City of Bainbridge Island
Surface Water Management Plan

An Element of the Water Resources Study

Prepared by

Kato & Warren, Inc.

Final December 2001

City of Bainbridge Island
Surface Water Management Plan

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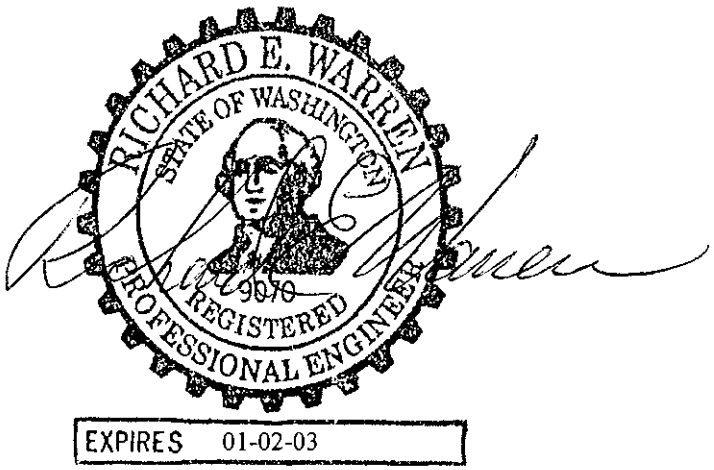
Certificate of Engineer

The engineering material and data contained in this study was prepared under the supervision and direction of the undersigned, whose seal as Registered Professional Engineer is affixed below.



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APPENDIX A
SURFACE WATER MANAGEMENT PLAN DEFINITIONS

DEFINITIONS

APWA	American Public Works Association
AWWA	American Waterworks Association
Acre-feet	A unit of measuring the volume of water, equal to the quantity of water required to cover 1 acre to a depth of 1 foot and equal to 43,560 cubic feet or 325, 851 gallons.
Basic Stormwater Program	Required in the Puget Sound Water Quality Management Plan for all cities and counties.
Basin Plan	A plan and all implementing regulations and procedures including, but not limited to, land use management adopted by ordinance for managing surface and storm water quality and quantity facilities, and features within individual subbasins.
Biofiltration	The process of reducing pollutant concentrations in water by filtering the polluted water through biological materials.
BMP	Best Management Practice. Physical, structural, and/or managerial practices that, when used singly or in combination, prevent or reduce pollution of water.
Catch Basin	A basin combined with a storm-drain inlet to trap solids.
CCC	Cross-Connection Control
CCWF	Centennial Clean Water Fund
cfs	Cubic feet per second
Channel	(1) A natural or artificial watercourse of perceptible extent which periodically or continuously contains moving water or which forms a connecting link between two bodies of water. It has a definite bed and banks which were to confine the water. (2) The deep portion of a river or waterway which is used by watercraft.
CIP	Capital Improvement Plan

Class AA	A general water use and criteria class specified in WAC 173 201A-030.
Clean Water Act	Federal legislation with the objective of restoring and maintaining the chemical, physical, and biological integrity of the Nation's Waters.
CMP	Corrugated Metal Pipe
Comprehensive Plan	Comprehensive Land Use, Growth, and Capital Facility Plan developed in response to the Growth Management Act.
Comprehensive Monitoring Plan	A schedule that describes both the frequency and appropriate locations for sampling of drinking water contaminants as required by state and federal rules.
Comprehensive Stormwater Program	Required in the Puget Sound Water Quality Management Plan for all large urban areas.
Computer Modeling	The use of a computer to determine the effect of a particular rainfall storm on a particular drainage system.
Constructed Wetlands	Those wetlands intentionally created on sites that are not wetlands, for the primary purpose of wastewater or stormwater treatment, and managed as such. Constructed wetlands are normally considered as part of the stormwater collection and treatment system.
Conveyance System	A system of drainage elements, ditches, gutters, pipes, culverts, drains, channels and lakes which, in combination, carry water from headwater to receiving waters.
Culverts	A man-made system that allows water to go under a road or landfill.
CWSP	Coordinated Water System Plan
CWSSA	Critical Water Supply Service Area
Delta	Sediments deposited at the mouth of a stream or drainage system when the flow velocity is checked by a larger river, lake or ocean.

Design Storm	A prescribed hyetograph and total precipitation amount (for a specific duration recurrence frequency) used to estimate runoff for a hypothetical storm of interest or concern for the purpose of analyzing existing drainage, designing new drainage facilities or assessing other impacts of a proposed project on the flow of surface water.
Detention	The release of stormwater runoff from a site at a slower rate than it is collected by the stormwater facility system, the difference being held in temporary storage.
Direct Runoff	Surface runoff and a substantial portion of interflow entering the storm drainage system during and/or immediately after a rainfall
Discharge	Outflow; the flow off stream, canal, pipeline, culvert or aquifer. Also the discharge of a canal or stream into a lake, river, or ocean. (Hydraulics) Rate of flow, specifically fluid flow; a volume of fluid passing a point per nit of time, commonly expressed a cubic foot per second, cubic meters per second, gallons per minute, gallons per day, or millions of gallons per day.
DOE	Department of Ecology
DOH	Department of Health
DOT	Department of Transportation
Drainage	Refers to the collection, conveyance, containment, and/or discharge of surface and storm water runoff.
Drainage Area	(1) The contributing area of a single drainage basin, expressed in acres, square miles or other unit area, also called watershed or basin. (2) The area served by a drainage system receiving storm and surface water or by a watercourse.
DOE Guidance Manual	Stormwater Program Guidance Manual for the Puget Sound Basin Volumes I and 2, July 1992. (To be amended spring of 2000)
DOE Technical Manual	Stormwater Management Manual for the Puget Sound Basin (The Technical Manual), Volumes 1-4, July 1992.

DOE Manual	Ecology Technical Manual, complete title is: The 1992 Stormwater Management Manual for the Puget Sound.
Easement	The legal right to use a parcel of land for a particular purpose. It does not include fee ownership, but may restrict the owner's use of the land.
Ecology	Washington State Department of Ecology
Elicit Discharge	All non-stormwater discharges to stormwater drainage systems that cause or contribute to a violation of state water quality, sediment quality or groundwater quality standards, including but not limited to, sanitary sewer connections, industrial process water, interior flood drains, car washing, and graywater systems.
EPA	Environmental Protection Agency. A federal agency which administers many federal environmental laws. Region X, which includes Puget Sound, is headquartered in Seattle.
Erosion	The wearing away of the land surface by running water, wind, ice, or other geologic agents.
ERU	Equivalent Residential Unit
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
Fire Flow	The rate of water flow needed to fight fires under WAC 246-293-640 or adopted city, town, or county standards.
Flood	Water from a river, stream, watercourse, lake or other body of standing water that temporarily overflows or inundates adjacent lands and which may affect other lands and activities through stage elevation, backwater, and/or increased groundwater levels.
Flood Control	The elimination or reduction of flood losses by the construction of flood storage reservoirs, channel improvements, dikes and levees, bypass channels, or other engineering works.
Floodplain	The total area subject to inundation by the base flood including the flood fringe and the floodway.

Floodplain Regulations	A general term applied to the full range of codes, ordinances, and regulations relating to the use of land and construction as influenced by water. The term also encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment line status, open-area regulations, and other similar methods of control affecting the use and development of the area.
Frequency	The number of repetitions of a periodic process in a unit period of time.
Future Service Area	A specific area for which water service is planned by a public water system, as identified in a water system plan.
FTE	Full Time Employee
GMA	Growth Management Act
Groundwater	Water in the ground stored within a saturated zone.
Habitat	The specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all the basic requirements for life and should be free of harmful contaminants. Puget Sound habitats includes streams, lakes, beaches, marshes, shorelines, mudflats, the water itself, etc.
Heavy Metals	Metals of high specific gravity, present in municipal and industrial wastes that pose long-term environmental hazards. Such metals include cadmium, chromium, cobalt, copper, lead, mercury, nickel, and zinc.
Hydraulics	A branch of science that deals with practical applications of the mechanics of water movement.
Hydric	Soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor growth and regeneration of hydrophytic vegetation.
Hydrograph	A curve obtained by plotting discharge verses time that results from a particular rain storm.
Hydrophytes	Plants growing in water or on soil that is at least periodically deficient in oxygen as a result of excessive water content.

Hydrologic Cycle	The circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages or processes as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.
Hyetograph	A graph of percentages of total precipitation for a series of time steps representing the total time during which the precipitation occurs.
IOU	Investor Owned Utility
I/I	Inflow and Infiltration (Refers to extraneous water that enters a sewer system.)
Impervious Surfaces	Man-made or natural surface conditions that do not permit rain fall to soak into the ground.
In-Stream Storage	Storage ponds physically built in the channel area. This is in contrast to storage which is not physically in the main channel of a drainage system.
Infiltration	The entering of water through the interstices or pores of a soil or other porous medium.
Interflow	Water from precipitation that infiltrates the soil surface then moves laterally through the upper layers of soil above the water table until it reaches a stream channel or returns to the surface at some point downslope from its point of infiltration.
Invert	The bottom or lowest portion of the internal cross section of a conduit. Used particularly with reference to sewers and drains.
KCRTS	King County Runoff Time Series
LID	Local Improvement District
Metals	See Heavy Metals
MSL	Mean Sea Level
Non-Structural Control	Includes runoff control, land use measures, modifications and flood-plain zoning.

NPDES	National Pollutant Discharge Elimination System. Part of the Federal Clean Water Act, which requires point source discharges to obtain permits. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington State Department of Ecology.
Nutrients	Essential chemicals (e.g. nitrogen, phosphorous) needed by plants or animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and the growth of excessive numbers of algae. Some nutrients can be toxic at high concentrations.
O/M	Operations and Maintenance
Pervious Surfaces	Surface conditions that permit rainfall to soak into the ground.
Plat	A map or representation of a subdivision showing the division of a tract or parcel of land into lots, blocks, streets, or other divisions and dedications.
Potable	Water suitable for drinking by the public.
PSWQA	Puget Sound Water Quality Authority
PSWQMP	Puget Sound Water Quality Management Plan
Public Works	Department of Public Works
Puget Sound Water Quality Authority	Body created in 1985 by the Washington State Legislature to adopt and oversee implementation of a comprehensive strategy to protect Puget Sound.
Purveyor	An agency, municipal corporation, firm, company, mutual or cooperative association, partnership, or person or other entity owning or operating a public water system. Purveyor also means the authorized agents of such entities.
Rate of Runoff	Stormwater runoff volume and rate expressed in cubic feet per second, gallons per minute, etc.
RCP	Reinforced Concrete Pipe.
Receiving Water	Main body of water receiving flow from tributary creeks and streams.

Recurrence	To occur again after an interval.
Regional Detention Facility	A stormwater quantity control structure designed to correct existing excess surface water runoff problems of a basin or subbasin. The area downstream has been previously identified as having existing or predicted significant and regional flooding and/or erosion problems.
Release Rate	The computed peak rate of surface and stormwater runoff for a particular design storm event and drainage area conditions.
Riparian Corridor	A perennial or intermittent water body its lower banks and upper banks, and the vegetation that stabilized the slopes, protects the waterway from erosion and sedimentation, provides cover and shade, and maintains the fish and wildlife habitat.
Riprap	Armor-platting materials consisting of either rock or sand bags filled with sand and cement that are used to prevent erosion.
Runoff	That part of precipitation which reaches a stream, drain, sewer, etc. directly or indirectly.
Runoff Control	Physical devices which are used to limit runoff from an area.
Scour	Erosion of channel banks and bed due to excessive velocity of the flow of surface water and stormwater runoff.
Sediment	Fragmented material that originates from weathering and erosion of rocks or unconsolidated deposits and is transported by, suspended in, or deposited by water. Certain contaminants tend to collect on and adhere to sediment particles.
Sedimentation	The depositing or formation of sediment.
SEPA	State Environmental Policy Act. The Washington State law intended to minimize environmental impacts.
Source Control	Refers to control of runoff waters before they enter the public storm water conveyance system.

Source Control BMP	A BMP that is intended to prevent pollutants from entering stormwater. A few examples of source control BMPs are: erosion control practices, maintenance of stormwater facilities, constructing roofs over storage and working areas, and directing wash water and similar discharges to the sanitary sewer or a dead end sump.
Storage	Water artificially impounded in surface or underground reservoirs for future release.
Storm	A disturbance of the ordinary average conditions of the atmosphere, which may include any or all disturbances such as wind, rain, snow, hail, or thunder.
Storm Drain	A closed conduit for conducting stormwater that has been collected by inlets or collected by other means. The various parts of a drainage system are defined as follows: (1) Lateral (Collection Storm Drain) is a drain that has inlets connected to it but has no other storm drain connected. (2) Trunk (Main) Storm Drain is a drain which receives the discharge from several laterals and generally serves a relatively large area, and may or may not, have inlet connections. (3) Outfall Storm Drain. A drain which receives the runoff from a collecting system - such system being lateral or trunk storm drains, as are required - and carries such runoff to a point of final discharge.
Storm, 10-year	A rainfall storm that has a probability of occurrence on an average of once every 10 years.
Storm, 100-year	A rainfall storm that has a probability of occurrence on an average of once every 100 years.
Structural Control Measures	Includes placement of pipes, channel resizing, streambank protection and detention ponds to control runoff later.
Surface Runoff	That part of the runoff which travels over the soil surface to the nearest stream channel or conveyance system element.
Surface Water	Water on the surface of the earth.

Suspended Solids	Particles or organic and inorganic matter suspended in water. Toxicants may adhere to solid particles which can intensify chemical pollution problems.
SWMP	The City's Stormwater Management Plan
Topography	General term to include characteristics of the ground surface such as plains, hills, mountains, degree of relief, steepness of slopes, and other physical features.
Treatment	Chemical, biological, or mechanical procedures applied to an industrial or municipal discharge or to other sources of contamination to remove, reduce or neutralize contaminants.
Turbidity	Dispersion or scattering of light in a liquid, caused by suspended solids and other factors; commonly used as a measure of suspended solids in a liquid. High levels of turbidity overextended periods are harmful to aquatic life.
WMP	Winslow Master Plan
WSDOT or DOT	Washington State Department of Transportation
Water Quality	A term used to describe the chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water Quality Storm	6-month, 24-hour storm event
Watercourse	A channel in which a flow of water occurs wither continuously or intermittently, and if the latter, with some degree of regularity. such flow must be in a definite direction. Watercourses may be either natural or artificial, and the former may occur either on the surface or underground. (1) Artificial: A surface watercourse constructed or modified by human agencies, usually referred to as a channel or ditch. (2) Natural: A surface watercourse created by natural agencies and conditions.
Watershed	The geographic region in which all the surface water flows toward a particular river or other body of water.

Wellfield	A group of wells one purveyor owns or controls which: (1) Draw from the same aquifer or aquifers as determined by comparable inorganic chemical analysis; (2) Discharge water through a common pipe and the common pipe shall allow for collection of a single sample before the first distribution system connection.
Wellhead Protection Area	The surface or subsurface surrounding a water well or wellfield supplying a public water system through which contaminants would be likely to move toward the well or wellfield.
Wetlands	Those sensitive areas transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered with water. A wetland must have one or more of the following attributes: (1) At least periodically, the land supports predominantly hydrophytes. (2) The substrate is predominantly undrained hydric soil. (3) The substrate is non-soil and is saturated by water or covered shallow water at some time during the growing season each year.
Wetponds	Drainage facilities for water quality treatment that contain permanent pools of water that are filled during the initial runoff from a storm event. They are designed to optimize water quality by providing retention time in order to settle out particles of fine sediment to which pollutants such as heavy metal absorb, and to allow biologic activity to occur that metabolizes nutrients and organic pollutants.

APPENDIX B
SURFACE WATER MANAGEMENT PLAN
REFERENCES

REFERENCES

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APPENDIX C
SURFACE WATER MANAGEMENT PLAN
HYDROLOGIC AND HYDRAULIC ANALYSIS

Culvert Replacement Rating and Ranking
City of Bainbridge Island
Surface Water Management Plan
Appendix C

CROSSING NUMBER (A)	ROAD	STREAM BASIN NAME (B)	Road Type (C) 25% (1-4)	Capacity (D) 30% (1-4)	Pipe Condition (E) 20% (1-4)	Fish Passage Barrier (F) 25% (1-4)	Total Score 100% (1-4)	Priority Ranking 1-85	PROBLEM NUMBER (G)
PP-PM-5	Hidden Cove Road	Coho Creek	3	4	3	3	3.3	1	PM-002
PP-MB-4A	Miller Road	Manzanita Creek	4	2	3	4	3.2	2	MB-007
PP-MB-4	Peterson Hill	Manzanita Creek	3	4	2	3	3.1	3	MB-008
PP-FB-4	Battle Point Road	Issei Creek	2	3	3	4	3	4	FB-004
PP-EH-7	Wyatt Way	Hirakawa Creek	3	2	3	4	2.95	5	EH-033
PP-BH-1	Halls Hill Road *	Blakely Falls Creek	2	2	4	4	2.9	6	BH-004
PP-MC-3	North Madison	Grisdale Creek	2	4	3	2	2.8	7	MC-009
PP-MC-3AA	NE Koura Road	Woodward Creek	3	3	2	3	2.8	7	MC-010
PP-MC-2	Manitou Beach Road	Un-named	1	4	4	2	2.75	9	MC-011
PP-MB-5	Bergman	Manzanita Creek	2	3	4	2	2.7	10	MB-002
PP-BH-3	Country Club Road *	Mac's Dam Stream	2	2	4	3	2.65	11	BH-007
PP-FB-2AA	Fletcher Bay Road	Spring Brook	4	4	2	0	2.6	12	FB-015
PP-EH-6	Wyatt Way	Cannery Creek	3	2	2	3	2.5	13	EH-0
PP-EH-8A	High School Road	Head-of-the-Bay	3	3	3	1	2.5	13	EH-032
PP-FB-4A	Miller Road	Issei Creek	4	2	2	2	2.5	13	FB-005
PP-S-1	Lafayette Avenue	Heron Creek	2	2	2	4	2.5	13	S-007
PP-BH-3A	Blakely Avenue	Mac's Dam Stream	3	1	2	4	2.45	17	BH-010
PP-EH-4A	High School Road	Winslow Ravine	3	1	2	4	2.45	17	
PP-EH-7A	High School Road	Hirakawa Creek	3	2	3	2	2.45	17	
PP-FB-3	Miller Road	Issei Creek	4	2	3	1	2.45	17	FB-013
PP-PB-3B	Lynnwood Center	Schel-Chelb	2	1	3	4	2.4	21	PB-011
PP-EH-8	Bucklin Hill Road	Head-of-the-Bay	3	4	1	1	2.4	22	
PP-PB-3	Lynnwood Center	Schel-Chelb	3	4	1	1	2.4	22	
PP-PB-3A	Baker Hill Road	Schel-Chelb	2	4	1	2	2.4	22	
PP-FB-5	Battle Point Road	N. Fletcher Bay Creek	2	4	2	1	2.35	25	
PP-MC-3B	McRedmond Lane *	Woodward Creek	1	4	2	2	2.35	25	
PP-BH-4	Country Club Road *	Tani Creek	2	3	2	2	2.3	27	
PP-FB-2A	Fletcher Bay Road	Spring Brook	4	2	2	1	2.25	28	FB-007
PP-MC-3A	NE Wardwell Road	Woodward Creek	2	2	2	3	2.25	28	
PP-EH-4	Winslow Way	Winslow Ravine	2	1	2	4	2.2	30	
PP-PM-1	Mariner Avenue NE	Un-named	1	2	3	3	2.2	30	
PP-PM-4	NE Hidden Cove Road	Hidden Cove Creek	2	1	3	3	2.15	32	
PP-GL-1	Crystal Springs Drive	Lindquist Creek	2	4	2	0	2.1	33	
PP-S-4	Sunrise Drive	Dripping Water	2	3	1	2	2.1	34	S-008
PP-EH-2	Wing Point Way	Hawley Creek	3	2	1	2	2.05	35	
PP-EH-3	Wing Point Way	Hawley Creek	3	2	1	2	2.05	35	
PP-MB-5A	Day Road	Manzanita Creek	2	2	1	3	2.05	35	
PP-BH-2	Blakely Avenue	Un-named	3	2	2	1	2	38	
PP-ED-2	Eagle Harbor Drive	Un-named	2	2	2	2	2	38	
PP-ED-4A	Wiggins Road	Whiskey Creek	1	2	2	3	2	38	ED-004

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CROSSING NUMBER (A)	ROAD	STREAM BASIN NAME (B)	Road Type (C) 25% (1-4)	Capacity (D) 30% (1-4)	Pipe Condition (E) 20% (1-4)	Fish Passage Barrier (F 25% (1-4)	Total Score 100% (1-4)	Priority Ranking 1-85	PROBLEM NUMBER (G)
PP-FB-2B	Fletcher Bay Road	Spring Brook	2	2	2	2	2	38	
PP-PB-3C	Lynnwood Center Road	Schel-Chelb	3	2	2	1	2	38	
PP-PM-2	Skogan Lane	Un-named	1	2	2	3	2	38	
PP-ED-5	Eagle Harbor Drive	Un-named	3	2	3	0	1.95	44	
PP-MC-1	Manitou Beach Road	Un-named	2	2	4	0	1.9	45	
PP-BH-4A	Fort Ward Hill Road	Tani Creek	2	1	4	1	1.85	46	
PP-PM-3	NE West Port Madison *	Un-named	2	3	2	0	1.8	47	
PP-MB-3	Arrow Point Drive	S. Manzanita Stream	3	2	2	0	1.75	48	
PP-MC-4	Moran Drive	Un-named	2	2	2	1	1.75	48	
PP-MC-5	Lofgren Road	Un-named	2	2	2	1	1.75	48	
PP-S-2	Lafayette Avenue	Un-named	2	2	2	1	1.75	48	
PP-S-3	Lafayette Avenue *	Lagoon Creeklet	2	2	2	1	1.75	48	
PP-BH-5	Country Club Road	Crane Lake Creek	2	2	3	0	1.7	53	
PP-BH-7	Country Club Road *	Toe Jam Hill Creek	2	2	3	0	1.7	53	
PP-ED-1A	Old Mill Road	Cougar Creek	1	2	3	1	1.7	53	
PP-ED-3	Eagle Harbor Drive	Un-named	3	1	2	1	1.7	53	
PP-ED-4	Eagle Harbor Drive	Whiskey Creek	2	1	2	2	1.7	53	
PP-ED-6	Eagle Harbor Drive	Creosote Creek	3	1	3	0	1.65	58	
PP-BH-6	Country Club Road	Un-named	2	1	4	0	1.6	59	BH-011
PP-EH-5	Winslow Way	Madrone Creek	3	2	1	0	1.55	60	
PP-FB-2	Fletcher Bay Road *	Spring Brook	3	2	1	0	1.55	60	
PP-AP-1	Manzanita Road	Un-named	2	2	2	0	1.5	62	
PP-AP-3	Mariner Avenue NE	Huhuhup-Piyots Creek	2	2	2	0	1.5	62	
PP-EH-1	Grand Avenue	Yeomalt Springs	2	2	2	0	1.5	62	
PP-FB-5A	Tolo Road	N. Fletcher Bay Creek	2	2	2	0	1.5	62	
PP-GL-2	Crystal Springs Drive	Un-named	2	2	2	0	1.5	62	
PP-GL-3	Crystal Springs Drive *	Un-named	2	2	2	0	1.5	62	
PP-GL-4	Crystal Springs Drive *	Un-named	2	2	2	0	1.5	62	
PP-GL-5	Crystal Springs Drive *	Gazzam Creek	2	2	2	0	1.5	62	
PP-PB-1	Pleasant Beach Drive	Un-named	2	2	2	0	1.5	62	
PP-PB-2	Pleasant Beach Drive	Lytle Creek	2	2	2	0	1.5	62	
PP-PB-5	Point White Drive	Un-named	2	2	2	0	1.5	62	
PP-S-5	Sunrise Drive	Un-named	2	2	2	0	1.5	62	SB-003
PP-ED-1	Eagle Harbor Drive	Cougar Creek	2	1	2	1	1.45	74	
PP-BH-8	Country Club Road *	Un-named	2	1	3	0	1.4	75	BH-006
PP-BH-9	Country Club Road *	Un-named	2	1	3	0	1.4	75	BH-006
PP-ED-7	Rockaway Beach Road	Un-named	2	1	3	0	1.4	75	
PP-MB-1	Olallie Lane	Battle Point Creek	1	2	2	0	1.25	78	
PP-MB-2	Olympic View Blvd.	Fairy Dell Creek	1	2	2	0	1.25	78	
PP-PB-4	Point White Drive	Un-named	2	1	2	0	1.2	80	

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CROSSING NUMBER (A)	ROAD	STREAM BASIN NAME (B)	ROAD CLASS (C)	FLOW CAPACITY (D)	PIPE CONDITION (E)	FISH PASSAGE BARRIER (F)	DRAINAGE AREA (ac)	RANK	PROBLEM NUMBER (G)
PP-SS-0	Sunrise Drive	Rolling Bay Stream	2	1	2	0	1.2	62	
PP-SS-1	NE South Beach Road	South Beach Creek	2	1	1	0	1	52	SB-003
PP-SS-2	NE South Beach Road	Fort Ward	2	1	1	0	1	52	SB-003
PP-SS-3	NE South Beach Road	Un-named	2	1	1	0	1	52	
PP-AP-2	Retten Road NE	Young Cedars Creek	1	1	2	0	0.56	54*	

Footnotes:

* Road serves as sole access route.

(A) See Figure 4.1 (Hydrologic Model Subbasins) for crossing locations

(B) Source "Streams of Bainbridge Island: Names, History, Folklore, and Culture", 1997 and "Bainbridge Island Watersheds", Puget Sound Cooperative River Basin Team, 1995

(C) 4) Primary Arterial; 3) Secondary; 2) Collector; 1) Residential/Private

(D) Qualitative rating based on 100yr flow capacity for primary and secondary roads and 25yr for collector and residential roads unless the road serves as the sole access route.
4) >1001% of capacity 3) 501-1000% of capacity 2) 101-500% of capacity 1) capacity OK.

(E) Pipe condition based on field observations and/or City personnel reports

(F) Fish passage barrier: 4 for fish barrier to 1 for no barrier, and 0 for no fish reported

(G) See Figures 6.1 to 6.12 (Existing and Potential Drainage Problems and CIPs) for locations

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CROSSING NUMBER (A)	ROAD	STREAM BASIN NAME (B)	FISH REPORT	H (I)	LENGTH (I) (FT)	AVAIL. Q (CFS)	Q25 (CFS)	Q25/ AVAIL. Q	Q100 (CFS)	Q100/ AVAIL. Q
PP-AP-1	Manzanita Road	Un-named				5	11	228%	21	428%
PP-AP-2	Reitan Road NE	Young Cedars Creek				17	3	18%	7	41%
PP-AP-3	Mariner Avenue NE	Huhuhup-Piyots Creek	no			9	9	101%	18	195%
PP-BH-1	Halls Hill Road *	Blakely Falls Creek	yes			12	30	249%	58	484%
PP-BH-2	Blakely Avenue	Un-named				5	10	194%	19	383%
PP-BH-3	Country Club Road *	Mac's Dam Stream	yes (tidal			55	59	107%	115	210%
PP-BH-3A	Blakely Avenue	Mac's Dam Stream	blocked			50	18	35%	34	67%
PP-BH-4	Country Club Road *	Tani Creek	no			5	23	452%	46	927%
PP-BH-4A	Fort Ward Hill Road	Tani Creek	no			21	11	54%	23	110%
PP-BH-5	Country Club Road	Crane Lake Creek	no			21	23	111%	50	239%
PP-BH-6	Country Club Road	Un-named				7	5	70%	9	133%
PP-BH-7	Country Club Road *	Toe Jam Hill Creek	no			13	11	88%	22	172%
PP-BH-8	Country Club Road *	Un-named		9	60	10	4	43%	9	92%
PP-BH-9	Country Club Road *	Un-named		10	60	11	4	37%	9	82%
PP-ED-1	Eagle Harbor Drive	Cougar Creek	portions			46	46	100%	85	184%
PP-ED-1A	Old Mill Road	Cougar Creek	portions			9	35	383%	64	706%
PP-ED-2	Eagle Harbor Drive	Un-named				13	24	184%	43	334%
PP-ED-3	Eagle Harbor Drive	Un-named				30	15	50%	28	93%
PP-ED-4	Eagle Harbor Drive	Whiskey Creek	yes	61	280	320	81	25%	153	48%
PP-ED-4A	Wiggins Road	Whiskey Creek	yes			30	57	189%	106	353%
PP-ED-5	Eagle Harbor Drive	Un-named				21	12	57%	22	106%
PP-ED-6	Eagle Harbor Drive	Creosote Creek	no			20	5	25%	9	44%
PP-ED-7	Rockaway Beach Road	Un-named				30	10	35%	16	53%
PP-EH-1	Grand Avenue	Yeomalt Springs	no			14	18	127%	31	219%
PP-EH-2	Wing Point Way	Hawley Creek				45	69	154%	111	248%
PP-EH-3	Wing Point Way	Hawley Creek				13	29	224%	47	365%
PP-EH-4	Winslow Way	Winslow Ravine	yes (bloc			380	201	53%	299	79%
PP-EH-4A	High School Road	Winslow Ravine	yes (bloc			280	89	32%	138	49%
PP-EH-5	Winslow Way	Madrone Creek	no			32	86	270%	119	373%
PP-EH-6	Wyatt Way	Cannery Creek	yes			35	66	188%	101	289%
PP-EH-7	Wyatt Way	Hirakawa Creek	no (block			110	89	80%	156	141%
PP-EH-7A	High School Road	Hirakawa Creek	no			70	68	97%	119	169%
PP-EH-8	Bucklin Hill Road	Head-of-the-Bay	yes (tida	1	40	20	146	730%	274	1368%
PP-EH-8A	High School Road	Head-of-the-Bay				14	48	345%	86	611%
PP-FB-2	Fletcher Bay Road *	Spring Brook	yes			380	242	64%	452	119%
PP-FB-2A	Fletcher Bay Road	Spring Brook	yes			55	78	142%	154	280%
PP-FB-2AA	Fletcher Bay Road	Spring Brook	yes			12	79	658%	141	1177%
PP-FB-2B	Fletcher Bay Road	Spring Brook	yes			12	40	330%	77	644%
PP-FB-3	Miller Road	Issei Creek				23	36	156%	62	269%
PP-FB-4	Battle Point Road	Issei Creek	yes (bloc			20	105	525%	203	1016%
PP-FB-4A	Miller Road	Issei Creek	yes			68	90	132%	174	255%
PP-FB-5	Battle Point Road	N. Fletcher Bay Creek	no			9	146	1622%	274	3040%
PP-FB-5A	Tolo Road	N. Fletcher Bay Creek	no			9	22	248%	43	480%
PP-GL-1	Crystal Springs Drive	Lindquist Creek	no	1	60	2	30	1505%	56	2795%
PP-GL-2	Crystal Springs Drive	Un-named		3	60	6	9	150%	17	278%
PP-GL-3	Crystal Springs Drive *	Un-named				12	10	80%	18	150%
PP-GL-4	Crystal Springs Drive *	Un-named				12	12	103%	21	177%
PP-GL-5	Crystal Springs Drive *	Gazzam Creek	no			12	24	198%	45	372%
PP-MB-1	Olallie Lane	Battle Point Creek	no			14	32	226%	57	408%
PP-MB-2	Olympic View Blvd.	Fairy Dell Creek	no			5	17	334%	31	617%

Dentention/Rentention CIP Parameters Summary
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Sub-Basin Name[1]	Impervious[2]	Wetland[3]	Till Soils			Outwash Soils			Total
			Forest[4]	Pasture[5]	Grass[6]	Forest[4]	Pasture[5]	Grass[6]	
BH-009	6.6	6.0	0.0	0.0	43.0	0.0	0.0	16.1	71.7
ED-006	4.1	0.0	0.0	2.9	23.5	0.0	0.0	0.0	30.5
ED-007	7.3	7.8	1.3	0.4	59.0	0.0	0.0	0.0	75.9
ED-008	6.7	14.9	0.0	0.0	59.9	0.0	0.0	0.0	81.4
EH-025	13.3	0.0	2.9	0.0	82.2	0.4	0.0	28.5	127.2
EH-026	7.3	1.3	0.0	7.5	65.4	0.0	0.0	0.0	81.5
EH-027	3.4	0.6	0.0	0.0	30.7	0.0	0.0	0.0	34.7
EH-029									
EH-030									
FB-008	2.4	0.0	0.0	0.0	21.5	0.0	0.0	0.0	23.9
FB-010	8.7	6.1	0.7	0.6	56.2	1.5	0.0	22.2	96.0
FB-011	13.4	1.4	1.4	0.0	84.6	0.0	0.0	0.0	100.8
GL-006	3.0	15.1	0.0	65.9	27.0	0.0	0.0	0.0	110.9
MB-010	9.2	4.7	0.0	0.0	64.1	0.0	0.0	18.4	96.4
MB-011	10.2	4.0	0.0	0.0	78.4	0.0	0.0	0.0	92.6
MB-012									
MB-013	27.7	12.6	12.7	0.0	18.5	0.0	0.0	0.5	72.0
MB-014	33.3	0.0	0.8	0.0	40.1	0.0	0.0	0.0	74.2

Dentention/Rentention CIP Parameters Summary
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Sub-Basin Name[1]	Impervious[2]	Wetland[3]	Till Soils			Outwash Soils			Total
			Forest[4]	Pasture[5]	Grass[6]	Forest[4]	Pasture[5]	Grass[6]	
MB-016									
MC-003	24.7	0.0	0.1	0.0	86.0	0.0	0.0	7.1	117.9
MC-004									
MC-005									
PM-003									
S-010									
S-013	9.5	1.6	0.0	0.0	37.5	0.0	0.0	19.0	67.6

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Sub-Basin Name[1]	Total Sub-Basin Area (ac)	Facility Type	Dev. % Impervious	Facility Size (cf)	Facility Cost	Land Price	Land Cost	Mobilization	Erosion Control
BH-009	71.7	Level 2	9.2	281,000	$1,124,000	2	$323,000	8%	5%
ED-006	30.5	Level 1	13.5	133,000	$532,000	1	$102,000	8%	3%
ED-007	75.9	Level 2	9.6	301,000	$1,204,000	1	$230,000	8%	4%
ED-008	81.4	Level 2	8.2	311,000	$1,244,000	1	$238,000	8%	5%
EH-025	127.2	Level 2	10.4	514,000	$2,056,000	2	$590,000	8%	3%
EH-026	81.5	Level 2	8.9	317,000	$1,268,000	2	$364,000	8%	4%
EH-027	34.7	Level 1	9.8	86,000	$344,000	2	$99,000	8%	4%
EH-029	?	Level 2	?	150,000	$600,000	1	$115,000	10%	5%
EH-030	?	Level 2	?	85,000	$340,000	1	$65,000	10%	5%
FB-008	23.9	Level 2	10.1	96,000	$384,000	2	$110,000	8%	3%
FB-010	96	Retention	9.1	55,000	$220,000	3	$84,000	9%	4%
FB-011	100.8	Level 2	13.3	437,000	$1,748,000	3	$669,000	10%	3%
GL-006	110.9	Level 2	2.7	363,000	$1,452,000	1	$278,000	10%	4%
MB-010	96.4	Level 2	9.5	381,000	$1,524,000	1	$292,000	8%	3%
MB-011	92.6	Level 2C	11.1	570,000	$2,280,000	2	$654,000	10%	5%
MB-012	?	Level 1	?	200,000	$800,000	1	$153,000	9%	5%
MB-013	72	Level 1C	38.5	577,500	$2,310,000	1	$442,000	9%	5%
MB-014	74.2	Level 2C	44.9	834,000	$3,336,000	1	$638,000	9%	3%

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Sub-Basin Name[1]	Total Sub-Basin Area (ac)	Facility Type	Dev. % Impervious	Facility Size (cf)	Facility Cost	Land Price	Land Cost	Mobilization	Erosion Control
MB-016	?	Level 2	?	45,000	$180,000	2	$52,000	9%	5%
MC-003	117.9	Level 2C	20.9	901,500	$3,606,000	2	$1,035,000	8%	4%
MC-004	?	Level 2	?	150,000	$600,000	2	$172,000	8%	4%
MC-005	10.4	Level 2	10.0	42,000	$168,000	1	$32,000	8%	4%
PM-003	?	Level 2C	?	120,000	$480,000	1	$92,000	8%	3%
S-010	?	Level 2	?	65,000	$260,000	2	$75,000	10%	5%
S-013	67.6	Level 2	14.0	297,000	$1,188,000	3	$455,000	9%	4%

Pinch Point Hydrologic Analysis
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Sub-Basin Name[1]	Impervious[2]	Wetland[3]	Till Soils			Outwash Soils			Flowrate[7]	
			Forest[4]	Pasture[5]	Grass[6]	Forest[4]	Pasture[5]	Grass[6]	100 Yr	25 Yr
PP-AP-1	4.7	0.7	4.1	0.0	26.8	0.0	0.0	0.0	21.4	11.4
PP-AP-2	2.0	0.0	0.0	0.0	0.0	1.0	0.0	17.7	7.0	3.1
PP-AP-3	4.6	1.1	0.0	0.0	17.2	0.0	0.0	24.0	17.6	9.1
PP-BH-9	2.5	0.6	0.5	0.0	1.0	0.3	0.0	21.8	9.0	4.1
PP-BH-2	4.3	4.1	0.0	0.0	21.4	0.7	0.0	16.9	19.2	9.7
PP-BH-1	12.2	6.6	0.1	0.0	70.9	0.8	0.0	27.8	58.0	29.9
PP-BH-8	2.6	0.9	0.1	0.0	1.9	9.3	0.0	21.7	9.2	4.3
PP-BH-7	5.0	1.0	1.2	0.0	25.2	0.5	0.0	20.0	22.3	11.4
PP-BH-6	2.7	3.6	0.1	0.0	4.7	0.1	0.0	19.8	9.3	4.9
PP-BH-5	14.1	8.5	0.6	0.0	6.5	2.2	0.0	120.6	50.2	23.4
PP-BH-4-A	6.4	8.6	0.0	0.0	3.7	3.4	0.0	54.3	23.2	11.3
PP-BH-4	12.9	17.2	0.0	0.0	7.4	6.7	0.0	108.6	46.3	22.6
PP-BH-3-A	9.5	20.7	1.3	0.0	8.2	7.6	0.0	74.8	33.7	17.6
PP-BH-3	29.5	26.6	4.7	1.0	112.1	20.0	0.0	150.1	115.3	59.1
PP-ED-7	8.4	0.0	0.5	0.0	8.5	3.7	0.0	1.7	15.8	10.4
PP-ED-6	2.6	0.0	1.6	0.0	9.0	2.0	0.0	2.3	8.7	4.9
PP-ED-5	5.4	0.0	0.2	0.0	27.2	0.6	0.0	0.4	22.2	11.9
PP-ED-4	31.9	22.8	3.6	2.1	193.9	7.9	0.0	13.7	152.7	81.3
PP-ED-4-A	21.1	22.7	0.2	1.9	136.3	0.5	0.0	9.5	105.8	56.6
PP-ED-3	6.1	0.0	0.0	3.0	34.7	0.0	0.0	0.0	27.9	14.9
PP-ED-2	7.2	7.6	1.5	0.4	59.9	0.0	0.0	0.2	43.4	23.9
PP-ED-1A	9.7	32.2	0.1	0.0	87.4	0.0	0.0	0.0	63.6	34.5
PP-ED-1	13.3	37.4	1.2	0.0	116.0	6.5	0.0	2.1	84.8	46.0

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Sub-Basin Name[1]	Impervious[2]	Wetland[3]	Till Soils			Outwash Soils			Flowrate[7]	
			Forest[4]	Pasture[5]	Grass[6]	Forest[4]	Pasture[5]	Grass[6]	100 Yr	25 Yr
PP-EH-2	49.0	9.6	0.8	0.0	84.6	0.9	0.0	3.7	111.4	69.2
PP-EH-4-A	68.4	29.6	1.1	0.0	84.2	0.0	0.0	0.0	137.6	88.6
PP-EH-1	10.6	5.6	0.0	0.0	29.7	0.0	0.0	0.0	30.7	17.8
PP-EH-3	20.3	8.9	0.9	0.0	36.3	0.2	0.0	1.7	47.4	29.1
PP-EH-4	168.2	45.3	9.8	0.0	137.4	5.3	0.0	1.3	298.8	200.9
PP-EH-5	80.5	0.0	0.0	2.4	25.6	0.0	0.0	2.0	119.3	86.3
PP-EH-6	50.4	1.1	0.0	9.6	60.5	0.0	0.0	0.0	101.3	65.9
PP-EH-7	49.4	19.2	0.7	0.0	162.3	0.0	0.0	0.0	155.6	88.5
PP-EH-8	49.8	36.4	4.2	9.6	357.2	3.3	0.0	66.3	273.6	145.8
PP-EH-8-A	13.6	1.0	0.1	0.0	122.1	0.0	0.0	0.0	85.6	48.3
PP-EH-7-A	38.4	13.4	0.7	0.0	122.2	0.0	0.0	0.0	118.6	67.7
PP-FB-5	17.3	5.3	0.0	34.2	145.9	0.0	0.0	8.0	273.6	145.8
PP-FB-1	17.7	5.5	0.4	0.0	85.8	0.7	0.0	1.0	71.2	38.3
PP-FB-5-A	6.0	0.0	0.0	27.9	52.0	0.0	0.0	1.8	43.2	22.3
PP-FB-4	37.8	55.6	110.9	0.0	253.6	0.0	0.0	0.0	203.2	104.5
PP-FB-4-A	33.1	40.1	90.0	0.0	216.7	0.0	0.0	0.0	173.7	89.8
PP-FB-3	20.9	0.0	0.2	0.0	62.7	0.0	0.0	0.0	62.0	35.8
PP-FB-2-AA	22.2	18.4	0.1	0.6	199.7	0.0	0.0	0.0	141.2	78.9
PP-FB-2-A	26.7	35.2	0.9	35.2	187.8	3.3	0.0	52.8	154.0	77.9
PP-FB-2-B	13.4	6.5	0.7	27.7	91.2	1.7	0.0	29.5	77.3	39.6
PP-FB-2	74.6	102.0	14.5	35.8	600.3	4.0	0.0	56.0	451.9	241.5
PP-GL-1	12.6	0.1	1.9	0.0	70.7	0.5	0.0	1.1	55.9	30.1
PP-GL-2	3.0	0.0	2.6	16.6	14.6	1.5	2.7	7.8	16.7	9.0
PP-GL-3	2.5	0.3	0.4	21.0	17.1	3.0	0.8	4.3	17.9	9.6

Pinch Point Hydrologic Analysis
City of Bainbridge Island
Surface Water Management Plan
Appendix C

Sub-Basin Name[1]	Impervious[2]	Wetland[3]	Till Soils			Outwash Soils			Flowrate[7]	
			Forest[4]	Pasture[5]	Grass[6]	Forest[4]	Pasture[5]	Grass[6]	100 Yr	25 Yr
PP-GL-4	0.8	0.0	0.2	79.3	3.2	1.0	1.0	4.2	21.2	12.4
PP-GL-5	4.3	15.1	0.7	73.8	37.8	1.2	0.2	0.7	44.7	23.7
PP-MB-5	37.8	75.7	51.0	0.0	282.4	0.0	0.0	1.3	215.9	114.4
PP-MB-4	273.1	104.7	20.7	0.0	468.0	1.6	0.0	12.0	624.9	386.0
PP-MB-3	6.4	70.7	0.0	0.0	57.8	0.0	0.0	0.0	45.7	22.8
PP-MB-2	4.7	8.3	1.4	39.9	26.7	1.3	0.0	0.9	30.9	16.7
PP-MB-1	9.5	0.8	0.5	3.6	79.1	0.0	0.0	0.0	57.1	31.6
PP-MC-5	14.3	0.2	0.6	0.0	42.8	0.1	0.0	0.3	42.4	24.5
PP-MC-4	24.8	0.0	0.0	0.0	63.8	0.0	0.0	0.0	67.6	40.0
PP-MC-3-A	108.5	104.5	77.7	0.0	441.5	0.0	0.0	0.0	400.1	218.9
PP-MC-3-B	69.5	17.6	23.7	0.0	101.8	0.0	0.0	0.0	149.8	94.7
PP-MC-3	176.7	193.8	94.7	3.0	901.0	3.1	0.0	1.7	753.0	400.1
PP-MC-3-AA	35.1	0.0	0.5	0.0	177.4	0.0	0.0	0.0	143.9	77.6
PP-MC-2	45.6	4.0	0.5	0.0	167.8	0.0	0.0	6.9	153.0	85.8
PP-MC-1	18.8	0.1	0.0	0.0	53.6	0.0	0.0	0.0	54.2	31.6
PP-PB-5	6.2	0.0	0.1	0.0	33.0	0.6	0.0	1.7	26.5	14.2
PP-PB-4	4.8	0.0	1.4	0.0	26.0	0.5	0.0	0.8	20.9	11.1
PP-PB-3	65.8	95.1	6.2	54.7	297.0	19.4	0.0	181.8	285.4	148.4
PP-PB-3-A	47.7	63.8	5.3	35.1	219.0	6.0	0.0	144.9	208.7	108.1
PP-PB-3-AA	6.4	0.0	0.3	13.8	35.8	7.7	0.0	21.7	33.2	17.2
PP-PB-3-C	6.8	0.0	0.5	35.1	47.5	0.3	0.0	13.2	44.4	23.2
PP-PB-3-B	27.3	43.1	3.8	35.1	138.1	1.5	0.0	82.0	130.4	67.1
PP-PB-2	14.0	0.4	0.3	0.0	46.3	1.4	0.0	32.5	46.6	25.5

Pinch Point Hydrologic Analysis
City of Bainbridge Island
Surface Water Management Plan
Appendix C

Sub-Basin Name[1]	Impervious[2]	Wetland[3]	Till Soils			Outwash Soils			Flowrate[7]	
			Forest[4]	Pasture[5]	Grass[6]	Forest[4]	Pasture[5]	Grass[6]	100 Yr	25 Yr
PP-PB-1	11.4	3.6	0.0	0.0	14.8	0.2	0.0	59.4	28.9	15.7
PP-PM-5	30.5	36.3	0.4	0.0	272.8	0.0	0.0	0.4	193.7	107.8
PP-PM-4	8.2	2.3	1.2	0.0	66.5	0.1	0.0	3.0	48.1	26.6
PP-PM-3	5.9	1.0	0.0	0.0	38.6	0.0	0.0	14.1	30.3	16.0
PP-PM-1	7.6	6.0	0.3	0.0	33.4	0.1	0.0	29.6	31.3	16.1
PP-PM-2	3.5	2.0	2.5	0.0	22.9	0.8	0.0	3.6	18.0	9.5
PP-SB-1	5.9	1.4	2.5	0.0	1.1	0.5	0.0	51.5	21.0	9.4
PP-SB-2	5.1	2.4	3.4	0.0	1.8	2.3	0.0	44.4	18.6	8.5
PP-SB-3	5.4	0.4	0.4	0.0	0.8	1.5	0.0	47.4	19.1	8.5
PP-S-6	12.6	1.8	0.2	0.0	54.0	0.0	0.0	19.5	48.1	25.8
PP-S-5	10.7	5.5	0.0	0.0	59.8	0.0	0.0	16.7	48.9	25.4
PP-S-4	32.8	31.4	0.1	0.0	246.8	0.0	0.0	0.0	181.9	99.9
PP-S-1	25.5	19.3	0.7	0.0	118.9	0.5	0.0	22.2	102.2	54.6
PP-S-2	11.3	0.5	0.2	0.0	40.8	0.0	0.0	0.0	37.4	21.1
PP-S-3	11.7	1.6	0.0	2.6	35.0	0.0	0.0	0.2	35.4	20.4

Notes:

1. See Figure 4.1 for graphical representation of location.
2. As recommended by KCSWDM Chapter 3.2.2.1, impervious area calculated as a percentage of developable property (ie non-wetland, and unprotected forest and pasture land), shown as developed in Figure 4.3, for build out zoning conditions as follows: 90% for R-14, LM, NSC, WD-I; 60% for R-8; 52% for R-6; 48% for R-5; 46% for R-4.3; 38% for R-3.5; 34% for R-2.9; 25% for R-2; 15% for R-1; and 10% for R-0.4. The affects of BIMC 16.22 - Vegetation Management or BIMC 15.20 - Surface and Stormwater Management were not included as discussed in the report.
3. Wetland area calculated from City delineated and potential wetland map. See Figure 3.3.
4. Forest area calculated from undevelopable steep slope areas over 40% and permanent forest tracts, see Figure 3.5.
5. Pasture area calculated from permanent pasture tracts. See Figure 4.3.
6. Grass area calculated from all remaining developable lands minus impervious area. See Figure 4.3.
7. Return Frequency Flowrate calculated from the King County Runoff Time Series (KCRTS) hydrology model with the reduced Seatac rainfall record; regional scale factor =1.1; 15 minute time steps; and uneditted flowpaths.

Assumptions for Detention/Retention CIP Hydrology and Cost Estimates
City of Bainbridge Island
Surface Water Management Plan
Appendix C

Level 2 Detention Pond Estimates:

- Level 2 Ponds were designated where identified pond locations are in close proximity to an existing stream. These facilities were based on the King County Runoff Time Series method of sizing Level 2 facilities to match the runoff duration for the given basin, assuming a forested condition.

- Where the tributary drainage to a potential facility location was easily identifiable, the basin was delineated and analyzed for future land cover conditions (based on zoning, land use, steep slopes, etc., see culvert analysis for details).

- Three delineated basins were chosen to serve as the basis for sizing the remaining basins using empirical methods.

    - Two of the basins were similar in future land cover characteristics (~10% Impervious) but differed greatly in overall size. These ponds were sized using KCRTS to match the durations from a forested land cover time series (this is considered conservative for basin sizing). The different modeled sizes of the ponds were used to develop an empirical equation for the size of the facility as a function of the total basin area. From this analysis a base of 4000 cf/gross acre was applied to all Level 2 facilities with delineated basins.

    - Two of the basins were similar in overall size (~73 acres) but differed greatly in future land cover characteristics. These ponds were also sized using KCRTS to match the durations from a forested land cover time series. The different modeled sizes of the ponds were used to develop an empirical equation for correcting the above calculated facility size (as based on total area) for differing future percent impervious. From this analysis a correction factor of 100 cf/gross acre multiplied by %Impervious minus 10.

Level 1 Detention Pond Estimates:

- Level 1 Ponds were designated where identified pond locations were not in close proximity to an existing stream. These facilities were based on the King County Runoff Time Series method of sizing Level 1 facilities to match the 10-year and 2-year peak flowrates for the given basin, assuming a forested condition.

- Where the tributary drainage to a potential facility location was easily identifiable, the basin was delineated and analyzed for future land cover conditions (based on zoning, land use, steep slopes, etc., see culvert analysis for details).

- One delineated basin was chosen to serve as the basis for sizing the remaining basins using empirical methods.

    - One basin with ~10% future impervious area was sized using the KCRTS Level 1 methods to match the 2 and 10-year peaks from the forested condition. From this sizing, a base of 2500 cf/gross acre was used size the remaining facilities. The same correction factor was applied for future %impervious as was used in Level 2 facilities above.

Retention Pond Estimates:

- Retention Ponds were designated where identified pond locations were located where good permeable soils are anticipated and aquifer recharge is desirable. These facilities were designed to bypass a flow equivalent to one-half of the 2-year peak as a base flow to maintain streams below the facilities.

- Where the tributary drainage to a potential facility location was easily identifiable, the basin was delineated and analyzed for future land cover conditions (based on zoning, land use, steep slopes, etc., see culvert analysis for details).

- One delineated basin was chosen to serve as the basis for sizing the remaining basins using empirical methods.

    - One basin was sized, using KCRTS and an assumed infiltration rate of 6 inches/hr, to discharge a maximum of one-half of the forested 2-year flow to surface water. The remaining flows were designed to infiltrate to recharge aquifers.

    - From this analysis a base of 1000 sf/gross acre was used to size the remaining facilities. A correction factor of 25 sf/gross acre•Δ%impervious was applied for future land cover (based on a 1:4 ratio of size vs. Level 2 facilities).

Water Quality Facilities:

- Water Quality facilities were assumed to equal 50% of the total volume of the above sized detention/retention facilities.

General Pond Estimating:

- Where the basins were not easily delineated or sized as described above, a facility size was assumed based on the available space as determined from site topography and parcel information.

- Facilities were estimated as lump sums as functions of the facility size, based on available K&W estimates of similar facilities.

- Estimates for Erosion Control, Traffic Control, and Mobilization were estimated based on assumed site factors including: surrounding sensitive areas and steep slopes, classification of surrounding roads and parcels, difficulty of construction, etc.

- Land acquisition was estimated as 150% of the facility footprint based on a six-foot deep pond multiplied by an assumed land cost. The land cost was chosen from three different costs ($100K, $150K & $200K/acre) based on zoning, available views, surrounding development, etc.

APPENDIX D
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: NE Hidden Cove Rd./Coho Creek Culvert Replacement (PM-002) (PP-PM-5)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation Using Large Equipment	1500	CY	$ 5	$ 7,500
2	Channel Excavation	150	CY	$ 15	$ 2,250
3	Stream Gravel	30	TN	$ 15	$ 450
4	Riprap	20	TN	$ 40	$ 800
5	Embankment Armoring (riprap)	15	TN	$ 45	$ 675
6	Backfill / Compaction	1500	CY	$ 5	$ 7,500
7	Dewatering	1	LS	$ 2,000	$ 2,000
	Roadways and Asphalt				
8	Aspahlt, Class B	28	TN	$ 55	$ 1,540
9	Crushed Surfacing Top Course	60	TN	$ 30	$ 1,800
	Drainage Structures				
10	83 Inch Span, Tr. 2 St. Pipe Arch	122	LF	$ 400	$ 48,800
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 5,000	$ 5,000
12	Bank Stabilization / Bioengineering	380	SY	$ 50	$ 19,000
13	Traffic Control (3%)	1	LS	$2,900	$ 2,900
14	Erosion Control (10%)	1	LS	$9,700	$ 9,700
15	Mobilization (8%)	1	LS	$7,800	$ 7,800
				Subtotal	$ 118,000
	Contingency (50%)				$ 59,000
	State Sales Tax (8.2%)				$ 15,000
				Construction Cost	$ 192,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 67,000
	Land Acquisition				$ 0
				Total Project Cost	$ 259,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 1 Regional Detention/Water Quality Pond (PM-003)
NE West Port Madison Rd. and Skogan Ln. NE Detention/Water Quality

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 320,000	$ 320,000
2	Water Quality Pond	1	LS	$ 160,000	$ 160,000
3	Traffic Control (5%)	1	LS	$16,000	$ 16,000
4	Erosion Control (3%)	1	LS	$9,600	$ 9,600
5	Mobilization (8%)	1	LS	$25,600	$ 25,600
				Subtotal	$ 531,000
	Contingency (50%)				$ 266,000
	State Sales Tax (8.2%)				$ 65,000
				Construction Cost	$ 862,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 302,000
	Land Acquisition				$ 92,000
				Total Project Cost	$ 1,300,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (S-010)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 260,000	$ 260,000
2	Traffic Control (3%)	1	LS	$7,800	$ 7,800
3	Erosion Control (5%)	1	LS	$13,000	$ 13,000
4	Mobilization (10%)	1	LS	$26,000	$ 26,000
				Subtotal	$ 307,000
	Contingency (50%)				$ 154,000
	State Sales Tax (8.2%)				$ 38,000
				Construction Cost	$ 499,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 175,000
	Land Acquisition				$ 75,000
				Total Project Cost	$ 750,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (S-013)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,188,000	$ 1,188,000
2	Traffic Control (5%)	1	LS	$59,400	$ 59,400
3	Erosion Control (4%)	1	LS	$47,500	$ 47,500
4	Mobilization (9%)	1	LS	$106,900	$ 106,900
				Subtotal	$ 1,402,000
	Contingency (50%)				$ 701,000
	State Sales Tax (8.2%)				$ 172,000
				Construction Cost	$ 2,275,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 796,000
	Land Acquisition				$ 455,000
				Total Project Cost	$ 3,600,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Fish Passage Culvert Replacement (MB-002) (PP-MB-5)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation	133	CY	$ 12	$ 1,596
2	Channel Excavation	15	CY	$ 15	$ 225
3	Stream Gravel	8.5	TN	$ 15	$ 128
4	Riprap	73	TN	$ 13	$ 949
5	Embankment Armoring (riprap)	5	CY	$ 45	$ 225
6	Backfill / Compaction	130	CY	$ 18	$ 2,340
7	Dewatering	1	LS	$ 1,000	$ 1,000
	Roadways and Asphalt				
8	Aspahlt, Class B	11	TN	$ 55	$ 605
9	Crushed Surfacing Top Course	20	TN	$ 30	$ 600
	Drainage Structures				
10	Precast 4' x 5' Concrete Box Section	50	LF	$ 350	$ 17,500
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 1,000	$ 1,000
12	Bank Stabilization / Bioengineering	56	SY	$ 50	$ 2,800
13	Traffic Control (5%)	1	LS	$1,400	$ 1,400
14	Erosion Control (5%)	1	LS	$1,400	$ 1,400
15	Mobilization (10%)	1	LS	$2,900	$ 2,900
				Subtotal	$ 35,000
	Contingency (50%)				$ 18,000
	State Sales Tax (8.2%)				$ 4,000
				Construction Cost	$ 57,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 20,000
	Land Acquisition				$ 0
				Total Project Cost:	$ 77,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Fish Passage Culvert Replacement (MB-007) (PP-MB-4A)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation Using Large Equipment	4020	CY	$ 5	$ 20,100
2	Channel Excavation	40	CY	$ 15	$ 600
3	Stream Gravel	45	TN	$ 15	$ 675
4	Riprap	28.5	TN	$ 13	$ 371
5	Embankment Armoring (riprap)	20	CY	$ 45	$ 900
6	Backfill / Compaction	4000	CY	$ 5	$ 20,000
7	Dewatering	1	LS	$ 3,000	$ 3,000
	Roadways and Asphalt				
8	Aspahlt, Class B	37	TN	$ 55	$ 2,035
9	Crushed Surfacing Top Course	67.5	TN	$ 30	$ 2,025
	Drainage Structures				
10	87 Inch Span, Tr. 2 St. Pipe Arch	183	LF	$ 450	$ 82,350
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 2,000	$ 2,000
12	Bank Stabilization / Bioengineering	837	SY	$ 50	$ 41,850
13	Traffic Control (5%)	1	LS	$8,800	$ 8,800
14	Erosion Control (10%)	1	LS	$17,600	$ 17,600
15	Mobilization (5%)	1	LS	$8,800	$ 8,800
				Subtotal	$ 211,000
	Contingency (50%)				$ 106,000
	State Sales Tax (8.2%)				$ 26,000
				Construction Cost	$ 343,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 120,000
	Land Acquisition				$ 0
				Total Project Cost	$ 463,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Fish Passage Culvert Replacement (MB-008) (PP-MB-4)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation Using Large Equipment	375	CY	$ 5	$ 1,875
2	Channel Excavation	40	CY	$ 15	$ 600
3	Stream Gravel	22	TN	$ 15	$ 330
4	Riprap	73	TN	$ 13	$ 949
5	Embankment Armoring (riprap)	12	CY	$ 45	$ 540
6	Backfill / Compaction	372	CY	$ 18	$ 6,696
7	Dewatering	1	LS	$ 2,000	$ 2,000
	Roadways and Asphalt				
8	Aspahlt, Class B	20.5	TN	$ 55	$ 1,128
9	Crushed Surfacing Top Course	37	TN	$ 30	$ 1,110
	Drainage Structures				
10	Precast 5' x 10' Concrete Box Section	65	LF	$ 800	$ 52,000
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 2,000	$ 2,000
12	Bank Stabilization / Bioengineering	105	SY	$ 50	$ 5,250
13	Traffic Control (5%)	1	LS	$3,700	$ 3,700
14	Erosion Control (10%)	1	LS	$7,400	$ 7,400
15	Mobilization (12%)	1	LS	$8,900	$ 8,900
				Subtotal	$ 94,000
	Contingency (50%)				$ 47,000
	State Sales Tax (8.2%)				$ 12,000
				Construction Cost	$ 153,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 54,000
	Land Acquisition				$ 0
				Total Project Cost	$ 207,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (MB-010)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,524,000	$ 1,524,000
2	Traffic Control (5%)	1	LS	$76,200	$ 76,200
3	Erosion Control (3%)	1	LS	$45,700	$ 45,700
4	Mobilization (8%)	1	LS	$121,900	$ 121,900
				Subtotal	$ 1,768,000
	Contingency (50%)				$ 884,000
	State Sales Tax (8.2%)				$ 217,000
				Construction Cost	$ 2,869,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 1,004,000
	Land Acquisition				$ 292,000
				Total Project Cost	$ 4,200,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention/Water Quality Pond (MB-011)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,520,000	$ 1,520,000
2	Water Quality Pond	1	LS	$ 760,000	$ 760,000
3	Traffic Control (5%)	1	LS	$76,000	$ 76,000
4	Erosion Control (5%)	1	LS	$76,000	$ 76,000
5	Mobilization (10%)	1	LS	$152,000	$ 152,000
				Subtotal	$ 2,584,000
	Contingency (50%)				$ 1,292,000
	State Sales Tax (8.2%)				$ 318,000
				Construction Cost	$ 4,194,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 1,468,000
	Land Acquisition				$ 654,000
				Total Project Cost	$ 6,400,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 1 Regional Detention Pond (MB-012)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 800,000	$ 800,000
2	Traffic Control (5%)	1	LS	$40,000	$ 40,000
3	Erosion Control (3%)	1	LS	$24,000	$ 24,000
4	Mobilization (9%)	1	LS	$72,000	$ 72,000
				Subtotal	$ 936,000
	Contingency (50%)				$ 468,000
	State Sales Tax (8.2%)				$ 115,000
				Construction Cost	$ 1,519,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 532,000
	Land Acquisition				$ 153,000
				Total Project Cost	$ 2,300,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 1 Regional Detention/Water Quality Pond (MB-013)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,540,000	$ 1,540,000
2	Water Quality Pond	1	LS	$ 770,000	$ 770,000
3	Traffic Control (5%)	1	LS	$77,000	$ 77,000
4	Erosion Control (5%)	1	LS	$77,000	$ 77,000
5	Mobilization (9%)	1	LS	$138,600	$ 138,600
				Subtotal	$ 2,603,000
	Contingency (50%)				$ 1,302,000
	State Sales Tax (8.2%)				$ 320,000
				Construction Cost	$ 4,225,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 1,479,000
	Land Acquisition				$ 442,000
				Total Project Cost	$ 6,200,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention/Water Quality Pond (MB-014)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 2,224,000	$ 2,224,000
2	Water Quality Pond	1	LS	$ 1,112,000	$ 1,112,000
3	Traffic Control (5%)	1	LS	$111,200	$ 111,200
4	Erosion Control (3%)	1	LS	$66,700	$ 66,700
5	Mobilization (9%)	1	LS	$200,200	$ 200,200
				Subtotal	$ 3,714,000
	Contingency (50%)				$ 1,857,000
	State Sales Tax (8.2%)				$ 457,000
				Construction Cost	$ 6,028,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 2,110,000
	Land Acquisition				$ 638,000
				Total Project Cost	$ 8,800,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (MB-016)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 180,000	$ 180,000
2	Traffic Control (3%)	1	LS	$5,400	$ 5,400
3	Erosion Control (5%)	1	LS	$9,000	$ 9,000
4	Mobilization (9%)	1	LS	$16,200	$ 16,200
				Subtotal	$ 211,000
	Contingency (50%)				$ 106,000
	State Sales Tax (8.2%)				$ 26,000
				Construction Cost	$ 343,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 120,000
	Land Acquisition				$ 52,000
				Total Project Cost	$ 520,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention/Water Quality Pond (MC-003)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 2,404,000	$ 2,404,000
2	Water Quality Pond	1	LS	$ 1,202,000	$ 1,202,000
3	Traffic Control (5%)	1	LS	$120,200	$ 120,200
4	Erosion Control (4%)	1	LS	$96,200	$ 96,200
5	Mobilization (8%)	1	LS	$192,300	$ 192,300
				Subtotal	$ 4,015,000
	Contingency (50%)				$ 2,008,000
	State Sales Tax (8.2%)				$ 494,000
				Construction Cost	$ 6,517,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 2,281,000
	Land Acquisition				$ 1,035,000
				Total Project Cost	$ 9,900,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (MC-004)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 600,000	$ 600,000
2	Traffic Control (3%)	1	LS	$18,000	$ 18,000
3	Erosion Control (5%)	1	LS	$30,000	$ 30,000
4	Mobilization (9%)	1	LS	$54,000	$ 54,000
				Subtotal	$ 702,000
	Contingency (50%)				$ 351,000
	State Sales Tax (8.2%)				$ 86,000
				Construction Cost	$ 1,139,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 399,000
	Land Acquisition				$ 172,000
				Total Project Cost	$ 1,710,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (MC-005)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 168,000	$ 168,000
2	Traffic Control (3%)	1	LS	$5,000	$ 5,000
3	Erosion Control (4%)	1	LS	$6,700	$ 6,700
4	Mobilization (8%)	1	LS	$13,400	$ 13,400
				Subtotal	$ 193,000
	Contingency (50%)				$ 97,000
	State Sales Tax (8.2%)				$ 24,000
				Construction Cost	$ 314,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 110,000
	Land Acquisition				$ 32,000
				Total Project Cost	$ 460,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Stream Detention Retrofit (MC-006)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Constructed Log Weir	1	LS	$ 50,000	$ 50,000
2	Access Road	1	LS	$ 50,000	$ 50,000
3	Traffic Control (3%)	1	LS	$1,500	$ 1,500
4	Erosion Control (4%)	1	LS	$2,000	$ 2,000
5	Mobilization (8%)	1	LS	$4,000	$ 4,000
				Subtotal	$ 108,000
	Contingency (50%)				$ 54,000
	State Sales Tax (8.2%)				$ 13,000
				Construction Cost	$ 175,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 61,000
	Land Acquisition				$ 32,000
				Total Project Cost	$ 270,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Fish Passage Culvert Replacement (FB-004) (PP-FB-4)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation	196	CY	$ 12	$ 2,352
2	Channel Excavation	20	CY	$ 15	$ 300
3	Stream Gravel	14	TN	$ 15	$ 210
4	Riprap	74	TN	$ 13	$ 962
5	Embankment Armoring (riprap)	4	CY	$ 45	$ 180
6	Backfill / Compaction	195	CY	$ 18	$ 3,510
7	Dewatering	1	LS	$ 1,000	$ 1,000
	Roadways and Asphalt				
8	Aspahlt, Class B	13	TN	$ 55	$ 715
9	Crushed Surfacing Top Course	23.3	TN	$ 30	$ 699
	Drainage Structures				
10	Precast 4' x 4' Concrete Box Section	80	LF	$ 300	$ 24,000
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 1,000	$ 1,000
12	Bank Stabilization / Bioengineering	111	SY	$ 50	$ 5,550
13	Traffic Control (5%)	1	LS	$2,000	$ 2,000
14	Erosion Control (5%)	1	LS	$2,000	$ 2,000
15	Mobilization (10%)	1	LS	$4,000	$ 4,000
				Subtotal	$ 48,000
	Contingency (50%)				$ 24,000
	State Sales Tax (8.2%)				$ 6,000
				Construction Cost	$ 78,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 27,000
	Land Acquisition				$ 0
				Total Project Cost	$ 105,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Fish Passage Culvert Replacement (FB-005) (PP-FB-4A)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation	375	CY	$ 12	$ 4,500
2	Channel Excavation	40	CY	$ 15	$ 600
3	Stream Gravel	29	TN	$ 15	$ 435
4	Riprap	20	TN	$ 40	$ 800
5	Embankment Armoring (riprap)	6	TN	$ 45	$ 270
6	Backfill / Compaction	370	CY	$ 5	$ 1,850
7	Dewatering	1	LS	$ 2,000	$ 2,000
	Roadways and Asphalt				
8	Aspahlt, Class B	15	TN	$ 55	$ 825
9	Crushed Surfacing Top Course	27	TN	$ 30	$ 810
	Drainage Structures				
10	83 Inch Span, Tr. 2 St. Pipe Arch	122	LF	$ 400	$ 48,800
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 5,000	$ 5,000
12	Bank Stabilization / Bioengineering	200	SY	$ 50	$ 10,000
13	Traffic Control (3%)	1	LS	$2,300	$ 2,300
14	Erosion Control (10%)	1	LS	$7,600	$ 7,600
15	Mobilization (8%)	1	LS	$6,100	$ 6,100
				Subtotal	$ 92,000
	Contingency (50%)				$ 46,000
	State Sales Tax (8.2%)				$ 11,000
				Construction Cost	$ 149,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 52,000
	Land Acquisition				$ 0
				Total Project Cost	$ 201,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Fish Passage Culvert Replacement (FB-006)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation	160	CY	$ 12	$ 1,920
2	Channel Excavation	16	CY	$ 15	$ 240
3	Stream Gravel	9	TN	$ 15	$ 135
4	Riprap	73	TN	$ 13	$ 949
5	Embankment Armoring (riprap)	4	CY	$ 45	$ 180
6	Backfill / Compaction	160	CY	$ 18	$ 2,880
7	Dewatering	1	LS	$ 1,000	$ 1,000
	Roadways and Asphalt				
8	Aspahlt, Class B	12.5	TN	$ 55	$ 688
9	Crushed Surfacing Top Course	23	TN	$ 30	$ 690
	Drainage Structures				
10	Precast 4' x 5' Concrete Box Section	67	LF	$ 350	$ 23,450
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 1,000	$ 1,000
12	Bank Stabilization / Bioengineering	68	SY	$ 50	$ 3,400
13	Traffic Control (5%)	1	LS	$1,800	$ 1,800
14	Erosion Control (5%)	1	LS	$1,800	$ 1,800
15	Mobilization (10%)	1	LS	$3,700	$ 3,700
				Subtotal	$ 44,000
	Contingency (50%)				$ 22,000
	State Sales Tax (8.2%)				$ 5,000
				Construction Cost	$ 71,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 25,000
	Land Acquisition				$ 0
				Total Project Cost:	$ 96,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (FB-008)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 384,000	$ 384,000
2	Traffic Control (5%)	1	LS	$19,200	$ 19,200
3	Erosion Control (3%)	1	LS	$11,500	$ 11,500
4	Mobilization (8%)	1	LS	$30,700	$ 30,700
				Subtotal	$ 445,000
	Contingency (50%)				$ 223,000
	State Sales Tax (8.2%)				$ 55,000
				Construction Cost	$ 723,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 253,000
	Land Acquisition				$ 110,000
				Total Project Cost	$ 1,100,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Regional Retention/Aquifer Recharge Pond (FB-010)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Retention Pond	1	LS	$ 220,000	$ 220,000
2	Traffic Control (5%)	1	LS	$11,000	$ 11,000
3	Erosion Control (4%)	1	LS	$8,800	$ 8,800
4	Mobilization (9%)	1	LS	$19,800	$ 19,800
				Subtotal	$ 260,000
	Contingency (50%)				$ 130,000
	State Sales Tax (8.2%)				$ 32,000
				Construction Cost	$ 422,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 148,000
	Land Acquisition				$ 84,000
				Total Project Cost	$ 660,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (FB-011)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,748,000	$ 1,748,000
2	Traffic Control (5%)	1	LS	$87,400	$ 87,400
3	Erosion Control (3%)	1	LS	$52,400	$ 52,400
4	Mobilization (10%)	1	LS	$174,800	$ 174,800
				Subtotal	$ 2,063,000
	Contingency (50%)				$ 1,032,000
	State Sales Tax (8.2%)				$ 254,000
				Construction Cost	$ 3,349,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 1,172,000
	Land Acquisition				$ 669,000
				Total Project Cost	$ 5,200,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Fish Passage Culvert Replacement (FB-013) (PP-FB-3)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation	126	CY	$ 12	$ 1,512
2	Channel Excavation	20	CY	$ 15	$ 300
3	Stream Gravel	7	TN	$ 15	$ 105
4	Riprap	73	TN	$ 13	$ 949
5	Embankment Armoring (riprap)	4	CY	$ 45	$ 180
6	Backfill / Compaction	126	CY	$ 18	$ 2,268
7	Dewatering	1	LS	$ 1,000	$ 1,000
	Roadways and Asphalt				
8	Aspahlt, Class B	13	TN	$ 55	$ 715
9	Crushed Surfacing Top Course	23.3	TN	$ 30	$ 699
	Drainage Structures				
10	Precast 4' x 4' Concrete Box Section	50	LF	$ 300	$ 15,000
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 1,000	$ 1,000
12	Bank Stabilization / Bioengineering	38	SY	$ 50	$ 1,900
13	Traffic Control (5%)	1	LS	$1,300	$ 1,300
14	Erosion Control (5%)	1	LS	$1,300	$ 1,300
15	Mobilization (10%)	1	LS	$2,600	$ 2,600
				Subtotal	$ 31,000
	Contingency (50%)				$ 16,000
	State Sales Tax (8.2%)				$ 4,000
				Construction Cost	$ 51,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 18,000
	Land Acquisition				$ 0
				Total Project Cost:	$ 69,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (EH-025)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 2,056,000	$ 2,056,000
2	Traffic Control (5%)	1	LS	$102,800	$ 102,800
3	Erosion Control (3%)	1	LS	$61,700	$ 61,700
4	Mobilization (8%)	1	LS	$164,500	$ 164,500
				Subtotal	$ 2,385,000
	Contingency (50%)				$ 1,193,000
	State Sales Tax (8.2%)				$ 293,000
				Construction Cost	$ 3,871,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 1,355,000
	Land Acquisition				$ 590,000
				Total Project Cost	$ 5,900,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (EH-026)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,268,000	$ 1,268,000
2	Traffic Control (5%)	1	LS	$63,400	$ 63,400
3	Erosion Control (4%)	1	LS	$50,700	$ 50,700
4	Mobilization (8%)	1	LS	$101,400	$ 101,400
				Subtotal	$ 1,484,000
	Contingency (50%)				$ 742,000
	State Sales Tax (8.2%)				$ 183,000
				Construction Cost	$ 2,409,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 843,000
	Land Acquisition				$ 364,000
				Total Project Cost	$ 3,700,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 1 Regional Detention Pond (EH-027)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 344,000	$ 344,000
2	Traffic Control (5%)	1	LS	$17,200	$ 17,200
3	Erosion Control (4%)	1	LS	$13,800	$ 13,800
4	Mobilization (8%)	1	LS	$27,500	$ 27,500
				Subtotal	$ 403,000
	Contingency (50%)				$ 202,000
	State Sales Tax (8.2%)				$ 50,000
				Construction Cost	$ 655,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 229,000
	Land Acquisition				$ 99,000
				Total Project Cost	$ 990,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (EH-029)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 600,000	$ 600,000
2	Traffic Control (3%)	1	LS	$18,000	$ 18,000
3	Erosion Control (5%)	1	LS	$30,000	$ 30,000
4	Mobilization (10%)	1	LS	$60,000	$ 60,000
				Subtotal	$ 708,000
	Contingency (50%)				$ 354,000
	State Sales Tax (8.2%)				$ 87,000
				Construction Cost	$ 1,149,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 402,000
	Land Acquisition				$ 115,000
				Total Project Cost	$ 1,700,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (EH-030)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 340,000	$ 340,000
2	Traffic Control (3%)	1	LS	$10,200	$ 10,200
3	Erosion Control (5%)	1	LS	$17,000	$ 17,000
4	Mobilization (10%)	1	LS	$34,000	$ 34,000
				Subtotal	$ 401,000
	Contingency (50%)				$ 201,000
	State Sales Tax (8.2%)				$ 49,000
				Construction Cost	$ 651,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 228,000
	Land Acquisition				$ 65,000
				Total Project Cost	$ 950,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (GL-006)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,452,000	$ 1,452,000
2	Traffic Control (5%)	1	LS	$72,600	$ 72,600
3	Erosion Control (4%)	1	LS	$58,100	$ 58,100
4	Mobilization (10%)	1	LS	$145,200	$ 145,200
				Subtotal	$ 1,728,000
	Contingency (50%)				$ 864,000
	State Sales Tax (8.2%)				$ 213,000
				Construction Cost	$ 2,805,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 982,000
	Land Acquisition				$ 278,000
				Total Project Cost	$ 4,100,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 1 Regional Detention Pond (ED-006)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 532,000	$ 532,000
2	Traffic Control (5%)	1	LS	$26,600	$ 26,600
3	Erosion Control (3%)	1	LS	$16,000	$ 16,000
4	Mobilization (8%)	1	LS	$42,600	$ 42,600
				Subtotal	$ 617,000
	Contingency (50%)				$ 309,000
	State Sales Tax (8.2%)				$ 76,000
				Construction Cost	$ 1,002,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 351,000
	Land Acquisition				$ 102,000
				Total Project Cost	$ 1,500,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (ED-007)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,204,000	$ 1,204,000
2	Traffic Control (5%)	1	LS	$60,200	$ 60,200
3	Erosion Control (4%)	1	LS	$48,200	$ 48,200
4	Mobilization (8%)	1	LS	$96,300	$ 96,300
				Subtotal	$ 1,409,000
	Contingency (50%)				$ 705,000
	State Sales Tax (8.2%)				$ 173,000
				Construction Cost	$ 2,287,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 800,000
	Land Acquisition				$ 230,000
				Total Project Cost	$ 3,400,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (ED-008)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,244,000	$ 1,244,000
2	Traffic Control (5%)	1	LS	$62,200	$ 62,200
3	Erosion Control (5%)	1	LS	$62,200	$ 62,200
4	Mobilization (8%)	1	LS	$99,500	$ 99,500
				Subtotal	$ 1,468,000
	Contingency (50%)				$ 734,000
	State Sales Tax (8.2%)				$ 181,000
				Construction Cost	$ 2,383,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 834,000
	Land Acquisition				$ 238,000
				Total Project Cost	$ 3,500,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Fish Passage Culvert Replacement (BH-004) (PP-BH-1)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
	Earthwork				
1	Excavation	320	CY	$ 12	$ 3,840
2	Channel Excavation	30	CY	$ 15	$ 450
3	Stream Gravel	15	TN	$ 15	$ 225
4	Riprap	12	TN	$ 40	$ 480
5	Embankment Armoring (riprap)	9	TN	$ 45	$ 405
6	Backfill / Compaction	320	CY	$ 5	$ 1,600
7	Dewatering	1	LS	$ 2,000	$ 2,000
	Roadways and Asphalt				
8	Aspahlt, Class B	19	TN	$ 55	$ 1,045
9	Crushed Surfacing Top Course	34	TN	$ 30	$ 1,020
	Drainage Structures				
10	83 Inch Span, Tr. 2 St. Pipe Arch	60	LF	$ 400	$ 24,000
	Landscaping				
11	Restoration and Landscaping	1	LS	$ 3,000	$ 3,000
12	Bank Stabilization / Bioengineering	83	SY	$ 50	$ 4,150
13	Traffic Control (3%)	1	LS	$1,300	$ 1,300
14	Erosion Control (10%)	1	LS	$4,200	$ 4,200
15	Mobilization (8%)	1	LS	$3,400	$ 3,400
				Subtotal	$ 51,000
	Contingency (50%)				$ 26,000
	State Sales Tax (8.2%)				$ 6,000
				Construction Cost	$ 83,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 29,000
	Land Acquisition				$ 0
				Total Project Cost	$ 112,000

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN
PLANNING LEVEL PROJECT COST ESTIMATE
Kato & Warren, Inc.

PROJECT: Level 2 Regional Detention Pond (BH-009)

ITEM	BID ITEM	QUANTITY	UNIT	UNIT PRICE (2000$)	AMOUNT (2000$)
1	Regional Detention Pond	1	LS	$ 1,124,000	$ 1,124,000
2	Traffic Control (5%)	1	LS	$56,200	$ 56,200
3	Erosion Control (5%)	1	LS	$56,200	$ 56,200
4	Mobilization (8%)	1	LS	$89,900	$ 89,900
				Subtotal	$ 1,326,000
	Contingency (50%)				$ 663,000
	State Sales Tax (8.2%)				$ 163,000
				Construction Cost	$ 2,152,000
	Engineering, City Administration, Permitting, Construction Mgmt (35%)				$ 753,000
	Land Acquisition				$ 323,000
				Total Project Cost	$ 3,300,000

APPENDIX E
SURFACE WATER MANAGEMENT PLAN
CITY'S DRAFT CIP 2001 - 2006

City's Draft Capital Improvement Program (CIP) SUMMARY

City of Bainbridge Island

Surface Water Management Plan

Appendix E

	Priority	M/E/N	2001 FTE	Funding Source		SWMP Problem ID	Roads	Water	Wastewater	Drainage	2001		2002		2003		2004		2005		2006	2007-2020	PROJECT TOTAL
					CAPITAL/RECONSTRUCTION IMPROVEMENTS																		
		M	0.85		Roads Resurfacing Program - Annual		100%				861		1,000		1,000		1,000		1,000		1,000	14,000	19,861
		E	0.14		Bike Lanes - Annual		100%				100		100								100	1,400	1,700
		E	0.08		Pedestrian Access - Annual		100%				50		50								50	700	850
		E	0.08		Enhancements-Intersection/Transit		100%				50		50		50		50		50		50	700	1,000
			0.00		WMP - Parking																		
*		E	0.36	$380 $601	High School Road (Madison-Sportsman)	EH-001	90%	0%	0%	10%	1,500	c											1,500
		E	0.00		Manitou Beach Rd. Phase I	MC-008	93%	0%	0%	7%			658	c									658
*		E	0.03	G$623	Wyatt Way Reconst. (Madison-Finch)	EH-009	70%	0%	0%	30%	228	dr	228	dr	1,714	c							2,170
*		E	0.24	LID $147	Madison Ave-WMP (HS-New Brook)		100%	0%	0%		191	drc	191	drc									382
		E	1.75	Dev LID G$100	Ericksen Trf. Calming (WinWay-Wallace)	EH-006	60%	20%	10%	10%	114	d			836	c							950
			0.14	Bnd 2001	Winslow Loop, Knetchel, Wallace Ped-Bike Safety Non-Motorized Plan Isl-Wide	EH-004	70%	10%	10%	10%	100	d	1,000	c	1,000	c	1,000	c	900	c			4,000
*		E	0.00		WinWay Dwntwn-WMP (SR305-Madison)	EH-038	65%	10%	12%	13%			257	d			1,782	c					2,039
		E	0.00	dev	Halls Hill/Blakely Hill Relocation	BH-013	100%						170	d/c									170
		E	0.00	dev	Ft. Ward Hill Reconst. (north-end)	BH-005	90%			10%			168	d	562	c							730
		E	0.00		Ericksen-WinWay I/S-South	EH-038	60%	20%	10%	10%					220	c							220
		E	0.00		Ericksen-Hildebrand Opening	EH-041	60%	20%	10%	10%													
		E	0.00		Ericksen-HSRD I/S	EH-041	60%	20%	10%	10%													
		E	0.00		Manitou Beach Phase II	MC-002	93%	0%	0%	7%												414	414
		N	0.00		Bypass Road-WMP	EH-007	70%	10%		20%												1,500	1,500
		E	0.00		Wing Pt. Road Reconstruction	EH-022	65%	15%	5%	15%							255	dr	833	c			1,088
		E	0.00	LID	Upper Crystal Springs	GL-003	65%	15%	5%	15%													0
		E	0.00		High School Rd-WMP (Madison-Ferncliff)		100%															384	384
		E	0.00		Sands Avenue ( )		100%																0
		N	0.00		Shephard Way ( )		100%																0
		M	0.00		Day Road East (SR305-Sunrise)	S-004	90%			10%												1,005	1,005

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City's Draft Capital Improvement Program (CIP) SUMMARY

City of Bainbridge Island

Surface Water Management Plan

Appendix E

Priority	M/E/N	2001 FTE	Funding Source		SWMP Problem ID	Roads	Water	Wastewater	Drainage	2001	2002	2003	2004	2005	2006	2007-2020	PROJECT TOTAL
	E	0.00		Winslow Way W. (Eagle-Grow)	EH-013	65%	10%	10%	15%							866	866
	E	0.00		Winslow Way E. (Ferncliff-Eagle Harbor)	EH-014	55%	12%	15%	18%							159	159
	E	0.00		MFNB Intersection - Phase II	FB-014	85%			15%							524	524
				PROJECT(S) SUB-TOTAL						**3,194**	**3,872**	**5,382**	**4,087**	**2,783**	**1,200**	**24,152**	**44,670**
				ROADS						2,900	3,351	4,089	3,074	2,221	1,200	23,119	
				WATER						33	126	311	316	215	0	256	
				WASTEWATER						21	131	206	327	132	0	110	
				DRAINAGE						240	265	776	370	215	0	667	
										3,194	3,872	5,382	4,087	2,783	1,200	24,152	
				DRAINAGE/EROSION/EARTH MOVEMENT													
	E	0.25		Drainage Upgrades - Annual					100%	200	200	200	200	200	200	2,800	4,000
8	E	0.08		Shoreline Protection - ESA Response					100%	50	50	50	50	50	50	700	1,000
3	E	0.00		Fairview/Madrona AREA	EH-021				100%	190							190
4	E	0.00		McRedmond/Wardwell AREA	MC-007				100%	150							150
5	E	0.00		Mountain View Drive	S-005				100%	80							80
1	N/E	0.33		Decant Facility	EH-037				100%	275							275
	E	0.00		Manzanita AREA	MB-004				100%	150							150
2	E	0.00	dev	Halls Hill Area	BH-003				100%		220						220
	E	0.00		Upper Crystal Springs	GL-003				100%		200						200
6	E	0.00		Crystal Springs AREA	GL-010				100%			379					379
	E	0.00		Pt. White Drive AREA	GL-004				100%			150					150
7	E	0.00		Lynwood Center	PB-001				100%			75					75
	E	0.00		Country Club Rd. Revetment	BH-006				100%							550	550
	E	0.00		Battle Point Area	FB-001				100%							60	60
	E	0.00		Beck/Pleasant Beach AREA	PB-004				100%							225	225
	E	0.00		Eagle Harbor Rd. Cut Stabilization	ED-001				100%							225	225
	E	0.00		Erickson Ave - WMP - Convenance	EH-006				100%							144	144
	E	0.00		Euclid Ave. (Dorsey & Loop)	S-002				100%							350	350

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City's Draft Capital Improvement Program (CIP) SUMMARY

City of Bainbridge Island

Surface Water Management Plan

Appendix E

Priority	M/E/N	2001 FTE	Funding Source		SWMP Problem ID	Roads	Water	Wastewater	Drainage	2001		2002		2003		2004		2005		2006	2007-2020	PROJECT TOTAL
	E	0.00		Lovell Avenue Drainage (HS-Wyatt)	EH-039				100%												300	300
	E	0.00		Lower Weaver (Sportsman Club) - WMP conveyance	EH-012				100%												153	153
	E	0.00		Park Avenue	EH-011				100%												40	40
	E	0.00		Phelps Rd. Drainage	PM-001				100%												80	80
	E	0.00		Reitan Road	AP-003				100%												60	60
	E	0.00		Rockaway Beach	ED-002				100%												175	175
	E	0.00		Rolling Bay Walk	S-006				100%													0
	E	0.00		Rotary - WMP - Detention	EH-036				100%												35	35
	E	0.00		South Beach Drive Revetment	SB-003				100%												336	336
	E	0.00		Sunrise AREA	S-003				100%												85	85
	E	0.00		Taylor/New Sweden AREA	ED-004				100%												150	150
	E	0.00		Venice Loop AREA	MB-003				100%												380	380
	E	0.00		WinWay/Cave - WMP - Conveyance	EH-031				100%												297	297
	E	0.00		Wyatt Basin A - WMP - Detention	EH-035				100%												50	50
	E	0.00		Wyatt/Grow Basin B - WMP Conveyance	EH-010				100%												500	500
				DRAINAGE SUB-TOTAL						**1,095**		**670**		**854**		**250**		**250**		**250**	**7,695**	**11,064**
				FACILITIES																		
		0.08		PWYard North Annex						250	d/c										1,950	2,200
	N	0.01		ROW/Land Acq.						50		50		50		50		50		50		300
	E	0.08		Police & Court						50	d										5,000	5,050
		0.00		PWYard South Annex								50	d	200	c						450	700
	M	0.00		City Hall																		0
	N/E	0.00		Energy - Telecommunications																		
		5.71		**FACILITIES SUB-TOTAL**						**350**		**100**		**250**		**50**		**50**		**50**	**7,400**	**8,250**
				EQUIPMENT - FLEET						**400**		**400**		**400**		**400**		**400**		**400**	**5,600**	**8,000**
				EQUIPMENT - NON-FLEET						**80**		**80**		**80**		**80**		**80**		**80**	**1,120**	**1,600**

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SECTION 1
SURFACE WATER MANAGEMENT PLAN
EXECUTIVE SUMMARY/ACTION PLAN

SECTION 1
SURFACE WATER MANAGEMENT PLAN
EXECUTIVE SUMMARY/ACTION PLAN

The development of a **Surface Water Management Plan** (SWMP) is mandated by the Department of Ecology through the **Puget Sound Water Quality Management Plan (PSWQMP)**. Other regulatory requirements addressed in this **Surface Water Management Plan** include the National Pollutant Discharge Elimination System (NPDES) Phase II Rule, and anticipated requirements of the ESA Section 4(d) rule resulting from the listing of the Puget Sound chinook salmon as threatened. This plan also attempts to implement the long-range water resources and surface water goals and policies contained in the **Bainbridge Island Comprehensive Plan.**

The purpose of the **Surface Water Management Plan** is to provide guidance to the City of Bainbridge Island for day to day decision-making, budgeting, and developing policy related to all aspects of surface water management, including:

- Capital Facility Needs
- Development Regulations and Review
- Inspection and Enforcement of Development Regulations
- Operation and Maintenance
- Illicit Discharge Detection and Elimination
- Public Education and Involvement
- Comprehensive Storm Drainage Mapping
- Funding

Capital Facility Needs

An assessment of Bainbridge Island's existing surface water systems was performed for this study through meetings with City Public Works staff, field visits, review of previous studies, review of existing mapping, review of the City's Draft 2001-2006 CIP, and hydrologic/hydraulic modeling of future build-out land use conditions on existing infrastructure. From these efforts a list of known and future surface water problems was assembled, and additional research was performed to assess potential solutions to the problems.

It is recommended that the City's **Drainage Upgrades Program** be continued to resolve large individual drainage problems across the island. It is recommended that smaller

problems typically reported by citizens or maintenance personnel should continue to be addressed immediately by Operations and Maintenance. It is also recommended to continue the recently added Shoreline Protection/ESA Response funding found in the City's Draft 2001-2006 CIP. These funds can be used for minor energy dissipation, culvert replacement, fish passage barrier removal, and as match money for grant applications. Given available funding, capital projects will continue to proceed as funding is available. Increasing the combined annual budget for these programs from $250,000 to $450,000 for a period of 30 years is recommended in order to eliminate the current estimated $6 million Drainage/Erosion/Earth Movement CIP backlog found in the City's Draft 2001-2006 CIP.

To address those projects in between the small O&M-sized immediate fixes and the larger high priority projects addressed as a CIP it is recommended that the City authorize staff or consultant time and funding to investigate, evaluate alternatives, and perform the preliminary engineering and cost analysis necessary to categorize and rank each reported drainage problem. Once categorized and ranked the problems can be added to the CIP process or if small enough the staff or consultant information generated could be turned over after little additional effort to O&M for construction.

Development Regulations and Review

Bainbridge Island has adopted its own surface water management code (City of Bainbridge Island Municipal Code Chapter 15.20) and the most recent edition of the Ecology Manual as modified by BIMC 15.20 as the standard stormwater management criteria for new development and redevelopment projects on public and private property. Surface Water Management techniques and BMPs have developed rapidly in recent years and Ecology is in the process of updating their Manual. Continued use of the Ecology Manual is recommended, with modifications to close exemption "loop-holes" and to implement Bainbridge Island's surface water goals and policies. It is recommended that City staff continue reviewing the draft Ecology Manual and when published recommend its adoption via ordinance with selective edits. These modifications would include but are not limited to:

- Decreasing the number of projects exempt from surface water review (including roofdrains from single family residences) and reduce the number of projects eligible for the less restrictive "small site" review requirements.

- Increase the flow control and/or retention requirements for redevelopment projects, and for all projects draining to streams regardless of their salmon-bearing status.

- Require developers to consider aesthetics in the design of surface water facilities, and to incorporate multiple-use facilities wherever possible.

Inspection and Enforcement of Development Regulations

To insure compliance with stormwater regulations the City must be able to inspect development throughout the building process and then revisit existing systems to confirm continued function. It is recommended that the City continue field inspections of all new development during the construction process and strengthen its periodic visitation to established systems. The City should utilize their municipal prescriptive access, maintenance and enforcement rights on private property when they can show landowner or natural modifications to runoff courses have adversely impacted the drainage system. During busy periods, it is recommended that the City utilize contract consultants for performing surface water reviews and inspections for both residential and commercial projects.

Operation and Maintenance

A program for maintaining the conveyance and storage capacity of natural drainage ways, constructed culverts, channels and ditches as well as detention/retention basins can reduce or prevent erosion and flood damage. Current maintenance practice falls short of City code requirements and state and federal guidelines. Systematic, routine preventative maintenance should be performed on vital public and private stormwater infrastructure. These same stormwater facilities should be tracked and reporting on annually. Disposal of waste from maintenance procedures should follow the minimum Functional Standards for Solid Waste Handling and/or the Dangerous Waste Regulations.

Illicit Discharge Elimination and Detection

An expanded program is recommended to identify and eliminate pollutants entering the storm drainage system. Bainbridge Island currently tests CB sediments for contaminants in high use areas. This expanded program is needed to better comply with requirements of the Puget Sound Water Quality Management Plan, Phase II NPDES permitting (if applicable), and anticipated requirements of the ESA Section 4(d) rule. This expanded program would include individual site inspections and in some cases chemical or biological sampling to identify water quality code violations. This expanded program should be coordinated with the City's public education program. The annual cost of this new program is estimated to be $20,000 for the first year for a comprehensive program to inspect all commercial and representative residential sites. After the initial effort, it may be possible to decrease the program coverage and focus only on sites with previous or anticipated future violations.

Public Education and Involvement

Many degrading activities, such as wetland filling, removal of streamside vegetation, or disposal of used oil and household chemicals into storm drains, occur because residents don't understand the consequences of their actions. The City should continue to implement and develop programs for surface water public education, outreach and involvement in order to continue compliance with requirements of the Puget Sound Water Quality Management Plan. These programs should also comply with anticipated Phase II NPDES permitting (if applicable), and anticipated requirements of the ESA

Section 4(d) rule. Public education, outreach and involvement enhance community participation in solutions to surface water-related problems. The Bainbridge Island Watershed Action Plan (1997) outlines an extensive program to involve the general community in a variety of educational experiences for understanding natural systems on the island. The City should continue to implement the Action Plan. Ongoing public involvement opportunities include stream monitoring, habitat enhancement and restoration, storm drain marker program, rain barrel program and other surface water education programs, for example, the City has waived the Bainbridge Island School District's stormwater fees in exchange for providing watershed education to the schools. It is recommended that additional staff be acquired and approximately $25,000 of the surface water budget be set aside each year to fund public education, outreach and involvement.

Comprehensive Storm Drainage Mapping

A comprehensive storm drainage asset inventory and associated facility documentation is lacking. Operations and Maintenance (O&M) has an annually updated culvert inventory and Engineering is compiling an inventory of storm conveyance and mitigation systems from development plans but the stormwater infrastructure inventory is limited and questions of ownership hamper operation and maintenance efforts. Comprehensive mapping of all storm sewers, culverts, ditches, and streams is recommended for efficient operation and maintenance of the system. If incorporated into a GIS system, this mapping could be attached to a maintenance database used for scheduling maintenance and repair. Storm drainage system mapping is also a requirement of Phase II NPDES permitting, if such permitting proves to be applicable to the City. The estimated cost of mapping Bainbridge Island's entire stormwater system is $50,000 and would use recent LiDAR data to document open drainage channels. This is an effort that could be spread over several years.

Funding

The current revenues are not adequate to fund the stormwater system operation and maintenance, the Drainage Upgrades Program and the education, enforcement and other efforts recommended in the SWMP. The City should consider a gradual increase in the storm and surface water service charge and development of a stormwater impact fee as discussed further in Section 8.

SECTION 2
SURFACE WATER MANAGEMENT PLAN
INTRODUCTION

SECTION 2
SURFACE WATER MANAGEMENT PLAN
INTRODUCTION

2.1 Introduction

In 1991, Island residents elected to annex all portions of Bainbridge Island to the existing City of Winslow and change the name of their new city to Bainbridge Island. The city now has a population just over 20,000 covering just over 27 square miles. The City of Bainbridge Island wishes to actively define and manage water resources throughout the island. These resources provide the basis for a number of beneficial uses, including fisheries, agriculture, domestic supply, and wildlife habitat to name a few. Deficiencies in the amount and quality of available data, an overall lack of understanding of hydrologic systems, especially the deeper aquifers, and no previous efforts related to regional water resource management are some of the issues to be addressed. To achieve a suitable balance in the allocation of water resources and to protect the integrity of existing natural systems, the City seeks to substantially improve its understanding of the multiple aspects of this resource.

To help the City in this undertaking, existing water resources data has been compiled and interpreted and new data has been generated reflecting future probable scenarios. Resource management alternatives have been developed for the City and an Action Plan, including a CIP, has been generated to assist the City in achieving its resource management goals.

The Water Resources Study is divided into three parts: Level II Basin Assessment, Water System Plan, and **Surface Water Management Plan**. The general focus of the Level II Basin Assessment is to further explore hydrogeologic conditions discussed in the Level I Basin Assessment. It assesses among other things: hydrogeologic characteristics of substrates; groundwater levels; flow directions; groundwater quality; water budgets; land use; zoning; anticipates impacts of growth; surface and ground water system interactions; water rights and water use.

The general focus of the Water System Plan is to explore management and distribution alternatives given aquifer resources, system capacities and projected population distributions. Fire flow requirements and the condition of pipes, reservoirs, and facilities were considered. The purpose and scope of the **Surface Water Management Plan** is discussed in the following section.

2.2 Purpose and Scope

The purpose of the **Surface Water Management Plan** is to provide guidance to the City of Bainbridge Island for the development of policy related to stormwater management. As the island develops, large areas of impervious surfaces are created that result in increased runoff volumes and decreased groundwater recharge. This in turn increases flooding and erosion of the receiving ditches and stream channels to which it is directed. Erosion can

cause damage to both public and private property and is generally the responsibility of the Department of Public Works to correct. This study assesses existing conditions within the different drainage basins and assesses impacts from stormwater runoff on both natural and built drainage systems. Problem areas are identified and recommendations made to correct specific problems as well as to create a management plan to reduce impacts in the future.

The Scope of Work for this study has included:

- Development of AutoCAD maps of the City and its drainage basins.
- A review of City regulations and codes related to drainage.
- Identify known or suspected problem areas.
- A review of current operation and maintenance of the drainage systems.
- A hydrologic and hydraulic analysis of the drainage systems in each basin based on future build-out conditions.
- Recommended capital improvements to address identified problems.
- Development of a funding strategy to accomplish the highest priority recommendations.

The intent of this study is to provide a program of improvements, regulatory actions, and funding to achieve the following:

- Provide for the long-term protection and rehabilitation of the Island's streams, wetlands and other beneficial uses of water.
- Provide a plan of drainage improvements and regulatory actions to reduce or eliminate problems of erosion, landslides and flooding on public or private property.

2.3 State, Federal and Local Surface Water Planning Requirements

Several regulations were considered in the preparation of this **Surface Water Management Plan.** The primary regulating document at this time is the 1994 Puget Sound Water Quality Management Plan (PSWQMP), established by the Puget Sound Water Quality Authority and the Washington State Department of Ecology (DOE). The federal Endangered Species Act (ESA) listing for the threatened chinook salmon will affect Bainbridge Island surface water regulations in the near future as may the "Phase II Rule" of the National Pollutant Discharge Elimination System (NPDES) if it proved applicable. Several other local planning documents as listed in the next section and the reference section were reviewed during the preparation of this plan.

2.3.1 Puget Sound Water Quality Management Plan

The Puget Sound Water Quality Management Plan requires all cities and counties to adopt a Basic Stormwater Program by implementing the following:

- A Stormwater Management Ordinance that addresses:
  1. The control of storm water quality and quantity effects
  2. The use of Best Management Practices (BMPs) for source control and treatment
  3. The effective treatment of the design storm for proposed development
  4. The use of infiltration as the first consideration in stormwater management
  5. The protection of stream channels and aquatic habitat
  6. Local enforcement of stormwater controls
- A Stormwater Maintenance and Operations Program (including education)
- A Stormwater Management Manual

DOE requires jurisdictions in urbanized areas to determine and implement a range of activities in addition to the basic stormwater requirements. Bainbridge Island falls under the basic requirements of the Puget Sound Water Quality Management Plan.

2.3.2 Endangered Species Act

The March 1999 listing of Puget Sound chinook salmon as threatened under the federal Endangered Species Act (ESA) requires regional and local jurisdictions as well as the entire state of Washington to take proactive steps toward the protection and the ultimate recovery of the species. The National Marine Fisheries Service (NMFS) is the agency responsible for ESA listing of threatened salmon species. NMFS is currently in the process of developing ESA Section 4(d) rules for Chinook salmon that will establish protective regulations, which each jurisdiction must follow. Several regional ESA response efforts are underway. The Tri-County effort includes King, Pierce, and Snohomish counties in negotiations with NMFS on Section 4(d) rules. Although the 4(d) rules for the Tri-County region have not been finalized, a draft "Stormwater Management Checklist" has been published by the Tri-County group that is expected to be similar to stormwater regulations in the adopted 4(d) rules by 2001. The 14 programmatic elements of the draft "Stormwater Management Checklist" mostly elaborate on elements already required under Phase II NPDES, the PSWQMP, and the Growth Management Act (GMA). Specific timelines and objectives are included that could require more stringent development standards and additional funding for stormwater management programs. Kitsap County is also preparing an ESA response. The City of Bainbridge Island is drafting its own response to the ESA Chinook salmon listing.

2.3.3 Phase II National Pollutant Discharge Elimination System (NPDES)

Under federal regulations, the National Pollutant Discharge Elimination System (NPDES) is the fundamental regulatory mechanism of the 1972 Clean Water Act. The NPDES program requires anyone discharging a pollutant from a point source into the waters of the United States to obtain an NPDES permit. The Phase I rule, issued in November 1990, addressed storm water discharges from communities with populations of at least 100,000 as well as all storm water discharges associated with industrial activity. The final Phase II regulations, issued in October 1999, expanded the Phase I regulations to include smaller communities. Bainbridge Island was not published in the Federal Register as a NPDES Phase II City but WSDOE is the local permitting authority

and they have not evaluated which City's are to be included. The decision is anticipated in 2001 in order to meet permit deadlines.

Under Phase II regulations small communities must:

- Specify BMPs for six minimum control measures and implement them to the "maximum extent practicable." The six minimum control measures are:
  1. Public Education and Outreach
  2. Public Involvement/Participation
  3. Illicit Discharge Detection and Elimination
  4. Construction Site Storm Water Runoff Control
  5. Post-Construction Storm Water Management in New Development and Redevelopment
  6. Pollution Prevention/Good Housekeeping for Municipal Operations
- Identify measurable goals for control measures.
  Examples of measurable goals include inspection or repairing a certain number of drain inlets each year, conducting street-sweeping operations a certain number of times each year, conducting a certain number of training classes for municipal operations each year, soliciting help of a certain number of volunteers each year, etc.
- Show an implementation schedule of activities or frequency of activities
- Define the entity responsible for implementation (e.g. department or individual)

Permit applications must be submitted by March 2003, with programs developed and implemented by 2008. For the most part this **Surface Water Management Plan** addresses Phase II NPDES requirements, which are similar to the anticipated requirements for ESA 4(d). As a result, Bainbridge Island will be better positioned if necessary to apply for a municipal NPDES permit in the future.

2.3.4 Bainbridge Island Goals and Policies

As part of the comprehensive planning process, the City developed water resources and stormwater goals and policies listed below that more fully develop the community's vision for their city and assist policymakers make long-range planning, future legislative and administrative decisions. The following select goals and policies were considered when developing this **Surface Water Management Plan**.

2.3.4.1 Water Resources Goal

Protection of water resources is of primary importance to the Island. Therefore, the goal is to manage the water resources of Bainbridge Island so that, with future development on the Island:

- *Degradation of ground water quality and quantity is not allowed.*
- *Water supplies and systems are efficiently utilized.*
- *The long-term sustainability of the Island's water resources is maintained.*

- *The water needs of new development approved under the Comprehensive Plan are adequately met.*
- *Adequate data of the water resource is available.*

2.3.4.2 Selected Water Resources Policies

WR 1.1
City land use policies should be consistent with the prudent use and protection of the water resources of Bainbridge Island.

WR 1.4
The City should institute a program of water resource data gathering and analysis with periodic publication of the results. Such program shall include geologic studies and monitoring of static water levels, water use, water quality, surface water flows, and acquisition of other data as necessary. Developers should be required to fund monitoring of water quality and quantity of water resources that a development directly impacts.

WR 1.5
Hydrogeologic assessments shall be required for development exceeding specified densities, characteristics, or water use thresholds, since water resources are highly complex and adverse hydrologic impacts can take many forms. These assessments shall also be required for all commercial and industrial development. If the hydrogeologic assessment identifies hydrologically sensitive conditions, then development shall not be permitted without appropriate mitigation that prevents long-term degradation of the resource.

WR 1.6
To protect groundwater resources, areas identified as high groundwater recharge areas should be maintained in low impact uses.

WR 1.8
The City shall request notification from the Bremerton-Kitsap County Health District of all waivers or variances of Health District requirements, such as modifications of setbacks, vertical separation, minimum lot size, reserve drainfields, etc., prior to issuance of an approved Building Site Application.

WR 1.9
The City shall restrict activities that would reduce the flow of springs and streams and levels of wetlands that are either sustained by groundwater discharge or contribute recharge to groundwater.

WR 1.10

New wellhead protection procedures should be instituted by the City in cooperation with the appropriate regulatory agencies (e.g., Washington State Department of Health and the Bremerton-Kitsap County Health District).

WR 1.11

Water conservation, water re-use, and reclamation should be aggressively pursued by the City to promote the efficient use of water and to protect the resource. Water re-use and reclamation shall serve as a supplementary source for high-water users such as industry, parks, schools, and golf courses. The planting of vegetation which prevents soil erosion, protects habitat for wildlife, retains surface water for recharge, and which does not require additional water during normally dry months shall be encouraged.

2.3.4.3 Stormwater Goal

Manage stormwater runoff to protect property from flooding and erosion; to protect streams and shorelines from erosion and sedimentation to avoid the degradation of environmental quality and natural system aesthetics; to protect the quality of groundwater, surface water, and the waters of Puget Sound, and to provide recharge of groundwater where appropriate.

2.3.4.4 Storm Drainage Policies

SD 1.1

The City should develop a comprehensive storm drainage plan which:

- *Identifies existing and potential problems at the drainage basin level.*
- *Proposes solutions to those problems.*
- *Identifies location of major conveyance and regional retention/detention facilities.*
- *Recognizes the importance of natural systems and receiving waters and their preservation and protection.*
- *Provides a strategy for implementation and funding.*
- *Sets design and development guidelines.*

SD 1.2

The City should plan watershed management approaches to provide improved performance, maintenance, and cost efficiency. Wherever possible, facilities should be considered as a multi-functional community resource which provides additional public benefits such as recreational, habitat, cultural, educational, open space, and aesthetic opportunities.

SD 1.3

The City should require new development to provide both on-site improvements and all off-site improvements necessary to avoid adverse downstream water quality and quantity impacts.

SD 1.4
Where appropriate and feasible, infiltration of stormwater is preferred over surface discharge to downstream system. The return of uncontaminated precipitation to the soil at natural rates near where it falls should be encouraged through the use of detention ponds, grassy swales, and infiltration facilities.

SD 1.5
Stormwater systems should be encouraged which provide for removal of pollutants and sediment through biofiltration where appropriate and feasible.

SD 1.6
Development should be designed and constructed to minimize disruption and/or degradation of natural drainage systems, both during and after construction.

SD 1.7
Zoning and development design standards should encourage site permeability and minimize impervious areas by restricting site coverage, retaining natural vegetation and buffers, and specifying use of permeable materials.

SD 1.8
The City should consider encouraging industrial, commercial, and agricultural land uses to manage surface water in a manner which prevents pollutants from entering ground or surface waters.

SD 1.9
Maintain water level fluctuations in regulated wetlands used for stormwater retention/detention similar to those which would be present under natural conditions. Surface water should be of high quality prior to release to wetlands for retention or detention.

SD 1.10
The City shall consider stormwater retention systems for roads which run along the shoreline in order to minimize pollution of Puget Sound by runoff from the roadways.

2.4 Approach to Stormwater System Analysis

In keeping with the goals and policies of the Storm Drainage section of the City's Comprehensive Plan, this work has identified existing and potential problems at the drainage basin level and proposes solutions to those problems. Also identified are possible locations of major conveyance and regional retention/detention facility improvements. Every effort has been made to recognize the importance of natural

systems and receiving waters and to preserve and protect these features. A strategy for implementation and funding of drainage capital improvement projects as well as recommendations for design and development guidelines are included. Drainage basins have been considered in their entirety and suggestions for drainage management have included the use of retention/detention facilities as recreational, habitat, cultural, educational, open space, and aesthetic opportunities.

2.4.1 Prior Studies

The following earlier works were considered during the **Surface Water Management Plan** development:

- Streams of Bainbridge Island, Elfendahl, G., 1997
  Bainbridge Island Watershed Action Plan, Bainbridge Island Watershed Management Committee, 1997
- Generalized Data Dictionary: Bainbridge Island Coverages, 1995
- Bainbridge Island Watersheds, Puget Sound Cooperative River Basin Team, 1995
- Bainbridge Island Watershed Action Plan Implementation – Final Summary, Garitone, J., 1998
- Bainbridge Island Watershed Nonpoint Source Pollution Water Quality Assessment Project, Grellner, K., Bauman, B., Ultican, S., and McNickle, M. 1997
- Bainbridge Island Drainage Reconnaissance Study, Kato & Warren, 1992
- City of Bainbridge Island Capital Facilities Plan, City of Bainbridge Island, 1999
- City of Bainbridge Island Comprehensive Plan, City of Bainbridge Island, 1994
- Winslow Master Plan, City of Bainbridge Island, 1998
- City of Winslow Stormwater Drainage Plan, Gardener Engineering, Inc., and Warren Consultants, Inc., 1985

2.4.2 Basin Analysis

For purposes of future deficiency analysis, 12 Bainbridge Island drainage basins have been divided into 85 pinch-point drainage basins. Drainage characteristics of each were entered into the King County Runoff Time Series (KCRTS) continuous flow computer model, using Bainbridge Island hydrologic data, which simulated build-out conditions (i.e., the land cover expected when the island is fully developed). This was done to anticipate the peak-flow rate of stormwater runoff to be accommodated at each "pinch point", which on the relatively rural island would be culvert crossings of roads. Details of the pinch-point analysis are given in Section 4.3 but the most common problems relating to stormwater in all basins are anticipated to be:

- Landslides where roads have been built on unconsolidated materials.
- Undersized culverts that have lead to flooding of roadways.
- Lack of recorded access and maintenance drainage easements on private property.
- Sedimentation resulting from erosion.
- Uncontrolled runoff onto adjacent properties due to insufficient drainage systems.

SECTION 3
SURFACE WATER MANAGEMENT PLAN
EXISTING CONDITIONS

SECTION 3
SURFACE WATER MANAGEMENT PLAN
EXISTING CONDITIONS

3.1 Natural Features

The City of Bainbridge Island encompasses roughly 17,400 acres or about 27 square miles. Land cover is predominately forested, with some parcels in agricultural use having open pastures. The natural appearance of the land is an expression of factors such as topography, soils, and climate. The topography determines the direction of surface water flow and drainage paths, while the amount and type of vegetation is directly related to soil and climate. The following sections describe these physical attributes.

3.1.1 Topography

The island is dominated by gently rolling hills with ridges extending in a north-south direction. **(See Figure 3.1 Level II Assessment)** The major hills and uplands tend to have relatively flat to gently sloping summits with an average elevation of approximately 320 feet. Roughly four percent of the island has slopes greater than 40 percent, most of which are coastal. Wetlands are found in some of the depressions and nearly level areas. A number of shallow stream valleys generally radiate outward from the island's upland areas or run parallel between ridges before turning to the coast. Tidal erosion has also produced steep, intermittent sea cliffs around the edge of the island. The roughly 50 miles of somewhat irregular shoreline consists of numerous bays, harbors, coves, and lagoons. The shoreline topography varies from relatively flat or gently sloping to steep with nearly vertical bluffs. (Bainbridge Island Watersheds, 1995)

3.1.2 Vegetation

Much of the land (approximately 73 percent) is tree-covered. Most of this is second growth vegetation with scattered old growth Douglas-fir found only on the southern part of the island near Blakely Harbor and the Country Club. Much of the tree cover for the rest of the island is greater than 50 years old. Hardwood trees such as red alder, black cottonwood, and big leaf maple make up about 50 percent of this forest cover. The majority of these trees are located along stream corridors, within wetlands, and on steeper hillsides, especially in areas of seeps or where past disturbance exposed soil for seed germination. The dominant conifer species include Douglas fir on well drained soils and western red cedar, western hemlock, and grand fir on damper soils.

Grass/shrub cover is found on roughly 20 percent of the island, usually in valley bottoms but also within small parcels, usually where agriculture is practiced or where residential development occurs. Approximately six percent of the island is developed with 25 to 100 percent impervious surfaces. (Bainbridge Island Watersheds, 1995)

3.1.3 Climate

The northern Kitsap County climate is moderated by maritime air masses from the Pacific Ocean. The Olympic Mountains partially shield the area from the more intense

Pacific winter storms. The prevailing southwest wind in fall and winter shifts to the northwest in late spring and summer. A well defined dry season occurs during July and August when rainfall is roughly five percent of the annual total. Nearly 75 percent of the annual precipitation falls between October and March. Precipitation rates vary across the island, ranging from approximately 35 inches in the north to roughly 45 in the south. Average daytime winter temperatures are in the 40 to 50 degree range and summer temperatures vary between 70 to 80 degrees. (Bainbridge Island Watersheds, 1995)

3.1.4 Geology

Puget Sound regional topography and geologic formations were shaped by the cycles of glacial ice encroachment and recession that occurred during the middle to late Pleistocene period. Over the past approximately 300,000-year period, at least six glacial and interglacial episodes have affected the region. (Easterbrook, 1994) During this time, a large volume of glacial and interglacial material was deposited over the Puget Sound basin, resulting in a complex layering of geological units.

The most recent glacial deposits were laid down during the Vashon period roughly 18,000 to 13,000 years ago. Recessional outwash, the youngest of the Vashon deposits, was deposited by meltwater streams emanating from the receding Vashon glacier. This unit has limited distribution in the study area and typically consists of poorly sorted sand and gravel. Vashon till, lying below the recessional outwash, has a much greater distribution, making up the majority of the island's exposed surfaces. This is a relatively dense unit of unsorted deposits of sand, gravel, and boulders in a silt and clay matrix, forming a low permeability cap over much of the island. Vashon advance outwash, deposited by meltwater streams flowing from the advancing glacier, consists of sand and silty sand with lesser amounts of gravel and occasional lenses of silt. This unit is relatively widespread and contains the uppermost aquifer material (Perched Aquifer System) in the study area. Common but not continuous under these units are the deposits of Lawton Clay, a clay/silt mixture deposited in the lakes that formed ahead of the advancing Vashon glacier. Below these units are several groups of undifferentiated glacial and non-glacial sediments that extend to depths greater than 1,200 feet.

At the south end of the island, just south of Eagle Harbor, a major fault (an extension of the commonly known Seattle fault of Yount and Holmes, 1992[1]) transects the island east to west where ancient sediments of the Pleistocene epoch are juxtaposed against sedimentary bedrock from the Tertiary period. This latter is overlain somewhat inconsistently with Vashon drift. The consolidated formations of the Blakely Harbor and Blakeley Formations (Fulmer, 1975[2]) are the oldest deposits (20 to 40 million years old) in the study area, consisting of shale, sandstone, and conglomerates. These are estimated

[1] Yount, J.C., and Holmes, M.L., 1992, The Seattle fault—A possible Quaternary reverse fault beneath Seattle, Washington (abstract): Geological Society of America Abstracts with Programs, v.24, no. 5, p. 93.
[2] Fulmer, C.V., 1975, Stratigraphy and paleontology of the type Blakeley and Blakely Harbor formations: in Weaver, D.W., Hornaday, G.R., and Tipton, Ann (eds), Conference on future energy horizons of the Pacific Coast, Paleogene symposium and selected technical papers: Am. Association Petroleum Geologists, Soc. Econ. Paleontologists and Mineralogists, and Soc. Econ. Geophysicists, Ann. Mtg., Pacific Secs., Proc., p.210-271.

to be approximately 8,500 feet thick and are thought to be inclined between 45 to 90 degrees from horizontal.

3.1.5 Post-Glacial Geology and Land Forms

Postglacial processes, including weathering, erosion, sedimentation, landslides, and human activities have modified the land surface. Weathering and erosion, together with mass wasting (landslides) and stream processes, have led to the development of soil profiles on the different geologic units, accumulation of colluvium on slopes, deposition of stream sediment, erosion of stream banks and valley walls, and formation of peat deposits.

3.1.6 Soils

The following general descriptions of soils units found on Bainbridge Island are taken from the Soil Survey of Kitsap County Area, Washington (USDA, 1980[3]). Descriptions of soil characteristics, drainage qualities, and septic considerations relevant to Bainbridge Island are taken from Bainbridge Island Watersheds, 1995.

Kapowsin/Harstine Group

This soil type is the most common and occurs throughout the island (74 percent) in areas ranging from flat to moderately steep. This group contains about a quarter of the island's wetlands. This soil is formed in sandy glacial till. Permeability is moderate in the uncompacted till layer, about 20 to 40 inches deep, overlying very compact material (hardpan). These soils are moderately drained above the hardpan but have low permeability through the pan. As a result, precipitation drains quickly to the hardpan, then flows laterally to an outlet in a depression, hillside seep, stream, or road cut. Creeks draining these soils generally have little or no floodplain. Water often collects above the hardpan, creating a seasonal high water table during the winter months.

Surface runoff is slow to medium depending on whether or not the soil above the till layer is saturated. Erosion hazard is slight to moderate. The main limitations for on-site septic tank fields are seasonal wetness, steep slopes, and depth to the layer of compact glacial till. These soils, if contaminated, are rated as having moderate to high potential for contributing to surface water pollution and a low potential for impacting groundwater (assuming there is no connection between a water table perched on the till layer and an aquifer).

Norma/McKenna Group (Hydric)

Covering roughly eight percent of the island, this soil group is made up of a variety of materials: glacial alluvium, organic matter (partially to fully decomposed plant material), or in depressions in glacial till. These soils are most often found in stream valleys, lowlands, and depressions on uplands. Soils in this group are saturated or inundated for a specified time period and are listed as hydric soils. This soil group forms surface water

[3] United States Department of Agriculture Soil Conservation Service, 1980, Soil Survey of Kitsap County Area, Washington, 127p., 31 plates.

ponds or is saturated during the winter months. Runoff is slow and the hazard of water erosion is slight. However, stream bank erosion could occur if vegetation were to be removed. These saturated soils are often in or near streams or wetlands and transport of contaminants off site could occur. These soils may have high agricultural productivity, limited only by excess moisture retention in some areas.

Cathcart Group
Located primarily south of Blakely Harbor, this group covers roughly eight percent of the island. It includes three slope phases, ranging from two to 30 percent slopes. This is a silty loam that formed in glacial drift over weathered Blakely Formation. This underlying material is found near the surface only on the southern part of the island south of the Seattle fault. This group has slow to medium runoff, moderate permeability, and slight to moderate erosion potential.

Ragnar Group
Concentrations of this soil type occur in the northwestern part of the island near Agate Passage as well as southwest of Eagle Harbor. This group of soils formed in glacial outwash and covers seven percent of the island, occurring on broad uplands of nearly level to very steep slopes. These soils are very deep and are moderately to somewhat excessively drained because of the loose, coarse nature of the outwash material. The gravelly/sandy material results in rapid permeability, slow runoff, and a low-to-medium potential to impact surface water and a high potential to impact groundwater. Because water moves through these soils rapidly, they may not have time to adequately filter contaminated water, such as on-site sewage system effluent or runoff from manure piles. The on-site sewage system drainfield limitation rating for these soils is severe. The water erosion hazard is slight to moderate on most of these soils; however, where slopes are steeper than six percent, the hazard from water erosion is severe. The ability of this soil to hold moisture and nutrients is less than other island soils.

Kitsap Group
The Kitsap Group is the smallest mapping unit, covering three percent of the island, generally scattered on hillsides. Slopes range from two to 45 percent in this silt loam soil formed in sediment from glacial lakes. Permeability is slow and the soil has a seasonal high water table. Runoff and erosion potential increase as the slope increases, from slow to very rapid runoff and from slight to severe erosion. This group has a high potential for slippage on slopes greater than eight percent. If suitable precautions are not taken during development, slope failure is possible. The slow permeability creates problems for septic tank absorption fields.

3.1.7 Recent Geological Processes
Mass wasting and water erosion occur throughout island landscapes and are often the result of development disrupting water flow patterns and rates. Mass wasting includes landslides, slumps, and debris flows. Landslides are caused by saturation of the ground above less permeable surfaces and they often occur in areas of previous slides. Slumps are caused by undercutting the toe of a slope and sometimes result from a poorly planned construction activity or erosion by water. Debris flows occur where small slides have

sufficient water available to form a slurry, causing damage both at the site of erosion and the site of deposition.
Critical areas for erosion were determined by the geological characteristics of underlying material and steepness of slope (>15 percent and >40 percent). **(See Figures 3.5 and 3.6 Surface Water Management Plan)**

Seismic hazard areas were identified in the **City of Bainbridge Island Comprehensive Plan** as unstable slopes, recent/historical landslide areas, and prehistoric landslide areas. Wetland areas are generally also considered to have high potential for instability because of seismically induced settlement or soil liquefaction.

3.1.8 Drainage Basins

A drainage basin is an area of land on which precipitation drains to a common outlet. For the purposes of analysis, the City of Bainbridge Island has been divided into 12 basins by topography. **(See Figure 3.1)** With the exception of the Winslow area where stormwater is removed from city streets using catchbasins and pipes, the Island's basins are drained by ditches and swales that discharge to streams. The 12 basins are:

- Agate Passage Drainage Basin
- Port Madison Drainage Basin
- Sunrise Drainage Basin
- Manzanita Bay Drainage Basin
- Murden Cove Drainage Basin
- Fletcher Bay Drainage Basin
- North Eagle Harbor Drainage Basin
- Gazzam Lake Drainage Basin
- Pleasant Beach Drainage Basin
- Eagledale Drainage Basin
- Blakely Harbor Drainage Basin
- South Beach Drainage Basin

3.1.9 Lakes

Gazzam Lake is the largest on the island and has a lacustrine wetland associated with it. This lake is high on a plateau and receives runoff from surrounding forested woodland as well as a few single family residences. Mac's Dam is a small former retention facility with an associated lacustrine wetland. (Bainbridge Island Watersheds, 1995)

3.1.10 Streams

There are 43 miles of mapped streams on Bainbridge Island, half of which appear to be perennial and the other half are intermittent. **(See Figure 3.2)** The base flow of these streams is thought to be maintained by groundwater discharging from springs, seeps, wetlands and septic drainfields, but little data is available regarding flow. Fish are known to reside in seven of the island's creeks. The estimated extent of fish utilization in the creeks is shown on **Figure 3.2**. Groundwater support for the larger streams occurs where coarse sands and gravels in the underlying soils allow a relatively free flow of water. For

smaller streams the discharge occurs from moisture moving through layers of soil above the hardpan. This movement of water to small streams is especially vulnerable to disruption from land development, particularly when the building of hard surfaces covers recharge areas, and sewerage that eliminates septic drainfield recharge. Wells located in areas near streams and wetlands can reduce the amount of water available to natural systems.

Two small streams on Bainbridge Island with estimated mean annual flow of 5 cfs or less have been identified by Ecology and noted in WAC 173-515-030 as having high instream values for anadromous fish, aesthetics, water quality, and/or recreation. In accordance with the general intent of RCW 75.20.050 the department has determined that the total natural flow of these streams is required for protection and preservation of instream resources, and that no water is available for additional consumptive appropriation. The natural flow, in effect, constitutes the minimum flow for protection of the instream resources. Streams number 0340 and 0323 (or 434 and 461 as identified on Plate I, instream resources protection program, Kitsap water resource inventory area (WRIA) 15) possess such characteristics and are therefore closed year-round to further consumptive appropriation.

3.1.11 Wetlands

Wetlands are broadly classified by their characteristic vegetation and their location. **(See Figure 3.3)** The majority of the island's wetlands are considered Palustrine, meaning that they are not associated with any major body of water. Some of these are forested or contain a forested component, while others have a scrub-shrub cover, and some have an emergent cover (dominated by non-woody plants that emerge out of the soil or water). Estuarine wetlands occur where there is a mixture of fresh and salt water and lacustrine wetlands are found along the shallow part of lakes. Adjacent to stream channels, where the presence of moisture in the banks supports wetland vegetation, riverine wetlands occur. (Bainbridge Island Watersheds, 1995)

Wetlands can be areas for groundwater recharge or discharge. They store precipitation, runoff, and floodwater and release it slowly through surface connections and subsurface flow along impermeable soil layers. The slow release of water helps support stream flow during the summer months. An estimated seven percent of the island is covered with wetlands (about 1,242 acres). Together with areas of hydric soils, wetlands (excluding intertidal wetlands along the shoreline) make up about 11 percent of the island.

Of the 12 defined drainage basins on the island, the Manzanita Bay Drainage Basin contains the most wetland acreage (21 percent of all the wetland acres). Most of the island's wetlands are found in valleys and ravines, but slopes with constant seepage are also counted. Wet-lands range in size from less than an acre to 114 acres. Twenty-eight are ten or more acres in size.

3.1.12 Floodplains

The Federal Emergency Management Agency (FEMA) documented areas that are subject to 100- and 500-year floods for the City of Bainbridge Island. The 100-year flood has been adopted as the base flood for purposes of floodplain management measures nationwide. A 100-year flood area is defined as those lands subject to a one percent or greater chance of flooding in any one year. The 500-year flood area is subject to a 0.2 percent or greater chance of flooding in any one year. **Figure 3.2** delineates floodplain and tidal flat boundaries for the City of Bainbridge Island, many of which generally correspond to the shoreline areas and are tidal flats.

3.1.13 Depressions

Small depressions occur throughout the island, many on plateaus where they are found in glacially-formed irregularities. Some were formed by melting ice blocks in less compact till. Most occur in clusters but others are found in isolated spots. Most are very small and many are considered wetlands where water is held in a perched condition by the underlying till layer.

3.1.14 Coastal Areas

Bainbridge Island has more than 50 miles of Puget Sound shoreline. All basins have some exposure to the Puget Sound waterfront, either along steep bluffs bordering Puget Sound or gentle slopes leading down to coves or harbors. Many small intermittent or perennial streams drain these hillsides. Development has occurred along the bluffs, where access and views are best, or along the shoreline, and in many cases development has resulted in increased runoff that has caused erosion, slides, damage to habitat, and/or damage to beaches.

3.2 The Built Environment

3.2.1 Land Use

Land use on Bainbridge Island is predominately residential (62 percent), with the largest concentration of settlement in the Winslow area. Waterfront property around the periphery of the island is more densely settled than the interior. The center of the island has some large tracts of open land (13 percent), public use recreation land (seven percent), as well as small pockets of agricultural uses (six percent) interspersed with residential holdings. Roughly six percent of the island is given to transportation corridors, two percent is in commercial/industrial use, two percent is in designated forest land, and two percent is given to public facilities. (Bainbridge Island Watersheds, 1995) It is estimated that roughly 60 percent of island residents work off island. (City of Bainbridge Island Planning staff)

In 1990 the population was 15,846, in 1995 it was 17,910, while its population on April 1, 2000 was 20,150 (Office of Financial Management, July 2000). Projections are for a population of 24,280 by 2012. Most of the island will likely grow at a rate of roughly 2.5 percent a year, although some areas platted for new development may grow more rapidly. Under the **City of Bainbridge Island Comprehensive Plan,** 50 percent of future growth will be directed to the Winslow area where densities of up to 28 units per acre are

recommended. Three small neighborhood service centers, Lynwood Center, Island Center, and Rolling Bay will also experience a slight increase in growth.

3.2.2 Zoning

While Winslow has a variety of zoning densities, the majority of the interior of the island is zoned for one residential unit per 2.5 acres. Zoning around the periphery of the island varies between one to two units per acre. (**City of Bainbridge Island Comprehensive Plan, 1994**) Nonresidential uses include commercial areas in Winslow, schools, community facilities, and a small industrial center near the north end of the island. The three small neighborhood service centers have some commercial uses. No areas are zoned for agricultural use, although a number of small farms exist throughout the length of the island. **(See Figure 7.1 Level II Assessment)**

3.2.3 Roads and Highways

Bainbridge Island has over 1,000 acres of paved City and State roads, including SR-305 that runs the length of the island. Outside the Winslow area, drainage from roads and parking lots is directed to roadside swales and ditches, from which it flows to the island's streams and wetlands. Within Winslow and other urbanized areas, storm runoff is collected in gutters and routed to a series of catch basins and pipes. In many cases it is discharged from these to quantity and quality improvement facilities before discharging to natural systems.

3.2.4 Sewage/Wastewater Disposal

Both Winslow and Fort Ward have sanitary sewer collection and secondary wastewater treatment. All other island residents (90 percent) are served by on-site septic systems. Administered by the Bremerton-Kitsap County Board of Health, most older systems are not inventoried nor regularly inspected for compliance with rules and regulations. (*Bremerton-Kitsap County Health Department spokesman, personal conversation.*) Septic systems may be contributing significant nutrients to island streams, but the number of failing systems is undocumented. (Bainbridge Island Watershed Nonpoint Source Pollution Water Quality Assessment Project, 1997)

3.2.5 Power Utilities

No dams or hydroelectric projects are located on the island.

3.2.6 Stormwater

Outside the historic Winslow area, there are few storm conveyance systems. The most extensive systems are privately owned and maintained and are associated with newer residential developments. Areas zoned as Neighborhood Service Centers such as Lynwood Island Center typically have piped storm systems that discharge to a nearby stream or wetland via mitigation facilities designed and constructed to the prevailing industry standards of the time. For the rest of the Island, the road drainage system consists predominantly of ditch and culvert systems. O&M has an annually updated culvert inventory and Engineering is compiling an inventory of storm conveyance and mitigation systems from development plans. The stormwater infrastructure inventory is limited and questions of ownership hamper operation and maintenance efforts.

3.3 Surface Water Program Administration

The City of Bainbridge Island's Engineering Branch of Public Works currently has two staff members (2 FTEs) performing development review as well as field inspections of stormwater facilities. Stormwater development review and inspection is seldom contracted out to consultants. The City's Operation and Maintenance Branch of Public Works currently has ten staff members assigned to road or storm sewer maintenance, but less than a third of those FTEs are managing and performing stormwater maintenance. Except for catch basin sediment testing, stormwater maintenance is not contracted out to consultants or contractors.

3.4 Regulatory Compliance

3.4.1 Puget Sound Water Quality Management Plan

The Puget Sound Water Quality Management Plan (1994) required all cities and counties in the Puget Sound Basin to adopt stormwater management programs. These programs were to include ordinances for all new development and redevelopment and were to address control of off-site water quality and quantity effects; the use of source control Best Management Practices (BMPs); the effective treatment of the water quality design storm; the use of infiltration where appropriate; the protection of stream channels, fish and shellfish habitat, and wetlands; erosion and sediment control at construction projects, and local enforcement of these stormwater controls.

The same plan requires each city to develop and enforce operation and maintenance programs and ordinances for new and existing public and private stormwater systems. To meet the requirements in the Plan, local governments must ensure that all public and privately owned stormwater facilities are properly operated and adequately maintained. The City is required to adopt an ordinance ensuring that private stormwater facility maintenance and requires records be kept of new stormwater facilities. Stormwater facilities are to be maintained in accordance with the maintenance provisions for each BMP as contained in the Stormwater Management Manual for the Puget Sound Basin (Ecology Manual), and as a minimum:

- Facilities are to be inspected annually and cleared of debris, sediment, vegetation
- Grassy swales and other biofilters are to be inspected monthly or mowed or replanted as necessary
- Where lack of maintenance is causing or contributing to a violation or water quality criteria, actions are to be taken immediately to correct the problem
- A master maintenance schedule is to be kept for all public and private facilities
- Records of new stormwater facilities are to record as-built plans, location, finding of fact from any exemption granted by local government, operation and maintenance requirements and records of inspections, maintenance actions and frequencies, and engineering reports, as appropriate

Bainbridge Island has adopted ordinances in accordance with the basic requirements of the Puget Sound Water Quality Management Plan.

Department of Ecology The Department of Ecology has published several works creating guidelines for all Washington jurisdictions to improve runoff management:

- **Stormwater Management Manual for the Puget Sound Basin** defines minimum technical requirements for controlling stormwater discharges and provides guidance in applying BMPs.
- **Water Quality Standards** establish constituent concentration criteria to support designated uses of water bodies.
- **Sediment Standards** establish criteria for marine sediment constituent concentrations.
- **Shoreline Management Act** regulates activities in or near wetlands and shorelines consistent with shoreline designations.
- **State 401 Certification** requires short term water quality modifications approval for work in or near waters of the state.
- **Floodplain Management Program** coordinates local floodplain regulation under the National Flood Insurance Program, assists in floodplain delineation, and establishes land management criteria in floodplains.

Bainbridge Island was not published in the Federal Register as a NPDES Phase II City. While its population of 20,150 on April 1, 2000 (Office of Financial Management, July 2000) is over the 10,000 threshold, its population density of roughly 740 people per square mile is below the 1,000 threshold. Other more subjective criteria may lead WSDOE to list Bainbridge Island as a Phase II City. WSDOE has not evaluated which City's are to be included but the decision is anticipated in 2001 in order to meet permit deadlines.

3.4.3 City of Bainbridge Island Municipal Code

The City has met the requirements of the **Puget Sound Water Quality Management Plan** outlined in Section 3.4.1 above through Bainbridge Island Municipal Code (BIMC) Chapter 15.20 - Surface and Stormwater Management, which regulates new development and redevelopment and Chapter 15.21 - Stormwater Facilities Maintenance Program, which requires maintenance of all stormwater facilities within the City. The City has also adopted the most recent edition of the Ecology Manual as modified by BIMC 15.20 as the standard stormwater management criteria. These standards apply to both new and redevelopment projects on public and private property.

Bainbridge Island Municipal Code, Chapter 15.20.040, outlines those activities that are subject to surface and stormwater drainage review. Plans for new development where land-disturbing activities would occur, structural development or expansion would take place, new impervious surfaces greater than 800 square feet would be created, or Class IV general forest practices would convert to other uses, and subdivisions, as well as, binding site plans are subject to review. Redevelopment where new impervious surfaces would be built or existing surfaces expanded, where new construction would occur or existing buildings expanded, any land disturbing activity and/or replacement of impervious surfaces are subject to review.

The City regulates floodway modification and construction within floodways via BIMC 15.16 - Flood Damage Prevention. Among other things, the general standards include restrictions on new development within a floodway; structure anchoring; flood resistant construction materials and methods; flood resistant utilities and on-site waste disposal systems; minimum finish floor elevations above base flood elevation; and wetland management.

3.5 Drainage Issues

Although some of the drainage problems for the City of Bainbridge Island have been caused by local geology (steep slopes, unconsolidated underlying soils), other problems are the result of uncontrolled stormwater runoff from built surfaces such as driveways, roads, parking lots, roofs, and sidewalks. **(See Figure 3.4)** Runoff from these impermeable surfaces flows at a faster rate and with greater volume than occurred under pre-development conditions. Both the volume and peak discharge rates are increased when stormwater flows across hard surfaces to off-site receiving bodies of water, often wetlands or streams. Without the City's stormwater regulations, drainage problems would continue to increase as new development increases the quantity of impervious surface, reduces vegetative cover, changes runoff patterns, and accelerates runoff rates. Increasing impervious surface decreases groundwater recharge and base flows to streams as well as decreases water quality.

3.5.1 Flooding While flooding on the Island is not widespread, there are areas where drainage problems have led to localized inundation of driveways, yards, and roads. A number of sites are flooded along the coast line where waterfront banks are eroding or where culverts are being damaged by tidal action. **(See Figure 3.2)**

3.5.2 Erosion and Sedimentation

Erosion of soils is a natural, ongoing process. The rate of erosion can be accelerated by unmitigated land clearing and grading. It would also increase over time as a result of increased runoff resulting from unmitigated development. Removal of vegetation, modification of topography, and poorly managed discharge of stormwater can contribute to increased soil erosion rates if not properly mitigated.

Erosion of stream beds and steep slopes is directly related to the quantity of runoff entering a stream bed or waterway. Adverse runoff quantity changes from unmitigated development can include:

- Increased peak discharges (up to two to five times higher than predevelopment levels)
- Increased volume of runoff produced by each storm
- Decreased time necessary for runoff to reach a stream due to conveyance facilities constructed by mankind (which reduces the natural infiltration of surface water into the soil)
- Increased frequency and severity of flooding
- Reduced stream flow during prolonged periods of dry weather due to reduced base flow resulting from decreased infiltration

- Greater runoff velocity during storms due to the combined effects of high peak discharges, rapid time of concentration, and smoother hydraulic surfaces that occur as a result of development

These adverse runoff quantity changes from unmitigated development are mostly or fully mitigated by current City code. City drainage staff are currently reviewing the stormwater management regulations to increase their effectiveness and accommodate the coming update of the Ecology Manual.

3.5.3 Landslide and Steep Slope Hazards

Landslide and steep slope hazard areas occur naturally at a number of sites around Bainbridge Island, most often along the steep bluffs bordering Puget Sound. **Figure 3.5** shows slopes 40 percent and greater. These slopes are not likely to be developed under current City codes. **Figure 3.6** shows slopes between 15 and 40 percent. These slopes require geotechnical analysis in order to be developed under current City codes. Also considered landslide/steep slope hazards are:

- Areas with slopes greater than 15 percent; having springs or groundwater seepage and having impermeable soils (typically silt and clay) overlain or frequently inter-bedded with permeable granular soils (predominantly sand and gravel)
- Any area potentially unstable due to rapid stream incision or stream bank erosion
- Any area located on an alluvial fan presently subject to or potentially subject to inundation by debris flows or deposition of stream-transported sediments
- Any area with a slope of 40 percent or greater and with a vertical relief or 10 or more feet except areas composed of consolidated rock
- Any area with slope defined by the U.S. Department of Agriculture Soil Conservation Service as having a severe limitation for building site development
- Any area designated or mapped as class Unstable (U), Unstable Old Slide (UOS), or Unstable Recent Slide (URS) by the Department of Ecology Coastal Zone Atlas. (Bainbridge Island Municipal Code Chapter 16.20)

3.5.4 Water Quality and Nonpoint Source Pollutants

The quality of urban stormwater varies depending on the stage of development within a drainage area, the overall age of the developed area, and the density of development. The quantity and characteristics of pollutants depend on land use activities and drainage system maintenance programs. The most common contaminants carried in stormwater are heavy metals, inorganic chemicals, nutrients, petroleum products, and fecal bacteria. Older, poorly maintained urban neighborhoods generally have higher levels of pollutants than newer developments. The increased pollutant concentrations in older neighborhoods are due to higher levels of traffic, accumulation of debris, and deteriorating housing stock. Developments under construction, however, contribute a higher level of sediment to runoff because of the removal of vegetation during clearing and grading activities. Solution alternatives to this are discussed in Section 5.

While Operations and Maintenance has tested CB sediments for contaminants in high use areas on a regular basis, a more detailed study entitled Bainbridge Island Watershed

Nonpoint Source Pollution Water Quality Assessment Project (1997) was conducted on behalf of the Bremerton-Kitsap County Health District and the City of Bainbridge Island. This was a baseline water quality assessment of the City's major streams and included intertidal sediment monitoring, shellfish tissue monitoring, and preliminary on-site sanitary sewage survey investigations. **(See Figure 3.7)** Water quality results for the streams studied were generally good, although among the findings were:

- Elevated levels of fecal coliform bacteria (FC) above state water quality standards was found in some stream segments. (However, the exact source for this form of waste, human or animal, is not known)
- Conventional parameters (e.g., temperature, pH, dissolved oxygen, turbidity, etc.) were found to be in compliance with state water quality standards 88 percent of the time
- Shellfish tissue and intertidal sediment data indicate highest concentrations of trace metals are at Eagle Harbor, a federal Superfund Cleanup Site
- Intertidal sediment data from Blakely Harbor indicated some exceedance of state sediment quality screening levels (WAC 173-204 Table 1) of the low and high weight polynuclear aromatic hydrocarbons (LPAH and HPAH, respectively)
- There is a need to conduct comprehensive sanitary surveys to identify failing on-site sewage systems along the south shore of Eagle Harbor, at Rockaway Beach, and at Rolling Bay

3.5.5 Septic Disposal

Soils are marginal in many areas of the island for on-site wastewater disposal. During the rainy season, which brings seasonally high groundwater levels, drainfields are particularly susceptible to inundation and septic effluent can find its way to the surface or roadside ditches that discharge into water courses. On the Island, new developments are required to present soil tests and septic designs to the Bremerton-Kitsap County Health District as part of the septic system permit-approval process. By Health Department code, both older and new gravity systems are required to be pumped and inspected every three years though the health department only enforces this upon request due to limited staffing levels. By code, new alternative systems are required to establish an operation and maintenance contract with a third party to inspect and maintain the system twice a year. Older alternative systems were not required to sign an operation and maintenance contract though they are required to be inspected and maintained twice a year. Upon the request of a home buyer or mortgage lender, the health department provides an individual septic system condition report called a "loan status report" at the time of a house sale. Health department staff says this is less frequently requested on Bainbridge Island than it is in other areas of the County. Older systems are typically replaced and upgraded via complaint and enforcement actions.

On October 6, 2000 the Environmental Protection Agency (EPA) released draft Septic System Management guidelines. The guidelines are designed to assist communities in establishing comprehensive management programs for properly functioning onsite/decentralized wastewater systems. The guidelines list a progressive series of five separate model programs. Management requirements for the onsite system become more

rigorous as the technology that is employed becomes more complex and the sensitivity of the environment increases. Each model program includes a set of management objectives and an accompanying set of key activities. The EPA's septic management guidelines may require the Bremerton-Kitsap County Health District to upgrade their regulations.

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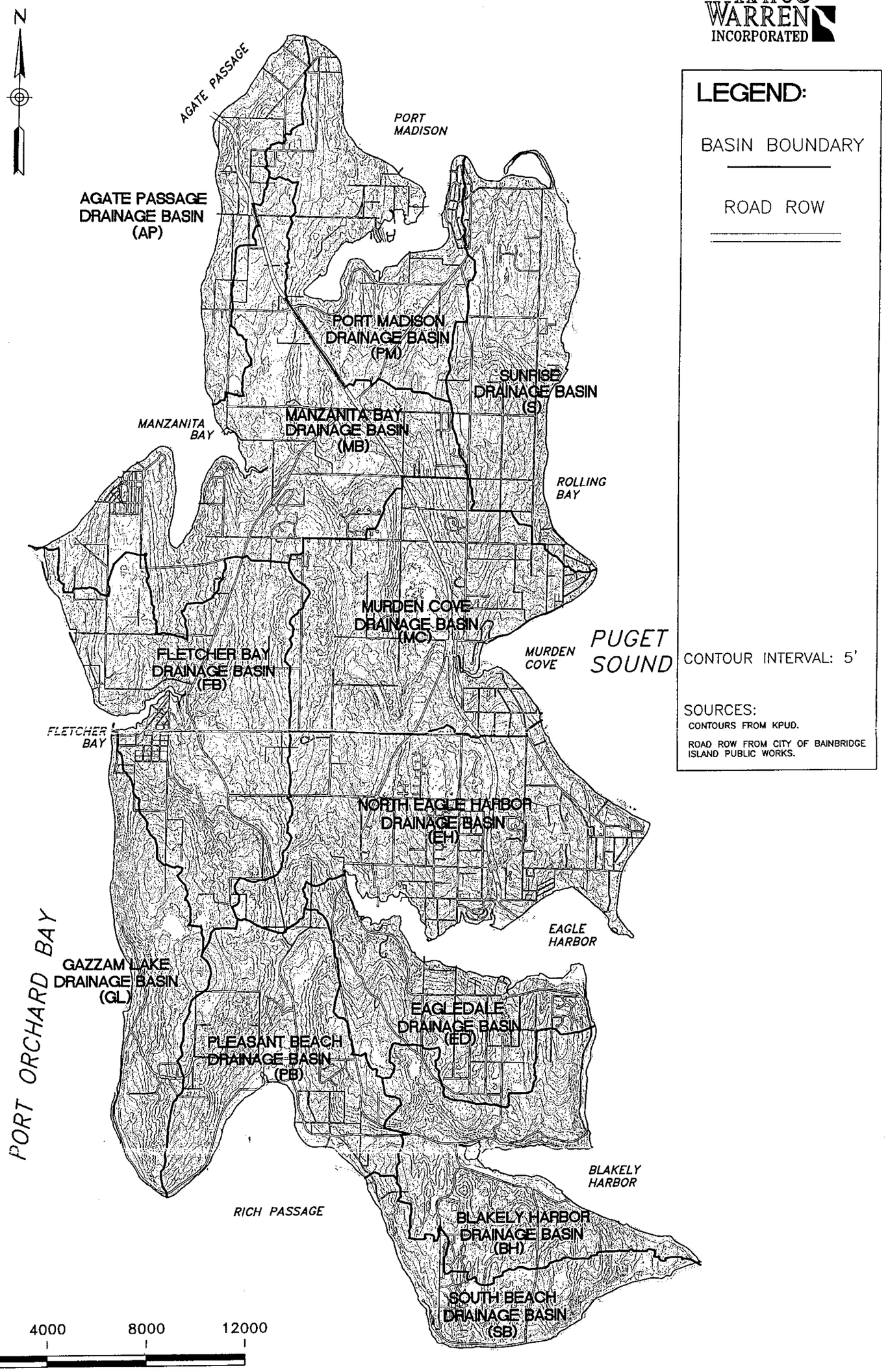


LEGEND:

BASIN BOUNDARY

ROAD ROW

CONTOUR INTERVAL: 5'

SOURCES:

CONTOURS FROM KPUD.

ROAD ROW FROM CITY OF BAINBRIDGE ISLAND PUBLIC WORKS.

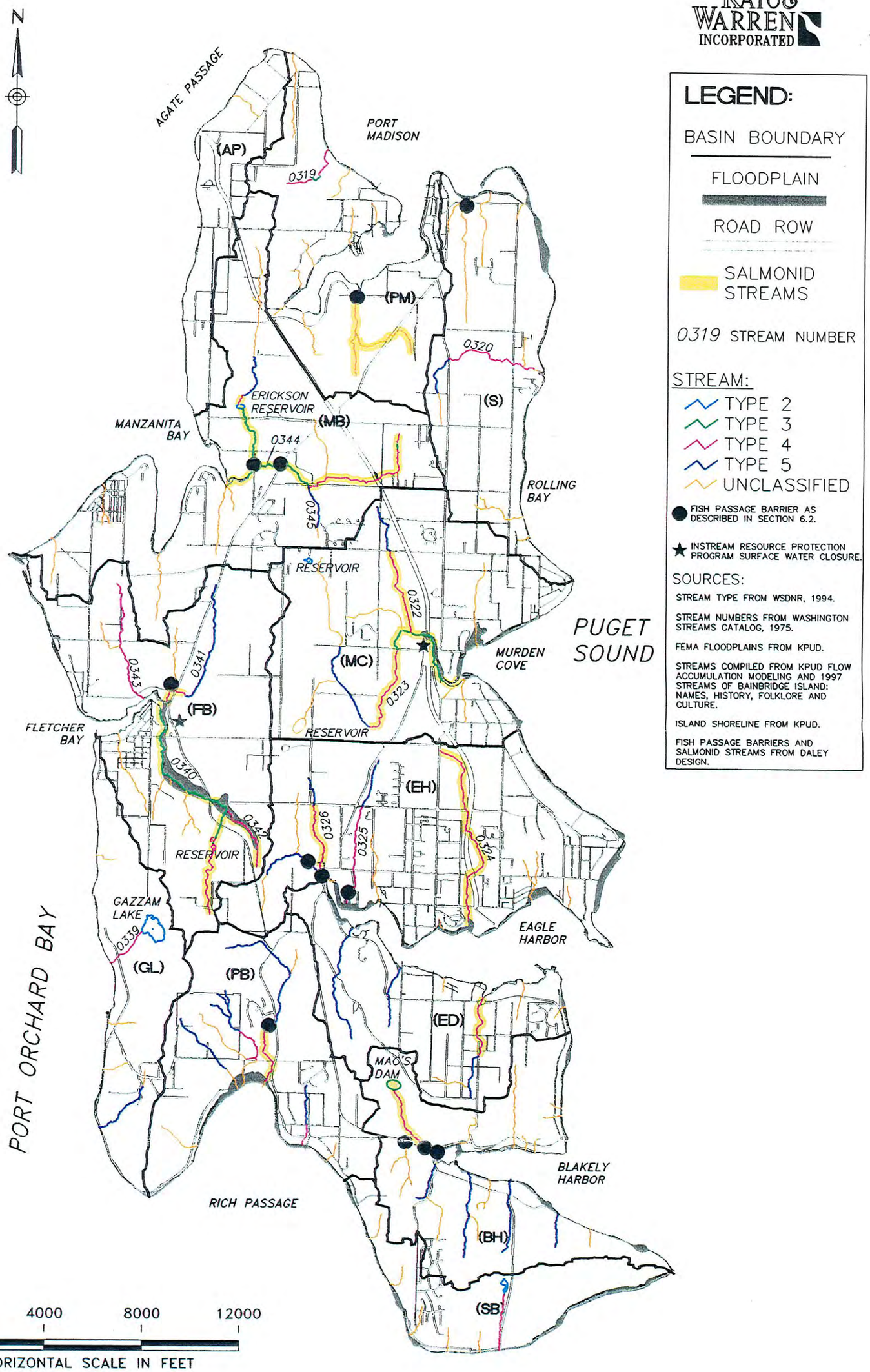
CITY OF BAINBRIDGE ISLAND

SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND
DEPT. OF PUBLIC WORKS

FIGURE 3.1
DRAINAGE BASINS

KATO & WARREN, INCORPORATED



CITY OF BAINBRIDGE ISLAND

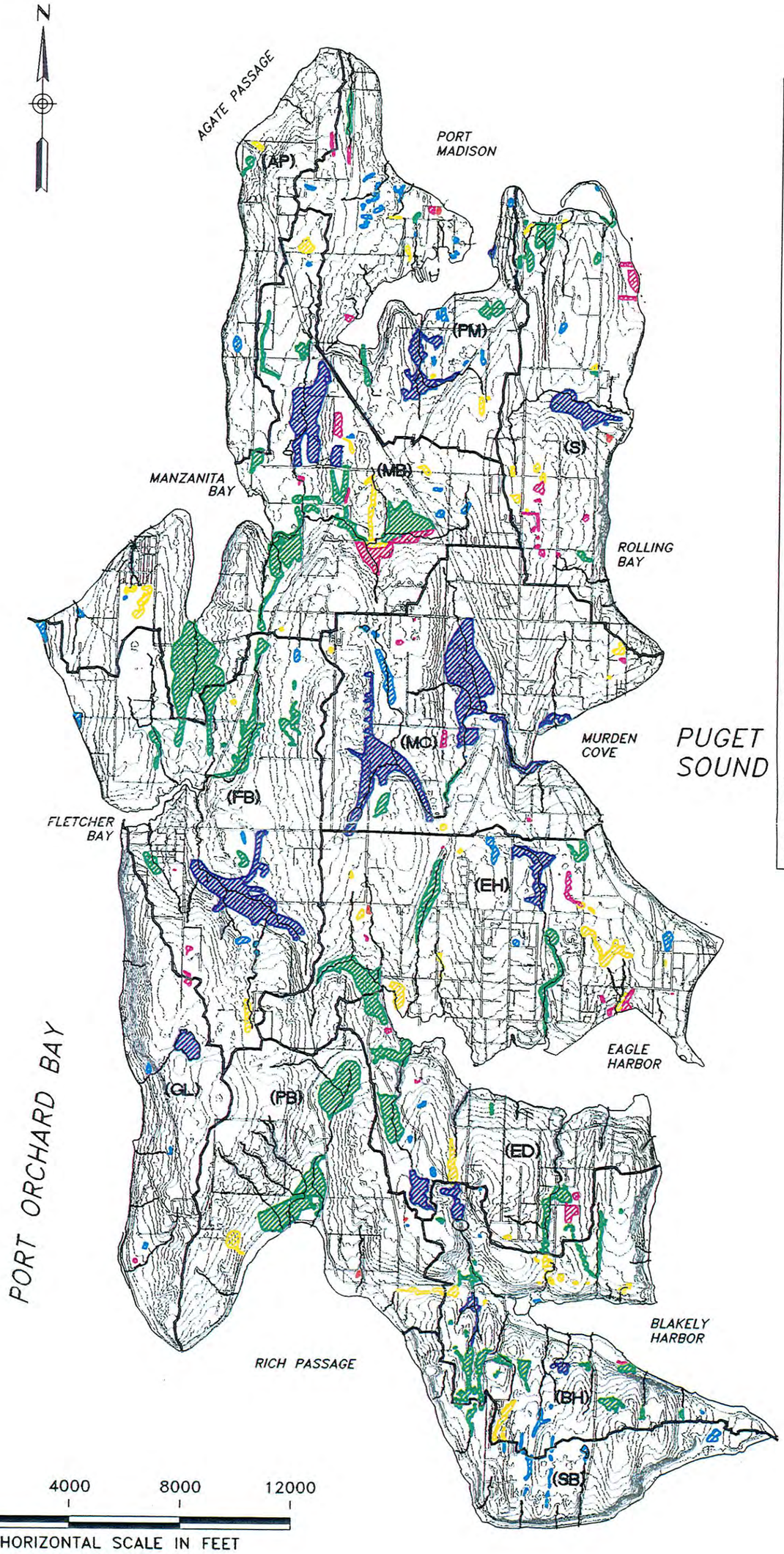
SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND
DEPT. OF PUBLIC WORKS

FIGURE 3.2
STREAMS/FLOODPLAINS/TIDAL FLATS

KATO & WARREN, INCORPORATED

KATO & WARREN INCORPORATED



LEGEND:

BASIN BOUNDARY

STREAM

ROAD ROW

- CATEGORY I
- CATEGORY II
- CATEGORY III
- CATEGORY IV
- POTENTIAL
- NOT RATED

CONTOUR INTERVAL: 25'

SOURCE:

WETLAND CLASSIFICATION FROM 1993 INVENTORY BY SHELDON & ASSOC.

WETLAND AND POTENTIAL WETLAND LOCATIONS FROM CITY OF BAINBRIDGE ISLAND PLANNING DEPT.

CITY OF BAINBRIDGE ISLAND

SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND
DEPT. OF PUBLIC WORKS

FIGURE 3.3
WETLANDS

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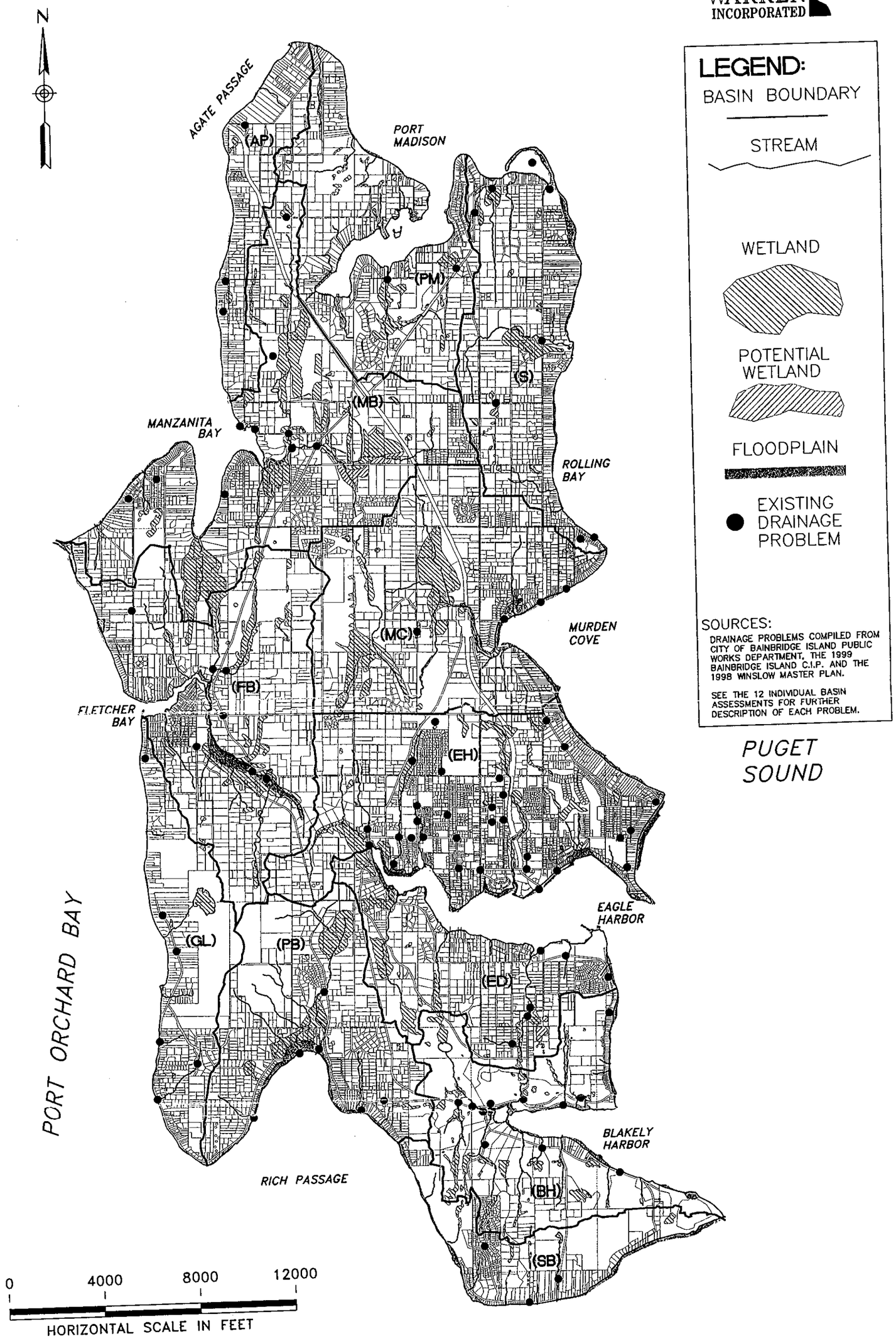
KATO & WARREN INCORPORATED



CITY OF BAINBRIDGE ISLAND

SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND
DEPT. OF PUBLIC WORKS

FIGURE 3.4
DRAINAGE PROBLEMS

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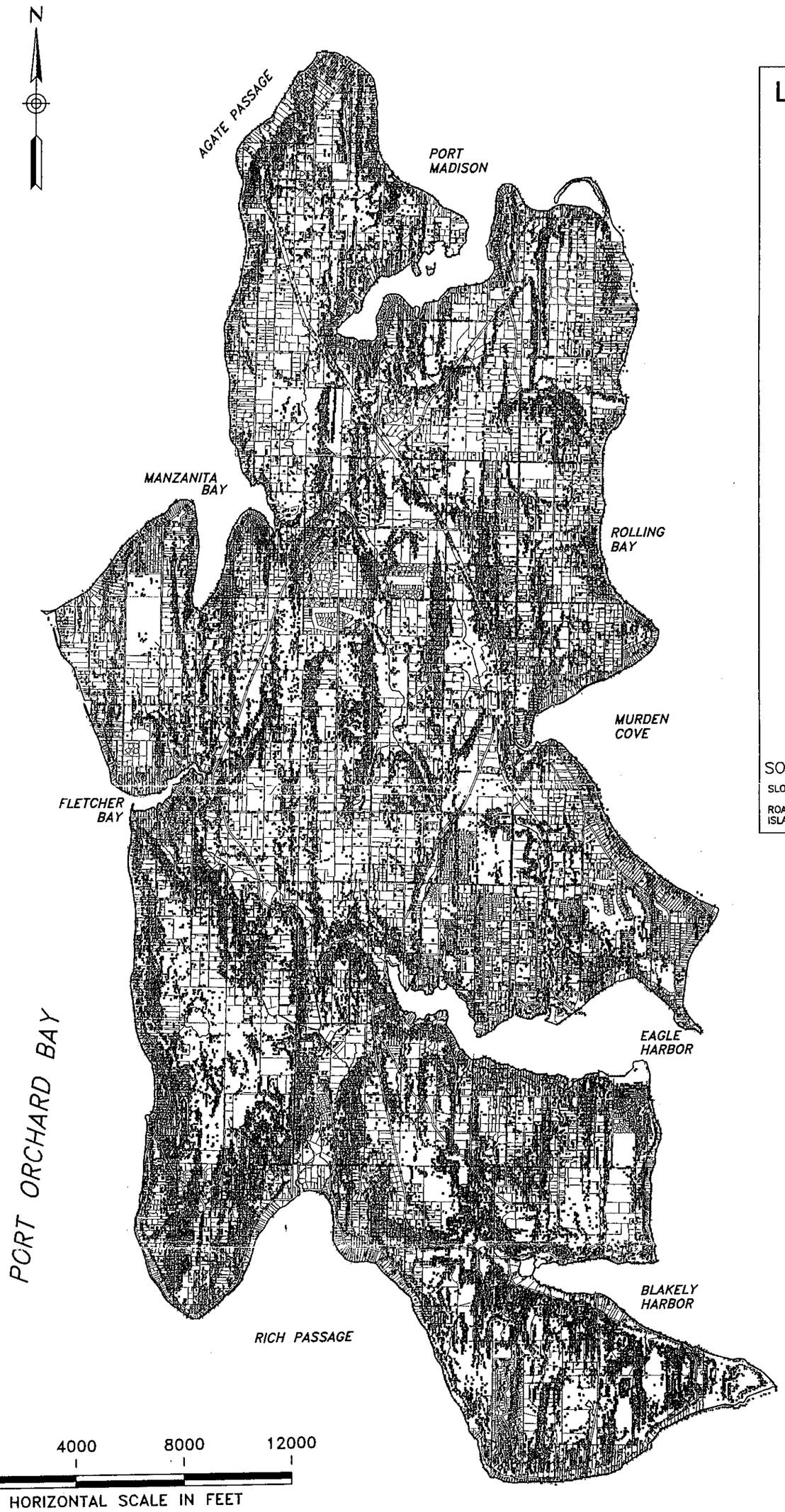
KATO & WARREN INCORPORATED



LEGEND:

STEEP SLOPES BETWEEN 15% AND 40%

SOURCES:

SLOPES AND SHORELINE FROM KPUD.

ROAD ROW FROM CITY OF BAINBRIDGE ISLAND PUBLIC WORKS.

CITY OF BAINBRIDGE ISLAND

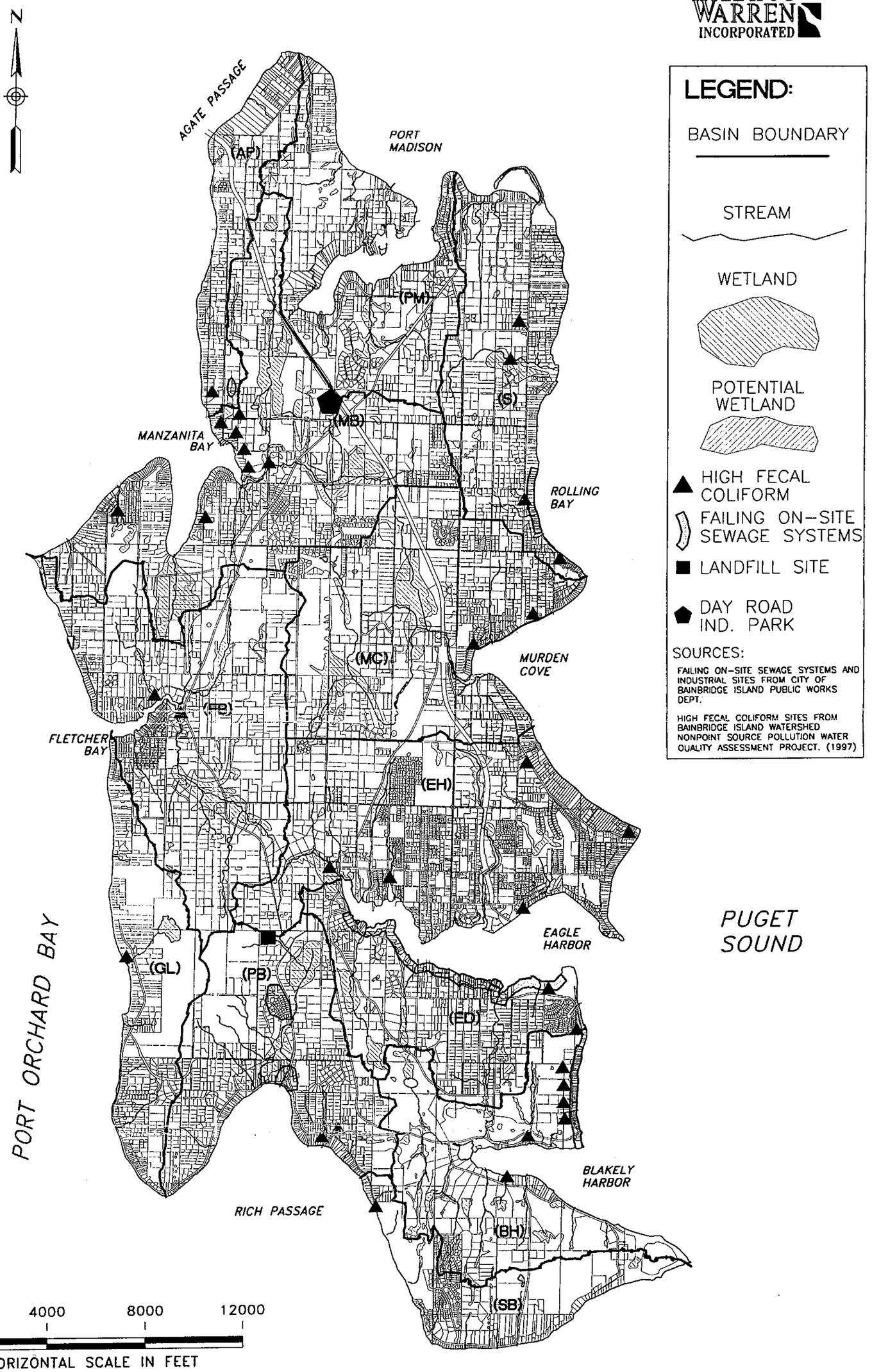
SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND
DEPT. OF PUBLIC WORKS

FIGURE 3.6
SLOPES BETWEEN 15% AND 40%

KATO & WARREN, INCORPORATED

KATO & WARREN INCORPORATED



LEGEND:

BASIN BOUNDARY

STREAM

WETLAND

POTENTIAL WETLAND

HIGH FECAL COLIFORM

FAILING ON-SITE SEWAGE SYSTEMS

LANDFILL SITE

DAY ROAD IND. PARK

SOURCES:

FAILING ON-SITE SEWAGE SYSTEMS AND INDUSTRIAL SITES FROM CITY OF BAINBRIDGE ISLAND PUBLIC WORKS DEPT.

HIGH FECAL COLIFORM SITES FROM BAINBRIDGE ISLAND WATERSHED NONPOINT SOURCE POLLUTION WATER QUALITY ASSESSMENT PROJECT. (1997)

CITY OF BAINBRIDGE ISLAND

SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND DEPT. OF PUBLIC WORKS

FIGURE 3.7
WATER QUALITY PROBLEMS

KATO & WARREN, INCORPORATED

SECTION 4
SURFACE WATER MANAGEMENT PLAN
FUTURE CONDITIONS

SECTION 4
SURFACE WATER MANAGEMENT PLAN
FUTURE CONDITIONS

4.1 Effects of Urbanization in a Watershed

As development increases the impervious area in a watershed, the volume of stormwater runoff also increases, which in turn can have a significant impact on natural areas receiving these stormwater flows including an increase in flooding, streambank erosion, and pollutant transport. Development creates rooftops, roads, parking lots, sidewalks, and driveways that make much of the watershed impervious to rainfall. Unable to percolate into the soil, rainfall is almost completely converted into runoff, which can quickly overwhelm existing constructed drainage systems and natural stream tributaries. Thus, drainage improvements, such as culverts, curbs, gutters, open channels and storm sewers are constructed to collect and convey the runoff through the watershed.

Studies have shown that such an improved collection network results in peak discharges increasing 200 to 500 percent (Schueler 1987). An increased volume of runoff is produced by each storm, and runoff takes much less time to reach a receiving stream, wetland, or lake. These combine to increase the frequency and severity of flooding and erosion. Additionally, decreased infiltration reduces the water availability to stream base flows and previously perennial streams can become seasonally dry.

At the discharge end of a stormwater conveyance network, a receiving stream channel must adapt to the new hydraulic conditions. The primary adjustment is through channel widening, which occurs through stream bank erosion. Stream banks become undercut and slump into the channel. Trees that previously provided bank stability are exposed at the roots and are more likely to fall, triggering landslides. Large quantities of sediment eroded from the stream banks remain in the channel as shifting deposits of mud and sand. This can have a dramatic impact on habitats of fish and aquatic insects (a major food resource for fish).

Other changes accompanying urbanization, such as changes in water temperature, oxygen levels, and pollutants carried in the runoff, can also adversely affect the fish and insect communities. In the natural system, pollutants in the runoff are removed from the water as it soaks into the ground or flows through the organic litter at the soil surface. With urbanization, these areas are replaced with pavement and buildings, and deposited pollutants are washed directly into stream channels. Pollutants in urbanized streams are frequently 10 times higher than in pre-development streams. These pollutants and conditions include suspended sediment, nutrients (phosphorus and nitrogen), bacteria, biological oxygen demand (BOD), oil and grease, trace metals, chlorides or salts, and thermal effects due to reduced vegetation cover over the stream. These pollutants and conditions affect not only the receiving stream, but also downstream waters, such as wetlands, lakes, and Puget Sound (Schueler 1987).

A community can manage its stormwater through requirements implemented during the permit process for new developments. Historically, management efforts have primarily concentrated on reducing the risk of downstream flooding, often using dry detention basins that temporarily store and slowly releases runoff from large storms to reduce peak stormwater discharges. A second approach has been to restrict development in stream floodplains that are susceptible to frequent flooding. While both approaches have proved reasonably effective in curtailing flooding problems, they cannot completely mitigate the adverse impact that urbanization has on stream habitat through increased pollutant transport.

4.2 Special Effects of Urbanization on Existing Features

As development continues on Bainbridge Island, stormwater quality and quantity will be affected. If no improvements are made to existing conditions and no mitigation is included in future development, the following changes could be expected:

- **Steep Slopes** – Erosion and landslides would be expected to increase in size and frequency, endangering homes, properties, roads, and lives. The sediment introduced into downslope water courses could result in water quality mandates from the Department of Ecology and/or National Marine Fisheries Service.
- **Creeks** – Streambeds would be expected to scour and erode at an increasing rate as flows increase the velocity and volume of water in creeks. This could result in degradation and loss of fish and wildlife habitat. Creeks could overflow their banks, damaging adjacent properties. Road closures due to slides and washouts could be expected to become more frequent and severe. Increased impervious surfaces would reduce the amount of groundwater recharge to aquifers and creeks.
- **Roads** – Road failure would continue in those areas where drainage conveyance systems and outfalls are insufficient to deal with the flow rate and volume of runoff entering them.
- **Culverts** – Culverts installed under roads for stream channels were generally sized without an attempt to quantify the volume of flow to be expected after severe storms or to quantify the volume of flow created as a result of increasing urbanization. As a result, a number of the Island's culverts are either restricting stream flow or have failed and are causing flooding problems.
- **Constructed Conveyance Systems** – Conveyance systems could be expected to reach capacity and surcharge prematurely as tributary areas build out and surface water mitigation facilities upstream don't adequately deal with the increased runoff volumes during major storm events.
- **Public and Private Property Damage** – As runoff rates and volumes increase, the potential for erosion and flooding increases. During the wet winters property owners experience flooding and sheetflow with the result that local streams are being degraded with erosion.

4.3 Hydrologic and Hydraulic Modeling and Analysis

To predict impacts to drainage elements from future urbanization, a simplified hydrology model (King County's Runoff Time Series or KCRTS) was used to generate peak-flow rate return frequencies using fully saturated buildout land use conditions, using Bainbridge Island hydrologic data. The KCRTS model is a variant of the Hydrologic Simulation Program – FORTRAN (HSPF) model simplified by King County for western King County use. The model is a continuous rainfall model as opposed to a rainfall event model and therefore can account for the affects of back to back rainfall events common to this area. For more information on the model, refer to Chapter 3.1.3 and Chapter 3.2.2 of the 1998 King County Surface Water Design Manual.

Conservatively, the affects of the City's vegetation preservation code (BIMC 16.22 - Vegetation Management) was not included since City staff indicated that often significant clearing is done under permits obtained from non-City sources. The affects of the City's stormwater management code (BIMC 15.20 – Surface and Storm Water Management) were also conservatively omitted as the detention requirements closely match that of the Ecology Manual which is recognized by the industry as being insufficient. Both these City regulations are useful but their effectiveness is difficult to quantify.

The results of the hydrologic and hydraulic modeling and analysis from this section is used to support structural and non-structural alternative selections in Section 5 and 6 of the report.

4.3.1 Culverts

To predict capacity deficiencies at selected pinch-points (culverts) across the island due to future urbanization, 100-year and 25-year peak-flow rate return frequencies were generated and compared to the estimated capacity of the existing culverts. Culvert capacity, road importance, pipe condition and fish passage barrier information was compiled in the following culvert replacement rating and ranking table. The top ranked culverts are included in the recommended priority actions list in Section 7. Detailed model input parameters and the results of the modeling and analysis are shown in **Appendix C** and supported by **Figure 4.1, Figure 4.2 and Figure 4.3.**

4.3.2 Regional Retention/Detention and Water Quality Facilities

For long-range planning purposes, the consultant team was asked to locate potential regional retention, detention and water quality facility sites across the island. Regional mitigation facilities in general were located downstream of areas with future development potential; adjacent to convenient public access; and upstream of sensitive areas that could benefit from the regional runoff mitigation suggested.

Detention facilities were either sized to mitigate flow durations when within close proximity to a stream or peak flowrates when not in close proximity to a stream. They were sized utilizing the KCRTS model to mitigate full buildout land use conditions back to forested conditions assuming no other mitigation measures in the basin have been utilized. Retention facilities were sized using the same model to bypass a flow equivalent

to one-half the 2-year peak as a base flow to maintain flow in creeks downstream. Water quality facilities were assumed to be half the volume of the above sized R/D facility. Where tributary basins were not easily delineated or sized, a facility size was assumed based on the available space as determined from site topography and parcel information.

Facility costs were estimated based on costs of similar facilities of similar size familiar to the consultant team. Land acquisition was estimated as 150% of the facility footprint based on a six-foot deep pond multiplied by an assumed land cost of $100k to $200k/acre based on zoning, probable views, and surrounding development. Land availability was not confirmed. Please see **Appendix C** for more detailed information on facility assumptions, sizing or costs.

4.3.3 Comparison to Level II Assessment

Given assumptions discussed in the preceding subsections above, a runoff volume of 15.5 inches per year was computed for the entire island. This is more than double the 7.0 inches per year runoff volume computed in Section 8 of the Level II Basin Assessment which was based on existing land use conditions and an assumed 20% rule of thumb annual runoff component. While the whole island runoff figure cannot be directly compared to the Level II Basin Assessment figure due to different input parameters, the KCRTS model did however predict an annual precipitation value of 33.8 inches per year which is within 5% of the 35 inches per year found in the Level II Basin Assessment.

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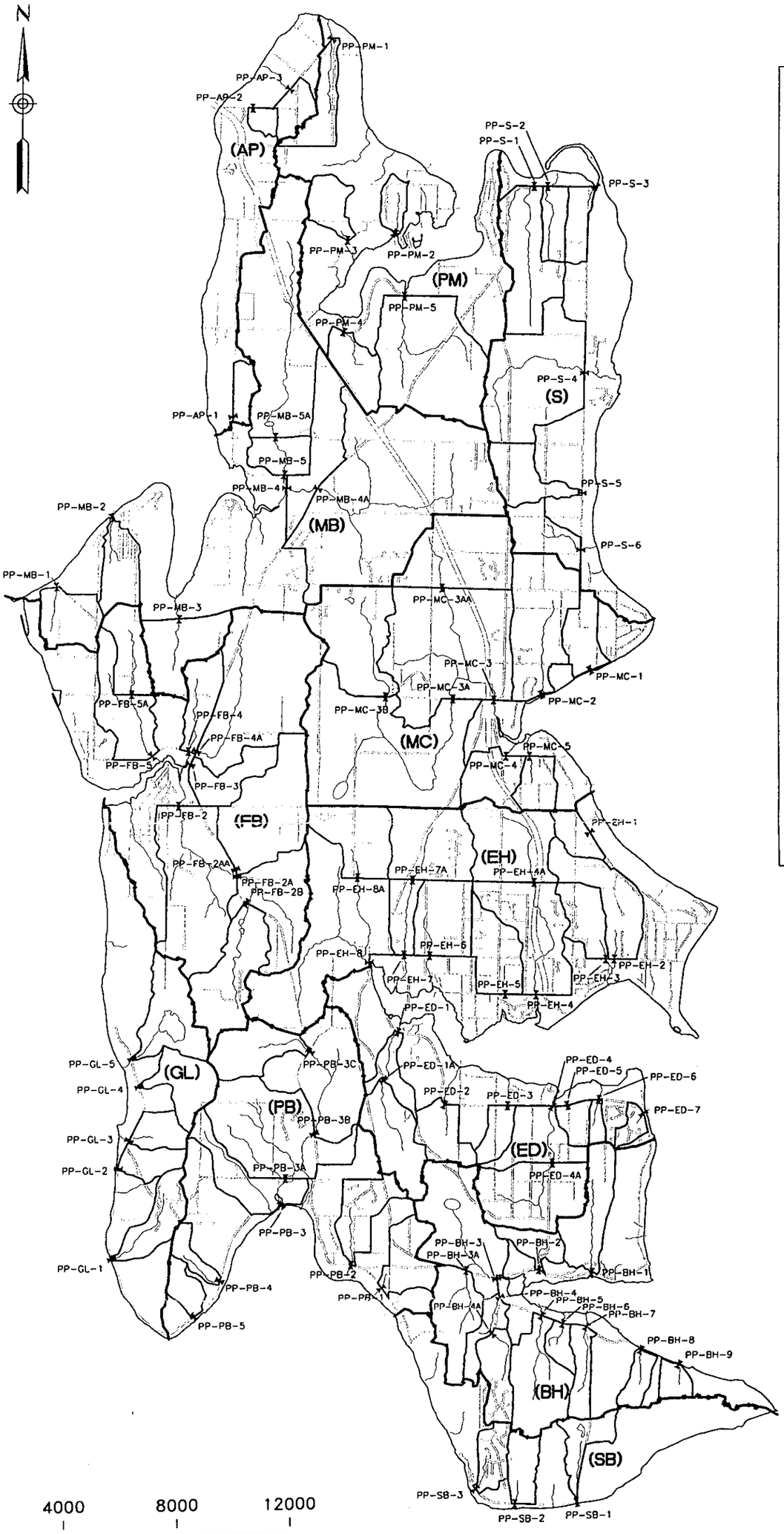

0 4000 8000 12000

HORIZONTAL SCALE IN FEET

LEGEND:

BASIN BOUNDARY

SUB-BASIN BOUNDARY

STREAM

ROAD ROW

PINCH POINT

PP-XX-X PINCH POINT LABEL

SOURCES:

ROW FROM CITY OF BAINBRIDGE ISLAND PUBLIC WORKS.

CITY OF BAINBRIDGE ISLAND

SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND
DEPT. OF PUBLIC WORKS

FIGURE 4.1
HYDROLOGIC MODEL SUBBASINS

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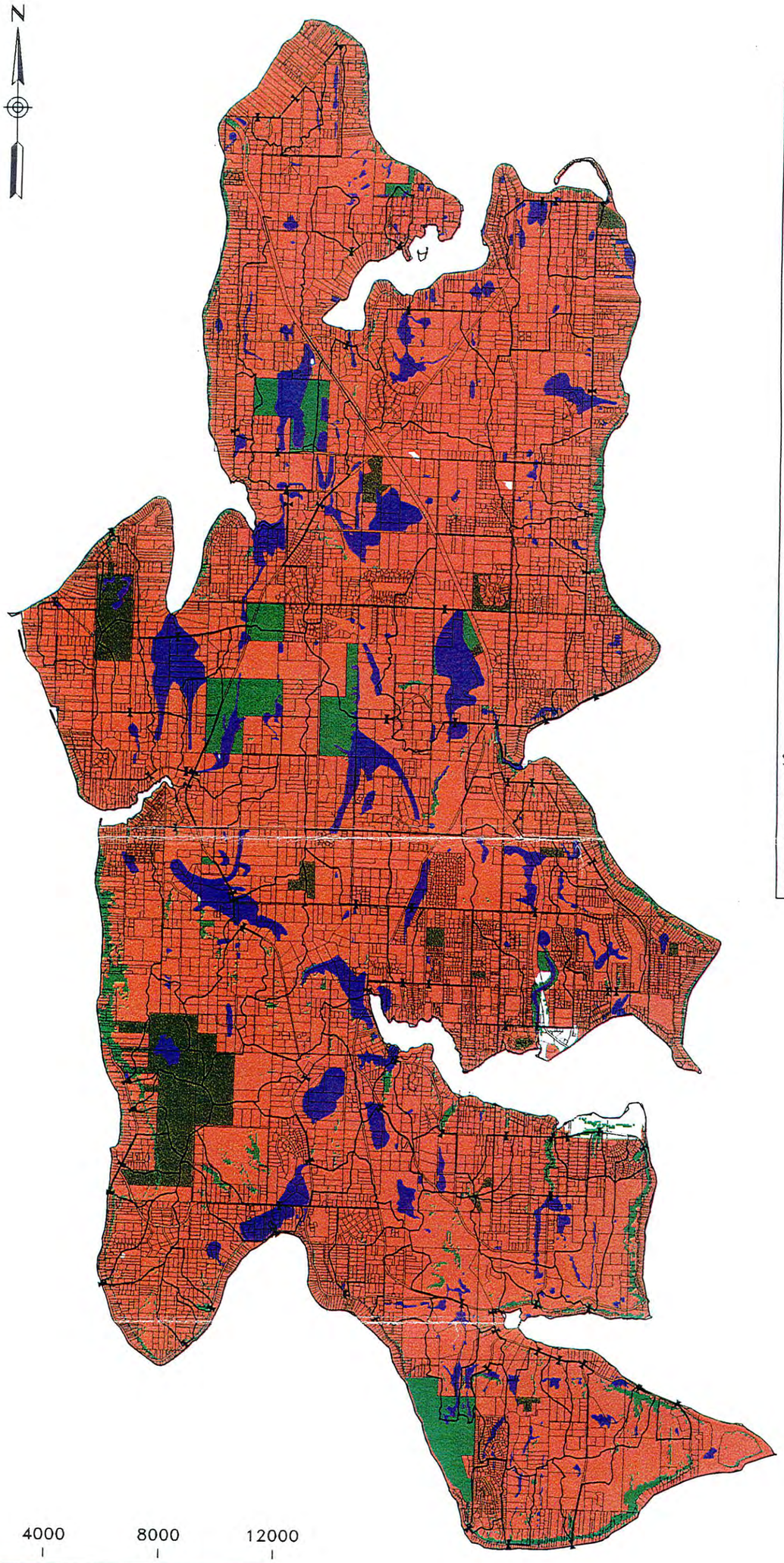
KATO & WARREN INCORPORATED



LEGEND:

- DEVELOPED*
- WETLAND
- FOREST
- PASTURE

SUB–BASIN LIMITS

PINCH POINT

* THE IMPERVIOUS ACREAGE OF DEVELOPED AREAS IS DEPENDANT ON FULLY BUILT OUT ZONING CONDITIONS. SEE PINCH POINT HYDROLOGIC ANALYSIS TABLE NOTE #2 IN APPENDIX FOR PERCENTAGES. THE REMAINING DEVELOPED AREA ACREAGE IS CONSIDERED GRASSED / LANDSCAPED.

SOURCES:

CITY OF BAINBRIDGE ISLAND PLANNING DEPT. FOR WETLANDS.

1995 BAINBRIDGE ISLAND WATERSHEDS STUDY FOR PERMANENT FOREST AND PASTURE AREAS.

KPUD FOR SLOPES > 40% WHERE PERMANENT FOREST COVER IS ASSUMED.

CITY OF BAINBRIDGE ISLAND

SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND
DEPT. OF PUBLIC WORKS

FIGURE 4.3
HYDROLOGIC MODEL LANDCOVER TYPES

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SECTION 5
SURFACE WATER MANAGEMENT PLAN
DEVELOPMENT OF ALTERNATIVES

SECTION 5
SURFACE WATER MANAGEMENT PLAN
DEVELOPMENT OF ALTERNATIVES

5.1 Overview

The City of Bainbridge Island has experienced several different problems associated with road wash out and steep slopes in recent winters. Road settlement, localized flooding, and landslides have placed a burden on the City's Department of Public Works and have resulted in time and money spent on repairs. Many of the problems are related to uncollected stormwater runoff and lack of sufficient conveyance routes. Development on the Island began well before the advent of modern stormwater management and requirements for control of runoff quantity as well as quality. City staff met with the study team to identify known problem areas and to assemble past reports and drainage plans. Information presented at these meetings was used in developing base maps and the hydraulic model of the drainage system.

Solutions to current and future drainage problems will require a combination of structural and nonstructural approaches. Nonstructural solutions will require coordination with the Bainbridge Island Municipal Code and the Bainbridge Island Planning Department with regard to creating regulations on development in sensitive areas, zoning ordinances, and economic incentives for property owners in sensitive areas. Restrictive drainage design standards and regulations can also be highly effective in preventing stormwater problems from occurring. Structural solutions could include construction of detention structures, preservation of existing floodplain storage capacity, improvement or enlargement of existing channels and replacement of undersized culverts, and/or creation of a storm drain network.

5.2 Fisheries and Endangered Species Act Considerations

On Bainbridge Island, salmonid species have been noted in several streams. The largest stream entering Fletcher Bay ("Springridge Brook") (0340) supports cutthroat trout, coho, and chum salmon. The largest stream on the island, known as "Little Mosquito Bay Creek" or "Big Manzanita Creek" (0344), supports cutthroat trout, coho, and chum salmon. Cutthroat trout and coho are found in the largest stream in the Port Madison drainage. The primary stream that drains into Murden Cove (0323) and its tributaries contain some of the best fish habitat on the island and support cutthroat trout, coho, and chum salmon. All of the streams in Blakely Harbor drainage, except the one draining Mac's Dam, have insufficient flow to support salmonids. The Mac's Dam stream supports coho and cutthroat trout. Chum salmon and cutthroat trout have been identified in stream referred to as "Canyon Creek", "Winslow Creek", or "the Ravine" (0324) in the Eagle Harbor drainage.

None of the streams are known to support chinook salmon, which was listed in March 1999 as threatened. Coho salmon have been considered for listing by National Marine Fishery Service and will probably be listed in 2001. The estuaries that are part of all the

streams of the island form critical habitat for migrating juvenile chinook salmon. All of these estuaries are managed by the Washington State Department of Fish and Wildlife as chinook habitat.

The Bainbridge Island Watershed Stewardship Program has conducted physical and chemical monitoring since 1998. In 2000, watershed stewards were trained and began monitoring for macro-benthic organisms using James Carr's IBI methodology. Also in 2000, in coordination with Kitsap County's training and protocol, the program evolved to include stream assessment and mapping of stream corridors. If regularly monitored in certain locations, gauging stations would prove beneficial for evaluating and monitoring island water budgets and runoff quantity and quality. This information could also be helpful for code enforcement.

5.3 Nonstructural Measures

Nonstructural alternatives to contain stormwater include such techniques as education; economic incentives used to acquire floodplain, wetland or other conservation easements; inspection and enforcement; land use management; development standards and regulation on such things as clearing and grading; subdivision, residential and commercial site developments; stormwater management design criteria and regulation. Drainage system maintenance, as required by Ecology, should improve water quality and should reduce impacts from uncontrolled runoff. These alternatives are explained in more detail in the following subsections.

5.3.1 Education

Many degrading activities, such as wetland filling, removal of streamside vegetation, or disposal of used oil and household chemicals into storm drains, occur partly because residents don't understand the consequences of their actions. Public awareness is a critical aspect of environmental protection and citizen participation is critical. The Bainbridge Island Watershed Action Plan (1977) outlines an extensive program to both educate and involve the general community in a variety of experiences for understanding natural systems on the island. The City should continue implementing and developing the public education, outreach and involvement programs outlined in the Action Plan to address non-point pollution issues.

5.3.2 Economic Incentives for Resource Protection

High property taxes on properties with sensitive surface water features, such as flood-plains, wetlands, and stream corridors, could encourage landowners to recover costs through maximum development of their lands. One way to address this problem is to provide incentives, such as current-use taxation, and to encourage the donation of conservation easements. Current-use taxation is established under RCW 84.34 and allows a major portion of property taxes to be deferred if land is maintained in open space uses.

Using a conservation easement recorded against a property, a landowner can permanently donate some or all of the development rights to a parcel of land to a governmental agency or private charity. This donation permanently reduces the market value of the donated property, resulting in reduced property taxes for the owner. Donation can also be used for a one-time federal income tax deduction (26CFR Parts 1, 20, 25, and 602). The Bainbridge Island Land Trust and the Natural Resources Conservation Service work with landowners to place stream corridors and wetlands in perpetual conservation easements via the Conservation Program and the Wetland Reserve Program respectively. The first pays rent to owners who plant trees in stream buffer zones. The second program pays owners for either a permanent conservation easement, a 30-year conservation easement, or a 10-year restoration agreement. Landowners retain ownership but agree to limit land use. USDA National Resource Conservation Service staff have indicated that the programs are considered to be under utilized at this point.

Incentives can supplement other resource protection programs, but are not by themselves a reliable way to protect threatened resources. Incentives can reward landowners who take the initiative in resource protection. If incentives are not provided, higher property assessments may build landowner expectations that resource lands should be developed to a maximum density. As a result, greater enforcement costs and greater resource loss may be incurred. Incentives such as these can work very well in protecting sensitive areas and creating a cooperative attitude with concerned property owners.

5.3.3 Floodplain/Wetland Protection

The protection of wetlands by acquisition or regulation (BIMC 16.20 – Critical Areas) is the single most effective tool for the prevention of future loss of riparian habitat, and the prevention of erosion and reduced water quality. Acquiring fee title or easements is effective because it permanently prevents development of these lands and preserves them in their natural state for use as parks, floodwater storage areas, or as flow conveyance areas during large flood events. By maintaining the flood storage capacity of these lands, flood peaks are attenuated and the severity of downstream flooding is minimized. If these areas are maintained in a natural state, the habitat is not reduced and the quality of the water can more easily be maintained at a high level.

5.3.4 Land Use Management Techniques

The objective of land use management as part of an overall surface water management program is two-fold. The first objective is preventing land development or certain land use activities from adversely affecting the hydrologic and hydraulic characteristics of the drainage system. To be effective, land use management measures should be supported at all levels of government, should have an effective enforcement program, and should be consistent throughout the basin. The second objective of land use management is the establishment of performance standards used to minimize the negative impact of new development. The Bainbridge Island Stormwater Management Ordinance is a performance-oriented ordinance containing minimum standards for new developments. This ensures that all new developments are built to minimize the impact on the environment and drainage facilities.

5.3.5 Clearing and Grading Ordinance

Regulations to control the amount and location of clearing and grading on individual parcels can be used to reduce or prevent flooding, erosion and water quality degradation. By minimizing the amount of cleared land, the increased runoff peaks are minimized and the impact on water quality is kept to a minimum. Of particular importance is the need to minimize or eliminate the clearing of native vegetation from stream banks and steep slopes within the City. Preserving this vegetation in stream corridors helps to maintain high water quality, reduces the amount of stream erosion, and can help to reduce the impacts of flooding both at the site and farther downstream. Limiting clearing and adopting buffers in steep slope areas also helps to stabilize the slopes and limit landslides.

The City has no "Clearing and Grading Ordinance" that would require a permit to be obtained before removing trees and beginning earth-moving activities. The City has begun work on a proposed clearing ordinance which would require a permit to remove vegetation on a parcel and allow the City to review the site for sensitive areas while requiring erosion, sediment and surface water controls among other things. This effort should be continued and is expected in draft form soon. Grading permits are covered elsewhere in city regulations.

Unless exempted by the code, the City's Vegetation Management code, (Chapter 16.22 City of Bainbridge Island Municipal Code) requires landowners wishing to harvest trees and/or remove vegetation to obtain a permit in any of the following areas: a) undeveloped properties and developed properties which may further subdivide, b) sensitive areas and their required buffers, c) designated open space, d) designated scenic or wildlife corridors, or e) as part of a Class IV general forest practice permit. The code does not cover soil modifications. The code establishes a six-year development moratorium for properties harvested under a Class I, II, or III forest practices permit but waives the moratorium if a conversion option harvest plan is submitted. City staff concedes that the intent of the code is not to preserve trees and vegetation but provides a method to avoid the six-year development moratorium following a forest practices permit. It was also noted that due to inspection staff levels that the code receives inconsistent enforcement often relying on citizen complaints to initiate an enforcement action. A tree and vegetation retention ordinance failed to win sufficient support in the spring of 1993. Given the current stormwater regulatory climate, vegetation retention concepts should be revisited as part of the stormwater management code revisions contemplated as part of the new Ecology Manual adoption.

5.3.6 Surface and Stormwater Management Code

As discussed in Section 3.4, the City's Surface and Stormwater Management Code (City of Bainbridge Island Municipal Code Chapter 15.20) lists minimum requirements that must be met by developers to minimize damage to surface waters from uncontrolled runoff. Surface Water Management techniques and BMPs have developed rapidly in recent years and Ecology is in the process of updating their Manual. Among other things, the updated Ecology Manual is anticipated to address small site quantity and quality control for single family residential projects and clearing of less than an acre; incorporates many 1998 King County Surface Water Design Manual definitions and

thresholds; runoff quality treatment will only be necessary for pollution-generating surfaces; increases the volume, size and/or number of water quality facilities at the site; the runoff quantity control standard for discharge to streams is more stringent; the required pre-developed land-cover assumption must be forest or pasture for new developments; the use of a continuous flow model is proposed for discharges to streams and wetlands; and the number of BMPs listed in the Ecology Manual have been expanded. Ecology is accepting comments on its Draft Ecology Manual and they plan on publishing the final Ecology Manual by April 2001. City staff is reviewing the draft Ecology Manual and when published plans to recommend its adoption via ordinance with selective edits.

City staff have noted that BIMC 15.20.060.C.5.b is not worded such that stormwater mitigation facilities can be located within natural vegetated stream and wetland buffers or other critical areas as necessary for conveyance and energy dissipation. Staff also notes that existing basin plans fall short of needed specifics. Lynwood Center should be corrected via both private development associated with Lynwood Commons and the City's Drainage Upgrades Program. Fort Ward is under survey and engineering study to develop specific solutions. A study of Fort Ward is currently underway. Staff would also like to see compensatory flood storage requirements for localized upland potholes since the only regulated floodplains at this point are coastal marine areas. Staffing shortages prevent effective erosion and sediment control inspection and enforcement resulting in sedimentation of downstream sensitive wetland and stream areas. These regulatory and planning shortfalls should be addressed.

5.3.7 Inspection/Enforcement

For stormwater management measures to be effective, steps must be taken beyond initial review of building permit applications. To insure compliance with stormwater regulations the City must be able to inspect development throughout the building process and then revisit existing systems to confirm continued function. It is recommended that the City continue field inspections of all new development during the construction process and strengthen its periodic visitation to established systems. The City should utilize their municipal prescriptive access, maintenance and enforcement rights on private property when they can show landowner or natural modifications to runoff courses have adversely impacted the drainage system. Currently, two City staff persons review, inspect and enforce new site development projects. Public stormwater facilities get inspected on an infrequent as-requested basis.

5.3.8 Stormwater Facilities Maintenance Program Ordinance

A program for maintaining the conveyance and storage capacity of natural drainage ways, constructed culverts, channels and ditches as well as detention/retention basins can reduce or prevent erosion and flood damage. Chapter 15.21.040 (City of Bainbridge Island Municipal Code) requires that all stormwater facilities be maintained.

Generally speaking, City staff concedes that current maintenance practice falls short of code requirements and the Ecology Manual. Stormwater facility tracking and annual reporting is not occurring. Systematic, routine preventative maintenance is performed

only on cross culverts which are inspected annually and their locations marked on the crossing pavement. Biofiltration swales are inspected inconsistently; not mowed due to lack of proper equipment; not replanted regularly; and only recently have the clippings and/or dead material been removed. There is irregular maintenance of public stormwater ponds and conveyance systems. Private pond and storm system maintenance is usually initiated by City request due to a drainage complaint or occasionally by personal observation by City personnel. Disposal of waste from maintenance procedures is not strictly following the minimum Functional Standards for Solid Waste Handling and/or the Dangerous Waste Regulations. Maintenance can generally be described as reactive. Generally speaking, private property owners have faired no better. In some places, landowners have landscaped conveyance ditches to the detriment of flow capacity.

Except for a culvert database and isolated studies and/or construction/asbuilt plans, drainage facility documentation and an asset inventory are somewhat lacking. The maintenance department doesn't know what older ponds are their responsible. Even if they did, they lack the equipment needed to muck out the ponds such as a small dozer and excavator. Crews lack recorded easements and access for maintenance and in some cases where recorded easements are available, adjacent landowners have landscaped or built structures such that access is blocked. The City should utilize their municipal prescriptive access, maintenance and enforcement rights on private property when they can show landowner or natural modifications to runoff courses have adversely impacted the drainage system.

Ten staff members are assigned to road or storm sewer maintenance, but less than a third of those FTEs are managing and performing stormwater maintenance. Additional staffing and equipment should be directed toward this effort. BIPW staff have suggested that a digital camera and an additional Aqua-Tech would be helpful. The existing fleet equipment inventory shows that roughly one third of the equipment was purchased in the last 5 years, the second third within the last ten and up to 95% of the equipment within the last 15 years. The boom trucks are the oldest pieces of equipment and should be upgraded.

Table 5.1 summarizes intended benefits of nonstructural stormwater control methods discussed here. None of the alternatives would have adverse environmental impacts on fish, water quality, or hydrology.

TABLE 5.1
EVALUATION OF NONSTRUCTURAL STORMWATER MANAGEMENT METHODS

	Intended Benefits					
Management Method	Reduce Peak Flows	Reduce Damage Exposure	Control Floodplain Development	Sensitive Areas Control	Improve Public Safety	Fish
Education	X	X	X	X	X	X
Economic Incentives			X	X		X
Floodplain/Wetland Protection	X		X	X		X
Land Use Management	X	X	X	X	X	X
Clearing & Grading Ordinance		X	X	X		X
Stormwater Mgmt Code	X	X	X	X	X	X
Inspection/Enforcement		X		X	X	X
Drainage Maintenance Ordinance		X			X	X

5.4 Structural Measures

Structural alternatives can include improved conveyance systems and detention/retention facilities. A conveyance system is made up of large and small channels, culverts, and storm drain pipelines. A detention/retention system is composed of lakes, wetlands, and large manmade storage facilities. Each of these facilities, with a description of its purpose, how it functions and its impact, is listed below. Facilities for the improvement of water quality are also discussed. **Table 5.2** summarizes the intended benefits of the structural stormwater control methods described in this section.

5.4.1 Conveyance Facilities

- **Culverts**

  The installation of new or replacement culverts in stream channels at road crossings is one method of increasing flow capacity and reducing the potential for upstream flooding. When culverts are too small to convey the design flow, stormwater backs up behind the roadway, flooding upstream property, until the water level is high enough to flow over the roadway. This is normally not acceptable if there is a danger of the road failing or if upstream structures are being damaged by flood waters. By increasing the size or number of culverts, the possibility of upstream damage and road failure is reduced and the ability of fish to migrate upstream is increased. One potential negative effect from increasing the conveyance is the potential for additional downstream flooding caused by the loss of the existing active storage immediately upstream of the roadway. Although this must be considered for each culvert replacement, the benefit to fish passage generally outweighs any hydraulic concerns.

Storm Drain Pipelines

Underground storm drain lines are commonly installed to convey stormwater runoff from urban developments to a receiving body such as a lake, river, or stream. Adequately sized pipes should be installed to convey larger design flows. Installation of new pipelines in developed areas is more expensive and disruptive than the installation of pipelines in an undeveloped area. These work only where there is adequate gradient to maintain flow rates and keep the pipe from filling with sediment. Typically, these lines are installed in road rights-of-way, so there is little land acquisition cost, although some temporary easements may be required.

Either at the beginning of the line before the stormwater enters the pipeline, or at the end before it discharges into the natural system, a facility to treat the water and improve its quality will be needed to ensure a high level of water quality is maintained. This may consist of an oil/water separator followed by one or two hundred feet of grass-lined swale, or a constructed wetland.

- **High Flow Bypass Pipelines**

  Bypass pipelines are used to convey flows that existing channels or pipelines cannot handle without flooding or erosion. They are used only during times of high flow to safely divert flood waters around constrictions in channels or existing pipelines or sensitive areas. By eliminating the erosion, valuable habitat can be saved. A control structure is needed at the upstream end to ensure that normal flows do not enter the pipeline, but that flood flows are diverted. In addition, a bypass pipeline can be used to decrease the size of required detention facilities, or even eliminate them. This can be done by piping all of the runoff from a new or existing development until it can safely enter a stream or Puget Sound.

- **Steep Slope Pipelines**

  On steep erosive slopes, high density polyethylene (HDPE) pipes can be used to convey stormwater to the bottom of the steep slope in place of an open channel. These pipes can efficiently convey large quantities of water on much steeper slopes than can conventional concrete or metal pipes. They also can be welded into one continuous pipeline and can be installed directly on top of the existing ground, thereby avoiding the need to disturb the existing site. Installation of these pipes is expensive, but much cheaper than other structural solutions to prevent erosion caused by increased stormwater runoff on steep slopes.

  At the upstream end of the pipe, a structure is needed to fix the pipe in place and to back the water up to a sufficient depth to allow the design flow to enter the pipe. At the downstream end of the pipe, an energy dissipater is needed to prevent erosion and to stabilize the end point of the pipe. Normally, several anchors are installed along the length of the pipe to maintain its alignment and prevent it from flexing uncontrollably.

- **Stream Channel Reconstruction**
  The conveyance capacity of streams can often be increased by reconstructing a channel. Channel reconstruction is usually limited by the permit process to short sections of streams where sedimentation has reduced the flow capacity. By excavating material below the tops of the stream banks, more water can flow through the channel before it overtops its bank and floods the surrounding land. This can be an effective option for small channels and projects where there are sufficient funds available to properly maintain the channel cross-section.

  However, a reconstructed channel often fills with sediment until it returns to equilibrium at a reduced capacity. Even though the channel's capacity to carry water is increased by widening, the capacity of the water to carry sediment may be reduced and some sediment may be deposited in the channel, thereby reducing its ability to convey floodwaters. Other disadvantages are the temporary disturbance of the riparian habitat and the potential for additional erosion. However, if properly constructed and maintained, these channel improvements can provide flood protection.

  Revegetation or bioengineering techniques are strongly recommended for use in conjunction with channel widening or deepening to ensure long-term stability in the affected reach. Special care must be taken to replace any lost spawning gravels.

  Another streambank reconstruction technique is bank slope reduction, used to protect steep slopes that are subject to failure due to undercutting, debris slides, or sloughing. Banks slopes are reduced by cutting the highest portion of the bank back away from the channel, then stabilizing the bank using bioengineering techniques, riprap, or other methods.

- **Stream Bank Stabilization**
  Eroding stream banks can be stabilized by a variety of methods to prevent the loss of economically valuable land, the loss of valuable habitat, or the addition of undesired sediments into the stream system. Bioengineered designs that emphasize the use of native vegetation are generally preferred over the armoring of stream banks with riprap, concrete, or gabions. This is because of the potential increase of riparian habitat when bioengineered designs are used instead of the other techniques. Also, they are typically much less expensive to build and maintain. Habitat improvement features are much more easily incorporated into bioengineering methods than into the more standard type of engineered bank stabilization. This is an important consideration whenever construction on a salmonid stream is considered.

- **Directional Drilling**
  Also known as regional tunneling, directional drilling installs a gravity pipeline below the surface without having to open cut a utility trench. A remotely operated device drills the tunnel and installs the pipeline as it goes. This alternative has the advantage of not requiring a deep, open trench, greatly reducing erosion control, safety and sensitive area disturbance concerns. It is somewhat expensive to implement and additionally requires obtaining easements for passing beneath all of the properties between the inlet and outlet but these drawbacks can be less onerous than other alternatives in steep slope, wetland/stream or highly urbanized locations where surface disturbance is problematic.

  Generally, the drilling is done uphill from the outlet point toward the inlet area, allowing the line to be easily drained during construction. Almost any size pipeline can be installed. Inlet control is provided through a typical detention pond elbow or tee structure; the outlet requires energy dissipation in the same manner as any other drainage pipeline. Downstream effects must be evaluated to determine the impact on fisheries, receiving waters and channel, if connecting to a creek, or on the downstream storm drainage network, if connecting to an existing conveyance system.

5.4.2 Detention/Retention Facilities

The temporary storage of floodwaters in detention or retention facilities can result in a wide range of flood-modifying effects. The effects include a reduction in peak flow rates, the extent of flooded area, and downstream erosion potential; changed timing of flood peaks; and an opportunity to provide water quality treatment by deposition of sediment.

- **Detention Facilities**
  Detention facilities are constructed for any one or a combination of the above reasons. By providing detention upstream of an inadequate conveyance system and reducing the peak flow rate, the need for upgrading or replacing the conveyance system can be eliminated. If the land is available, this is frequently a less expensive option than installing new pipes, and is preferred due to the multiple benefits possible. Detention basins can also be used to mitigate stormwater runoff downstream of development, reducing peak flows before being discharged into a creek or over a steep slope.

  Detention facilities can be constructed within the stream channel under limited circumstances or for most circumstances at a site not located within a riparian corridor (off-channel). Both options can be effective. Although in-stream sites are attractive because they make use of existing wet lands and their adjacent earthen embankments, disadvantages include buffer requirements, potential disturbance of habitat, and the associated permits required for construction and maintenance. Locating off-channel sites are more flexible, but may require a great deal of excavation to create an effective storage volume.

  All detention facilities require the construction of an outlet flow control structure, an emergency spillway, possibly the excavation of additional storage volume,

revegetation of the site once construction is complete, and frequently a dike or dam to contain impounded runoff within the facility.

- **Retention Facilities**
  With a retention facility, unlike a detention facility, the entering water will normally remain until it either evaporates or percolates into the ground. Many wetlands function hydrologically as retention facilities, and many retention facilities become wetlands after years of use. Some of the island's wetlands function as retention facilities and should be preserved. It is much less expensive to protect these existing natural retention facilities than to construct the conveyance, detention, and retention facilities that would be needed to replace them. Also there are additional environmental benefits (water quality and habitat) from retaining these areas in a natural state.

  Retention facilities are most effective in very porous well-drained soils. In these soils, a relatively small basin can discharge a large volume of water to the underlying aquifer. The porous soils of all retention basins will eventually clog with fine sediments and organic matter if they are not properly maintained. This is especially true of constructed basins that receive runoff from roads and construction sites. This clogging can increase the flood elevations and therefore the potential for flood damage if it is neither removed nor allowed for in the initial design. Pond design should allow for settlement of sediments and removal of pollutants before percolation into the ground.

5.5 Water Quality Control Measures

A number of factors are contributing to water quality degradation, among which is runoff carrying oils, gasoline, and antifreeze; waste from livestock and pets; land clearing practices without adequate erosion controls; and leaking septic tanks. Water quality control measures include the following:

5.5.1 Dry Well Replacement

Older dry wells often discharge untreated stormwater runoff directly to the soil. The contamination of aquifers needs to be prevented since groundwater is the sole source of drinking water for City residents. In order to prevent the contamination of the aquifer and to meet DOE guidelines, older dry wells should be replaced entirely or upgraded during redevelopment to include oil-water separating devices, or to include a filtration device such as a grass-lined swale.

5.5.2 Pipeline Outfalls

Reconstruction of existing stormwater pipeline outfalls to Puget Sound as well as to streams to provide improved water quality may include the addition of energy dissipaters, oil- water separators and grass-lined swales. Some of these devices, especially some types of oil-water separators, are expensive to install, but provide significant water quality benefits if properly maintained. Grass-lined swales and oil-water separators work

best with low flows, and may be more effective at the collection points rather than at the outfalls of the pipe systems.

5.5.3 Aquifer Recharge via Injection

Vashon Till is the predominant surficial deposit on the island and covers roughly 75 percent of the island's land surface. It varies in thickness from roughly 10 to 150 feet. Despite its relatively low permeability, leakage through it to the lower aquifer systems does occur. Because island water supplies depend entirely on underlying aquifers that are recharged from the surface, aquifer recharge via deep injection wells from stormwater could be considered an option.

The Department of Ecology implements regulations on groundwater injection. Any "aided" infiltration or pumping system falls under these regulations, and any water withdrawn for drinking purposes must be treated to drinking water standards before being injected into the ground. Such deep stormwater recharge is considered groundwater injection and would require extensive treatment before being pumped into the aquifer.

It is physically more difficult to pump water into an aquifer than to pump it out. Injection wells typically require frequent maintenance to alleviate clogging and fouling of screens caused by fine particles of sediment suspended in the surface water. The volume of water to be recharged through injection would likely require drilling multiple wells at a cost of roughly $7,000 to $10,000 per well, assuming the wells to be 80 to 100 feet deep.

Extensive facilities would be required to hold and treat the stormwater prior to aquifer injection. Maintenance treatment costs would be ongoing and high compared with other stormwater recharge techniques. During periods of high precipitation, groundwater levels rise and there may not be storage available.

This technique can be difficult for technical and financial reasons and is not recommended for Bainbridge Island.

5.5.4 Aquifer Recharge via Infiltration

Aquifers may also be recharged via infiltration through surface soils at both natural infiltration areas and built regional and on-site infiltration facilities. Natural landcovers such as forests and grasslands will continue to infiltrate a portion of the precipitation they receive via BIMC 16.22 - Vegetation Management and natural conditions. The City should proactively seek to preserve natural infiltration regions through acquisitions and methods discussed in Section 5.4.2.

Developed pervious surfaces such as landscaping and lawn areas will also infiltrate but to a lesser degree as often these areas have been disturbed and compacted by construction equipment. Small project-specific on-site infiltration facilities will continue to be constructed and utilized as required under BIMC 15.20 - Surface and Stormwater Management.

To encourage aquifer recharge and optimize public and private funds, the City should consider the use of regional recharge facilities within each drainage basin as shown in **Figures 6.1 to 6.12** though it should be recognized that most of the island is covered by till soils which is unable to effectively support infiltration facilities. Private on-site facilities required by BIMC 15.20 could be fully or partially waived and the funds for these facilities could be combined with public funds where necessary to create regional infiltration holding ponds and park open spaces. Locations of well draining surface soils, underlying hydrogeological units and tributary land use must be coordinated to effectively site each regional facility but can improve stream base flows and wetland hydroperiods by not routing runoff to overland conveyance and direct discharge to Puget Sound.

TABLE 5.2
BENEFITS OF STRUCTURAL STORMWATER MANAGEMENT METHODS

	Intended Benefits						
Management Method	**Reduce Peak Flows**	**Reduce Backwater Flooding**	**Increase Conveyance Capacity**	**Reduce Standing Water**	**Reduce Channel Erosion**	**Improve Water Quality**	**Fish**
Culverts		*primary*	*primary*	*primary*	*secondary*		*primary*
Directional Drilling	*primary*			*primary*	*secondary*		*secondary*
Steep Slope Pipelines			*primary*	*secondary*	*primary*		*secondary*
Storm Drain Pipelines			*primary*	*primary*			
High Flow Bypass Pipelines			*secondary*	*secondary*	*primary*		*primary*
Stream Channel Reconstruction		*primary*	*primary*		*primary*	*secondary*	*primary*
Stream Bank Stabilization					*primary*	*primary*	*primary*
Stormwater Detention Site	*primary*					*secondary*	*secondary*
Stormwater Retention Site	*primary*			*secondary*	*secondary*	*secondary*	*secondary*
Dry Well Replacement	*primary*			*primary*		*primary*	
Aquifer Recharge via Injection	*not applicable*						
Aquifer Recharge via Infiltration	*primary*			*secondary*	*secondary*	*primary*	
Dry Well Replacement				*primary*		*primary*	
Pipeline Outfalls					*primary*	*secondary*	*primary*

SECTION 6
SURFACE WATER MANAGEMENT PLAN
BASIN AND ALTERNATIVE ASSESSMENT

6.1 Basin and Alternative Assessment Approach

The City of Bainbridge Island has been divided into 12 major basins totaling 17,409 acres. Each of the major basin existing drainage systems have been reviewed for known problems through meetings with City Public Works staff, field visits, review of previous studies, review of existing mapping, review of the current CIP, and hydrologic/hydraulic modeling of future build-out land use conditions on existing infrastructure. Citizen complaint records and stormwater reports from private developments were not readily available. From available sources a list of known and future surface water problems was assembled, and additional research was performed to assess potential solutions to the problems.

In developing the **Surface Water Management Plan** for the City, every effort was made to find ways to reduce and eliminate impacts of runoff. The high degree of development in the Eagle Harbor drainage basin severely limits available options for providing stormwater detention and water quality mitigation facilities. For long-range planning purposes described in Section 4.3.2, several potential regional stormwater mitigation sites have been identified for further consideration. However, even if all identified sites were developed, the impact of urban runoff would still cause some continuing damage to existing natural drainage systems and to private property since structural stormwater mitigation techniques cannot fully replicate natural landcover functions.

6.1.1 Estimated Project Costs

Total project cost estimates were prepared for select capital improvement projects. The detailed cost estimates are included in one-page summary sheets in **Appendix D.** Individual component costs are based on recent bid estimates for construction in the Puget Sound area or taken from general estimating procedures such as the Means Cost Estimating Guide.

The cost estimates developed for the City have the following features in common:

- Traffic Control (3 to 5 percent) – A project operating in or near the road right-of-way will have some signing and barrier requirement (3 percent of construction costs), while a project requiring road closures and detours will have higher traffic control costs (5 percent).
- Erosion Control (5 to 10 percent) – The 5 or 10 percent of total construction costs depends on whether the construction is located primarily in a roadway or in a creek system, respectively.
- Mobilization (4 to 12 percent) – This percentage varies quite a bit based on the size and localized nature of each project.

- Contingency (50 percent) – Since detailed designs have yet to be prepared, a high contingency rate is being applied which also could cover permitting and SEPA compliance.
- State Sales Tax (8.2 percent) – Drainage improvements are assessed under the state sales tax, which the city must pay.
- Engineering, City Administration, and Construction Management (35 percent)
- Land Acquisition – Since detailed project site locations and facility sizes were not determined for this study, the costs are based on a city-wide average acreage cost, based on Kitsap County Assessor's Office records. A range of $80,000 to $200,000 per acre was used.

The cost estimates provide a basis for comparison of drainage improvements by relative estimated costs. These costs should be considered planning level estimates only, often made without survey information, field visits, or detailed design. Should projects be selected for implementation, the cost estimates would need to be updated to reflect actual design conditions and the actual cost of construction at the time.

6.1.2 Evaluation Criteria

A variety of alternatives is available to address each existing and future drainage problem. These alternatives involve both structural and non-structural measures. When selected through a comprehensive surface water management process, an appropriate mix of alternatives to minimize the effects of stormwater runoff on the community can be found. Only alternatives consistent with the Comprehensive Plan are considered as possible solutions. Identified solutions are not necessarily exclusive of one another as some problems may require a combination of several alternatives.

Once possible alternatives are selected they can be evaluate against one another using they following evaluation criteria:

Effectiveness would look at such issues as the permanence of the resolution, alternative and causal factors; the percentage of the problem that could be realistically addressed; and its ability to address both existing and future problems.

Feasibility would address constraints such as land acquisition; maintenance and construction access; groundwater table; grades; soil; and the parties involved.

Cost Effectiveness would evaluate cost/benefit; construction and on-going maintenance costs; and distribution of costs among the City and other parties.

Implementation Issues and Concerns would examine possible fatal flaws with an alternative; the potential of inadvertently moving the problem to other areas; social issues; regulatory or permitting concerns; unknowns; and implementation time.

Impact would examine the positive and negative social and environmental impacts to the community including water quality; stream low flow and peaks; wetland hydroperiod and habitat; and determine if there would be any anticipated mitigation requirements.

Maintenance Requirements would examine such issues as inspection and maintenance frequency; parts and/or materials; and operation.
Cost would examine the estimated solution alternative design, construction, administration, and land acquisition cost.

6.2 Basin and Alternative Assessment by Drainage Basin

Each of the islands 12 drainage basins have been assessed individually in order to determine both larger drainage patterns and specific characteristics particular to each basin. Topography, significant natural drainage features, density of development, and land use was identified. Based on current zoning, the island is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

TABLE 6.1
BAINBRIDGE ISLAND
BUILDOUT LANDCOVER ACREAGE BASED ON CURRENT ZONING

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	2,630	11,929	498	1,312	1,040	17,409
Percentage	15	69	3	7	6	100

Known and anticipated future drainage problems were identified and are described in the following sub-sections. This information is supplemented with maps depicting existing and projected drainage problems and CIPs, topography, basin boundaries, tax lots, slopes greater than 40%, streams, wetlands, potential wetlands, and floodplains/tidal flats. The intent of Section 6.2 and its subsections is to make the reader familiar with as many aspects of drainage within each drainage basin as possible. Understanding the many elements that affect drainage will help the City provide long-term protection and rehabilitation of its natural drainage features and will help reduce or eliminate local erosion, landslide, and flooding problems. Detailed basin descriptions are presented in the following sections:

6.2.1 Agate Passage Drainage Basin
6.2.2 Port Madison Drainage Basin
6.2.3 Sunrise Drainage Basin
6.2.4 Manzanita Bay Drainage Basin
6.2.5 Murden Cove Drainage Basin
6.2.6 Fletcher Bay Drainage Basin
6.2.7 North Eagle Harbor Drainage Basin
6.2.8 Gazzam Lake Drainage Basin
6.2.9 Pleasant Beach Drainage Basin
6.2.10 Eagledale Drainage Basin
6.2.11 Blakely Harbor Drainage Basin
6.2.12 South Beach Drainage Basin

6.2.1 Agate Passage Drainage Basin

Description

The Agate Passage Drainage Basin (**Figure 6.1**), located on the northwestern corner of the island, is bordered on the west by Port Orchard Bay, Port Madison Drainage Basin on the northeast, and Manzanita Bay Drainage Basin on the southeast. Slopes vary from relatively level along the upper elevations to steep escarpments as well as gently sloping waterfront areas. The 596-acre basin slopes west to Port Orchard Bay and several small unnamed streams drain the hillsides.

State Route 305 connecting the Winslow ferry terminal to the Kitsap and Olympic Peninsulas passes across this drainage, elevated on a high bridge. Few other roads serve the area. Land use is entirely residential and density varies from two units per acre along the west side to one unit per acre at the northwest corner. The higher elevations are zoned one unit to two and a half acres.

Development

Existing development is single family residential. It is unlikely that this basin would develop extensively in the future because of zoning limits and potable water availability. Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	95	457	0	8	36	596
Percentage	16	77	0	1	6	100

Known Problems (See Figure 6.1)

Because the tributary area remains largely tree covered and is not densely developed, existing problems are generally the result of poorly designed or maintained drainage systems. The known problems are discussed in more detail below:

AP-001 NE Ralston Rd. End Overflow and Erosion

The storm system across private property is possibly blocked, causing overflow across private property. Waterfront bank loss is occurring. Recorded easements do not exist. Source: BIPW staff.

Potential Solution: As part of the Drainage Upgrades Program, the City should offer assistance to the private property owner where appropriate to resolve the private overflow and erosion problem. Potential solutions may involve private conveyance maintenance and repair, waterfront bank stabilization and a private operation and maintenance program. If the existing drainage system when repaired proves to be inadequate then more substantial improvements such as steep slope pipelines, outfall energy dissipation or a detention tank may need to be considered. The City undoubtedly has prescriptive rights to the drainage path downstream of NE Ralston Rd. and should enforce corrective actions if necessary.

AP-002 NE Hidden Cove Rd. Overflow and Erosion
The storm system across private property is possibly blocked, causing overflow across private property. Waterfront bank loss is occurring. Recorded easements do not exist. Source: BIPW staff.

Potential Solution: As part of the Drainage Upgrades Program, the City should offer assistance to the private property owner where appropriate to resolve the private overflow and erosion problem. Potential solutions may involve private conveyance maintenance and repair, waterfront bank stabilization and a private operation and maintenance program. If the existing drainage system when repaired proves to be inadequate then more substantial improvements such as steep slope pipelines, outfall energy dissipation or a detention tank may need to be considered. The City undoubtedly has prescriptive rights to the drainage path downstream of NE Ralston Rd. and should enforce corrective actions if necessary.

AP-003 Reitan Rd. NE
Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

Future Problems (See Figure 6.1)
Much of the Puget Sound waterfront in this basin has slopes greater than 40 percent and in places is underlain by outwash soils that are prone to slumps, slides, or severe erosion. Clearing and grading activities as well as stormwater systems will have to be sensitive to potential impacts to soil and slope stability.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts.

Since the basin has short runoff routes and small tributary subbasins, no potential regional retention, detention and water quality facilities were located.

6.2.2 Port Madison Drainage Basin

Description
Located at the north end of the island, this basin has two smaller subbasins, one of which drains northeast directly to Madison Bay and the other drains to the narrow, three-and-a-half mile coast line of Hidden Cove before entering Madison Bay. Topography is irregular with a few level areas in the upper part of the basin, then the land slopes steeply to the water. The basin contains roughly 1,387 acres and 2.2 miles of small streams that have been mapped. Around the shoreline the land is zoned two units per acre, with two small areas zoned one unit per acre. The upper part of the basin is zoned one unit to two and a half acres. The Bloedel Reserve in this drainage contains 150 acres of wooded property.

The largest stream in this drainage empties into Hidden Cove and is used by coho salmon. The mouth of the stream ends at a culvert under Hidden Cove Road. The outfall

of the culvert has a 16-inch drop and a fairly steep gradient, making it appear to be impassable for fish. However, during high tides the culvert outfall appears to be partially submerged and allows some fish passage. (Bainbridge Island Watersheds, 1995)

Development
At the time of this writing a 73-unit subdivision is being built in this basin. Single-family residences are to be constructed at a density of one unit per two and a half acres. Additional acreage is available for development, much of it zoned one unit per two and a half acres.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	167	1,102	0	78	40	1,387
Percentage	12	79	0	6	3	100

Known Problems (See Figure 6.2)
Flooding occurs in one small area on Phelps Road NE near North Madison. Along NE West Port Madison Road there is a culvert and pipe failure resulting in damage to the road. The known problems are discussed in more detail below:

PM-001 Phelps Rd. NE Drainage Near North Madison Ave. NE
Approximately three homes have flooded from runoff traveling north along North Madison Ave. NE crossing Phelps Rd. NE and backing up on private property due to insufficient conveyance system capacity. The insufficient conveyance system was installed by private parties and replaced a historically functional drainage route. The private parties would like North Madison Ave. NE runoff diverted northeast along the east side of Phelps Rd. NE to beyond their properties and then cross under Phelps through a culvert to rejoin the downstream system. There is some concern by BIPW staff regarding the expenditure of public dollars for private drainage course realignment. Source: BIPW staff and Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

Potential Solution: This private drainage issue should be removed from the City's Draft 2001-2006 CIP and then as part of the Drainage Upgrades Program, the City should offer assistance to the private property owners where appropriate to resolve the private flooding problem. Potential solutions may involve private conveyance maintenance and improvement, and a private operation and maintenance program. If the existing drainage system when maintained and improved is anticipated to be inadequate then more substantial improvements such as reestablishing the historic conveyance route and system components may need to be considered. The City undoubtedly has prescriptive rights to the drainage path downstream of Phelps Rd. NE and should enforce corrective actions if necessary.

PM-002 NE Hidden Cove Rd./Coho Creek Road Embankment and Culvert
Steep 1H:1V road embankment sideslopes are failing and causing road surface slumping. The existing 36" diameter concrete culvert end has separated and dropped off. Private watermains have been installed inside (parallel) to the culvert. Low tide fish blockage. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows this culvert will be under capacity. Source: BIPW staff and Consultant team.

Potential Solution: Due to the unique circumstances, only reconstruction would effectively resolve the problems at this site. Watermain removal and a culvert replacement will protect this important road, provide adequate flow capacity, restore pipe condition and assist fish migration. Estimated total project cost for this solution: $259,000.

Future Problems (See Figure 6.2)
Some Port Madison Bay and Hidden Cove waterfront in this basin has slopes greater than 40 percent and underlain in places by outwash soils that are prone to slumps, slides, or severe erosion. Clearing and grading activities as well as stormwater systems will have to be sensitive to potential impacts to soil and slope stability. Additional development in slide-prone areas or in areas of steep slopes will need to be well engineered to deal with underlying soils and slope stability.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts except for those described above.

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

PM-003 NE West Port Madison Rd. and Skogan Ln. NE Detention/Water Quality
A regional detention/water quality facility here can mitigate tributary road and private development prior to discharge to adjacent wetlands and streams. Estimated total project cost for this alternative: $1,300,000.

PM-004 Phelps Rd. NE/Coho Creek Detention
A regional detention facility here can protect adjacent wetlands and streams by mitigating tributary road and private development.

6.2.3 Sunrise Drainage Basin

Description

This 1,335 acre basin drains primarily east to Puget Sound, although a small portion at the north end drains more directly north. **(See Figure 6.3)** Some areas in the upper part of the basin are nearly level. The land falls fairly gently to the water along a small portion of the coastline in the northern part. Most of the upland areas drop off to Puget Sound at slopes over 40%. A precipitously steep section exists at Rolling Bay where 100-foot high cliffs drop nearly vertically to the water, an area prone to slumps and landslides. The basin can be divided into three smaller basins, each of which has at least one small, usually unnamed, stream draining it.

Development

The shoreline area is zoned two units per acre, although along the spit at the north end, at Point Monroe, is an area zoned six units per acre. West of Sunrise Drive NE zoning is one unit per acre, and along the upper part of the basin the zoning is for one unit per two and a half acres. Residential development has occurred along the length of Sunrise Drive NE. Additional acreage is available for development, much of it zoned one unit per two and a half acres.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	214	977	13	78	53	1,335
Percentage	16	73	1	6	4	100

Known Problems (See Figure 6.3)

Flooding occurs along the low-lying Point Monroe. Siltation occurs within the lagoon formed by Point Monroe spit. Drainage from the park and the northeast section of Lafayette needs to be addressed. Along much of Sunrise Drive NE are problems associated with a lack of road-side drainage and conveyance systems in steep slope areas. The waterfront southern part of this basin is susceptible to severe landslides. The known problems are discussed in more detail below:

S-001 *Point Monroe Dr. NE Area Flooding*

Tidal influence on the drainage system causes flooding problems. Homes have been damaged in low-lying areas. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include revised operation and maintenance procedures; conveyance improvements; flood proofing or elevation of flooded structures and facilities out of tidal influence zone; and full buyout of affect properties. A BIPW staff member stated that there is "no physical solution" to this problem as if it had been studied in the past and the City resolved that there was no reasonable solution.

S-002 Euclid Ave. NE Drainage
Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

S-003 Sunrise Dr. NE Culverts and Ditches
Insufficient culvert, ditch and outfall systems. Outfalls often lack recorded easements. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

S-004 NE Day Rd. East Improvement (SR305 to Sunrise)
Road and drainage improvement. Capital/Reconstruction Improvement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

S-005 NE Mountain View Dr. Drainage
Runoff sheet flows down steep slope. Location of fatal Herron landslide of March 1997. Geologically unstable area, many homes at risk or condemned. Area homeowners have had a study done. Drainage/Erosion/Earth Movement CIP scheduled for 2001. See City's Draft 2001-2006 CIP and local studies for more information.

S-006 Rollingbay Walk NE Drainage
Location of fatal Herron landslide of March 1997. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and local studies for more information.

S-007 NE Lafayette Ave./Heron Creek Culvert
Blockage to fish migration from perched culvert. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows this culvert will be under capacity. Source: Consultant team.

Potential Solution: A culvert replacement here would restore adequate fish passage and pipe conditions, while accommodating future flow capacity demands.

S-008 Cascade & Knight Parcels/Dripping Water Creek Culvert
BIPW staff have stated that this culvert has problems. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows this culvert will be under capacity. Source: BIPW staff.

Potential Solution: A culvert replacement here would protect this important road, restore adequate pipe conditions, while accommodating future flow capacity demands.

Future Problems (See Figure 6.3)
Much of the Puget Sound waterfront in this basin has slopes greater than 40 percent and in places is underlain by outwash soils that are prone to slumps, slides, or severe erosion. Clearing and grading activities as well as stormwater systems will have to be sensitive to potential impacts to soil and slope stability.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts except for those described above.

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

S-010 *Sunrise Dr. NE/Dripping Water Creek Detention*
A regional detention facility here can protect the creek from erosion downstream while mitigating tributary road and private development. Estimated total project cost for this alternative: $750,000.

S-011 *N Madison Ave. NE/Heron Creek Detention*
A regional detention facility here can protect the creek from erosion downstream while mitigating tributary road and private development.

S-012 *Sunrise Dr. NE/NE Cherry Road Detention*
A regional detention facility here can protect steep slopes downstream while mitigating tributary road and private development.

S-013 *Sunrise Dr. NE/Rolling Bay Stream Detention*
A regional detention facility here can protect the creek from erosion downstream while mitigating tributary road and private development. Estimated total project cost for this alternative: $3,600,000.

S-014 *Point Monroe Dr. NE Sedimentation Facility*
A regional sediment facility here can capture sediment prior to discharge to estuary.

6.2.4 Manzanita Bay Drainage Basin

Description

One of the larger basins on the island, it contains approximately 2,289 acres, most of which drains to the irregular shoreline of Manzanita bay. **(See Figure 6.4)** From Battle Point Park the drainage flows west to Port Orchard Bay. Some upper parts of the basin are nearly level to gently sloping, but the greater part of the basin slopes fairly steeply to the water. There are 3.8 miles of mapped streams in the watershed of which the main stream, Big Manzanita Creek, supports coho and chum salmon as well as searun cutthroat trout. The basin also supports a number of wetlands in some of the more level areas, a result of earlier glacial activity.

Development

The south central portion of this drainage basin is fairly well developed at two units per acre. Around Arrow Point the land is zoned one unit per acre as is a portion of subbasins MB-1 and 2. Upper portions of the subbasins are generally zoned one unit per two and a half acres. Roughly 80 acres of subbasin MB-2 along Day Road and SR-305 are zoned for light manufacturing. Battle Point Park is a 90-acre public open space, largely grass

covered, that provides active recreation fields. The Grand Forest, 240 acres of wooded land is in this drainage basin.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	328	1,452	69	314	126	2,289
Percentage	14	63	3	14	6	100

Known Problems (See Figure 6.4)
In some areas, the combination of a high watertable, flat topography, and a lack of storm drains results in flooding. Along the steep slopes facing Port Orchard Bay landslides are occurring due to rotational slope failure. The known problems are discussed in more detail below:

MB-001 NE Jay St. Area Flooding
Lack of storm drainage network, high groundwater table, and flat topography create neighborhood flooding. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include ditch and culvert conveyance improvements. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

MB-002 NE Bergman Rd./Manzanita Creek Culvert
Road shoulders washed out when stream overtopped road due to undersized 24" diameter concrete cross culvert. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows this culvert will be under capacity. Source: BIPW staff.

Potential Solution: A culvert replacement would provide adequate flow capacity and assist fish migration. Estimated total project cost for this solution: $77,000.

MB-003 Venice Loop Area Drainage
Lack of storm drainage network, high groundwater table, and flat topography create neighborhood road and yard flooding. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

MB-004 NE Monte Vista Dr. Area Drainage
Rotational slope failure has caused three landslides. NE Monte Vista Dr. cul-de-sac is settling. City and neighborhood residents have each commissioned studies. Drainage/Erosion/Earth Movement CIP scheduled for 2001. See City's Draft 2001-2006 CIP for more information.

MB-005 NE Bergman Rd. Failure

This road reportedly has flooding problems during storms. Premature road failure and shoulder sloughing is occurring. The pavement is badly cracked, suggesting that the road base has been undermined by runoff. No drainage facilities in road. Difficult ditch maintenance conditions due to steep road embankments. Quarry spalls have been added to downhill side of road embankment as a temporary measure. Photo near the site is on the report cover. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include ditch and culvert conveyance improvements or perhaps removing the road in the troubled area creating two dead end streets. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

MB-006 Dock Street Outfall

Outfall culvert undermined/damaged due to tidal action. Source: BIPW staff.

Potential Solution: As part of the Drainage Upgrades Program, the City could install protection from tidal action.

MB-007 Miller Rd. NE/Manzanita Creek Culvert

Perched culvert fish blockage. Worn culvert. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows this culvert will be under capacity. Source: Consultant team.

Potential Solution: A culvert replacement here would restore fish passage and pipe condition while providing adequate flow capacity for the future and protecting this important road. Estimated total project cost for this solution: $463,000.

MB-008 Peterson Hill Rd. NE/Manzanita Creek Culvert

Low-flow fish blockage of existing 48" CMP. Road failing along Peterson Hill Rd where stream runs along road embankment toe of slope. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows this culvert will be under capacity. Source: Consultant team and BIPW staff.

Potential Solution: A culvert replacement would improve fish passage and future capacity under this important road. Estimated total project cost for this solution: $207,000.

MB-009 NE West Port Madison Rd./Manzanita Creek Culvert

Piping along, and failure of, culvert. South side washed out. Road erosion. Road at risk of failure as roadbed is sinking. Culvert ends are buried and on private property. Temporary fix installed recently. Since the upstream tributary area was so small, this culvert was not part of the hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report). Source: BIPW staff.

Potential Solution: A culvert replacement would restore culvert and road condition. The City should consider obtaining a drainage easement. The City undoubtedly has prescriptive rights to maintain and inspect the existing system and should enforce this right if necessary.

MB-017 Morgan Ave. NE/Norris Blvd. NE Road End
Road end drainage problem. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem may be assumed to include outfall and energy dissipation, steep slope pipeline, and/or slope stabilization/reconstruction improvements. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem. The City undoubtedly has prescriptive rights to maintain and inspect the existing system and should enforce this right if necessary.

Future Problems (See Figure 6.4)
About half of the Puget Sound waterfront in this basin has slopes greater than 40 percent and in places is underlain by outwash soils that are prone to slumps, slides, or severe erosion. Clearing and grading activities as well as stormwater systems will have to be sensitive to potential impacts to soil and slope stability. Portions of the upper reaches of this drainage basin could be developed at low density and roads built to serve those areas should provide adequate mitigation for stormwater runoff to wetlands and other sensitive areas.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts except for those described above.

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

MB-010 SR-305/Manzanita Creek Detention
A regional detention facility here can protect the downstream wetlands and creek while mitigating tributary road and private development. Estimated total project cost for this alternative: $4,200,000.

MB-011 Manzanita Creek/Wetland 3-5 Detention/WQ
A regional detention/WQ facility here can protect the adjacent wetland and creek while mitigating tributary road and private development. Estimated total project cost for this alternative: $6,400,000.

MB-012 NE Bergman Rd./Manzanita Creek Detention
A regional detention facility here can protect the downstream wetlands and creek while mitigating tributary road and private development. Estimated total project cost for this alternative: $2,300,000.

MB-013 NE Day Rd. West Detention/WQ
A regional detention/WQ facility here can protect the adjacent wetland while mitigating tributary road and private development. Estimated total project cost for this alternative: $6,200,000.

MB-014 Manzanita Creek/Wetland 3-12 Detention/WQ
A regional detention/WQ facility here can protect the adjacent wetland and creek while mitigating tributary road and private development. Estimated total project cost for this alternative: $8,800,000.

MB-015 SR-305/Manzanita Creek Detention
A regional detention facility here can protect adjacent wetlands and streams by mitigating tributary road and private development.

MB-016 Peterson Hill Rd. NE/Manzanita Creek Detention
A regional detention facility here can protect the downstream wetland and creek while mitigating tributary road and private development. Estimated total project cost for this alternative: $520,000.

6.2.5 Murden Cove Drainage Basin

Description:
A large (2,041 acres) watershed that drains east to Puget Sound, this like the other basins has upper portions that are gently sloping and lower elevations that are steeper. **(See Figure 6. 5)** In the most southern subbasin the upper areas are nearly level and then close to the shoreline the hills fall steeply. The major stream within the watershed along with its tributaries possess some of the best fish habitat on the island and support coho and chum salmon as well as cutthroat trout. (Bainbridge Island Watersheds, 1995) Two large wetlands occur in this basin, both in areas where the topography is nearly flat.

Development
Residential development is focused on the east-facing slopes overlooking Puget Sound where zoning is two units per acre. One eastern portion of the drainage basin, along a north-south ridge, is zoned one unit per acre. The inland portion is zoned at one unit per two and a half acres. Additional inland acreage is available for development, much of it zoned one unit per two and a half acres.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	272	1,434	17	205	113	2,041
Percentage	13	70	1	10	6	100

Known Problems (See Figure 6.5)
Along Manitou Beach Road, tidal action is depositing sediment and debris and thereby raising grades. A bulkhead here is being damaged by tidal action. The known problems are discussed in more detail below:

MC-001 NE Manitou Beach Rd. Culvert at Murden Cove Dr. NE
Culvert failure. Tidal action is depositing sediment and driftwood at culvert outfall and on road. Culvert is mostly blocked. The jetter from the City's AquaTech equipment got stuck in the culvert during maintenance. Source: BIPW staff.

Potential Solution: This problem can be addressed during the NE Manitou Beach Road Phase 1 project (see below) by revising the culvert and outfall configuration.

MC-002 NE Manitou Beach Rd. Phase 2
Damaged bulkhead. No ditches, roadbed in poor condition. Frequent tidal action damage. Capital/Reconstruction Improvement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

MC-007 NE Bucsit Ln. Culvert
Runoff over roadway at cross culvert. Since the upstream tributary basin was so small, this culvert was not part of the hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report). Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include culvert maintenance or replacement. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

MC-008 NE Manitou Beach Rd. Phase 1
Capital/Reconstruction Improvement CIP scheduled for 2002. See City's Draft 2001-2006 CIP for more information.

Future Problems (See Figure 6.5)
About half of the Puget Sound waterfront in this basin has slopes greater than 40 percent and in places is underlain by outwash soils that are prone to slumps, slides, or severe erosion. Clearing and grading activities as well as stormwater systems will have to be sensitive to potential impacts to soil and slope stability. Portions of the upper reaches of this drainage basin could be developed at low density and roads built to serve those areas should provide adequate mitigation for stormwater runoff to wetlands and other sensitive areas.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) uncovered the following highly ranked under capacity culverts:

MC-009 NE Manitou Beach Rd./Grisdale Creek Culvert
The City's culvert database shows an existing 12" diameter concrete culvert at this location. This needs to be confirmed. If it is confirmed then a culvert replacement here can provide adequate capacity for future flow while assisting fish passage and upgrading pipe condition under this important road.

MC-010 NE Koura Rd./Grisdale Creek Culvert
A culvert replacement here can provide adequate capacity for future flow while assisting fish passage and upgrading pipe condition under this important road.

MC-011 NE Manitou Beach Rd./Unnamed Creek Culvert
A culvert replacement here can provide adequate capacity for future flow while assisting fish passage and upgrading pipe condition under this important road. This problem can be addressed during the NE Manitou Beach Road Phase 1 project (see above).

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

MC-003 NE Beachcrest Dr./Unnamed Creek Detention/WQ
A regional detention/WQ facility here can protect the downstream wetland and creek while mitigating tributary road and private development. Estimated total project cost for this alternative: $9,900,000.

MC-004 NE Wardwell Rd./Grisdale Creek Detention
A regional detention facility here can protect the adjacent wetland, creek and downstream steep slopes while mitigating tributary road and private development. Estimated total project cost for this alternative: $1,710,000.

MC-005 NE McRedmond Ln./Grisdale Creek Detention
A regional detention facility here can protect the adjacent wetland and creek while mitigating tributary road and private development. Estimated total project cost for this alternative: $460,000.

MC-006 NE Stayer Ct./Grisdale Creek Detention
A stormwater facility expansion here at the Brookfield Plat or log weir installation may better protect the downstream wetland, creek and steep slopes while better mitigating tributary road and private development. The existing dedicated facilities include two bioswales, a sedimentation trap, and two R/D facilities. Estimated total project cost for this alternative: $270,000.

6.2.6 Fletcher Bay Drainage Basin

Description

At 2,101 acres, this is one of the larger watersheds on the island, as shown in **Figure 6.6**. The basin is on the west side of the island and surface water flows to the narrow, somewhat elongated Fletcher Bay and from there to Port Orchard Bay. Topography is complex, resulting from earlier periods of glaciation. Upper elevations are nearly level

with many small depressions. Slopes fall fairly gently to the lower elevations where there are valleys at a shallow slope that have wetlands along their length. Many small streams drain the hillsides, the longest being Springridge Brook (Stream #0340) that is reported to have good fish habitat below High School Road to the mouth.

Development

The area along the waterfront is zoned two units per acre. Near Island Center is an area zoned two units per acre, although according the **City of Bainbridge Island Comprehensive Plan** Island Center will be a designated receiving area that could have up to three units per acre. Upper elevations are generally zoned two and a half units per acre. Further residential development is expected within this basin.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	226	1,491	70	174	140	2,101
Percentage	11	71	3	8	7	100

Known Problems (See Figure 6.6)

A lack of adequate stormwater conveyance has led to flooding in one area. The known problems are discussed in more detail below:

FB-001 Battle Point Rd. NE Drainage

Water over road at 10258 Battle Point Rd. NE. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

FB-003 Spring Ridge Rd. NE Drainage

Flooding over road in three places. Road lacks appropriate ditches and culverts. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include roadside ditches and culverts. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

FB-004 NE Battle Point Rd./Issei Creek Culvert

Perched culvert fish blockage. A temporary fish ladder on south side of existing 24" concrete pipe doesn't help juveniles and limits adults. Pipe in good condition. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows this culvert will be under capacity. Source: BIPW staff and Consultant team.

Potential Solution: Replacing culvert and installing rock and soil fill material at outfall would provide fish passage while providing adequate flow capacity for the future. Estimated total project cost for this solution: $105,000.

FB-005 Miller Rd. NE/Issei Creek Culvert
Inlet controlled twin 18" CMP culverts backwater the wetland to the east. No reported flooding. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows these culverts will be under capacity. Source: BIPW staff and Consultant team.

Potential Solution: A culvert replacement here would improve fish passage, pipe condition and provide adequate flow capacity for the future. Estimated total project cost for this solution: $201,000.

FB-006 NE High School Rd./Springridge Brook Culvert
Bottom rusting out of this existing 36" diameter, inverse-sloped CMP culvert. Source BIPW staff and Consultant team.

Potential Solution: A culvert replacement here would restore pipe condition under this important road, improve fish passage and provide adequate flow capacity for the future. Estimated total project cost for this solution: $96,000.

FB-007 Fletcher Bay Rd. NE/Springridge Brook Culvert
This rusty culvert is pinched on both ends due to vehicular impact. The inlet controlled culvert currently backwaters upstream private property during significant storm events. No recorded complaints. Culvert should be repaired by O&M when time allows. Source: BIPW staff and Consultant team.

FB-014 Miller/Fletcher/New Brooklyn I/S – Phase 2
Intersection improvement. Capital/Reconstruction Improvement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

Future Problems (See Figure 6.6)
The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) uncovered the following highly ranked under capacity culvert:

FB-013 Miller Rd. NE Culvert
The City's culvert database shows an existing 24" aluminum CMP culvert at this location. This needs to be confirmed. If it is confirmed then a culvert replacement here would restore pipe condition under this important road while providing future flow capacity. Estimated total project cost for this alternative: $69,000.

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

FB-008 NE Tolo Rd./North Fletcher Bay Creek Detention
A regional detention facility here can protect the creek and wetland downstream while mitigating tributary road and private development. Estimated total project cost for this alternative: $1,100,000.

FB-009 Miller Rd. NE/Issei Creek Detention
A regional detention facility here can protect adjacent wetlands and streams by mitigating tributary road and private development.

FB-010 Fletcher Bay Rd. NE/Springridge Brook Retention
A regional retention facility here can recharge aquifers and adjacent wetlands and streams as well as mitigate tributary road and private development. Estimated total project cost for this alternative: $660,000.

FB-011 NE Hansen Ave./Fosters' Creek Detention
A regional detention facility here can protect the creek, adjacent wetland and steep slopes downstream while mitigating tributary road and private development. Estimated total project cost for this alternative: $5,200,000.

6.2.7 North Eagle Harbor Drainage Basin

Description

The most urbanized of all the drainage basins, this 2,180-acre watershed shown in **Figure 6.7** is one of gently rolling topography descending south to the irregular shoreline of Eagle Harbor. A number of small streams drain the slopes to the waterfront. The main highway serving the island (SR-305) begins at the Winslow ferry terminal and roughly parallels a ravine designated as stream #0324. Within the ravine are areas prone to slumps and slides as well as wetlands.

Development

Although this basin is largely developed, the intent of the **City of Bainbridge Island Comprehensive Plan** is to direct 50 percent of the island's future growth to the Winslow area. Zoning densities are greater here than any other part of the island and most of the commercial/retail activity occurs in this central area as well. Zoning currently varies from 2.9 units per acre to 14 units per acre, although under the incentive program using the Transfer of Development Rights (TDR) a developer could increase the density of a site up to 28 units per acre. The 1998 Winslow Master Plan identified several parcels of vacant land in this area as well as a number of parcels with redevelopment potential.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	674	1,265	35	145	61	2,180
Percentage	31	58	1	7	3	100

Known Problems (See Figure 6.7)
Because the city developed before the advent of drainage master plans, numerous problems exist due to lacking storage and conveyance facilities. Detention facilities are needed in a number of spots to prevent flooding problems. In some areas culverts are undersized and need replacing. The known problems are discussed in more detail below:

EH-001 NE High School Rd. Reconstruction
Road and associated drainage reconstruction from Madison Ave. to Sportsman Club Road NE. Capital/Reconstruction Improvement CIP scheduled for 2001. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-002 Sportsmans Club Retention Pond
Private, in-stream retention pond for sport fishing recreational use. Debris often blocks CMP outlet elbow structure. Source BIPW staff.

Potential Solution: Given available information, potential solutions to this problem may be assumed to include enforcement or revised operation and maintenance procedures.

EH-004 Winslow Loop, Knechtel, Wallace Ped-Bike Safety Non Motorized Plan
Road and associated sewer, water and drainage improvement. Capital/Reconstruction Improvement CIP scheduled for 2001-2005. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-006 Erickson Ave. Traffic Calming
Road and associated sewer, water and drainage improvement from Winslow Way to Wallace Way. Capital/Reconstruction Improvement CIP scheduled for 2001 and 2003. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-007 Bypass Rd. Improvement
Road and associated water and drainage improvement. Capital/Reconstruction Improvement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-008 Bucklin Hill Rd. NE/Head-of-the-Bay Creek Culvert
Culvert under roadside gravel shoulder has collapsed due to its top and bottom rusting out. Toe of Bucklin Hill Road embankment is eroding. While fish utilize this creek up to the existing culvert mouth, there is only a short reach above the culvert before the stream again is blocked this time by a BIPW water department runoff diversion facility. Source: BIPW staff.

Potential Solution: Multiple City departments will need to weigh the City's runoff diversion facility water needs and rights against fish passage restoration needs. Fish friendly alternatives would include daylighting much of the existing culvert stretch along Bucklin Hill Road and removing/retrofitting the runoff diversion structure to provide fish passage. Other alternatives range from restoring the existing culvert or daylighting much of the existing culvert stretch. Once City staff have agreed on a proposed solution, the

City could then hire a consultant or perhaps use in-house engineering staff to design the chosen solution to the problem.

EH-009 NE Wyatt St. Reconstruction
Road and associated drainage improvement from Madison Ave. to Finch Rd. NE. Capital/Reconstruction Improvement CIP scheduled for 2001-2003. See City's Draft 2001-2006 CIP for more information.

EH-010 NE Wyatt St. Detention Basin B
Detention Basin B. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-011 Park Ave. NE/Wing Point Golf
Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

EH-012 Lower Weaver Rd. (Sportsman Club)
Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-013 Winslow Way West Improvement
Road and associated water, sewer and drainage improvement. Capital/Reconstruction Improvement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-014 Winslow Way East Improvement
Road and associated water, sewer and drainage improvement. Capital/Reconstruction Improvement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-019 NE Grand Ave./Broomgerrie Rd. NE Landslide
Several consultants are studying the rotational failure along an ancient landslide reported to be threatening 18 homes. It has been reported that reducing runoff to the slope would be beneficial. Depending on the results of the independent consultant studies, the problem could be addressed via the Drainage Upgrades Program as appropriate. Source: BIPW staff.

EH-020 Yeomalt Area Outfalls
Two road end storm system outfalls have problems in this area. The south outfall is covered with concrete causing upstream road and building flooding. The north outfall is difficult to maintain. Source: BIPW staff

Proposed Solution: BIPW staff proposes to close the north outfall and reopen the south outfall. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and design the proposed solution.

EH-021 Fairview Ave./Madrona Drive Area Drainage
Drainage/Erosion/Earth Movement CIP scheduled for 2001. See City's Draft 2001-2006 CIP for more information.

EH-023 Hirakawa Creek Obstruction
Fish blockage from old dam. Source: Consultant team.

Potential Solution: The City, WSDFW and the dam owner should coordinate and negotiate water rights needs and fish passage needs at this location. Alternatives would include the installation of a fish ladder and/or removing/retrofitting the dam to provide fish passage. Once the parties have agreed on a proposed solution, the City could then hire a consultant or perhaps use in-house engineering staff to design the chosen solution to the problem.

EH-024 Eagle Harbor Rd./Head-of-the-Bay Creek Obstruction
Fish blockage from historic runoff diversion structure. Source: Consultant team.

Proposed Solution: This issue should be resolved in conjunction with *EH-008 - Bucklin Hill Rd. NE/Head-of-the-Bay Creek Culvert.*

EH-031 Winslow Way East/Cave Ave. E
Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and the Winslow Master Plan for more information.

EH-034 Ferncliff Ave. NE/Grand Ave. NE Culvert
The bottom of an 18" diameter galvanized steel culvert is rusted out and requires replacement. Source: BIPW staff.

Proposed Solution: As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

EH-035 NE Wyatt St. Detention
Small regional detention facility for Winslow Master Plan Basin A. Drainage/Erosion/ Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-036 Rotary Club Detention
Small regional detention facility at Rotary ball field site for Winslow Master Plan Basin A. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-037 Decant Facility
Construction of a decant facility to dewater urban sediment from City stormwater CB sumps. Site not finalized. Drainage/Erosion/Earth Movement CIP scheduled for 2001. See City's Draft 2001-2006 CIP for more information.

EH-038 Winslow Way East & Ericksen/Winslow Way I/S – South
Road and associated intersection, water, sewer and drainage improvements from SR305 to Madison. Capital/Reconstruction Improvement CIP scheduled for 2002-2004. See City's Draft 2001-2006 CIP and Winslow Master Plan for more information.

EH-039 Lovell Ave. SW Drainage Improvement
Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

EH-040 Wing Point Rd. Reconstruction
Road and associated water, sewer and drainage improvements. Capital/Reconstruction Improvement CIP scheduled for 2004-2005. See City's Draft 2001-2006 CIP for more information.

EH-041 Erickson – Hildebrand Opening and Erickson/High School I/S
Road and associated intersection, water, sewer and drainage improvements. Capital/Reconstruction Improvement CIP. See City's Draft 2001-2006 CIP for more information.

Future Problems (See Figure 6.7)
As development continues in this basin and more impervious surfaces are created, there will be a greater need for conveyance systems as well as storage facilities. Water quality will be an issue as well because of the impact of contaminants from urban runoff reaching streams and Eagle Harbor.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) uncovered the following highly ranked under capacity culverts:

EH-032 NE High School Rd./Head-of-the-Bay Creek Culvert
A culvert replacement will restore pipe condition and provide adequate future flow capacity for this important road.

EH-033 NE Wyatt St./Hirakawa Creek Culvert
A culvert replacement will protect this important road, restore pipe condition, assist fish passage and provide future flow capacity.

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

EH-025 Wetland 8-12/Head-of-the-Bay Creek Detention
A regional detention facility here can protect the creek and adjacent wetland while mitigating tributary road and private development. Estimated total project cost for this alternative: $5,900,000.

EH-026 NE High School Rd./Head-of-the-Bay Creek Detention
A regional detention facility here can protect the creek and downstream wetland while mitigating tributary road and private development. Estimated total project cost for this alternative: $3,700,000.

EH-027 Mid Head-of-the-Bay Creek Detention
A regional detention facility here can protect the creek and downstream wetland while mitigating tributary road and private development. Estimated total project cost for this alternative: $990,000.

EH-029 Hawley Creek Detention – West
A regional detention facility at the golf course can protect the creek and downstream steep slopes while mitigating tributary road and private development. Estimated total project cost for this alternative: $1,700,000.

EH-030 Hawley Creek Detention – East
A regional detention facility at the golf course can protect the creek and downstream steep slopes while mitigating tributary road and private development. Estimated total project cost for this alternative: $950,000.

6.2.8 Gazzam Lake Drainage Basin

Description

This 887-acre watershed (**Figure 6.8**) faces west onto Port Orchard Bay, which separates the island from the rest of the Kitsap Peninsula. Like the other drainage basins this has relatively level higher elevations and fairly steep walls facing west to the water. Many small depressions that are the result of glacial activity are found in the upper portion of the basin. One large portion of the Crystal Springs area is known for old or ancient slides and many of the west-facing slopes continue to be prone to slumps, slides, or erosion. Some of the coastal area has slopes greater than 40 percent. The 318-acre Gazzam Lake Park is found in the upper portion of the watershed and is largely tree-covered. With the exception of the southern end, this basin is well vegetated and has little residential development.

Development

Zoning along the waterfront is two units per acre and along the southern inland is one unit per acre. A portion of an area zoned one unit per acre is found closer to the Fletcher Bay Drainage Basin. The upland just north of Point White is zoned one unit per two and a half acres, including the area around Gazzam Lake Park.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	89	458	217	16	107	887
Percentage	10	52	24	2	12	100

Known Problems (See Figure 6.8)

A lack of ditches and culverts along roads at lower elevations has resulted in flooding and erosion. The known problems are discussed in more detail below:

GL-001 Hansen Rd. Drainage
Hansen Road lacks appropriate ditches and culverts. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include roadside ditches and culverts and perhaps a steep slope pipeline and/or an outfall/energy dissipation improvement. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

GL-003 (Upper) Crystal Springs Dr. NE Drainage
Rural gravel road runoff causing erosion on private properties. A home has been lost to erosion. Capital/Reconstruction Improvement CIP scheduled for 2002. See City's Draft 2001-2006 CIP for more information.

GL-004 Point White/Crystal Springs Dr. NE Landslides
Annual slides upland of road. Similar problem as Manitou Rd. Bulkhead. Drainage/Erosion/Earth Movement CIP scheduled for 2003. See City's Draft 2001-2006 CIP for more information.

GL-007 3570 & 3574 Crystal Springs Dr. NE Shoreline Erosion
An outfall improvement may reduce shoreline erosion. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include an outfall/energy dissipation improvement, shoreline stabilization or a regional detention facility. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

GL-008 Sorrel Way/Lindquist Creek Culvert
Existing 12" diameter culvert is collapsed 10' from outfall. Source: BIPW staff.

GL-009 Crystal Springs Dr. NE Landslides
Two or three slides upland of road. Trees leaning and roots exposed on steep sandy slope. Source: Consultant team.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include bioengineered embankment stabilization, a retaining wall or perhaps removing the road in the troubled area creating two dead end streets. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

GL-010 Crystal Springs Dr. NE Area Drainage
Rural gravel road runoff causing erosion on private properties. Capital/Reconstruction Improvement CIP scheduled for 2003. See City's Draft 2001-2006 CIP for more information.

Future Problems (See Figure 6.8)
Landslides will continue to be a problem along the west-facing, unstable slopes.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts.

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

GL-006 Gazzam Creek Detention
A regional detention facility here can protect the creek and downstream steep slopes while mitigating tributary road and private development. Estimated total project cost for this alternative: $4,100,000.

6.2.9 Pleasant Beach Drainage Basin

Description
Some upper elevations of this 1,429-acre drainage are fairly level with small depressions, then steep slopes descend to the waterfront in the area of Lynwood Center. **(See Figure 6.9)** Along some of the streams that drain the east-facing hillsides are areas where the slopes are greater than 40 percent. Much of this steep hillside is prone to slumps and slides. Two large wetlands occur along the drainage of the basin's main stream, one at an elevation of roughly 100 feet and the other in the lower, waterfront section. Much of the waterfront portion of this basin is listed as floodplain.

Development
As the western steep-sloped ridge reaches toward Rich Passage, slopes become less steep and residential development at one unit per acre is the predominant land use on the south-facing slopes. The waterfront portion is zoned two units per acre, with one unit per acre east and north of Lynwood Center. Higher elevations are zoned at one unit per two and a half acres. Lynwood Center is one the three designated Neighborhood Service Centers on the island and could see a slight increase in density once public sewer service is in place.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	187	1,032	63	106	41	1,429
Percentage	13	72	4	7	4	100

Known Problems (See Figure 6.9)

Local problems include runoff from roads along the waterfront where stormwater facilities are inadequate to deal with drainage. The known problems are discussed in more detail below:

PB-001 Lynwood Center Outfall
A property owner in Lynwood Center built a structure across an easement line which limited maintenance easement access. A new access agreement has been established recently which will require the City to make some modifications in the field. Drainage/Erosion/Earth Movement CIP scheduled for 2003. See City's Draft 2001-2006 CIP for more information.

PB-002 Point White Dr. NE West of Estuary Outfall Culvert
This beach outfall culvert located west of the estuary is constantly being blocked by beach aggregate deposited by tidal action. The existing 12" diameter concrete culvert is most likely separating at its joints under Point White Dr. NE. Source: BIPW staff.

Potential Solution: A new alignment should be investigated rather than replacing the existing small diameter culvert in its current location and dealing with similar maintenance problems. An alternative alignment would involve ditching north along the west side of Point White Dr. NE, passing under a driveway with a new 12" diameter culvert and discharging to the estuary. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

PB-003 Point White Dr. NE/NE Tara Ln.
A natural depression in the Baker Hill development located adjacent to Point White Dr. was fitted with a stormwater mitigation control structure during development. While maintenance easements have been recorded, two landslides into the pond have occurred recently forces impounded runoff across Point White Drive. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem may be assumed to include enforcement or revised operation and maintenance procedures.

PB-005 NE Oddfellows Rd./Pleasant Beach Dr. NE Culvert
Blocked culvert on private property results in public road flooding. Source: BIPW staff.

Potential Solution: Given available information, potential solutions may involve private conveyance maintenance and repair or a private operation and maintenance program. The City undoubtedly has prescriptive rights to the drainage path and should enforce corrective actions if necessary.

PB-006 Lytle Rd. NE Outfall
Drainage problem similar to NE Beck Rd. end. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include an outfall/energy dissipation improvement, shoreline stabilization or a regional detention facility. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

PB-011 Lynwood Center Rd. NE/Schel-Chelb Creek Restoration
Fish blockage due to old dam. Source: Consultant team.

Potential Solution: A regional detention and fish passage facility here can protect the adjacent wetland and creek while mitigating tributary road and private development while restoring fish passage. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

Future Problems (See Figure 6.9)
As more development occurs in this basin adequate facilities and increased maintenance operations will be needed.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts except for those described above.

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

PB-007 NE Baker Hill Rd./Schel-Chelb Creek Retention
A regional retention facility here can recharge aquifers and adjacent wetlands and streams as well as mitigate tributary road and private development.

PB-009 Lower Lynwood Center Rd./Schel-Chelb Creek Retention
A regional retention facility here can protect downstream steep slopes, recharge aquifers and adjacent wetlands and streams as well as mitigate tributary road and private development.

PB-010 Upper Lynwood Center Rd./Schel-Chelb Creek Retention
A regional retention facility here can recharge aquifers and adjacent wetlands and streams as well as mitigate tributary road and private development.

6.2.10 Eagledale Harbor Drainage Basin

Description
Upper portions of this 1,096-acre basin are nearly level, while the lower slopes fall fairly regularly to the waterfront at Eagle Harbor. **(See Figure 6.10)** A number of small streams drain the slopes that are still largely wooded with second-growth vegetation.

Development
In the northeastern part of this drainage shed is the site of the former Wycoff lumber mill, now a federal Superfund Cleanup Site. Immediately south of this is a residential development zoned 4.3 units per acre. The remainder of the inner harbor waterfront area, is zoned for residential use at two units per acre. Much of the rest of the watershed is zoned one unit per acre although some of the higher elevations are zoned one unit per two and a half acres.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	183	760	6	95	52	1,096
Percentage	17	69	0	9	5	100

Known Problems (See Figure 6.10)
Along NE Eagle Harbor Drive is an area with frequent slide problems where over-steep cuts have been made in sandy gravels near the road. The entire length of the Rockaway Beach area is subject to slides. Undersized culverts cross both New Sweden Avenue and Taylor Avenue causing backwater to built and overflow the road. The known problems are discussed in more detail below:

ED-001 *NE Eagle Harbor Dr. Cut Slopes*
Over-steep cut slopes in sandy gravels. Frequent landslide problems. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

ED-002 *Rockaway Beach Rd. NE Landslides*
Two large landslides have blocked road in the past. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

ED-003 *New Sweden Ave. NE Culvert*
Culvert is undersized and backwater overflows road. Source: BIPW staff.

Potential Solution: As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

ED-004 *Taylor Ave. NE Culverts in Series*
Two culverts are undersized and backwater overflows road. Downstream 36" concrete culvert lost a section from erosion. Purchase of impoundment easements and installation of a control structure on the end of the new culvert would provide additional detention for downstream Salmonids. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

ED-009 Taylor Ave. NE Road End Outfall Pipe
An existing 18" galvanized steel road end outfall pipe discharging to Eagle Harbor is rusted out. The pipe is located by drinking well. Source: BIPW staff.

Potential Solution: As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

Future Problems (See Figure 6.10)
Instability along Rockaway Beach Road will continue due to the nature of underlying materials. Because much of this basin slopes at greater than 15 percent, roads built to serve future residential development will have to provide adequate drainage.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts.

For long-range planning purposes described in Section 4.3.2, potential regional retention, detention and water quality facilities are located at the following locations:

ED-006 NE Eagle Harbor Rd. Detention
A regional detention facility here can protect the creek and downstream steep slopes while mitigating tributary road and private development. Estimated total project cost for this alternative: $1,500,000.

ED-007 NE Eagle Harbor Rd./Unnamed Creek Detention
A regional detention facility here can protect the creek and downstream steep slopes while mitigating tributary road and private development. Estimated total project cost for this alternative: $3,400,000.

ED-008 Upper Cougar Creek Detention
A regional detention facility here can protect the creek and adjacent wetland and downstream steep slopes while mitigating tributary road and private development. Estimated total project cost for this alternative: $3,500,000.

6.2.11 Blakely Harbor Drainage Basin

Description
Surrounding the elongated Blakely Harbor, this 1,371-acre drainage contains many steep-sided slopes that face down to the harbor, as shown in **Figure 6.11**. Upper portions of the watershed are fairly level, and from small wetlands at higher elevations, a number of streams drain to the harbor. A few stands of old-growth vegetation are found in this watershed that remains, with the exception of the Restoration Point area, very forested with little residential development. Several areas are prone to slumps or slides. Much of this basin is underlain with bedrock, and as a result, lack of groundwater for domestic use has precluded a greater amount of development.

Development
Waterfront lots around the harbor are generally zoned two units per acre, except along Restoration Point. The remainder of the watershed is zoned one unit per two and a half acres. Because of restrictions on water supply and limits to septic systems due to underlying materials, this basin may develop at a slower rate than other areas on the island.

Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	136	1,042	8	81	104	1,371
Percentage	10	76	1	6	7	100

Known Problems (See Figure 6.11)
Most of the problems in this drainage basin occur along the Rockaway Beach Road where steep slopes with unstable materials were cut for road building. A lack of recorded drainage easements is resulting in erosion along this road. Elsewhere are roads that are failing due to flooding from unconfined runoff. The known problems are discussed in more detail below:

BH-001 Rockaway Beach Rd. NE Landslides
Over-steep road cut slope may have contributed to approximately four separate landslides along the road. Inadequate runoff collection contributes to road flooding and fissuring. City ditch maintenance has been denied by private property owners as the ditch is reported to be located on private property. Guardrail failing. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include a combination of retaining walls, cut slope flattening, roadside ditches, culverts and closed conveyance systems. Road repair and/or realignment may be preferred depending on right-of-way acquisition needs. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

BH-003 NE Halls Hill Rd. Area
Unimproved roads have an upland drainage problem. Drainage/Erosion/Earth Movement CIP scheduled for 2002. See City's Draft 2001-2006 CIP for more information.

BH-004 NE Seaborn Rd. and 3-T Rd. Culverts
Two undersized culverts are in poor condition. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows these culverts will be under capacity. Source: BIPW staff and Consultant team.

Potential Solution: Replacing the culverts would restore pipe condition while providing adequate flow capacity for the future. Estimated total project cost for this solution: $112,000.

BH-005 Fort Ward Hill Rd. NE Reconstruction (north end)
Road failing from stream erosion. Road and drainage improvement. Capital/Reconstruction Improvement CIP scheduled for 2002-2003. See City's Draft 2001-2006 CIP for more information.

BH-006 NE Country Club Rd. Erosion
Revetment needed to prevent continued road failure and loss of culverts from tidal erosion. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

BH-007 NE Country Club Rd./Mac's Dam Stream Culvert
Fish blockage during low tide. The downstream concrete headwall is undercutting. Minor separation in first pipe joint. Source: BIPW staff and Consultant team.

Potential Solution: A culvert and headwall replacement will provide future capacity, restore pipe and headwall condition and potentially assist fish migration.

BH-008 NE Blakely Ave./Lower Mac's Dam Stream Culvert
Culvert is rusting and may fail soon. Perched culvert fish blockage. A culvert replacement will protect this important road, provide adequate flow capacity, and assist fish migration. Culvert is to be replaced by PSELC project (Brainards). Source: BIPW staff and Consultant team.

BH-010 NE Blakely Ave./Upper Mac's Dam Stream Culvert
Perched culvert fish blockage. Hydrologic and hydraulic modeling for buildout conditions (see Section 4.3 of the report) shows this culvert is adequately sized for future conditions. Source: Consultant team.

Potential Solution: Installing rock and soil fill material at outfall would provide fish passage under this important road.

BH-011 NE Country Club Rd./Unnamed Creek Culvert
Ditch outfall blow out downstream of 15" diameter galvanized steel culvert. Culvert is collapsed and needs replacement to provide adequate flow capacity. Source: BIPW staff.

Potential Solution: A culvert replacement and ditch restoration/reinforcement will restore pipe and ditch condition. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

BH-012 NE Blakely Ave. Culvert
The perched 12" diameter culvert is under capacity. Source: BIPW staff.
Potential Solution: Replacing the culvert and installing rock and soil fill material at the outfall would provide fish passage while providing adequate flow capacity for the future. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

BH-013 NE Halls Hill Rd./Blakely Hill Rd. NE Realignment & Drainage Improv.
The roadbed has settled 5.5' due to creek erosive action at the embankment toe of Blakely Hill Road. Open ditch along Halls Hill Rd. may be replaced by closed system when road is realigned. Halls Hill Rd. portion has developer involvement. Capital/Reconstruction Improvement CIP scheduled for 2002. See City's Draft 2001-2006 CIP for more information.

Future Problems (See Figure 6.11)
The history of slides along the Rockaway Beach Road means this section of road requires special study for long-term solutions to drainage problems. Elsewhere drainage problems along roads in steeper areas must be assessed for drainage requirements.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts except for those described above.

For long-range planning purposes described in Section 4.3.2, a potential regional detention facility was located at the following location:

BH-009 NE Halls Hill Rd./Blakely Falls Creek Detention
A regional detention facility here can protect the creek and downstream steep slopes while mitigating tributary road and private development. Estimated total project cost for this alternative: $3,300,000.

6.2.12 South Beach Drainage Basin

Description
This is the smallest of all the watersheds on the island (697 acres) and is at the islands southernmost end. **(See Figure 6.12)** The underlying geologic unit is the Blakely Formation bedrock which contains little water. Upper reaches of the watershed have areas of fairly level or gently sloping topography, then the slopes descend steeply to the water front. Small wetlands dot the upper portions of the watershed and a few small streams drain the steep slopes. Along the steep, south-facing slopes are areas prone to slumps and slides. With the exception of Fort Ward area and the Country Club area, the watershed has good vegetative cover. Fort Ward State Park, over 130 acres, is in this basin.

Development
Fort Ward, located on the upper plateau, was a WWI army base that, at the time of this writing, is being redeveloped with residential housing at a density of two units per acre. The waterfront portion of this drainage basin is also zoned two units per acre. Residential units are built along the waterfront of Rich Passage.
Based on current zoning, the basin is permitted to develop to the following buildout land-cover limits as shown in **Figure 4.3** and the table below:

	Impervious	Grass/Landscaped	Pasture	Wetland	Forest	Total
Acres	59	459	0	12	167	697
Percentage	8	66	0	2	24	100

Known Problems (See Figure 6.12)
Within the Fort Ward area are a number of problems associated with poorly designed and maintained storm drain systems. Runoff from Toe Jam Hill Road is contributing to erosion in a stream. A revetment requires upgrading at NE South Beach Road. The known problems are discussed in more detail below:

SB-002 Toe Jam Hill Rd. NE Erosion
Stream eroding its channel including the toe of adjacent road embankment. Trees fall into the creek causing blockages which further the erosion. Erosion is occurring at the downstream outfall also. Source: BIPW staff.

Potential Solution: Given available information, potential solutions to this problem area may be assumed to include stream bank stabilization or reconstruction, a high-flow bypass pipeline, an outfall/energy dissipation improvement, and/or a regional detention facility upstream. The solution may involve realigning the road away from the sensitive areas. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem.

SB-003 NE South Beach Rd. Revetment
Storm system undersized and may overflow. Revetment improvement needed. Drainage/Erosion/Earth Movement CIP scheduled for 2007+. See City's Draft 2001-2006 CIP for more information.

SB-004 Fort Ward Plat Drainage
Degraded and substandard Fort Ward Plat drainage system. Four runoff discharge points are located at the top of steep slopes without adequate conveyance down the slope. Runoff drains across Parkview Dr. NE and Fort Ward Hill Rd. A survey and engineering study is underway to recommend solution alternatives. Source: BIPW staff.

Future Problems (See Figure 6.12)
Nearly the entire Puget Sound waterfront in this basin has relatively flat beach/road areas below bluffs with slopes greater than 40 percent overlain in places by outwash soils that are prone to slumps, slides, or severe erosion. Clearing and grading activities as well as stormwater systems will have to be sensitive to potential impacts to soil and slope stability.

The hydrologic and hydraulic modeling at selected culvert locations under buildout conditions (see Section 4.3 of the report) did not uncover any highly ranked under capacity culverts.
Since the basin has short runoff routes and small tributary subbasins, no potential regional retention, detention and water quality facilities were located except as noted above.

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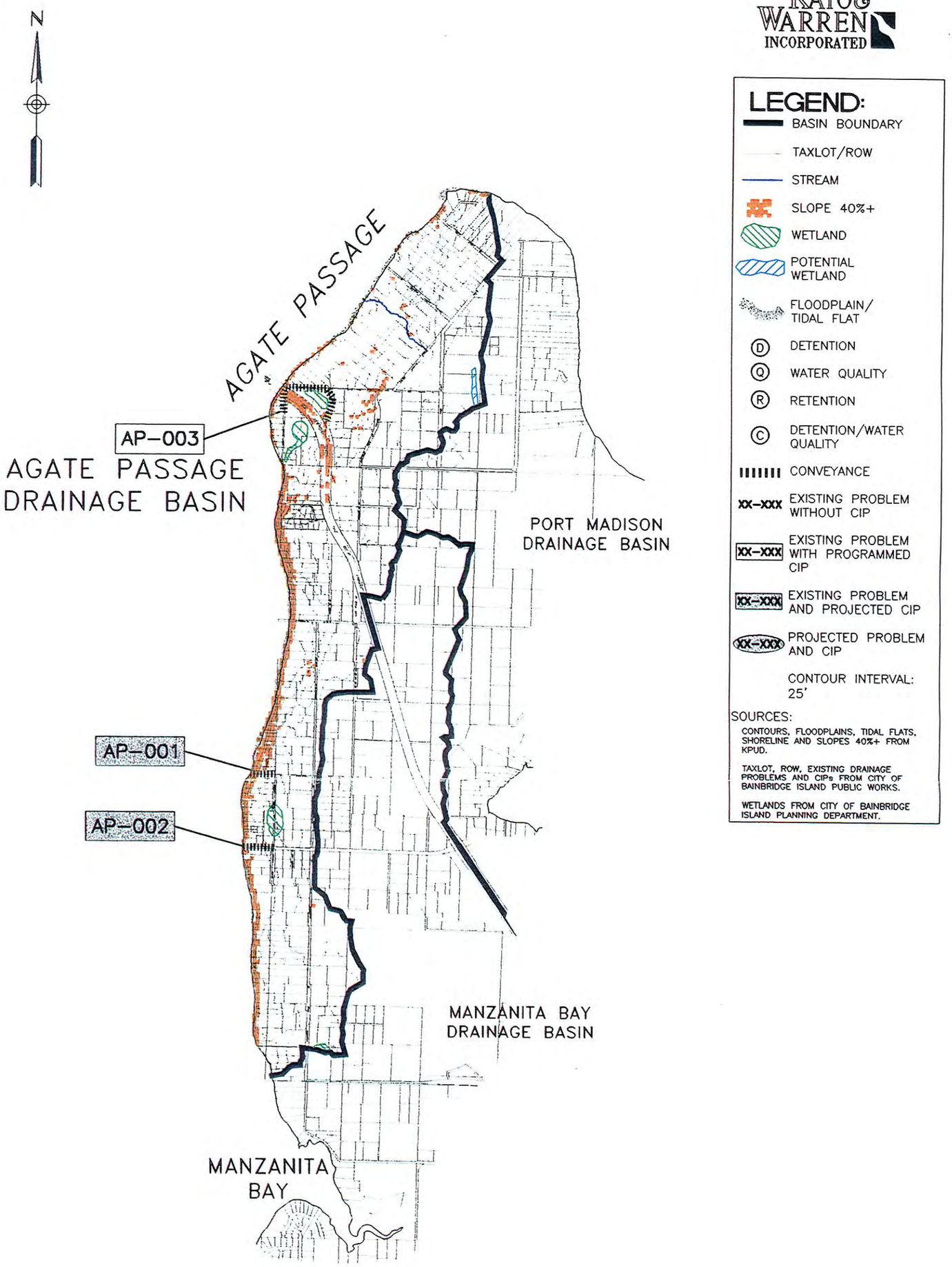

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN

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FIGURE 6.1
AGATE PASSAGE DRAINAGE BASIN
EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs

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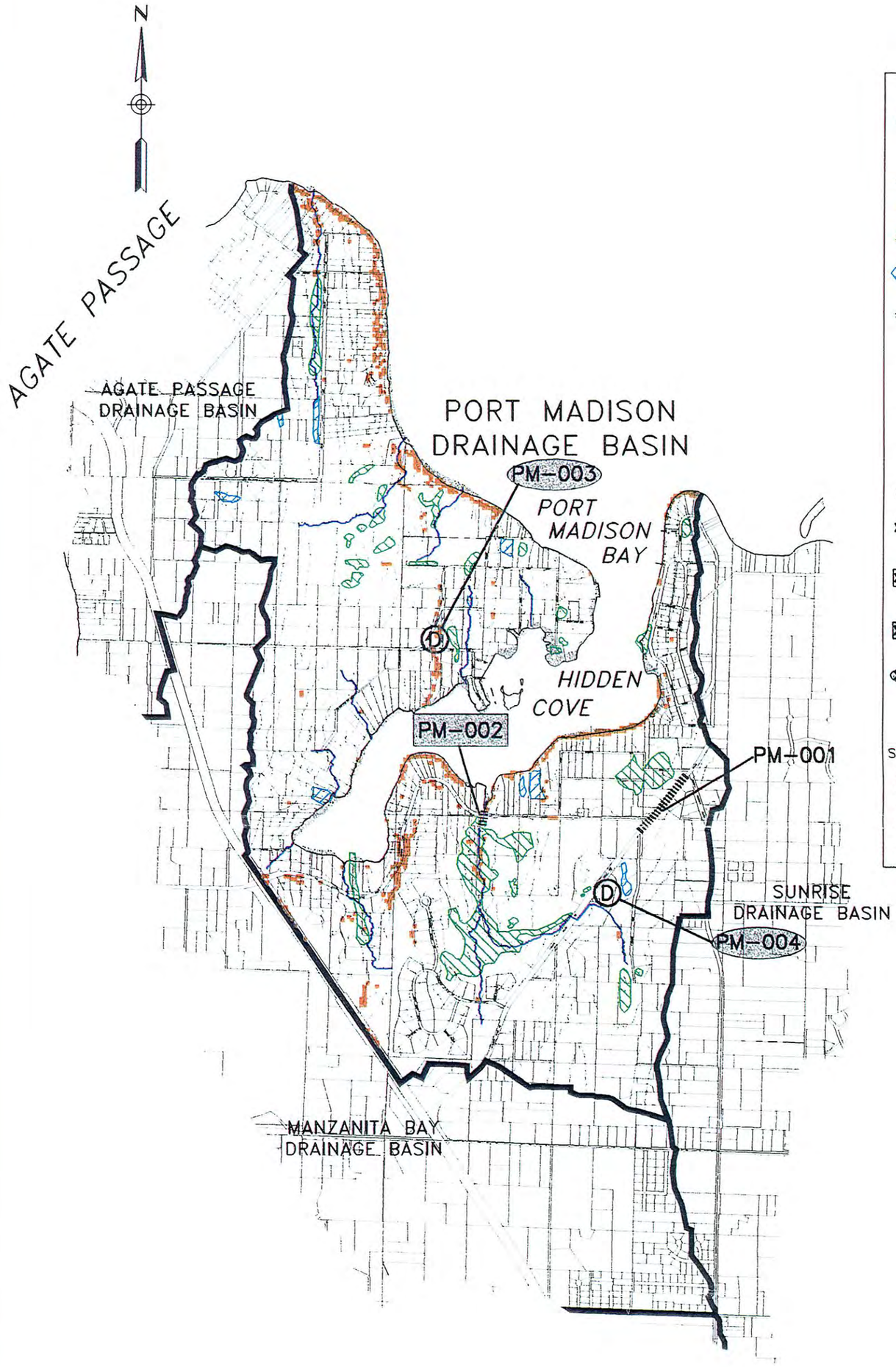

LEGEND:

- BASIN BOUNDARY
- TAXLOT/ROW
- STREAM
- SLOPE 40%+
- WETLAND
- POTENTIAL WETLAND
- FLOODPLAIN/ TIDAL FLAT
- (D) DETENTION
- (Q) WATER QUALITY
- (R) RETENTION
- (C) DETENTION/WATER QUALITY
- CONVEYANCE
- XX-XXX EXISTING PROBLEM WITHOUT CIP
- XX-XXX EXISTING PROBLEM WITH PROGRAMMED CIP
- XX-XXX EXISTING PROBLEM AND PROJECTED CIP
- XX-XXX PROJECTED PROBLEM AND CIP
- CONTOUR INTERVAL: 25'

SOURCES:

CONTOURS, FLOODPLAINS, TIDAL FLATS, SHORELINE AND SLOPES 40%+ FROM KPUD.

TAXLOT, ROW, EXISTING DRAINAGE PROBLEMS AND CIPs FROM CITY OF BAINBRIDGE ISLAND PUBLIC WORKS.

WETLANDS FROM CITY OF BAINBRIDGE ISLAND PLANNING DEPARTMENT.

0 1/3 2/3 1 MILE

HORIZONTAL SCALE IN MILES

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FIGURE 6.2
PORT MADISON DRAINAGE BASIN
EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs

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KATO & WARREN INCORPORATED

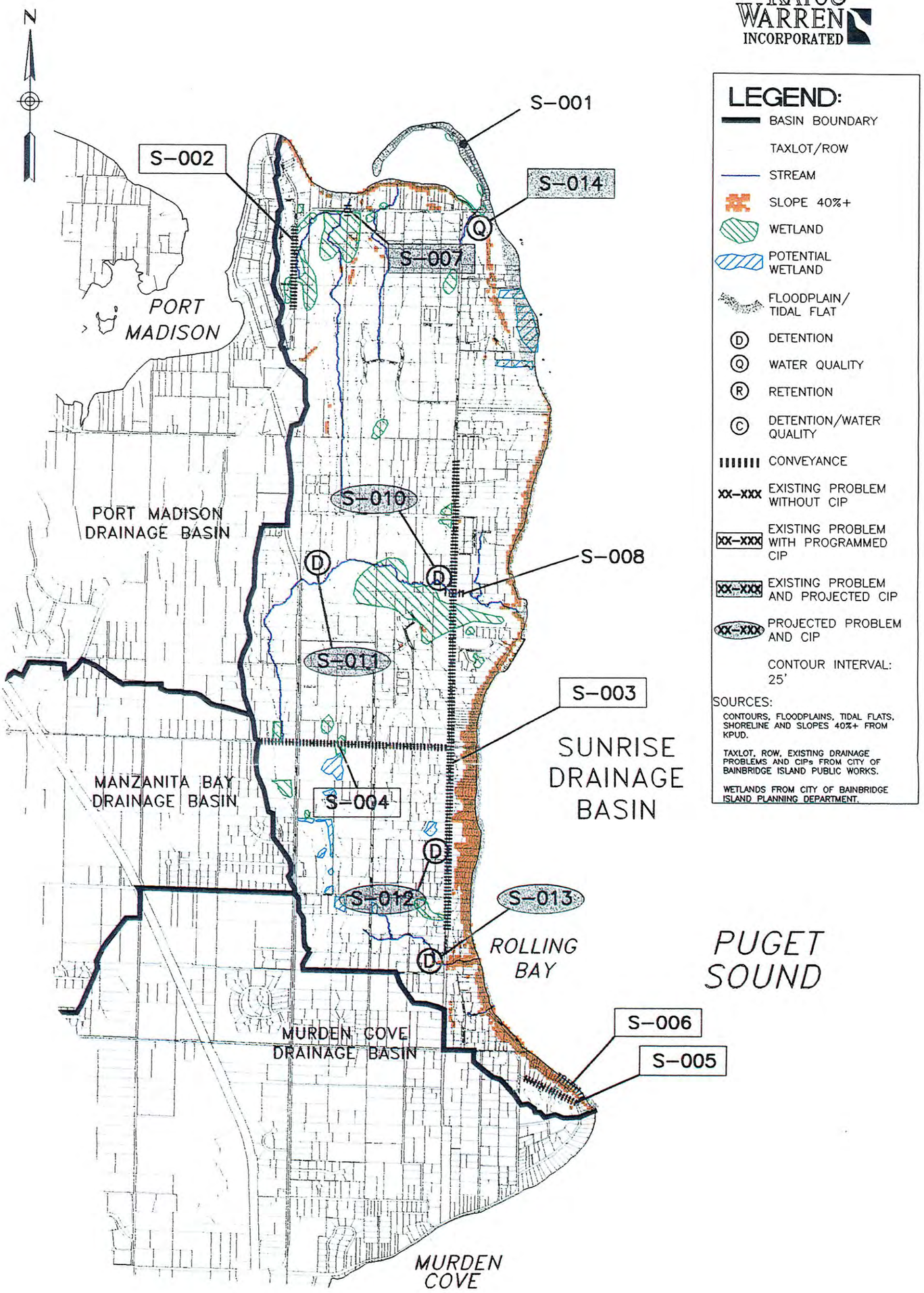

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FIGURE 6.3
SUNRISE DRAINAGE BASIN
EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs

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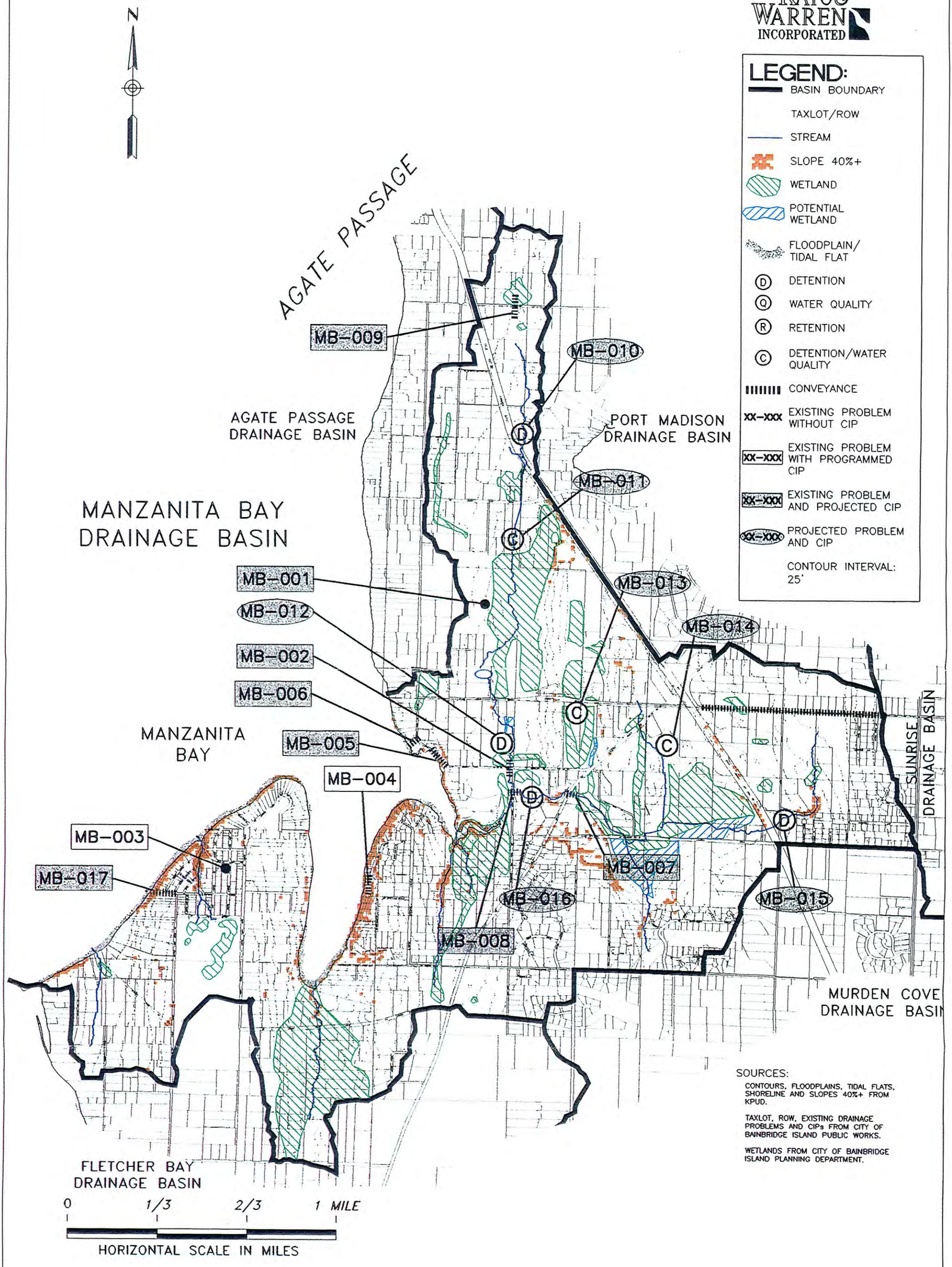

SOURCES:

CONTOURS, FLOODPLAINS, TIDAL FLATS, SHORELINE AND SLOPES 40%+ FROM KPUD.

TAXLOT, ROW, EXISTING DRAINAGE PROBLEMS AND CIPs FROM CITY OF BAINBRIDGE ISLAND PUBLIC WORKS.

WETLANDS FROM CITY OF BAINBRIDGE ISLAND PLANNING DEPARTMENT.

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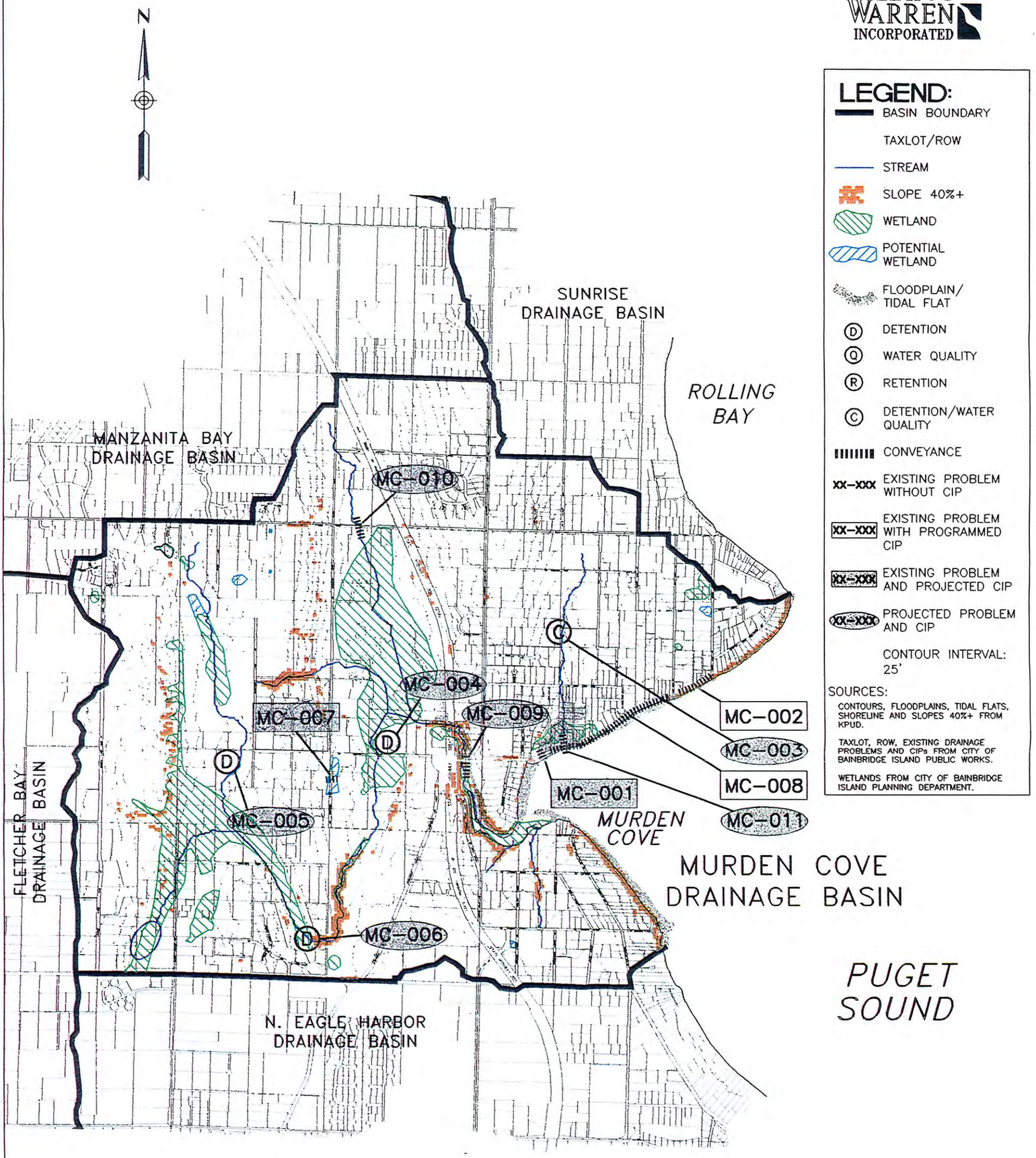
FIGURE 6.4
MANZANITA BAY DRAINAGE BASIN EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs

KATO & WARREN, INCORPORATED

KATO & WARREN INCORPORATED



CITY OF BAINBRIDGE ISLAND

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FIGURE 6.5
MURDEN COVE DRAINAGE BASIN
EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs

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KATO & WARREN INCORPORATED

N

MURDEN COVE

MURDEN COVE DRAINAGE BASIN

PUGET SOUND

FLETCHER BAY DRAINAGE BASIN

PLEASANT BEACH DRAINAGE BASIN

EAGLEDALE DRAINAGE BASIN

N. EAGLE HARBOR DRAINAGE BASIN

EH-001
EH-002
EH-004
EH-006
EH-007
EH-008
EH-009
EH-010
EH-011
EH-012
EH-013
EH-014
EH-016
EH-019
EH-020
EH-021
EH-023
EH-024
EH-025
EH-026
EH-027
EH-029
EH-030
EH-031
EH-032
EH-033
EH-034
EH-035
EH-036
EH-037
EH-038
EH-039
EH-040
EH-041

LEGEND:

- BASIN BOUNDARY
- TAXLOT/ROW
- STREAM
- SLOPE 40%+
- WETLAND
- POTENTIAL WETLAND
- FLOODPLAIN/ TIDAL FLAT
- (D) DETENTION
- (Q) WATER QUALITY
- (R) RETENTION
- (C) DETENTION/WATER QUALITY
- CONVEYANCE
- XX-XXX EXISTING PROBLEM WITHOUT CIP
- XX-XXX EXISTING PROBLEM WITH PROGRAMMED CIP
- XX-XXX EXISTING PROBLEM AND PROJECTED CIP
- XX-XXX PROJECTED PROBLEM AND CIP

CONTOUR INTERVAL: 25'

SOURCES:

CONTOURS, FLOODPLAINS, TIDAL FLATS, SHORELINE AND SLOPES 40%+ FROM KPUD.

TAXLOT, ROW, EXISTING DRAINAGE PROBLEMS AND CIPs FROM CITY OF BAINBRIDGE ISLAND PUBLIC WORKS.

WETLANDS FROM CITY OF BAINBRIDGE ISLAND PLANNING DEPARTMENT.

NOTE: ITEMS SHOWN BUT NOT LABELED ARE DESCRIBED IN THE WINSLOW MASTER PLAN, 1998.

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0 1/3 2/3 1 MILE

HORIZONTAL SCALE IN MILES

FIGURE 6.7

N. EAGLE HARBOR DRAINAGE BASIN
EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs

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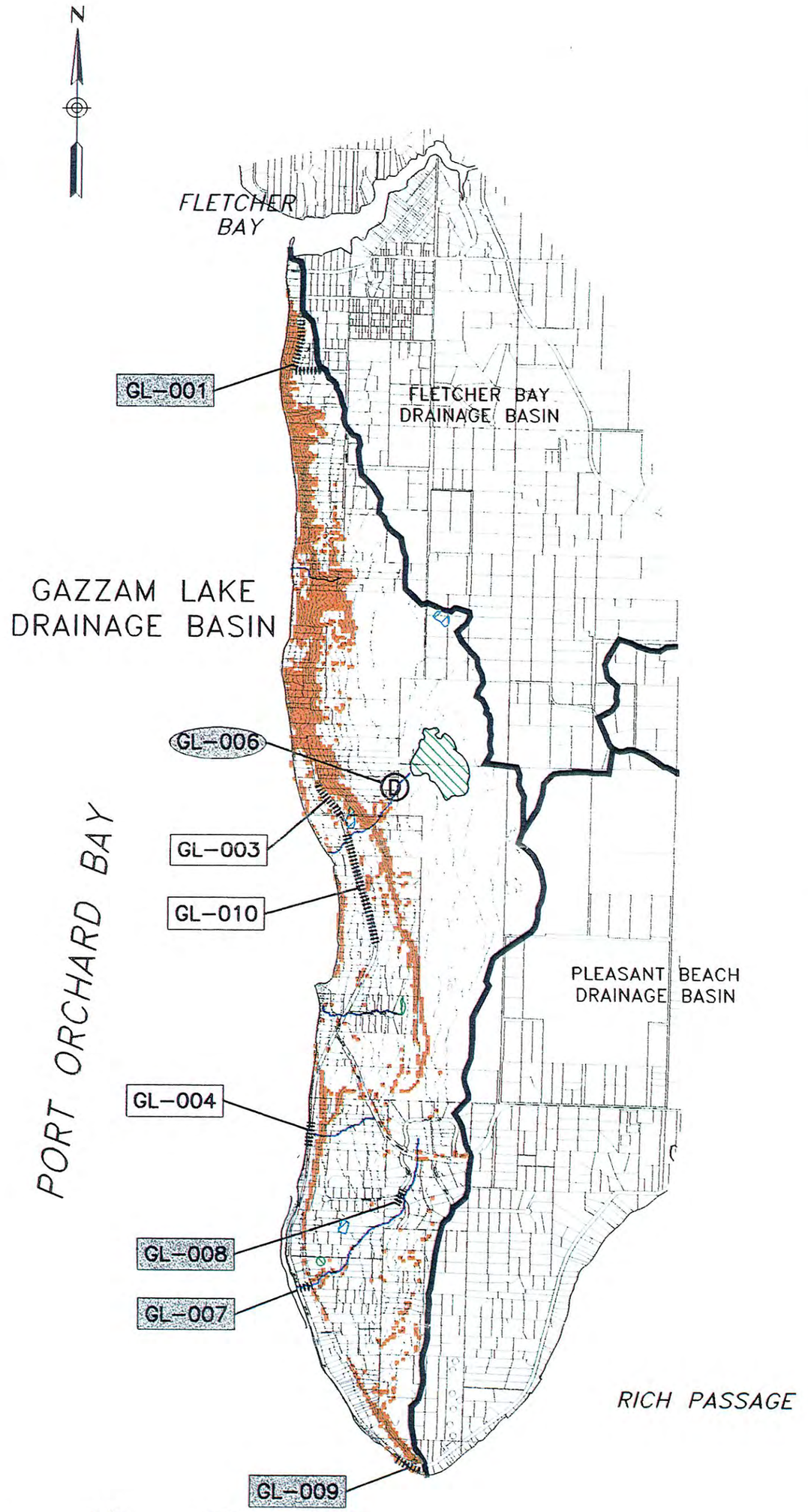
KATO & WARREN INCORPORATED



LEGEND:

- BASIN BOUNDARY
- TAXLOT/ROW
- STREAM
- SLOPE 40%+
- WETLAND
- POTENTIAL WETLAND
- FLOODPLAIN/ TIDAL FLAT
- (D) DETENTION
- (Q) WATER QUALITY
- (R) RETENTION
- (C) DETENTION/WATER QUALITY
- CONVEYANCE
- XX-XXX EXISTING PROBLEM WITHOUT CIP
- XX-XXX EXISTING PROBLEM WITH PROGRAMMED CIP
- XX-XXX EXISTING PROBLEM AND PROJECTED CIP
- XX-XXX PROJECTED PROBLEM AND CIP
- CONTOUR INTERVAL: 25'

SOURCES:

CONTOURS, FLOODPLAINS, TIDAL FLATS, SHORELINE AND SLOPES 40%+ FROM KPUD.

TAXLOT, ROW, EXISTING DRAINAGE PROBLEMS AND CIPs FROM CITY OF BAINBRIDGE ISLAND PUBLIC WORKS.

WETLANDS FROM CITY OF BAINBRIDGE ISLAND PLANNING DEPARTMENT.

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FIGURE 6.8
GAZZAM LAKE DRAINAGE BASIN
EXISTING AN DPROJECTED DRAINAGE PROBLEMS AND CIPs

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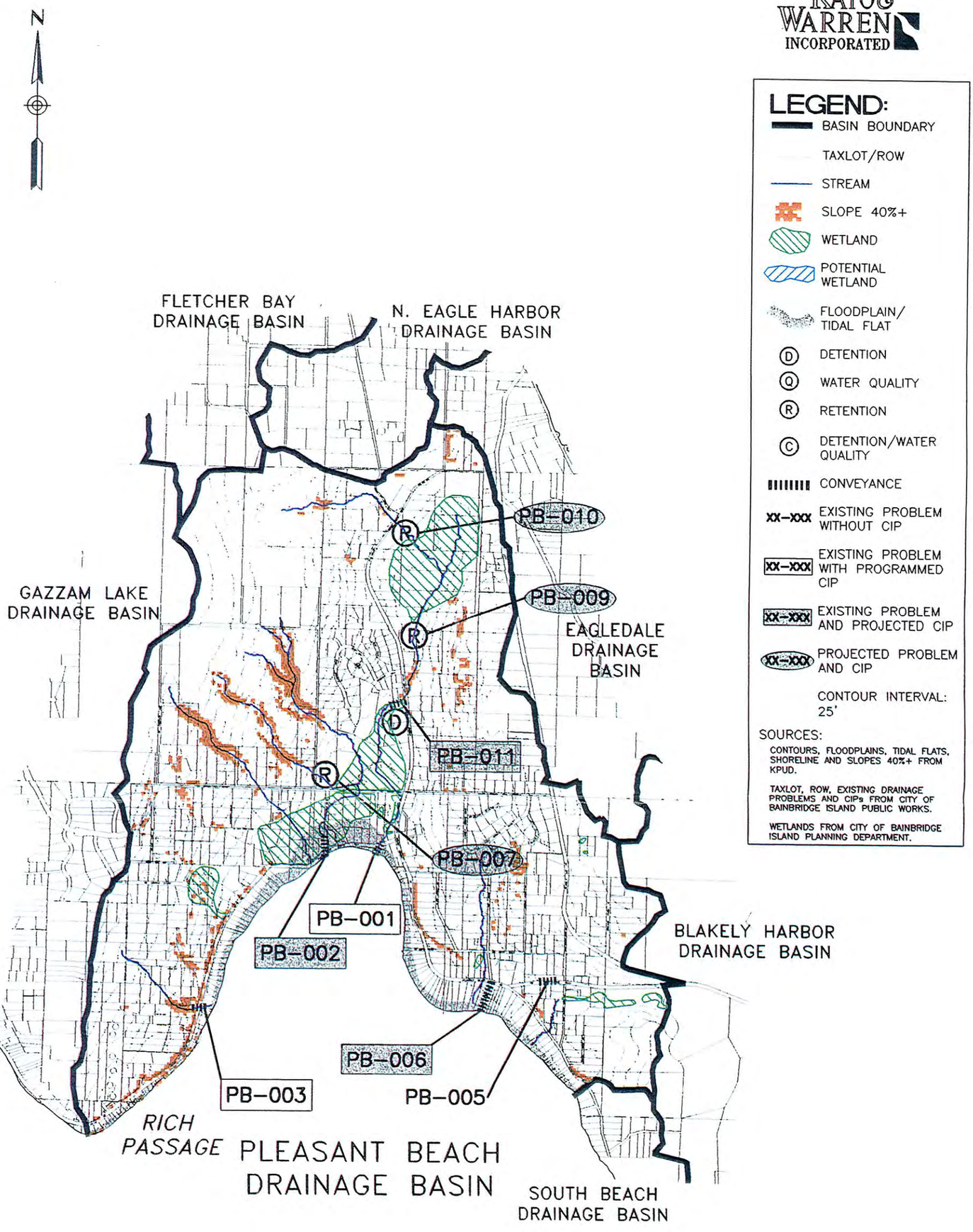

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FIGURE 6.9
PLEASANT BEACH DRAINAGE BASIN
EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs
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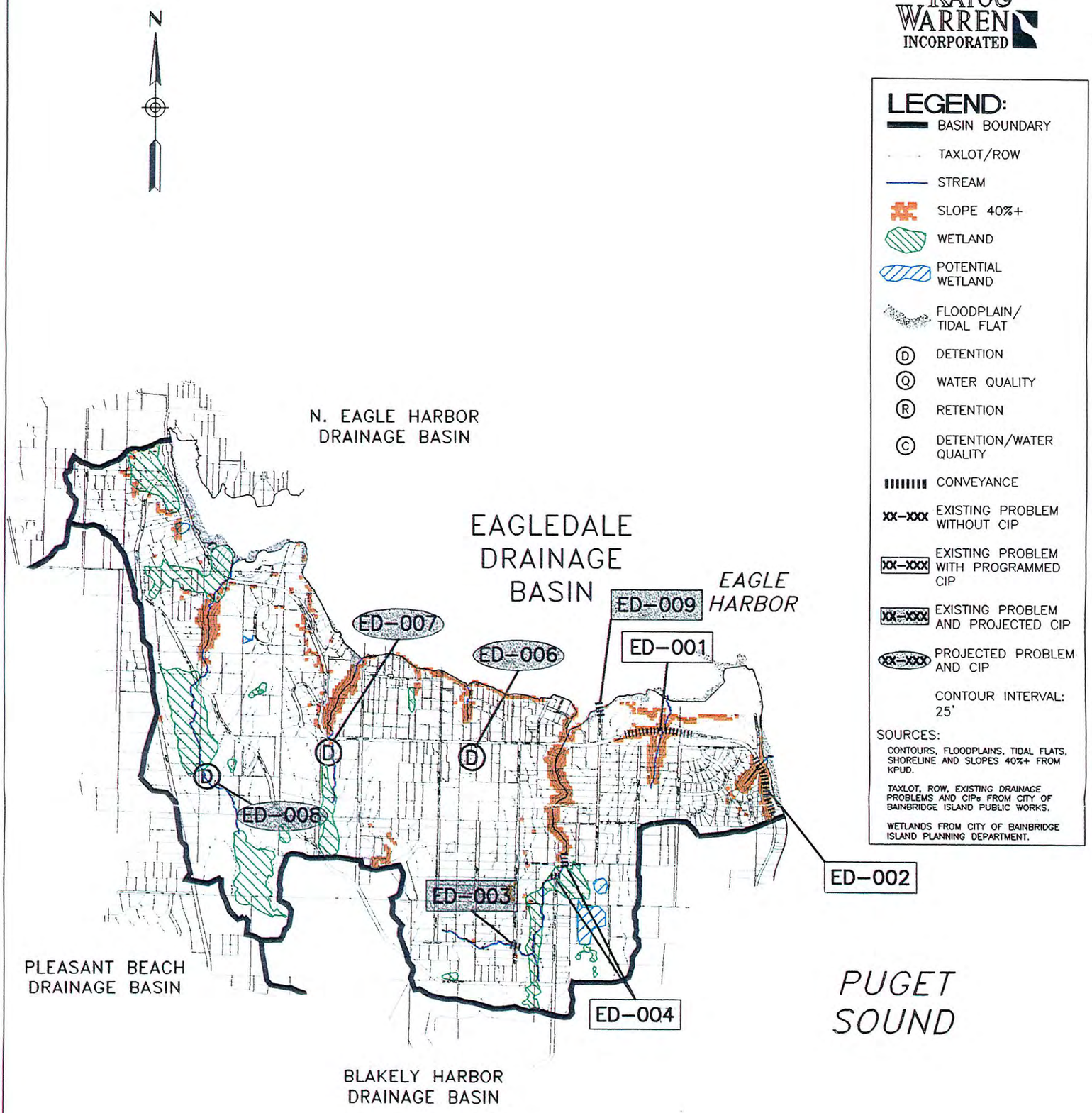
KATO & WARREN INCORPORATED



CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN

CITY OF BAINBRIDGE ISLAND
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FIGURE 6.10
EAGLEDALE DRAINAGE BASIN
EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs
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KATO & WARREN INCORPORATED

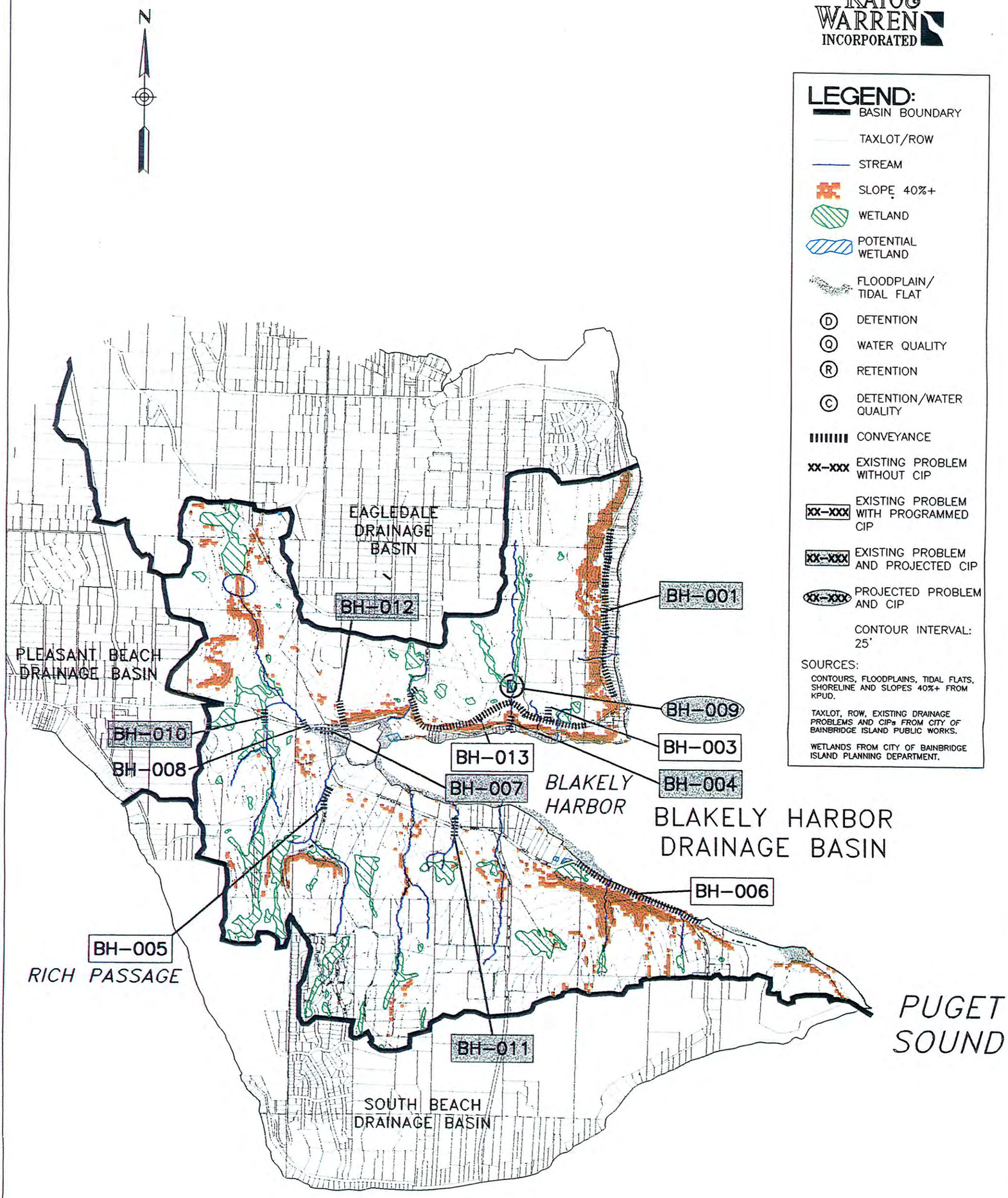

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FIGURE 6.11
BLAKELY HARBOR DRAINAGE BASIN EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs
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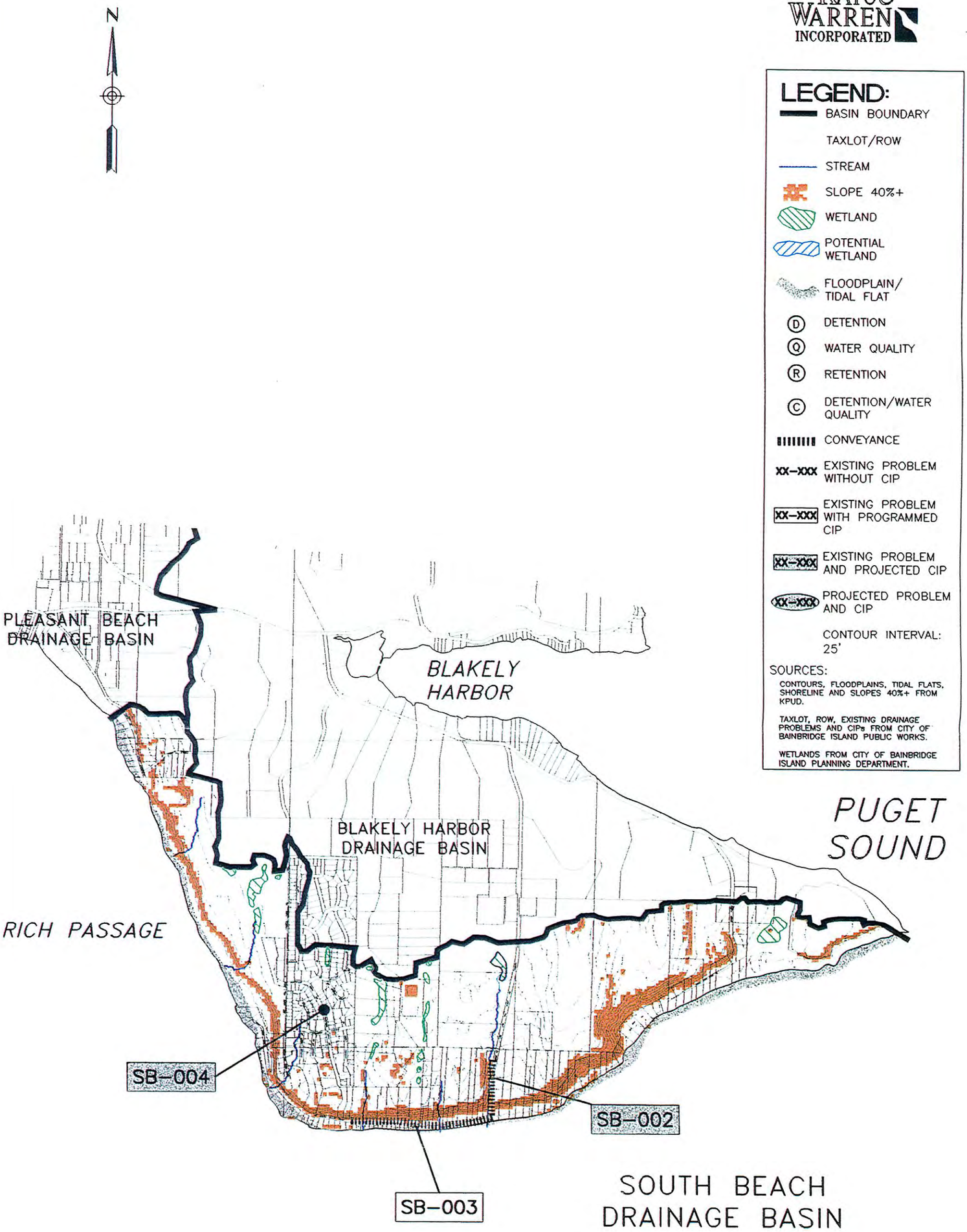

CITY OF BAINBRIDGE ISLAND
SURFACE WATER MANAGEMENT PLAN

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FIGURE 6.12
SOUTH BEACH DRAINAGE BASIN
EXISTING AND PROJECTED DRAINAGE PROBLEMS AND CIPs

KATO & WARREN, INCORPORATED

SECTION 7
SURFACE WATER MANAGEMENT PLAN
RECOMMENDED PRIORITY ACTIONS

SECTION 7
SURFACE WATER MANAGEMENT PLAN
RECOMMENDED PRIORITY ACTIONS

It is recommended that the priority actions listed below begin the implementation of solutions to the surface water problems identified in Section 6.2. The recommended priority actions below should be added to the City's Draft 2001-2006 CIP. The recommended priority actions were selected based on their perceived public health and safety benefit, property protection, fisheries benefit and other criteria as discussed in Section 6.1.2 including right-of-way requirements, land availability (where known), disruption to the community, effectiveness, feasibility, cost effectiveness, implementation and permitting issues and concerns, environmental impact and protection, maintenance requirements, and overall cost. For a discussion on each of the drainage problems below see **Section 6.2** and see **Figure 6.1 through 6.12** as appropriate.

7.1 Recommended Priority Actions

Hidden Cove Rd./Coho Creek Culvert Replacement
This recommended priority project addresses drainage problem PM-002 at an estimated total project cost of $259,000.

Miller Rd. NE/Manzanita Creek Culvert Replacement
This recommended priority project addresses drainage problem MB-007 at an estimated total project cost of $463,000.

Peterson Hill Rd. NE/Manzanita Creek Culvert Replacement
This recommended priority project addresses drainage problem MB-008 at an estimated total project cost of $207,000.

NE Battle Point Rd./Issei Creek Culvert Replacement
This recommended priority project addresses drainage problem FB-004 at an estimated total project cost of $105,000.

NE Grand Ave./Broomgerrie Rd. NE Landslide
The City should review consultant recommendations for addressing drainage problem EH-019 when complete. Depending on the results of the independent consultant studies, the problem should be addressed via the Drainage Upgrades Program as appropriate.

Yeomalt Area Outfalls
As part of the Drainage Upgrades Program, the City should hire a consultant or perhaps use in-house engineering staff to evaluate and design the proposed solution to drainage problem EH-020.

Hirakawa Creek Fisheries Obstruction
The City, WSDFW and the dam owner should coordinate and negotiate water rights needs and fish passage needs at location EH-023. Alternatives would include the installation of a fish ladder and/or removing/retrofitting the dam to provide fish passage. Once the parties have agreed on a proposed solution, the City should then hire a consultant or perhaps use in-house engineering staff to design the chosen solution to the problem.

Eagle Harbor Rd./Head-of-the-Bay Creek Fisheries Obstruction
The fish blockage from the historic runoff diversion structure at location EH-024 should be resolved in conjunction with *EH-008 - Bucklin Hill Rd. NE/Head-of-the-Bay Creek Culvert Replacement.*

Bucklin Hill Rd. NE/Head-of-the-Bay Creek Culvert Replacement
Multiple City departments will need to weigh the City's runoff diversion facility water needs and rights against fish passage restoration needs at location EH-008. Fish friendly alternatives would include daylighting much of the existing culvert stretch along Bucklin Hill Road and removing/retrofitting the runoff diversion structure to provide fish passage. Other alternatives range from restoring the existing culvert or daylighting much of the existing culvert stretch. Once City staff have agreed on a proposed solution, the City should then hire a consultant or perhaps use in-house engineering staff to design the chosen solution to the problem.

Crystal Springs Dr. NE Landslides
As part of the Drainage Upgrades Program, the City should hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem at location GL-009.

Lynwood Center Rd. NE/Schel-Chelb Creek Restoration
As part of the Drainage Upgrades Program, the City should hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem at location PB-011.

NE Blakely Ave./Upper Mac's Dam Stream Bed Enhancement
Installing rock and soil fill material at outfall would provide fish passage under this important road located at BH-010.

NE Blakely Ave. Culvert Replacement
Replacing the culvert and installing rock and soil fill material at the outfall would provide fish passage while providing adequate flow capacity for the future. As part of the Drainage Upgrades Program, the City could hire a consultant or perhaps use in-house engineering staff to evaluate and propose a solution to the problem located at BH-012.

Fort Ward Plat Drainage

The City should review the consultant recommendations for addressing drainage problem SB-004 when complete. Depending on the results of the independent consultant study, the problem should be addressed via the Drainage Upgrades Program as appropriate.

SECTION 8
SURFACE WATER MANAGEMENT PLAN
FUNDING

8.1 Funding Needs

The **Surface Water Management Plan** has identified funding needs and shortfalls if the City is to deliver and improve stormwater management for Bainbridge Island residents and meet state and federal regulatory commitments. Estimates of funding needs are shown below in **Table 8.1.**

TABLE 8.1

SURFACE WATER MANAGEMENT PROGRAM - ANTICIPATED ANNUAL FUNDING NEEDS

Element of Surface Water Program	Estimated Annual Funding Needed	Notes
Drainage Upgrades Program	$400,000	Increased to eliminate $6 million drainage/ erosion/ earth movement backlog in 30 years while funding existing $200k annual funding level
Shoreline Protection – ESA Response	$50,000	Continue existing funding level
Development Regulations and Review	$0	Paid by development fees
Inspection and Enforcement of Development Regulations	$0	Paid by development fees
Operation and Maintenance	$400,000	Increase existing funding level by $100k
Illicit Discharge Detection and Elimination	$20,000	Increase existing funding level by $20k for initial year of program expansion
Public Education/Involvement	$25,000	Continue existing funding level
Additional Studies		
Comprehensive Storm Drainage Mapping	$20,000	New program to run till mapping is complete in 4-6 years
Total	**$915,000**	

8.2 Available Resources

The City's 2000 Final Budget Storm and Surface Water Management Sub-Fund (Sub-Fund) assumes a budget of $1,458,227 in total resources and expenditures. It assumes a beginning working capital balance of $297,688 and an ending balance of $63,740. **See Table 8.2.**

Table 8.2
CITY OF BAINBRIDGE ISLAND – 2000 FINAL BUDGET
STORM & SURFACE WATER MGMT SUB-FUND – No. 403

EST. BEGINNING WORKING CAPITAL January 1, 1999		**$297,688**
REVENUES:		
Service Charges – Storm & Surface Water	$360,000	
Engineering Misc. & All Other	1,000	
Investment Interest	9,000	
TOTAL REVENUES		370,000
OPERATING TRANSFERS IN		
Taxpayer Support for Major Projects	750,000	
Debt Service for LTGO (SSWM) Bonds	40,539	
TOTAL NON-REVENUES		790,539
TOTAL RESOURCES		$1,458,227
EXPENDITURES:		
Salaries	221,606	
Benefits	66,767	
Supplies	32,100	
Professional Services	64,375	
Other Svcs & Charges	15,200	
Intergov't Charges	31,261	
Debt Service – Principal	25,560	
Debt Service – Interest	14,979	
Capital – Projects	882,100	
TOTAL EXPENDITURES		1,353,948
OPERATING TRANSFERS OUT		
Debt Service for LTGO (SSWM) Bonds	40,539	
Insurance, Wellness & Unemployment	0	
TOTAL NON-EXPENDITURES		40,539
ENDING WORKING CAPITAL December 31, 2000		**63,740** ⇦
TOTAL USES		$1,458,227

The City's Storm & Surface Water Mgmt Utility was established to fund the maintenance of storm water drainage; and its service charges are sufficient for that purpose. Also, it is the proper place to record capital improvements, for which taxpayer support is provided.

NOTE: The City's Water, Sewer and Surface Water Mgmt utilities are all part of a single, unified utility. Negative balances in one area may be offset against positive balances in another.

The bulk of the funding available for capital improvement projects in FY 2000 came from general City funds transferred to the Storm and Surface Water Management Sub Fund ($750,000.00). Revenue from the monthly storm and surface water service charge fee is projected to be $360,000.00 in FY 2000 at a fee rate of $3.07 per equivalent billing unit (EBU). This rate is projected to go to $4.00/EBU in FY 2001 which should increase total fee revenue to $470,000.00. This increase in service charge revenues, if applied to capital project needs only would support the issuance of $1,000,000.00 in utility revenue bonds. The same revenues would increase inspection and maintenance by 1 FTE with the needed support.

To meet the long term operating and capital needs of the storm and surface water systems will require additional resources either in the form of higher service charge fees or greater contributions from the City road fund or general fund.

8.3 Funding Options

8.3.1 Storm and Surface Water Service Charges

The total number of equivalent billing units (EBU) is approximately 9,700. This number will grow slowly given the City's present zoning and the concentration of commercial activity in the Winslow area where higher levels of impervious area already exist. To increase service charge revenues therefore will require an increase in the service charge fee rate. Each $1.00/EBU fee raise approximately $120,000.00. To fund the $915,000.00 projected funding need would require an EBU rate of $7.60 per month. While there are cities with higher rates it would seem unlikely that such a rate could be adopted except over an extended time (i.e., 5-10 years).

The City is gradually increasing the storm and surface water service charge to $4.00/EBU stated for 2001.

8.3.2 Impact Fees

It is common practice for cities to charge connection fees, or impact fees, to new users of their utilities including stormwater. Such fees are often based on specific sub-basin needs or on general system values. Impact fees of up to $1,000.00 per EBU are found in the Puget Sound area. More common are charges in the range of $400.00-$600.00. The City does not charge such a fee at this time.

Given the growth potential on the Island impact fees could not be expected to raise more than $50,000-$100,000 per year.

8.3.3 Other Charges

The City already charges for development review and inspection. Since stormwater from new development can be a major component of water quality problems it is conceivable that somewhat higher fees could be charged to fund an increase in development inspection and enforcement of the City's standards for erosion control. Any increase in such fees would be offset by additional staff costs and would not contribute to the overall funding need of the stormwater system.

8.3.4 Grants

Grants from State and Federal agencies are not particularly reliable sources of funding for on-going surface water program but rather as a project-specific opportunity. Several programs do exist, although available funds are limited and there is competition for such funds. The Centennial Clean Water Grant is a state program that has been a source for cities of both grants and loans to improve natural systems and protect water quality. The Endangered Species Act has spawned both planning and physical improvement grants for stream habitat and fish passage issues however the same caveats apply to this grant source. The City should assign staff to pursue grants for specific projects.

8.4 Implementation

Any action to address the issues raised by the SWMP have to be balanced against available revenues. Consequently our suggested action plan begins rather modestly and builds to a more proactive approach as funding is established.

1. Continue and strengthen the stormwater program staff so they can also pursue grant opportunities.
2. Continue to work closely with new development to require needed downstream improvements.
3. When completed, adopt the updated Ecology Manual with appropriate modifications to require more effective control of stormwater from development.
4. Increase the Drainage Upgrades Program and budget to $400,000.00 for FY 2001 and subsequent 30 years to address the highest priority annual projects and eliminate the $6 million backlog.
5. Evaluate the stormwater program annually and build a capital reserve. Depending on what outside funding has been obtained, for FY 2003 consider the possibility of revenue bonds with an increase in the stormwater utility rate.
6. Continue to monitor the cost of maintenance of the stormwater system to achieve the most cost-effective approach to reduce drainage problems and improve water quality.