CITY OF
BAINBRIDGE ISLAND

ENVIRONMENTAL TECHNICAL ADVISORY COMMITTEE
SPECIAL MEETING
FRIDAY, APRIL 20, 2018
3:00 PM – 5:00 PM
COUNCIL CONFERENCE ROOM
280 MADISON AVENUE NORTH
BAINBRIDGE ISLAND, WA 98110

AGENDA

1. **CALL TO ORDER / ROLL CALL / ACCEPT OR MODIFY AGENDA / CONFLICT OF INTEREST DISCLOSURE**
   3:00 PM

   CHAIR: FRANK GREMSE

   MEMBERS: JASON FLOWERS, CHARLIE KRATZER, DYLAN FRAZER, KARL SHEARER

   COUNCIL LIAISON: RASHAM NASSAR

2. **APPROVAL OF MINUTES** – MARCH 15, 2018

3. **COUNCIL LIAISON REPORT** – RASHAM NASSAR

4. **DISCUSSION OF GROUND WATER MANAGEMENT PLAN REPORT**– ALL

5. **PUBLIC COMMENTS**

6. **ADJOURNMENT**
   5:00 PM

For special accommodations, please contact Roz Lassoff,
206-780-8624 or at rlassoff@bainbridgewa.gov

City of Bainbridge Island

Environmental Technical Advisory Committee
Regular Meeting
Thursday, March 15, 2018
3:00 PM – 5:00 PM
Council Conference Room
280 Madison Avenue North
Bainbridge Island, WA 98110

MINUTES

1. CALL TO ORDER / ROLL CALL / ACCEPT OR MODIFY AGENDA / CONFLICT OF INTEREST DISCLOSURE
3:04 PM

Chair:	Frank Gremse	
Members:	Jason Flowers Dylan Frazer	Charlie Kratzer (call in) Karl Shearer
Council Liaison:	Rashman Nassar	
Public:	Greg Geehan Arnold Stern Melanie Keenan	Doug Hastings Cami Apfelbeck Malcolm Gander

2. APPROVAL OF MINUTES – March 15, 2018

3. COUNCIL LIAISON REPORT – Rashman Nassar

4. Discussion of Ground Water Management Plan Analysis –
Status of the bedrock aquifer which extends from "Toe-Jam" fault to the south end of the island was discussed. The five aquifers which exist north of the fault are not present in this area of the island. This is a geologically complex area in which mapping and modeling of units and predicting performance are not practical and come with large uncertainties. Available water is held in highly-fractured, discontinuous voids which are unlikely to support significant production. Fortunately, there are a few wells drilled in this area.

5. PUBLIC COMMENTS –

- **a.** It is important to look at the water quality of the aquifers and the potential for contamination from hazardous spills. Information about spills on the island is available from DOE.
- **b.** It is important to ensure that the effects of contaminated soils are excluded from the aquifers.
- **c.** Infiltration of rainfall to the bedrock aquifer is similar to that of the perched aquifer.

6. ADJOURNMENT
4:30 PM

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1. **<u>Introduction:</u>** Groundwater is the sole source of drinking water on Bainbridge Island. The increased demand for groundwater resulting from population growth and the anticipated effects of climate change has created concern about the sustainability of island's aquifers as well as the potential for saltwater intrusion. ETAC has been asked by the City Council to analyze the possible need for the development of a Groundwater Management Plan. To complete that assessment we have reviewed the available information on the aquifers, aquifer modeling efforts, well hydrographs and groundwater quality information. We have summarized that information in this report. The final section of this report presents our recommendations.

2. **<u>Bainbridge Island Aquifers' Descriptions:</u>**

a. Perched Aquifer (Qva) & Semi-Perched Aquifer (QC1pi)

The top of the Perched Aquifer (Qva) ranges from sea level to more than 300 feet above mean sea level, with a thickness of 20 to 200 feet. However, the unit generally is absent along the margins of the Island, likely due to erosion of the unit, and data do not indicate that it is connected to aquifers in the the Kitsap Peninsula (Figure 1).

The Semi-Perched Aquifer (QC1pi) consists of locally continuous and mappable permeable interbeds within the confining unit below the Perched Aquifer. These interbeds are from 10 to 50 feet thick and may be present from sea level to more than 200 feet above mean sea level. The Semi-Perched Aquifer was originally delineated by Kato and Warren, Inc., and Robinson and Noble, Inc (Level II Assessment, 2000). However, in 2011, the USGS re-classified much of that original area as part of the Perched Aquifer with very little area remaining classified as Semi-Perched Aquifer (Figure 2).

b. Sea Level Aquifer (QA1)

The Sea Level Aquifer (QA1) is extensive, widely-used, and mostly confined.. However, it is exposed at land surface near Fletcher Bay and Manzanita Bay and near part of Eagle Harbor. The aquifer is absent near Port Madison. The top of the aquifer ranges from 200 feet below sea level to 200 feet above sea level, with a typical thickness of 25 to 200 feet but exceeds 200 feet in several places (Figure 3). It is believed to extend beneath Agate Passage to the Kitsap Peninsula.

c. Glaciomarine Aquifer (QA2)

This aquifer consists of water-bearing units within a thick sequence of fine-grained Glaciomarine drift. The top of the aquifer ranges between more than

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500 feet below sea level to 300 feet below sea level with a typical thickness of 20 to 300 feet (Figure 4).

d. Fletcher Bay Aquifer (QA3)

This aquifer is the deepest identified aquifer on Bainbridge Island (Figure 5).The top of the aquifer ranges between more than 900 feet below sea level to slightly less than 600 feet below sea level, with a typical thickness of 50 to 300 feet. It is believed to extend beneath Port Orchard to the Kitsap Peninsula.

e. **Bedrock Aquifer**

Geologic information indicates that the Bedrock Aquifer which exists south of “Toe Jam Fault” (Figures 6 and 7, Appendix A) is a geologically complex area in which mapping and modeling of units and predicting performance are not practical and come with large uncertainties. Available water is held in highly-fractured, discontinuous voids which are unlikely to support significant production. It is estimated that approximately 10 to 20 wells exist in this area.

3. <u>Aquifer Water Balance:</u>

a. The water balance of an aquifer is the summation of the inflows minus the outflows. The inflows are primarily from surface water infiltration, septic system (OSS) returns and to a minor extent from on island water features (lakes, ponds, streams, etc.) and aquifer water flow from off island to the island for some of the aquifers. The outflows are from pumping, evapotranspiration, seepage to island water features and aquifer water flow off of the island (i.e. Puget Sound). If the outflows exceed the inflows then the difference must be made up from the water existing in the aquifer termed aquifer storage. Similarly if the inflows exceed the outflows then the surplus will be added to the aquifer storage with secondary effects on hydraulically influenced outflows.

b. In the 2011 USGS study of the Bainbridge Island aquifers (USGS 2011) they used data from over 400 wells to develop a groundwater model, and used synoptic measurements from over 100 wells and 20 stream flow measurement stations to calibrate the model. 2008 water balance conditions using the USGS model are presented in Table 1. These data indicate aquifer discharge volumes from pumping wells were approximately 11% of the precipitation and OSS volume. Net groundwater flow was approximately 3,259 million gallons of storage loss; however, it should be noted that the precipitation for 2008 was approximately 40% below normal based on a review of 30 years of data (USGS 2011).

Table 1 Water Budget Bainbridge Island 2008 (USGS 2011)

Component	Million Gallons per Year
Precipitation and OSS Recharge	5,865
Net Aquifer Storage	3,259
Well Pumping	-652
Surface Water Features	-5,214
Net Groundwater flow	-3,259

c. In 2015 Aspect reviewed and revised the USGS modeling effort reported in USGS (Aspect, 2015; Aspect 2015b; Aspect 2016). In Aspect modeling effort they made three changes to the USGS approach:

- c.i. Revise the Precipitation Recharge Rate: Aspect used the precipitation recharge rate from USGS 2014 Kitsap Peninsula Report (USGS 2014) which is approximately 44% lower then what USGS 2011 used. Aspect also removed the OSS return flows from their modeling.
- c.ii. Update Well Pumping Rates: Aspect used well pumping rates from COBI and KPUD for the years 2009 through 2014 in addition to the well data from 2004 through 2008 used by USGS in their 2011 study. Those additional years exhibited pumping rates which are two percent lower then what USGS used.
- c.iii. Revised Modeling Approach: Aspect implemented several modifications to the modeling approach which while simplifying the model also had the benefit of taking a more critical approach to evaluating seawater intrusion, looking at a scenario where it was more probable to occur. Thus, Aspect implemented a modeling approach which they believed would more reliably simulate groundwater conditions, including the potential for saltwater intrusion.

d. The results of Aspect's modeling for 2014 are presented in Table 2.

Table 2 Water Balance Components (Aspect 2016)

Component	Million Gallons per Year
Precipitation Recharge	4,456
Net Aquifer Storage	0
Well Pumping	-834
Surface Water Features	-1,261
Net Groundwater flow	-2,362

e. Comparing the USGS and Aspect modeling numbers yields observations based on differences attributable to different modeling techniques (such as Aspect not modeling aquifer storage and changing the interface with surface water features) and due to differences in changed data inputs between 2008 and 2014. One notable data point is the significant increase (approximately 28%) in the well pumping volume from 2008 to 2014.The well pumping volume number is a combination of measurements and estimation. Water volumes pumped from water purveyors are measured and reported. However, about half the wells on the island are exempt from reporting because they are rather small (less than 15 connections). The pumping volumes associated with these wells are estimated based upon per individual usage estimates, individual to connect estimates, and population estimates for the Island.

f. The information presented in Table 3 is developed from Aspect 2016 and Apfelbeck and Berg 2017, and illustrates that the three most significant aquifers on the island are the Perched Aquifer, the Sea Level Aquifer and the Fletcher Bay Aquifer.

Table 3 Bainbridge Island Withdrawal by Aquifer

Aquifers	Percentage of Wells	No. of Monitoring Wells	Aquifer Withdrawal, mgy	Withdrawal Percentage
Perched Aquifer	4.00%	16	240	19.00%
Semi-Perched	25.00%	8	7	1.00%
Sea Level	53.00%	43	387	46.00%
Glaciomarine	2.00%	6	16	2.00%
Fletcher Bay	1.00%	12	264	32.00%
Bedrock	1.00%	1	not modeled	not modeled
Confining Units or Indeterminate Completion Wells	15.00%		Included in aquifer modeling	Included in aquifer modeling
Total		86	834	

4. Water Level Measurements for Some Bainbridge Island Wells

a. COBI analyzed water level data from 67 wells from the well monitoring group for which they had water level data. Their results are presented in Table 4 (Apfelbeck and Berg, 2017). Fifty Three of the well hydrographs reviewed showed positive trends over a 10 year period (2006 – 2016) while only 15 showed a negative trend and the negative trend lines mostly exhibited a gradual downward slope. In general, this study presents a condition which attests to an overall state of all five aquifers as being operationally functional to satisfy present island needs over the specific 10-year period. However, this 10-year period may not be representative of historical groundwater levels, and it does not present a basis to determine long term sustainability of the aquifer system.

Table 4 Water Level Trends for Some Bainbridge Island Wells (2007-2016)

Aquifers	No. of Monitoring Wells	Positive Trend	Negative Trend	Neutral
Perched Aquifer	16	15	1	0
Semi-Perched	8	7	1	0
Sea Level	30	22	8	0
Glaciomarine	5	4	1	0
Fletcher Bay	9	5	4	0
Total	68	53	15	0

b. ETAC reviewed hydrographs for 26 Bainbridge Island wells. We did not find any basis for not accepting the results presented in Apfelbeck and Berg, 2017.

5. **<u>Water Quality</u>**

a. Chloride measurements were reviewed for data collected between 2007 and 2016. No chloride concentrations measured for this assessment period exceeded 100 mg/L. Chloride concentrations in all aquifers were low (usually less than 21 mg/L). (Apfelbeck and Berg, 2017)

b. Water quality results did not exceed the Early Warning Level of 100 milligrams per liter (mg/L) nor exhibit an increasing trend for chloride nor did they exceed the U.S. Environmental Protection Agency's (EPA) Maximum Contaminant Level (MCL) of 10 mg/L for nitrate (Aspect 2015).

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c. As shown in Figures 8 and 9 (Appendix A) from the WA Dept. of Ecology there are a number contaminated cleanup sites on Bainbridge Island. Thus there exists a potential for contamination to seep into the aquifers and/or into the well heads. However, the actual probability of this is unknown and maybe quite small. This is something which would be addressed in a GWMP.

6. **Modeling Forecasts**

a. The USGS developed a calibrated model for Bainbridge Island (USGS 2011). The model simulates the possible effects of increased groundwater pumping and changes to recharge due to changes in land use and climactic conditions between 2008 and 2035 under minimal, expected, and maximum impact conditions. Results indicate drawdown levels to be relatively small for most of the Island (less than 10 ft) for the minimal and expected impact scenarios, and were larger (25 ft.) for the maximum impact scenario. They did not calculate saltwater intrusion occurring with respect to any scenario by the year 2035. However, the direction of flow in the deep Fletcher Bay aquifer was calculated to flow from east to west direction for the extreme scenario in response to increased pumping in both Bainbridge Island and the Kitsap Peninsula.

b. Aspect also modeled Bainbridge Island aquifers with certain refinements with respect to the USGS 2011 modeling effort (Aspect 2016). The model was run for a 100-year time frame and found the following results:

- The Perched Aquifer system showed an average 0.10 foot per year of water level decrease at 25 locations simulated across the Island;
- The Semi-Perched Aquifer system showed an average 0.13 foot per year of water level decrease at 12 locations simulated across the Island;
- The Sea Level Aquifer system showed an average 0.09 foot per year of water level decrease at 49 locations simulated across the Island;
- The Glaciomarine Aquifer showed an average 0.02 foot per year of water level decrease at 6 locations simulated across the Island; and

- The Fletcher Bay Aquifer showed an average 0.15 foot per year of water level decrease at 9 locations simulated across the Island.

- The predictive model results indicate that groundwater from the Bainbridge Island aquifer system flows to Puget Sound and keeps the freshwater/seawater interface at a distance from the Bainbridge Island shoreline.

7. Discussion and Recommendations

a. Existing data indicates the potential for reduced groundwater storage in aquifers utilized by residents of Bainbridge Island due to changes in inputs (e.g. precipitation, septic returns) and outputs (e.g. evapotranspiration, well pumping).

b. A groundwater management plan should be developed to address the current and future Bainbridge Island groundwater needs of the island. This plan should include a groundwater monitoring program, monitoring action levels for groundwater storage quantity and quality, and proposed responses if action levels are reached. The Groundwater Management Plan could also include and to closely monitor water withdrawal rates to insure the modeling forecasts' assumptions remain valid. An outline of Groundwater Management Plans is included in Appendix B.

c. The monitoring well network should be expanded with emphasis on wells along the shore area to improve saltwater intrusion monitoring data coverage. Where possible this network should include private, Group A, and Group B water systems.

d. The Bed Rock aquifer (area south of the "Toe Jam Fault") is not included in current Bainbridge Island groundwater models, and is not expected to be included in any future models because of its geologic complexity. Pumping wells in this area should not be promoted. Residences south of the "Toe Jam Fault" should be encouraged to obtain a connection with a water purveyor.

e. Analyses from USGS and Aspect indicated that well pumping volumes could have increased by 28% from 2008 to 2014. A more appropriate interpretation of what is being represented is that the USGS used a rational method for estimating well pumping volume for 2008 and a few years later Aspect used a different rational method for estimating well pumping and obtained a very different number for 2014. What this indicates is that we are uncertain as to how much water is being withdrawn from the Aquifers. This is concerning. It means that we do not have a firm basis upon which to found a determination of sustainability. Bainbridge Island must develop a viable estimate our aquifer water withdrawal rates (and rate increases) in order to establish a rational management approach to obtain a sustainable use of this critical resource.

f. The existing data from USGS and Aspect should be reviewed to determine if a reliable estimates of aquifer withdrawal rates and of aquifer storage capacity can be developed from their information.

g. If these estimates cannot be obtained, then they need to be developed. Synoptic measurements should be obtained from a statistically significant number of exempt wells during both low groundwater demand and high groundwater demand seasons.

h. In order to have accurate measurements the withdrawal environment should be stabilized to the extent practicable.

i. Existing data do not indicate aquifers utilized by Bainbridge Island are in imminent danger of storage reductions that would threaten current groundwater availability.

j. It is evident from available climate change information that our precipitation patterns are changing and will continue to change into our future. The present prediction for the Pacific Northwest is that the incidence of increased rainfall intensity will increase (Mauger et al 2015) with a concomitant increase in runoff (Aspect 2016).

k. Climate change is also predicted to increase our normal temperatures which during the dry summer months will result in increased water usage both indoors and out side. This could lead to more severe droughts. There is also the possibility of multi-year droughts, although the probability of this for the Pacific Northwest is deemed to be low.

l. The new withdrawal rates and the storage capacity estimates should be used in conjunction with the expected population growth estimates as well as the effects of climate change.

m. As the withdrawal rates from the aquifers increases it is expected that there will be an associated reduction in groundwater contribution from the aquifers to the island's streams and wetlands. This will need to be addressed.

References:

1) Kato & Warren, Inc., and Robinson & Noble, Inc., 2000, City of Bainbridge Island Level II Assessment, an element of water resources study, December 2000.

2) United States Geological Survey (USGS) 2011, Conceptual Model and Numerical Simulation of the Groundwater-Flow System of Bainbridge Island, Washington, 2011.

3) Apfelbeck and Berg, July 2017, Groundwater Monitoring Program Early Warning Level Assessment (2016), , City of Bainbridge Island, Public Works, Groundwater Management Program

4) Aspect, 2016, Bainbridge Island Groundwater Model: Aquifer System Carrying Capacity Assessment (Task 3 Scenario), Prepared for the City of Bainbridge Island, March 2, 2016

5) .Aspect Consulting, LLC (Aspect), 2015, Hydrogeological Assessment of Groundwater Quantity, Quality, and Production, Prepared for the City of Bainbridge Island, October 22, 2015

6) Aspect Consulting, LLC (Aspect), 2015b, Bainbridge Island Groundwater Model: Review Findings and Recommendations; Critical Aquifer Recharge Area Assessment, Prepared for the City of Bainbridge Island, December 21, 2105b.

7) Aspect, 2016b, Bainbridge Island Groundwater Model: Modeling Support for Operational Scenario Analysis, Prepared for the City of Bainbridge Island and Kitsap Public Utility District, December 2, 2016.

8) Mauger, G.S.., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L Whitely Binder, M.B. Krosby, and A.K. Snover, 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D.

9) Cook, B.I., J.E. Smerdon, R. Seager, and S. Coats, 2015, Unprecedented 21st Century Drought Risk in the American Southwest and Central Plains, in *Science Advances*, Feb. 12, 2015.

10) Ardnt, Deke, 2017, Western drought: It ain't over 'til...well, it ain't over, Climate Watch Magazine, https://www.climate.gov/news-features/blogs/beyond-data/western-drought-it-aint-over-tilwell-it-aint-over

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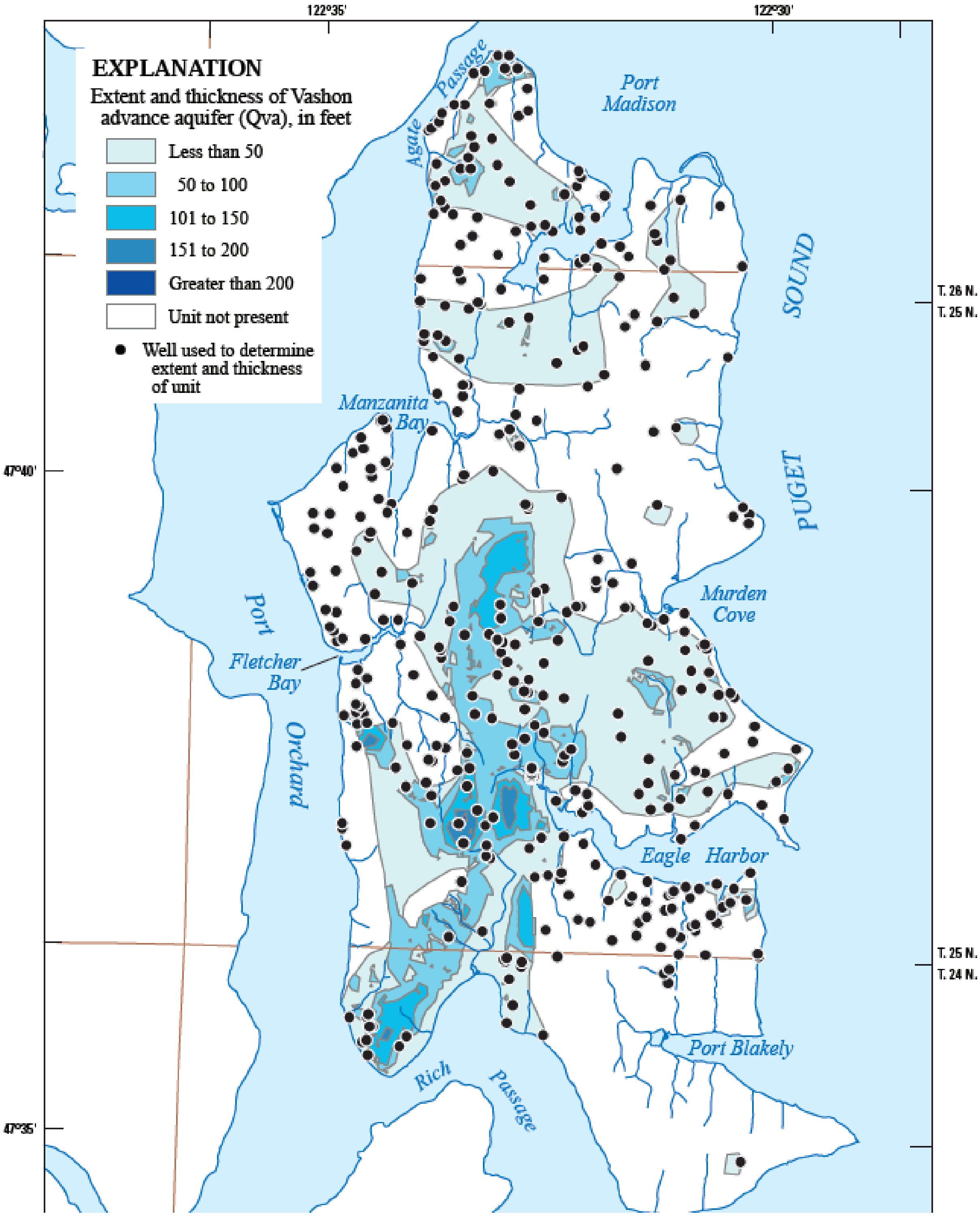
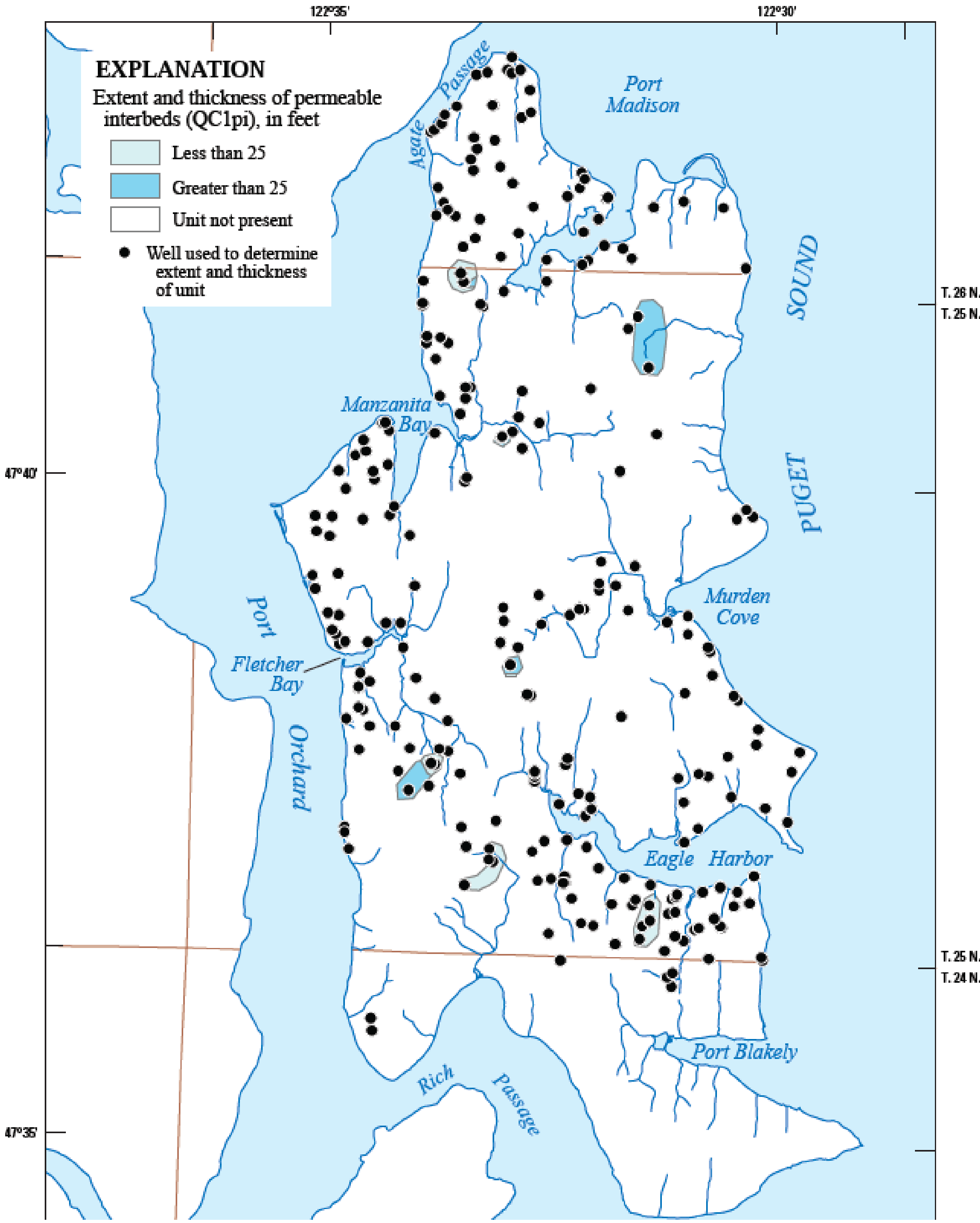
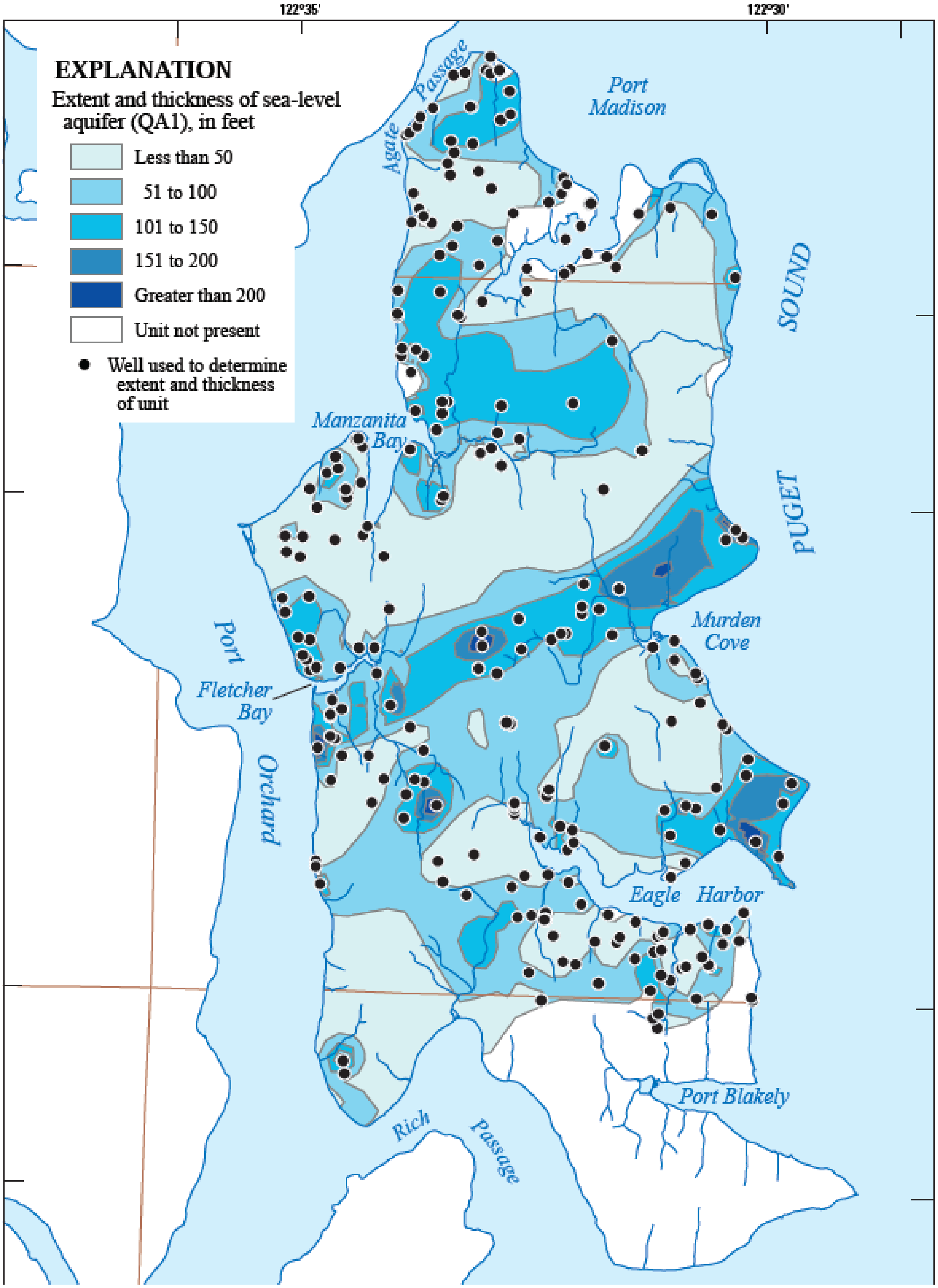
Appendix A Figures



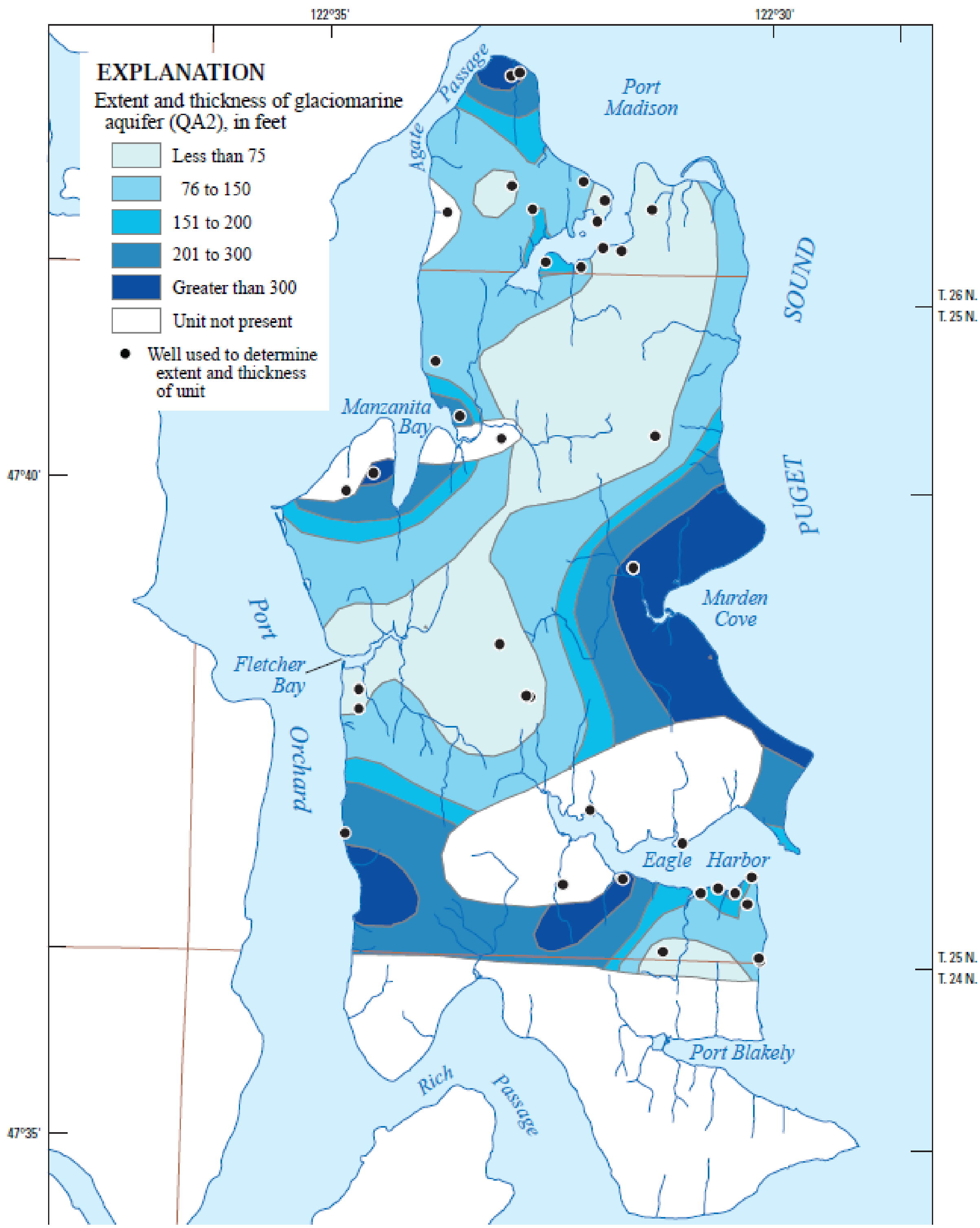
Perched Aquifer (Qva) Figure 1 (USGS 2011)



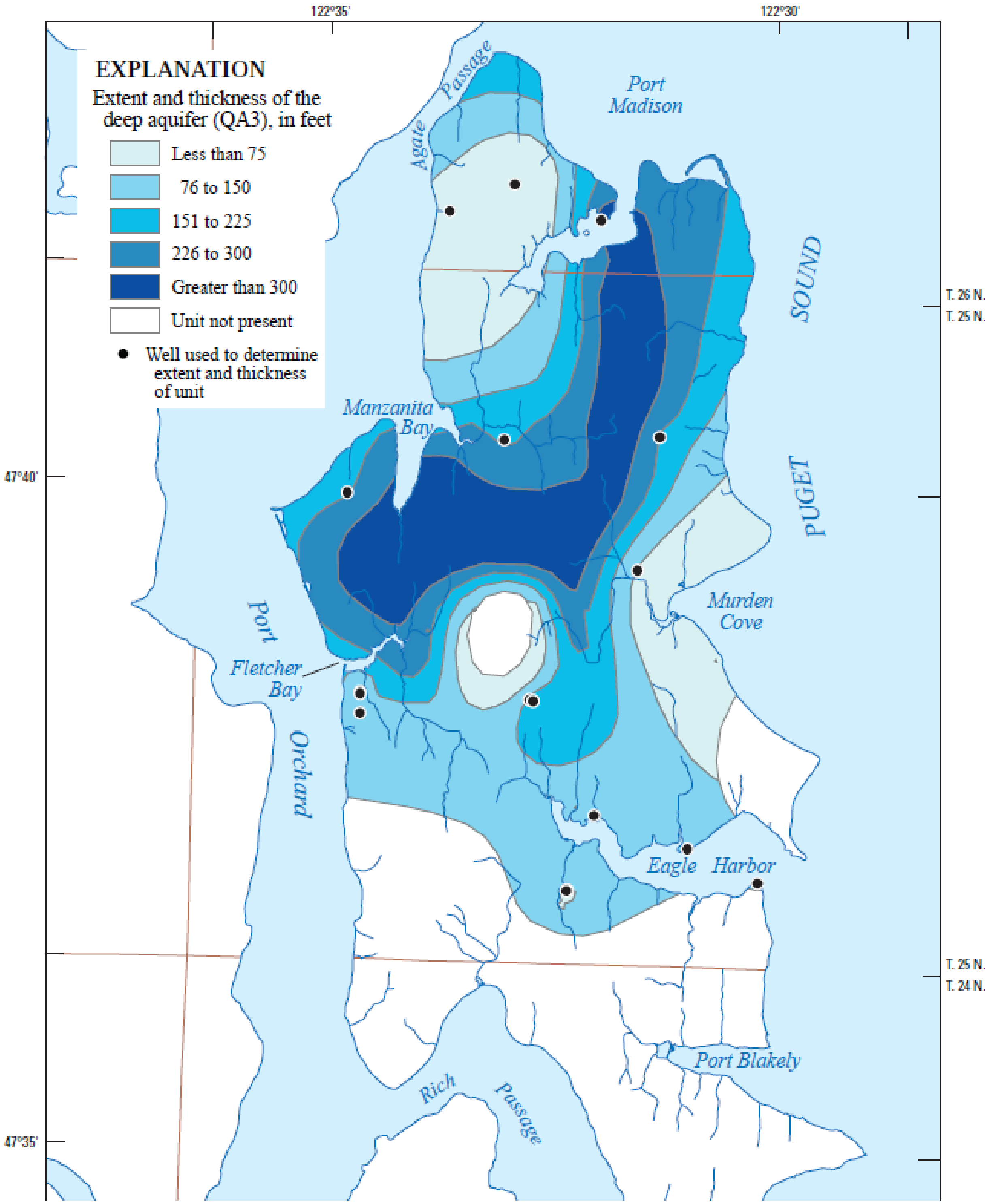
Semi-Perched Aquifer (QC1pi) Figure 2 (USGS 2011)



Sea Level Aquifer (QA1) Figure 3 (USGS 2011)



Glaciomarine Aquifer (QA2) Figure 4 (USGS 2011)



Fletcher Bay Aquifer (QA3) Figure 5 (USGS 2011)

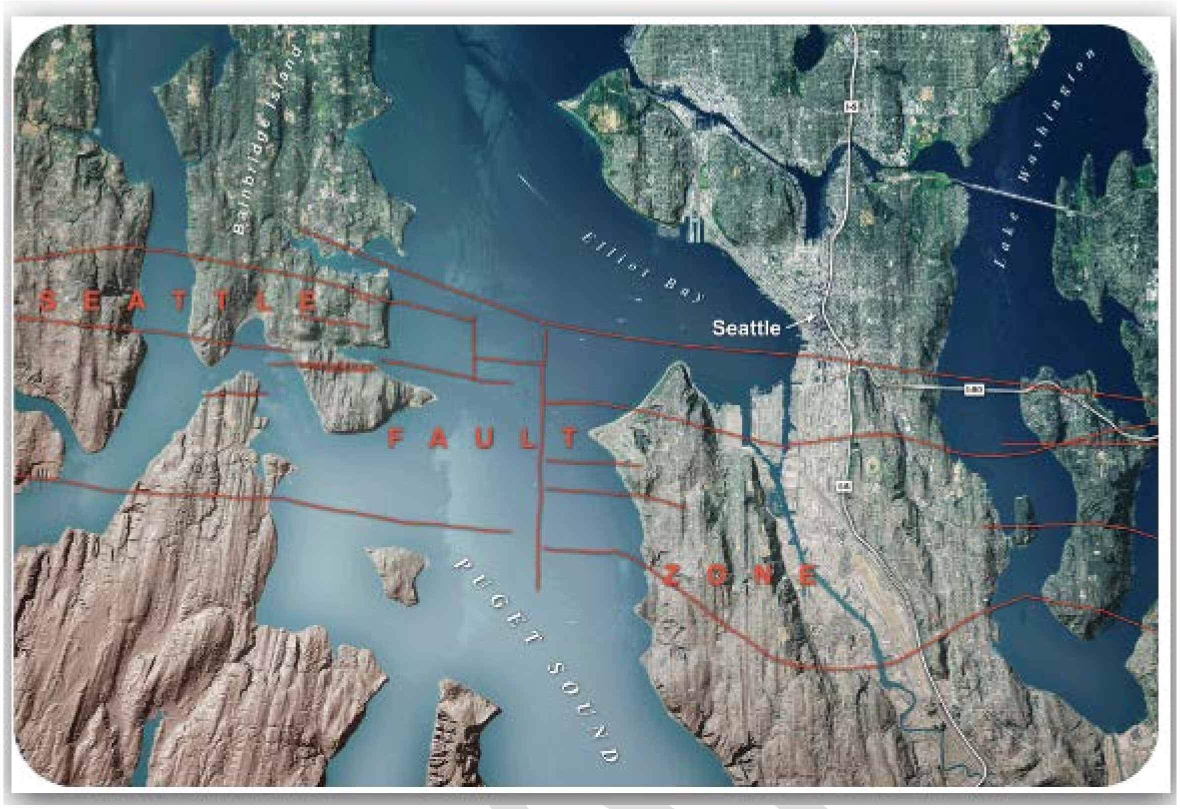


Figure 6 Seattle Fault

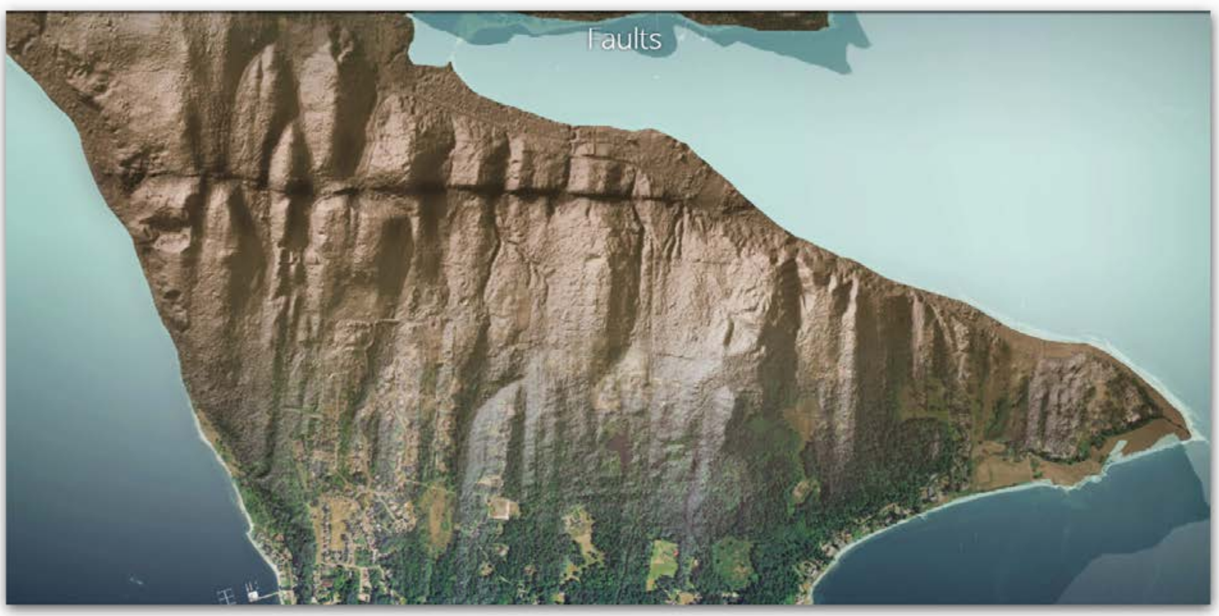


Figure 7 Toe Jam Fault

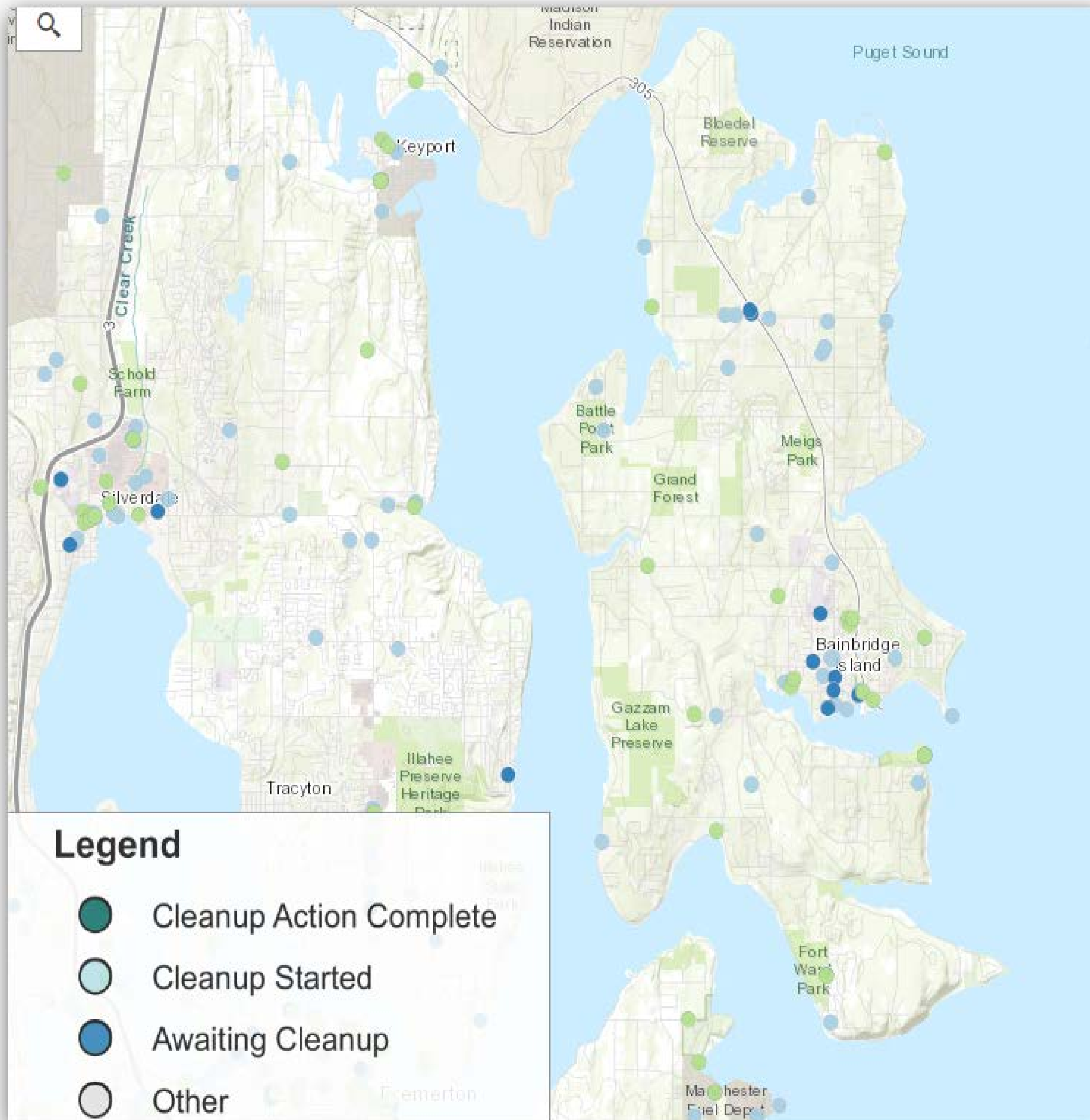


Figure 8 Bainbridge Island Cleanup Sites

https://fortress.wa.gov/ecy/neighborhood/

Ecology Hazardous Sites List – February 21, 2018
https://fortress.wa.gov/ecy/publications/documents/1809042a.pdf
https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Site-Register-lists-and-data

	FSID	SITE NAME	CITY	RANK	STATUS	RU
1	64365396	BI Intermodal Transfer	Bainbridge	5	Cleanup Started	NW
2	2602	BI Landfill	Bainbridge	5	Cleanup Started	NW
3	96325489	Chevron	Bainbridge	2	Cleanup Started	NW
4	23096	Clean Center	Bainbridge	2	Awaiting Cleanup	NW
5	2611	Day Road Industrial Park	Bainbridge	2	Awaiting Cleanup	NW
6	151	Eagle Harbor **Superfund Site** State	Bainbridge		Cleanup Started	HQ
7	153	Eagle Harbor E **Superfund Site** State	Bainbridge		Performance Monitoring	HQ
8	154	Eagle Harbor W **Superfund Site** -Federal	Bainbridge		Cleanup Started	EP
9	152	Eagle Harbor Wyckoff **Superfund Site** State	Bainbridge		Cleanup Started	HQ
10	3804318	Lynwood Center Corner	Bainbridge	2	Cleanup Started	NW
11	44882172	Madison Ave S & Parfitt Way SW	Bainbridge	5	Awaiting Cleanup	NW
12	61317581	Norge Equipped Cleaning Village Store	Bainbridge	2	Cleanup Started	NW
13	15438	Strawberry Plant	Bainbridge	2	Cleanup Started	NW
14	26595127	TOSCO Bainbridge Island Bulk Plant 1784	Bainbridge	2	Awaiting Cleanup	NW
15	46126151	Unocal 4388	Bainbridge	2	Cleanup Started	NW
16	28682498	Winslow Way W & Madison Ave N	Bainbridge	5	Awaiting Cleanup	NW

Figure 9 Hazardous Sites – Bainbridge Island

Washington Ranking Method (WARM): The results of the Site Hazard Assessment step are used in the Washington Ranking Method (WARM) to yield a WARM score (a number between 1 and 5). A score of 1 represents the highest level of risk and 5 the lowest. Generally, Federal Superfund sites and sites ranked 1 or 2 are higher priority for cleanup. Factors that enter into site hazard ranking include: the amount and type of contaminants present, how easily contaminants could come into contact with people and the environment, and the level of public concern.

Questions regarding the Hazardous Sites List or Site Register should be directed to Ted Benson at (360) 407-6683 or ted.benson@ecy.wa.gov

Appendix B Groundwater Management Plan Content

The program for each groundwater management area will be tailored to the specific conditions of the area. The following guidelines on program content are intended to serve as a general framework for the program, to be adapted to the particular needs of each area. Each program shall include, as appropriate, the following:

(1) An area characterization section comprised of:

1. A delineation of the groundwater area, subarea or depth zone boundaries and the rationale for those boundaries;
2. A map showing the jurisdictional boundaries of all state, local, tribal, and federal governments within the groundwater management area;
3. Land and water use management authorities, policies, goals and responsibilities of state, local, tribal, and federal governments that may affect the area's groundwater quality and quantity;
4. A general description of the locale, including a brief description of the topography, geology, climate, population, land use, water use and water resources;
5. A description of the area's hydrogeology, including the delineation of aquifers, aquitards, hydrogeologic cross-sections, porosity and horizontal and vertical permeability estimates, direction and quantity of groundwater flow, water-table contour and potentiometric maps by aquifer, locations of wells, perennial streams and springs, the locations of aquifer recharge and discharge areas, and the distribution and quantity of natural and man-induced aquifer recharge and discharge;
6. Characterization of the historical and existing groundwater quality;
7. Estimates of the historical and current rates of groundwater use and purposes of such use within the area;
8. Projections of groundwater supply needs and rates of withdrawal based upon alternative population and land use projections;
9. References including sources of data, methods and accuracy of measurements, quality control used in data collection and measurement programs, and documentation for and construction details of any computer models used.

(2) A problem definition section that discusses land and water use activities potentially affecting the groundwater quality or quantity of the area. These activities may include but are not limited to:

1) Commercial, municipal, and industrial discharges
2) Underground or surface storage of harmful materials in containers susceptible to leakage
3) Accidental spills
4) Waste disposal, including liquid, solid, and hazardous waste
5) Stormwater disposal
6) Mining Activities

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7) Application and storage of roadway deicing chemicals
8) Agricultural activities
9) Artificial recharge of the aquifer by injection wells, seepage ponds, land spreading, or irrigation
10) Aquifer over-utilization causing seawater intrusion, other contamination, water table declines or depletion of surface waters
11) Improperly constructed or abandoned wells
12) Confined animal feeding activities

The discussion should define the extent of the groundwater problems caused or potentially caused by each activity, including effects which may extend across groundwater management area boundaries, supported by as much documentation as possible. The section should analyze historical trends in water quality in terms of their likely causes, document declining water table levels and other water use conflicts, establish the relationship between water withdrawal distribution and rates and water level changes within each aquifer or zone, and predict the likelihood of future problems and conflicts if no action is taken. The discussion should also identify land and water use management policies that affect groundwater quality and quantity in the area. Areas where insufficient data exists to define the nature and extent of existing or potential groundwater problems shall be documented.

(3) A section identifying water quantity and quality goals and objectives for the area which

1. recognize existing and future uses of the aquifer,

2. are in accordance with water quality standards of the department, the department of social and health services, and the federal environmental protection agency, and

3. recognize annual variations in aquifer recharge and other significant hydrogeologic factors.

(4) An alternatives section outlining various land and water use management strategies for reaching the program's goals and objectives that address each of the groundwater problems discussed in the problem definition section. If necessary, alternative data collection and analysis programs shall be defined to enable better characterization of the groundwater and potential quality and quantity problems. Each of the alternative strategies shall be evaluated in terms of feasibility, effectiveness, cost, time and difficulty to implement, and degree of consistency with local comprehensive plans and water management programs such as the coordinated water system plan, the water supply reservation program, and others. The alternative management strategies shall address water conservation, conflicts with existing water rights and minimum instream flow requirements, programs to resolve such conflicts, and long-term policies and construction practices necessary to protect existing water rights and subsequent facilities

installed in accordance with the groundwater management area program and/or other water right procedures.

(5) A recommendations section containing those management strategies chosen from the alternatives section that are recommended for implementation. The rationale for choosing these strategies as opposed to the other alternatives identified shall be given;

(6) An implementation section comprised of:

1. A detailed work plan for implementing each aspect of the groundwater management strategies as presented in the recommendations section. For each recommended management action, the parties responsible for initiating the action and a schedule for implementation shall be identified. Where possible, the implementation plan should include specifically worded statements such as model ordinances, recommended governmental policy statements, interagency agreements, proposed legislative changes, and proposed amendments to local comprehensive plans, coordinated water system plans, basin management programs, and others as appropriate;
2. A monitoring system for evaluating the effectiveness of the program;
3. A process for the periodic review and revision of the GWMP.

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Appendix C Groundwater Management Plan Experience

a. **King County**:

   i. South King County – Draft completed in 2003 but never certified nor approved. Its implementation is limited to water purveyors and thus, the implementation is far less then described in their GWMP.

   ii. Issaquah Creek Valley: Plan approved 1999 and implemented in the early 2000's. It became inactive as of 2007 due to lack of funding. The paired back activity deemed to be of value was merged into existing groundwater monitoring programs for Sammamish.

   iii. East King County - Plan approved 1999 and implemented in the early 2000's. It became inactive as of 2004 due to funding issues. No current actions being conducted.

   iv. Redmond-Bear Creek Valley - Plan approved 1999 and implemented in the early 2000's. It became inactive as of 2007 due to funding issues. No county coordinated activities currently being conducted. Data collection is limited to water purveyors and cities.

   v. Vashon-Maury Island – Plan approved 2000 and has been pared back to a well monitoring plan which is presently active. The impetus for the implementation of the plan was discovery of chlorine levels in a few wells on the island. This problem has not persisted. The GWMP was approved and implemented which includes an oversight Committee. Primary concern is with growth impacts as it related to: overuse, contamination (land-use activities [i.e. pesticides] and septic concerns), saltwater intrusion, and loss of recharge zones. The groundwater monitoring program, which has an annual cost of approximately $200,000, consists of:

      1. 24 sites for water quality on an annual basis

      2. 9 monitoring wells have water level data loggers providing daily data – downloaded quarterly

      3. 4 self-monitoring volunteers who take monthly water levels and monthly meter readings

b. **Island County:** Island County experienced significant sea water intrusion issues at several of their coastal wells. Benefiting from King County's experience they decided to address their problem through a watershed planning process. They became the first county in the state to develop a sea water intrusion policy not using chloride as the primary indicator. Instead they created an Island County Code with two prongs for evaluating sea water intrusion risks. Primarily they are using the trend of in- well measured high water level elevations. They developed a matrix where projects are rated for risk and go through a sea water intrusion planning process. They established water level criteria which are designed to prevent sweater intrusion. They monitor 60 wells and are funded through a clean water utility tax.

c. **Kitsap County:** Kitsap County developed a Groundwater Management Plan in 1991. This recommended a hydrologic monitoring network which Kitsap PUD established and presently maintains. It currently consists of 28 precipitation monitoring sites, 28 stream flow monitoring sites, 128 groundwater (level) monitoring sites and 80 sites that are monitored (semi-annually) for seawater intrusion (link: http://kpudhydrodata.kpud.org/). The purpose of the network is to provide information relevant to understanding long term sustainability of groundwater resources. In addition, Kitsap PUD owns and operates 27 "Group A" public water systems. For these systems they do not rely on EWLs but maintain a focus on well water levels for short term sustainable production goals. Source wells for these systems are routinely monitored for water quality as required by the Safe Drinking Water Act. Kitsap PUD has 2 FTEs allocated to the monitoring network at an annual cost of approximately $238,000.

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