WATER RESOURCES ELEMENT

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INTRODUCTION

Bainbridge Island, as a quasi-enclosed environment, must protect its water resources to ensure that future generations will have a sufficient quantity of high quality water to support life and natural habitat on the Island. Thus, it is important to view water resources from a holistic perspective because of the interdependence of different water types. However, it is challenging to address, for example, groundwater, surface water, and aquifer recharge issues in isolation due to the interrelationship. To address these interrelationships in respect to management of our Island water resources, a separate Water Resources Element has been developed as follows:

- General water resource management policies.
- Groundwater protection policies.
- Drinking water policies.
- Sanitary sewage disposal policies.
- Storm and surface water management policies.
- Monitoring and public education policies.

Water on Bainbridge Island

Precipitation is the sole source of water for the groundwater and surface water (streams, springs and wetlands) on Bainbridge Island. All public and private water systems are dependent on groundwater (wells) as a source of domestic potable water. Aquatic life is dependent on the surface waters of the Island. For this reason it is important to protect these water resources. Adequate protection of this important resource requires an understanding of what can affect the quality and quantity. Also of great importance is the management of the resource by guarding against potential impacts and monitoring the resource to ensure that water quality and quantity is in fact maintained at high standards.

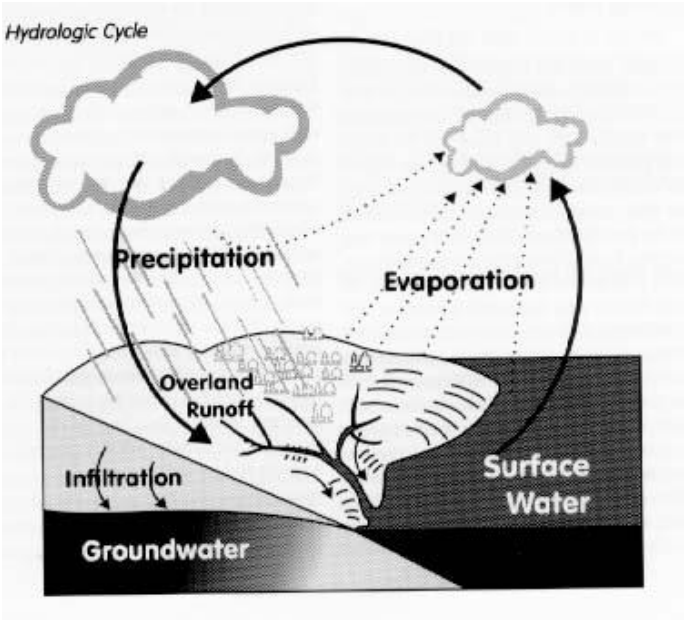
As the local government, the City of Bainbridge Island should be the overseeing agency for the Island's water resources, working in concert with the federal, state and county agencies that are charged by law to administer specific aspects of water resource management.

Hydrologic Cycle

From the time Bainbridge Island was formed, water has been endlessly circulating. This circulation is known as the hydrologic cycle. Surface water is evaporated from the earth by the sun. The water vapor forms clouds in the sky. Depending on the temperature and weather conditions, the water vapor condenses and falls to the earth as precipitation. When precipitation falls on the Island, some of it flows along the surface and into streams or wetlands, some of it is used by plants, some evaporates and returns to the atmosphere, some sinks into the ground and some flows to the Puget Sound. It is important to understand the hydrologic cycle as it relates to our Island. Studies, such as the *City of Bainbridge Island*

Level II Assessment: An Element of the Water Resources Study (2000, by Kato & Warren, Inc. and Robinson & Noble, Inc.) have been conducted and will continue to be required to build an understanding of the geology and hydrology of our Island.

In understanding the various aspects of the hydrologic cycle on Bainbridge Island, we must look at the different stages within the cycle. These include the Island watersheds (surface water) and aquifers (groundwater).



Watersheds

Precipitation, once it hits the ground, becomes surface water. Surface water flows from high geographic points to lower elevations collecting in streams and wetland systems within the watersheds of the Island. Watershed boundaries are determined by the topography of the Island with ridgelines defining the boundaries of separate watersheds. Studies have determined that Bainbridge Island has 12 separate watersheds.[1]

Aquifers

The water that flows into the ground moves slowly through layers of soil, sand and rocks, and is stored in underground spaces called aquifers. The speed at which groundwater flows or infiltrates depends on the size of the spaces in the soil or rock and how well the spaces are connected. Aquifers typically consist of gravel, sand, sandstone, or fractured rock, like limestone. These materials are permeable because they have large connected spaces that allow water to flow through them. Studies have identified five principal aquifer systems on Bainbridge Island.[2]

[1] *Bainbridge Island Watersheds*, 1995, Puget Sound Cooperative River Basin Team, *City of Bainbridge Island Level II Assessment: An Element of the Water Resources Study*, 2000, Kato & Warren, Inc., Robinson & Noble, Inc.
[2] *City of Bainbridge Island Level II Assessment: An Element of the Water Resources Study*, 2000, Kato & Warren, Inc., Robinson & Noble, Inc.

The aquifers of the Island provide the drinking water for the city. Drinking water is extracted from the ground through piped wells drilled down into the Island's aquifers. Generally the public water purveyors and large private water purveyors utilize wells from deeper aquifers. However, many private wells are quite shallow, being drilled to the aquifer closest to the surface. These shallow wells can be adversely affected by the fluctuations in groundwater levels, going dry when the aquifer water level falls below the bottom of a shallow well.

Land Use Connection

In the development of policies related to the management of our Island water resources, it is important to understand the links between water resources and land use and links between water quality, quantity and growth. Most water quality problems are caused by the way land is used. Developed land allows for rapid runoff and inundation of natural conveyance systems such as wetlands and streams. Rapid runoff, however, can cause damage through flooding, erosion, and water-borne contamination. In addition, households create sewage, which, on the majority of Bainbridge Island, means disposal by on-site, sanitary, sewer septic systems. These systems can fail and cause contaminants to enter the surface water and/or groundwater. Furthermore, improper livestock management can add significant fecal contamination to surface water and/or groundwater.

Without proper coordination of the regulations that will implement these policy statements, conflicting signals may be given when dealing with water resource issues. For example, a surface water problem may be resolved by efficiently collecting and removing all water from the area, whereas a groundwater recharge issue may require that the water be kept on-site to allow for infiltration. Another conflict arises when infiltration of stormwater competes for space with septic drainfield infiltration systems. There are physical limitations to the rates of infiltration and absorption based on soil types, which may make it impossible to have both of those facilities on the same site. Where development occurs in important aquifer recharge areas, special consideration is needed to preserve the volume of recharge available to the aquifer and to protect the ground water from contamination.

A key component of the water resources protection strategy contained in this Element is the establishment of an adequate monitoring system. The overriding theme, however, that runs through all of the policies and goals established in the water resource section is the preservation of water quality and water quantity.

GOALS AND POLICIES

GOAL 1

Protection of water resources is of primary importance to the Island. Therefore, the goal is to manage the water resources of Bainbridge Island for present and projected land uses, recognizing Island water resources are the sole water supply and that:

- **Degradation of groundwater 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.**

General Water Resource Policies

WR 1.1

The City shall coordinate with other major private water purveyors, government agencies and citizens to ensure protection and preservation of water resources and to provide efficient high quality Island-wide water service.

WR 1.2

To foster sustainable water resources, planning, protection, management, monitoring and on-going education outreach that is based on watersheds and natural systems should be provided by the City in coordination with appropriate agencies.

Groundwater Protection Policies

WR 2.1

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

Discussion: Low impact uses and low impact development are appropriate for areas with high aquifer recharge. Low impact uses includes development for buildings, roads or parking that has a reduced area of impact on the land. Low impact uses do not depend on regular applications of fertilizers or pesticides. Low impact development is an environmentally-friendly approach to site development and stormwater management, emphasizing the integration of site design and planning techniques that conserve and protect the natural systems and hydrologic functions of a site.

WR 2.2

To protect Island groundwater resources, the City shall encourage the development and expansion of public and private water systems, rather than encouraging shallow or individual residential wells.

WR 2.3

The City shall assess the impacts of proposed activities and development on the flow of springs and streams and levels of wetlands that are either sustained by groundwater discharge or contribute recharge to groundwater by requiring a hydrologic assessment report, and restricting the activities or development based on the report, and/or mitigating impacts.

WR 2.4

The City, in cooperation with the appropriate regulatory agencies (e.g., Washington State Department of Health and the Kitsap County Health District) should institute new wellhead protection procedures.

WR 2.5

For the purpose of protecting surface and groundwater quality, the City Parks Department and School District shall develop plans to eliminate the use of biocides on their properties through the use of integrated pest management techniques.

WR 2.6

The City shall promote the use of integrated pest management techniques and the reduction of pesticide and herbicide use within the City boundaries.

Drinking Water Service Policies

WR 3.1

Development of new public water sources and systems or expansion of existing systems shall not reduce the quantity or quality of existing water supplies below naturally sustainable levels.

WR 3.2

The City may elect to facilitate small water system management services by applying to the Department of Health to be an approved Satellite System Management Area (SMA).

WR 3.3

New development in previously unclaimed water service areas may be required to dedicate public water systems to the City if the system meets City standards and the City determines it is appropriate to accept, own and operate such systems.

WR 3.4

Engineering specifications of new public water systems and expansions or improvements to existing public water systems to be located within public right-of-ways shall meet standards set forth by the City.

WR 3.5

Water system infrastructure, which may provide water supplies exceeding local needs, shall not be used to justify development counter to the City Comprehensive Plan.

WR 3.6

All purveyors of public water systems shall depict water service areas on maps and evaluate modifications to their system boundaries based on the following criteria:

A. There is sufficient capacity to serve the area; and
B. The service area modification does not limit the system from providing service to targeted growth areas; and
C. Modification will serve a public need or the water system will benefit by such modification; and
D. An analysis of the cumulative impacts to the water system resulting from providing service on an individual basis to single parcels beyond the current service area is provided.

GOAL 2

Ensure that sewage is collected, treated, and disposed of properly to prevent public health hazards and pollution of groundwater, and surface water, including waters of the Puget Sound, and to promote recharge of the waters of Puget Sound.

Sanitary Sewer On-Site Systems Policies

SSP 1.1

Properly designed and maintained on-site wastewater disposal systems that are approved by the Kitsap County Health District or the State Department of Health are a long-range solution to sewage disposal in most areas of the Island. However, there may be areas of the Island determined by the Kitsap County Health District to be unsuitable for on-site wastewater disposal systems due to site conditions (such as steep slopes, geological or soil conditions, lot size, or proximity to sensitive bodies of water).

SSP 1.2

Regulations and procedures of the Washington State Department of Health and the Kitsap County Health District shall apply to all on-site disposal systems. The City shall work with these agencies to assure regular maintenance and repair of all sanitary sewer and on-site systems located on the Island.

SSP 1.3

Certification of adequate design and proper operation of septic systems shall be required prior to issuance of permits for remodeling of existing buildings.

SSP 1.4

Prior to issuance of a building permit, on-site drainfield and reserve areas should be identified and marked, and a protection plan should be approved for any building lot.

SSP 1.5

The City shall request notification of all waivers or variances of Kitsap County Health Department requirements, such as modification of setbacks, vertical separation, minimum lot size, reserve drainfield, etc., prior to issuance and subsequent modifications by the Health District of an approved Building Site Application.

SSP 1.6

Kitsap County Health District approved alternative systems, such as sand filters, aerobic treatment, composting toilets, living-systems, etc., should be encouraged for sites where conventional on-site systems are not suitable or feasible.

SSP 1.7

Regulations shall require coordination between the on-site septic and storm drainage disposal systems designs to ensure the proper functioning of both systems.

SSP 1.8

The City shall assist the Kitsap County Health District in developing a program to require proper maintenance of all on-site waste disposal systems in order to reduce public health hazards and pollution. This program shall include periodic system inspection and pumping when necessary.

SSP 1.9

The City and the Kitsap County Health District should work together on a collaborative program to fund and pursue grants or low-cost loans for low and moderate-income households to repair failed septic systems.

SSP 1.10

On-site waste disposal systems serving more than one household should be allowed only with assurance of proper design, operation, management and approval from the Health District.

SSP 1.11

The City may provide the service of operation and maintenance management for approved large on-site sanitary sewer systems (LOSS) or community sanitary sewer systems in coordination with the Kitsap County Health District.

SSP 1.12

The City should support the Kitsap County Health District in establishing a public education program to foster proper construction, operation, and maintenance of on-site septic systems.

SSP 1.13

The City should support the Kitsap County Health District in developing and maintaining an ongoing inventory of existing on-site disposal systems to provide needed information for future studies.

Public Sanitary Sewer Policies

SSP 2.1

Public sewer service should be provided for areas designated in the Comprehensive Plan, including Winslow, the City-contracted service areas of Sewer District 7 and the future service areas at Point Monroe Drive and Lafayette Avenue. Such public sewer service shall not be used to justify development counter to the Comprehensive Plan.

SSP 2.2

In public sewer system service areas, new construction should provide for eventual connection to public sewer systems.

SSP 2.3

The City sewer service area for the south end of Bainbridge Island (contracted service areas of the Sewer District 7) is shown on Figure 2B. Emergency service or other minor modifications to Figure 2B, which are within the existing sewer facility capacity, may be allowed with approval by the City Council by resolution, but major service area expansions that require a facility capacity analysis shall be evaluated under Policy SSP 2.7.

The future City sewer service areas for Point Monroe Drive and Lafayette Avenue (contracted service areas of the Washington State Parks and Recreation Commission) shown on Figure 2c are established to address an existing environmental problem and are not a necessary action to facilitate the growth planned under the City's Comprehensive Plan. The future sewer service areas shown in Figure 2c shall not become effective unless (1) a sewer treatment facility is built by the Washington State Parks and Recreation Commission at Fay Bainbridge State Park with capacity to serve the areas shown in Figure 2c, and (2) a local improvement district is successfully formed or other non-city funds are secured to pay for the City's full cost of providing the infrastructure to serve the areas shown in Figure 2c.

Future sewer service area A will become effective without further amendment to the Comprehensive Plan when items 1 and 2 listed above are met.

Future sewer service area B will become effective without further amendment to the Comprehensive Plan when the following requirements are met:

- Items 1 and 2 listed above are met; and
- The two lots fronting Puget Sound are aggregated into a single lot; and
- Development rights are extinguished through a conservation easement on the three lots fronting the Pt Monroe Lagoon shown in Figure 2c as "Conservation area related to future sewer service area B"; and
- A shoreline variance permit application allowing the development of a single-family residence is approved, issued, and survives any appeal.

Future sewer service area C will become effective without further amendment to the Comprehensive Plan when the following requirements are met:

- Items 1 and 2 listed above are met; and

- The two lots are aggregated into a single lot; and
- A shoreline variance permit application allowing the development of a single-family residence is approved, issued, and survives any appeal."

Discussion: Future sewer service to the Pt Monroe and Lafayette areas was created because the Washington State Parks and Recreation Commission proposed building a sewer treatment facility at Fay Bainbridge State Parks as part of a larger effort to clean up and restore Puget Sound. State Parks offered the excess capacity to serve adjacent areas where water quality would be benefitted and the Pt Monroe and Lafayette neighborhoods requested the City to establish sewer service that would be tied to the Fay Bainbridge State Park facility. Future sewer service area A includes lots with existing homes and those that were considered to be buildable with the need for variances. Future sewer service areas B and C includes lots whose property owners requested sewer service knowing that they would have to receive approval under a variance process and who offered to aggregate lots and in one case extinguish development rights on several lots. The projected capacity of the proposed treatment plant would allow for 95 connections beyond the capacity needed for State Park operations. Accordingly, future sewer service areas A, B, and C would utilize all 95 connections.

SSP 2.4

The service area for the Winslow Sanitary Sewer System shall be the area designated in Figure 2. Emergency service or other minor modifications to Figure 2, which are within the existing sewer facility capacity, may be allowed with approval by the City Council, provided that such extensions serve areas that have an environmental need for sewer due to 1) a high number of documented failing septic systems; or 2) proximity to sensitive bodies of water that are unsuitable for on-site septic systems, according to the Kitsap County Health District. Major service area expansions that require a facility capacity analysis shall be evaluated under Policy SSP 2.7.

Discussion: An emergency requiring sewer connection is defined pursuant to the regulation and guidance of the Department of Health.

SSP 2.5

Sewer connections shall not be mandated for uses with existing septic systems that are fully functioning and maintained, provided that the use does not change.

SSP 2.6

Those properties receiving new public sewer service shall pay a proportional share of the cost for providing that service.
(Alternative: Funding for public sewer facilities will be paid primarily by users, in accordance with Capital Facilities Policy CF 1.12.)

SSP 2.7

Public Sewer Facilities Planning and Major Improvements

A. When the existing capacity of public sewer facilities reaches the threshold set for mandatory evaluation of the treatment plant as established by regulatory agencies, planning to address the shortfall in sewer facility capacity shall be initiated. The Public Works Department, in consultation with the Planning and Community Development Department, will perform the preliminary planning on the methods of providing sewer service utilizing a public participation process. The planning will include evaluation of the following:
    1. Feasibility of alternatives to large sewer facilities;
    2. Operational changes to the existing public sewer facility;
    3. Expansion of the existing sewer facility; and
    4. Siting of a new public sewer facility.

B. In developing alternatives for providing sewer service, the Public Works Department shall:
    1. Investigate alternatives to modifications of existing or placement of new sewer facilities that would be satisfactory to the regulatory agencies for their consideration;
    2. Prepare a comparative analysis of alternatives, including a capacity analysis of the existing facility; and
    3. Develop costs and alternate financing methods for the feasible alternatives.

C. A comprehensive plan amendment will be necessary if new sewer service areas are proposed for a new public sewer facility or major expansion of an existing public sewer facility.
    1. In planning and establishing a new service area for a new public sewer facility or major expansion of an existing public sewer facility that provides additional service, service area boundaries will be evaluated using the following considerations in descending order of importance:
        (a) Areas that have an environmental need for sewer due to 1) a high number of documented failing septic systems; or 2) proximity to sensitive bodies of water that are unsuitable for on-site septic systems according to the Kitsap County Health District.
        (b) Areas used as or planned for development that serves a public need, such as a public school.
        (c) Areas designated for commercial and mixed use.
        (d) Areas designated for residential use at densities of four units to the acre or greater.
        (e) Areas planned for an increase in density through a special planning area process.
    2. The boundaries of new public sewer service areas shall be based on consideration of the topography, public street system, lot layout and other factors, to form a reasonably contiguous service area boundary.

SSP 2.8

Re-use of treated wastewater for irrigation, fire flow, and other non-potable uses should be considered in the planning and design of treatment facilities. These facilities shall be consistent with health and safety considerations and evaluate financial impact to ratepayers and taxpayers.

Stormwater Management and Protection

GOAL 3

Stormwater runoff shall be managed comprehensively to:

- **Protect property from flooding and erosion;**
- **Protect streams and shorelines from erosion and sedimentation to avoid the degradation of environmental quality and natural system aesthetics;**
- **Protect the quality of groundwater, surface water, and the waters of Puget Sound; and**
- **Provide recharge of groundwater where appropriate.**

SD 1.1

The City shall maintain a comprehensive storm drainage plan which:

- Identifies and ranks existing and potential problems at the drainage basin level.
- Proposes solutions to those problems and a basin level implementation plan.
- 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 shall require new development to provide both on-site improvements and 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 systems. 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 shall be encouraged to provide for removal of pollutants and sediment through bio-filtration or other means, where appropriate and feasible.

SD 1.6

Zoning and development design standards should minimize disruption and/or degradation of natural drainage systems, minimize impervious areas by restricting site coverage, and encourage site permeability through retaining natural vegetation and buffers, and specifying use of permeable materials.

SD 1.7

Industrial, commercial, and agricultural land uses should be encouraged to manage surface water in a manner which prevents pollutants from entering ground or surface waters.

SD 1.8

The city should consider a program of retrofitting existing roads with water quality and quantity stormwater system improvements in order to minimize pollution of natural drainage systems and the waters of the Puget Sound resulting from runoff of roadways.

Monitoring Policies

M 1.1

The City should institute a comprehensive program of water resource data gathering and analysis. Such a 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.

M 1.2

Periodic monitoring and reporting of water quality and quantity of public water systems[3] is required by the Kitsap County Health District. Single units shall be encouraged by the City to provide well data to the Kitsap Public Utility District and the Department of Health regarding water level recordings, quality degradation, etc.

M 1.3

The City should support the Kitsap County Health District in developing a program for proper maintenance of on-site waste disposal systems in order to reduce public health hazards and pollution. This program should include periodic system inspection and pumping when necessary.

M 1.4

The City should support the Kitsap County Health District in developing and maintaining an ongoing inventory of existing on-site disposal systems to provide needed information for future studies.

[3] A public water system is defined as a system with two or more hookups.

Public Education Policies

PE 1.1

The City, special districts, and water purveyors will develop and implement a comprehensive public education program in water resource management and protection. The program should address all aspects of water conservation and groundwater protection, including septic system maintenance, spill management and non-point pollution impacts from farm animal/agricultural activities, and homeowner maintenance practices.

PE 1.2

Water conservation should be aggressively pursued by the City to promote the efficient use of water and to protect the resource. Water conservation programs should encourage the use of vegetation that prevents soil erosion, protects habitat for wildlife, retains surface water for recharge, and which does not require additional water during normally dry months.

PE 1.3

Water re-use and reclamation will be encouraged to serve as a supplementary source for high-water users such as industry, parks, schools, and golf courses, as approved by the Washington State Department of Health.

PE 1.4

The City should develop a program that encourages homeowners to reduce impervious surface area and explore innovative methods for recapturing and reusing surface water runoff and grey water, as approved by the Washington State Department of Health and the Kitsap County Health District.

PE 1.5

The City should support the Kitsap County Health District in establishing a public education program to foster proper construction, operation, and maintenance of on-site septic systems.

WATER RESOURCES ELEMENT
EXISTING CONDITIONS AND FUTURE NEEDS

Bainbridge Island is a quasi-enclosed environment that requires a holistic perspective be utilized to understand the interdependence between groundwater, drinking water, sanitary sewage disposal, storm and surface water. The following outlines the present conditions and understanding of the water resources of the Island and the future needs for protection and utilization of these resources.

Groundwater Conditions

Groundwater

Groundwater is the sole source of drinking water on Bainbridge Island. It is found in underground reservoirs called aquifers. An aquifer is defined as a permeable sand and/or gravel formation that is capable of yielding a significant amount of water to a well. Wells on Bainbridge Island penetrate several distinct aquifers to allow withdrawal of drinking water by individual homeowners and municipal water purveyors. Most individual household wells penetrate to depths of less than 300 feet. Some residents are still using hand-dug wells less than 40 feet deep, completed in the permeable sediments known as the Vashon Recessional Outwash. Groundwater found at this level also feeds the base flow for Island streams. High capacity wells have been drilled as deep as 1,200 feet to find adequate marketable quantities of water for public and private water purveyors. While few in number, these wells produce a large portion of the Island's potable water. The Blakely Formation, a sedimentary bedrock formation, dominates the geology on the southern end of the Island and limits groundwater production in this area.

Aquifer systems on the Island have been mapped where there is sufficient geologic and hydrologic data available to define them. Our understanding of the Island's water resources has been enhanced through the *City of Bainbridge Island, Level II Assessment*[4] prepared by Kato & Warren and Robinson Noble. The following information on existing conditions was drawn from the Level II Assessment by Hydrogeologists and Bainbridge Island residents Doug Dow, Russ Prior, and Mark Shaffer and is subject to change with further study. These aquifers are described in detail in the *Kitsap County Groundwater Management Plan*, Volumes I II, dated April 1991, and more recently in the Level II Assessment. Brief descriptions of each aquifer system identified are as follows:

Perched Aquifer (PA)

The Perched Aquifer is a sand and gravel aquifer system under the major upland areas. It is found above 200 feet elevation and averages 90 feet in thickness. This aquifer underlies nine square miles (33%) of the Island's land surface and serves a number of domestic wells, with yields averaging 16 gpm. It is recharged from leakage through overlying sediments and discharges through underlying sediments into deeper aquifers or through springs where the aquifer intercepts land surface.

[4] Subtitled *An Element of the Water Resource Study, dated December 2000*.

Semi-Perched Aquifer (SPA)

The Semi-Perched Aquifer is found under approximately 20 square miles (73%) of the land surface and averages about 30 feet in thickness. Where identified, it is found between 20 feet below and 100 feet above sea level. Approximately 25% of the domestic wells on the Island obtain an average of 19 gpm from this aquifer. However, uncharacteristically high yields from wells completed for Meadowmeer provide local yields over 300 gpm. The aquifer is recharged from leakage through overlying sediments and discharges into deep cut stream valleys, deeper aquifers, or to Puget Sound.

Sea Level Aquifer (SLA)

The Sea Level Aquifer underlies 85% (23.5 square miles) of the Island's land surface but is noticeably absent south of Blakely Harbor where bedrock is found above sea level. The aquifer's average thickness is 110 feet. It is found from 40 feet above to 230 feet below sea level. The Sea Level Aquifer is the Island's primary aquifer system, supplying water to approximately 53% of Island wells. Several of the Island's larger water purveyors obtain yields of more than 300 gpm from this aquifer. The average yield to the majority of (domestic) wells is 20 gpm. The aquifer accepts recharge from leakage through overlying sediment with natural discharge into Puget Sound. The City's wells at the head of Eagle Harbor are completed in the SLA.

Glaciomarine Aquifer (GMA)

The Glaciomarine Aquifer is the shallower of the two deep aquifer systems present below Bainbridge Island. The data available confirms estimates of a depth of 400 to 760 feet below sea level under approximately 9.5 square miles (35%) of the Island and an average thickness of 120 feet. This aquifer may exist under a greater portion of the Island but lack of exploration precludes a definitive analysis. Only 2% of Island wells penetrate this fine-grained aquifer which yields an average of 18 gpm. Notable wells completed in the GMA are the City's Taylor Avenue well and the old and new wells completed at the former creosote plant site at Bill Point. Recharge to the aquifer is obtained through leakage from overlying sediments. Discharge is likely to deeper areas in Puget Sound.

Fletcher Bay Aquifer (FBA)

The Fletcher Bay Aquifer is named for a pair of wells drilled into the deep aquifer system near Fletcher Bay. Several other wells are also completed in this permeable sand and gravel formation found from 690 to 1,280 feet below sea level. Because very few wells penetrate to this depth, the extent of the aquifer is not well defined. The aquifer is believed to underlie 55% (15 square miles) of the Island, mainly in the north central area. The City obtains the majority of the drinking water for the Winslow water system from the FBA through its Fletcher Bay and Sands Road wells. Yields from this aquifer average 330 gpm. Because of the depth of this aquifer, it has been theorized that it is connected to a similar aquifer identified at this depth on the Kitsap Peninsula. However, this connection has not been proven and recharge to the FBA can only have been assumed to originate on the Island through leakage from overlying sediments.

Hydrologic Cycle and the Water Budget

Understanding the Island's water budget requires a look at the components of the water system. These components are defined as:

- Precipitation (rain or snow);
- Evapotranspiration: the combined amount of water that evaporates directly from the surface plus the amount that is taken up by vegetation and transpired back into the air;
- Runoff: the amount of water that flows directly off the Island via streams;
- Recharge: the amount of water that infiltrates into the aquifer; and
- Discharge: well pumpage, springs, streams and direct discharge into Puget Sound.

Although the variability of the natural system is great, educated assessments of the individual components are commonly used to predict sustainable use of the groundwater.

All water entering the Island's natural water system originates as precipitation. Only a portion of the precipitation is available for recharge because some of it exits the system before it percolates into the ground. Water exits the system through evapotranspiration, surface runoff and discharge. The quantity of groundwater available for use is a function of the water balance: water entering the system is equal to water flowing out of the system, plus or minus the change in storage of water within the aquifer.

Precipitation on Bainbridge Island averages about 35 inches per year. In the absence of more precise water budget data it is generally thought that one-half to one-third of all precipitation is lost through evaporation from surface water and evapotranspiration from trees, plants and grass. It is estimated that approximately one-quarter to one-third of the precipitation is discharged to springs and stream flow or directly to Puget Sound.

The remaining precipitation infiltrates the surface sediments through direct absorption, supplemented to some extent through on-site stormwater infiltration, to recharge the Island aquifers. An unknown quantity of recharge is discharged from the Perched and Semi-Perched Aquifer, and to a lesser extent the Sea Level Aquifer providing (base) stream flow for fish and other wildlife. However, only a portion of the remaining recharge that reaches the major aquifers is available for use without serious disruption of the hydrologic system. Withdrawing too much water will cause aquifer water levels to decline and may cause seawater intrusion into the Sea Level Aquifer and deeper aquifers.

Hypothetical groundwater (aquifer) yield

A simplistic approach for determining the "hypothetical groundwater yield" is the product of the general recharge rate times the recharge area (27.5 square miles or 17,600 acres) producing a volume of water in acre feet per year. The Level II study provided a hypothetical groundwater recharge of 19,000 acre feet per year (afy). However, it is recognized that the sustainable yield of an aquifer can be more accurately determined by monitoring aquifer water levels for many years. Such monitoring would include: flow metering of typical wells for water use or measurement of surface water diversions; well water monitoring; and stream flow monitoring. Management of the groundwater resources of Bainbridge Island will require balancing withdrawals from specific aquifers to sustainable water levels. Actual sustainable withdrawal rates are unknown.

Aquifer Recharge Areas

Springs and streams reflect a natural system of discharge for Island groundwater. All of the remaining land surface (except for portions of the southern end of the Island) serves as aquifer recharge area. Soil type, slopes, vegetative cover and impervious surfaces significantly affect the distribution of recharge. The identification of aquifer recharge areas is important both from the standpoint of groundwater quantity and quality. Aquifer recharge areas have geologic and soil conditions which allow high rates of surface water infiltration, which also means they are particularly susceptible to contamination. Increasing impervious surfaces through development reduces the amount of recharge available to the Island's aquifers. At the same time, runoff from impervious surfaces in developed areas contains increased contaminants. Efforts to protect and preserve the Island's natural water supply are warranted, as the resources that would be required to clean up after contamination or to secure a new source would be prohibitive.

Where development overlays aquifer recharge areas, special considerations need to be made to preserve the volume of recharge available to the aquifer and to protect the groundwater from contaminates such as nitrates, biocides and heavy metals found in septic systems and stormwater runoff. The most extensively used aquifer underlies 85% of the Island and occurs under all zoning classifications.

The Recharge Areas Map (Figure 5) was developed by Russ Prior with assistance from Mark Shaffer, Doug Dow and Kitsap County PUD. This recharge map is based on a spreadsheet model produced by Robinson and Noble for the Level II Assessment (December 2000). Figure 5 identifies high, moderate and low aquifer recharge areas on Bainbridge Island. Generally recharge depends on the ease with which precipitation can move from the land surface to the aquifer based on the types of conditions in the area. The elements used in the Level II spreadsheet model include: amount of rainfall, surficial soil types (based on USDA Soil Survey of Kitsap County), slope, ground cover and water holding capacity.

Aquifer recharge areas have been mapped for the Island using available assessment information described in the Level II Assessment. The mapping identifies high, moderate, and low aquifer recharge areas in accordance with the following definitions:

Susceptibility	**Characteristics**
High	Greater than 20 inches of infiltration into the groundwater system per year – generally areas with high recharge have permeable surficial soils and shallow slopes.
Moderate	Between 10 and 20 inches per year of infiltration into the groundwater system – includes many areas underlain by Vashon till which allows significant quantities of infiltration.
Low	Less than 10 inches per year of infiltration into the groundwater system – generally areas with low recharge have surficial soils of low permeability and steep slopes.

Source: 2000 Bainbridge Island Level II Assessment

Aquifer Concerns

The Island has many shallow and deep aquifers, some of which may be connected vertically as well as horizontally. No data has been developed to date to determine how much water can be withdrawn from any of the Island aquifers without causing over-drafting. Monitoring is important to further our understanding of the Island's aquifer systems.

Based on current water quality data, the 2000 *Bainbridge Island Level II Assessment* concluded there was no evidence of extensive seawater intrusion on the Island nor was there evidence of increasing salinity.

Drinking Water Conditions and Future Needs

Background

Bainbridge Island's potable water is provided from well water supplies drawn from the Island's aquifers – no water is obtained from off-Island sources.

Domestic drinking water is supplied by the City of Bainbridge Island, North Bainbridge Water Company, South Bainbridge Water Company, numerous smaller public water systems (two or more hookups), and over 1,000 private single-dwelling wells. Information was obtained from the *Bainbridge Island Water System Plan* prepared for the Winslow Water System by R.W. Beck and Associates in 1993 (updated by Gray & Osborne), the 1992 *Kitsap County Coordinated Water System Plan* (CWSP), the *Kitsap County Groundwater Management Plan*, 1991 (GWMP), and the *Bainbridge Island Level II Assessment*, 2000, completed by Kato & Warren working with Robinson & Noble.

Under the federal Clean Water Act, the State required regional planning administered by the Department of Ecology and the Department of Health. Through this process, Kitsap County Commissioners declared Bainbridge Island to be a Critical Water Supply Service Area in accordance with state authorizing statutes. The declaration invokes the Public Water System Coordination Act that requires procedures be established, subject to county approval, to identify all existing and future service areas for public water utilities.

The County Commissioners, in accordance with the Act, established exclusive water utilities service areas throughout the county with minimum domestic supply and fire flow requirements and standards for construction of temporary and permanent improvements. All developments must abide by Kitsap County and Bainbridge Island standards and the standards that the authorizing water utility may append within the service areas, regardless of whether the user will connect to the system at the time of development. Projects that propose to use satellite or stand-alone water supply systems for an interim period must also abide by the standards and agree to contract the operation of the system from the designated water purveyor. The CWSP is currently being updated and is expected to be approved and adopted in late 2004 or early 2005.

Level of Service

The levels of service are the minimum design standards and performance specifications provided in the 1992 *Kitsap County Coordinated Water System Plan*. Fire flow requirements are adopted by ordinance and based on zoning and type of construction. Residences can satisfy deficiencies by installing individual sprinkler systems. Levels of service are as follows:

Pressure	30 pounds per square inch (psi) residual
Pipe sizing	8-inch minimum diameter where a fire system is required
Storage	"Sizing Guidelines for Public Water Systems"
Quality	Federal and State minimum standards
Fire flow	Residential zone R-0.4 & R-1 = 500 gallons per minute (gpm) or sprinkler
Fire flow	Residential other zones = 1,000 gallons per minute (gpm) or sprinkler
Fire flow	Commercial & LM = 1,000 gallons per minute or don't build

Source: 1992 Kitsap County Coordinated Water System Plan (CWSP) – currently being updated in 2004.

Island water sources

According to Kitsap Health District records, approximately 170 water purveyors or systems on Bainbridge Island provide consumptive water, of which five systems serve more than 100 connections. The largest purveyors are the City of Bainbridge Island, North Bainbridge Water Company and South Bainbridge Water Company. There are numerous smaller public water systems (two or more hookups) and another 1,000 private single-dwelling wells. The number of Group A and B systems and a summary of systems with more than 100 connections are listed below.

System Type	Classification Criteria	Number
Group A Systems	15 or more connections	44
Group B Systems	<15 connections	124

Capacity				
System	**Connections**	**ERU**	**Supply**	**Storage**
Meadowmeer	279	335	530,000	235,000
PUD #1 (North Bainbridge)	1,646	2,028	450,000	860,000
South Bainbridge	788	1,114	900,000	562,000
City of Bainbridge Island	2,100	4,727	1,000,000	2,910,000
Total	**4,813**	**8,204**	**2,880,000**	**4,567,000**

Capacity: ERU = equivalent residential units, Supply in gallons per day (gd), Storage in gallons

Source: 2004 Draft Kitsap County Coordinated Water System (CWSP) Update

According to the Draft 2004 *Kitsap County Coordinated Water System Plan* (CWSP) Update, Island sources have a combined "water rights" annual capacity (Qi) of 9,260,000 gallons per day (gpd) and an instantaneous quantity (Qa) capacity of 16,730,000 gallons per day (gpd).

Water records	Certificates	Permits	Claims	Applicants
Bainbridge Island	139	9	1,476	28
Permit/certificate	**Qa-afy**	**Qa-gd**	**Qi-gpm**	**Qi-gd**
Groundwater	10,282	9,170,000	11,618	16,730,000
Surface water	102	90,000	2.71	0
Total		9,260,000		16,730,000

Qa = annual quantity in acre-feet per year (afy), Qi = instantaneous quantity in gallons per minute (gpm) or gallons per day (gd)
Source: Draft 2004 Kitsap County Coordinated Water System Plan (CWSP) and Washington State Department of Ecology's Water Right Application Tracking System (WRATS), December 2001

It should be noted that the "water rights" listed above do not reflect actual current usage of the water resource – they only identify the potential maximum legal appropriations that can be made under the water rights granted by the Washington Stated Department of Ecology (DOE).

Most existing water systems were established under state and local guidelines and for the most part provide high quality water at an adequate pressure and flow rate. Because of the high number of systems on the Island, however, there are likely to be systems that are not in compliance with Washington State Department of Health (DOH) water quality requirements, and may not meet minimum requirements for pressure and reliability. Many of the smaller systems have poor or nonexistent fire protection due to the cost of providing large diameter pipes and storage tanks.

Wells

The majority of the systems on the Island take water from wells or spring systems. Bainbridge Island wells penetrate several of the aquifers identified above to withdraw drinking water for individual homeowners and municipal water purveyors. Most individual household wells penetrate to depths of less than 300 feet. Some residents are still using hand-dug wells less than 40 feet deep, completed into the permeable sediments known as the Vashon Recessional Outwash. Groundwater found at this level also feeds the base flow for Island streams.

High capacity wells have been drilled as deep as 1,200 feet to find adequate marketable quantities of water for public and private water purveyors. While few in number, these wells produce a large portion of the Island's potable water. The Blakely Formation, a sediment bedrock, dominates the ecology on the southern end of the Island, limiting groundwater production in this area.

According to the 1996 *Kitsap County Groundwater Management Plan* (GWMP) *Update*, Washington State Department of Ecology (DOE) has approved permitted water rights for 3,580,000 gallons per day (4,008 acre-feet per year). Private wells that produce less than 5,000 gallons per day are exempt from permit filing requirements.

Well-head Protection

A well-head is the area defined around a well site that denotes the amount of time it would take contaminants to enter the surface of subsurface surrounding the well or well field to reach the underlying water resources.

In 2003 the City completed a wellhead protection plan for the City-owned well sites only, including land use restrictions. The Washington State Department of Health has approved the plan.

Island Water Quality

A 1986 water quality survey conducted by Kitsap County indicated 77% of the county population was served by a Class 1 system providing more than 100 connections or Class 2 system providing from 10-99 connections. Of the systems surveyed by Kitsap County, 50% of all systems in each class failed to submit any or all of the bacteriological samples.

Because of the number of systems on Bainbridge Island, Kitsap County concluded that there are likely to be numerous systems that may not be in compliance with Washington State Department of Health (DOH) requirements.

Beginning in July 1993, Bainbridge Island established a lead and copper monitoring program based on federal Environmental Protection Agency (EPA) regulations that required tap water samples from high-risk homes.

Island Water Requirements

The *Kitsap County Coordinated Water System Plan* (CWSP) developed future water usage projections and water requirements for Bainbridge Island using different per capita consumption rates and peaking factors for the rural, semi-urban/rural, and urban areas.

According to the CWSP projections, the water requirement will grow from 1,800,000 gallons per average day in 1995 to 2,430,000 by the year 2012 when the Island population reaches 24,280 persons. The drinking water requirement will depend on whether the actual capacity of a "hypothetical aquifer" can yield 4,800,000 gallons per day or 8,000,000 gallons per day. The lower capacity will require Island water purveyors to generate additional water sources; the latter indicates the Island has a more than sufficient reserve.

Projected Island water usage	**1995**	**2002**	**2012**
Population	17,800	20,527	24,280
Gallons per average day	1,800,000	1,980,000	2,430,000
Peak gallons per day	5,420,000	5,960,000	7,270,000
Average day water capacity	**1995**	**2002**	**2012**
Hypothetical aquifer yield	4,800,000-8,000,000	4,800,000-8,000,000	4,800,000-8,000,000
Less water rights	(3,600,000)	(3,600,000)	(3,600,000)
Water available	1,200,000-4,400,000	1,200,000-4,400,000	1,200,000-4,400,000
Less average daily demand	(1,800,000)	(1,980,000)	(2,430,000)
Water capacity available/required	**(600,000)-2,600,000**	**(780,000)-2,420,000**	**(1,230,000)-1,970,000**

Assumes 100 gallons per capita per day (gpcd) for rural areas and 140 gallons per capita per day (gpcd) for semi-urban/rural areas with a 3.0 peaking factor and 175 gallons per consumptive day (gpcd) for urban areas with a 2.3 peaking factor.
Source: Kitsap County Coordinated Water System Plan (CWSP) updated for current population estimates.

City Water System

The City's Water System is managed as a utility. Information regarding the City's water system, including production capacity, storage capacity, and its distribution network is provided in the City's Water System Plan, which is updated at least every six years.

Sanitary Sewage Disposal Conditions and Future Needs

Existing Facilities

Bainbridge Island has one treatment plant serving the Winslow service area in addition to a package wastewater treatment plant which serves Messenger House (a nursing home) and the Kitsap County Sewer District No. 7 treatment plant, servicing customers within the District's service area at the south end of the Island. The City also serves a sewer service area at the south end through an agreement with District No. 7. All other areas of the Island are served by on-site disposal systems.

Winslow

Bainbridge Island has a wastewater treatment plant that provides secondary treatment for the Winslow area.

Collection	5.12 miles of gravity sewer in 8 to 16-inch diameter pipes 2.69 miles of force mains in 4 to 12-inch diameter pipes 11 pumping stations with 100 to 2,300 gallons per minute (gpm) pumping capacity
Treatment	Secondary treatment facility located on Donald Place NE, east of the ferry terminal
LOS	Level of service based on 100 gallons per capita per day (gcd) flow and secondary treatment in accordance with Washington State Department of Ecology (DOE) standards

The sewer collection lines and pumping stations have adequate capacity to convey projected wastewater requirements to the treatment plant through the year 2012, assuming the Winslow area grows at a 6% annual rate. However, wet season pumping data should be continuously collected to determine the impacts on peak hourly rates of wet weather, differing area population growth rates, and the aging of the collection system.

The Winslow wastewater treatment plant is a secondary treatment facility designed to provide sewage treatment for an effective population of 10,000 residents.

The plant was upgraded in 1996 to meet design capacity treatment and allow some expansion beyond. The City also added emergency generators and telemetry to the system to reduce demands. Pump stations have also been taken out of service, where possible, to further reduce system costs.

The City system has seasonal stormwater inflow and infiltration problems, reducing treatment capacity. The City acquired a television camera in 1997 to monitor inflow locations, and initiated an effort to correct infiltration problems in the years following. Subsequent improvements have reduced the severity of inflow peaks.

Kitsap Sewer District No. 7

Kitsap County Sewer District No. 7 was established in the early 1960s to take over the sewer system built by the military in 1900. In 1997, the District completed a secondary sewage treatment facility, an outfall, and major interceptor lines that can serve approximately 400 dwelling units, equivalent to a population of 1,061 residents. The District Service Area includes approximately 450 acres serving 68 dwelling units on the south end of Bainbridge Island in the Fort Ward area, in addition to providing treatment to Lynwood Center and other south end properties through an interlocal agreement with the City of Bainbridge Island.

According to the District's 1990 Comprehensive Sewer Plan, most of the collection system was undersized under Washington State Department of Ecology (DOE) standards with maintenance, location, and infiltration/inflow problems. An interim treatment plant was built in 1987 consisting of on-line septic tanks and a chlorination-detention tank located next to the outfall into Rich Passage. The facility was not adequate to provide secondary treatment in accordance with Washington State Department of Ecology (DOE) requirements. Consequently, the District was under order by the Superior Court to construct a secondary treatment plant.

District 7 is updating its comprehensive plan to include:

- Wastewater treatment plant upgrade to increase reliability and decrease maintenance and operations costs;
- Continuing program to reduce stormwater inflows;
- Access to public records as a public facility; and
- Coordination with the city on available wastewater treatment capacity.

The existing sewer system consists of about 6,850 feet of 6-inch diameter and 8-inch diameter main lines and an additional 2,000 feet of 4-inch diameter laterals. According to the District's 2003 Comprehensive Plan, some of the collection system remains undersized since the upgrade of the plant, based on Washington State Department of Ecology Standards.

South End Sewer District

The City entered into an agreement with Sewer District No. 7 to provide sewer treatment for specific south end properties located outside the District's service area. The City defined a service area and performs operation and maintenance for an approximate total of 80 hookups to properties in Emerald Heights, North Pleasant Beach, Blakely School, Rockaway Beach, and Point White. The utility extension from the District No. 7 plant is being constructed under a local improvement district (LID). The City maintains a lift station at Lynwood Center as part of the operation to this service district.

All Other Areas of the Island

The remaining population of the Island is served by on-site sanitary sewer disposal systems. Kitsap County estimates roughly 4,600 on-site septic systems are on the Island, of which an estimated 11% may be failing or near failing, causing contamination of surface and groundwater.

New on-site systems are built to Kitsap County Health Department requirements. The Health Department currently requires a minimum lot size of 12,500 square feet to qualify for on-site septic drainfields. The Department requires additional treatment plants or expansion of current service areas for densities above three dwelling units per acre, though community-operated drainfields may be allowed under certain conditions.

Sewerage Facilities Analysis and Future Needs

Projecting quantities and loadings of wastewater is usually done on a per capita basis for domestic flows. If industrial users are anticipated, specific limitations of the type of wastes allowed into the system are usually set. Pretreatment of the industrial flows may be required to keep the parameters of the wastewater within acceptable levels (i.e., domestic). Industrial flows can be couched in terms of population equivalents.

Winslow Wastewater Treatment Facility

According to the 1992 Facilities Plan, the existing sewers have ample capacity to convey the projected wastewater to the treatment plant through the year 2012. This capacity is available because the minimum size for sewers is 8 inches in order to prevent plugging and allow access for servicing equipment. One sewer in Basin 2 was identified where the projected peak flow is 6% greater than the sewer capacity. However, the planning methods used for this analysis were conservative and it is likely that the future peak flow will never exceed the capacity of the sewer.

Pumping Stations

The capacities of each of the pumping stations were compared to the existing and projected flows they are required to pump. During wet weather periods, the peak hourly flow rates will exceed the daily average flow rate by a factor of approximately 2 to 1, based on examination of plant flow charts.

Present indications are that the capacity needs of the system can be met through the year 2012 with the existing pump stations. However, wet season data must be continuously kept to provide ongoing information related to differing growth rates and deterioration of the collection system.

Sewage Treatment Plant

The existing treatment plant was designed to accommodate an effective population of 10,000. The Brown and Caldwell study determined that the plant is functioning at about 30 to 35 % of its design capacity. An upgrade of the treatment plant to bring it up to design capacity was completed in 1996.

The 2002 Esveldt Reliability and Redundancy Engineering Report recommended upgrades to the Winslow plant. The Washington State Department of Health (DOH) renewed the Winslow Wastewater Treatment permit in 2003. The City has installed new effluent pumps and improved treatment by installing an ultraviolet treatment disinfection system in order to comply with lower chlorine residual values of the Department of Ecology NPDES permits and as recommended by the engineering report.

Future Needs

The existing sanitary sewers in the Winslow system have adequate capacity to accommodate a projected increase in population to 7,112 by the year 2012. This growth is anticipated within the historic Winslow area, which is generally consistent with the existing sanitary sewer service area. Wastewater flow projections are developed based on the projected population increase in the service area and compared to the capacity of the existing trunk sewers and pump stations. Basin 2 was identified as potentially having flows of 6 percent greater than the sewer capacity. However, the planning methods are conservative and it is likely that the future peak flow will never exceed the capacity of the sewer. See Appendix B for complete details of the amendment to wastewater facility plan.

The Winslow Treatment Plant was required to be upgraded to meet Washington State Department of Health (DOH) standards for reliability and redundancy. The 2002 Esveldt Reliability and Redundancy Engineering Report recommended upgrades to the Winslow plant. The Washington State Department of Health (DOH) renewed the Winslow Wastewater Treatment permit in 2003. Further improvements may need to be completed as recommended in the Esveldt report. Such improvement projects are presented annually in the six-year Capital Facility Program (CFP).

Kitsap Sewer District No. 7

Kitsap County Sewer District (KCSD) No. 7 analyzed the sewer system and concluded that hydraulic capacity exists to serve the current customers, but that problems of maintainability, location and infiltration/inflow exist.

Sewage Treatment

Existing treatment is available through the septic tanks and chlorination system. Under order by the Superior Court to construct a secondary treatment plant as required by the Washington State Department of Ecology (WSDOE), the District completed an upgrade in 1997.

All Other Areas

There is no data on the reliability or proper functioning of the private, on-site disposal systems. Policy SSP 1.6 would establish a program that would require regular maintenance of on-site systems and, in so doing, would develop an inventory of these systems.

Surface Water Conditions

Surface water drainage (stormwater) is generated when rainfall encounters hard or impervious surfaces. Most stormwater is intercepted and evapotranspirated by vegetation in a natural state. Plant root systems hold the soil in place and absorb most excess moisture.

The amount of stormwater runoff generated from road, roof, parking lot, and other impervious surfaces created by urban developments can be of a higher volume than what existed in the natural state. Peak flows that follow immediately after a storm can be much greater than existed when the land was in a natural state with vegetative cover.

The volume of stormwater generated by impervious surfaces has tremendous force and can cause erosion if allowed to flow into natural drainage systems provided by streams and wetlands. Stormwater can loosen soil and stream banks in the natural drainage way causing suspended particulates to flow into other bodies of water.

Excessive stormwater runoff may cause streams to expand and overflow, creating flooding conditions on adjacent lands. Any sedimentation will eventually drop as the water slows down and loses its force, causing siltation and the degradation of wetlands, particularly of salmon spawning habitat.

Stormwater runoff from driveways and parking lots also transports pollutants such as gas and oil as well as residues from pesticides, fertilizers, and other chemicals used in lawn care, as well as animal waste in agricultural areas. Non-point source pollution accumulates as water runs over hard surfaces and is carried to the nearest body of water.

Watersheds

Surface water flows from high geographic points to lower elevations collecting in streams and wetland systems within the watersheds of the Island. Watershed boundaries are determined by Island topography where ridgelines define the separate boundaries. Bainbridge Island is composed of 12 basins and 45 sub-basins that drain an area of approximately 17,620 acres.

Watershed	Sub-basins	Acres
Agate Passage	1	590
Blakely Harbor	3	1,350
Eagledale	4	1,180
Fletcher Bay	5	2,190
Gazzam Lake/Crystal Springs	3	850
Manzanita Bay	4	2,090
Murden Cove	4	2,100
North Eagle Harbor	7	2,100
Pleasant Beach	3	1,530
Port Madison	3	1,610
South Beach	2	720
Sunrise	3	1,310
Total (12 basins)	**45**	**17,620**

Source: 2000 Bainbridge Island Level II Assessment

The watersheds feed into 43 miles of mapped streams that generally lack reliable hydrologic data. It is estimated that about 50% of the streams are perennial and the other 50% are intermittent.

Land cover

The dominant land cover on the Island is tree-covered, amounting to 12,849 acres, or 73% of the Island – which includes home sites when the cleared area is less than one acre. Grass and shrub cover account for 20% of Island land cover, located in valley bottoms and also on small parcels in all watersheds. Developed areas with impervious surfaces cover about 6% of the Island, mostly in the Winslow town center.

Land use	Acres	Percent
Residential	13,002	75%
Commercial/light manufacturing	325	2%
Agricultural	1,155	6%
Forest Land	385	2%
Recreation land	1,300	7%
Transportation corridors	1,084	6%
Public facilities	350	2%
Total	**17,601**	**100%**

Source: 2000 Bainbridge Island Level II Assessment

Storm Drainage Conditions – Existing Facilities

Island watersheds and sub-basins are drained by a combination of natural stream channels, roadside ditches, and piped collectors in the Winslow urban area. The existing system removes stormwater but is subject to erosion, siltation, and water quality degradation problems. The incomplete or obstructed nature of the natural drainage system has also created a number of wet areas and flooding of private property and failing roadways.

Stormwater is managed in the Winslow area by a combination of piped collectors, roadside ditches, and natural stream channels. Analysis previously conducted for the City of Winslow (Storm Water Drainage Plan, 1985) concluded that the 1985 build-out scenario for Winslow would accommodate the 2012 population of 7,112 with the improvements recommended at that time.

Except for the primarily piped system in the Winslow area, all other watersheds and sub-basins on the Island are drained by natural streams and roadside ditches. A complete description of Bainbridge Island watersheds and sub-basins can be found in the *City of Bainbridge Island Surface Water Management Plan*, by Kato & Warren (2001).

The following drainage problems have been identified as a result of the Island's natural stormwater drainage management system:

- Erosion of private property;
- Erosion of drainage-ways;
- Siltation on the beach, in wetlands, and in the streams;
- Slides caused by misdirected runoff;
- Excessive wetness due to springs or lack of drainage;
- Steep banks with subsequent erosion risks; and
- Blocked or incomplete drainage-ways.

The largely natural drainage system that has been developed on the Island is labor intensive, requiring a great deal more routine maintenance that would be required of a more highly developed piped system. City crews are hard-pressed to provide adequate drainage maintenance to the more than 120 miles of roadways and hundreds of road culverts and driveway crossings in the system.

Storm Drainage Requirements

Stormwater runoff and flows are calculated as a function of the watershed area, the amount of impervious surface, the type of collection system in place, soils types, topography, and storm intensity and duration. Normally, as development occurs, the amount of impervious surface area increases and the collection of runoff can be more efficient. Runoff rates, if not controlled, will rise dramatically, and can be 10 times more than that of a natural, undeveloped site.

Rainfall events, detention and piping design criteria, and pollutant controls determine storm drainage protection capacity requirements. Storm drainage capacity estimates must account for the use of natural systems versus piping alternatives, the sensitivity of natural systems, desired levels of protection against flood damage, and protection of the receiving water's quality.

The City updated the *City of Bainbridge Island Surface Water Management Plan* (formerly the 1985 Winslow Storm Water Drainage Plan) to include the entire Island and consider water quality as well as water quantity issues by Kato & Warren in 2001.

Existing Capacity

Capacity for storm drainage systems is established by selecting rainfall events, detention and piping design criteria, and pollutant controls, thereby establishing the protection levels. As an example, the criteria selected may be a detention volume to hold 25-year storm event. The level of protection would be surpassed when the 25-year storm volume is surpassed and the detention facilities do not have enough capacity to hold the storm runoff.

Capacity determinations are made based on criteria such as use of natural systems versus use of pipes, sensitivity of natural systems, desired levels of protection against flood damage, and protection of receiving water quality.

A detailed, hydrologic study was performed as part of the 2001 Surface Water Management Plan and produced data on the natural storm drainage release rates. These data were used to develop the requirements of Ordinance 98-31 which requires the control for stormwater runoff from new development and sets the level of service.

In those sub-basins where pipelines and other capital improvements are planned or constructed, the ordinance allows a reduction in storage and an increase in the runoff rate, provided the development contributes monies representing the property's share of downstream drainage facilities.

In addition to the water quantity issues brought up by the Department of Ecology, there are also water quality best management practice guidelines. These guidelines are directed toward the development of bio-filtration channels for sedimentation and erosion control practices. There are also recommendations as to regular maintenance of these facilities.

Storm and Surface Water Management - Future Needs

Future Needs

Runoff and flow calculations are a function of the watershed area, the amount of impervious surface, the type of collection systems in place, soil type, topography, and storm intensity and duration. Normally, as development occurs, the amount of impervious surface area increases and the collection of runoff can be more efficient. Runoff rates, if not controlled, will increase dramatically. In fact, amount of runoff from a developed parcel with significant impervious area can be as much as ten times that of a natural, undeveloped site. Guidelines that require individual or regional detention or infiltration can reduce runoff impacts.

Land use and development density affect the drainage volumes and rates. Flows can be modeled for various storm events using mathematical formula that account for land use types. For various build-out scenarios, runoff impacts can be developed.

Conceivably, Bainbridge Island could develop a dependency on privately installed and maintained stormwater detention facilities that discharge into natural systems. This is much like the concept of privately owned and operated, on-site, septic drainfields in place of collection and treatment of sanitary sewer flows. In this approach, capital requirements would focus on the downstream sections, particularly at roadway crossings and under other filled drainage ways. Development in some watersheds may be more organized than others and structural facility needs could intensify. In addition, bypass system pipes that route high velocity and high volume runoff around natural system may be required.

Storm Drainage Requirements

Rainfall events, detention and piping design criteria, and pollutant controls determine storm drainage protection capacity requirements. Storm drainage capacity estimates must account for the use of natural systems versus piping alternatives, the sensitivity of natural systems, desired levels of protection against flood damage, and protection of the receiving water's quality.

A detailed, hydrologic study was performed as part of the *2001 Surface Water Management Plan* and produced data on the natural storm drainage release rates. These data were used to develop the requirements of Ordinance 98-31, which requires the control for stormwater runoff from new development and sets the level of service. Ordinance 98-31 allows a reduction in storage and an increase in the runoff rate in sub-basins where pipelines and other capital improvements are planned or constructed – provided the development contributes monies representing the property's share of downstream drainage facilities. Stormwater Ordinance 98-31 defines policies that establish exacting performance standards governing the release of stormwater runoff, fertilizer, herbicide, and other pollutants from ground improvements, oils, greases and other pollutants from impervious surfaces. The standards control adverse impacts associated with land development and reduce surface and groundwater pollution potentials under best management practices and assigned maintenance responsibilities for private and publicly owned stormwater management facilities. Revisions to the stormwater ordinances are currently underway to address the amended Washington State Department of Ecology stormwater management manual.

Development plans and project funding for stormwater system improvement projects as recommended in the 2001 Surface Water Management Plan are presented annually in the six-year Capital Facility Program (CFP).

The City's Department of Planning and Community Development has completed an inventory of natural features on the Island including streams, lakes, wetlands, steep slopes, and slide prone areas. These sensitive areas are an important aspect of the natural drainage system.