File No. G1-28039
WAC Doc ID: 2223954

State of Washington
DRAFT REPORT OF EXAMINATION FOR WATER RIGHT APPLICATION

PRIORITY DATE	APPLICATION NUMBER
June 10, 1999	G1-28039

MAILING ADDRESS	SITE ADDRESS (IF DIFFERENT)
Freeland Water & Sewer District PO Box 222 Freeland, WA 98249-0222	

Quantity Authorized for Withdrawal or Diversion

DIVERSION RATE	UNITS	ANNUAL QUANTITY (AF/YR)
285	GPM	262

Purpose

PURPOSE	WITHDRAWAL OR DIVERSION RATE			ANNUAL QUANTITY (AF/YR)		PERIOD OF USE (mm/dd)
	ADDITIVE	NON-ADDITIVE	UNITS	ADDITIVE	NON-ADDITIVE	
Municipal Supply	285			262		Year-round, as needed

Source Location

WATERBODY	TRIBUTARY TO	COUNTY	WATER RESOURCE INVENTORY AREA
		Island	6

SOURCE FACILITY/DEVICE	PARCEL	TWN	RNG	SEC	QQ Q	LATITUDE	LONGITUDE
Well 1	S8245-00-00006-0	29N	2E	14	NW NW	48° 00’ 19”	122° 31’ 12”
Well 2	S8245-00-00004-0	29N	2E	14	NE NW	48° 00’ 16”	122° 31’ 20”
Well 3	S8245-00-00017-3	29N	2E	14	SE NW	48°00’ 16”	122° 31’ 20”
Well 4	R22914-450-4380	29N	2E	14	NW NE	48°00’ 54”	122° 51’ 30”

Datum: WGS84

Place of Use (See Map, Attachment 1)

PARCEL

LEGAL DESCRIPTION OF AUTHORIZED PLACE OF USE

The place of use (POU) of this water right is the service area described in the most recent Water System Plan approved by the Washington State Department of Health, so long as the Freeland Water District is and remains in compliance with the criteria in RCW 90.03.386(2). RCW 90.03.386 may have the effect of revising the place of use of this water right.

Proposed Works

Four existing wells, Well 1 is 210-feet deep, Well 2 is 200-feet deep, Well 3 is 369-feet deep and Well 4 is 235 feet.

Development Schedule

BEGIN PROJECT	COMPLETE PROJECT	PUT WATER TO FULL USE
Started	Completed	September 1, 2030

Measurement of Water Use

How often must water use be measured?	Weekly
How often must water use data be reported to Ecology?	Annually (Jan 31)
What volume should be reported?	Total Annual Volume
What rate should be reported?	Annual Peak Rate of Withdrawal (gpm)

Provisions

Measurements, Monitoring, Metering and Reporting

An approved measuring device shall be installed and maintained for each of the sources identified by this water right in accordance with the rule "Requirements for Measuring and Reporting Water Use", WAC 173-173, which describes the requirements for data accuracy, device installation and operation, and information reporting. It also allows a water user to petition the Department of Ecology for modifications to some of the requirements.

Recorded water use data shall be submitted via the Internet. To set up an Internet reporting account, contact the Northwest Regional Office. If you do not have Internet access, you can still submit hard copies by contacting the Northwest Regional Office for forms to submit your water use data.

Water Use Efficiency

Use of water under this authorization shall be contingent upon the water right holder's maintenance of efficient water delivery systems and use of up-to-date water conservation practices consistent with established regulation requirements and facility capabilities.

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Proof of Appropriation
The water right holder shall file the notice of Proof of Appropriation of water (under which the certificate of water right is issued) when the permanent distribution system has been constructed and the quantity of water required by the project has been put to full beneficial use. The certificate will reflect the extent of the project perfected within the limitations of the permit. Elements of a proof inspection may include, as appropriate, the source(s), system instantaneous capacity, beneficial use(s), annual quantity, place of use, and satisfaction of provisions.

Schedule and Inspections
Department of Ecology personnel, upon presentation of proper credentials, shall have access at reasonable times, to the project location, and to inspect at reasonable times, records of water use, wells, diversions, measuring devices and associated distribution systems for compliance with water law.

Findings of Facts
Upon reviewing the investigator's report, I find all facts, relevant and material to the subject application, have been thoroughly investigated. Furthermore, I concur with the investigator that water is available from the source in question; that there will be no impairment of existing rights; that the purpose(s) of use are beneficial; and that there will be no detriment to the public interest.

Therefore, I ORDER approval of Application No. G1-28039, subject to existing rights and the provisions specified above.

Your Right To Appeal

You have a right to appeal this Order to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of this Order. The appeal process is governed by Chapter 43.21B RCW and Chapter 371-08 WAC. "Date of receipt" is defined in RCW 43.21B.001(2).

To appeal you must do the following within 30 days of the date of receipt of the Order.

- File your appeal and a copy of this Order with the PCHB (see addresses below). Filing means actual receipt by the PCHB during regular business hours.
- Serve a copy of your appeal and this Order on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.

You must also comply with other applicable requirements in Chapter 43.21B RCW and Chapter 371-08 WAC.

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Street Addresses	Mailing Addresses
Department of Ecology Attn: Appeals Processing Desk 300 Desmond Drive SE Lacey, WA 98503 **Pollution Control Hearings Board** 111 Israel RD SW STE 301 Tumwater, WA 98501	**Department of Ecology** Attn: Appeals Processing Desk PO Box 47608 Olympia, WA 98504-7608 **Pollution Control Hearings Board** PO Box 40903 Olympia, WA 98504-0903

Signed at Bellevue, Washington, this _____ day of _____ 2012.

_____

Jacqueline Klug, Section Manager
Water Resources Program/NWRO
Department of Ecology

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BACKGROUND

Application G1-28039 has an application priority date of June 10, 1999. The application was filed for 400 gpm, and 282.5 acre-feet per year (afy); however, it was subsequently modified to clarify only a requested additive withdrawal of 285 gallons per minute (gpm). The purpose of use is municipal supply of the Freeland community, and the source is from four existing wells. The project site is located in the Island Water Resource Inventory Area (WRIA) 6 in Island County which includes Whidbey and Camano Islands.

Project Description

The Freeland service area lies near the center of Whidbey Island centrally located between two seawater bodies, Mutiny Bay and Holmes Harbor. Wells 1, 2 and 3 are located in the NW ¼ of Section 14, Township 29 North and Range 2 West, and Well 4 is located in the NE ¼ of the same section.

The points of withdrawal (POWs) for the application are referred to as Wells 1, 2, 3 and 4. The proposed place of use (POU) is the District's water service area (Washington State Department of Health Group A Water System ID 26450) as described in the most recent Water System Plan (Davido Consulting Group, 2004 with pending update 2011). (Figure 1)

Table 1
Summary of Application No. G1-28039

Attributes	*Proposed*
Applicant	Freeland Water District
Application Received	June 10, 1999
Instantaneous Quantity	400 gpm (requested), 285 gpm (adjusted)
Annual Quantity	282.5 acre-feet per year (requested)
Point of Diversion	4 Wells
Purpose of Use	Municipal Supply Purposes
Period of Use	Year-round as needed
Place of Use	Service area of the Freeland Water District

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Legal Requirements for Application Processing
The following requirements must be met prior to processing a water right application:

- **Public Notice**
  A notice of publication was published in the Whidbey News-Times on February 25th and March 4th, 2009 and again on May 14th and 18th, 2011. No protests were received as a result.

- **State Environmental Policy Act (SEPA)**
  The subject water right is not subject to SEPA [WAC 197-11-305 and WAC 197-11-800(4)] because the instantaneous quantity is less than the threshold of 2,250 gallons per minute.

- **Water Resources Statutes and Case Law**
  Chapters 90.03 and 90.44 RCW authorize the appropriation of public water for beneficial use and describe the process for obtaining water rights. Laws governing the water right permitting process are contained in RCW 90.02.250 through 90.03.050.

  Based on the provisions of RCW 43.21A.690 and RCW 90.03.265, this application has been processed by Pacific Groundwater Group under Ecology Cost-Reimbursement Agreement No. PGG005 (master contract No. C1000192).

INVESTIGATION

The examination of Ground Water Right Application G1-28039 was led by consultants from Pacific Groundwater Group contracted as part of Ecology's cost reimbursement program to facilitate the processing of the application. Noel S. Philip, LHG, of the Water Resources Program, Ecology (Northwest Region), oversaw the examination and provided review.

A site visit was conducted by Jill Van Hulle of Pacific Groundwater Group and Jeff Tasoff of Davido Consulting on April 5, 2011. The tour included the inspection of the production wells and the service area.

The investigation included, but was not limited to, the review of:

- The State Water Code, specifically WAC 173 and RCW 90. 03 and 90.44
- Washington State Department of Ecology, 2011, Washington State Well Log Viewer website, <http://apps.ecy.wa.gov/welllog/index.asp> .
- Washington State Department of Ecology, 2011, Water Rights Tracking System (WRTS) website <http://www.ecy.wa.gov/programs/wr/rights/tracking-apps.html> .
- Washington State Department of Ecology, April 19, 2004, Hydrogeological Report for Change Application GWC 5825 (Freeland Water District).
- Anderson, H.W., Jr. 1968, Groundwater Resources of Island County Washington Division of Water Resources, Water Supply Bulletin 25, Part 11, 317 p.

- Davido Consulting Group, 2011, Draft Freeland Water District, Water System Planning Update
- Memo to Noel Philip, Washington State Department of Ecology from Dan Matlock, Pacific Groundwater Group, November 22, 2011 RE: Freeland Water & Sewer District Water Right Application G1-28039 Hydrogeological Summary and Analysis.

The intent of this application is to secure additional water rights for the Freeland Water District. The District is currently supplied by three wells, referred to as Well 1, Well 2, and Well 3, which are authorized by Ground Water Certificate 5825-A to withdraw 250 gpm and 168 acre-feet per year. The wells have a combined pump capacity of 550 gpm, however, the well controls restrict the peak flows to the safe/sustainable flow rate for each well and to ensure that, when operated together, they don't exceed the current water right limitation of 250 gpm. The intent of this application is to secure a permit for an additional 285 gpm, which will bring the authorized rate of withdrawal for Wells 1, 2, and 3 to 535 gpm. Well 4 has been designated as a potential point of withdrawal, however there are no immediate plans to integrate that well into the system.

Table 2
Existing Freeland Production Wells

Well #	Max. Pump Capacity, gpm	Sustainable Rate, gpm	Operational Rate Requested, gpm
1	200	180	180
2	220	363	220
3	135	232	135
Combined	**550**	**775**	**535**

The District recently acquired the Sunny View Farms Water System and with it a fourth well and associated water right permits. Groundwater permit G1-27463 authorizes the withdrawal of 100 gpm and 80 acre-feet per year from this well, which increases the District's total annual authorization to 248 acre-feet per year.

Production Wells

Well 1 was constructed in 1965, with an 8-inch casing installed to a depth of 261 feet. Well 1 was rehabilitated in December of 2009 following a rapid decline in well production due to significant iron deposits on the well screen. A new pump was installed with a flow rating of 200 gpm, at a dynamic head of 300 feet. Based on the District's hydrogeologist's recommendations, Well 1 is operated at a rate not exceeding 180 gpm to ensure that water is not drawn down below the pump's intake level.

Well 2 is located about 400 feet west of Well 1. The well was drilled in 1980, with an 8-inch casing installed to a depth of 200 feet. The Well 2 pump was replaced recently and is capable of producing 220 gpm; however, the well could be pumped at rates approaching 360 gpm before water would be drawn down into the screen interval.

Well 3 was drilled in 2000, with a 6-inch casing installed to 361, and screen assemble between 357 to 368 feet. The well is equipped to produce 135 gpm.

Well 4 was drilled in 1994 with a 6-inch casing to 235 feet and is completed with 15 feet of screen from 220 to 235 feet. The well is currently used as a stand-alone system for the Sunny View Farms Water System.

Table 3
Freeland Well Construction Details

Well Name	*Unique Well ID*	*Year Drilled*	*Depth Drilled (ft)*	*Screen Depth (ft)*	*Well-Site Elevation (MSL)*
Well 1	AGA907	1965	261	251-261	245
Well 2	AGA908	1981	200	185-200	180
Well 3	AFJ868	2000	368	357-368	325
Well 4	ALQ382	1994	235	220-235	213

Quantities for Permit\Demand Forecast

The current population of the District is estimated at about 1,028 full time residents and 447 service connections, which translates to 463 Equivalent Residential Units (ERU), with an average daily demand of approximately 210 gallons per ERU.

- Currently, the lack of a sewer system is the most restrictive barrier to large-scale development in the area, and the future development of a new sewer system would likely be the largest driver of growth within the District in the foreseeable future. The District water system service area has been expanded by annexation. The water service area includes and exceeds in some areas the boundaries of the sewering project.

If the sewer system is constructed, the estimated number of ERU's in 15 years is 1,557, increasing to 2,167 by 2030. Based on the District's current ADD of 210 gallons per ERU, the District would ultimately need to acquire rights of 510 acre-feet per year. Although the rights currently allocated to the District would be adequate for minimal growth through 2030, based on the more aggressive predictions, additional water would be required by 2019. Thus, an additional 262 acre-feet per year are needed to meet the 20-year demand projection.

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Site Description

General Hydrogeology

The hydrogeology of Southern Whidbey Island has been shaped by at least three periods of glaciation, within intervening non-glacial periods between them. All of the aquifers tapped in this portion of the island are completed in unconsolidated sediments. The *Island County Ground Water Management Plan, Part A, Technical Memorandum* (GWMP, 2005) describes the groundwater-flow system as a series of discontinuous, permeable, water-bearing sediments (sand and gravel aquifers) surrounded by zones of lower-permeability sediments (silt, clay, and glacial-till aquitards).

The USGS (1968) described five aquifer zones , Aquifer A (oldest and deepest) through E (youngest and shallowest). Erosion and deposition result in some units being missing in some areas.

The Island County Water Resource Management Plan (2005) established 33 Sub-basins that are based on estimated groundwater flow divides and assumed that groundwater withdrawals in one sub-basin would have little, if any, effect on adjacent sub-basins. All four of the Freeland wells are located in Sub-basin 25.

Freeland Water District Hydrogeological Assessment

As part of this investigation Pacific Groundwater Group (PGG) developed a two-dimensional, steady-state analytic-element computer model in order to evaluate regional drawdown and the potential for saltwater intrusion and well interference in response to increased pumping by Freeland Water and Sewer District as well as assess potential changes resulting from moving from the use of individual septic systems to a municipal sewer system (PGG, 2011). Figure 2 shows the current condition and modeled head used in the evaluation.

The Freeland area is currently un-sewered, with individual septic systems and larger combined septic systems providing sewage disposal in the area. Installation of a sewer system in the area is currently under consideration. Because septic systems can provide recharge to the groundwater system, and the construction of a sewer system would remove this recharge from the groundwater system, the current-condition computer model specifically includes estimated recharge from septic systems and evaluates the effects of removing that recharge once a regional sewer is in place.

The aquifer in which the District's wells are completed is composed of a thick (nearly 100 feet) layer of unconsolidated quaternary aged sand, although only about 45 feet of this layer is saturated. The base of the aquifer occurs at an elevation of approximately 20 to 40 feet below sea level, which based on mapping of Sapik and others (1988) corresponds to USGS Aquifer C, also known as the 'Sea Level Aquifer'. Sapik mapped several aquifers above and below Aquifer C, but based on local well logs, it appears that Aquifer C is the uppermost viable aquifer in this area of Whidbey Island with overlying sand layers having little or no saturation. All four of the District's wells appear to be completed in Aquifer C, with an aquifer bottom elevation of 40 feet below sea level and a saturated thickness of approximately 45 feet (PGG 2011).

Initial estimates of aquifer transmissivity were derived from aquifer tests for District Wells 1 (6,600 ft^2/day) and Well 2 (16,900 ft^2/day), and the Sunny View Farms well (19,100 ft2/day). Using the geometric mean of these three estimates (12,900 ft^2/day) and dividing by the saturated aquifer thickness (45 feet) yields an average hydraulic conductivity of 286 ft/day. Estimates of recharge for the aquifer were derived from deep percolation modeling conducted by the USGS (Summioka and Bauer, 2003).

Estimates of septic system flows were derived from the Island County Assessor's parcel information, and when available from licensing data for the individual systems. The conditions modeled took into consideration Freeland Water's current and proposed use under this water application, other wells associated with public water systems and individual wells associated with single family residences.

Once the model was calibrated with known data, future pumping simulations were conducted to evaluate the potential effects of increased withdrawals associated with the both the District's inchoate current water right and the proposed new water right, as well as the potential impacts of removal of septic return flows in the proposed sewered area. Figures 3 and 4 illustrate future drawdown with and without septic returns.

Modeling of projected impacts to Aquifer C showed the creation of a wide but shallow drawdown cone due to the simulated withdrawal from the District's wells. In order to assess whether interference drawdown effects might impair other wells, the available drawdown (above the pump) was compared to the calculated interference drawdown. In general, the likelihood of impairment is highest in the immediate vicinity of the wellfield, where interference drawdown values are the highest.

Table 4 provides a listing of public water system wells from the Island County Hydrogeology database (March 2003) that are located within one mile of the District's wellfield - where pump test and static depth to water information are available. The location of these wells is indicated on Figure 2. The third to the last column on the right (Available DDN) quantifies the available drawdown which is defined as the depth of the well minus the pumping water level, that is, the height of the water column remaining in the well while pumping. The interference-drawdown (Interference DDN) column displays the estimated interference drawdown resulting from pumping the full (existing and proposed) Qa from the District's wells (septic returns are still active). The combined drawdown column (Combined DDN) provides the estimated drawdown from increased withdrawals for the District wells, and the removal of septic returns due to sewering

Table 4
Well Impairment Analysis

Site ID	Dist (ft)	Dir	Well Depth (ft)	Qi (gpm)	Drawdown (ft)	Average DTW (ft)	Available DDN (ft)	Interference DDN (ft)	Combined DDN (ft)
7NT	1064	N	208	15	3	178	27	1.73	1.91
7HN	2177	S	381	17	1	331	49	1.50	1.63
78D	2801	E	170	15	1.1	158	11	1.20	1.33
7MB	2813	NE	171	33	2	137	32	1.19	1.33

7FU	3700	SW	248	17	3	218	27	1.10	1.22
AFV	3704	W	77	30	0.95	52	25	1.10	1.25
7EX	3697	S	271	15	5	230	36	1.09	1.19
7HD	3741	SE	200	50	8.5	165	26	1.07	1.16
7NC	3961	W	116	35	4	88	24	1.05	1.18
7E3	4373	S	272	31	3.9	240	28	0.97	1.06
7E4	4419	S	111	40	5	86	20	0.97	1.06
BPJ	4403	W	120	30	6.7	78	35	0.97	1.11
7DP	4568	SW	260	15	1.75	236	22	0.96	1.05
EBF	5238	SE	178	15	4.07	148	26	0.83	0.91

As shown in **Table** 4, the high transmissivity of Aquifer C leads to relatively low drawdown values in nearby wells (due to their own pumping), as well as relatively low interference drawdown values from District's pumping. Given that the available drawdown significantly exceeds the interference and combined drawdown in all wells, there appears to be little potential for impairment of existing wells in this area. Although the list of wells presented in Table 4 may not represent all wells or record for this area, it does confirm that properly designed wells that fully utilize the aquifer should not be impaired by interference drawdown from District pumping.

Four Statutory Tests

This Report of Examination (ROE) evaluates the application based on the information presented above. To approve the application, Ecology must issue written findings of fact and determine that each of the following four requirements of RCW 90.03.290 has been satisfied:

1. The proposed appropriation would be put to a beneficial use;
2. Water is available for appropriation;
3. The proposed appropriation would not impair existing water rights; and
4. The proposed appropriation would not be detrimental to the public welfare.

Beneficial Use

Municipal water supply is considered a beneficial use of water.

Availability

Water is physically available for appropriation. The wells are capable of sustaining higher withdrawals and the increased annual water use is not anticipated to impact other water users.

Potential for Impairment

Other Groundwater Users

Groundwater wells at greatest risk of potential impairment are those which are completed in the same aquifer zone as the subject well, located in close proximity to the subject well. An evaluation of wells

within a one mile radius of the Freeland production wells indicates that projected drawdown at the nearest documented neighboring well will be less than 2 feet, and not significant enough to impair its operation.

The Department of Ecology Water Rights Application Tracking System (WRATS) show 3 water right certificates, and approximately 40 water right claims that have been filed within a one mile radius of the Freeland wellfield. Ecology's Well Log database has approximately 50 wells of record within this same area. These well are either tied to water right documents – certificates or claims, or to exempt wells that are used for smaller non-permitted uses. Since the Freeland Water District supplies domestic water to the area immediately surrounding its wellfield there are no known actively used production wells closer than those already identified on Table 4.

Washington water law does not consider drawdown to be an impairment of existing water rights, unless the affected wells fully penetrate the aquifer and can no longer produce adequate water to meet the demands for which they were intended. The aquifer shows adequate capability to produce water in the amount requested without impairment to neighboring wells.

Surface Water Bodies

Minimum instream flows have not been established for WRIA 6. There are no significant surface streams within 1 mile of the District's wells.

Sea Water Intrusion Evaluation

One of the primary considerations when evaluating a water right change application in Island County is the potential of the proposed change to cause seawater (a.k.a. salt water) intrusion. If the change is anticipated to result in seawater intrusion, it cannot be allowed because it is against the public interest to cause seawater intrusion and it could potentially impair other water right holder's ability to withdraw high-quality water.

The location of the Freeland Water District's Wells are defined as a low risk area for seawater intrusion using the definition contained within Island County Code (ICC 8.09.099). Based on the classification scheme defined in ICC 8.09.099 this site is classified as low risk because it is not within 1 mile of other wells that have historical or current chloride concentrations above 100 mg/L.

Seawater intrusion is the movement of saline (salty) marine water into a freshwater aquifer. When an aquifer is in hydraulic connection with saline marine waters, such as Puget Sound, portions of the aquifer may contain saltwater, while other portions contain freshwater. Freshwater is slightly less dense (lighter) than saltwater and, as a result, tends to float on top of the saltwater when both fluids are present in an aquifer.

When a well is pumped, water levels in the vicinity of the well are lowered, creating a drawdown cone. If a saltwater zone exists in the aquifer beneath the well, the saltwater will rise up toward the well screen (upconing) when the well is pumped. In some places a salty zone is not present beneath the well, in which case the water level (head) can be pulled significantly below sea level by pumping and yet not induce seawater intrusion, as long as the head in the aquifer between the pumping well and the

submarine aquifer outcrop remains high enough to prevent saltwater from entering into the base of the aquifer (lateral intrusion).

As previously discussed, as part of this investigation Pacific Groundwater Group (PGG) developed a two-dimensional, steady-state computer model in order to evaluate regional drawdown and the potential for saltwater intrusion in response to increased pumping by Freeland Water and Sewer District as well as potential changes in aquifer recharge resulting from sewering.

PGG notes that static heads in the vicinity of the District's wellfield are approximately 8 feet above mean sea level and are currently sufficient to prevent the movement of saline water into aquifer. Based on the worst-case future simulation analysis performed, combined drawdowns resulting from withdrawals associated with the full combined existing and future water rights for the District and removal of septic returns for the proposed sewered area are unlikely to result in any intrusion problems in the area. Nor are conditions in more coastally located neighboring wells projected to change. Island County Code 8.09.099 (Seawater Intrusion Protection) classifies seawater intrusion risk based on water level elevations and chloride concentrations in wells within ½ mile of the project location. If any well has a water level elevation less than 8.4 feet (NAVD88) then the area is classified as *medium risk* for seawater intrusion. If low water level elevations are combined with elevated chlorides, a project would be classified as a *high risk* if chloride is between 100 and 250 mg/l or *very high risk* if chloride > 250 mg/l. Water level elevation data are all greater than 8.4 feet NAVD 88, and chloride data are all < 100 mg/l for wells within 1 mile of the project location; therefore this area is not currently at risk for seawater intrusion even when considering the additional withdrawal by the District.

The requested withdrawal is not expected to interrupt or interfere with the availability of water to existing rights.

Public Welfare

RCW 90.03.290 requires that a proposed appropriation not be detrimental to the public interest.

The 1971 Water Resources Act provides the most comprehensive list of legislative policies that guide the consideration of public interest in the allocation of water. These policies generally require a balancing of the state's natural resources and values with the state's economic well-being. Specifically, the policies require allocation of water in a manner that preserves instream resources, protects the quality of the water, provides adequate and safe supplies of water to serve public need, and makes water available to support the economic well-being of the state and its citizens.

The withdrawal of additional 262 acre-feet of water year-round at an instantaneous rate of up to 285 gpm for municipal supply is consistent with state policy without adversely impacting instream flows or other public needs and values.

Municipal supply is considered a beneficial use in accordance with RCW 90.54.020. No detriment to public interest could be identified during the examination of the subject application

CONCLUSIONS

The conclusions based on the above investigation are as follow:

1. The proposed appropriation for municipal supply is a beneficial use of water;
2. The 285 gpm and 265 acre-feet per year is available for appropriation;
3. The new appropriation will not impair senior water rights; and
4. The new appropriation will not be detrimental to the public interest.

RECOMMENDATION

Based on the information presented above, the author recommends that the request to appropriate 285 gpm and 265 acre-feet per year be approved in the amounts described, limited, and provisioned on page 1 through 3 of this report.

Report by: _____

Jill Van Hulle, Pacific Groundwater Group Date

Reviewed by: _____

Noel S. Philip, LHG (#2662), Water Resources Program Date

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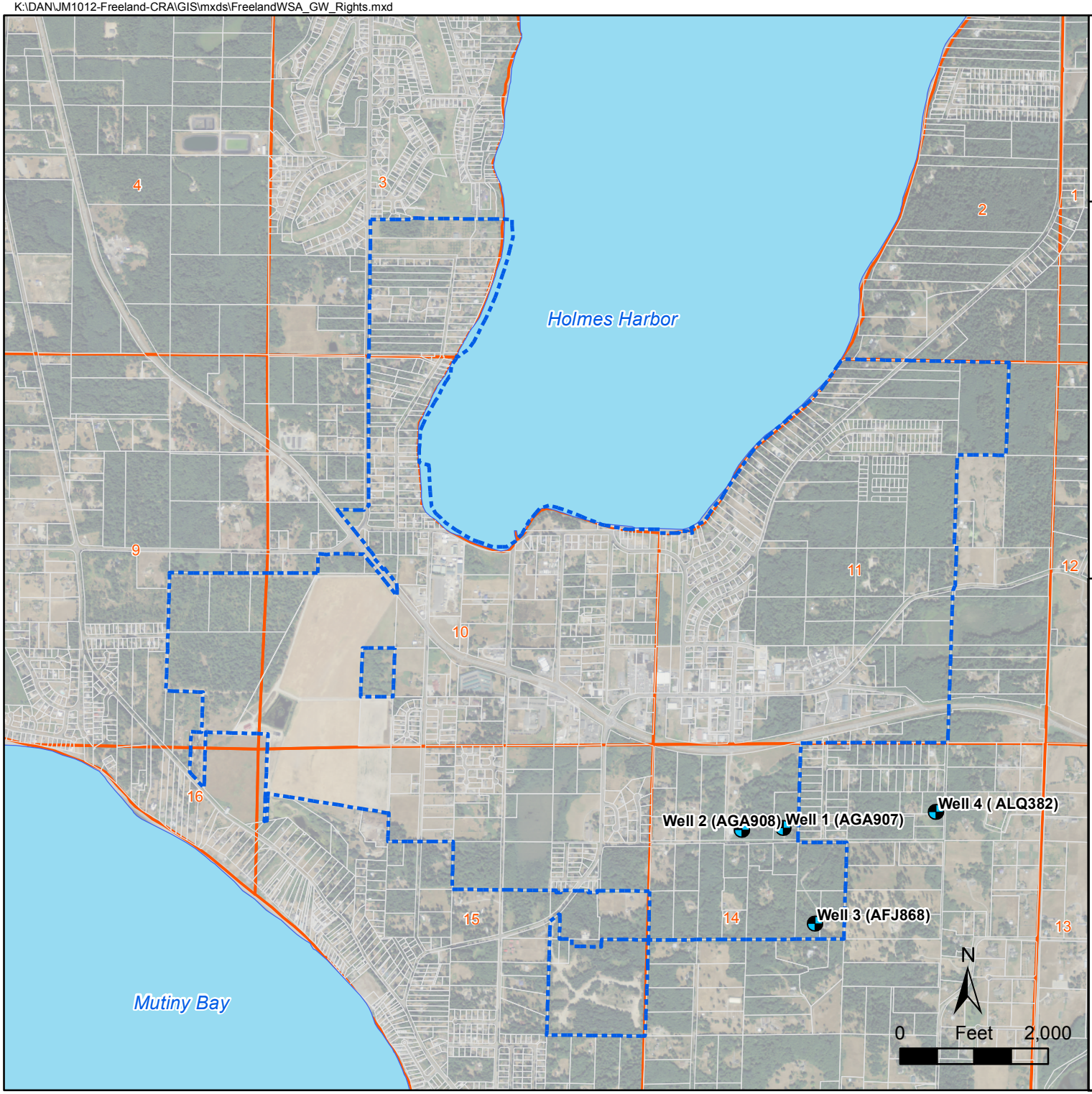
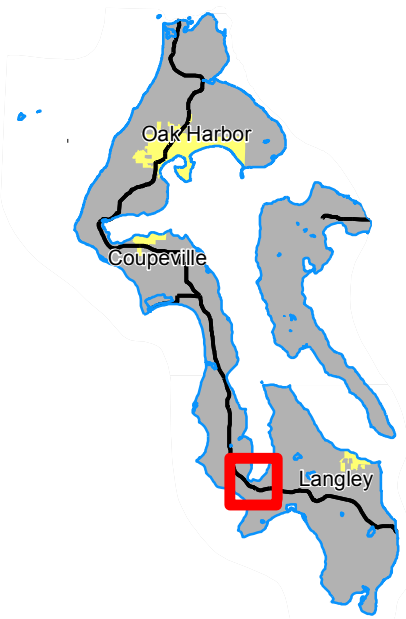


Figure 1
Freeland WSD
G1-28039

JM1012
Freeland Water & Sewer District

PgG

Freeland Wells
Freeland WSA
Parcels
Sections (T29N/R02E)



Technical Memorandum

To: Noel Philip, Washington State Department of Ecology

From: Dan Matlock, Pacific Groundwater Group

Re: Freeland Water & Sewer District Water Rights Application G1-28039
Hydrogeologic Summary & Analysis

Date: November 22, 2011

1.0 INTRODUCTION

As part of the preparation of a report of examination (ROE) for water-right application G1-28039, Pacific Groundwater Group (PGG) developed a two-dimensional, steady-state computer model in order to evaluate regional drawdown and the potential for saltwater intrusion in response to increased pumping by Freeland Water and Sewer District (District).

2.0 HYDROGEOLOGIC SETTING

The aquifer in which the District's wells are completed is composed of a thick (nearly 100 feet) layer of unconsolidated quaternary aged sand, although only about 45 feet of this layer is saturated. The base of the aquifer occurs at an elevation of 20 to 40 feet below sea level, which based on mapping of Sapik and others (1988) corresponds to Aquifer C, also know as the sea level aquifer. Sapik mapped several aquifers above and below Aquifer C, but based on local well logs, it appears that Aquifer C is the uppermost viable aquifer in this area of Whidbey Island with overlying sand layers having little or no saturation.

3.0 MODEL DESIGN

The model was developed using the analytic element code and graphical user's interface "GFLOW" (Haitjema Software). The model extends at least two miles in all directions from the District's wells (**Figure 1**). Due to the distance to marine shorelines and the magnitude of the proposed withdrawal, the areal extent (domain) of the model was relatively large in relation to the extent of the expected pumping effects.

In order to represent the marine aquifer outcrops, constant-head boundaries ("line sinks with resistance") were modeled along the Holmes Harbor, Mutiny Bay, and Useless Bay shorelines. All three of the District's wells appear to be completed in Aquifer C, with an aquifer bottom elevation of 40 feet below sea level and a saturated thickness of approximately 45 feet. Field-measured water-level elevations rise near to the eastern and northwestern edges of the model due to large recharge areas outside of the model domain.

These external influences were simulated through constant-head line sinks along the model boundaries, with the constant heads set approximately equal to the water level elevations found in these areas. Due to the distances between the boundaries and the District's wells (approximately 3 miles), little influence on modeling results is expected.

Initial estimates of aquifer transmissivity were derived from aquifer tests for District Wells 1 (6,600 ft^2/day) and 2 (16,900 ft^2/day), and the Sunny View Farms well (19,100 ft2/day). Using the geometric mean of these three estimates (12,900 ft^2/day) and dividing by the saturated aquifer thickness (45 feet) yields an average hydraulic conductivity of 286 ft/day.

Estimates of recharge for the aquifer were derived from deep percolation modeling (DPM) conducted by the USGS (Summioka and Bauer, 2003). The recharge estimates vary spatially, so a total of 44 inhomogeneity zones were used to simulate the varying recharge rates across the area (**Figure 1**).

The Freeland area is currently un-sewered, with individual septic systems and larger combined septic systems (LOSS) providing sewage disposal in the area. Installation of a sewer system in the area is currently under consideration. Because septic systems can provide recharge to the groundwater system, and the construction of a sewer system would remove this recharge from the groundwater system, the current condition computer model specifically includes estimated recharge from septic systems. Estimates of septic system flows were derived from the Island County Assessors parcel information, where parcels with significant building values were assumed to have a septic system, and that the system would process the average quantity of water used in the Freeland area (210 gallons per day). Larger LOSS system flows were derived from licensing data for the individual systems. Recharge to the groundwater system was estimated to be 50% of the water use (Adelsman etal, 2006).

The current conditions simulated in the model during calibration included pumping of all known wells within the model domain, as follows:

- Freeland Water and Sewer District's Wells 1, 2, and 3 were pumped at the reported annual average use of 210 gallons per day per connection (Davido Consulting Group, 2010) times the current number of active connections (196).

- wells associated with other public water systems also were pumped at 210 gallons per day times the total approved connections (Washington State Department of Health).

- individual wells (not associated with a Group A or B public water system) were pumped at an average rate of 210 gallons per day.

In all, pumping from a total of 409 (69 public and 340 individual) wells was simulated in the "current conditions" model.

Calibration targets for the current conditions model included 12 wells completed in Aquifer C that had surveyed measuring point elevations and accurate depth to water measurements. While holding the hydraulic conductivity and recharge distribution estimates constant, the resistance of the marine boundaries (constant head) was modified to provide a best fit of model-predicted heads to field-measured heads. **Table 1** provides a comparison of modeled to field-measured heads. **Figure 2** displays the current conditions head distribution and model calibration target locations.

Table 1. Model Calibration Results

Site ID	Distance from Well Field (ft)	Direction from Well Field	Well Bottom Elevation (ft MSL)	Field Head (ft MSL)	Modeled Head (ft MSL)	Head Difference (ft)
7HD	2844	SE	-23	6.53	6.95	0.42
63N	3951	SW	-8	5.72	5.95	.23
7FW	4193	SW	-14	5.53	6.31	.78
BPJ	4617	W	-30	7.54	6.99	-0.55
7BP	4832	S	-7	5.01	5.21	0.20
7WV	5275	NE	-56	10.30	11.13	0.83
AUJ	5418	NW	5	14.04	10.80	-3.24
79X	6150	S	-16	7.09	4.66	-2.43
ARK	6390	S	-17	3.88	4.64	0.77
78Y	9086	SW	-36	2.05	3.24	1.19
4RG	9090	NE	-3	11.34	11.80	0.45
74Y	9808	S	-3	2.52	4.23	1.71
					Mean Difference:	0.03

Once the current conditions model calibration appeared to be sufficient, future pumping simulations were conducted to evaluate the potential effects of increased withdrawals associated with the both the District's inchoate current water right and the proposed new water right, as well as the potential impacts of removal of septic return flows in the proposed sewered area.

In the first predictive model run, it was assumed that septic return flow would continue and that discharge rates from the District's three wells would increase to the sum of existing (248 acre-feet per year) and proposed (262 acre-feet per year) maximum annual water right quantities (Qa). This summed quantity of 510 acre-feet per year (afy) equates to an average withdrawal rate of 312 gallons per minute (gpm), equally divided amongst the three wells (104 gpm per well). Because Aquifer C is unconfined in this area, the effects of transient variations in pumping rates will be largely damped due to the high specific yield (coefficient of storage) of the aquifer. Given the highly damped nature of the aquifer and the propensity of saltwater interfaces to adjust slowly to head changes, we believe that the Qa rate (converted to gpm) is a more reasonable value for the future predictive simulation than the instantaneous peak rate (Qi), which is always short-term and alternates both seasonally and daily with much higher pumping rates.

Water level elevations for the future pumping scenario were subtracted from the initial conditions simulation to provide an estimate of spatial distribution of drawdown resulting from the increased withdrawals. Aquifer C in the area of the District's well field has a high transmissivity (12,900 ft^2/d), resulting in the formation of a broad-but-shallow drawdown cone, as shown in **Figure 3.**

A second predictive simulation was conducted to evaluate the effects of sewering in the Freeland area. This simulation removed the recharge associated with septic system return flows, and also included the increased pumping of the District's three wells. As expected, drawdowns for this simulation were slightly greater than in the previous simulation due to the removal of septic return flows (**Figure 4.**)

4.0 SEAWATER INTRUSION EVALUATION

Seawater intrusion is the movement of saline (salty) marine water into a freshwater aquifer. When an aquifer is in hydraulic connection with saline marine waters, such as the Puget Sound, portions of the aquifer may contain saltwater, while other portions contain fresh water. Freshwater is slightly less dense (lighter) than saltwater and, as a result, tends to float on top of the saltwater when both fluids are present in an aquifer.

The Ghyben-Herzberg relationship is used to estimate the depth to the freshwater/saltwater interface based on the head of the freshwater zone above sea level. It is derived from the density difference between saltwater and freshwater, and can be used to estimate the depth to the freshwater/saltwater interface based on the head of the freshwater zone above sea level. For typical freshwater and seawater salinities/densities, the Ghyben-Herzberg ratio is roughly 40 to 1 (i.e. at a given location, for every foot that the freshwater head extends above sea level, the freshwater/saltwater interface extends 40 feet below sea level). For example, a location with a freshwater head of 0.5 feet above sea level would have a freshwater/saltwater interface at 20 feet below sea level. In addition, reductions or increases in the salinity/density of seawater will have a corresponding change in the Ghyben-Herzberg ratio.

When a well is pumped, water levels in the vicinity of the well are lowered, creating a drawdown cone. If a saltwater zone exists in the aquifer beneath the well, the saltwater will rise up toward the well screen (upconing) when the well is pumped. In many places a salty zone is not present beneath the well, in which case the head can be pulled significantly below sea level by pumping and yet not induce seawater intrusion, as long as the head in the aquifer between the pumping well and the submarine aquifer outcrop remains high enough to prevent saltwater from entering into the base of the aquifer (lateral intrusion). This situation creates what is known as a 'false interface' and is illustrated in **Figure 5**. The drawdown cone at the pumping well extends below sea level, which causes the Ghyben-Herzberg predicted interface position to move upward to the well screen. Heads are significantly above sea level in the aquifer between the well and the shoreline (A), resulting in the predicted interface position falling below the base of the aquifer (B) and preventing the movement of saltwater to beneath the well, which prevents seawater intrusion at the well. Thus, the important factor in preventing seawater intrusion is not the head at the pumping well, but instead it is the head in the area

between the well and the saltwater interface. If heads in an aquifer are lowered, reducing the pressure above sea level (A), the predicted interface position at (B) will rise until a critical level is reached where the base of the interface rises up to the base of the aquifer. Once the critical rise has been reached, intrusion of the pumping well can occur rather rapidly, if the interface migrates as far inland as the pumping well.

Static heads in the vicinity of the District's wellfield are approximately 8 feet above mean sea level and are currently sufficient to prevent the movement of saline water into aquifer, since the aquifer base is at 40 feet below sea level and the calculated freshwater / saltwater interface is at 320 feet below sea level (based on a 40:1 Ghyben/Herzberg ratio). **Figure 6** displays the simulated head distribution for the worst-case future withdrawal scenario (pumping the combined existing and proposed Qa, and removal of septic returns), with simulated heads ranging from nearly 20 feet above sea level, to a low of roughly 2.5 feet above sea level near the eastern shoreline of Mutiny Bay. Heads of 2.5 feet above sea level result in an estimated interface position of approximately 100 feet below sea level (60 feet below the base of Aquifer C), indicating saline waters cannot move into Aquifer C. Based on the worst-case future simulation analysis performed, combined drawdowns resulting from withdrawal at full use of existing and future water rights for the FSWD, and removal of septic returns for the proposed sewered area are unlikely to result in any intrusion problems in the area.

5.0 INTERFERENCE DRAWDOWN EVALUATION

As discussed earlier, Aquifer C's high transmissivity results in the creation of a wide but shallow drawdown cone due to the simulated withdrawal from the District's wells. In order to assess interference drawdown effects that might impair other wells, the available drawdown (above the pump) is compared to the calculated interference drawdown. In general, the likelihood of impairment is highest in the immediate vicinity of the wellfield, where interference drawdown values are the highest. **Table 2** provides a listing of wells within one mile of the District's wellfield, where pump test and static depth to water information are available. The third to the last column on the right (Available DDN) quantifies the available drawdown which is defined as the depth of the well minus the pumping water level, that is, the height of the water column remaining in the well while pumping. The interference-drawdown (Interference DDN) column displays the estimated interference drawdown resulting from pumping the full (existing and proposed) Qa from the District's wells (septic returns are still active). The combined drawdown column (Combined DDN) provides the estimated drawdown from increased withdrawals for the District wells, and the removal of septic returns due to sewering.

Table 2. Impairment Analysis

SiteID	Dist (ft)	Dir	Well Depth (ft)	Q (gpm)	Drawdown (ft)	Average DTW (ft)	Available DDN (ft)	Inteference DDN (ft)	Combined DDN (ft)
7NT	1064	N	208	15	3	178	27	1.73	1.91
7HN	2177	S	381	17	1	331	49	1.50	1.63
78D	2801	E	170	15	1.1	158	11	1.20	1.33
7MB	2813	NE	171	33	2	137	32	1.19	1.33

7FU	3700	SW	248	17	3	218	27	1.10	1.22
AFV	3704	W	77	30	0.95	52	25	1.10	1.25
7EX	3697	S	271	15	5	230	36	1.09	1.19
7HD	3741	SE	200	50	8.5	165	26	1.07	1.16
7NC	3961	W	116	35	4	88	24	1.05	1.18
7E3	4373	S	272	31	3.9	240	28	0.97	1.06
7E4	4419	S	111	40	5	86	20	0.97	1.06
BPJ	4403	W	120	30	6.7	78	35	0.97	1.11
7DP	4568	SW	260	15	1.75	236	22	0.96	1.05
EBF	5238	SE	178	15	4.07	148	26	0.83	0.91

As shown in **Table** 2, the high transmissivity of Aquifer C leads to relatively low drawdown values in nearby wells (due to their own pumping), as well as relatively low interference drawdown values from District's pumping. Given that the available drawdown significantly exceeds the interference and combined drawdown in all wells, there is little potential for impairment of existing wells in this area.

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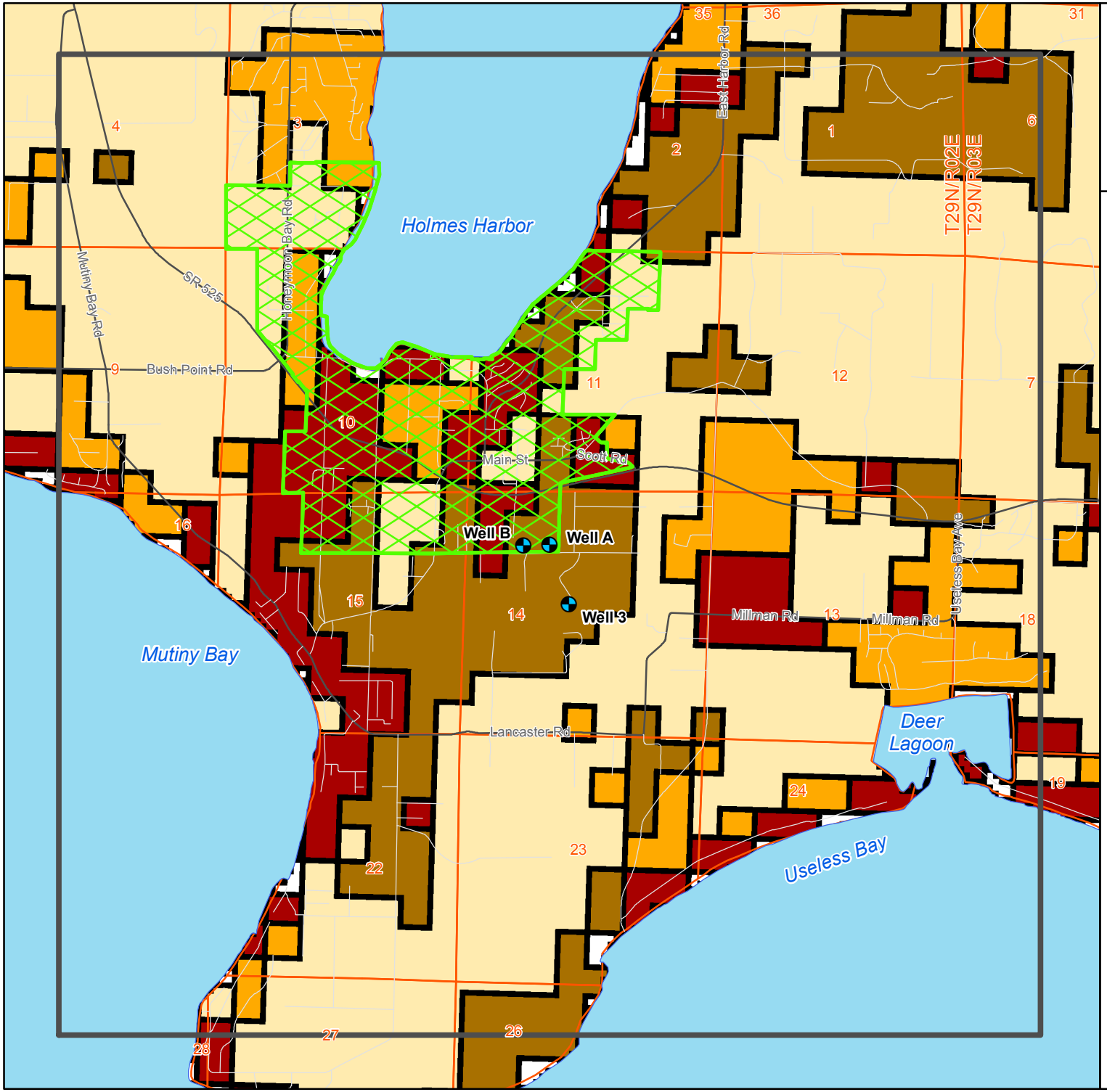

Figure 1
Site Plan

JM1012
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PgG

Freeland Wells
Model Boundary
Sewer Service Area
Sections

SIMULATED AVERAGE ANNUAL RECHARGE, IN INCHES PER YEAR

- 0 - 4.00
- 4.01 - 8.00
- 8.01 - 12.00
- 12.01 - 16.00

From USGS
Water-Resources Investigations Report 03-4101

N

0 Feet 2,000

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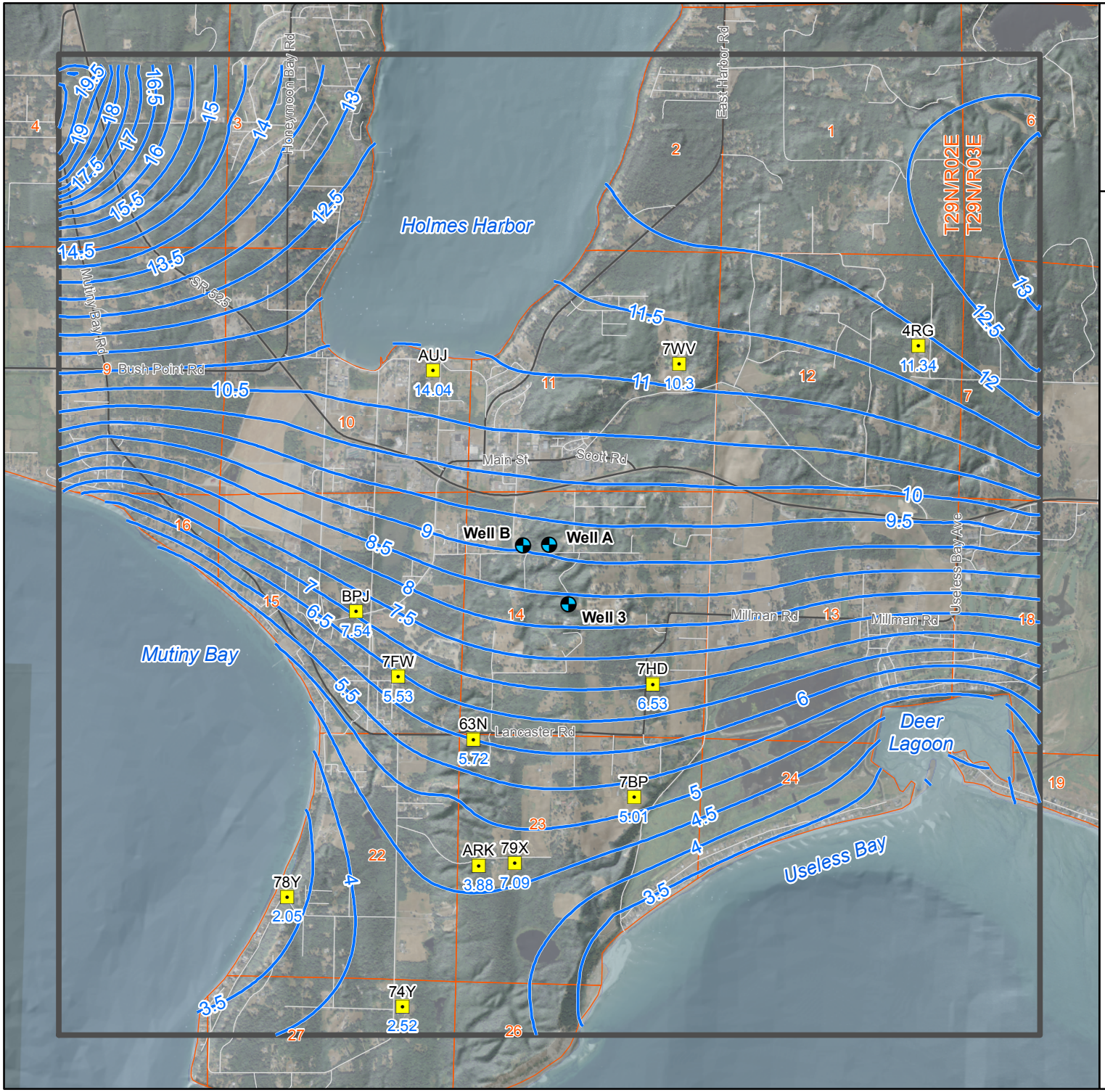

Figure 2
Current Conditions Modeled Head

JM1012
Freeland Water & Sewer District

PgG

Freeland Sewer and Water District Supply Wells

Calibration Target Wells (with field measured water level elevations in feet)

Modeled Head Contours (0.5-foot interval)

Model Boundary

Sections

N

0 Feet 3,000

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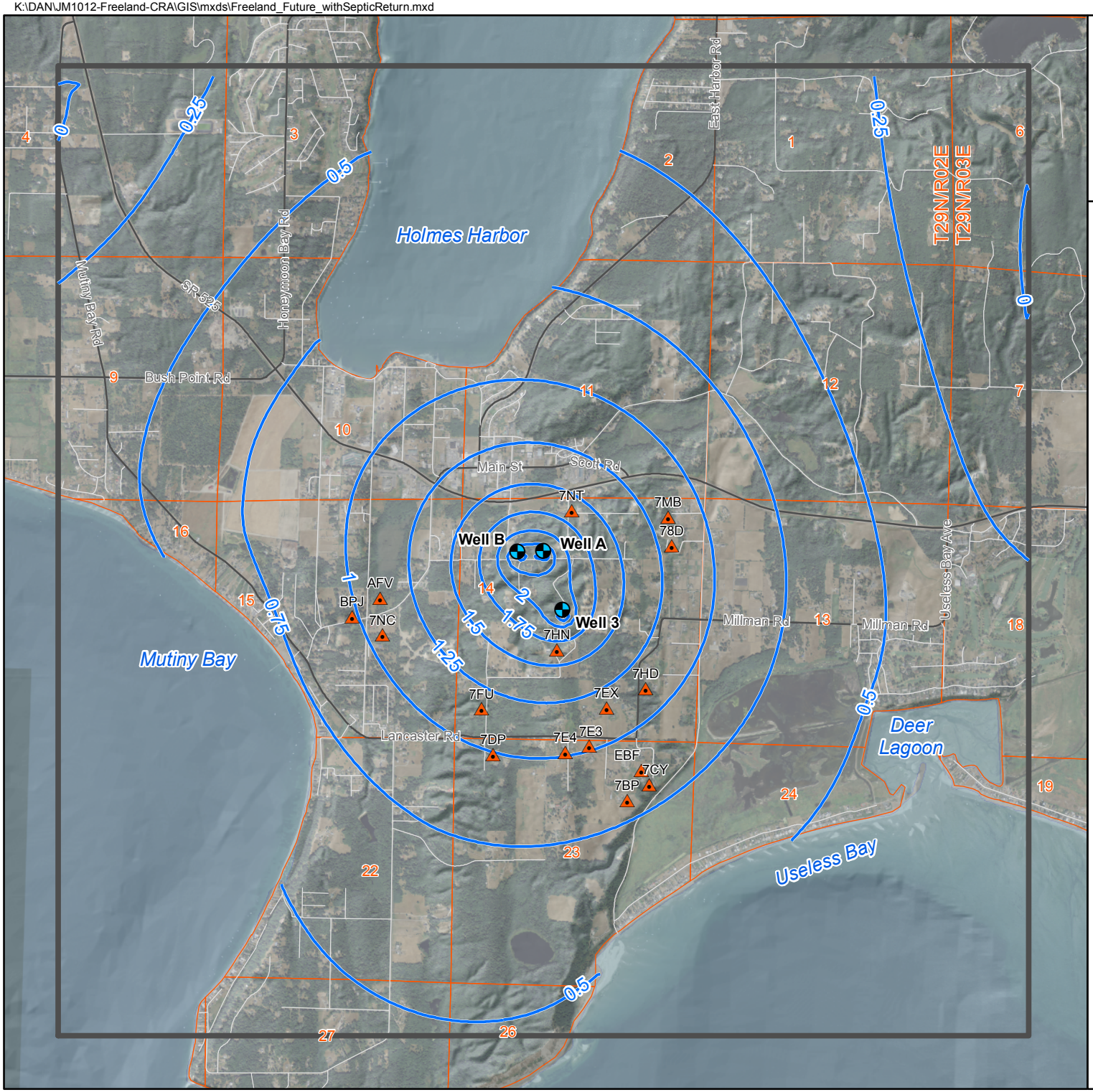

Figure 3
Future Simulation with Septic Return

JM1012
Freeland Water & Sewer District

PgG

Freeland Sewer and Water District Supply Wells

Impairment Analysis Wells

Modeled Drawdown Contours (0.25-foot interval)

Model Boundary

Sections

N

0 Feet 3,000

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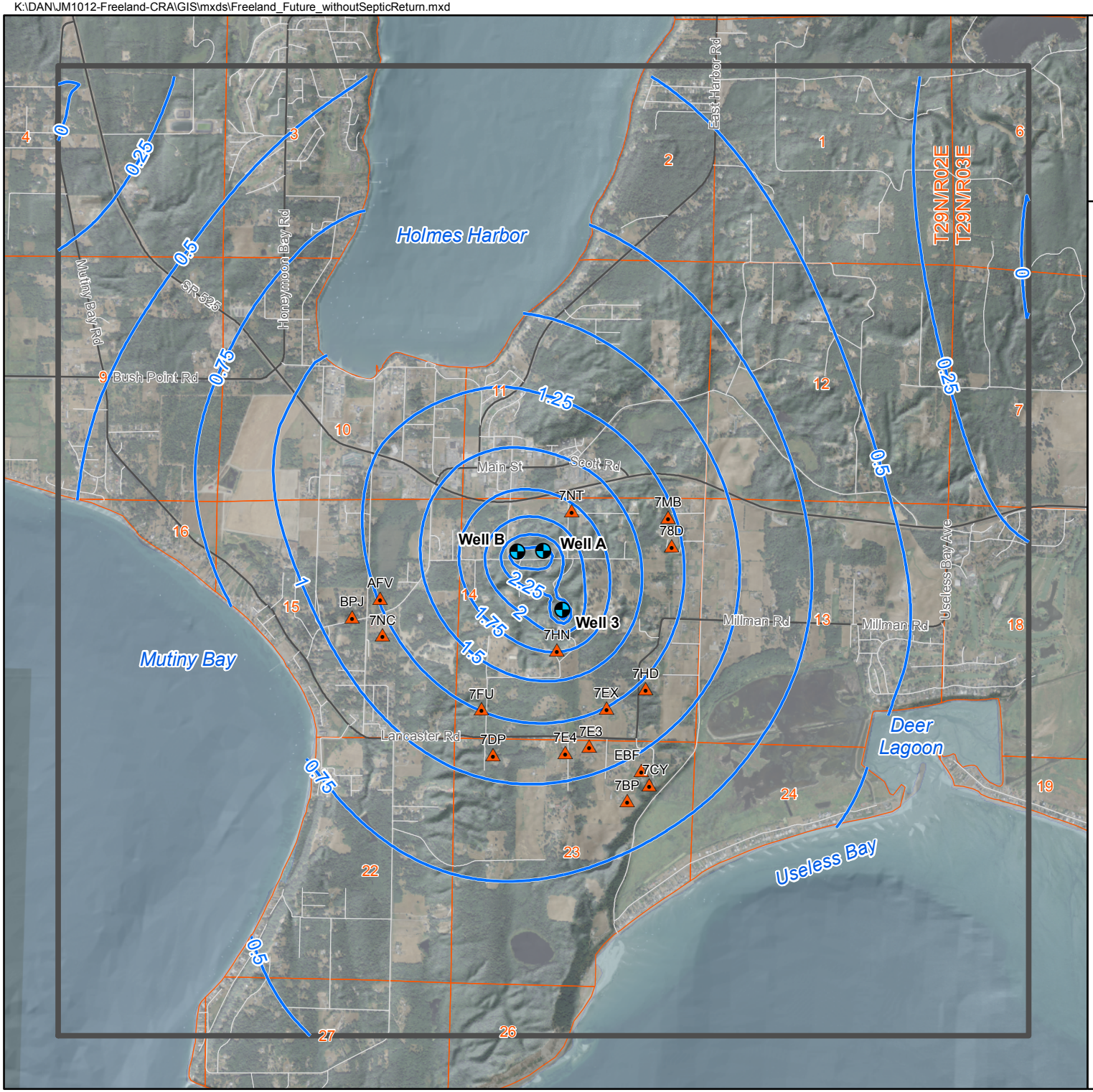

Figure 4
Future Simulation without Septic Return

JM1012
Freeland Water & Sewer District

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Freeland Sewer and Water District Supply Wells

Impairment Analysis Wells

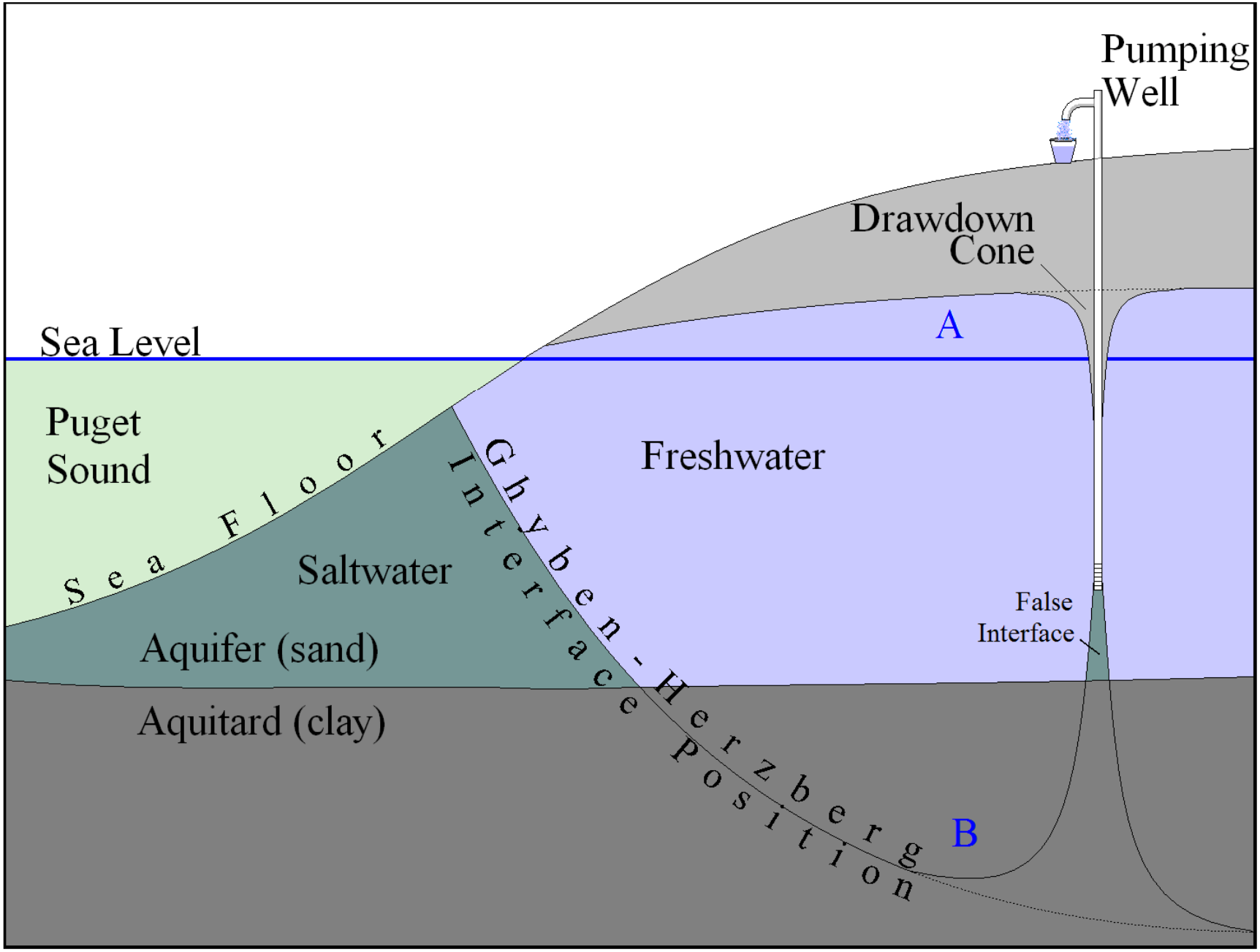
Modeled Drawdown Contours (0.25-foot interval)

Model Boundary

Sections

N

0 Feet 3,000



Adapted From:
Island County Seawater Intrusion Topic Paper
D. Kelly, 2005

Figure 5
Seawater Intrusion and False Interface

JM1012
Freeland Water & Sewer District

PgG

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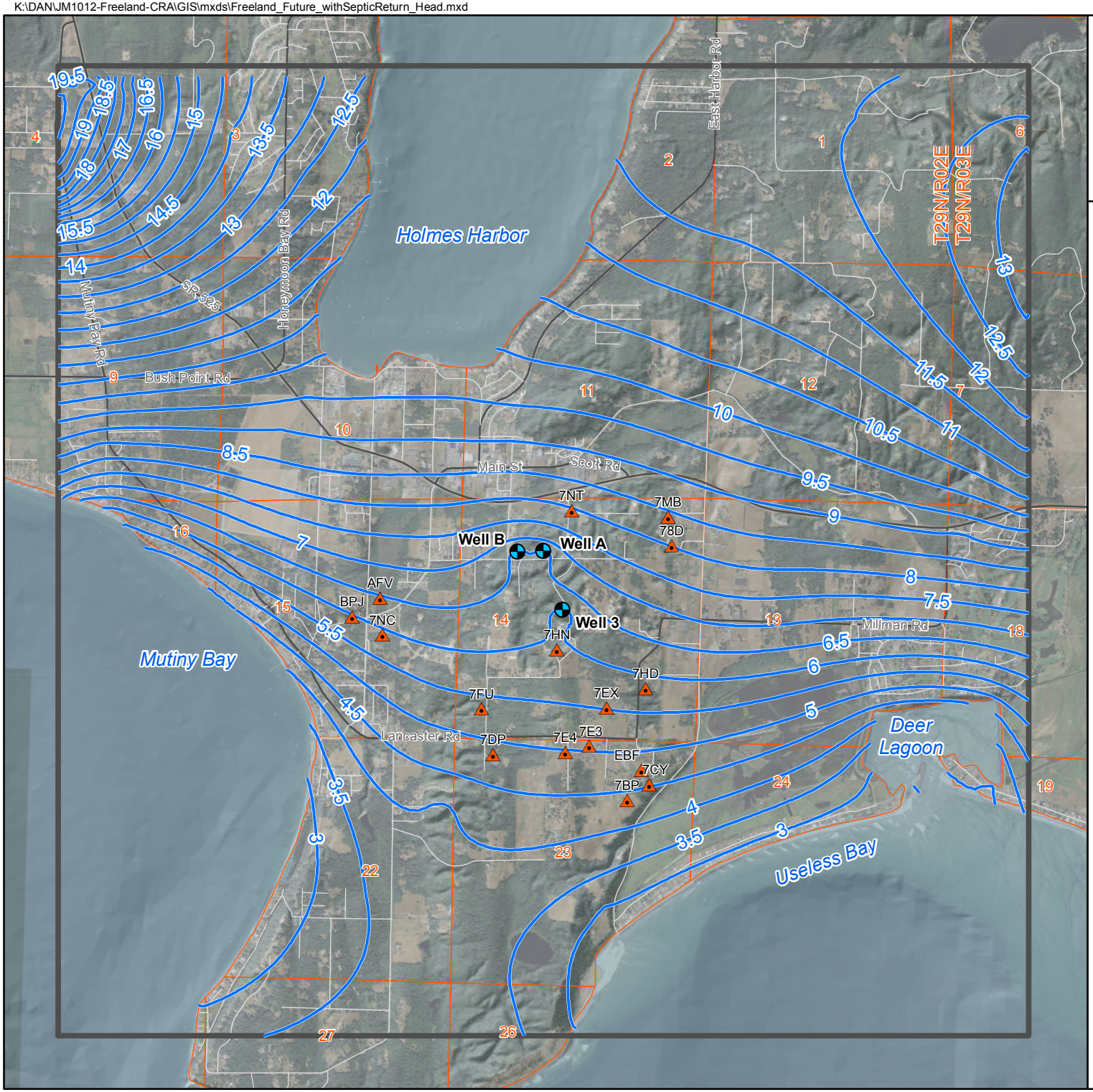

Figure 6
Future Simulation Without Septic Returns

JM1012
Freeland Water & Sewer District

PgG

- Freeland Sewer and Water District Supply Wells
- Impairment Analysis Wells
- Modeled Head Contours (0.5-foot interval)
- Model Boundary
- Sections

N

0 Feet 3,000