STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

DRAFT

REPORT OF EXAMINATION
TO APPROPRIATE PUBLIC WATERS OF THE STATE OF WASHINGTON

☐ Surface Water (Issued in accordance with the provisions of Chapter 117, Laws of Washington for 1917, and amendments thereto, and the rules and regulations of the Department of Ecology.)

☒ Ground Water (Issued in accordance with the provisions of Chapter 263, Laws of Washington for 1945, and amendments thereto, and the rules and regulations of the Department of Ecology.

PRIORITY DATE	APPLICATION NUMBER	PERMIT NUMBER	CERTIFICATE NUMBER
05/19/2010	G1-28658		

NAME
Whidbey Island Naval Air Station Gallery Golf Course, Erik Ruud, Regional Program Manager, Business Activities

ADDRESS (STREET)	(CITY)	(STATE)	(ZIP CODE)
610 Dowell Street, Building 94	Keyport	WA	98345

PUBLIC WATERS TO BE APPROPRIATED

SOURCE
Two wells

TRIBUTARY OF (IF SURFACE WATERS)

MAXIMUM CUBIC FEET PER SECOND	MAXIMUM GALLONS PER MINUTE	MAXIMUM ACRE FEET PER YEAR
	150	120

QUANTITY, TYPE OF USE, PERIOD OF USE
Irrigation of 85 acres (April 15 to October 15)

LOCATION OF DIVERSION/WITHDRAWAL

APPROXIMATE LOCATION OF DIVERSION--WITHDRAWAL
The existing well is located about 1,500 feet north and 2,500 feet east of the SW corner of Section 7.

LOCATED WITHIN (SMALLEST LEGAL SUBDIVISION)	SECTION	TOWNSHIP N.	RANGE, (E. OR W.) W.M.	W.R.I.A.	COUNTY
NE1/4 SW1/4	28	33	1E	6	Island

The existing well (Well 1) is located on the Navy golf course (Gallery Golf) west of Golf Course Road. A second well may be drilled as an additional point of withdrawal within the same ¼ ¼ section.

RECORDED PLATTED PROPERTY

LOT	BLOCK	OF (GIVE NAME OF PLAT OR ADDITION)

LEGAL DESCRIPTION OF PROPERTY ON WHICH WATER IS TO BE USED

W ½, Sec. 28, T33N, R1E W.M.

DESCRIPTION OF PROPOSED WORKS

Whidbey Island Naval Air Station has requested a groundwater right to withdraw groundwater from an aquifer known locally as “Aquifer C” using an existing well (Well #1) and one additional well. Available information indicates the existing well was drilled in or around 1942. Existing information (Easterbrook 1968) and a video inspection (PGG 2010b) indicate the existing well was drilled to a depth of 142 feet below ground surface (bgs), and has 12-inch diameter casing from ground surface to 118 feet bgs , and is also cased from ground surface to 155 feet bgs with 8-inch diameter casing. The well is screened from 155 feet to 180 feet bgs. There is no well log, and it is unknown if a surface seal is present.

A groundwater right was requested to withdraw groundwater at a maximum instantaneous rate (Qi) of 150 gallons per minute (gpm) and an annual quantity (Qa) of 92 AF for irrigation of 85 acres between April 15 and October 15. Based on an air photo review, 85 acres is a reasonable estimate of the amount of acreage that will be irrigated. This is in the lower range of acreage typically irrigated at a golf course. The well(s) will be connected to the existing high-efficiency irrigation system at the golf course. The requested annual quantity of 92 AF corresponds with a duty of 1.1 feet (13 inches) for the 85 acres of irrigated land, which is less than the estimated crop irrigation requirement of up to 23.2 inches. This permit sets upper limit on the Qa of 120 AF, equivalent to pumping full time during the irrigation season at the instantaneous Qi of 150 gpm. This represents 17 inches of irrigation for the 85 acres of irrigated land. No modifications to the requested Qi are granted by this permit.

DEVELOPMENT SCHEDULE

BEGIN PROJECT BY THIS DATE:	COMPLETE PROJECT BY THIS DATE:	WATER PUT TO FULL USE BY THIS DATE:
Already Started	April 30, 2013	April 30, 2018

PROVISIONS

Chapter 173-173 WAC describes the requirements for data accuracy, device installation and operation, and information reporting. It also allows a water user to petition Ecology for modifications to some of the requirements. Installation, operation and maintenance requirements are enclosed as a document entitled "Water Measurement Device Installation and Operation Requirements".

Water Level Monitoring: In order to protect the ground water resource, static water level in the well shall be measured quarterly each year). The water level data shall be maintained and made available to Ecology upon request.

Water Use: An approved measuring device shall be installed and maintained for each well used under this water right in accordance with the rule "Requirements for Measuring and Reporting Water Use," Chapter 173-173 WAC.

Water use data shall be recorded weekly. The maximum rate of diversion/withdrawal and the annual total volume shall be submitted to the Department of Ecology by January 31st of each calendar year. Reported water use data shall be submitted via the Internet or by using the enclosed forms. To set up an internet account, access Https://fortress.wa.gov/ecy/wrx/Meteringx/. If you have questions or need additional forms, contact the Northwest Regional office.

Department of Ecology personnel, upon presentation of proper credentials, shall have access at reasonable times, to the records of water use that are kept to meet the above conditions, and to inspect at reasonable times any measuring device used to meet the above conditions.

Sea Water Intrusion: The Gallery Golf Course is not required to monitor for chlorides, conductivity or hardness. However, if any of the source wells are deepened in the future or replaced by deeper wells, then semi-annual chloride, conductivity and hardness sampling will be required, and the following paragraphs shall apply.

Permittee or certificate holder and its successor(s) shall provide data on chloride concentrations for the well authorized by this permit or certificate with analysis performed by a state accredited laboratory. Accreditation information may be obtained from Ecology's Quality Assurance Program at (360) 895-4649. Sampling shall occur in April and August of each year, with a copy of the laboratory results for both sampling events submitted by October 15 of the same year, to the Department of Ecology, Northwest Regional Office, Bellevue, Washington.

If pumping from any well authorized by this water right causes chloride concentrations to show an increasing trend, immediate action shall be required to prevent pumping concentrations from increasing, as is consistent with the water quality anti-degradation policy WAC 173-200-030. These actions include, but are not limited to reducing the instantaneous withdrawal rate (gpm) of the well, lowering the annual quantity removed from the well, drilling additional wells, installing more storage capacity, or revising the pumping schedule. If chloride concentrations continue to increase, even after corrective measures are taken, the permit holder shall relinquish the option to perfect additional allocated quantities regardless of the stage of development.

Water Allocation: The applicant is advised that the certificate will issue for only that quantity of water that has been withdrawn and applied to actual beneficial use. Such quantity applied to actual beneficial use shall not exceed the quantity specified in this report of examination and will be calculated on the basis of the best information available to Ecology, including metering data and/or water duty analysis. The applicant is advised that the quantity of water allocated by this permit may be reduced at the time of final certification to reflect system capacity and actual usage.

A water right certificate shall not be issued until a final investigation has been made.

FINDINGS

Upon reviewing the investigator's report, I find all facts, relevant and material to the subject application, have been thoroughly investigated. Furthermore, I find the change of water right as recommended will not be detrimental to existing rights or the public welfare.

Therefore, I ORDER the requested permit to be granted under Groundwater Application No. G1-28658, subject to existing rights and the provisions specified above.

You have a right to appeal this decision to the Pollution Control Hearing Board (PCHB) within 30 days of the date of receipt of this decision. 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 this decision:

- File your appeal and a copy of this decision 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 decision on Ecology in paper form - by mail or in person. (See addresses below.) E-mail is not accepted.
- Serve a copy of your appeal and this decision on the Northwest Regional Office of the Water Resources Program in paper form – by mail or in person. (See address below.) E-mail is not accepted.

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

ADDRESS AND LOCATION INFORMATION

Street Addresses	***Mailing Addresses***
Department of Ecology Attn: Appeals Processing Desk	Department of Ecology Attn: Appeals Processing Desk

300 Desmond Drive SE
Lacey, WA 98503

PO Box 47608
Olympia, WA 98504-7608

Pollution Control Hearings Board
1111 Israel RD SW
STE 301
Tumwater, WA 98501

Pollution Control Hearings Board
PO Box 40903
Olympia, WA 98504-0903

Department of Ecology
Northwest Regional Office
Attn: Water Resources Program
3190 160th Ave SE
Bellevue, WA 98008

Department of Ecology
Northwest Regional Office
Attn: Water Resources Program
3190 160th Ave SE
Bellevue, WA 98008

Signed at Bellevue, Washington, this day of , 2011.

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Jacqueline Klug, Section Manager
Water Resources Program
Northwest Regional Office

INVESTIGATOR'S REPORT

Background

Ground Water Application #:	G1-28658
Applicant Name:	Whidbey Island Naval Air Station Gallery Golf Course.
Priority Date:	May 19, 2010
Source:	Well # 1 and one additional well
Purpose of Use:	Irrigation (Golf Course)
Period of Use:	April 15 through October 15
Notice of Publication:	July 28, 2010 and August 4, 2010 in *The Whidbey Examiner*.
Protests:	None received
SEPA Compliance:	This application is exempt from the provisions of the State Environmental Policy Act (SEPA), Chapter 43.21 RCW, due to the fact that the cumulative quantity of water constitutes a withdrawal of less than 2,250 gallons per minute (gpm) of groundwater (WAC 197-11-800(4)).

INVESTIGATION

In considering this application, the investigation included, but was not limited to, research and/or review of:

- Pacific Groundwater Group, 2010a, Phase I Review (Gallery Golf) Water Rights Processing, G1-28658, Ecology Cost Recovery Agreement, August 2, 2010.
- Pacific Groundwater Group, 2010b, Hydrogeologic Evaluation of Gallery Golf Course Well #1, April, 2010.
- Ecology's online Water Rights Tracking System (WRTS) database
- Records of water rights in the vicinity
- Ecology's online Well Log Database
- Topographic and local area maps
- Site visit
- Available regional geologic and hydrogeological information:
    - Anderson, H.W., Jr., Ground-Water resources of Island County, Part II, Water Supply Bulletin 25, Washington State Department of Water Resources.
    - Cline, D.R., Jones, M.A., Dion, N.P., Whiteman, K.J., and Saplk, D.B., 1982, Preliminary Survey of Ground-Water Resources for Island County, Washington: U.S. Geological Survey Open-File Report 82-561, 46 p.
    - Dragovich, J.D., G. T. Petro, G. W. Thorsen, S. L. Larson, G. R. Foster, and D. K. Norman, 2005, Geologic Map of the Oak Harbor, Crescent Harbor, and Part of the Smith Island 7.5-minute Quadrangles, Island County, Washington, Washington State Division of Geology and Earth Resources Geologic Map GM-53.
    - Easterbrook, D.J. Pleistocene Stratigraphy of Island County Washington, Part I, Water Supply Bulletin 25, Washington State Department of Water Resources.
    - Island County Water Resources Management Plan, Adopted June 20, 2005.
    - Jones, M.A., 1985, Occurrence of Ground Water and Potential for Seawater Intrusion, Island County, Washington: U.S. Geological Survey Water- Resources Investigations Report 85-4046.
    - Sapik, D.B., G.C. Bortleson, B.W. Drost, M.A. Jones, and E.A. Prych, 1988, Ground-Water Resources and Simulation of Flow in Aquifers Containing freshwater and Saltwater, Island County, Washington, U.S. Geological Survey Water Resources Investigations Report 87-4182.
    - Sumioka, S. S. and H. H. Bauer, 2004, Estimating Ground-Water Recharge from Precipitation on Whidbey and Camano Islands, Island County, Washington, Water Years 1998 and 1999, U.S. Geological Survey Water-Resources Investigations Report 03-4101
    - The Environmental Company, Inc, 2004, Final Five-Year Review, Operable Units 1 Though 5, Naval Air Station Whidbey Island, Oak Harbor, Washington.
    - Western Regional Climate Center, 2011, Climate Data for Coupeville, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa1783.

Golder Associates Inc. provided consulting support for preparation of the Report of Examination (ROE) through Ecology's Cost-Reimbursement Program.

Background

Well #1 was drilled in 1942 to serve as part of a backup emergency supply for the Whidbey Island Naval Air Station (NAS). Figure 1 shows the location of the well and the surrounding area. Well #1 was not used as a backup supply but was occasionally pumped to check proper operation. The NAS obtains water from the City of Oak Harbor via an intertie. Water from the intertie is currently used for irrigation at the Gallery Golf Course. Current golf course irrigation water use is estimated to be about 4 to 5 million gallons a month starting in late April or early May. Starting in August, an existing onsite pond tied in with the irrigation system is used for supply, which can continue though late September or early October.

The NAS wishes use Well #1 and possibly an additional well to be installed as a source or irrigation water for the golf course. The NAS recently installed a new irrigation system, allowing the greens, tee boxes, and fairways to be irrigated. The roughs surrounding the fairways are not irrigated but receive some overspray from adjacent fairways.

Purpose of Use

Groundwater is requested for irrigation of a golf course, from April 15 to October 15.

Whidbey Island Geology and Hydrogeology

The local geologic units in the vicinity of the Golf Course consist of glacial and interglacial sediments that were deposited by repeated advances and retreats of continental glaciers, and during interglacial periods. The typical glacial and interglacial sequence for Island County (Anderson, 1968; Easterbrook 1968), from youngest to oldest, is:

- Everson Glaciomarine drift – poorly sorted sediments varying from pebbly silt and clay to till-like deposits.
- Partridge Formation – Pebble to cobble gravel and sand.
- Vashon Till – Vashon Drift – poorly sorted boulders, pebbles, sand, silt and clay.
- Esperance Sand (advance outwash) – Vashon Drift – well sorted fluvial sand and pebbly sand with occasional lenses of gravel.
- Quadra Formation – Olympia interglaciation – peat near Strawberry Point and possible silt and sand deposits that cannot be distinguished from parts of the Whidbey deposits.
- Possession Drift – till, sand and gravel, and pebbly clay.
- Whidbey interglacial sediments – sand, silt, and clay interbedded with peat and lenses of gravel.
- Double Bluff Drift, and older units – till, gravel, sand, and pebbly clay

The glacial and interglacial sediments are underlain by Tertiary sedimentary rocks and pre-Tertiary metasedimentary and metavolcanic rocks. The pre-Tertiary bedrock is exposed about 5,100 feet northwest of the well at Rocky Point.

The surficial geology of the Oak Harbor area, including the area of the golf course, was mapped in detail by the Washington State Department of Natural Resources (Dragovich et. al. 2005). The surficial and subsurface geology in the area of the golf course is shown on the geologic map (Figure 2) and cross–section (Figure 3) and consists of:

- Qf: Artificial fill and modified land.
- Qb: Beach deposits (Holocene) – Sand, gravel, pebbly sand, and boulder gravel.
- Qm: Saltwater marsh deposts (Holocene) – Organic-rich silt and mud.
- Qp: Peat (Holocene) – Fibrous to woody peat and organic sediments of fresh-water bogs and swamps.
- Qd: Dune deposits (Holocene) – Dune deposits (Holocene) – Wind-deposited, well-sorted, and well-rounded sand and silty sand.
- $Qgdm_{ec}$ and $Qgdm_{ed}$: Glaciomarine drift – clast-rich dimicton with abundant dropstones and mud with few or no dropstones.
- $Qgos_{e}$: Glaciomarine sand deposits – Sand, pebbly sand, and silty fine sand with local thin interbeds of silt and rare cobbly sand.
- Qgi_{e}: Diamicton – Sandy, sitly pebble gravel to boulder, gravelly sandy silt.
- $Qgom_{ee}$: Emergence (bbeach) deposits – Pebbly sand or sand and gravel.
- $Qgim_{e}$: Moraine deposits – Bouldery cobble gravel with interbeds of sand or pebbly san and minor diamicton.
- $Qgod_{e}$: Deltaic deposits – Sandy and cobbly pebble gravel, pebbly sand, and sand with thin beds of silt.
- $Qgog_{e}$: Gravel deposits – Pebble cobble (boulder) gravel to pebbly cobbly sand with minor beds and lenses of sand.
- Qgt_{v}: Vashon Stade – Till – diamicton consisting of clay, silt, sand, and gravel in various proportions, with scattered pebbles, cobbles, and boulders.
- Q_{cw}: Whidebey Formation, undivided
- Qc_{wc}: Whidbey Formation – Fluvial channel facies deposits consist of sand and pebbly sand.
- Qgt_{d}: Till, Double Bluff Glaciation – Diamicton with rare lenses of sand and gravel.
- Qgn_{pd}: Glacial and nonglacial deposits – dense sand, silt, clay, gravel, peat, and dimicton older than the Double Bluff till.
- Ec_{bcg}: Rocks of Bulson Creek (Oligocene-Eocene) – Pebble and cobble conglomerate and lesser pebbly sandstone.
- $KJhmt_{rp}$: Metamorphic Rock of Rocky Point – mixed metasedimentary and metavolcanic rocks.

As shown on the geologic map and cross section (Figures 2 and 3, respectively), a northwest-trending dip-slip fault (Utsalady Point Fault No. 5) occurs north of Well #1. The faulting has resulted in juxtaposition of bedrock on the north side of the fault against Whidbey Formation sediments south of the fault.

Local Hydrogeology

The hydrogeologic units in the vicinity of the golf course consist of unconsolidated glacial and interglacial sediments that form a series of aquifers separated by low-permeability materials. The USGS delineated five aquifer units on Whidbey Island summarized as follows (Jones 1985):

Summary of Whidbey Island Aquifers

Aquifer Unit	Thickness (feet)	Altitude of Top of Aquifer (feet msl)	Groundwater Elevation (feet msl)	Geology	Notes
E	Up to 160	20 to 490	24 to 420	Recessional Gravels	Not present
D	Up to 220	-80 to 335	-50 to 300	Advance Outwash, Olympia Interglacial sediments	Present
C	Up to 440	-150 to 270	-140 to 235	Whidbey Interglacial Sediments	Present
B	Up to 180	-345 to 20	-80 to 70	Double Bluff and Older Units	Present
A	Up to 50	-600 to -300	-30		Present

Note: Modified from M.A. Jones, 1985, Occurrence of Ground Water and Potential; for Seawater Intrusion, Island County, Washington, U.S. Geological Survey Water Resource Investigations Report 85-4046.

Aquifer E is composed of sand and gravel and is as much as 160 feet thick. The top of aquifer E ranges from 20 to 490 feet above sea level on the northern and central regions of Whidbey Island and from 150 to 420 feet above sea level on the southern tip of Whidbey Island. Aquifer E is not present at the site. Specific capacities range from 10.5 to 135 gallons per minute per foot of drawdown (gpm/ft).

Aquifer D is composed primarily of sand with thickness as much as 220 feet. The top of this aquifer ranges from 335 feet above sea level to 80 feet below sea level. Specific capacities range for 0.04 to 27 gpm/ ft

Aquifer C is composed of sand, with known thickness up to 440 feet and is assumed to be continuous throughout Island County. The top of this aquifer ranges from 270 feet above sea level to 150 feet below sea level. Generally, water levels in Aquifer C are between sea level and 50 feet above sea level. Specific capacities in unit C range from 0.03 to 42 gpm/ft. The Utsalady Point Fault No. 5 causes the rise of bedrock in the vicinity of Rocky Point to the north of the well and results in a truncation of Aquifer C north of the golf course (Island County Water Resources Management Plan 2005; Dragovitch et. al. 2005). Based on pumping test results from the Gallery Golf Course Well#1 (PGG), Aquifer C has a transmissivity ranging from 39,000 to 57,000 gpd/ft and storativity of 0.0007.

Aquifer B is composed mainly of sand and is as much as 180 feet thick. The maximum thickness is unknown. The top of this aquifer ranges from 20 feet above sea level to 345 feet below sea level. Water levels in unit B are between 25 feet below sea level and 25 feet above sea level. The range of specific capacities is from 0.3 to 25 gpm/ft.

Aquifer A is composed of sand and gravel. Its thickness is as much as 50 feet. The maximum thickness is unknown. The top of aquifer A ranges from 300 to 600 feet below sea level and is the deepest known aquifer. Its presence is based on data from two wells that are known to tap it and data from eight test holes. Specific capacity is 0.75 gpm/ft based on one well for which data are available.

Aquifers C and D are referred to as the Sea Level Aquifer, which is the most productive aquifer and supplies a significant portion of the groundwater pumped in Island County. The Sea Level Aquifer is susceptible to salt water intrusion particularly in wells where the pumping groundwater level is at or near sea level. This situation occurs in areas near Oak Harbor.

The bedrock underlying the glacial and interglacial sediments and occurring in the subsurface north of the Utsalady Point Fault No. 5 is low permeability and does not form an aquifer.

All of Island County's groundwater aquifers are recharged by infiltration of precipitation. Precipitation across the island ranges from 17 inches to 40 inches annually and averages 94,000 acre-feet per year (Cline, 1982). Most recharge occurs during the winter and spring, when most of the precipitation occurs. The average annual precipitation is about 19 inches per year at Ault Field due to the rain-shadow effect of the Olympic Mountains (Cline et al. 1982). Precipitation at Coupeville, about 6.7 miles southeast of the golf course, is similar at about 20 inches per year (Western Regional Climate Center 2011). Infiltration is typically less than rainfall because precipitation runs as surface water, evaporates, or is taken up through plant life (Island County Water Resources Management Plan 2005). Groundwater recharge for Island County was estimated to be about 55,000 acre-feet per year by the USGS (Cline 1982). Sapik et al (1987) estimated groundwater recharge for range or barren land to be about 12 inches per year in areas with 20 to 25 inches per year of precipitation.

Groundwater is discharged from springs where the aquifers are exposed at the land surface such as along cliffs and bluffs on the perimeter of the island or where streams intersect the water table, and is pumped from wells. Springs occur both above sea level and where the aquifer units crop out below sea level and discharge to Puget Sound.

Groundwater moves from recharge areas, through the groundwater system, to discharge areas. Groundwater moves both horizontally and vertically, from areas of high hydraulic head to areas of low head. GW movement is horizontal and toward Puget Sound in aquifers, downward in confining units that underlie high-altitude areas (Sapik, 1988).

Island County delineated 33 groundwater subbasins based on estimated groundwater divides that were located based on extensive groundwater elevation measurements and preparation of groundwater elevation and flow maps (Island County 2005). Geologic units and geologic structure were not considered in delineation of the subbasin boundaries. The Island County Water Resources Management Plan (2005) concluded that that groundwater withdrawn in one subbasin would have little, if any effect on the other subbasins (Island County 2005). The Gallery Golf Course Well #1 is located in subbasin 32. The Utsalady Point Fault No. 5 is located about 1.5 miles southwest of the subbasin 32 boundary delineated by Island County.

Whidbey Island NAS Groundwater Contamination

Groundwater contamination has been identified at Whidbey Island Naval Air station. The area of contamination is classified as Area 6 and encompasses approximately 260 acres. It is bordered to the north by Ault Field Road, to the east by State Highway 20, and to the south and southwest by the City of Oak Harbor solid waste landfill. The NAS contamination is in groundwater subbasins 32 and 10, approximately 1.75 miles east of Well #1.

Contamination occurred in a 45-acre municipal waste landfill and an adjoining area used for liquid industrial waste disposal. The liquid waste area consisted of one or more unlined disposal pits. The constituents of concern at the site are volatile organic compounds (VOC) tetrachloroethane, tetrachloroethene, 1,2-dichloroethane , *cis*-1,2-dichloroethene , 1,1-dichloroethene, and vinyl chloride.

There are two distinct groundwater plumes present at Area 6. The first plume is referred to as the western groundwater plume and is near the former industrial waste disposal area (i.e., the former waste oil pit). Multiple VOCs were detected at concentrations exceeding risk levels in the western groundwater plume The second plume is referred to as the southern plume, and is in the southern part of the landfill where contaminants originate from the capped landfill (i.e., landfill leachate is the source). Vinyl chloride was detected at concentrations exceeding risk levels in the southern groundwater plume.

The remediation and source control measures used for groundwater are a combination of landfill capping and groundwater control actions, including groundwater extraction, treatment by air stripping, and groundwater recharge (pump and treat). The pump and treat method has been effective in containing the plume onsite, with no offsite migration. The area or contamination continues to be monitored, (The Environmental Company, Inc, 2004).

Although part of Area 6 is in subbasin 32, source control and remedial measures are in place as described above that are designed to reduce the risk of offsite migration of the Area 6 plume. Groundwater communication between the well and Area 6 is expected to be limited because of the presence of low-permeability glacial till and glaciomarine drift below Area 6, the distance between the well and Area 6, and the remedial measures in place. Well #1 is also located on the south side of the Utsalady Point Fault No.5 and the Strawberry Point Fault No. 1, while Area 6 is on the north side of these faults.

Surface Water

Streams on Whidbey Island are generally groundwater fed from spring discharge or where the streambeds intersect the water table. There is some runoff during the rainy season particularly where lower permeability materials occur at the surface such as till or glaciomarine drift. The stream catchments are generally small. Because surface water is limited, it is not utilized as a drinking water source in most areas of the island except for local domestic use.

In the vicinity of the golf course, there is a wetland in the southeast corner of Section 28 (Figure 1) that feeds into an unnamed stream, which feeds into another wetland and pond on the coast in Section 29. The wetland to the southeast is in Holocene nonglacial deposits consisting of peat and organic sediments of fresh-water bogs and swamps, glaciomarine sand deposits, and till and is likely formed by water perched on these materials. The wetland and pond along the coast are in Holocene saltwater marsh deposits consisting of organic-rich sit and mud (Dragovich, 2005). Within subbasin 32, south of the golf course, Swantown Creek has been identified as a potential stream restoration site to establish fish (Island County Water Resources Management Plan 2005). Swantown Creek feeds into a pond near the coast in Section 32 (Figure 1).

Instream Flow Regulations

There have been no instream flow regulations set in WRIA 6. Surface water bodies are subject to administrative rules governing the right to withdraw water for beneficial use. There are no significant streams within one mile of the existing well. There are no streams in subbasin 32 subject to limitations or closure listed under Surface Water Source Limitations by the Washington Department of Fish and Wildlife

Pumping Test Results

A 72-hour pumping test was conducted in Well #1 in February 2010 (PGG 2010b). Groundwater levels were monitored in Well #1 and in a domestic well (Sullivan well) located about 580 feet from Well #1 (Figure 1) using pressure transducers and dataloggers. Groundwater levels were monitored for a week prior to the start of the test to evaluate antecedent groundwater elevation trends and for three days after pump shutdown to monitor groundwater level recovery. Barometric pressure was also monitored to evaluate the barometric response of the aquifer. Discharge water from the test was routed to a drainage ditch on the golf course about 1,000 feet north of the well

Well #1 was pumped at an average rate of 151 gallons per minute (gpm). The drawdown data were corrected for antecedent groundwater level trends and barometric pressure fluctuations. At the end of the test there was about 37 feet of drawdown in

Well #1 (including well losses) and 2.5 feet of drawdown in the Sullivan well. At the end of the 3-day recovery period, there was about one foot of residual drawdown remaining in both wells. The water level response during pumping and recovery suggested a low-permeability aquifer boundary was intersected after about 1,000 minutes of pumping, possibly the bedrock on the north side of the Utsalady Point Fault No. 5 (Figure 3).

PGG analyzed the test data using a variety of methods to estimate the aquifer transmissivity and storativity:

- The aquifer transmissivity (before the effects of the boundary) was estimated to be 45,000 to 57,000 gpd/ft based on drawdown data and 57,000 to 61,000 gpd/ft based on recovery data before the effects of the low-permeability boundary. The storativity was estimated to be 0.0006 to 0.0007.
- The software package AQTESOLV was used to incorporate a low-permeability aquifer boundary in the analysis. This method produced an estimated aquifer transmissivity of 39,000 gpd/ft and a storativity of 0.0007.
- The pumping test was simulated using a 2-dimensional, 1-layer MODFLOW model that incorporated the low-permeability boundary. A transmissivity of 15,000 gpd/ft and a storativity of 0.0012 produced the best fit of the simulate data to the drawdown data observed in the Sullivan well.

The transmissivity obtained from the pumping test is consistent with information summarized in Sapik and others (1988), who report an range in transmisisvities for Aquifer "C" of about 550 to over 800,000 gpd/ft (assuming an aquifer thickness of 50 feet). Sapik and others (1988) used a transmissivity of about 52,000 gpd/ft for Aquifer "C" in the groundwater flow model developed for Whidbey Island.

Assessment of Salt Water Intrusion Potential

Salt water intrusion either from landward migration of the freshwater-saltwater interface or upconing of the interface as a result of pumping is a known problem in some areas on Whidbey Island. The Island County Health Department (ICHD) developed a matrix based on chloride concentrations and groundwater elevation in a well (Island County Watershed Plan). The chloride concentration in Well #1was measured at the start and end of the pumping test at 62 mg/L. The pre-pumping groundwater elevation was about 12.8 feet msl. Using the criteria developed by ICHD (Island County Code 8.09.099), if a well has a groundwater elevation greater than 8.4 feet msl, the well is classified as "low risk". Under these criteria, Well #1 is classified as low risk.

PGG (2010b) also evaluated the risk of saltwater intrusion using the groundwater flow model. They estimated drawdown and groundwater elevations resulting from continuous pumping of 114 gpm over a four month period. At the end of the four month period, the model predicted a maximum groundwater elevation of 8.3 feet between Well #1 and the nearest shoreline. The base of the "C" Aquifer is about 50 feet msl. Using the Gyben-Herzberg relationship and assuming a saltwater density of 1.025, a head of 1.25 feet is needed to prevent landward migration of the interface. The predicted head is about seven times greater. Thus the risk of saltwater intrusion resulting from pumping Well #1 is low.

Assuming two wells are developed to supply the golf course with the pumping quantity divided between the wells, the drawdown in each well should be lower assuming that similar aquifer hydraulic properties are present at the second well, resulting in less upconing at the wells.

Evaluation of Potential Surface Water Impacts

Any surface water bodies or diversions located within a close proximity of the subject well are not likely to be affected by the proposed groundwater withdrawal, because of the lack of continuity between surface water and the groundwater bearing zones in the Aquifers C and D associated with intervening low-permeability materials (till and glaciomarine drift). Aquifers C and D discharge to salt water and do not impact surface water flows in the area.

Site Visit

A site visit was made on January 18, 2011. The existing well location and general golf course area were visited. The existing well is located in a small wellhouse west of Golf Course Road. The well is equipped with a submersible pump and motor. The pump column from the original line-shaft turbine pump was visible outside the wellhouse. A logbook inside the wellhouse documented previous regular operational testing of the well including hour meter readings.

The discharge line and flowmeter used in the January 2010 pumping test completed by PGG were attached to the well. The flowmeter reading was 696,035 gallons. The observation well for the pumping test (Sullivan Well) was visible in a field southeast of the well.

Protests

No protests were received from the public notice, which was published on July 28, 2010 and August 4, 2010 in *The Whidbey Examiner*.

CONCLUSIONS

In accordance with state law, the following considerations must be addressed prior to the issuance of a permit:

- Water Availability
- Impairment to Existing Rights
- Beneficial Use of Water
- Detriment to Public Interest

Water Availability

Based on an air photo review conducted as part of this investigation, 85 acres is a reasonable estimate of the amount of acreage that will be irrigated and is on the low range of irrigated acreage for a typical golf course. Irrigation water use was

determined using the Washington Engineering Guide – Part 652, Irrigation Guide (USDA 1997) and Water Resources Program Guidance GUID-1210 – Determining Irrigation Efficiency and Consumptive Use. Appendix B of the irrigation guide indicates consumptive use for pasture turf during irrigation season in Coupeville (April through October) is 23.5 inches. Effective precipitation over this period is 6.14 inches. The crop irrigation requirement is therefore 17.39 inches. If the efficiency of the irrigation system is 75% to 90%, the crop irrigation requirement would be 19.3 to 23.2 inches, or a duty of 1.6 to 1.9 feet. This is higher than the requested duty of 1.1 feet. In order to allow for irrigation that is closer to the estimated crop irrigation requirement, this permit sets an upper limit on Qa of 120 AF, equivalent to pumping full time during the irrigation season at the instantaneous Qi of 150 gpm. This represents 17 inches of irrigation for the 85 acres of irrigated land.

The Island County Watershed Management Plan (2005) prepared estimates of water availability by groundwater subbasin. The water availability was estimated by calculating groundwater use in each subbasin for domestic use based on 2000 census data, and estimating water use for other purposes based on water right information on file with Ecology. Groundwater recharge was estimated from data presented in the Island County Groundwater Management Plan. The water availability was taken to be the percentage of annual groundwater recharge used for domestic, irrigation, and other purposes. Subbasins with a low percentage indicates a small portion of recharge is being used, and water may be available. A high percentage suggests little water may be available. The Watershed Management Plan (2005) indicated annual groundwater recharge may be 2,118 AF in subbasin 32. Annual water use in subbasin 32 was estimated to be 961 AF, or about 45% of the groundwater recharge, suggesting that water remains available for additional use in subbasin 32.

Well #1 was pumped at 151 gpm for 72 hours. The results of the pumping test confirm that the aquifer material is capable of supplying water at the requested rate of 150 gpm. The pumping test indicted that pumping the well at a rate of 150 gpm for 72 hours approached the available drawdown in Well #1 because of well losses. The applicant has indicated a second well will be installed to provide an additional point of withdrawal to reduce problems associated with well. Use of a second well can be expected to provide the full 150 gpm if the existing well is unable to do so for long term pumping.

Impairment to Existing Groundwater Rights

Impairment occurs when there is an adverse impact on the physical availability of water for a beneficial use that is entitled to protection.

Qualifying ground water withdrawal facilities are defined as those wells which in the opinion of Ecology are adequately constructed. An adequately constructed well is one that (a) is constructed in compliance with well construction requirements; (b) fully penetrates the saturated thickness of an aquifer or withdraws water from a reasonable and feasible pumping lift (WAC 173-150); (c) has withdrawal facilities capable of accommodating a reasonable variation in seasonal pumping water levels; and (d) the withdrawal facilities and pumping facilities are properly sized to match the ability of the aquifer to produce water. 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 their allocations.

Well interference is the overlap of the cones of depression for two or more wells. Well interference reduces the water available to the individual wells and may occur when several wells penetrate and withdraw ground water from the same aquifer. Each pumping well creates a drawdown cone. When several wells pump from the same aquifer, well density, aquifer characteristics, and pumping demand may result in individual drawdown cones that intersect and form a composite drawdown cone.

Groundwater wells that are 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, and also located hydrogeologically down-gradient from the subject well. As water in the aquifer travels toward wells that are located down-gradient from the subject well, the subject well may potentially capture this water and impair the production of down-gradient wells. Any surface water diversions located within a close proximity of the subject well (subbasin 32) are not likely to be impaired by the proposed groundwater withdrawal, because of the limited continuity between surface water and the water bearing zones in the glacial aquifer.

<u>WRTS Database</u>

Ecology's online water rights database (2011) was searched for claims, permits, and certificates in an approximate 1-mile radius of Well#1 in T33N/R1E, sections 28 and 33. The water rights are summarized on Table 1. Within these two sections, there are 25 long and short-form claims, one permit, and five certificates. Change applications have been filed for two of the certificates. All water rights and claims are for groundwater.

<u>Exempt Wells</u>

Ecology's online well log database (2011) was searched for wells on file in an approximate 1-mile radius of Well#1 in T33N/R1E, sections 28 and 33. The wells are summarized on Table 2. There are 50 wells on file. There may be other wells in the area of the golf course that are not on file with Ecology because they were drilled before filing of logs was required.

<u>Analysis</u>

Impairment to the existing wells was estimated using the results of the PGG (2010) groundwater flow model and estimated available drawdown in nearby wells. Interference drawdown resulting from pumping Well #1 at a rate of 114 gpm continuously for four months were estimated. At the end of four months, the model predicted a drawdown of 3.4 feet of drawdown at the Sullivan well (580 feet from Well #1) and 2.7 feet at the Sainsbury Well located 1,190 feet from Well #1. Based on well log information, the available drawdown in these wells is about 69 feet at the Sullivan well and 55 feet at the Sainsbury well. Given these available drawdowns, pumping from Well #1 is not expected to impair these wells.

There are other exempt wells within an approximate 1-mile radius of Well #1. Information on the well logs was used to estimate the available drawdown in these wells (assuming the pump is set 5 feet above the base of the well). All of the wells had greater than five feet of available drawdown with the exception of the Hoffman well, located about 4,000 feet northeast

of Well #1. The available drawdown in this well is estimated to be about one foot. Pumping from Well #1 is unlikely to affect this well because the Hoffman well intersected bedrock at a shallow depth (132 feet below ground) suggesting it is on the north side of the Utsalady Point Fault No. 5.

Beneficial Use

Water used for irrigation is considered a beneficial use under RCW 90.54.020(1).

Public Interest

No detriment to the public interest was identified during the investigation of the subject application.

The golf course presently uses water that is purchased from the City of Anacortes. Use of water from Well #1 will reduce demand on the Anacortes water system, resulting in additional water being available for future demand from this system.

RECOMMENDATIONS

It is recommended that a groundwater permit be issued for irrigation (golf course) at an instantaneous rate of **150 gpm**. The permit shall be issued subject to the following provisions.

In accordance with chapters 90.03 and 90.44 RCW, I find there is water available for this beneficial appropriation from the source in question and that the appropriation as authorized will not impair existing rights or be detrimental to the public interest. Therefore, a permit should be issued, subject to the above-indicated provisions.

Purpose of Use and Authorized Quantities

The amount of water recommended is a maximum limit and the water user may only use that amount of water within the specified limit that is reasonable and beneficial.

150 gpm (Qi) for irrigation of 85 acres, with a maximum total annual withdrawal (Qa) of 120 ac-ft per year (April 15 to October 15).

Point of Withdrawal

NE¼, SW¼, Section 28, Township 33 North, Range 1 East W.M.

Place of Use

As described on Page 1 of this Report of Examination.

REPORT BY_____ DATE_____

REVIEWED BY_____ DATE_____

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Western Regional Climate Center, 2011, Climate Data for Coupeville, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wa1783.

TABLES

Table 1. Summary of Water Rights and Claims

File Number	Certificate Number	Person	Document Type	Priority Date	Purpose of Use	Qi (gpm)	Qa (AF/yr)	TRS Location	QQ/Q Section
G1-163173CL		SPRAGUE WARREN B	Claim S		ST,IR			33.0N 01.0E 28	
G1-159198CL		MEYERS LOIS	Claim S		ST,IR			33.0N 01.0E 28	
G1-101182CL		VANCE CHARLES E	Claim S		ST,IR			33.0N 01.0E 28	
G1-089871CL		HALLBERG JACK E	Claim S		ST,IR			33.0N 01.0E 28	
G1-058537CL		STOCKMYER DONALD D.	Claim S		ST,DG			33.0N 01.0E 28	
G1-031506CL		EELKEMA KENNETH	Claim S		ST,DG			33.0N 01.0E 28	
G1-029524CL		ANGELL LEWIS E.	Claim L		DG			33.0N 01.0E 28	
G1-028962CL		UTERMARK LUCILLE	Claim L		ST,DG			33.0N 01.0E 28	
G1-028963CL		JAMES ROY E.	Claim L		ST,DG			33.0N 01.0E 28	
G1-014303CL		KAMBEAGER JOHN H.	Claim L		ST,DG			33.0N 01.0E 28	
G1-23108CWRIS		GUISINGER LAWRENCE B	Cert	05/15/78	DM	20	6	33.0N 01.0E 28	SW/NE
G1-28658		Whidbey Isl Naval Air Station Golf	NewApp	05/19/10	IR	150	92	33.0N 01.0E 28	NE/SW
G1-147267CL		TROYAN BERNARD J	Claim L		DG			33.0N 01.0E 33	
G1-136244CL		HENDERSON DEAN T	Claim S		DG			33.0N 01.0E 33	
G1-136299CL		NEAL F E	Claim S		DG			33.0N 01.0E 33	
G1-102650CL		HONSBERGER DELBERT L	Claim S		ST,IR			33.0N 01.0E 33	
G1-097884CL		EPPES M E	Claim S		ST			33.0N 01.0E 33	
G1-088070CL		TONCRAY JAMES R.	Claim L		DG			33.0N 01.0E 33	
G1-086636CL		EPPES M E	Claim S		ST,DG			33.0N 01.0E 33	
G1-075001CL		STOCKMYER CONSTANCE N.	Claim S		ST,DG			33.0N 01.0E 33	
G1-069844CL		CALLAHAN ROBERT W.	Claim S		ST,DG			33.0N 01.0E 33	
G1-047702CL		THOMAS WALTER E.	Claim L		DG			33.0N 01.0E 33	
G1-046157CL		KNUE JEAN M.	Claim S		ST,DG			33.0N 01.0E 33	
G1-037246CL		GADEHOLT G. D.	Claim S		DG			33.0N 01.0E 33	
G1-032936CL		HELLER ONNO E.	Claim S		ST,DG			33.0N 01.0E 33	
G1-028714CL		GILL THOMAS F.	Claim L		ST,DG			33.0N 01.0E 33	
G1-011393CL		FANTRY WILLIAM T. JR.	Claim L		DG			33.0N 01.0E 33	
CG1-*07004C		Hillcrest Village Water	Chng/ROE	07/24/92	DM	200	194	33.0N 01.0E 33	
CG1-*08893C		Hillcrest Village Water	Chng/ROE	07/24/92	DM	110	194	33.0N 01.0E 33	SW/SE
G1-20683GWRIS		MCKINNON PATRICK C	Cert	06/04/73	ST,IR	20	21	33.0N 01.0E 33	SW/SW
G1-*08893C	6480	Hillcrest Village Water	Cert	08/11/67	DM	110	176	33.0N 01.0E 33	
G1-*06843CWRIS	5084	DEANGELO M J ET AL	Cert	08/22/63	DM	27	13.5	33.0N 01.0E 33	NE/NE
G1-*07004C	4958	Hillcrest Village Water	Cert	01/27/64	DM	200	194	33.0N 01.0E 33	
G1-25385		Westwoods Water System	Pmt	02/07/89	DM	30	2.7	33.0N 01.0E 33	SW/NW
CG1-*07004C@1	4958	Hillcrest Village Water Co	Chng/ROE	05/03/95	DM	200	194	33.0N 01.0E 33	SE/SE
CG1-*08893C@1	6480	Hillcrest Village Water Co	Chng/ROE	05/03/95	DM			33.0N 01.0E 33	

Data downloaded from Washington State Department of Ecology, Online Water Rights Tracking System (WRTS) Database, https://fortress.wa.gov/ecy/wrx/wrtssp1/wrtsmain.aspx?xpage=intro&xnavigate=clear, January 19, 2011.

Table 2. Summary of Wells

Well Tag	Well Depth (feet bgs)	Well Diameter (inches)	Well Owner	TRS Well Location	Tax Parcel Number	Depth to Water (feet)	Available Drawdown (feet)
AHG024	244	6	PETE MORGAN	T33/1E - 28NE-NW	R13328-429-363	86.5	152.5
AHG023	445	6	PETE MORGAN	T33/1E - 28NE-NW	R13328-429-363	194	246
	100	6	DON ROCKWOOD	T33/1E - 28NW-NE		54	41
	190	6	DON ROCKWOOD	T33/1E - 28NW-NE		54	131
	134	6	FRED BIRERSHAND	T33/1E - 28NW-NE		87	42
	28	8	WHIDBEY NAVAL AIR STATION	T33/1E - 28NW-NW		17	6
ALT254	201	6	FRED BENNETT	T33/1E - 28NW-SE		149	47
	106	6	GUNNAR LOVENG	T33/1E - 28NW-SE		70	31
ALA585	117	6	LARRY PHILLIPS	T33/1E - 28NW-SE	R13328-313-2800	68	44
ALT256	210	6	ROGER MEYER	T33/1E - 28NW-SE	R13328-068-3730	156	49
	155	6	CARY TILLMAN	T33/1E - 28SE-NE		135	15
ABD980	132	6	RUSS HOFFMAN	T33/1E - 28SE-NE	R133284374950	126	1
	122	6	FRED BRETT	T33/1E - 28SE-SE		89	28
	120	6	ALAN FLACK	T33/1E - 28SW-NE		104	11
	240	6	FANKLIN TRALLE	T33/1E - 28SW-NE		165	70
	300	6	FRANK TRALLE	T33/1E - 28SW-NE		140	155
APH291	147	6	L GUISINGER/DUFFERS LANE WATER SYSTEM	T33/1E - 28SW-NE	R13328-380-3760	110.5	31.5
	147	6	L. GUISINGER	T33/1E - 28SW-NE		110.5	31.5
	152	6	R. HOFFMAN R. STRANDELL	T33/1E - 28SW-NE		134	13
	178	6	RICK & KELLEY TERRILL	T33/1E - 28SW-NE		148	25
	140	6	S. FAUST	T33/1E - 28SW-NE		98	37
ALQ224	158	6	SCHULT	T33/1E - 28SW-NE		134	19
	153	6	JOE DIXON	T33/1E - 28SW-NW		120	28
	160	6	FRANKLIN TRALLE	T33/1E - 28SW-SE		NA	-
APR929	153	6	GOLDA SULLIVAN	T33/1E - 28SW-SE	R13328-005-2820	116	32
APR930	201	6	RAYMOND SULLIVAN	T33/1E - 28SW-SE	R13328-082-7970	127	69
ABD976	102	6	SEAN BYRNE	T33/1E - 28SW-SE	R133280253120	90	7
	193	6	TOM SAINSBURY	T33/1E - 28SW-SE		132.6	55.4
	221	6	HILLCREST VILLAGE WATER CO	T33/1E - 33-		163	53
	105	6	MARK J DEANGELO	T33/1E - 33NE-NE		75.5	24.5
APH276	162	6	M EPPES/HILL WATER ASSOCIATION	T33/1E - 33NE-NW	R13333-428-1450	124	33
	162	6	M. EPPES	T33/1E - 33NE-NW		124	33
ALQ391	134	6	MARVIN EPPES	T33/1E - 33NE-NW	R13333-494-2450	102	27
	94	6	TIM SHELLEY	T33/1E - 33NW-NE		79	10
	128	6	DAVE WILLIAMS	T33/1E - 33NW-NW		51	72
AFJ294	124	6	DAVE WILLIAMS	T33/1E - 33NW-NW		45	74
ALT095	74	6	SANDERS	T33/1E - 33NW-NW	R13333-495-0500	53	16
	109	6	DALE NORSTON	T33/1E - 33NW-SE		56	48
APH117	161		D.L. HONSBERGER / WEST MEADOWS WATER SYSTEM	T33/1E - 33SE-NE	R13333-339-4510	148	8
	160	6	GTE NORTHWEST	T33/1E - 33SE-NE		NA	-
	285	6	F. E. NEAL	T33/1E - 33SW-NW		197.5	82.5
	286	6	F. E. NEAL & DAN MC GUIRE	T33/1E - 33SW-NW		197.6	83.4
APH268	280	6	M J MCGUIRE	T33/1E - 33SW-NW		186	89
APH268	280	6	M J MCGUIRE/WESTWOODS ASSOCIATES	T33/1E - 33SW-NW	R13333-281-0820	186	89
AGA892	217	8	HILLCREST VILLAGE WATER	T33/1E - 33SW-SE		163	49
AGA890	245	8	Hillcrest Village Water Co	T33/1E - 33SW-SE		Abandoned	-
	218	8	HILLCREST VILLAGE WATER CO	T33/1E - 33SW-SE		166	47
ABH320	243	8	HILLCREST VILLAGE WATER CO INC - LES ALLEN	T33/1E - 33SW-SE		195	43
AGA562	159	8	PATRICK MCKINNON	T33/1E - 33SW-SW		114	40
AGR528	77	6	RICHARD~ HAP~ FAKKEMA	T33/1E - 33SW-SW	R13333	27	45

Data downloaded from Washington State Department of Ecology, Online Well Log Database, http://apps.ecy.wa.gov/welllog/index.asp, January 18, 2011.
Available drawdown assumes pump set five feet above base of well.

FIGURES

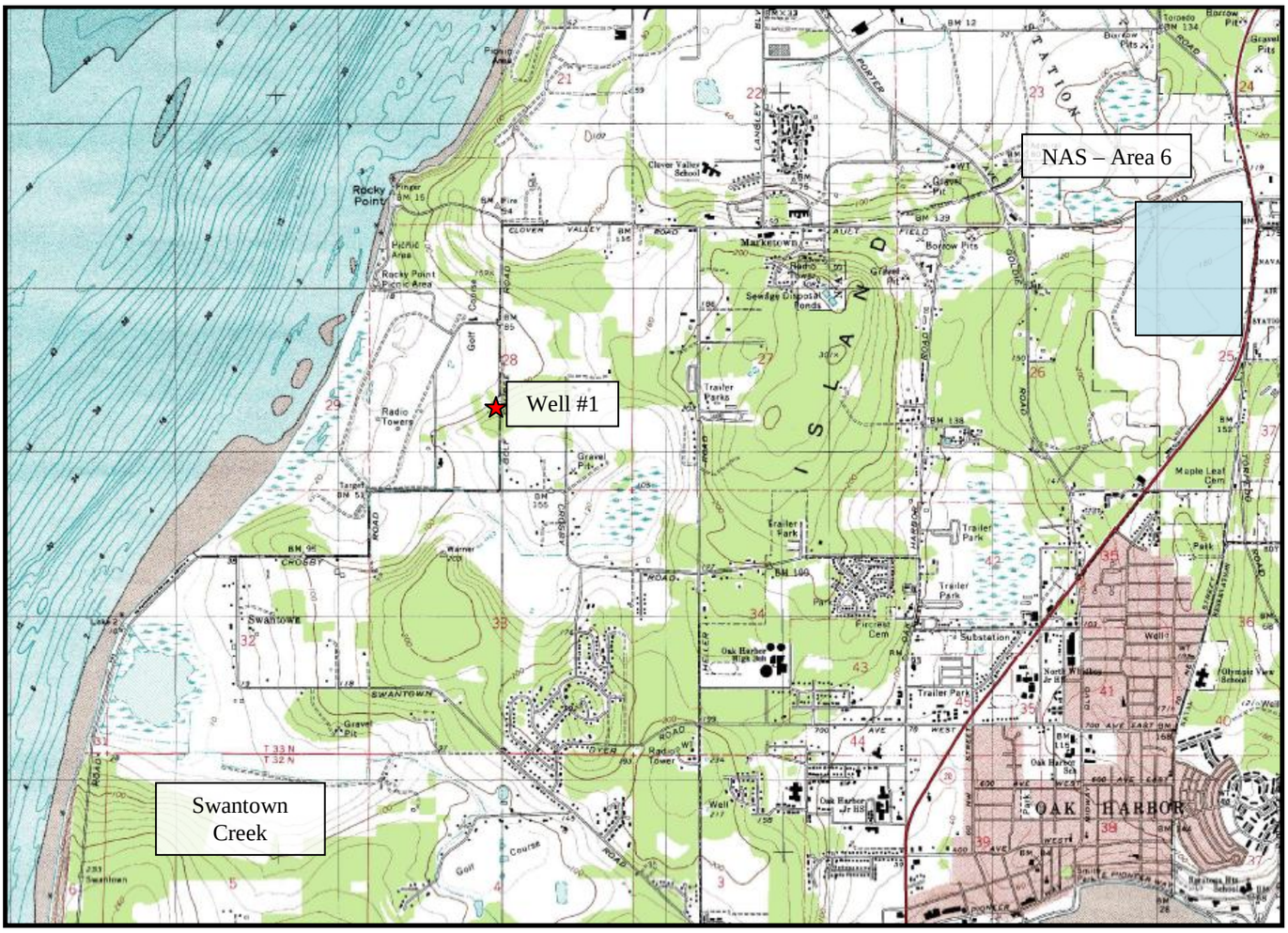


Figure 1. Location Map (U.S.G.S. Oak Harbor 7.5 Minute Quadrangle, 1980)

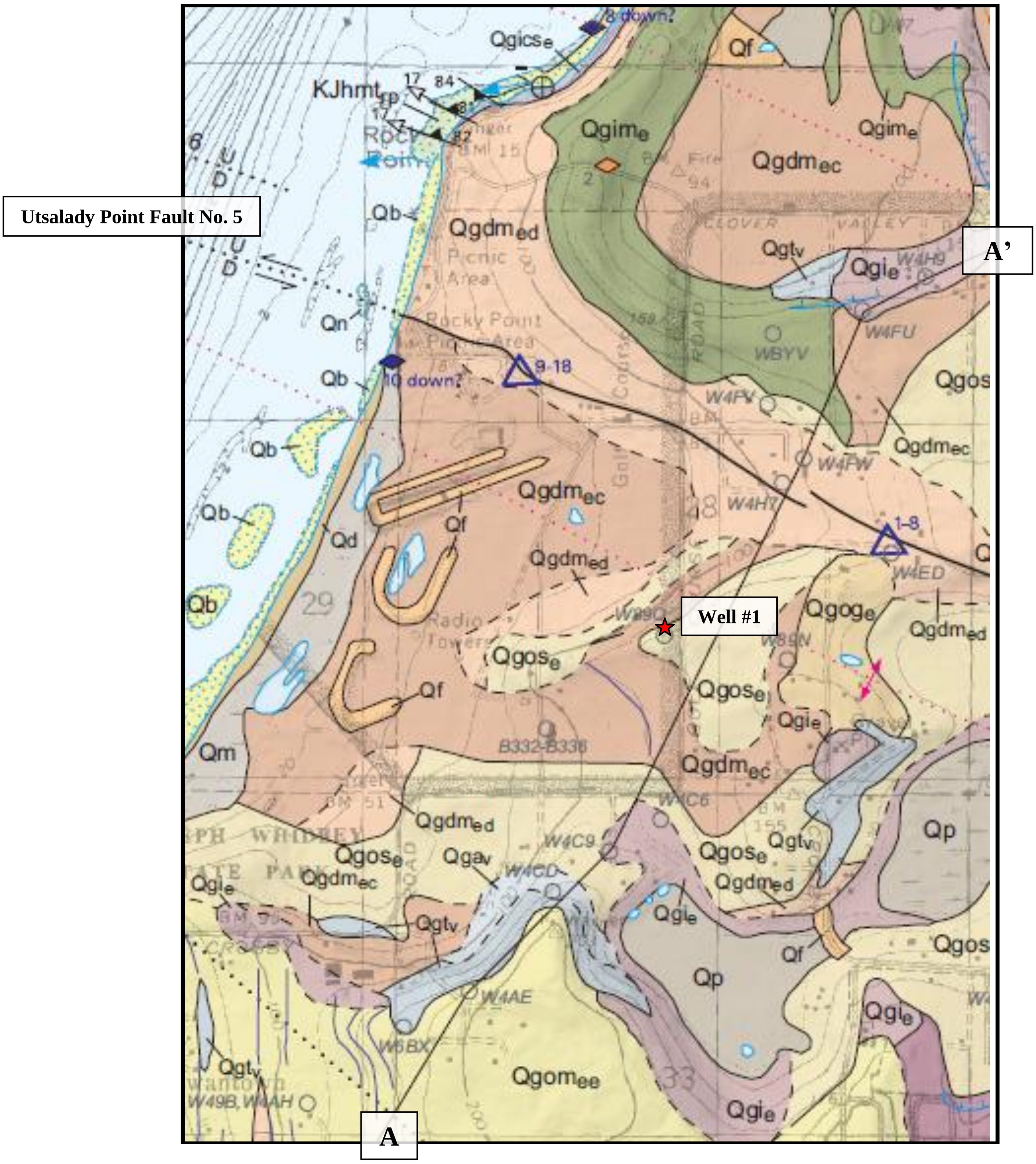


Figure 2. Surficial Geologic Map (Dragovich et. al. 2005)

Qf: Artificial fill and modified land.
Qb: Beach deposits (Holocene) – Sand, gravel, pebbly sand, and boulder gravel.
Qm: Saltwater marsh deposts (Holocene) – Organic-rich silt and mud.
Qp: Peat (Holocene) – Fibrous to woody peat and organic sediments of fresh-water bogs and swamps.
Qd: Dune deposits (Holocene) – Dune deposits (Holocene) – Wind-deposited, well-sorted, and well-rounded sand and silty sand.
Qgdm$_{ec}$ and Qgdm$_{ed}$: Glaciomarine drift – clast-rich dimicton with abundant dropstones and mud with few or no dropstones.
Qgos$_e$: Glaciomarine sand deposits – Sand, pebbly sand, and silty fine sand with local thin interbeds of silt and rare cobbly sand.
Qgi$_e$: Diamicton – Sandy, sitly pebble gravel to boulder, gravelly sandy silt.
Qgom$_{ee}$: Emergence (bbeach) deposits – Pebbly sand or sand and gravel.
Qgim$_e$: Moraine deposits – Bouldery cobble gravel with interbeds of sand or pebbly san and minor diamicton.
Qgod$_e$: Deltaic deposits – Sandy and cobbly pebble gravel, pebbly sand, and sand with thin beds of silt.
Qgog$_e$: Gravel deposits – Pebble cobble (boulder) gravel to pebbly cobbly sand with minor beds and lenses of sand.
Qgtv: Vashon Stade – Till – diamicton consisting of clay, silt, sand, and gravel in various proportions, with scattered pebbles, cobbles, and boulders.
Qcw: Whidbey Formation, undivided
Qc$_{wc}$: Whidbey Formation – Fluvial channel facies deposits consist of sand and pebbly sand.
Qgt$_d$: Till, Double Bluff Glaciation – Diamicton with rare lenses of sand and gravel.
Qgn$_{pd}$: Glacial and nonglacial deposits – dense sand, silt, clay, gravel, peat, and dimicton older than the Double Bluff till.
Ec$_{bcg}$: Rocks of Bulson Creek (Oligocene-Eocene) – Pebble and cobble conglomerate and lesser pebbly sandstone.
KJhmt$_{rp}$: Metamorphic Rock of Rocky Point – mixed metasedimentary and metavolcanic rocks.

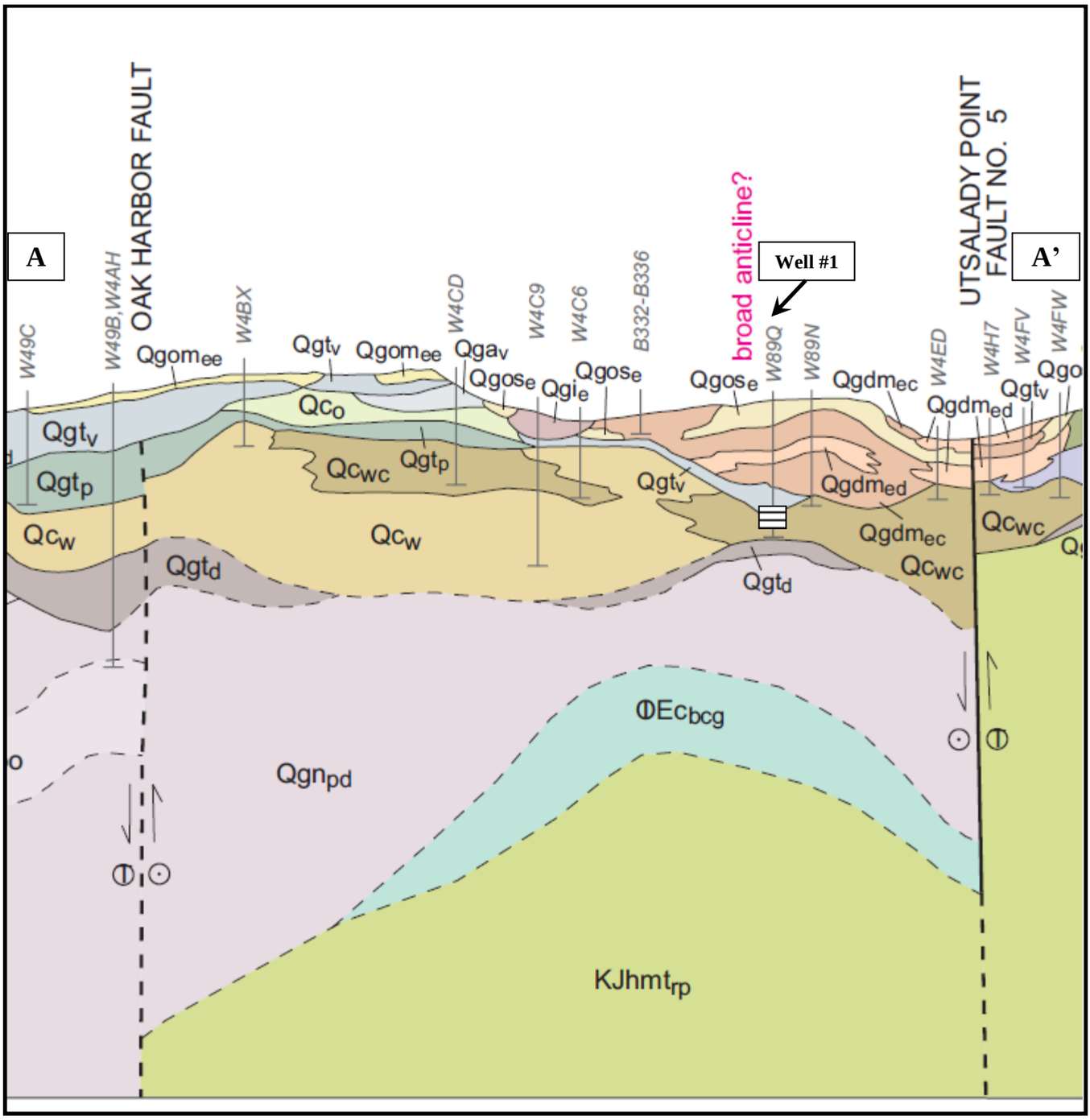
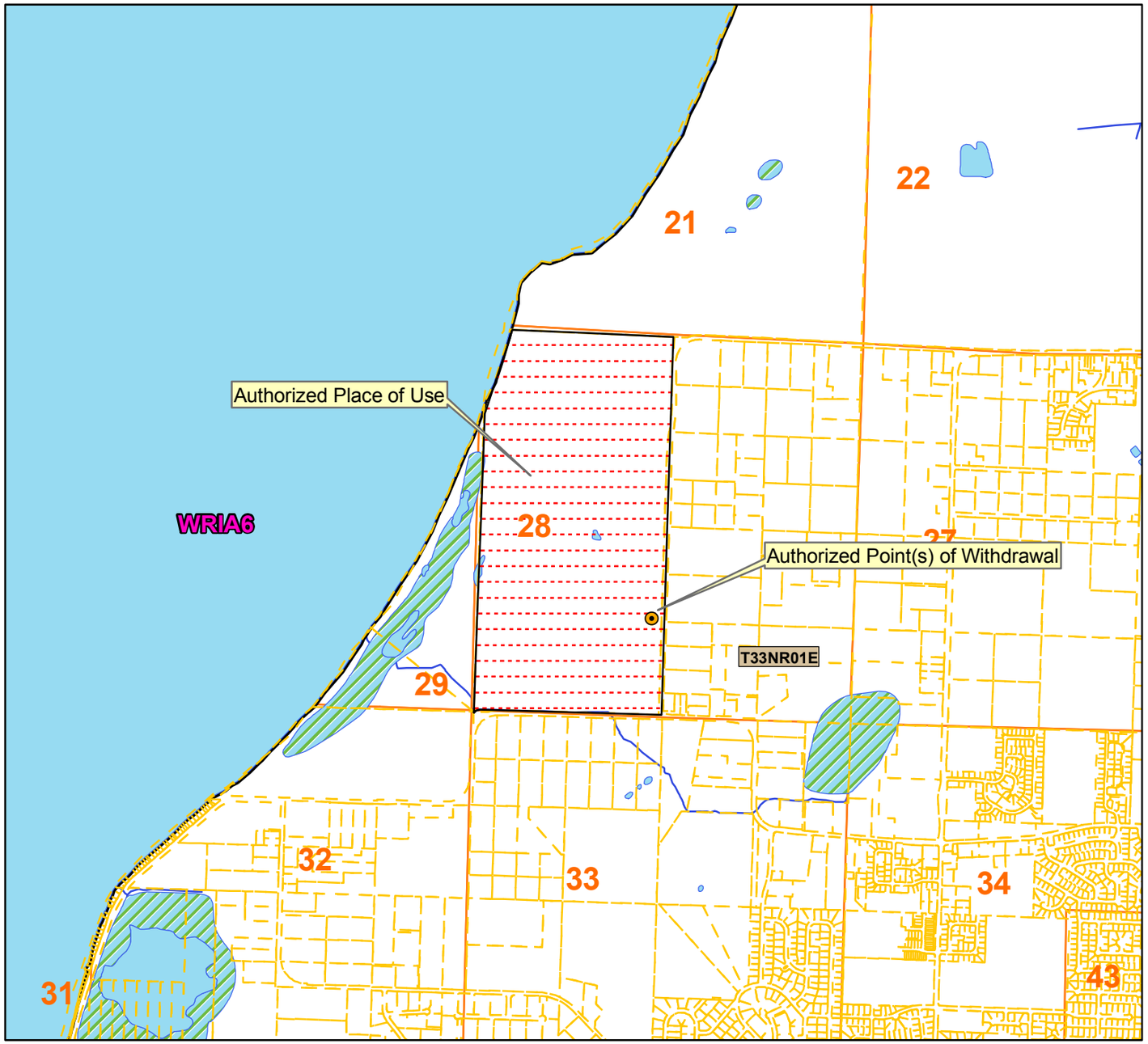


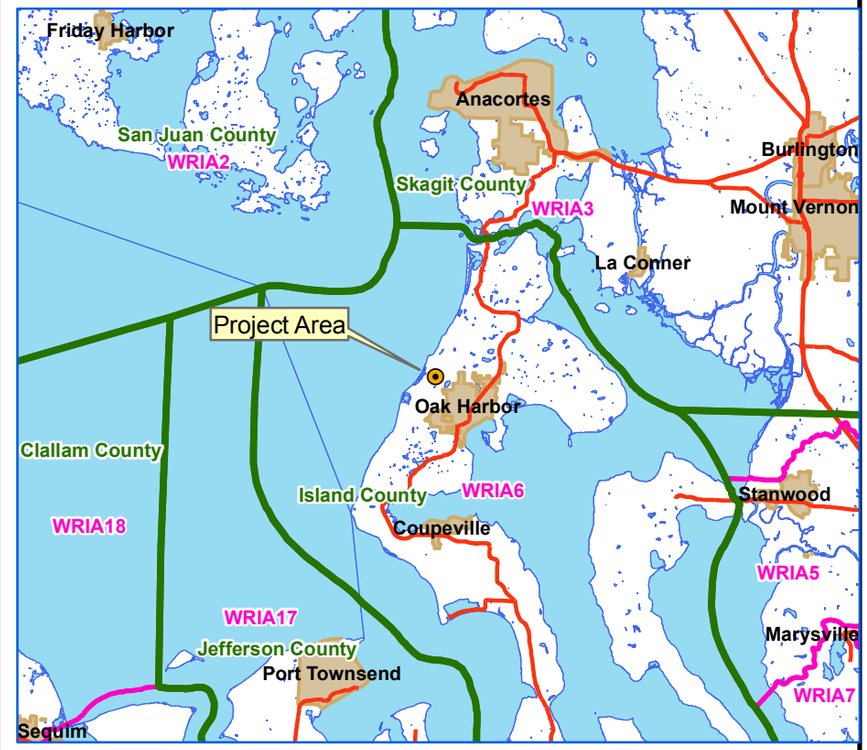
FIGURE 3. Geologic Cross Section A-A' (Dragovitch et. al. 2005). Refer to Figure 2 for geologic unit descriptions.

Whidbey Isl Naval Air Station Gallery Golf Course
Water Right Number G1-28658
Sec.28, T 33N, R 01E W.M.
WRIA 6 - Island County

DEPARTMENT OF ECOLOGY
State of Washington



2,500 1,250 0 2,500 5,000 7,500 Feet



5 2.5 0 5 10 Miles

Legend

- County
- WRIA
- Highways
- Townships
- cities
- Sections
- Authorized Point of Withdrawal
- Authorized Place of Use

Place of use and point(s) of diversion/withdrawal are as defined on the cover sheet under the headings, 'LOCATION OF DIVERSION/WITHDRAWAL' and 'LEGAL DESCRIPTION OF PROPERTY ON WHICH WATER IS TO BE USED.'

Attachment 1