Some items do not need to be looked at every time an inspection is done. Use the suggested frequency at the left of each item as a guideline for your inspection.

You may call the jurisdiction for technical assistance. Please do not hesitate to call, especially if you are unsure whether a situation you have discovered may be a problem.

ATTACHMENT "A": MAINTENANCE PROGRAM

COVER SHEET

Inspection Period: ______________________________

Number of Sheets Attached: ______________________________

Date Inspected: ______________________________

Name of Inspector: ______________________________

Inspector's Signature ______________________________

ATTACHMENT "A": MAINTENANCE PROGRAM

Maintenance Checklist for Closed Detention Systems (Pipes/Tanks)

Frequency	Drainage Systems Feature	√	Problem	Conditions To Check For	Conditions That Shall Exist
M	Storage area (pipe tank)		Plugged air vents (small pipe that connects catch basin to storage pipe)	One-half of the end area of a vent is blocked at any point with debris and sediment. Plugged vent can cause storage area to collapse.	Vents free of debris and sediment.
M			Debris and sediment	Accumulated sediment depth exceeds 15% of diameter. Example: 72-inch storage tank would require cleaning when sediment reaches depth of 10 inches.	All sediment and debris removed from storage area. Contact City Public Works for guidance on sediment removal and disposal.
A			Joints between tank/pipe section	Any crack allowing material to leak into facility.	All joints between tank/pipe sections are sealed.
A			Tank/pipe bent out of shape	Any part of tank/pipe is noticeably bent out of shape.	Tank/pipe repaired or replaced to design. Contact a professional engineer for evaluation.
M,S	Manhole		Cover not in place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
A			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.
A			Cover difficult to remove	One Maintenance person cannot remove lid after applying 80 pounds of lift. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
A			Ladder rungs unsafe	Maintenance person judges that ladder is unsafe due to missing rungs, misalignment, rust, or cracks.	Ladder meets design standards and allows maintenance persons safe access.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

Key

A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

ATTACHMENT "A" (CONTINUED)

Maintenance Checklist for Control Structure/Flow Restrictor
(structure that controls rate at which water exits facility)

Frequency	Drainage Systems Feature	√	Problem	Conditions To Check For	Conditions That Should Exist
M	Structure		Trash & debris (includes sediment)	Distance between debris buildup and bottom of orifice plate is less than 1½ feet.	All trash and debris removed.
A			Structural damage	Structure is not securely attached to manhole wall and outlet pipe structure should support at least 1,000 pounds of up or down pressure.	Structure securely attached to wall and outlet pipe.
A				Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
A				Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are watertight; structure repaired or replaced and works as designed.
M				Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
M,S	Cleanout gate		Damaged or missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
A				Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
M,S				Chain leading to gate is missing or damaged.	Chain is in place and works as designed.
A				Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
M,S			Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
M,S	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.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

Key
- A = Annual (March or April preferred)
- M = Monthly (see schedule)
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Maintenance Checklist for Catch Basins and Inlets

Frequency	Drainage System Feature	√	Problem	Conditions To Check For	Conditions That Should Exist
M,S	General		Trash, debris, and sediment in or on basin	Trash or debris in front of the catch basin opening is blocking capacity by more than 10%.	No trash or debris located immediately in front of catch basin opening. Grate is kept clean and allows water to enter.
M				Sediment or debris (in the basin) that exceeds 1/3 the depth from the bottom of basin to invert of the lowest pipe into or out of the basin.	No sediment or debris in the catch basin. Catch basin is dug out and clean.
M,S				Trash or debris in any inlet or pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
M			Structural damage to frame and/or top slab	Corner of frame extends more than 3/4 inch past curb face into the street (if applicable).	Frame is even with curb.
M				Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (intent is to make sure all material is running into the basin).	Top slab is free of holes and cracks.
M				Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab.	Frame is sitting flush on top slab.
A			Cracks in basin walls/bottom	Cracks wider than 1/2 inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards. Contact a professional engineer for evaluation.
A				Cracks 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.	No cracks more than 1/4 inch wide at the joint of inlet/outlet pipe.
A			Settlement/ misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards. Contact a professional engineer for evaluation.
M,S			Fire hazard or other pollution	Presence of chemicals such as natural gas, oil, and gasoline. Obnoxious color, odor, or sludge noted.	No color, odor, or sludge. Basin is dug out and clean.
M,S			Outlet pipe is clogged with vegetation	Vegetation or roots 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.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

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Maintenance Checklist for Ponds

Frequency	Drainage System Feature	√	Problem	Conditions to Check For	Conditions That Should Exist
M,S	General		Trash & debris buildup in pond.	Dumping of yard wastes such as grass clippings and branches into basin. Unsightly accumulation of non-degradable materials such as glass, plastic, metal, foam, and coated paper.	Remove trash and debris and dispose as prescribed by City Waste Management Section.
M,S			Trash rack plugged or missing	Bar screen over outlet more than 25% covered by debris or missing.	Replace screen. Remove trash and debris and dispose as prescribed by City Waste Management Section.
M			Poisonous vegetation	Any poisonous vegetation which may constitute a hazard to the public. Examples of poisonous vegetation include: tansy ragwort, poison oak, stinging nettles, devilsclub.	Remove poisonous vegetation. Do not spray chemicals on vegetation without obtaining guidance from the Cooperative Extension Service and approval from the City.
M,S			Fire hazard or pollution	Presence of chemicals such as natural gas, oil, and gasoline, obnoxious color, odor, or sludge noted.	Find sources of pollution and eliminate them. Water is free from noticeable color, odor, or contamination.
M			Vegetation not growing or is overgrown	For grassy ponds, grass cover is sparse and weedy or is overgrown. For wetland ponds, plants are sparse or invasive species are present.	For grassy ponds, selectively thatch, aerate, and reseed ponds. Grass cutting unnecessary unless dictated by aesthetics. For wetland ponds, hand-plant nursery-grown wetland plants in bare areas. Contact the Cooperative Extension Service for direction on invasive species such as purple loosestrife and reed canary grass. Pond bottoms should have uniform dense coverage of desired plant species.
M			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. Contact the Thurston County Health Department for guidance.
M			Insects	When insects such as wasps and hornets interfere with maintenance activities, or when mosquitoes become a nuisance.	Insects destroyed or removed from site. Contact Cooperative Extension Service for guidance.
A			Tree growth	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, or equipment movements). If trees are not interfering with access, leave trees alone.	Trees do not hinder maintenance activities. Selectively cultivate trees such as alders for firewood.
M	Side slopes of pond		Erosion on berms or at entrance/exit	Check around inlets and outlets for signs of erosion. Check berms for signs of sliding or settling. Action is needed where eroded damage over 2 inches deep and where there is potential for continued erosion.	Find causes of erosion and eliminate them. Then slopes should be stabilized by using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
M	Storage area		Sediment buildup in pond	Accumulated sediment that exceeds 10% of the designed pond depth. Buried or partially buried outlet structure probably indicates significant sediment deposits.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
A	Pond dikes		Settlements	Any part of dike which has settled 4 inches lower than the design elevation.	Dike should be built back to the design elevation.
A	Emergency overflow/ spillway		Rock missing	Only one layer of rock exists above native soil in area 5 square feet or larger, or any exposure of native soil.	Replace rocks to design standards.
One Time	Emergency overflow/ spillway		Overflow missing	Side of pond has no area with large rocks to handle emergency overflows.	Contact City for guidance.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.
Comments:

<u>Key</u>
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

ATTACHMENT "A" (CONTINUED)

Maintenance Checklist for Infiltration Systems

Frequency	Drainage System Feature	√	Problem	Conditions to Check For	Conditions That Should Exist
M,S	General		Trash & debris buildup in pond	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M			Poisonous vegetation	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M,S			Fire hazard or pollution	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M			Vegetation not growing or is overgrown	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M			Rodent holes	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
M			Insects	See Maintenance Checklist for Ponds.	See Maintenance Checklist for Ponds.
A	Storage area		Sediment buildup in system	A soil texture test indicates facility is not working at its designed capabilities or was incorrectly designed.	Sediment is removed and/or facility is cleaned so that infiltration system works according to design. A sediment trapping area is installed to reduce sediment transport into infiltration area.
A			Storage area drains slowly (more than 48 hours) or overflows	A soil texture test indicates facility is not working at its designed capabilities or was incorrectly designed.	Additional volume is added through excavation to provide needed storage. Soil is aerated and rototilled to improve drainage. Contact the City for information on its requirements regarding excavation.
M			Sediment trapping area	Any sediment and debris filling area to 10% of depth from sump bottom to bottom of outlet pipe or obstructing flow into the connector pipe.	Clean out sump to design depth.
One Time			Sediment trapping area not present	Stormwater enters infiltration area directly without treatment.	Add a trapping area by constructing a sump for settling of solids. Segregate settling area from rest of facility. Contact City for guidance.
M	Rock filters		Sediment and debris	By visual inspection little or no water flows through filter during heavy rain storms.	Replace gravel in rock filter.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

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M = Monthly (see schedule)
S = After major storms

ATTACHMENT "A" (CONTINUED)

Maintenance Checklist for Energy Dissipators

Frequency	Drainage System Feature	√	Problem	Conditions to Check For	Conditions That Should Exist
A	Rock pad		Missing or moved rock	Only one layer of rock exists above native soil in area 5 square feet or larger, or any exposure of native soil.	Replace rocks to design standard.
A	Rock-filled trench for discharge from pond		Missing or moved rock	Trench is not full of rock.	Add large rock (±30 lb. each) so that rock is visible above edge of trench.
M	Dispersion trench		Pipe plugged with sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed.
M			Perforations plugged	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Clean or replace perforated pipe.
M,S			Not discharging water property	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 must be redesigned or rebuilt to standard. Elevation of lip of trench should be the same (flat) at all points.
M,S			Water flows out top of "distributor" catch basin	Maintenance person observes water flowing out during any storm less than the design storm or it is causing or appears likely to cause damage.	Facility must be rebuilt or redesigned to standards. Pipe is probably plugged or damaged and needs replacement.
M,S			Receiving area over-saturated	Water in receiving area is causing or has potential of causing landslide.	Stabilize slope with grass or other vegetation, or rock if condition is severe.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

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ATTACHMENT "A" (CONTINUED)

Maintenance Checklist for Fencing/Shrubbery Screen/Other Landscaping

Frequency	Drainage System Feature	√	Problem	Conditions to Check For	Conditions That Should Exist
M	General		Missing or broken parts/dead shrubbery	Any defect in the fence or screen that permits easy entry to a facility.	Fence is mended or shrubs replaced to form a solid barrier to entry.
M,S			Erosion	Erosion has resulted in an opening under a fence that allows entry by people or pets.	Replace soil under fence so that no opening exceeds 4 inches in height.
M			Unruly vegetation	Shrubbery is growing out of control or is infested with weeds	Shrubbery is trimmed and weeded to provide appealing aesthetics. Do not use chemicals to control weeds.
A	Wire Fences		Damaged parts	Posts out of plumb more than 6 inches.	Posts plumb to within 1½ inches of plumb.
A				Top rails bent more than 6 inches.	Top rail free of bends greater than 1 inch.
A				Any part of fence (including posts, top rails, and fabric) more than 1 foot out of design alignment.	Fence is aligned and meets design standards.
A				Missing or loose tension wire.	Tension wire in place and holding fabric
A				Missing or loose barbed wire that is sagging more than 2½ inches between posts.	Barbed wire in place with less than 3/4-inch sag between posts.
A				Extension arm missing, broken, or bent out of shape more than 1½ inches.	Extension arm in place with no bends larger than 3/4 inch.
A			Deteriorated paint or protective coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.	Structurally adequate posts or parts with a uniform protective coating.
M			Openings in fabric	Openings in fabric are such that an 8-inch-diameter ball could fit through.	No openings in fabric.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

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ATTACHMENT "A" (CONTINUED)

Maintenance Checklist for Gates

Frequency	Drainage System Feature	√	Problem	Conditions to Check For	Conditions That Should Exist
M	General		Damaged or missing components	Gate is broken, jammed, or missing.	Pond has a functioning gate to allow entry of people and maintenance equipment such as mowers and backhoes. If a lock is used, make sure City Stormwater Section field staff have a key.
M				Broken or missing hinges such that gate cannot be easily opened and closed by a maintenance person.	Hinges intact and lubed. Gate is working freely.
A				Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	Gate is aligned and vertical.
A				Missing stretcher bar, stretcher bands, and ties.	Stretcher bar, bands, and ties in place.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

Key
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- M = Monthly (see schedule)
- S = After major storms

ATTACHMENT "A" (CONTINUED)

Maintenance Checklist for Conveyance Systems (Pipes, Ditches, and Swales)

Frequency	Drainage System Feature	√	Problem	Conditions to Check For	Conditions That Should Exist
M,S	Pipes		Sediment & debris	Accumulated sediment that exceeds 20% of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
M			Vegetation	Vegetation that reduces free movement of water through pipes.	All vegetation removed so water flows freely through pipes.
A			Damaged (rusted, bent, or crushed)	Protective coating is damaged; rust is causing more than 50% deterioration to any part of pipe.	Pipe repaired or replaced.
M				Any dent that significantly impedes flow (i.e., decreases the cross section area of pipe by more than 20%).	Pipe repaired or replaced.
M				Pipe has major cracks or tears allowing groundwater leakage.	Pipe repaired or replaced.
M,S	Open ditches		Trash & debris	Dumping of yard wastes such as grass clippings and branches into basin. Unsightly accumulation of non-degradable materials such as glass, plastic, metal, foam, and coated paper.	Remove trash and debris and dispose as prescribed by City Waste Management Section.
M			Sediment buildup	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned of all sediment and debris so that it matches design.
A			Vegetation	Vegetation (e.g., weedy shrubs or saplings) that reduces free movements of water through ditches.	Water flows freely through ditches. Grassy vegetation should be left alone.
M			Erosion damage to slopes	See Ponds Checklist.	See Ponds Checklist.
A			Rock lining out of place or missing (if applicable)	Maintenance person can see native soil beneath the rock lining.	Replace rocks to design standard.
Varies	Catch basins			See Catch Basins Checklist.	See Catch Basins Checklist.
M,S	Swales		Trash & debris	See above for Ditches.	See above for Ditches.
M			Sediment buildup	See above for Ditches.	Vegetation may need to be replanted after cleaning.
M			Vegetation not growing or overgrown	Grass cover is sparse and weedy or areas are overgrown with woody vegetation.	Aerate soils and reseed and mulch bare areas. Maintain grass height at a minimum of 6 inches for best stormwater treatment. Remove woody growth, recontour, and reseed as necessary.
M,S			Erosion damage to slopes	See Ponds Checklist.	See Ponds Checklist.
M			Conversion by homeowner to incompatible use	Swale has been filled in or blocked by shed, woodpile, shrubbery, etc.	If possible, speak with homeowner and request that swale area be restored. Contact City to report problem if not rectified voluntarily.
A			Swale does not drain	Water stands in swale or flow velocity is very slow. Stagnation occurs.	A survey may be needed to check grades. Grades need to be in 1-5% range if possible. If grade is less than 1%, underdrains may need to be installed.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.
Comments:

Key
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

ATTACHMENT "A" (CONTINUED)

Maintenance Checklist for Grounds (Landscaping)

Frequency	Drainage System Feature	√	Problem	Conditions to Check For	Conditions That Should Exist
M	General		Weeds (nonpoisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Weeds present in less than 5% of the landscaped area.
M			Safety hazard	Any presence of poison ivy or other poisonous vegetation or insect nests.	No poisonous vegetation or insect nests present in landscaped area.
M,S			Trash or litter	See Ponds Checklist.	See Ponds Checklist.
M,S			Erosion of Ground Surface	Noticeable rills are seen in landscaped areas.	Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded.
A	Trees and shrubs		Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
M				Trees or shrubs that have been blown down or knocked over.	Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.
A				Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Place stakes and rubber-coated ties around young trees/shrubs for support.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

Key

A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

Maintenance Checklist for Access Roads/Easements

Frequency	Drainage System Feature	√	Problem	Conditions to Check For	Conditions That Should Exist
One Time	General		No access road exists	If ponds or other drainage system features needing maintenance by motorized equipment are present, either an access road or access from public streets is required.	Determine whether an easement to drainage feature exists. If yes, obtain City permits and construct gravel (or equal) access road. If not, report lack of easement to City attention.
M			Blocked roadway	Debris which could damage vehicle tires (glass or metal).	Roadway free of debris which could damage tires.
A				Any obstructions which reduce clearance above road surface to less than 14 feet.	Roadway overhead clear to 14 feet high.
A				Any obstructions restricting the access to less than 15 feet width.	Obstruction removed to allow at least a 15-foot-wide access.
A,S	Road surface		Settlement, potholes, mush spots, ruts	When any surface defect exceeds 6 inches in depth and 6 square feet in area. In general, any surface defect which hinders or prevents maintenance access.	Road surface uniformly smooth with no evidence of settlement, potholes, mush sports, or ruts. Occasionally application of additional gravel or pit-run rock will be needed.
M			Vegetation in road surface	Woody growth that could block vehicular access. Excessive weed cover.	Remove woody growth at early stage to prevent vehicular blockage. Cut back weeds if they begin to encroach on road surface.
M,S	Shoulders and ditches		Erosion damage	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep.	Shoulder free of erosion and matching the surrounding road.

If you are unsure whether a problem exists, please contact the Jurisdiction and ask for technical assistance.

Comments:

Key
A = Annual (March or April preferred)
M = Monthly (see schedule)
S = After major storms

APPENDIX L

FALLING HEAD PERCOLATION TEST PROCEDURE

SOURCE: EPA, *Onsite Wastewater Treatment and Disposal Systems*, 1980.

1. Number and Location of Tests

A minimum of three tests shall be performed within the area proposed for an absorption system. They shall be spaced uniformly throughout the area. If soil conditions are highly variable, more tests may be required.

2. Preparation of Test Hole

The diameter of each test hole is 6 inches, dug or bored to the proposed depths of the absorption systems or to the most limiting soil horizon. To expose a natural soil surface, the sides of the hole are scratched with a sharp pointed instrument and the loose material is removed from the bottom of the test hole. Two inches of 1/2- to 3/4-inch rock are placed in the hole to protect the bottom from scouring when the water is added.

3. Soaking Period

The hole is carefully filled with at least 12 inches of clear water. The depth of water should be maintained for at least 4 hrs and preferably overnight if clay soils are present. A funnel with an attached hose or similar device may be used to prevent water from washing down the sides of the hole. Automatic siphons or float valves may be employed to automatically maintain the water level during the soaking period. It is extremely important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained.

In sandy soils with little or no clay, soaking is not necessary. If, after filling the hole twice with 12 inches of water, the water seeps completely away in less than ten minutes, the test can proceed immediately.

4. Measurement of the Percolation Rate

Except for sandy soils, percolation rate measurements are made 15 hrs but no more than 30 hrs after the soaking period began. Any soil that sloughed into the hole during the soaking period is removed and the water level is adjusted to 6 inches above the gravel (or 8 inches above the bottom of the hole). At no time during the test is the water level allowed to rise more than 6 inches above the gravel.

Immediately after adjustment, the water level is measured from a fixed reference point to the nearest 1/16th-inch at 30 minute intervals. The test is continued until two successive water level drops do not vary by more than 1/16-inch within a 90 minute period.

After each measurement, the water level is readjusted to the 6-inch level. The last water level drop is used to calculate the percolation rate.

In sandy soils or soils in which the first 6 inches of water added after the soaking period seeps away in less than 30 minutes, water level measurements are made at 10 minute intervals for a 1 hr period. The last water level drop is used to calculate the percolation rate.

5. Calculation of the Percolation Rate

The percolation rate is calculated for each test hole by dividing the time interval used between measurements by the magnitude of the last water level drop. This calculation results in a percolation rate in terms of minutes/inch. To determine the percolation rate for the area, the rates obtained from each hole are averaged. (If tests in the area vary by more than 20 minutes/inch, variations in soil type are indicated. Under these circumstances, percolation rates should not be averaged.)

Example: If the last measured drop in water level after 30 minutes is 5/8-inch, then:

percolation rate = (30 minutes)/(5/8 inch) = 48 minutes/inch.

APPENDIX M

STREAM CLASSIFICATIONS

(1) "Type 1 Water" means all waters, within their ordinary high-water mark, as inventoried as "shorelines of the state" under chapter 90.58 RCW, but not including those waters' associated wetlands.

(2) "Type 2 Water" classification shall be applied to segments of natural waters which:

(a) Are diverted for domestic use by more than 100 residential or camping units or by a public accommodation facility licensed to serve more than 100 persons, where such diversion is determined by the department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type 2 Water upstream from the point of such diversion for 1500 feet or until the drainage area is reduced by 50 percent, whichever is less;

(b) Are within a federal, state, local or private campground having more than 30 camping units: Provided, that the water shall not be considered to enter a campground until it reaches the boundary of the park lands available for public use and comes within 100 feet of a camping unit, trail or other park improvement;

(c) Are used by substantial numbers of anadromous or resident game fish for spawning, rearing or migration. Waters having the following characteristics are presumed to have highly significant fish populations:

(i) Stream segments having a defined channel 20 feet or greater in width between the ordinary high-water marks and having a gradient of less than four percent.

(ii) Impoundments having a surface area of 1 acre or greater at seasonal low water.

(3) "Type 3 Water" classifications shall be applied to segments of natural waters which:

(a) Are diverted for domestic use by more than 10 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, where such diversion is determined by the department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type 3 Water upstream from the point of such diversion for 1500 feet or until the drainage area is reduced by 50 percent, whichever is less;

(b) Are used by significant numbers of anadromous fish for spawning, rearing or migration. Waters having the following characteristics are presumed to have significant anadromous fish use:

(i) Stream segments having a defined channel of five feet or greater in width between the ordinary high-water marks; and having a gradient of less than 12 percent and not upstream of a falls of more than 10 vertical feet.

(ii) Impoundments having a surface area of less than 1 acre at seasonal low water and having an outlet to an anadromous fish stream.

(c) Are used by significant numbers of resident game fish. Waters with the following characteristics are presumed to have significant resident game fish use:

(i) Stream segments having a defined channel of 10 feet or greater in width between the ordinary high-water marks; and a summer low flow greater than 0.3 cubic feet per second; and a gradient of less than 12 percent.

(ii) Impoundments having a surface area greater than 0.5 acre at seasonal low water.

(d) Are highly significant for protection of downstream water quality. Tributaries which contribute greater than 20 percent of the flow to a Type 1 or 2 Water are presumed to be significant for 1,500 feet from their confluence with the Type 1 or 2 Water upstream until their drainage area is less than 50 percent of their drainage area at the point of confluence whichever is less.

(4) "Type 4 Water" classification shall be applied to segments of natural waters which are not classified as Type 1, 2, or 3, and for the purpose of protecting water quality downstream are classified as Type 4 Water upstream until the channel width becomes less than 2 feet in width between the ordinary high-water marks.

(5) "Type 5 Water" classification shall be applied to all natural waters not classified as Type 1, 2, 3, or 4; areas of perennial or intermittent seepage, ponds, and drainageways having short periods of spring or storm runoff.

APPENDIX N

RECOMMENDED WETLAND PLANTS FOR STORMWATER AREAS

Figure III-4.10 Suggested Plantings for Specific Depths of a Constructed Wetland

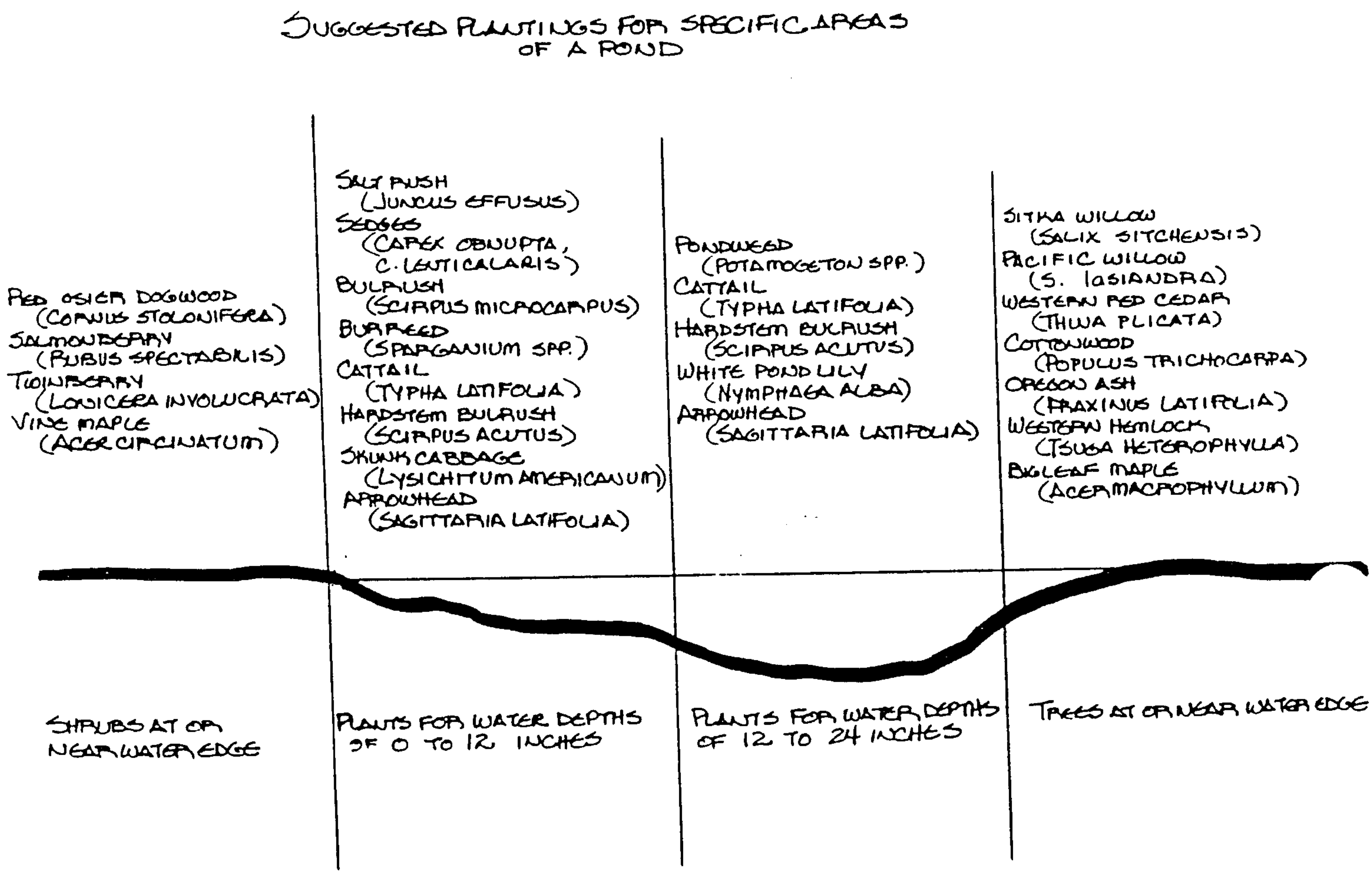

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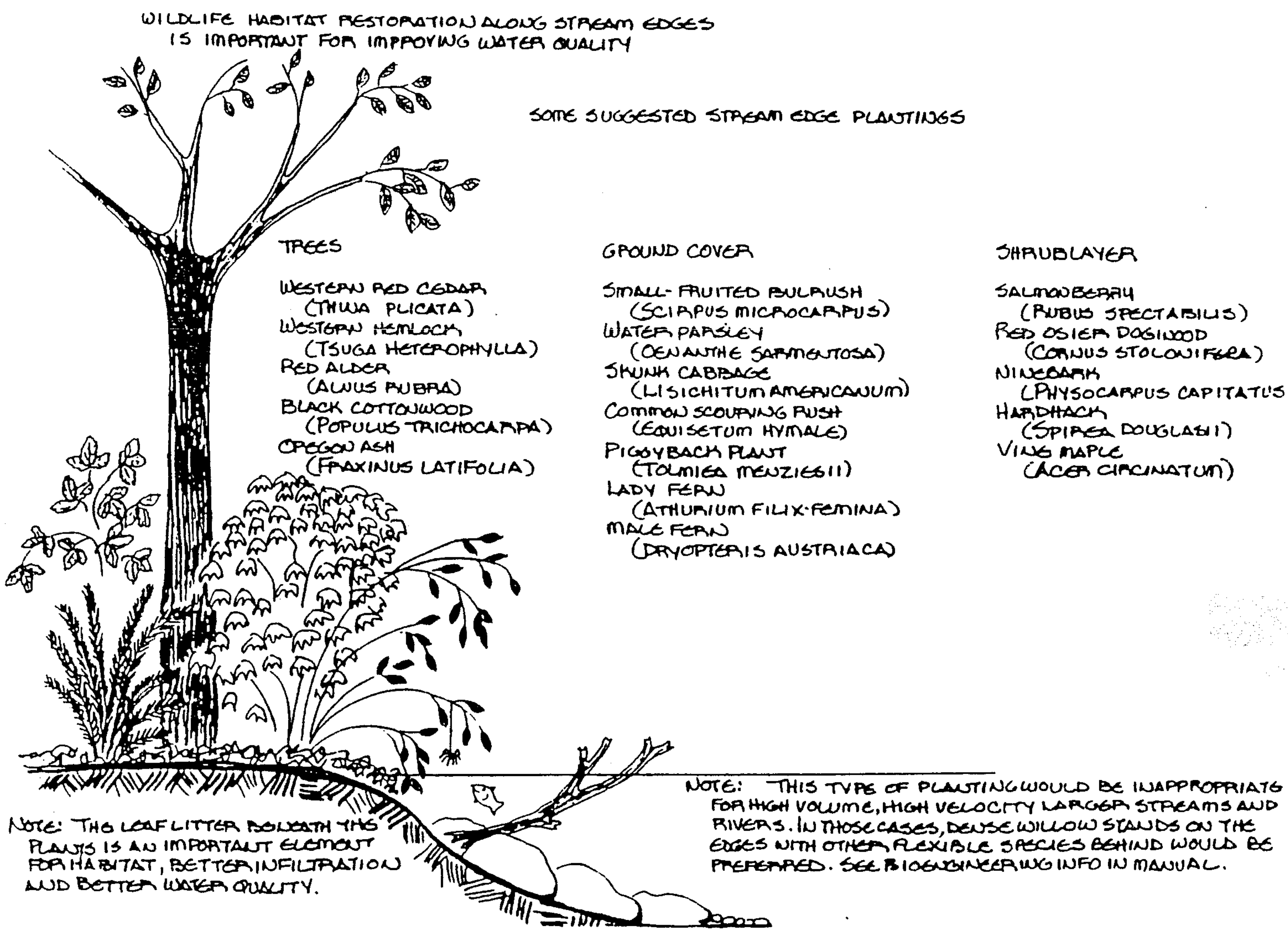
Figure III-4.11 Suggested Stream Edge Plantings for a Constructed Wetland



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Development of Guidance for Managing Urban Wetlands and Stormwater

Final Report

May 1991

King County
Environmental Division

Prepared by

King County Resource Planning Section
Environmental Division

WASHINGTON STATE
DEPARTMENT OF
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APPENDIX D

NATIVE AND RECOMMENDED NONINVASIVE PLANT SPECIES FOR WETLANDS IN THE PUGET SOUND REGION

Caution: Extracting plants from an existing wetland donor site can cause a significant negative effect on that site. It is recommended that plants be obtained from native plant nursery stocks whenever possible. Collections from existing wetlands should be limited in scale and undertaken with care to avoid disturbing the wetland outside of the actual point of collection.

Plants preferred in Puget Trough freshwater wetlands

Open water zone:

- Potamogeton species (pondweeds)
- Sagittaria latifolia (arrowhead)
- Nymphaea odorata (pond lily)
- Brasenia shreberi (water shield)
- Nuphar polysepalum, N. variegatum (cow lily)
- Polygonum hydropiper (smartweed)
- Alisma plantago-aquatica (American water plantain)
- Ludwigia palustris (water purslane)
- Menanthes trifoliata (bogbean)
- Utricularia minor, U. vulgaris (bladderwort)

Emergent zone:

- Carex obnupta, C. rostrata, C. arcta, C. stipata, C. vesicaria C. aquatilis, C. pauciflora (sedge)
- Scirpus cyperinus (wool-grass bulrush)
- Scirpus microcarpus (small-fruited bulrush)
- Eleocharis palustris, E. ovata (spike rush)
- Epilobium watsonii (Watson's willow herb)
- Typha latifolia (common cattail)
- Veronica americana, V. scouleriana (speedwell)
- Mentha arvensis (mint)
- Lycopus americanus, L. uniflora (cut-leaved water horehound)
- Angelica species (angelica)
- Oenanthe sarmentosa (water parsley)
- Heracleum lanatum (cow parsnip)
- Glyceria grandis, G. elata (manna grass)
- Juncus acuminatus (tapered rush)
- Juncus ensifolius (daggerleaf rush)
- Juncus bufonius (toad rush)
- Mimulus guttatus (yellow monkey flower)

Scrub-shrub zone:

- Salix lasiandra, S. rigida, S. sitchensis, S. scouleriana, S. pedicellaris (willow)
- Lystichum americanus (skunk cabbage)
- Athyrium filix-femina (lady fern)
- Cornus stolonifera (red-osier dogwood)
- Rubus spectabilis (salmonberry)
- Physocarpus capitatus (ninebark)
- Ribes species (gooseberry)
- Rhamnus purshiana (cascara)
- Sambucus racemosa (red elderberry) (occurs in wetland-upland transition)
- Loniceria involucrata (black twinberry)
- Oemleria cerafiformis (Indian plum)
- Stachys cooleyae (Stachy's horsemint)
- Prunus emarginata (bitter cherry)

Forested zone:

- Populus trichocarpa (black cottonwood)
- Fraxinus latifolia (Oregon ash)
- Thuja plicata (western red cedar)
- Picea sitchensis (Sitka spruce)
- Alnus rubra (red alder)
- Tsuga heterophylla (hemlock)
- Cornus stolonifera (red-osier dogwood)
- Acer cercinatum (vine maple)
- Maianthemum dilatatum (wild lily-of-the-valley)
- Ivzula pauciflora (small-flowered wood rush)
- Puccinellia pauciflora (no common name)
- Ribes species (currants)

Bog:

- Sphagnum species (sphagnum mosses)
- Ledum groenlandicum (Labrador tea)
- Vaccinium oxycoccos (bog cranberry)
- Kalmia occidentalis (bog laurel)

Exotic plants that should not be introduced to existing, created, or constructed Puget Trough freshwater wetlands

- Phalaris arundinacea (reed canarygrass)
- Lythrum salicaria (purple loosestrife)
- Elaeagnus augustifolia (Russian olive)
- Iris pseudocorus (yellow iris)

Native plants that should not be introduced to existing, created, or constructed Puget Trough freshwater wetlands

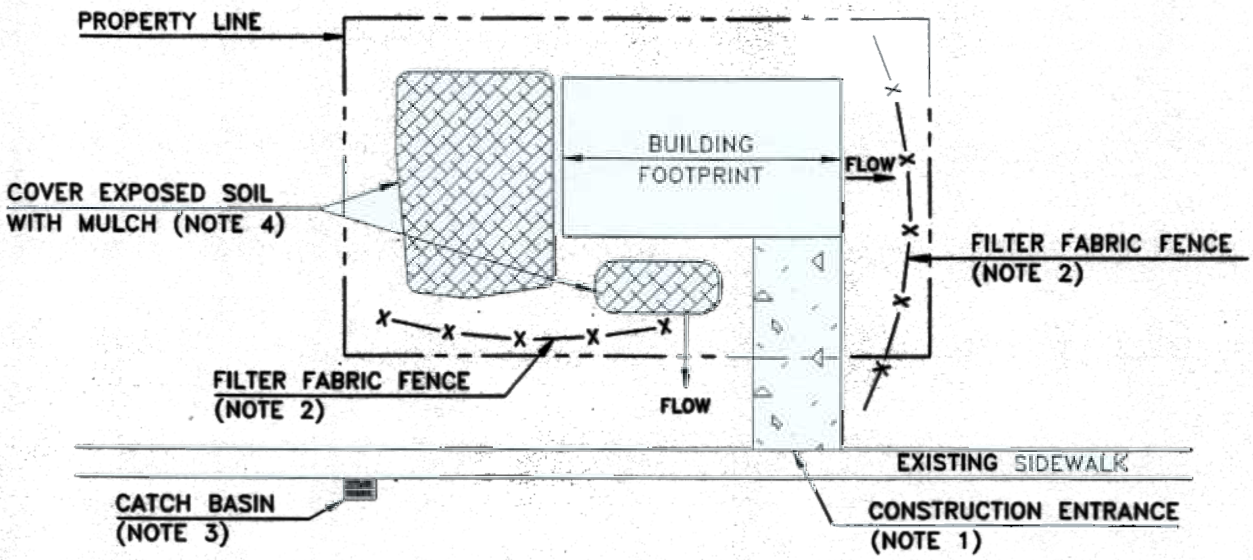
- Potentilla palustris (Pacific silverweed)
- Solarum dulcimana (nightshade)

APPENDIX O

EROSION AND SEDIMENT CONTROL REQUIREMENTS FOR SMALL PARCELS

The site diagram on the following page shows the required erosion and sediment control features for small sites. Every single-family or duplex building site must install erosion control similar to that shown to ensure that soils are kept onsite.

NOTE TO JURISDICTION COUNTER STAFF: A copy of this site diagram should be stapled to the approved building permit for each single-family residence or duplex. Please take a moment to explain the diagram to the builder, making sure they understand that erosion control is a requirement. If you or the builders have questions, please contact your jurisdiction's stormwater staff.



BASIC NOTES:

1. Provide rock or wood chip construction entrance for access, one location only. Can construct permanent driveway if desired. See Appendix B for figures.

2. Install filter fabric fence on bottom of exposed slopes. Fabric fence may not be required on flat lots or slopes less than 4% slope, when non-erodable soils are present,or when the runoff is self contained within the site. See appendix B for figures.

3. Protect accessible catch basins from silt. This step may not be necessary if no on-site erosion can occur. See Appendix B for figures.

4. Cover all disturbed and/or exposed soil with plastic, mulch, or other approved covering. Eroding soils must be stabilized. See guidelines.

OTHER GENERAL NOTES:

5. Retain native ground cover in undisturbed condition as much as possible.

6. Reseed, mulch, and cover disturbed areas.

7. Sweep sidewalks and streets on a daily basis when working.

8. Observe site during rainfall and provide additional erosion controls when needed.

9. Do not dispose of construction materials or hazardous materials on site. Use products wisely. Do not wash out concrete trucks or exposed aggregate driveways into storm systems.

REMEMBER – Tracking sediment off site is a violation of Drainage Manual requirements and results in downstream water quality impacts.

DATE: 01/24/94	ABBREVIATED EROSION CONTROL PLAN FOR SINGLE FAMILY RESIDENCE AND SMALL COMMERCIAL LOTS

APPENDIX P

STEPS TO DEVELOPING A DRAINAGE AND EROSION CONTROL PLAN

The Project Engineer should follow a thought process that generally includes these steps. Before beginning, and upon completion of each step, the Project Engineer is advised to discuss progress with the jurisdiction.

1. Collect necessary physical information about Project site.

   - Topography
   - Drainage (channel and sheet flows entering and leaving site)
   - Soils
   - Critical Areas (e.g., wetlands, steep slopes)
   - Overall Setting (e.g., adjacent development, utilities and other systems)

2. Evaluate information and collect more as needed

   - Topography--slope lengths, gradients
   - Drainage (patterns)
   - Soils (erosiveness, stability, variability with depth, infiltration at surface, percolation through lower strata)
   - Critical Areas (setbacks, avoidance versus mitigation, special reports required)
   - Overall Setting (connection with surrounding systems, downstream problems)

3. Develop Project site plan

   - Fit development into terrain
   - Locate most intensive activity in least critical areas
   - Concentrate intensive activity; preserve undisturbed areas
   - Minimize impervious coverage
   - Maintain natural drainage patterns
   - Set aside areas with best soils to treat and infiltrate stormwater wherever possible

4. Develop Drainage Design

   - Divide Project site into drainage areas
   - Design open stormwater conveyance (swales)
   - Select treatment practice from Chapter 7
   - Route stormwater for infiltration in best soils
   - Preserve predeveloped condition for offsite flows

- Consider use of multiple stormwater areas (e.g., more than one per drainage area to avoid danger of large failure)
- Ensure areas are large enough to provide required storage; account for high groundwater tables, setbacks
- Provide emergency overflow and ensure route followed will not endanger people or property
- Provide standard notes on installation and maintenance

5. Develop Erosion Control Design

- Emphasize prevention of erosion over treatment of sediment
- Choose practices based upon physical characteristics (soils, slope, size of area) and length of time site will be active
- Size practices correctly
- Provide standard notes on installation and maintenance
- Develop a construction sequence that minimizes exposed surfaces and exposure time

APPENDIX Q

STORMWATER FACILITY INFORMATIONAL SIGN SPECIFICATIONS

The stormwater facility sign is available at Hoy Sign Company. The Proponent is responsible for obtaining and installing the sign. Please verify with the jurisdiction what receiving water name(s) and contact person/telephone numbers they desire to have affixed to the sign.

Sign shall be installed on the street side of the stormwater facility, or in a location highly visible to passers-by. Sign may be affixed to a pressure-treated wood post and placed in concrete in the ground, or may be firmly attached to a pole or fence adjacent to the stormwater facility.

APPENDIX R

EXAMPLE OF SOIL EVALUATION REPORT FORMS

THIS IS YOUR NEIGHBORHOOD
STORMWATER FACILITY

This facility stores and treats stormwater, then gradually releases it to

YOU CAN HELP IT WORK

Compost yard waste. Don't dump it here.

Recycle or safely dispose of used oil, paint thinner, pet litter, and other wastes.

Keep this facility clear of trash & noxious weeds.

Work together with your neighbors and local government to help this facility do its job.

FOR INFORMATION CALL:

REPLACEABLE STICKER GOES HERE
REPLACEABLE STICKER GOES HERE

APPENDIX R (CONTINUED)
SOIL EVALUATION REPORT INSTRUCTIONS FOR COMPLETING FORM 1

Form 1 is the "cover page" for all projects that require a soil evaluation report. One copy of Form 1 must accompany all soil evaluation reports. Certain information may be omitted for soil evaluations completed for small projects (e.g., single-family residences, duplexes). The following instructions should give you the guidance needed to complete the form:

1. Provide project name and address or legal description. Attach a legible map on 8½" by 11" paper showing site and major landmarks (e.g., roadways and surface waters) within approximately one-quarter mile radius around site.

2. Provide acreage, parcel dimensions, type of development proposed, and approximate proposed coverage of impervious surfaces.

3. Describe site topography, geomorphology, terrain, and natural cover. Distinguish among areas of the site with significantly different characteristics.

4. Provide description and purpose of soils work done. List methods used to expose, sample, and test soils. Give number of test holes logged. Describe field and lab tests performed. Attach a scaled map of good accuracy on 8½" by 11" paper showing locations of soil logs. Except small projects, using soil log results, divide map area into sub-areas according to hydrologic group (A through D).

5. Describe soils work still needed. For example, more work may be needed to obtain accurate percolation or infiltration rates for stormwater facilities not yet constructed.

6. Describe results of soil logs and tests and compare with expected soils from SCS Soils maps. **As appropriate for the project, give your best estimate of the (a) overall predeveloped site infiltration rate, (b) the saturated infiltration rate for the above-ground stormwater facility, or (c) the saturated percolation rate for the below-ground stormwater trench or drywell.** Discuss soils factors related to erosion control, infiltration, percolation, and placement of buildings, as these vary on the site.

7. Describe the recommended general approach for managing stormwater on the site. For example, if stormwater can be infiltrated or percolated, indicate where and at what depth. If erosion, soil stability, or high ground water are problems, can these problems be avoided or mitigated?

Sign the form and affix any relevant professional seal (e.g., P.E., ARCPACS). The form becomes the cover page to one or more copies of Form 2, which has soil logs for each test hole evaluated.

PREPARER: PLEASE READ ALL INSTRUCTIONS FIRST.

STAFF USE ONLY

SOIL EVALUATION REPORT
FORM 1: GENERAL SITE INFORMATION

PROJECT TITLE: PROJECT NO. : PREPARED BY :	SHEET OF DATE:

1. SITE ADDRESS OR LEGAL DESCRIPTION:

2. PROJECT DESCRIPTION:

3. SITE DESCRIPTION:

4. SUMMARY OF SOILS WORK PERFORMED:

5. ADDITIONAL SOILS WORK RECOMMENDED:

6. FINDINGS (Including pre-development site percolation rate):

7. RECOMMENDATIONS:

I hereby certify that I prepared this report, and conducted or supervised the performance of related work. I certify that I am qualified to do this work. I represent my work to be complete and accurate within the bounds of uncertainty inherent to the practice of soil science, and to be suitable for its intended use.

SIGNED: ____________________

DATE: ____________

SOIL EVALUATION REPORT INSTRUCTIONS FOR COMPLETING FORM 2

Form 2 is the detailed record of soil information obtained on the development site. One copy of Form 2 must be completed for each soil location where testing has been done. For tests other than soil logs for which the scientist wants to submit numerical results, please attach a separate sheet and briefly describe the results under "Findings and recommendations." The summary information that heads the sheet should be self-explanatory. Regarding location, reference the location to features that are permanent and static, such as roads or property lines.

1. State briefly tests that were done. Indicate whether tests were field, laboratory, or other.

2. Determine the soil series from the maps provided in the Soil Conservation Service (SCS) *Soil Survey of Thurston County*. Then, indicate what soil series was mapped as a result of the soil testing done.

3. Indicate land form (e.g., till plain).

4. Indicate depositional history (e.g., alluvial plain).

5. Indicate SCS hydrologic soil group (e.g., letter designation A through D).

6. Indicate seasonal high water table depth based upon the presence of mottling, gleying, or other evidence. Indicate how you determined this value under "Findings..." section. If information available is inadequate, state value to be "greater than" bottom of hole depth.
7. Indicate current water table depth based upon observation. If saturated conditions are not observed, state value to be "greater than" bottom of hole depth.

8. Indicate depth to impervious layer (e.g., basal till). If information is inadequate, state value to be "greater than" bottom of hole depth.

9. Space for other miscellaneous observations regarding setting of site (e.g., concave, convex, swale, hillslope).

10. Indicate susceptibility of area to erosion, runoff, and ponding problems. The susceptibility should be rated based upon relevant physical characteristics and development operations planned for the area, such as shape of the area (e.g., concave, convex, flat) removal or addition of fill, time of year, existing and planned vegetative cover, degree of soil compaction, etc. For erosion, the K-factor for the soils series in question might help in assessing relative erodibility.

11. The profile description provides the minimum information on the physical attributes of the soil. Additional factors may be assessed at the option of the scientist, but data on these factors should be tabulated separately and summarized briefly in the "Findings and recommendations" section.

PREPARER: PLEASE READ ALL INSTRUCTIONS FIRST.

STAFF USE ONLY

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE:
PROJECT NO. :
PREPARED BY :

SHEET OF
DATE:

SOIL LOG:
LOCATION:

1. TYPES OF TEST DONE:	2. SCS SOIL SERIES:	3. LAND FORM:
4. DEPOSITION HISTORY:	5. HYDROLOGIC SOIL GROUP:	6. DEPTH TO SEASONAL HW:
7. CURRENT WATER DEPTH:	8. DEPTH TO IMPERV LAYER:	9. MISC:

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING

11. SOIL STRATA DESCRIPTION:

HORZ	DEPTH	COLOR	TEXTURE	%CL	%ORG	%CF	STR	MOT	IND	CEM	ROO	<X>	FSP

12. SITE PERCOLATION RATE:

13. FINDINGS & RECOMMENDATIONS:

TABLE 3.1 (CONTINUED)

All information provided for the profile shall utilize standard SCS nomenclature and abbreviations. The following are the factors to be addressed, with brief examples of acceptable responses. Further information on most of these is provided in the SCS *Soil Survey of Thurston County*.

a. Hor(izon): A layer of soil with distinct characteristics, labeled A, AB, B, C, Ccw, etc.
b. Depth: Starting at 0" (surface), depth and interval of horizon.
c. Color: Munsell code for hue, value, and chroma, such as 10 YR 3/4. Indicate whether color is wet or dry.
d. Textur(al class): Class that best describes relative percentages of sand, silt, and clay in horizon, such as sandy loam (SL).
e. %Cl(ay): Clay percentage is very useful as a guide to determining the drainage capability of a soil.
f. %Org(anic)M(atter): Organic matter percentage by volume is related to the infiltration as well as pollutant removal capability of soils.
g. %C(oarse)F(ragments): Coarse fragment percentage is relevant to drainage and other site management factors.
h. Str(ucture): Describes size and shape of soil "clods."
i. Mot(tling): Where present, describe using three-letter abbreviation to indicate abundance, size, and contrast, such as CFD (common, fine, distinct).
j. Ind(uration): Physical compaction of a layer such as a glacial till. Where present, describe as weak, mod(erate), or str(ong).
k. Cem(entation): Aggregation of soil particles due to chemical processes. Describe as in induration.
l. Roo(ts): Where present, describe using two-letter abbreviation to indicate abundance and size, such as CF (common, fine).
m. Generalized range of infiltration rates from SCS Soil Survey <X>.
n. F(ield) S(aturated) P(ercolation rate): Using all available information, estimate the field saturated percolation rate. This rate should be a single number, and may vary from that range (see previous column) published in the SCS Soil Survey due to horizon-specific factors.

12. Provide overall site (location) field-saturated percolation rate. Rate should reflect effects of the entire soil column. Alternate rates may be provided if placement of the infiltration surface beneath finer surface soils (in coarser subsoils) would increase the rate. If the type of stormwater system to be employed is known (e.g., pond or trench, and depth), factor this knowledge into the assessment.

13. Discuss results of tests done on soil. Indicate features of soil that most affect stormwater management at this location. Provide recommendations to the Project Engineer on soil-related factors such as problems and controls, and for additional work needed (if necessary).

APPENDIX S

STANDARD STORMWATER NOTES

1. All workmanship and materials shall be in accordance with City/County standards and the most current copy of the State of Washington Standard Specifications for Road, Bridge and Municipal Construction (WSDOT/APWA).

2. Temporary erosion/water pollution measures shall be required in accordance with Section 1-07.15 of the Standard Specifications and the Drainage Design and Erosion Control Manual ("Drainage Manual").

3. Proponent shall comply with all other permits and other requirements of the governing authority or agency.

4. A preconstruction meeting shall be held prior to the start of construction or staking of the site.

5. All storm mains and retention/detention areas shall be staked for grade and alignment by an engineering or survey firm licensed to perform such work.

6. Storm drain pipe shall be as specified in the Drainage Manual.

7. Special structures, oil/water separators, and outlet controls shall be installed per plans and manufacturers recommendations.

8. Provide traffic control plan(s) as required in accordance with MUTCD.

9. Call underground locate line 1-800-424-5555 minimum 48 hours prior to any excavations.

10. All surveying and staking shall be performed by an engineering or surveying firm capable of performing such work. The engineer or surveyor directing such work shall be licensed by the State of Washington.

11. The minimum staking of storm sewer systems shall be as follows:

    A. Stake location of all catch basins/manholes and other fixtures for grade and alignment.

    B. Stake location, size, and depth of retention/detention facility.

C. Stake finished grade of all stormwater features, including but not limited to catch basin/manhole rim elevations, overflow structures, weirs, and invert elevations of all pipes in catch basins, manholes, and those pipes that daylight.

12. Pipe materials used for stormwater conveyance shall be as approved by the jurisdiction. Pipe size, slope, cover, etc., shall be as specified in the Drainage Manual.

13. All driveway culverts shall be of sufficient length to provide a minimum 3:1 slope from the edge of the driveway to the bottom of the ditch. Culverts shall have beveled and sections to match the side slope.

14. If drainage outlets (stub-outs) are to be provided for each individual lot, the stub-outs shall conform to the following:

A. Each outlet shall be suitably located at the lowest elevation on the lot, so as to service all future roof downspouts and footing drains, driveways, yard drains, and any other surface or subsurface drains necessary to render the lots suitable for their intended use. Each outlet shall have free-flowing, positive drainage to an approved storm water conveyance system or to an approved outfall location.

B. Outlets on each lot shall be located with a five-foot-high, 2"x4" stake marked "storm" or "drain." The stub-out shall visibly extend above surface level and be secured to the stake.

C. Pipe material shall be as approved by the jurisdiction.

D. Drainage easements are required for drainage systems designed to convey flows through individual lots.

E. The developer and/or contractor is responsible for coordinating the locations of all stub-out conveyance lines with respect to the utilities (e.g., power, gas, telephone, television).

F. All individual stub-outs shall be privately owned and maintained by the lot home owner.

15. The storm drainage system shall be constructed according to approved plans on file with the jurisdiction. Any material deviation from the approved plans will require written approval from the jurisdiction.

16. A copy of the approved storm water plans must be on the job site whenever construction is in progress.

17. All disturbed areas shall be seeded and mulched or similarly stabilized to the satisfaction of the jurisdiction. For sites where grass has been planted through hydroseeding, the performance bond will not be released until the grass has been thoroughly established, unless otherwise approved by the jurisdiction.

18. All building downspouts on commercial sites shall be connected to the storm drainage system, unless otherwise approved by the jurisdiction.

19. All erosion control and stormwater facilities shall be regularly inspected and maintained by the contractor during the construction phase of the development project.

20. The contractor shall be responsible for providing adequate safeguards, safety devices, protective equipment, flaggers, and any other needed actions to protect the life, health, and safety of the public, and to protect property in connection with the performance of work covered by the contract. Any work within the traveled right-of-way that may interrupt normal traffic flow shall require at least one flagger for each lane of traffic affected. All sections of the current W.S.D.O.T. Standard Specifications for Traffic Control shall apply.

21. It shall be the sole responsibility of the contractor to obtain street use and other related or required permits prior to any construction activity in the jurisdiction's right-of-way. It shall also be the responsibility of the contractor to obtain all required permits prior to any construction.

22. No final cut or fill slope shall exceed two (2) horizontal to one (1) vertical without stabilization by rockery or by a structural retaining wall.

23. The project engineer shall verify the locations, widths, thicknesses, and elevations of all existing pavements and structures, including utilities and other frontage improvements, that are to interface with new work, provide all trimming, cutting, saw cutting, grading, leveling, sloping, coating, and other work, including materials as necessary to cause the interface with existing works to be proper, without conflict, acceptable to the engineer and the jurisdiction, complete in place, and ready to use.

24. Compaction of all fill areas shall be per current APWA specifications. Fill shall be provided in 6" maximum lifts and shall be compacted to 95 percent of its maximum relative density.

APPENDIX T

STANDARD EROSION CONTROL NOTES

Place the following standard notes on drawings showing silt fences:

1. Filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid use of joints. When joints are necessary, filter cloth shall be spliced together only at a support post, with a minimum 6-inch overlap, and securely fastened at both ends to post.

2. Posts shall be spaced a maximum of 6 feet apart and driven securely into the ground (minimum of 30 inches).

3. A trench shall be excavated approximately 8 inches wide and 12 inches deep along the line of posts and upslope from the barrier.

4. When standard strength filter fabric is used, a wire mesh support fence shall be fastened securely to the upslope side of the posts using heavy-duty wire staples at least 1 inch long, tie wires or hog rings. The wire shall extend into the trench a minimum of 4 inches and shall not extend more than 36 inches above the original ground surface.

5. The standard strength filter fabric shall be stapled or wired to the fence, and 20 inches of the fabric shall be extended into the trench. The fabric shall not extend more than 36 inches above the original ground surface. Filter fabric shall not be stapled to existing trees.

6. When extra-strength filter fabric and closer post spacing is used, the wire mesh support fence may be eliminated. In such a case, the filter fabric is stapled or wired directly to the posts with all other provisions of above notes applying.

7. Filter fabric fences shall not be removed before the upslope area has been permanently stabilized.

8. Filter fabric fences shall be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs shall be made immediately.

Place the following standard notes on drawings showing straw/hay bales:

1. Bales shall be placed in a single row, lengthwise, on the contour, with ends of adjacent bales tightly abutting one another.

2. All bales shall be either wire-bound or string-tied with bindings oriented around the sides rather than the tops and bottoms of the bales. This will prevent rapid deterioration of the bindings.

3. The barrier shall be entrenched and backfilled. A trench shall be excavated the length and width of the proposed barrier to a depth of at least 4 inches. After the

bales are staked and cracks between bales chinked as necessary, the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier.

4. Each bale shall be anchored by at least two stakes or rebars driven through the bale. The first stake in each bale shall be driven towards the previously laid bale in order to force the bales together.

Place the following standard notes on drawings showing gravel filter berms:

1. Berm material shall be 3/4 to 3-inch well-graded gravel or crushed rock with less than 5% fines.

2. Spacing of berms:

Distance Between Berms (Feet)	Max Slope (%)
300	5
200	10
100	>10

3. Berm dimensions: 1-foot high with 3:1 side slopes; 8 lineal feet per 1 cfs runoff based on the 10-year frequency storm.

Place the following standard notes on drawings showing sandbag berms:

1. The height of the berm shall be a minimum of 18 inches measured from the top of the existing ground at the upslope toe to the bottom of the berm.

2. The width of the berm shall be at least 48 inches at the bottom and 18 inches at the top.

3. Sandbags shall be 24 to 30 inches in length, 16 to 18 inches in width, and 6 to 8 inches in thickness. Each sandbag shall weigh between 90 and 125 pounds.

4. Suitable materials for sandbags are polypropylene, polyethylene, or polyamide woven fabric, minimum unit weight 4 ounces per square yard, mullin burst strength exceeding 300 psi, and ultraviolet stability exceeding 70 percent.

5. Coarse grade sand shall be used.

Place the following standard notes on drawings showing triangular sediment filter dikes:

1. If the slope exceeds 10 percent, the length of the slope above the dike shall be less than 50 feet.

2. All dikes shall be placed on the contour and shall be placed in a row with the ends tightly abutting the adjacent dike. Filter material shall lap over ends 6 inches to cover dike to dike junction; each junction shall be secured by shoat rings.

3. In general, each side of the triangle shall be a minimum of 18 inches.

4. Nonwoven polypropylene, polyethylene or polyamide geotextile fabric may be used as filter material. This material shall have a minimum unit weight of four and one-half (4.5) ounces per square yard, mullin burst strength exceeding 250 psi, ultraviolet stability exceeding 70 percent, and equivalent opening size exceeding 40. The fabric cover and skirt shall be a continuous wrapping of the fabric; the skirt shall be a continuous extension of the upstream face.

Place the following standard notes on drawings showing inlet protection:

1. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks shall abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 inches, and 12 inches wide. The row of blocks shall be at least 12 inches but no greater than 24 inches high.

2. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 1/2-inch openings.

3. Pile stone against the wire mesh to the top of the blocks. Use 3/4-to 3-inch gravel.

4. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with 1/2-inch openings. If more than one strip of mesh is necessary, overlap the strips. Place filter fabric over wire mesh.

5. Place 3/4-inch gravel over the wire mesh. The depth of stone shall be at least 12 inches over the entire inlet opening. Extend the stone beyond the inlet opening at least 18 inches on all sides.

6. If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced.

Place the following standard notes on drawings showing pipe slope drains:

1. The soil around and under the pipe and entrance section shall be thoroughly compacted.

2. The flared inlet section shall be securely connected to the slope drain with watertight connecting bands.

3. Slope drain sections shall be securely fastened together with watertight fittings, and be securely anchored into the soil.

4. Interceptor dikes shall be used to direct runoff into a slope drain. The height of the dike shall be at least 1" higher of all points then the top of the inlet pipe.

5. The area below the outlet must be stabilized with a rip-rap apron (see Chapter 6, Outfalls, for the appropriate protection).

Place the following standard notes on drawings showing stairstepped cut slopes:

1. Graded areas with slopes greater than 3:1 but less than 2:1 shall be roughened before seeding.

2. Graded areas steeper than 2:1 shall be stair-stepped with benches.

Place the following standard notes on drawings showing erosion control blankets:

1. Where soil is highly erodible, net shall only be used in conjunction with an organic mulch such as straw and wood fiber.

2. Jute net shall be heavy, uniform cloth woven of single jute yarn, which if 36 to 48 inches wide shall weigh an average of 1.2 lbs/linear yard. It must be so applied that it is in complete contact with the soil.

3. Netting shall be securely anchored to the soil with No. 11 gauge wire staples at least 6 inches long.

Place the following standard notes on drawings showing temporary dikes and swales:

1. Seed and mulch shall be applied within 5 days of dike construction (see vegetation).

2. The upslope side of the dike shall provide positive drainage to the dike outlet.

3. No erosion shall occur at the dike outlet. Provide energy dissipation measures as necessary.

4. Sediment laden runoff must be released through a sediment trapping facility such as a pond, trap, or silt fence as appropriate to drainage area size.

Place the following standard notes on drawings showing temporary gravel outlets:

1. Gravel shall be 5/8-inch minus washed rock. A layer of filter fabric shall be embedded in the gravel.

2. Minimum length in feet of the gravel outlet structure shall be equal to six times the number of acres of contributing drainage area.

3. The invert of the gravel outlet shall not be less than 6 inches lower than the minimum elevation of the top of the dike.

4. Water shall be discharged from the gravel outlet onto an already stabilized area or into a stable watercourse.

5. The gravel outlet structure shall be inspected and repaired after each runoff-producing rain. The gravel must be replaced when the structure ceases to function as intended due to sediment accumulation among the gravel.

Place the following standard notes on drawings showing check dams:

1. The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

2. Rock check dams shall be constructed of 2-to 4-inch diameter rock. The rock must be placed by hand or mechanical placement (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to insure that the center of the dam is lower than the edges.

3. Log check dams shall be constructed of 4- to 6-inch diameter logs. The logs shall be embedded into the soil at least 18 inches.

4. In the case of grass-lined ditches and swales, check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

5. Check dams shall be checked for sediment accumulation after each significant rainfall. Sediment shall be removed when it reaches one half of the original dam height or before.

Place the following standard notes on drawings showing plastic covering:

1. Plastic sheeting shall have a minimum thickness of 6 mills and shall meet the requirements of STANDARD SPECIFICATIONS Section 9-14.5.

2. Covering shall be installed and maintained tightly in place by using sandbags or tires on ropes with a maximum 10-foot grid spacing in all directions. All seams shall be taped or weighted down full length and there shall be at least a 12 inch overlap of all seams.

3. Clear plastic covering shall be installed immediately on areas seeded between November 1 and March 31 and remain until vegetation is firmly established.

4. When the covering is used on un-seeded slopes, it shall be kept in place until the next seeding period.

5. Plastic covering sheets shall be buried two feet at the top of slopes in order to prevent surface water flow beneath sheets.

6. Proper maintenance includes regular checks for rips and dislodged ends.

Place the following standard notes on drawings showing mulching:

1. Mulch materials used shall be __________, and shall be applied at the rate of _____ .

2. Mulches shall be applied in all areas with exposed slopes greater than 2:1.

3. Mulching shall be used immediately after seeding or in areas which cannot be seeded because of the season.

4. All areas needing mulch shall be covered by November 1.

Place the following standard notes on drawings showing seeding:

1. Seed mixture shall be ____________, and shall be applied at the rate of _____ per acre.

2. Seed beds planted between May 1 and October 31 will require irrigation and other maintenance as necessary to foster and protect the root structure.

3. For seed beds planted between October 31 and April 30, armoring of the seed bed will be necessary. (e.g., geotextiles, jute mat, clear plastic covering).

4. Before seeding, install needed surface runoff control measures such as gradient terraces, interceptor dikes, swales, level spreaders and sediment basins.

5. The seedbed shall be firm with a fairly fine surface, following surface roughening. Perform all cultural operations across or at right angles to the slope.

6. Fertilizers are to be used according to suppliers recommendations. Amounts used should be minimized, especially adjacent to water bodies and wetlands.

Place the following standard notes on plans for projects where topsoil will be stockpiled:

1. Stockpiles shall be stabilized (with plastic covering or other approved device) daily between November 1 and March 31.

2. In any season, sediment leaching from stock piles must be positively prevented.

3. Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.

4. Previously established grades on the areas to be topsoiled shall be maintained according to the approval plan.

Place the following standard notes on plans for projects where sod is to be placed:

1. Sod shall be machine cut at a uniform soil thickness of 3/4-inch at the time of curing. Measurements for thickness shall exclude top growth and thatch.

2. Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended by the end of a 3 foot section.

3. Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.

4. Sod shall be harvested, delivered and installed within a period of 36 hours.

Place the following standard notes on plans for projects with construction entrances:

1. Material shall be 4" to 6" quarry spalls and may be top-dressed with 1" to 3" rock. (STANDARD SPECIFICATIONS).

2. The rock pad shall be at least 12 inches thick and 100 feet long. Width shall be the full width of the vehicle ingress and egress area. Smaller pads may be approved for single-family residential and small commercial sites.

3. Additional rock shall be added periodically to maintain proper function of the pad.

4. If the pad does not adequately remove the mud from the vehicle wheels, the wheels shall be hosed off before the vehicle enters a paved street. The washing shall be done on an area covered with crushed rock and wash water shall drain to a sediment retention facility or through silt fence.

COUNTY COMMISSIONERS
Judy Wilson
District One
Diane Oberquell
District Two
Kevin J. O'Sullivan
District Three

THURSTON COUNTY
WASHINGTON
SINCE 1852

DEPARTMENT OF WATER AND WASTE MANAGEMENT

Richard D. Blinn, P.E.
Director

NOTICE OF ADOPTION MEMORANDUM

FROM Richard D. Blinn, P.E.
Thurston County Drainage Manual Administrator

TO Interested Parties

DATE March 22, 2000

SUBJECT Interim Stormwater Design Standards for New Development in Green Cove Creek Basin

Section 1 SUMMARY

Effective immediately, interim stormwater standards for new development are imposed for the Green Cove Creek Basin (the Basin). These interim standards will remain in effect until further notice pending conclusion of the City of Olympia's (the City) current consultant work within the Basin. This current work updates the County's comprehensive hydrologic model developed for the Green Cove Creek Comprehensive Drainage Basin Plan, (the Plan) December 1998. Additionally, the City's work will define appropriate stormwater discharges for new development within the Basin consistent with the recommendations of the Plan. The completion date for this work is expected sometime during the late fall of 2000. Interim stormwater design standards for new development in the Basin are presented below under Section 3.

Section 2. BACKGROUND

In December 1998, the Thurston County Board of County Commissioners adopted the Plan. One of the key recommendations of the Plan was to halve current release rates from stormwater detention facilities and double the current runoff storage requirement (Recommendation 8.5). The Thurston County Storm and Surface Water Program (the County) was unable to complete the specific modeling analysis necessary to provide design guidance for new development in the basin implementing Recommendation 8.5. Rather than placing the burden on new development to generate these design tools, the County and the City propose updating the County's hydrologic model and developing the design guidance for new development to meet the requirements of Recommendation 8.5. The City has hired the County's previous engineering consultant to update basin land use coverages and develop sizing guidance for new development in the Basin.

Solid Waste Management, Storm & Surface Water Management, Water & Sewer Utilities Operations, Utility Development & Special Services
Building No. 4, Room 100, 921 Lakeridge Drive SW, Olympia, WA 98502
(360) 357-2491 FAX (360) 754-4682 TDD (360) 754-2933

This work will also assist development and jurisdictions better understand the impact to land segments likely to result from implementing Recommendation 8.5.

Section 3. INTERIM DEVELOPMENT STANDARDS

Purpose: The County seeks to limit the potential adverse impact from new development within the Basin. These impacts include increased peak flow and other flow conditions that adversly impact the Creek's sensitive biologic system.. To this end, the County is providing interim stormwater design standards for new development within the Basin. These standards will remain in place until such time that the City's consultant completes the modeling and analysis necessary to provide stormwater facility size guidance for new development within the Basin. Upon review of the consultant's final modeling report and recommendations, the interim standards will be reconsidered to ensure consistency with the Plan.

A. **Interim Standards:** These interim standards are contained within "Interim Stormwater Design Standards for New Development in Green Cove Creek Basin, March 21, 2000," Thurston County Storm and Surface Water Program. These standards establish new site development modeling criteria. This additional guidance does not guarantee that new development can successfully complete the review process prior to the City completing the consultant modeling work. These interim standards are available upon request. Interested parties should contact Mark R. Cook, P.E., Storm and Surface Water Program Manager, at 360-754-4681 or visit 921 Lakeridge Drive SW, Building 4, Room 100, Olympia, WA 98502.

B. **Authority:** In taking this action, the Thurston County Drainage Manual Administrator is exercising the Administrative Authority of Section 1.2 of the *Drainage Design and Erosion Control Manual for Thurston County Washington*, 1994 (the Manual). Development proponents are encouraged to review "Interim Site Development Guidelines for New Development in Green Cove Creek Basin" prior to submitting any drainage plan for review. The following list is not intended to be all-inclusive but does provide some direction on key chapters and sections of the Manual affected by the interim guidelines.

C. **Relationship to Manual Standards:**

Section 3.1.1, Section 9 is amended to include input and output files from continuous simulation modeling.

Maximum release rates are amended to reflect the pre-developed runoff hydrograph as described by the continuous simulation model.

Section 4.1.2 is amended such that sizing is based on the results of the amended modeling requirements.

Section 4.2 is amended to reflect the sizing as defined by the amended modeling requirements.

Section 4.3 is amended to reflect the sizing as defined by the amended modeling requirements.

Section 4.5 is amended to reflect the sizing as defined by the amended modeling requirements.

- Section 5.1 is amended to utilize continuous simulation-modeling and the presumed existing condition is forested.

- Section 5.2 is amended to reflect regional parameters and the period of record for use in continuous simulation modeling provided by the County.

  Section 5.3 is amended to reflect regional parameters and the period of record for use in continuous simulation modeling provided by the County.

- Section 5.4 is amended to reflect regional parameters and the period of record for use in continuous simulation modeling provided by the County.

- Section 5.5 is amended to reflect regional parameters and the period of record for use in continuous simulation modeling provided by the County.

- Section 5.6 is amended to require that the design engineer specifically calculate the total impervious area for each individual development proposal and that this area be used as input to the continuous simulation model.

  Section 8.5.13 is amended to reflect the sizing as defined by the amended modeling requirements.

Unless otherwise amended by "Interim Stormwater Design Standards for New Development in Green Cove Creek Basin, March 22, 2000," Thurston County Storm and Surface Water Program, all other Manual provisions apply. If you have any questions regarding this administrative action, please contact Mark R. Cook, P.E., Storm and Surface Water Program Manager, at 360-754-4681.

cc: Board of County Commissioners
Linda Hoffman
URS Greiner Woodward Clyde
Mark R. Cook
DPA Mark Calkins
Fred Knotsman
Gary Cooper
Brent Payton

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COUNTY COMMISSIONERS
Judy Wilson
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Kevin J. O'Sullivan
District Three

THURSTON COUNTY
WASHINGTON
SINCE 1852

DEPARTMENT OF WATER AND WASTE MANAGEMENT

Richard D. Blinn, P.E.
Director

TECHNICAL MEMORANDUM

FROM: Mark Cook, P.E. (initials)

TO: Richard Blinn, Director

DATE: March 22, 2000

SUBJECT: Interim Stormwater Design Standards for New Development in Green Cove Creek Basin

1 Background

In December 1998, the Thurston County Board of County Commissioners adopted the Green Cove Creek Comprehensive Drainage Basin Plan (the Plan). During the five years of basin planning, several key issues were identified as necessary to limit increasing future peak flows to Green Cove Creek (the Creek). Of most significance, is Recommendation 8.5 that seeks to maintain or re-establish a minimum of 60% undisturbed forest canopy for the Basin and increasing current drainage manual standards for release rates and storage.

At the conclusion of the planning process, staff acknowledged that additional modeling analysis is required to provide development with specific guidance to meet the increased drainage manual requirements of Recommendation 8.5. In a complimentary effort, the City of Olympia (the City) recently completed the "City Streams and Wetlands Study." This study validates the environmental value of the Creek's eco-system and provides the focus of the City's desire to provide increased protection to the Creek. In a unanimous action taken February 8, 2000, the City Council:

- Imposed interim R4 zoning for Basin properties located within City limits.
- Increased stormwater requirements.
- Imposed seasonal clearing and grading restrictions.
- Imposed increased tree retention requirements.

As the basis for this action, the City is in the process of conducting additional modeling analysis of the Creek. The additional work is expected to take up to one year to complete. The analysis is expected to provide development proponents with specific tools necessary to meet the increased stormwater standards as recommended in the Plan. In recognition of the City's on-going work program, the County is imposing interim stormwater standards for the Basin. This action is being taken to ensure consistency for new development in the Basin and to minimize potential adverse impacts to the Creek while the City conducts additional modeling analysis for the Creek.

2. Interim Standards

The interim standards outlined below are intended to guide new development in the Basin until the City completes additional modeling analysis. The interim standards have one significant component; revised stormwater modeling criteria for new development. This revision alters the manner whereby runoff is predicted, allowable site discharge and associated onsite storage.

A Effective immediately, modeling standards for new development within the Basin will change from a single event to a continuous modeling methodology. The approved model for use is the Environmental Protection Agency (EPA) Hydrological Simulation Program FORTRAN (HSPF). Any and all other substitute models must be approved by the County prior to use.

B. New development within the Basin will assume a forest condition as being the pre-developed condition.

C Post development runoff shall match pre-development runoff flow duration and peak for the 1.05 year event to the 10-year event as defined by Thurston County Storm and Surface Water Program, Drainage Design and Erosion Control Manual for Thurston County, 1994 edition.

D A deviation from matching the pre-developed runoff flow duration and peak of ten percent (+/-) is allowed from the 10-year event to the 50-year event as defined by Thurston County Storm and Surface Water Program, Drainage Design and Erosion Control Manual for Thurston County, 1994 edition.

3. Target Dates

To assist new development in meeting these interim standards, the following products will be provided on the associated time frame:

A Continuous period of record: April 21, 2000.

B. Regionalized parameters for Hydrological Simulation Program FORTRAN (HSPF): April 28, 2000.

C. Final stormwater design guidance for new development within the Basin: February 2001.

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RESOLUTION No. 12018

A RESOLUTION extending the existing Storm and Surface Water Utility Rate Boundary to include the area delineated as the Salmon Creek Basin; imposing Utility rates and charges on properties included in the extended rate boundary; and providing for a process to amend the Basin boundary.

WHEREAS, the Board of County Commissioners (Board) has the authority pursuant to RCW 36.94 to delineate areas to be included in the Thurston County Storm and Surface Water Utility; (Utility) and

WHEREAS, the Utility was established to provide services pursuant to Resolution No. 9345 for those areas included within the Utility rate boundary; and

WHEREAS, the Board has established rates and charges for properties within the Utility area pursuant to Resolution 9345 as amended by Resolution No. 11860; and

WHEREAS, the area delineated herein as the "Salmon Creek Basin" includes property not previously incorporated in the Utility rate boundary; and

WHEREAS, the Board and County staff have conducted public meetings that included discussion of the extension of the Utility rate boundary to include the Salmon Creek Basin and the Board held a public hearing on August 2, 1999 to hear and receive comment on the extension; and

WHEREAS, based upon public comment about the Basin boundary being potentially overinclusive in areas and based upon staff reports regarding how the Basin study will develop a more definitive data base for boundary delineation , the Board has determined that a process to amend Basin boundary delineation should be established;

WHEREAS, by findings adopted below, the Board has determined that the Salmon Creek Basin should be delineated as part of the Utility rate boundary;

NOW, THEREFORE, the Board of County Commissioners of Thurston County, Washington does resolve as follows:

Section 1. Findings

The Board adopts the following findings in support of the extension of the Storm and Surface Water Utility (Utility) to include all property within the area delineated as the "Salmon Creek Basin".

A. The extension of the Utility to include the Salmon Creek Basin is necessary to protect and preserve public health, safety and welfare.

B. The extension is a necessary action to make available additional resources and programs to the Salmon Creek Basin area, which area includes private and public property adversely impacted by surface and groundwater flooding in recent years, including flooding during the winter of 1998/1999.

C. The extension of the Utility is an action consistent with the County Comprehensive Emergency Management Plan, including Appendix B thereto, and with the findings and response authority authorized by the Board pursuant to Resolution No. 11931, including the findings adopted therein and by reference to Resolution No. 11890 related to groundwater flooding and the County's emergency response. Pursuant to these emergency conditions, the steps necessary to effect the Utility rate boundary extension should be expedited.

Section 2. Purpose. Upon extension of the Utility rate boundary to include the Salmon Creek Basin, the Utility can undertake a comprehensive basin study leading to proposed adoption of a Salmon Creek Basin Plan. The adoption of a Salmon Creek Basin Plan is a prerequisite for any comprehensive long-term solutions to problems including the ground and surface water flooding occurring in recent years. In addition the extension allows for potential implementation of short term projects to be carried out by the County pending adoption of a basin plan, including any program or project adopted under the Board's emergency authority pursuant to Resolution No. 11931.

Section 3. Rate Boundary Extension Area Delineated. The existing Utility rate boundary area is hereby extended to include all property delineated in the area to be known as the "Salmon Creek Basin", which area is delineated in Exhibit A. Exhibit A is attached hereto and adopted by reference as though set forth herein in full.

Section 4. Salmon Creek Basin Boundary amendment(s).

A. The proposed Basin boundary may be amended to take effect in 1999 by application to the Thurston County Drainage Manual Administrator (Administrator) pursuant to Section 1.5 of the "Drainage Design and Erosion Control Manual for Thurston County" (1994) (Manual) prior to 5:00 p.m. on November 30, 1999. After the above time/date no applications for boundary amendment will be accepted until January 3, 2000.

B. Beginning January 3, 2000, amendments to the Salmon Creek Basin boundary may be authorized by the Board, to take effect beginning in 2000, as follows. The Board shall set a public hearing following receipt of a request by the Administrator. The Administrator shall request that the Board set a public hearing to consider any qualified request for a Basin boundary amendment based upon Basin study information or other information submitted by affected property owners suggesting that a Basin boundary adjustment may be justified. One or more of the following sources of information is a prerequisite for consideration of a Basin boundary amendment application for 1999 or thereafter:

- Ground survey performed by a licensed professional land surveyor in the State of Washington detailing specific site topography in sufficient detail confirming drainage away from any waters tributary to Hopkins Ditch or Salmon Creek.

- Subsurface exploration data which specifically identifies subsurface flow patterns prepared under the direct supervision of a licensed professional engineer in the State of Washington. Said data shall bear the seal and signature of the supervising engineer;

or

- Subsurface exploration data which specifically identifies subsurface flow patterns prepared under the direct supervision of a "pre-qualified" hydrogeologist approved by the Thurston County Drainage Manual Administrator.

C. No property within the Utility rate boundary prior to the adoption of this resolution shall be entitled to withdraw from the rate boundary as a consequence of a Basin boundary amendment.

Section 5. Rates and Charges. All property newly included within the Utility rate boundary pursuant to Section 3 shall be subject to payment of the Utility rates and charges pursuant to the provisions set forth in Resolution No. 9345 as amended by Resolution No. 11860.

Section 6. Effectiveness. This resolution shall take effect upon the date adopted below.

Section 7. Severability. If any Section, subsection, sentence, clause, phrase, or other portion of this Resolution, or its application to any person is, for any reason, declared invalid, in whole or in part by any court or agency of competent jurisdiction, said decision shall not affect the validity of the remaining portions hereof.

ADOPTED: 8/23/99

ATTEST:

BOARD OF COUNTY COMMISSIONERS
Thurston County, Washington

Kim Cross
Clerk of the Board

Judy Wilson
Chairman

APPROVED AS TO FORM:
EDWARD J. HOLM
PROSECUTING ATTORNEY

Commissioner

By: Mark H. Calkins
Mark H. Calkins
Deputy Prosecuting Attorney

Commissioner

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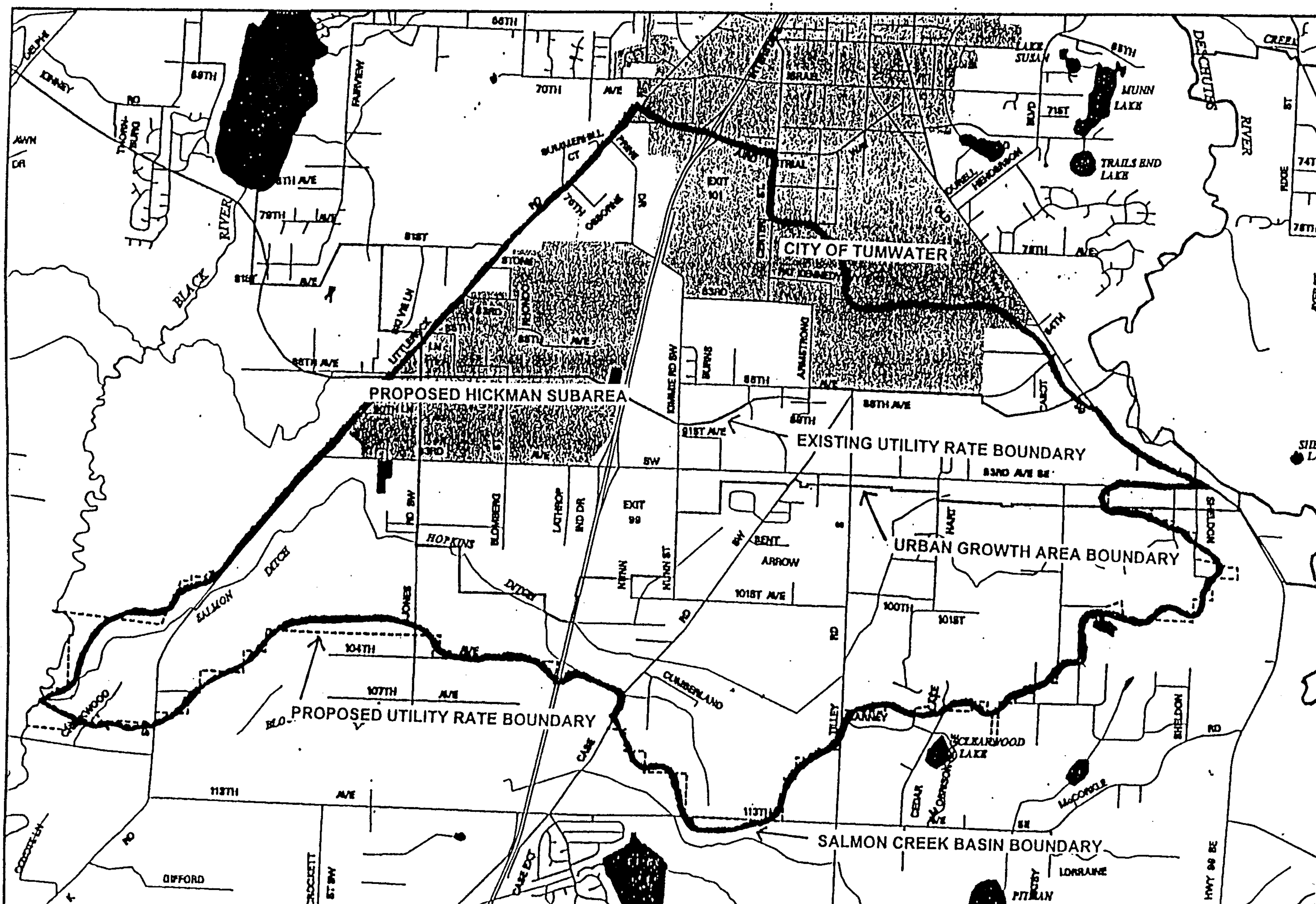

Proposed Utility Rate Boundary

Salmon Creek Basin Planning Area

THURSTON COUNTY
WASHINGTON
SINCE 1852

COUNTY COMMISSIONERS
Judy Wilson
District One
Diane Oberquell
District Two
Kevin J. O'Sullivan
District Three

DEPARTMENT OF WATER AND WASTE MANAGEMENT

Richard D. Blinn, P.E.
Director

NOTICE OF ADOPTION

Revised Interim Stormwater Design Standards for New Development in Salmon Creek Basin

FROM: Richard Blinn, P.E.
Thurston County Drainage Manual Administrator

DATE: October 30, 2000

Section 1. SUMMARY

Effective immediately, **revised** interim stormwater standards for new development are imposed for the Salmon Creek Basin (the Basin). These standards replace interim standards imposed on the Basin pursuant to the Administrator's action dated February 9, 2000. These interim standards will remain in effect until further notice pending conclusion of the County's consultant work evaluating the extent and possible mitigations to groundwater flooding throughout the Basin. The completion date for this work is expected sometime during the fall of 2002. Basin boundary maps maintained by the Thurston County Storm and Surface Water Utility describe the boundaries for the Basin. Interim stormwater design minimum standards for new development in the Basin is presented below under Section 3.

Section 2. BACKGROUND

In response to recurrent groundwater flooding within the Basin, the Thurston County Board of County Commissioners (BoCC) expanded the existing Storm and Surface Water Utility Rate Boundary in August 1999. During late summer 1999, the BoCC imposed a moratorium on new development in groundwater flooding areas. During early fall 1999, staff prepared a work plan and solicited for consultant support. During October 1999, a contract was signed with URS Greiner Woodward Clyde to produce a calibrated ground and surface water model for the Basin. Following the successful delivery of these models, specific alternatives will be evaluated to determine long-term flood alleviation strategies for the Basin.

Responding to concerns from county residents, the BoCC voted to approve Critical Area Ordinance amendments addressing groundwater-flooding areas on February 7, 2000 (Ordinance #12155). These amendments provide additional requirements for new development in areas identified on the "Resource Map" for groundwater flooding as maintained by Thurston County Development Services Department. On February 7, 2000, the BoCC took action extending the building moratorium for four months for the Basin (Ordinance #12156); this moratorium has since been lifted.

Section 3. INTERIM DEVELOPMENT STANDARDS

A. **Purpose:** The County seeks to limit the adverse potential impact from new development within the Basin. To this end, the County is providing interim stormwater design standards for new development within the Basin. These standards will remain in place until such time that the County's consultant completes the modeling and alternative evaluation for flood alleviation strategies for the Basin. Upon review of the consultant's final basin report and recommendations, the interim standards will be reconsidered for ensuring consistency with the basin report.

B. **Interim Standards:** These interim standards are contained within "Interim Site Development Standards for New Development in Salmon Creek Basin", URS Greiner Woodward Clyde, October 6, 2000. These standards establish screening criteria for impact, new groundwater monitoring requirements, alter the manner in which new developments are modeled (hydrologic) and require groundwater-mounding analysis where appropriate. This additional guidance does not guarantee that new development can successfully complete the review process prior to the County completing the consultant modeling work. These interim standards are available upon request. Interested parties should contact Mark R. Cook, Storm and Surface Water Program Manager, at 360-754-4681 or visit 921 Lakeridge Drive SW, Building 4, Room 100, Olympia, WA 98502.

C. **Authority:** In taking this action, the Thurston County Drainage Manual Administrator is exercising the Administrative Authority of Section 1.2 of the Drainage Design and Erosion Control Manual for Thurston County Washington, 1994 (the Manual). Development proponents are encouraged to review "Interim Site Development Guidelines for New Development in Salmon Creek Basin" prior to submitting any drainage plan for review. The following list is not intended to be all-inclusive but does provide some direction on key chapters and sections of the Manual affected by the interim guidelines:

D. **Relationship to Manual Standards:**

- New screening criteria are established to determine preliminary impact thresholds for new development. The County has created a "Depth to Water" (DTW) map for use within the Basin. This map provides gross guidance on the probable water table elevation for Basin properties during extreme recharge events. Providing a minimum vertical separation of six feet from the bottom of proposed drainage facilities is maintained, design methods as detailed in the 1994 edition of the Manual may be used for new development.
- Providing that the screening criteria suggest that less than six feet of vertical separation exists, new monitoring requirements apply. Monitoring shall be for a period of one year. Proponents may elect to minimally monitor for a period of four months, two of which must be from the period described by December to March. Providing that this reduced monitoring period is elected by the proponent, the

monitoring shall continue until final stormwater plan preparation. Prior to final stormwater plan preparation, the proponent will provide all monitoring data with a statistical correlation to County reference wells. If this final analysis alters previous determinations regarding the preliminary stormwater plan, then additional mitigation of the stormwater plan shall be required.

- Section 3.1.1, Section 3, is amended to include the additional bore analysis requirement
- Section 3.1.1, Section 9, is amended to include input and output files from continuous simulation modeling and water balance analysis
- Section 4.1.1 is amended to reflect the requirement that any increase in off-site groundwater flooding or septic system failures due to recharge be prevented. Maximum release rates are amended to reflect the predeveloped runoff hydrograph as described by the continuous simulation model.
- Sections 4.1.2 is amended such that sizing is based on the results of the amended modeling requirements.
- Section 4.2 is amended to reflect the sizing as defined by the amended modeling requirements.
- Section 4.2.2 is amended to reflect the sizing as defined by the amended modeling requirements.
- Section 4.3 is amended to refer to Chapter 8, Section 8.5.3.
- Chapter 5 is replaced by the continuous simulation-modeling requirement. Existing condition is as described by aerial photography as captured by the County's 1996 flight.
- Section 8.5.3 is amended to require six feet of vertical separation.

Unless otherwise amended by "Interim Site Development Guidelines for New Development in Salmon Creek Basin", URS Greiner Woodward Clyde. October 6, 2000, all other Manual provisions apply.

Any questions regarding this administrative action. please contact Mark R. Cook, Storm and Surface Water Program Manager, at 360-754-4681.

cc: Board of County Commissioners
Linda Hoffman
URS Greiner Woodward Clyde
DPA Jeff Fancher
Fred Knotsman
Don Krupp
Mark R. Cook

MC:rp\interimmem_1000.doc

FINAL

INTERIM SITE DEVELOPMENT STANDARDS FOR NEW DEVELOPMENT IN SALMON CREEK BASIN

Prepared for
Thurston County
Department of Water and Waste Management
Storm and Surface Water Program

October 6, 2000

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9900045.00.00601

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Appendices

1.1 BACKGROUND

The Salmon Creek basin has experienced significant flooding problems during the past several years. High groundwater conditions appear to be the primary cause of the recent flooding. In August 1999, Thurston County imposed a six-month moratorium on new development in the basin to avoid increasing the flooding problems.

Thurston County is now conducting a study of groundwater and surface water conditions in the basin to (1) evaluate the causes and estimated recurrence frequency of the recent flooding; (2) estimate (using groundwater analysis) the approximate extent of high groundwater conditions outside the flooded areas that could flood basements or impair septic system drainfields; and (3) identify and assess alternative measures to mitigate the existing problem areas and avoid future problems.

In June 1998, Thurston County began installing a network of monitoring wells and stream gages to collect the data needed to develop groundwater and surface water models of the basin. Calibrated models should be available in June of 2001.

As an interim measure to ensure that new development within the basin does not exacerbate the extent of existing flooding, the County is requiring that new development meet additional drainage review criteria, under the authority of Section 1.2 of the Drainage Design and Erosion Control Manual for Thurston County, 1994. The interim standards for new development in the basin are described below. The interim standards define the procedure that project proponents must follow to obtain approval for new development in the Salmon Creek basin.

The interim standards outlined below are intended to guide new development in the Salmon Creek basin until the basin plan has been completed. The interim standards have two basic components:

- **Screening Evaluation.** Because of the past history of groundwater flooding in the Salmon Creek basin, Thurston County has established a basin-specific screening criterion regarding the vertical separation between the bottom of an infiltration facility and the high (winter 1999) groundwater elevation at the site. Statistical analyses indicate that the 1999 groundwater elevations are likely the highest that have occurred during the last 50 years. According to the basin-specific screening criterion, the maximum groundwater elevation must be at least 6 feet below the bottom of any infiltration facility at the site. Each project proponent must conduct a site-specific evaluation to determine whether their proposed development would meet this basin-specific screening criterion.
- **Performance Standards.** If the site-specific evaluation shows that the proposed project is unlikely to flood or exacerbate existing groundwater flooding problems, the project proponent may proceed with design. However, the design must meet basin-specific performance standards intended to minimize potential impacts on basin hydrology. In addition, continuous simulation modeling will be required to design stormwater facilities for some projects.

The screening evaluation and basin-specific performance standards are described below.

2.1 SCREENING EVALUATION

The screening evaluation involves the steps outlined below. Figure 1a provides an overview of the screening process.

Step 1 - Estimate depth to water under winter 1999 conditions. The project proponent must estimate the depth to water at their site under winter 1999 conditions, using the Depth-to-Water map recently prepared by Thurston County.

- If the Depth-to-Water map indicates more than 6 feet of separation between the 1999 groundwater elevation and the bottom of any infiltration facility at the site, the project proponent may proceed with design and permitting. The project must be designed to comply with the most current version of the County's Drainage Design and Erosion Control Manual.
- If the Depth-to-Water map indicates less than 6 feet of separation at the project site, the project proponent can either defer the project until the Salmon Creek Basin engineering analysis and plan have been completed, or perform site-specific groundwater measurements as described in Step 2.

Step 2- Measure groundwater elevations and estimate the winter 1999 groundwater elevations at the project site. The project proponent must install and monitor piezometers to obtain on-site groundwater elevations at the project site. The project proponent must also obtain groundwater elevation data for several "reference wells" that are monitored by the County. The project proponent must then perform a regression analysis to correlate the on-site water level data to the reference well data, and use the resulting regression equation to estimate the winter 1999 water levels at the project site. The required procedures for piezometer installation, water level measurement, reference well data acquisition, regression analysis, and estimation of on-site water levels are specified in *Use of On-site Wells and Reference Wells to Estimate Winter 1999 Groundwater Levels in the Salmon Creek Basin* (Appendix A). The key requirements are outlined below.

- **Piezometer Installation & Surveying.** For sites less than 5 acres, three piezometers will be required, unless the County Drainage Manual Administrator determines that fewer piezometers will be acceptable. For sites greater than 5 acres, the County Drainage Manual Administrator will specify the number of piezometers required. Piezometers must be installed at or near the topographic low point of the site and at planned locations of stormwater infiltration facilities. Piezometer locations should also allow for broad coverage of site conditions, including triangulation for groundwater flow direction determinations.

  The borings must be advanced to contact the uppermost lower-permeability unit (e.g., till). If no low-permeability unit is encountered within 50 feet of ground surface, the drilling can be terminated and a piezometer installed. Piezometer screen lengths shall be 20 feet and screens shall extend downward from the highest anticipated water table depth unless geologic field conditions indicate a shorter screen. Piezometers should screen only those geologic materials generally considered to be the Vashon recessional deposits (Qvr) and should not span substantial low permeability layers. Piezometer diameter shall be at least 1 inch. The elevation of the top of the piezometer (measuring point) must be surveyed to within 0.01 foot, based on the NGVD 29 vertical datum. The height of the measuring point above the mean natural ground level within a radius of 5 feet of the piezometer must be reported to 0.1-feet precision.

- **Piezometer Monitoring.** The County recommends monthly groundwater level monitoring for one year. However, for the purposes of this initial screening, a project proponent may elect to monitor weekly for as little as four months, provided the monitoring period includes at least two months within the December to March timeframe. The on-site groundwater elevations must be measured to within 0.01 foot using methods standard for the industry.

- **Reference Well Data Acquisition.** Thurston County has installed automated groundwater elevation measuring devices in several reference wells in the Salmon Creek basin. These reference wells have groundwater records extending back to at least the fall of 1998. Therefore, these wells provide a record of water level changes during the worst of the groundwater flooding in the winter of 1999. Current daily groundwater elevation data are also available for each reference well. The proponent must contact the County and acquire water level elevations from all reference wells for those dates with on-site water level measurements. If more than one measurement was collected for a particular well, the mean daily depth-to-water shall be calculated and used throughout. County data shall be used at 0.01-foot precision.

- **Estimation of Winter 1999 Groundwater Elevations at Project Site.** The project proponent must perform a regression analysis using the on-site water level data and the reference well water level data for the same dates. The proponent must then use the resulting regression equation to estimate the winter 1999 water levels at the project site.

  - If the reference well evaluation indicates that the site meets the screening criterion (i.e., at least 6 feet of separation between the winter 1999 groundwater elevation and the bottom of any infiltration facility at the site), the project proponent may proceed with design and preparation of the requisite permit applications. The project must be designed to comply with the most current version of the County's Drainage Design and Erosion Control Manual and the Performance Standards described below.

- If the reference well evaluation indicates that the site does not meet the screening criterion (i.e., less than 6 feet of separation between the winter 1999 groundwater elevation and the bottom of any infiltration facility at the site), the proponent can either defer the project until the Salmon Creek Basin engineering analysis and plan have been completed, or conduct a site specific groundwater mounding analysis as described in Step 3.

Step 3 - Conduct site-specific groundwater mounding analysis. The project proponent may perform a site-specific mounding analysis to assess the potential impacts of the proposed project on neighboring properties. An HSPF continuous simulation model must be prepared for the project site to estimate pre- and post-development recharge rates. The HSPF model must be prepared using the parameter values and precipitation data provided by the County. The proponent must estimate the maximum water level that would occur given the same precipitation conditions that led to the winter 1999 groundwater levels, and considering discharge of imported potable water to drainfields. The mounding analysis must be conducted in accordance with the "Groundwater Mounding Analysis Guidelines" (Appendix B). Appendix C provides guidelines for County review of mounting analyses.

- If the site-specific groundwater mounding analysis shows that the proposed project will not increase groundwater elevations at the project site property line, the project proponent may proceed with the design and preparation of requisite permit applications. Stormwater facilities must be sized using the HSPF model developed for the project site, and the design must comply with the Performance Standards described below.

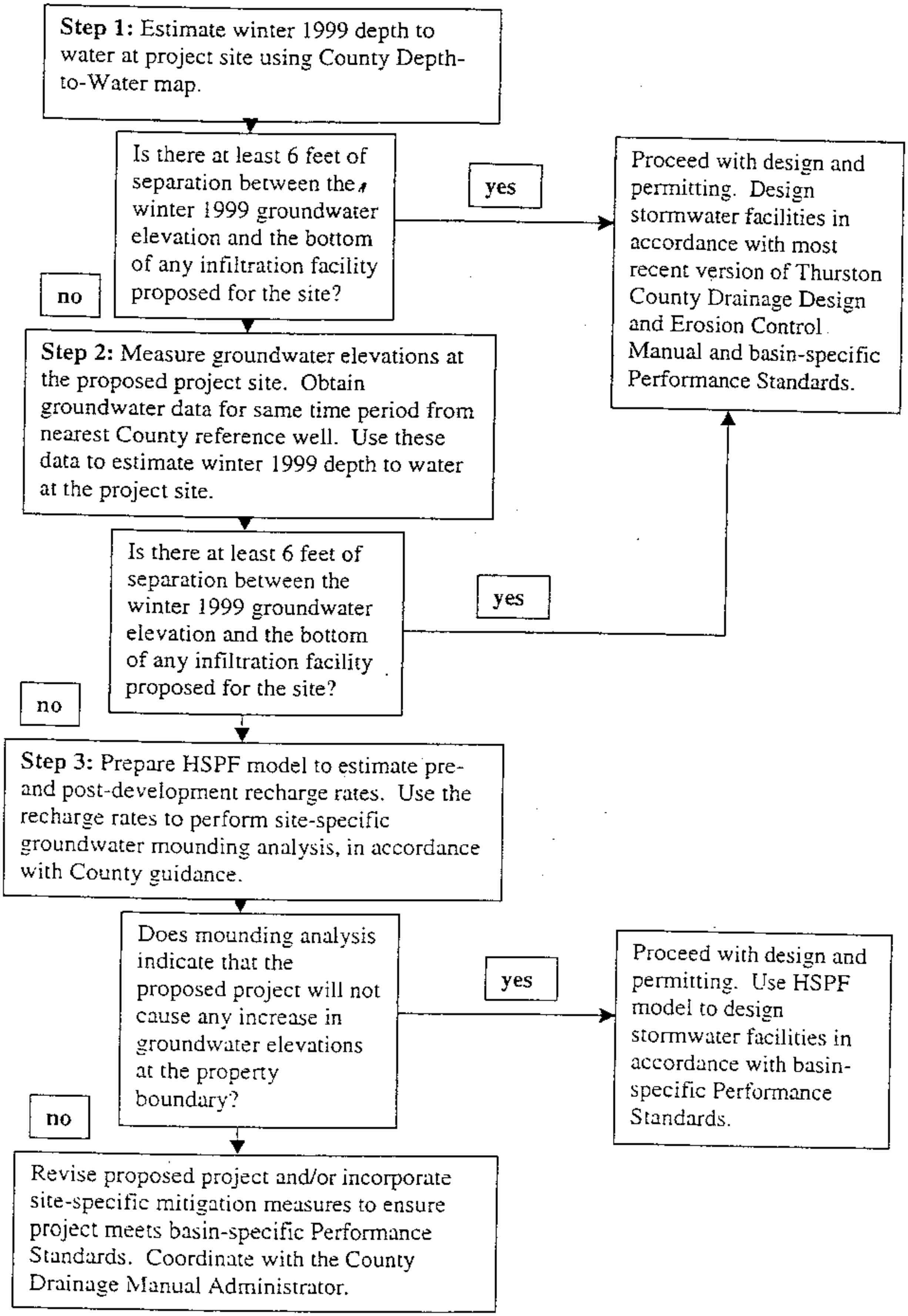
- If the groundwater mounding analysis indicates that the proposed project would cause an increase in groundwater levels at the property boundary, the project proponent must revise the proposed project and provide site-specific mitigation as needed to avoid such impacts.

2.2 PERFORMANCE STANDARDS

Proposed projects that pass the screening evaluation must be designed to meet all of the applicable requirements of the most recent version of the County's Drainage Design and Erosion Control Manual for control of surface water runoff. All new developments in the Salmon Creek basin must be designed to prevent on-site flooding for antecedent precipitation equivalent to that preceding the 1999 flooding, and prevent any increase in off-site groundwater flooding or septic system failures due to increased recharge (or runoff) from the site.

As noted above, the HSPF continuous simulation model must be used to design stormwater facilities for projects that require a groundwater mounding analysis (Step 3 above), and these projects must be designed so that they will not increase groundwater elevations at the property line.

Figure 1a. Interim Screening Evaluation Process for Salmon Creek Basin



Appendix A

Use Of On-Site Piezometers and Reference Wells for Estimation of Winter 1999 Groundwater Levels

Pacific Groundwater Group
2377 Eastlake Ave. E.
Seattle, Washington 98102
206.329.0141 FAX 329 6968

MEMORANDUM

To:	Mark Cook, Thurston County
From:	Charles T. Ellingson, Pacific Groundwater Group
Re:	**USE OF ON-SITE PIEZOMETERS AND REFERENCE WELLS FOR ESTIMATION OF WINTER 1999 GROUNDWATER LEVELS**
Date:	October 6, 2000

Introduction

If predicted depth-to-groundwater below a proposed stormwater infiltration facility is less than 6 feet based on the County's depth-to-water map for winter 1999, the proponent may collect new on-site depth-to-water data, correlate the new on-site data to new data from a reference well, then use the correlation to estimate on-site depth-to-water in the winter of 1999. The purpose of this document is to specify the requirements for on-site data collection and correlation analysis. The general procedure is also discussed in the County's *Interim Site Development Standards for New Development in Salmon Creek Basin.*

Step 1 - Install On-Site Piezometers

a. The project proponent must install three or more piezometers on the project site. For sites less than 5 acres, three piezometers will be required, unless the County Drainage Manual Administrator determines that fewer piezometers will be acceptable. For sites greater than 5 acres, the County Drainage Manual Administrator will specify the number of piezometers required. Piezometers must be installed at or near the topographic low point of the site and at planned locations of stormwater infiltration facilities. Piezometer locations should also allow for broad coverage of site conditions, including triangulation for groundwater flow direction determinations. Proponents should discuss piezometer locations with the County prior to installation.

The borings must be advanced to contact the uppermost substantial lower-permeability unit (expected to be till over most of the basin) or to a depth of 50 feet, which ever is less. Piezometer screen lengths shall be 20 feet and screens shall extend downward from the highest anticipated water table depth unless geologic field conditions indicate a shorter screen. Piezometers should only screen only the Vashon recessional deposits (Qvr) and screens and sand packs should not span substantial low permeability layers. Piezometer diameter shall be at least 1 inch.

b. The elevation of the top of the piezometer (measuring point) must be surveyed to within 0.01 foot, based on the NGVD 29 vertical datum. The height of the measuring point above the mean natural ground level within a radius of 5 feet of the piezometer must be reported to 0.1-feet precision.

c. Detailed logs of piezometers shall be generated and include at least the following information:

- geologic log
- drilling method
- sampling methods and intervals
- construction log showing piezometer and annular-space materials and dimensions (referenced to ground surface).
- elevation of the measuring point (top of piezometer) to 0.01-foot precision and referenced to the NGVD29 vertical datum
- State-plane north and east coordinates
- height of the measuring point above the mean ground level within a radius of 5 feet around the well
- drilling company name
- date of completion

Step 2 - Monitor On-Site Water Levels

The project proponent must monitor groundwater elevations in their on-site piezometers. The County recommends monthly groundwater level monitoring for one year. However, for the purposes of this screening, a project proponent may elect to monitor weekly for as little as four months, provided the monitoring period includes at least two months within the December-to-March timeframe. Depth-to-water in the piezometers must be measured to within 0.01-foot precision using methods standard for the industry. Measurements must be referenced to the surveyed measuring point (top of piezometer) and corresponding water-table elevations must be calculated.

Step 3 - Identify Most Appropriate County Reference Well and Generate Linear Regression Relationships

Thurston County has installed automated groundwater elevation measuring devices in several reference wells in the Salmon Creek basin (**Figure 1**). These reference wells have groundwater records extending back to the fall of 1998 (**Figure 2**). Therefore these wells provide a record of water level changes during the groundwater flooding period in the winter of 1999. Current daily groundwater elevation data are also available for each reference well.

a. The proponent must contact the County and acquire water level elevations from all reference wells for those dates with on-site water level measurements. If more than one measurement was collected for the reference well on the required day, the mean daily depth-to-water shall be calculated and used throughout. County data shall be used at 0.01-foot precision.

b. The proponent shall identify the reference well that will provide the best approximation of data from each on-site piezometer by calculating linear correlation parameters for each on-site piezometer/reference-well pair. The reference well with the highest correlation coefficient shall be selected.[1] A table showing the relationship between data from a hypothetical on-site piezometer and reference wells is shown in **Figure 3**. The reference well with the highest correlation coefficient for each piezometer shall be identified and used for further evaluations, as shown in **Figure 3**. The proponent shall prepare a table and graph similar to those on **Figure 3** for each on-site piezometer. Each figure shall show the correlation coefficients for each piezometer/reference-well pair, the best-fit line for the selected piezometer/reference-well pair, and the equation for the line.

If the linear correlation is poor using all of the data pairs (maximum $r^2 < 0.7$), or if the best-fit line through all the data pairs deviates from the data trend more than 2 feet at the highest recorded water level, a modified approach should be attempted. The analysis is most critical at high elevation because the equation for the best-fit line will be used to predict groundwater elevations that are higher than any measured on site.

In the case of a poor match to high elevation data, the proponent should first review the scatter-grams for other reference wells. If the best-fit line for an alternative reference well matches high-elevation data pairs and the correlation coefficient is only marginally below that of the maximum, the alternative reference well should be selected.

If alternative reference wells do not improve the match to high elevation data pairs, the proponent should remove low-elevation data pairs from the correlation and generate a new best-fit line. Best-fit lines using all the data pairs and a truncated data set are shown on **Figure 3**. As indicated on **Figure 3**, removing 6 data pairs decreased r^2 but improved the match between the line and the highest-elevation data pair. Whether or not such a modification is likely to improve the predictive capability of the resulting best-fit line at high elevation will depend on the degree of confidence in the field data and the number of high-elevation data pairs upon which to judge the match. These are project-specific factors that will require consideration by the proponent and County. In the example of **Figure 3** only one high-elevation data pair exists and the modified approach is probably not justified.

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[1] See standard statistical text books for definition of the correlation coefficient, r. A convenient method of calculating coefficients and plotting best-fit lines is to use a commercial software package such as Microsoft Excel.

Non-linear correlation approaches are discouraged because they can result in physically unrealistic relationships, particularly outside the field-data range. Nonetheless, the County will consider non-linear approaches that result in physically realistic predictions if the linear approaches described herein do not result in physically realistic predictions. The proponent must present and justify any non-linear approaches in a manner similar to that specified for the linear approaches herein.

Step 4 - Estimate Winter 1999 Depth to Water

The proponent must estimate a winter-1999 groundwater elevation in each on-site piezometer by using historical reference well data and the variables A and B from the best-fit line.

a. The proponent shall calculate the maximum average elevation of groundwater in the selected reference wells for any 10-day period between January 15, 1999 and May 15, 1999 – rounded to the nearest 0.1-foot. A 10-day running average of groundwater elevation between those dates is therefore required.

b. The proponent shall then estimate winter-1999 groundwater elevations in each on-site piezometer to 0.1-foot precision using the equations for the best-fit lines: The linear equations will have the form:

$$E_{on\text{-}site} = M * E_{reference} + B$$

where:

$E_{on\text{-}site}$ =	elevation of on-site groundwater
$E_{reference}$ =	maximum 10-day average groundwater elevation in reference well during the winter of 1999
M =	slope of best-fit line
B =	intercept of best-fit line

The variables M and B will be generated by the best-fit correlation between each piezometer and reference well as shown in **Figure 3**. Non-linear relationships would have different variables but the approach is the same.

c. Finally, depth-to-water shall be calculated to 0.1-foot precision by subtracting the maximum average winter-1999 elevation of groundwater in each piezometer from the local ground surface elevation from Step 1. In some cases the proponent may wish to create a depth-to-water map in addition to the piezometer-specific calculations. The map could be generated by contouring the groundwater data from on-site piezometers and subtracting the elevation contours from land surface elevation contours.

Step 5 - Calculate Groundwater Flow Direction

The groundwater elevation data for the maximum- and minimum elevation measurement rounds shall be contoured (separately). The contour maps shall indicate groundwater flow direction.

Step 6 - Report to County

An *On-Site Depth-to-Water Report* shall be submitted to the County and shall include at least the following:

- vicinity map showing the site and surrounding properties, buildings, roads, parcels, and hydrography
- site map showing piezometer locations and land surface elevation contours (two-foot contours are available from the County for all of the Salmon Creek basin)
- brief interpretation of on-site shallow geology
- geology/piezometer logs
- table of piezometer survey data
- table of on-site water level measurements
- table of reference well water level measurements
- table of piezometer/reference well correlation parameters
- scattergram (graph) of piezometer/reference well data pairs, showing best-fit line(s) and equation(s)
- table showing on-site maximum 10-day groundwater elevations and minimum depths-to-water from winter 1999
- groundwater contour maps of maximum and minimum measured water level elevations

Step 7 - County Interpretation

The County will review the report for consistency with these requirements. If the work is found to have been performed in reasonable conformance with these requirements and in general conformance with accepted hydrogeologic practices, the County will evaluate the depth-to-water criteria.

If the estimated (winter 1999) depth-to-water below a proposed stormwater infiltration facility is greater than 6 feet, the County will inform the proponent that the site has passed the screening evaluation identified in the *Interim Site Development Standards for New Development in Salmon Creek Basin.* If the depth to water is 6 feet or less, the County will inform the proponent that they can either defer the project until the Salmon Creek Basin engineering analysis and plan have been completed, or perform a site specific groundwater mounding analysis as described in *Groundwater Mounding Analysis Guidelines.*

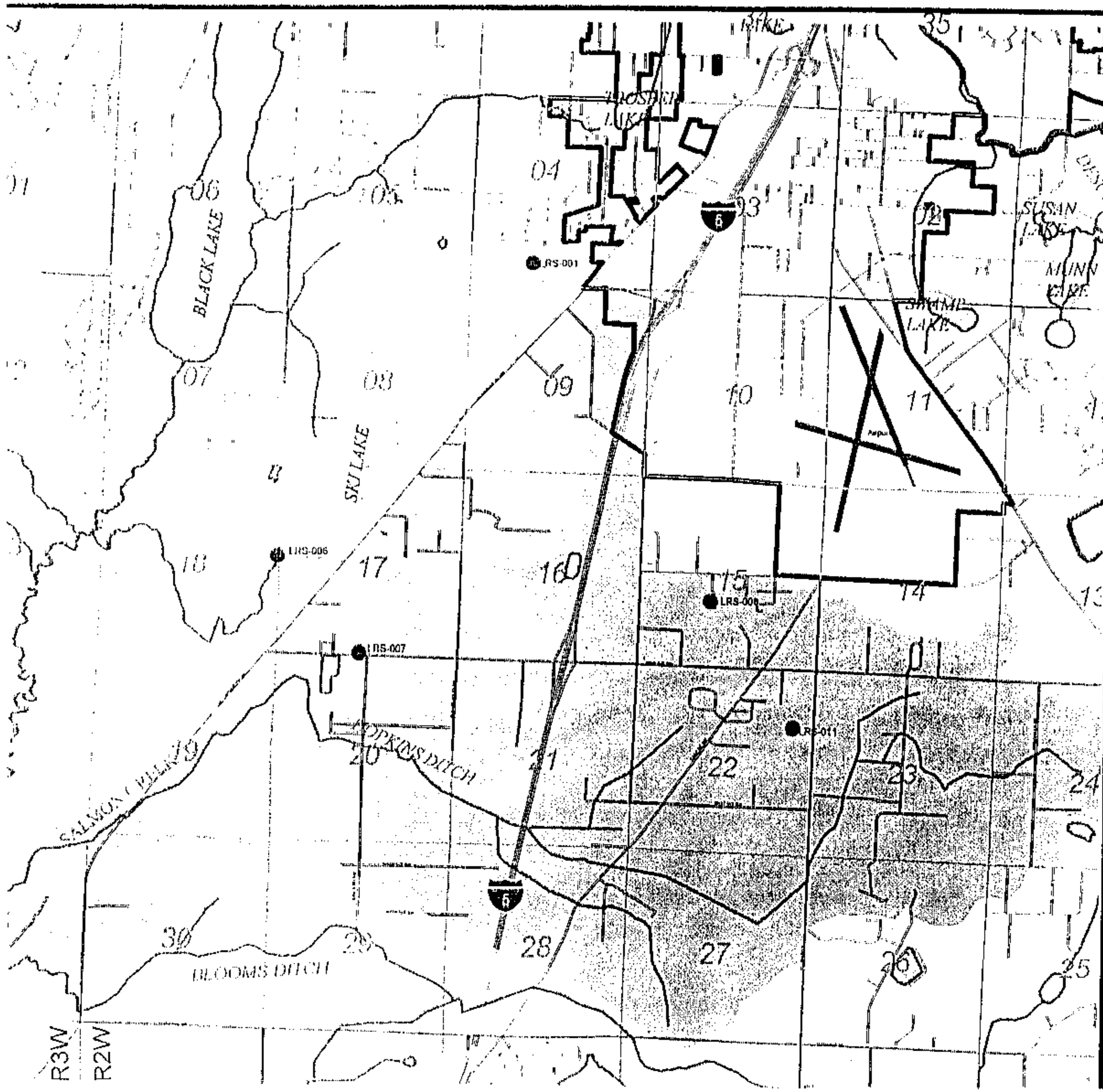


Figure 1
Reference Well Locations

N
W
E
S

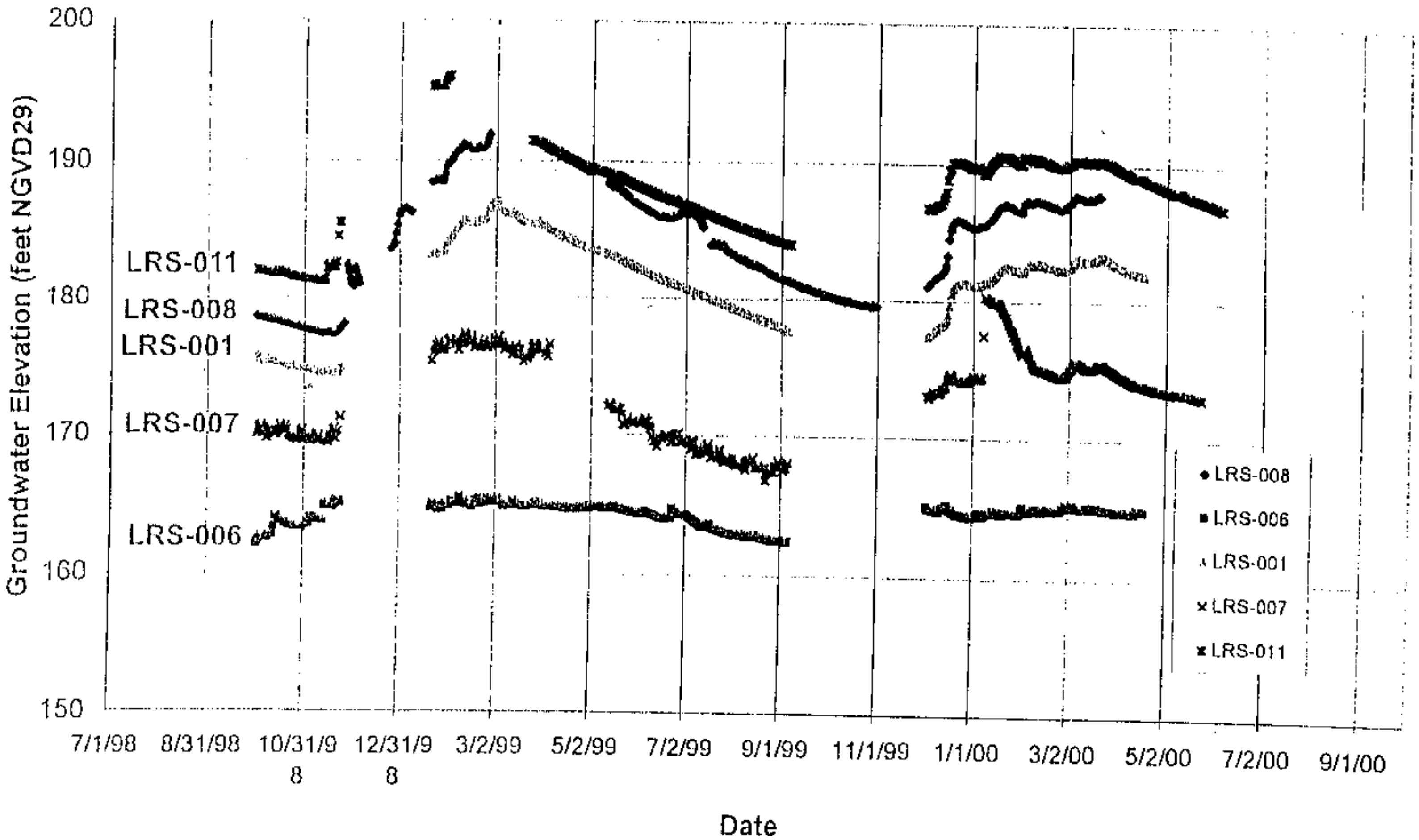
4000 Feet

Reference Wells
Tumwater City Limits
Salmon Creek Surface Water Basin (Thurston County)

Data Source
Thurston County Geodata Center and others

Pacific Groundwater Group

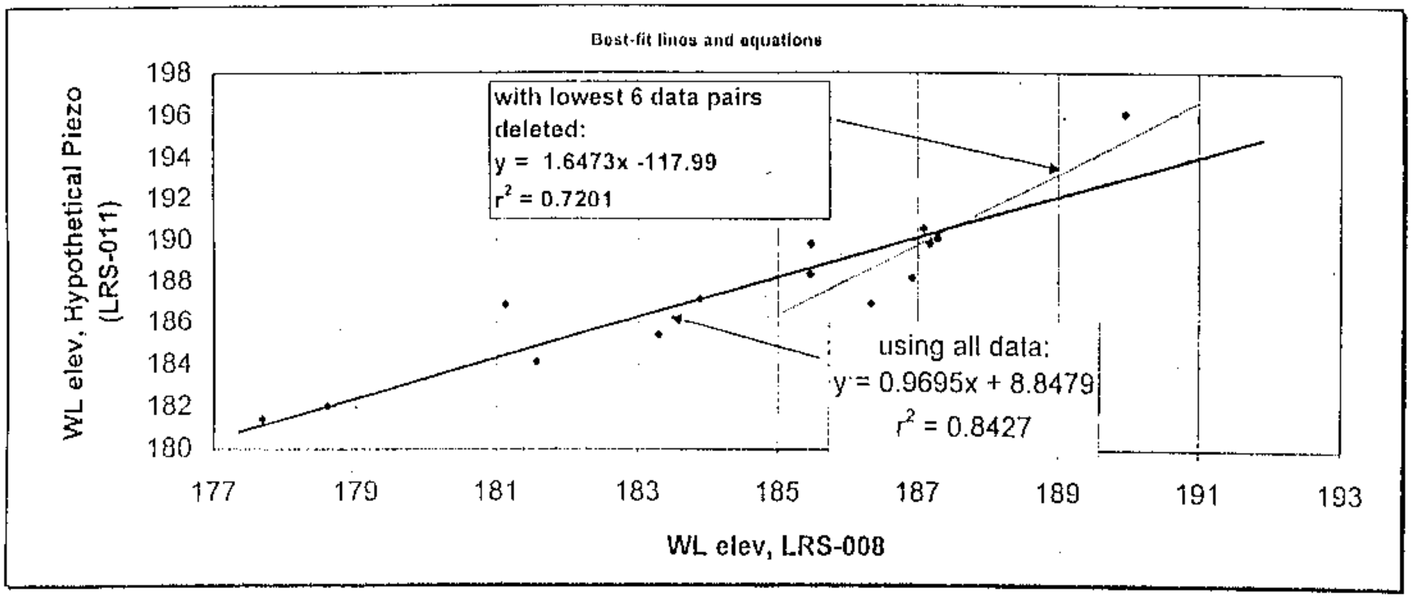
Figure 2 - Hydrographs for Reference Wells



Pacific Groundwater Group

Figure 3. Correlation of Hypothetical Piezometer and Reference-Well Data

Reference Well	using all data pairs			
	r^2	Correlation coefficient, r	M (slope)	B (intercept)
LRS-001	0.811	0.901		
LRS-006	0.554	0.744		
LRS-007	0.696	0.834		
LRS-008	*0.843*	*0.918*	*0.9695*	*8.8479*



Pacific Groundwater Group

Appendix B

Groundwater Mounding Analysis Guidelines

Pacific Groundwater Group
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206.329.0141 FAX 329.6968

MEMORANDUM

To:	Mark Cook, Thurston County
From:	Charles T. Ellingson, Pacific Groundwater Group
Re:	**GROUNDWATER MOUNDING ANALYSIS GUIDELINES**
Date:	October 6, 2000

Introduction

If predicted depth to groundwater is less than 6 feet based on the County's *Interim Site Development Standards for New Development in Salmon Creek Basin*, the proponent may perform a groundwater mounding analysis to try to demonstrate conformance with basin-specific Performance Standards as defined in the *Interim Standards*. The purpose of this mounding analysis guide is to specify the software, input data, calibration requirements, and output format for the referenced groundwater analyses. In general, the guidelines result in an estimate of the effects of site development on groundwater levels in the unconfined aquifer (a. k. a., water table) during the winter and possible exacerbation of groundwater flooding.

Processes that must be considered are:

- changes to average recharge quantity over the site as a result of changes in evapotranspiration.
- distribution of recharge on site (pavement and stormwater infiltration plans), and
- quantity and distribution of imported water supplies that will be disposed to drainfields, leak from pipes, or infiltrate as a result of excess irrigation.

Summary of Standard Approach

The proponent must develop a simplified, 2-dimensional, transient, finite difference groundwater model to simulate groundwater mounding under the current and built conditions. The County anticipates mounding as a result of increased total recharge caused by reduced use of water by plants (land clearing) and discharge of imported potable water through septic drainfields. The current- and built-condition models shall be the same, except for recharge quantity and distribution. Heads (groundwater levels) under the current condition shall be subtracted, on a cell-by-cell basis, from heads under the built condition. The recharge conditions used to evaluate the change shall be average recharge for each month (12 values) of water years 1997, 1998, and 1999 (October 1, 1996 through September 30, 1999) as calculated by an HSPF model also generated by the proponent using standardized properties defined by the County. The County will not approve projects that are predicted by this analysis to cause increased winter or spring heads at the proponent's property boundary. The County will apply this criterion using a precision of whole feet – in other words, results shall be rounded to the nearest foot. Projects will not be approved unless the predicted change at the property boundary in winter and spring is 0 feet.

Sources of Hydrogeologic and Hydrologic Information for the Area

Several sources of background information about the hydrogeologic environment in and near the Salmon Creek drainage basin are readily available. The most up-to-date are the *Hydrology and Quality of Ground Water in Northern Thurston County, Washington* (Drost and others, 1998), the report on 3-dimensional groundwater modeling of Thurston County (Drost and others, 1999), and the *Salmon Creek Drainage Basin Conceptual Hydrologic Model and Data Collection Plan* (Pacific Groundwater Group, 2000). Detailed information on local conditions also may be found in well logs on file with Dept. of Ecology (Southwest Regional Office, Lacey, WA) and in hydrogeologic reports on drilling and testing of water-supply wells and monitoring wells in the area. Many of the latter are listed in the bibliography of the Pacific Groundwater Group (2000) report.

Software and Computer Requirements

The project proponent must use either the MODFLOW or PLASM finite-difference modeling code to estimate changes due to proposed development.

The simple conceptual model to be simulated shall be two-dimensional and consist of a single-layer, unconfined aquifer with an impermeable base. Cell sizes shall be commensurate with the project size and details of site layout. Because of the need to account for mounding near infiltration ponds, cell sizes at the ponds must be small, yet the model boundaries must be sufficiently distant to not unacceptably-influence model results. Therefore, although all models will be simple, most will have large numbers of cells and users are cautioned against using a slow computer, or one with insufficient memory. Also, model versions with advanced pre- and post-processors are highly recommended.

Flexibility

These guidelines are designed to reduce work required of a proponent by specifying a set of acceptable, yet simplified, requirements. A proponent may modify these guidelines if the modifications are approved by the County Drainage Manual Administrator and result in a more realistic model. Additional simplifying assumptions are unlikely to be approved.

Although conceptually reasonable, these model requirements have not been "tested" and therefore modifications may be necessary during modeling to achieve reasonable results. For instance, the current-condition model should not predict surface flooding, if such conditions were not observed or expected based on field conditions. Also, the gradient of the uniform flow field may need to be altered to approximate the average measured hydraulic gradient – given that areal recharge also will be applied to the model.

Model Plan

The proponent shall review these guidelines and site data and then prepare a brief plan for modeling the site. The plan should be submitted to the County Drainage Manual Administrator for comment. The memo should include any proposed deviations from the standard approach that are deemed necessary by the proponent at that early stage. The County will comment on the plan; however, given unknowns that may arise during modeling, the County cannot assure that the plan will result in an acceptable model nor overall approval of the project.

Standard Model Domain and Grid Design

The model domain shall extend to ten times the project-site dimensions in all directions from the project boundary (with allowance for square cells approximating an irregular property boundary), unless the proponent demonstrates that a model with a smaller domain is equally insensitive to boundary conditions.

Model cells shall be sufficiently small to simulate the influence of stormwater infiltration ponds; however, because the model is numerical, the maximum groundwater-mound height will not be calculated by the model, and the model should not be solely relied upon for design purposes. The pond design must also be based on the County Drainage Manual. Stormwater ponds shall be modeled using no fewer than 4 model cells unless the pond is smaller than 400 square feet, in which case a single model cell may be used.

The distribution of impervious surfaces does not have to be explicitly simulated by arranging the model cells. However, the modeler must attempt to replicate the distribution of recharge given normal grid-design constraints. Also, the site-wide water balance must be maintained by any averaging process used to define recharge in cells with mixed land-surface coverage.

Given the small model cells required for stormwater-pond simulation, the number of cells used to simulate the project site (parcels) will likely be high and dictated by the following standard limitation on cell-size rates-of-change: *the length of adjacent cells shall not differ by more than a factor of 1.5.* The project area should be closely approximated by cell boundaries.

Standard Boundary Conditions

The simplified model shall consist of a uniform gradient equal to the average gradient as indicated by mapping the synoptic water-level data collected by Thurston County on March 20, 2000 (Groundwater-Basin Boundary and Synoptic Water-Level Survey for Salmon Creek Area, Pacific Groundwater Group, 2000). Model boundaries shall consist of a constant-head boundary up-gradient, either a constant-head or general-head downgradient, and no-flow boundaries on the sides of the model to create the uniform flow field. The superposition of areal recharge on the uniform flow field will alter the uniform flow field, and the modeler may need to adjust the heads at constant head or general-head boundaries in order to maintain reasonable saturated thicknesses and gradients in the project vicinity.

Pre-Calibration Aquifer Properties

The single layer shall be modeled as an unconfined aquifer (transmissivity shall be sensitive to head). Recommended pre-calibration aquifer properties are: hydraulic conductivity of 150 ft/d, based on Drost and others (1999), and a specific yield (S_y) of 0.25, based on mean values for fine to medium sand (Johnson, 1967). The layer thickness shall be site-specific, if known; otherwise the values from Drost and others (1999) may be substituted. Drost and others indicate that upper aquifer (Qvr) thickness is between 25 and 50 feet over most of the basin.

Current-Condition and Built-Condition Models

Current and built-condition models shall differ only in recharge quantity and distribution. The differences in recharge quantity shall be calculated by HSPF modeling using standard parameter and precipitation data provided by the County plus calculated discharges from septic drainfields. Septic drainfield discharges shall be based on existing Thurston County guidelines. Differences in recharge distribution shall be dependent on the development proposal and must consider locations of stormwater infiltration and the area, and approximate distribution, of impervious surfaces.

Standard Time Descretization

Both the current-condition and built-condition models shall have stress periods of one month and time steps established using the default (Modflow or PLASM) method. Both the current-condition and built-condition models must simulate transient conditions in order to estimate average head for each month. However, because the modeling goal is to simulate long-term changes in head, a cyclic, quasi-steady-state condition shall be achieved by simulating twelve one-month stress periods in a repetitive fashion for as many years (cycles) as necessary to reach approximate steady-state. Cyclic steady-state conditions shall be assumed when the head in all cells change by less than 0.05-feet from one year to the next for each monthly simulation period.

Standard Monthly Recharge

Input to the current-condition groundwater model shall consist of the average recharge rate for each month (12 values) as calculated by a site-specific, current-condition HSPF continuous-simulation model considering water years 1997, 1998, and 1999. The HSPF model must be prepared using the parameter values and precipitation data provided by the County. Attachment A to this memorandum contains more detailed guidance on generating recharge from the HSPF model.

The built-condition model must be exactly the same as the current-condition model except that recharge quantity and distribution shall be based on site-development plans (including septic discharge) and the output from a site-specific, built-condition HSPF continuous-simulation model. Average recharge shall be calculated for each month (12 values) considering HSPF modeling results for water years 1997, 1998, and 1999. Assumed septic discharge quantity shall be based on existing Thurston County guidelines.

Standard Convergence Criterion

The volumetric water budget for both models must balance to less than 1% in order to demonstrate convergence of the mathematical processing.

Current-Condition Model Calibration

A truly calibrated model is not required or appropriate given the simplified approach. However, since seasonal water-level fluctuations are the focal point of the analysis, some calibration to seasonal water-level fluctuation is required. Typical inter-season head changes were 7 to 12 feet at three in-basin wells, as summarized in the *Salmon Creek Drainage Basin Preliminary Conceptual Hydrologic Model and Data Collection Plan* (Figures 10, 11, and 13; Pacific Groundwater Group, 2000).

The proponent shall use measurements from on-site piezometers or representative off-site data to calibrate the current-condition model to seasonal water-level fluctuation. If less than one-year of on-site data are available, the proponent shall predict seasonal water level fluctuations by correlating on-site data to County reference well data (see "*Use of On-Site wells and Reference Wells to Estimate Winter 1999 Groundwater Levels in the Salmon Creek Basin*", Pacific Groundwater Group, October 2000). The aquifer's hydraulic conductivity, thickness, and specific yield may be modified within generally accepted ranges for on-site material types to achieve calibration. Recharge shall not be altered. Exact replication of measured water levels from specific years should not be expected (and is not required) unless HSPF recharge data from those specific years is used in calibration (not the time-averaged HSPF data specified as the standard approach).

Standard Data Reduction and Presentation

Models shall be documented completely in a report to the County, using standard model-reporting practices. The documentation shall include maps and tables defining:

- grid design superimposed on site-development plans and regional features
- aquifer hydraulic properties
- boundary definitions

- recharge quantities
- head output
- other model features, if implemented
- documentation of cyclic steady-state, model convergence, and calibration

In addition, specific output shall be generated to allow efficient evaluation of the County criteria. This output shall consist of hydrographs (head versus time) of the cyclic steady-state heads generated by the current- and built-condition models (two lines on one graph). The heads shall be from the last time step of each stress period. A third plot of the difference between the current- and built-condition heads over time shall also be provided, along with tabular data for each plot shall. These hydrographs shall be provided for the following key model cells:

- the cell with the highest head below each stormwater infiltration pond
- the cell just outside the property boundary downgradient of each stormwater pond
- the cell just outside the property boundary closest to each stormwater pond
- one cell just outside the property boundary along each segment of the property boundary (in other words - cells to represent typical conditions along each segment of the property line)

References

Drost and others, 1998, *Hydrology and quality of groundwater in northern Thurston County, Washington.* U. S. Geological Survey, Water-Resources Investigation Report 92-4109 (revised), Tacoma, WA.

Drost and others, 1999, *Conceptual model and numerical simulation of the ground-water-flow system in the unconsolidated sediments of Thurston County, Washington.* U. S. Geological Survey, Water-Resources
Investigation Report 99-4165, Tacoma, WA.

Johnson, A. I., 1967, *Specific yield – compilation of specific yields for various materials.* U. S. Geological Survey, Water-Supply Paper 1662-D, 74 p.

Pacific Groundwater Group, 2000, *Salmon Creek drainage basin, preliminary conceptual hydrologic model and data collection plan.* prepared for Thurston County Water and Waste Management.

Prickett, T. A. and Lonnquist, C. G., 1971, *Selected digital computer techniques for groundwater resource evaluation.* Illinois State Water Survey Bulletin No. 55, Champaign, IL, 62 p. (later nicknamed PLASM for Prickett-Lonnquist Aquifer Simulation Model).

ATTACHMENT A
TO
GROUNDWATER MOUNDING ANALYSIS GUIDELINES

Precipitation recharge shall be calculated for each groundwater model cell using HSPF. An additional component will be included to represent discharge of septic effluent. The following steps will be involved:

Outside the proposed developed boundary:

Since there are no changes proposed for this area, recharge will be the same between existing and built conditions.

1. Simulate historical precipitation records with long-term PET data between 1955/1/1 and 1999/12/30 for the combined total area outside the proposed developed boundary. Simulating storm events prior to water year 1997 is required to establish the correct initial soil condition prior to 1997.
2. Recharge shall be composed of three components in HSPF: Surface outflow (SURO), interflow outflow (IFWO) and groundwater outflow (AGWO). The monthly sum of these three components between October 1, 1996 and September 30, 1999 (water years 1997, 1998, and 1999) shall be output.
3. Calculate the recharge rate (length per time) for each off-site model cell using the HSPF recharge totals and HSPF areas.

Within the proposed developed parcels:

A detailed model is necessary to evaluate the impact to groundwater due to the development. For existing conditions, the procedure is same as the one described for the area outside the proposed developed boundary. The following steps summarize procedures for the built condition:

1. The surface outflow (SURO) from the proposed developed parcels will be assigned to recharge in the cells associated with the storm water infiltration facility, assuming all the storm water runoff will be carried to the facility by a conveyance system. If more than one infiltration facility is proposed, land area attributable to each facility should be delineated and separate calculations for each facility should be made.
2. In addition to the above, interflow (IFWO) and groundwater outflow (AGWO) should be calculated for the total developed site and be distributed as recharge throughout the groundwater model cells within the proposed developed parcels.
3. Recharge resulting from discharge of septic effluent shall also be distributed to groundwater model cells. A uniform distribution across the developed area is an acceptable approximation of actual septic discharge unless a community drainfield is proposed, in which case the actual location of the drainfield shall be simulated.

The table below summarizes the way the different recharge terms shall be distributed in the groundwater model:

	surface runoff	interflow	groundwater	septic
Existing Condition	distribute	distribute	distribute	NA
Built Condition	to stormwater pond	distribute	distribute	distribute unless a community drainfield is proposed

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DEPARTMENT OF WATER AND WASTE MANAGEMENT

Richard D. Blinn, P.E.
Director

NOTICE OF ADOPTION MEMORANDUM

FROM Richard D. Blinn, P.E.
Thurston County Drainage Manual Administrator

TO Interested Parties

DATE March 22, 2000

SUBJECT Interim Stormwater Design Standards for New Development in Green Cove Creek Basin

Section 1 SUMMARY

Effective immediately, interim stormwater standards for new development are imposed for the Green Cove Creek Basin (the Basin). These interim standards will remain in effect until further notice pending conclusion of the City of Olympia's (the City) current consultant work within the Basin. This current work updates the County's comprehensive hydrologic model developed for the Green Cove Creek Comprehensive Drainage Basin Plan, (the Plan) December 1998. Additionally, the City's work will define appropriate stormwater discharges for new development within the Basin consistent with the recommendations of the Plan. The completion date for this work is expected sometime during the late fall of 2000. Interim stormwater design standards for new development in the Basin are presented below under Section 3.

Section 2. BACKGROUND

In December 1998, the Thurston County Board of County Commissioners adopted the Plan. One of the key recommendations of the Plan was to halve current release rates from stormwater detention facilities and double the current runoff storage requirement (Recommendation 8.5). The Thurston County Storm and Surface Water Program (the County) was unable to complete the specific modeling analysis necessary to provide design guidance for new development in the basin implementing Recommendation 8.5. Rather than placing the burden on new development to generate these design tools, the County and the City propose updating the County's hydrologic model and developing the design guidance for new development to meet the requirements of Recommendation 8.5. The City has hired the County's previous engineering consultant to update basin land use coverages and develop sizing guidance for new development in the Basin.

This work will also assist development and jurisdictions better understand the impact to land segments likely to result from implementing Recommendation 8.5.

Section 3. INTERIM DEVELOPMENT STANDARDS

Purpose: The County seeks to limit the potential adverse impact from new development within the Basin. These impacts include increased peak flow and other flow conditions that adversly impact the Creek's sensitive biologic system.. To this end, the County is providing interim stormwater design standards for new development within the Basin. These standards will remain in place until such time that the City's consultant completes the modeling and analysis necessary to provide stormwater facility size guidance for new development within the Basin. Upon review of the consultant's final modeling report and recommendations, the interim standards will be reconsidered to ensure consistency with the Plan.

A. **Interim Standards:** These interim standards are contained within "Interim Stormwater Design Standards for New Development in Green Cove Creek Basin, March 21, 2000," Thurston County Storm and Surface Water Program. These standards establish new site development modeling criteria. This additional guidance does not guarantee that new development can successfully complete the review process prior to the City completing the consultant modeling work. These interim standards are available upon request. Interested parties should contact Mark R. Cook, P.E., Storm and Surface Water Program Manager, at 360-754-4681 or visit 921 Lakeridge Drive SW, Building 4, Room 100, Olympia, WA 98502.

B. **Authority:** In taking this action, the Thurston County Drainage Manual Administrator is exercising the Administrative Authority of Section 1.2 of the *Drainage Design and Erosion Control Manual for Thurston County Washington*, 1994 (the Manual). Development proponents are encouraged to review "Interim Site Development Guidelines for New Development in Green Cove Creek Basin" prior to submitting any drainage plan for review. The following list is not intended to be all-inclusive but does provide some direction on key chapters and sections of the Manual affected by the interim guidelines.

C. **Relationship to Manual Standards:**

Section 3.1.1, Section 9 is amended to include input and output files from continuous simulation modeling.

Maximum release rates are amended to reflect the pre-developed runoff hydrograph as described by the continuous simulation model.

Section 4.1.2 is amended such that sizing is based on the results of the amended modeling requirements.

Section 4.2 is amended to reflect the sizing as defined by the amended modeling requirements.

Section 4.3 is amended to reflect the sizing as defined by the amended modeling requirements.

Section 4.5 is amended to reflect the sizing as defined by the amended modeling requirements.

- Section 5.1 is amended to utilize continuous simulation-modeling and the presumed existing condition is forested.

- Section 5.2 is amended to reflect regional parameters and the period of record for use in continuous simulation modeling provided by the County.

  Section 5.3 is amended to reflect regional parameters and the period of record for use in continuous simulation modeling provided by the County.

- Section 5.4 is amended to reflect regional parameters and the period of record for use in continuous simulation modeling provided by the County.

- Section 5.5 is amended to reflect regional parameters and the period of record for use in continuous simulation modeling provided by the County.

- Section 5.6 is amended to require that the design engineer specifically calculate the total impervious area for each individual development proposal and that this area be used as input to the continuous simulation model.

  Section 8.5.13 is amended to reflect the sizing as defined by the amended modeling requirements.

Unless otherwise amended by "Interim Stormwater Design Standards for New Development in Green Cove Creek Basin, March 22, 2000," Thurston County Storm and Surface Water Program, all other Manual provisions apply. If you have any questions regarding this administrative action, please contact Mark R. Cook, P.E., Storm and Surface Water Program Manager, at 360-754-4681.

cc: Board of County Commissioners
Linda Hoffman
URS Greiner Woodward Clyde
Mark R. Cook
DPA Mark Calkins
Fred Knotsman
Gary Cooper
Brent Payton

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DEPARTMENT OF WATER AND WASTE MANAGEMENT

Richard D. Blinn, P.E.
Director

TECHNICAL MEMORANDUM

FROM: Mark Cook, P.E.

TO: Richard Blinn, Director

DATE: March 22, 2000

SUBJECT: Interim Stormwater Design Standards for New Development in Green Cove Creek Basin

1 Background

In December 1998, the Thurston County Board of County Commissioners adopted the Green Cove Creek Comprehensive Drainage Basin Plan (the Plan). During the five years of basin planning, several key issues were identified as necessary to limit increasing future peak flows to Green Cove Creek (the Creek). Of most significance, is Recommendation 8.5 that seeks to maintain or re-establish a minimum of 60% undisturbed forest canopy for the Basin and increasing current drainage manual standards for release rates and storage.

At the conclusion of the planning process, staff acknowledged that additional modeling analysis is required to provide development with specific guidance to meet the increased drainage manual requirements of Recommendation 8.5. In a complimentary effort, the City of Olympia (the City) recently completed the "City Streams and Wetlands Study." This study validates the environmental value of the Creek's eco-system and provides the focus of the City's desire to provide increased protection to the Creek. In a unanimous action taken February 8, 2000, the City Council:

- Imposed interim R4 zoning for Basin properties located within City limits.
- Increased stormwater requirements.
- Imposed seasonal clearing and grading restrictions.
- Imposed increased tree retention requirements.

Solid Waste Management, Storm & Surface Water Management, Water & Sewer Utilities Operations, Utility Development & Special Services
Building No. 4, Room 100, 921 Lakeridge Drive SW, Olympia, WA 98502
(360) 357-2491 FAX (360) 754-4682 TDD (360) 754-2933

As the basis for this action, the City is in the process of conducting additional modeling analysis of the Creek. The additional work is expected to take up to one year to complete. The analysis is expected to provide development proponents with specific tools necessary to meet the increased stormwater standards as recommended in the Plan. In recognition of the City's on-going work program, the County is imposing interim stormwater standards for the Basin. This action is being taken to ensure consistency for new development in the Basin and to minimize potential adverse impacts to the Creek while the City conducts additional modeling analysis for the Creek.

2. Interim Standards

The interim standards outlined below are intended to guide new development in the Basin until the City completes additional modeling analysis. The interim standards have one significant component; revised stormwater modeling criteria for new development. This revision alters the manner whereby runoff is predicted, allowable site discharge and associated onsite storage.

A Effective immediately, modeling standards for new development within the Basin will change from a single event to a continuous modeling methodology. The approved model for use is the Environmental Protection Agency (EPA) Hydrological Simulation Program FORTRAN (HSPF). Any and all other substitute models must be approved by the County prior to use.

B. New development within the Basin will assume a forest condition as being the pre-developed condition.

C. Post development runoff shall match pre-development runoff flow duration and peak for the 1.05 year event to the 10-year event as defined by Thurston County Storm and Surface Water Program, Drainage Design and Erosion Control Manual for Thurston County, 1994 edition.

D A deviation from matching the pre-developed runoff flow duration and peak of ten percent (+/-) is allowed from the 10-year event to the 50-year event as defined by Thurston County Storm and Surface Water Program, Drainage Design and Erosion Control Manual for Thurston County, 1994 edition.

3. Target Dates

To assist new development in meeting these interim standards, the following products will be provided on the associated time frame:

A Continuous period of record: April 21, 2000.

B. Regionalized parameters for Hydrological Simulation Program FORTRAN (HSPF): April 28, 2000.

C. Final stormwater design guidance for new development within the Basin: February 2001.

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DEPARTMENT OF WATER AND WASTE MANAGEMENT

Richard D. Blinn, P.E.
Director

MEMORANDUM

TO: Brent Payton
Development Review

FROM: Richard D. Blinn, P.E.
Manual Administrator

DATE: June 20, 1996

SUBJECT: Variance Requests for Short Subdivisions

Variances are routinely requested and granted for short subdivisions meeting certain conditions. To expedite and simplify County review and processing of short subdivisions, the following change will be effective this date:

The Drainage Design and Erosion Control Manual Administrator hereby grants variance authority to the Development Review Engineer for all short subdivisions meeting certain conditions. These conditions include

1. A Soils Professional or designee shall perform infiltration tests on site. Testing may be waived by the Development Review Engineer per section 4.4.2 if infiltration testing would not significantly improve the estimate. (This may be applicable in the Grand Mound - Rochester area, where there has been a great deal of soils work in nearby locations which may adequately characterize soils on site.) If testing is waived, the Soils Professional is still required to submit substantiating soils work and infiltration rate determination.

2. Sites with infiltration rates exceeding 6 inches per hour are granted variances, subject to meeting single-family requirements outlined in Section 8.5.13 of the Manual.

Sites with:

- infiltration rates less than 6 inches per hour,
- in areas of seasonal high water tables,
- near to surface waters such as streams, wetlands or lakes,
- indications of potential drainage concerns, or
- a designed roadway section

will not be granted variances.

Please contact Loretta Swanson at ext. 7343 if you have questions regarding this new process. Loretta will continue to provide variance request support, should you have questions on specific applications.

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DEPARTMENT OF WATER AND WASTE MANAGEMENT

Richard D. Blinn, P.E.
Director

MEMORANDUM

TO: Thurston County Drainage Manual Users

FROM: Mr. Richard Blinn, P.E.
Thurston County Drainage Manual Administrator
Mark R. Cook, P.E.
Interim Program Manager/Design Engineer

DATE: May 16, 1997

SUBJECT: Technical Memorandum
48 hour Drawdown Criteria

Effective immediately, all drainage proposals within Thurston County that fail to meet the required 48 hour drawdown criteria shall be designed as follows:

1. **The 7 day/100 year storm hyetograph will be used to size the required detention, retention or combination facility that does not drain within 48 hours from the end of the 100 year/24 hour design event. This design approach will eliminate the need to achieve drawdown within 48 hours.**

EXECUTIVE SUMMARY:

Recent rainfall events in 1995/96 and again in 1996/97 indicate that facilities which do not meet a 48 hour drawdown are susceptible to flow duration failure. Activation of emergency or overflow spillways has resulted in increased erosion to downstream properties and receiving waters. In an attempt to mitigate the detrimental impacts from flow duration, overflow spillway activation, the Storm and Surface Water Program examined hourly NOAA (National Oceanic and Atmospheric Administration) rainfall data from 1952 to the present. Several flow duration events were used to create specific hyetographs for each flow duration event. Some existing single event hydrologic models appear unable to handle the created hyetographs, owing to limitations within their source code. A maximum flow duration period of 30 days appears to work with the various single event models available to local consultants. The selected 30 day flow duration event does not appear to predict the required storage resulting from the existing

Thurston County 7 day/100 year hyetograph, used to design discharges to potholes. Staff has found that by increasing the volume of the 30 day hyetograph by 10%, predicted volumes exceed those of the 7 day/100 year hyetograph. Since the fact that the 30 day hyetograph only represents 52 years of record, the statistical extrapolation to a 100 year recurrence level is likely to result in volumes in excess of the 10% used as a gauge in hyetograph performance. To meet a commitment to the development community in a timely manner, the Storm and Surface Water Program is electing to use the existing 7 day/100 year hyetograph as the flow duration event at this time. The program will continue to pursue the statistical extrapolation of the 30 day hyetograph for possible use in future drainage manual editions.

BACKGROUND:

Recent storm events of 1995/96 and 1996/97 caused some area detention and retention facilities to discharge via overflow spillways. These discharges resulted from sustained flow duration storm events, saturated groundwater conditions and various site specific parameters. Current County design standards require minimum sizing criteria that relates to single event, 24 hour duration storms. Storm hyetographs are provided by the County for consultant use. Flow duration analysis is currently required for discharge to potholes, but not for typical discharge, retention or combination facilities. All facilities designed within the County are currently designed to drawdown (drain) within 48 hours. The 48 hour drawdown requirement is in place to account for flow duration rainfall storms and to ensure that adequate facility volume remains within 72 hours after the start of any rainfall event.

In 1994, the current maximum discharge rates were implemented for discharge facility design (maximum 2 year release rate = 0.04 cfs/disturbed acre and 0.35 cfs/disturbed acre for the maximum 100 year release rate). For certain land segments with certain levels of disturbed area, it is not possible to meet the 48 drawdown requirement. The question becomes one of what is a reasonable drawdown period to survive a flow duration rainfall event.

The Storm and Surface Water Program, acting on the information stated above, chose to examine flow duration events of record for Thurston County. The program has hourly precipitation data from NOAA (National Oceanic and Atmospheric Administration) from 1954 and various data increments from the U.S. Weather Service, as far back as 1897. Given that there was not an identified need for flow duration analysis prior to the original County drainage manual in 1991, and only identified for pothole analysis in the 1994 edition, the program has previously not created a flow duration hyetograph beyond a seven day period that could be used for facility design.

The County has made attempts in the past to limit peak discharges to receiving waters (McAllister/Eaton Creek Comprehensive Drainage Basin Plan, 1994) by imposing reduced maximum release rates beyond those in the current edition of the drainage manual. Preliminary analysis of another drainage basin, the Green Cove Creek basin, indicates that the creek will not be able to handle increasing peak flows. Though it is not identified at this time, current release rates may not fully protect Green Cove Creek. What is known, however, is that facilities that activate their overflow spillway during flow duration events are likely to send peak flows to Green Cove and other county creeks, that will increase stream bank erosion.

METHODOLOGY:

For the purpose of this analysis, four design storms were used to compare their impacts on required storage volumes over four separate urban land models. The modeled areas ranged in size from approximately 10 acres to over 100 acres.

Design Storms: Four design storm were chosen for this analysis. Two storms were the current 24hr/100 year and the 7 day/100 year design storms. In addition, two historic storm events were compared for their overall effect on required storage volumes. These storms were derived from historic precipitation data from NOAA. Thurston County historic storm #1 is the storm event of December 1996 to January 1997. This storm event was taken from data collected by the Thurston County Storm and Surface Water Program. Historic storm #2 is the worst continuous 30 day block recorded at NOAA's Olympia airport facility since hourly precipitation data was produced (1954). This 30 day block occurred during the winter of 1971/72. This storm was identified by plotting a graph of 30-day cumulative rainfall for the entire period of record and noting the various peaks of this graph.

Design Impact Analysis: This analysis used the 24hr/100 year design storm as a basis of comparison for the other storm events. For each of our modeled areas, all four test storms were run and the required storage volume for historic storm #1, historic storm #2, and the 7 day/100 year storm was compared to that obtained from the run of the 24hr/100 year design storm.

Modeled Areas: Three areas were modeled in this analysis. The Storm and Surface Water Program recently completed a dense urban model of the New Castle Division #1 for use in one of its capital design projects (Boulevard Road), hence it was selected for use. New Castle Division #1 was modeled with two separate pond configurations. First as a detention facility designed to 1994 standards, then as a retention facility with an effective vertical infiltration rate of one half inch per hour. The complete model for the Boulevard Road Facility, including the New Castle, Wilderness, and Sweet Briar subdivisions was also used to evaluate the various impacts resulting from the storms referenced above. A consultant model for the Hidden Ridge Division 1 subdivision was used to complete the three model areas evaluated during this effort.

DETENTION/RETENTION IMPACTS:

Impacts of the various test storms on the three model areas evaluated varied with the type of facility with one exception, that is: for all facility types, the 7 day/100 year event was the most challenging storm on storage requirements. In all cases, this storm had a significant impact on the required storage volume. Retention facilities showed 2 to 3 times the required storage volume for the 7 day/100 year event as compared to the 24hr/100 year event. Detention facilities showed significantly lower impact, however, required storage volumes were 15% to 35% greater for the 7 day/100 year event as compared to the 24hr/100 year event.

CONCLUSIONS:
Flow duration rainfall events in 1995/96 and again in 1996/97 have caused area facilities to activate overflow spillways. It appears as though the current design event, the 24 hr/100 year storm can lead to overflow spillway activation during flow duration storms. Several factors appear to be required for overflow spillway activation during flow duration, the single critical element being a failure of design facilities to completely drain within 72 hours from the onset of any storm. It appears as though historic rainfall in the County indicates a flow duration event of 30 days will, in the final analysis, be worth evaluating for future flow duration hyetograph use in designing stormwater facilities. Additional work needs to be done to account for the lack of a complete 100 year record for hourly rainfall data within Thurston County. This additional work is expected to take some time to complete and possibly would not be ready for consultant use until late summer of 1997. For three reasons, the Storm and Surface Water Program is choosing not to delay development proposals any longer at this time, providing that facilities that do not meet the required 48 hour drawdown are designed for volume and performance using the existing 7 day/100 year hyetograph. The three reasons are:

1. The Storm and Surface Water Program is unable to produce the statistical 30 day flow duration hyetograph prior to September 1, 1997.

2. Thurston County and the cities of Lacey, Olympia, and Tumwater expect to revise the drainage manual within the next several months. This time will allow the program to further evaluate the effects of a 30 day flow duration hyetogragh on minimum storage for proposed drainage facilities.

3. The Storm and Surface Water Program believes that using the existing 7 day/100 year hyetograph to design required storage volume for facilities that fail to drawdown in 48 hours is appropriate mitigation, to limit adverse environmental impact, at this time. The existing 7 day/100 year hyetograph is the current design standard for pothole analysis in Thurston County.

The Storm and Surface Water Program welcomes comments from drainage manual users. If manual users prefer alternate design approaches to mitigate flow duration failures, please contact Mark R. Cook, P.E. at (360) 754-4681, so that alternatives can be evaluated by the program.

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ATTENTION: NOTICE OF HIGHER STANDARDS FOR MCALLISTER/EATON CREEK BASIN

The McAllister/Eaton Creek Comprehensive Drainage Basin Plan, approved by resolution of the Board of County Commissioners, Thurston County, Washington (Resolution No. 10582, March 21, 1994) identifies specific stormwater requirements. By the authority of section 1.3 of the Drainage Design and Erosion Control Manual for Thurston County and the cities of Lacey, Olympia and Tumwater, 1991, as amended (Basin Plan Supersedes MANUAL), the following design standards apply to projects located in the McAllister/Eaton Creek basin.

Refer to the following map to determine if a proposed project is located in the McAllister/Eaton Creek basin. The Manual Administrator or a designee will make the final determination on location, for projects located on or near the basin boundary. For projects located in the basin, substitute the following pages for section 4.1.1 and Table 4.1 of the Manual.

ESTIMATING MAXIMUM RELEASE RATES TO SURFACE WATER IN THE MCALLISTER/EATON CREEK BASIN

This section replaces Section 4.1.1 of the Drainage Design and Erosion Control Manual for Thurston County and the cities of Lacey, Olympia and Tumwater, Washington, 1991, as amended, for projects within the McAllister/Eaton Creek Basin:

The Project Engineer shall estimate maximum allowable release rates by the following method:

1. Maximum standard unit release rates before adjustment for site specific soils are:

   Maximum Release, Two-year event = 0.026 cfs/disturbed acre

   Maximum Release, 100-year event = 0.23 cfs/disturbed acre

2. To estimate the unit release rate for a specific project, multiply the maximum standard unit release rates by the reduction factor from Figure 4.1. (Enter Figure 4.1 with the estimated project site infiltration rate; see Section 4.4.3.) It is anticipated that there will be slight errors in reading charts. The Administrator or designee will accept values two or three percent different from his/her estimate.

3. Example: if estimated project site infiltration rate is one-inch per hour, then, from Figure 4.1, the reduction factor is 0.43. Thus, project specific maximum release rates are:

   Q_2 = 0.026 * 0.43 = 0.0118 cfs/disturbed acre

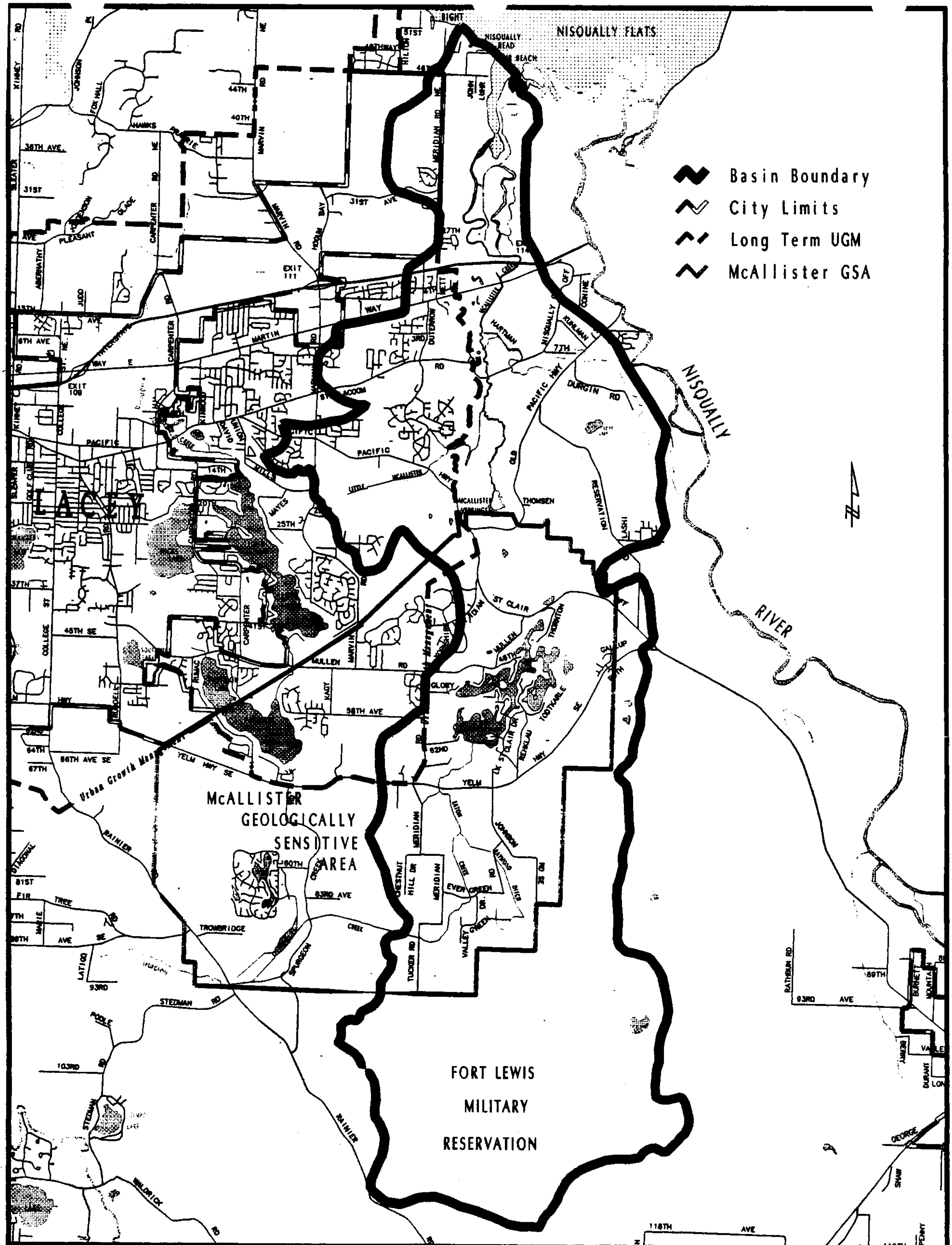
   Q_{100} = 0.23 * 0.43 = 0.099 cfs/disturbed acre

These calculations will yield the maximum release rate for the developing site. However, as the intent of this MANUAL includes maximizing infiltration, minimizing runoff, recharging groundwater, and maintaining stream baseflows in the summer, the Administrator or designee may direct the Project Engineer to route stormwater to project site soils with infiltration rates better than the project site average where the routing is facilitated by gravity flow. This routing results in a reduction in the maximum release rate for the project site. If the Project Engineer chooses not to route stormwater to the better soils, the stormwater facility may be located elsewhere, provided that it is upsized to allow for the recalculated (reduced) release rate.

MCALLISTER/EATON CREEK BASIN MINIMUM STORAGE VOLUMES AS A FUNCTION OF PROJECT SITE INFILTRATION RATE

This table replaces Table 4.1 in the Drainage Design and Erosion Control Manual for Thurston County and the cities of Lacey, Olympia and Tumwater, Washington, 1991, as amended, for projects within the McAllister/Eaton Creek Basin:

Project Site Infiltration Rate (inches per hour)	Minimum Storage Volume Required (cubic feet per acre of disturbed pervious)	Minimum Storage Volume Required (cubic feet per acre of impervious)
0.0	6000	18000
0.5	6000	18000
1.0	5640	16920
1.5	5276	15828
2.0	4912	14736
2.5	4548	13644
3.0	4184	12552
3.5	3820	11460
4.0	3456	10368
4.5	3092	9276
5.0	2728	8184
5.5	2364	7092
6.0	2000	6000
7.0	1929	5786
8.0	1857	5571
9.0	1786	5357
10.0	1714	5143
11.0	1643	4929
12.0	1571	4714
13.0	1500	4500
14.0	1429	4286
15.0	1357	4071
16.0	1286	3857
17.0	1214	3643
18.0	1143	3429
19.0	1071	3214
20.0	1000	3000



McALLISTER BASIN

MAP 2: Basin Boundaries

October 1993

GeoData Center

Scale: 1 in. • 1 mile