PUBLIC UTILITIES DISTRICT NO. 1
OF CLALLAM COUNTY

FAIRVIEW WATER SYSTEM SUPPLY PROJECT

FEASIBILITY STUDY REPORT

FINAL
March 2009

The undersigned has approved this document for and on behalf of Carollo Engineers, P.C.

[Signature]
Partner
PUBLIC UTILITIES DISTRICT NO. 1 OF CLALLAM COUNTY

FAIRVIEW WATER SYSTEM SUPPLY PROJECT

FEASIBILITY STUDY REPORT

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ES.1 EXECUTIVE SUMMARY

ES.1.1 Project Purpose

The purpose of this project is to assess the Clallam County Public Utility District No. 1 (District) water supply and water infrastructure needs for the Fairview Water System for a 30-year planning horizon and to develop, evaluate, and present potential water source options to augment the District’s current water supply to meet 2038 water demands. Project tasks included:

1. Analyzing the water demands over the 30-year planning horizon.

2. Investigating the feasibility of other water supply alternatives including: off-channel storage and treatment options, desalinized seawater, an interconnection with the Port Angeles system, and groundwater wells.

3. Investigating the feasibility of ground water resources around the Bluffs Well, near the Agnew Well, and the southern portion of the area near Morse Creek as a potential aquifer storage and recovery (ASR) site.

ES.1.2 Problems and Needs

The Fairview Water System is nearing equivalent supply and demand and could be impacted by source disruption because of low flows in Morse Creek. Therefore, new sources of supply need to be evaluated.

The District currently supplies approximately 1.0 million gallons per day (mgd) utilizing the Morse Creek Treatment Plant and the Bluffs Well. Two existing interties with the Port Angeles water system serve as emergency sources of supply, and have a combined capacity of 600 gallons per minute (gpm). The projected maximum day demand (MDD) for 2038 is 2.0 mgd. Therefore, during the planning horizon, the District will need to double the supply capability.

ES.1.3 Water Supply Alternatives

Four potential water supply options were evaluated for this study: off-channel storage options, desalination, an interconnection with Port Angeles water system, and conventional groundwater wells. Each option presents its own pumping, piping, treatment, and storage impacts to the Fairview Water System. Impacts to the Fairview Water System were simulated using an existing distribution system hydraulic model.
ES.1.4 Cost Analysis

The cost analysis includes total estimated construction costs, project costs, and 30-year life cycle costs. The costs are conceptual level costs with an expected accuracy of 50 percent over the estimate to 30 percent under the estimate.

Based on 30-year life cycle costs, the lowest cost options include New Bluffs Wells and Off-Channel Storage Option 2 - Deer Park Road Reservoir. Competitive cost options include the Off-Channel Storage Option 1 - Buchanan Drive Quarry Reservoir and interconnection options. The highest cost option is desalination. Detailed cost summaries for each option are appended at the end of this report (Appendix A).

ES.1.5 Water Supply Alternatives Screening and Recommendation

The alternatives were compared using qualitative ranking criteria of positive (+), neutral (0), or negative (-) for the screening criteria (listed in alphabetical order) described below:

- Cost: overall capital and operating costs for a 30-year life cycle.
- Environmental/Permitting: number of required permits and environmental impacts.
- Phasing: ability to phase project to increase capacity as demands increase.
- Public Opinion: the perceived opinion by the public.
- System Complexity: technical and physical complexity of the option.
- Use of Existing Assets: potential for existing facilities to be used.
- Water Rights: assumed difficulty obtaining water rights based on historical data.

The rankings are shown in the summary comparison Table ES.1 below.

ES.2 RECOMMENDATIONS

Based on the analyses and investigations performed during the study, the New Bluffs Wells alternative is recommended for implementation to act as a backup and complementary water supply to meet the short and long-term water supply needs of the Fairview Water System. It is one of the least expensive options, has the fewest permitting and implementation constraints, and the best probability of securing additional water rights.

In February 2009 during the review of the Draft Feasibility Study Report with District staff, the District received a Bilateral Compliance Agreement (BCA) (Appendix B) from the Washington State Department of Health (DOH) addressing its concerns about the lack of a reliable back-up water source to support the upper Fairview service area in the event of low flows in Morse Creek. The District requested that the New Bluffs Wells alternative be modified to address the short-term concerns listed in the BCA, as well as the 2038 supply
needs. The short and long-term issues and solutions for the District are presented in Table ES.2 below.

It is recommended to implement the New Bluffs Wells alternative in three phases, with the first two phases addressing short and mid-term supply concerns, and the third phase meeting the 2038 project MDD of 2.0 mgd. The three phases are:

- **Phase 1:** Construct new infrastructure (i.e. a new dedicated water supply line and booster pump station) to convey flow to the upper portion of the Fairview Water System from the existing Bluffs Well. Size and design the new infrastructure components with the flexibility to meet future demand, storage, and piping requirements.

- **Phase 2:** Site, permit, and install two of three recommended New Bluffs Wells and associated infrastructure, and increase the capacity of the booster pump stations as required.

- **Phase 3:** Seek additional water rights for the New Bluffs Wells and modify the existing Morse Creek water right to increase the instantaneous withdrawal rate and annual volume. Install the third New Bluffs Well, increase the capacity of the booster pump stations, and add additional conveyance capacity and distribution storage as required to optimize system operation and meet future demands.

Future predesign studies and design work will include a more detailed analysis to optimize the required infrastructure modifications described in the three phases.
## Table ES.1 Screening Criteria Comparison
### Fairview Water System Supply Project
**PUD No. 1 of Clallam County**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Off Channel Storage Option 1 - Buchanan Drive Quarry Reservoir</th>
<th>Off Channel Storage Option 2 - Deer Park Road Reservoir</th>
<th>Desalination</th>
<th>Interconnection - Point of Use Fluoride Removal</th>
<th>Interconnection - Full System Fluoride Removal</th>
<th>New Bluffs Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cost</td>
<td>0</td>
<td>+1</td>
<td>-1</td>
<td>0</td>
<td>0</td>
<td>+1</td>
</tr>
<tr>
<td>2. Environmental/Permitting</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>3. Phasing</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
<td>+1</td>
</tr>
<tr>
<td>4. Public Opinion</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>5. System Complexity</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>+1</td>
</tr>
<tr>
<td>6. Use of Existing Assets</td>
<td>+1</td>
<td>+1</td>
<td>-1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7. Water Rights</td>
<td>0</td>
<td>0</td>
<td>+1</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
</tr>
</tbody>
</table>

**SCORE**      | -1                                                              | 0                                                     | -3           | -5                                            | -4                                            | +3            |

**RANK**         | 3                                                               | 2                                                     | 4            | 6                                             | 5                                             | 1             |

### Notes:

- “+1” connotes: positive, more, or more desirable attributes
- “-1” connotes: negative, fewer, or less desirable attributes
- “0” connotes: neutral determination
### Table ES.2  Short and Long Term Issues and Solutions  
**Fairview Water System Supply Project**  
PUD No. 1 of Clallam County

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Issue</th>
<th>Recommendation</th>
<th>Benefit to District</th>
</tr>
</thead>
</table>
| **Short Term** | No water supply redundancy in upper Fairview Water System due to minimum Morse Creek streamflow restrictions and existing design system. | • **Phase 1**: Construct infrastructure to use water available from the existing Bluffs Well to convey water into upper Fairview Water System when the Morse Creek Treatment Plant may be out of operation due to low flows in Morse Creek.  
• **Phase 2**: Relocate Bluffs Well water right and site, permit, and construct two New Bluff Wells and a booster pump station. | • Addresses immediate concern discussed in DOH Bilateral Compliance Agreement by supplying some water to the upper Fairview Water System, and sets stage for future expansion as demands increase.  
• Phase 1 design and construction can occur in relatively short timeframe.  
• Phase 2 increases system capacity and redundancy. |
| **Long Term** | Water Rights | • Obtain additional annual and instantaneous water rights for Morse Creek and New Bluffs Wells.  
• **Phase 3**: Install third New Bluffs Well, increase capacity of booster pump stations, and add additional conveyance capacity and distribution storage as required. | • Phase 3 nearly meets 2038 projected demands - final flow determined when wells are installed.  
• Meets full system redundancy criteria. |
1.0 INTRODUCTION

1.1 Project Purpose

The purpose of this project is to assess the District’s water supply and water infrastructure needs for the Fairview Water System for a 30-year planning horizon and to develop, evaluate, and present potential water source options to augment the District’s current water supply to meet 2038 water demands. Project tasks included:

1. Analyzing the water demands over the 30-year planning horizon.

2. Investigating the feasibility of other water supply alternatives including: off-channel storage and treatment options, desalinized seawater, an interconnection with the Port Angeles system, and groundwater wells.

3. Investigating the feasibility of ground water resources around the Bluffs Well, near the Agnew Well, and the southern portion of the area near Morse Creek as a potential ASR site.

2.0 PROBLEMS AND NEEDS

The Fairview Water System is nearing equivalent supply and demand and could be impacted by source disruption because of low flows in Morse Creek. Therefore, new sources of supply need to be evaluated.

2.1 Existing Capacity

Current supply sources and operational capacities include the Morse Creek Treatment Plant (600 gpm), the Bluffs Well (350 gpm for short durations), and the Township Line Road Wells (20-30 gpm combined). Two existing interties with the Port Angeles water system serve as an emergency source of supply (600 gpm combined).

The Fairview Water System is divided into two service areas. The upper service area (roughly the region south of an east-west line through Deer Park Reservoir) includes Pressure Zones 1, 2, and 3 and the lower service area (roughly the region north of an east-west line through Deer Park Reservoir) includes Pressure Zones 4, 5, 6, and 7. Using flow predictions from the District’s current water system model, the upper service area uses approximately 25 percent of the total Fairview Water System demand, while the lower service area demand uses the remaining 75 percent.
2.2 Projected Water Demand

As reported in Technical Memorandum No. 1 (Appendix C) and summarized in Table 1, the projected MDD for 2038 is 2.0 mgd (1,390 gpm). The MDD is used as the design flow for this study.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Average Day Demand (ADD) and MDD Projections$^{(1)}$</th>
<th>Fairview Water System Supply Project</th>
<th>PUD No. 1 of Clallam County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>2008</td>
<td>2038</td>
<td></td>
</tr>
<tr>
<td>ADD, mgd</td>
<td>0.39</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>MDD, mgd</td>
<td>0.96</td>
<td>2.00</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
(1) Referenced Table 1.9 of “Technical Memorandum No. 1, Water Requirements, Revised Draft”, Carollo, October 2008.

2.3 System Limitations

The District’s system limitations are influenced by a combination of fisheries and water right restrictions, and current source production capacities. Washington Department of Fish and Wildlife (WDFW) regulations may restrict water withdrawal from Morse Creek when streamflows are below 25 cubic feet per second (cfs). Based on an analysis of available streamflow data, low streamflows occur in late summer months (mid-August through October) when water demands can be at their peak. The Bluffs Well operates during peak demand periods only. Based on historical operation data and discussions with District staff, saltwater intrusion has occurred when pumping at full capacity for extended periods of time.

The Township Line Road Wells produce little supply. District staff mentioned that the wells tend to run dry after 2 to 3 days of continuous pumping. The production volumes of these wells are ignored for the purposes of this report.

Two emergency interties with the Port Angeles system exist on the west end of the Fairview Water System: the 284 Pressure Zone (Port Angeles zone) 6-inch intertie with a 100 gpm operational capacity and the 484 Pressure Zone (Port Angeles zone) 10-inch intertie with a 500 gpm operational capacity. The 284-zone connection is not evaluated as a potential connection due to the distribution system tie-in location and limited production capacity. The 484-zone connection is assumed to not be hydraulically limiting and will be used for the interconnection analysis in this report.

To meet future demands, water rights and/or sources will need to be increased. A summary of water rights and source limitations is presented in Table 2.
### Table 2 Water Rights and Source Limitations

**Fairview Water System Supply Project**  
**PUD No. 1 of Clallam County**

<table>
<thead>
<tr>
<th>Available Sources</th>
<th>Maximum Operational Capacity (gpm)</th>
<th>Water Right, Max Instantaneous, $Q_i$ (gpm)</th>
<th>Water Right, Max Annual, $Q_a$ (acre-feet)</th>
<th>2038 Maximum Day Demand (gpm)</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morse Creek</td>
<td>600</td>
<td>673</td>
<td>379</td>
<td>1,390</td>
<td>Water Right and Source</td>
</tr>
<tr>
<td>Bluffs Well</td>
<td>350</td>
<td>1,350</td>
<td>187</td>
<td>1,390</td>
<td>Water Right and Source</td>
</tr>
<tr>
<td>Intertie with Port Angeles</td>
<td>500</td>
<td>500</td>
<td>807</td>
<td>1,390</td>
<td>Water Right$^{(3)}$</td>
</tr>
</tbody>
</table>

**Notes:**

1. Township Line Road Wells are not included in the analysis due to minimal production capacities.
2. Second emergency intertie (100 gpm) not included in the analysis due to the distribution system tie-in location and production capacity.
3. Intertie assumed to not be hydraulically limiting for the purposes of this report.
3.0 WATER SUPPLY ALTERNATIVES

Four potential water supply options were evaluated for this study: off-channel storage options, desalination, an interconnection with Port Angeles water system, and conventional groundwater wells. Each option presents its own pumping, piping, treatment, and storage impacts to the Fairview Water System. Impacts to the Fairview Water System were simulated using an existing distribution system hydraulic model. The hydraulic model is discussed in Section 5.0 of the report. Planning level capital and life cycle costs were calculated for each option.

3.1 Off-Channel Storage Options

Off-channel storage is an option to augment the existing Morse Creek source to meet future demands. This option assumes diversion into a new off-channel water storage reservoir from Morse Creek during months when surplus water is available. Reservoir water is then pumped to the Morse Creek Treatment Plant (expanded to meet the increased demand). Source of supply for this option relies on one source, Morse Creek, and does not require an additional treatment process. Two off-channel storage sites were analyzed: the Buchanan Drive Quarry Site and a site upstream of the falls located along Deer Park Road. There are two components to determine the required storage evaluated in this study: flow demand and evapotranspiration.

3.1.1 Morse Creek Flow Analysis

Flows for Morse Creek are based on data from a stream gauge managed by the Washington State Department of Ecology (DOE). The station is identified as “Morse Creek blw Aqueduct” with Station ID 18C150 (DOE, River and Streamflow Monitoring, 2009). Mean day flow from 2003 through 2008 is plotted in Figures 1 and 2 to illustrate the period of recent years in which Morse Creek flow was below 25 cfs.

As shown in Figure 1 and 2, Morse Creek streamflows have been below 25 cfs for a period of 2.5 months (August 15 to October 31) over the past six years. Initial analyses suggested that 3 months (August 1 to October 31) of storage be required. However, in a discussion with District staff, a storage period of 2.5 months was concluded to be sufficient.

Morse Creek Treatment Plant monthly production volumes from January 2001 through May 2008 are plotted in Figure 3 to determine the total production for the time period that off-channel storage is required. During project team meetings with District staff, it was decided to design the required storage for a maximum monthly average production volume. A maximum monthly average production volume of 13 million gallons (MG) for the period of August 15 to October 31 was calculated. For a period of 2.5 months, this equates to approximately 33 MG of required storage for 2008.
Figure 1
2003 - 2008 MEAN DAY MORSE CREEK STREAMFLOW
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY

See Figure 2
Figure 2
2003 - 2008 MEAN DAY MORSE CREEK
STREAMFLOW REQUIRED STORAGE
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY

Minimum Required Streamflow, 25 cfs

2.5 Months Storage
Required from August 15 to October 31
Figure 3
JANUARY 2001 - MAY 2008 FAIRVIEW MONTHLY PRODUCTION (MORSE CREEK WTP + BLUFFS WELL)
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY

Maximum Monthly Average Fairview Production for August 15 to October 31\(^{(1)}\) = 13 MG

Notes:
(1) Maximum monthly average based on August (50 percent), September, and October monthly production volumes.
3.1.1.1 Reservoir Evapotranspiration

Evapotranspiration is defined as the loss of water to the atmosphere from the Earth’s surface by evaporation and by transpiration through plants. Because the storage reservoir will be lined with an impermeable liner, water loss by transpiration through plants is assumed negligible; thus, reservoir evaporation is only considered. Evaporation rates were estimated using published USGS literature (U.S. Department of Commerce, 1968). The annual lake evaporation for the Fairview region is estimated to be 30 inches per year. Assuming a 20-foot deep storage reservoir with a surface area of 10 acres and that all evaporation occurs during the 2.5-month period, evaporation losses equates to approximately 8 MG of additional required storage.

3.1.1.2 Existing Bluffs Well Source

Discussions with District staff led to the decision to assume an average Bluffs Well capacity of 116 gpm over a period of 2.5 months to help reduce the required storage volume for this option. This capacity is based on averaging the annual water right allocated to the Bluffs Well for one year. The above approach in determining the Bluffs Well capacity minimizes the likelihood of seawater intrusion during the 2.5-month period. By including the Bluffs Well as an available source during the 2.5-month period, the required storage for the off-channel option can be reduced by approximately 13 MG.

3.1.1.3 Total Storage

The total required storage for 2038 was determined by estimating the production for the 2.5-month period in 2008, adding the evaporation rate, and subtracting the Bluffs Well production. The projected demand factor from 2008 to 2038 of 2.08 (developed in Technical Memorandum No. 1) is then applied to the 2008 required storage, which yields a total required storage for 2038 of 63 MG.

The equation for calculating the required storage is shown below.

\[
\text{Required Storage} = \text{[Months of Operation} \times \text{Fairview Maximum Monthly Average Production} \times \text{Projected Demand Factor}] + \text{Loss by Evaporation - Bluffs Well Production}
\]

3.1.2 Option 1 - Buchanan Drive Quarry Reservoir

The Buchanan Drive Quarry Reservoir option includes a reservoir located at the existing Buchanan Drive Quarry Site.

For this option, raw water is pumped from Morse Creek to the Buchanan Drive Quarry Reservoir and then pumped to the Flow Equalization Tank via two pump stations. From the Flow Equalization Tank, raw water flows by gravity through a control valve and metering station to the Morse Creek Treatment Plant. The system will operate in a fill and draw mode. This option is illustrated in Figure 4.
OFF-CHANNEL STORAGE OPTION 1:
PUMP FROM BUCHANAN DRIVE QUARRY RESERVOIR TO EXPANDED MORSE CREEK WTP
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY

Transmission Piping = 5.3 miles (28,000 feet)

See Figure 5 for Detail

Buchanan Drive Quarry Site

Potential Booster Pump Station Location

Transmission Piping = 5.3 miles (28,000 feet)

100,000 Gallon Flow Equalization Tank

Morse Creek Treatment Plant Expansion to 2.0 mgd Required

Upsize Transmission Piping from Morse Creek Treatment Plant to Township Line Road

New 1.5 MG Township Line Road Reservoir

Control Valve and Metering Station

Figure 4
3.1.2.1 Pumping

Raw water is pumped from Morse Creek via a conventional river intake pump station. Two potential river intake pump station locations were discussed with District staff and are shown on Figure 5. The pump station includes two constant-speed (one duty and one standby), vertical turbine pumps. Each pump is estimated to be 100 horsepower (hp) and rated at 2 mgd to provide full redundancy. The reservoir is estimated to fill in 32 days based on a pumping capacity of 2 mgd. It should be noted that the use of a 2 mgd pump would require an increase in the maximum instantaneous withdrawal rate allocated to the District in the Morse Creek water right.

Water is pumped from the Buchanan Drive Quarry Reservoir to the Flow Equalization Tank via two pump stations: one located at the reservoir and the other located approximately halfway to the equalization tank along Deer Park Road. Each pump station includes two constant-speed (one duty and one standby), vertical turbine pumps. Each pump is estimated to be 250 hp and rated at 2 mgd to provide full redundancy.

3.1.2.2 Piping

Two piping routes to the reservoir from the River Intake Pump Station were evaluated, and are shown on Figure 5. Pipe is assumed to be 12-inch diameter C-900 polyvinyl chloride (PVC). The preferred route varies based on the selected location of the River Intake Pump Station. If River Intake Pump Station 1 location is chosen, the pipe routing is within the Highway 101 right-of-way. If River Intake Pump Station 2 location is chosen, the pipe is routed parallel to the existing 6-inch distribution potable water line up the steep bank east of the pump station and along Cedar Park Drive.

A gravity drain line runs from the Buchanan Drive Quarry Reservoir back to Morse Creek to serve as a drain for the reservoir. The drain line also includes a separate tie-in with an isolation valve to the River Intake Pump Station to backwash the river intake screens.

Transmission piping from the Buchanan Drive Quarry Reservoir to the Morse Creek Treatment Plant is estimated to be 28,000 feet long. Piping is assumed to be 12-inch diameter cement mortar-lined ductile iron from Buchanan Drive Quarry Reservoir to the Flow Equalization Tank due to higher pipeline pressures. Piping from the Flow Equalization Tank to the Morse Creek Treatment Plant is assumed to be 12-inch diameter PVC C-900.

Distribution piping from the Morse Creek Treatment Plant to Township Line Road will be upgraded to 12-inch diameter cement mortar-lined ductile iron to convey increased flows and higher pipeline pressures.
Figure 5
OFF-CHANNEL STORAGE OPTION 1:
PUMP FROM BUCHANAN DRIVE
QUARRY RESERVOIR TO EXPANDED
MORSE CREEK WTP DETAIL
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY
3.1.3 **Option 2 - Deer Park Road Reservoir**

The Deer Park Road Reservoir option includes a new reservoir located along Deer Park Road. For this option, raw water is pumped from a location upstream of the falls on Morse Creek to the Deer Park Road Reservoir and then pumped to the Flow Equalization Tank via one pump station. Similar to Option 1, raw water flows from the Flow Equalization Tank through a control valve and metering station to the Morse Creek Treatment Plant. The system will operate in a fill and draw mode. This option is illustrated in Figure 6.

It should be noted that this option may have the potential to be simplified and costs reduced if the Deer Park Road Reservoir is located at an elevation in which gravity flow to the treatment plant is possible.

**3.1.3.1 Pumping**

Raw water is pumped from Morse Creek via a River Intake Pump Station. For the purposes of this Feasibility Study, one potential river intake location is shown on Figure 6 directly west of the reservoir; however, a final location will consider accessibility, natural river characteristics, and land acquisition considerations. The pump station includes two constant-speed (one duty and one standby), vertical turbine pumps. Each pump is estimated to be 250 hp and rated at 2 mgd to provide full redundancy. The reservoir is estimated to fill in 32 days based on a pumping capacity of 2 mgd. As previously discussed in the Buchanan Drive Quarry Reservoir option, the use of a 2 mgd pump would require an increase in the maximum instantaneous withdrawal rate allocated to the District in the Morse Creek water right.

Water is pumped from the Deer Park Road Reservoir to the Flow Equalization Tank via a pump station located adjacent to the reservoir. The pump station includes two constant-speed (one duty and one standby), vertical turbine pumps. Each pump is estimated to be 150 hp and rated at 2 mgd to provide full redundancy.

**3.1.3.2 Piping**

One piping route from the River Intake Pump Station to the Deer Park Road Reservoir is shown on Figure 6. For the purposes of this report, the pipeline route is shown as a direct route. A final pipeline route will depend on river intake location and pipeline installation accessibility. Pipe is assumed to be 12-inch diameter cement mortar-lined ductile iron due to high pipeline pressures.

A gravity drain line runs from Deer Park Road Reservoir back to Morse Creek to serve the same purpose to the drain line for the Buchanan Drive Quarry Reservoir.
Figure 6
OFF-CHANNEL STORAGE OPTION 2:
PUMP FROM DEER PARK ROAD RESERVOIR
TO EXPANDED MORSE CREEK WTP
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY
Transmission piping from Deer Park Road Reservoir to Morse Creek Treatment Plant is estimated to be 12,000 feet long. Piping is assumed to be 12-inch diameter PVC C-900. Transmission piping costs for this option also have the potential to be reduced by locating the reservoir closer to the existing Morse Creek Treatment Plant. Distribution piping from Morse Creek Treatment Plant to Township Line Road will require the same upgrades to distribution piping discussed for the Buchanan Drive Quarry Reservoir in Section 3.1.2.2.

3.1.3.3 Common Elements of Off-Channel Storage Options

3.1.3.3.1 Storage

Buchanan Drive Quarry and Deer Park Road Reservoir

As discussed earlier, it is estimated that both reservoirs require 63 MG storage to provide adequate water supply for 2.5 months in 2038. It is recommended that the reservoirs be lined with a textured, 0.08-inch thick (80 mil) high-density polyethylene (HDPE) liner material due to its cost and durability for this application. A compacted subgrade of 4 inches, free of debris, roots, and angular or sharp rocks larger than 1/2-inch diameter is required prior to laying the liner. The liners will be anchored in a trench with compacted soil on the top border of the reservoir eliminating the cost for concrete. Manufacturers estimate an approximate design life of 40 to 50 years.

The existing topography of the Buchanan Drive Quarry Site reduces excavation costs. Assuming a 20-foot water depth, the Buchanan Drive Quarry Reservoir will cover approximately 13 acres. Assuming flat terrain and 20-foot water depth, the Deer Park Road Reservoir will cover approximately 14 acres.

Equalization

A 100,000-gallon Flow Equalization Tank is recommended near the Morse Creek Treatment Plant on Deer Park Road. The tank is to be placed at the highest elevation of the pipeline and will serve as a level control device for constant speed pump operation. The tank is sized such that it will take approximately one hour to fill and one hour to drain assuming a 2.0-mgd flow. The storage tank will also provide approximately one hour of supply if one of the two pump stations needs to be taken offline for maintenance.

Township Line Road Reservoir Modifications

To accommodate the 2038 demand, the volume of storage at the Township Line Road Reservoir will need to increase from 0.3 MG to 1.5 MG. It is assumed that the new reservoir will be an aboveground steel tank.

3.1.3.3.2 Treatment

The Morse Creek Treatment Plant will require a plant expansion to 2.0 mgd total capacity to accommodate the 2038 MDD of 2.0 mgd. A membrane filtration plant identical to the
existing treatment plant is assumed to be located adjacent to the current facility and will include a separate Morse Creek raw water intake or tie into the existing treatment plant’s raw water intake (upgrades required). Maintenance and operation for this option is simplified based on similar treatment technologies. The old treatment facility (currently out of commission) is assumed to be demolished to provide a footprint for the expansion. The expanded treatment plant will operate when demands exceed the current Morse Creek Treatment Plant operational capacity of approximately 1.0 mgd. According to modeled results discussed later in this study, the existing pumps at the Morse Creek Treatment Plant will need to be upgraded to accommodate an additional 75 feet of total dynamic head. This may be accomplished by one of the following three options: replace pump and motor, speed existing pumps up and replace motor, or add additional pump stages (impellers) and replace motor if required. These options would be discussed with the District during predesign.

3.2 Desalination Options

Desalination is a process in which seawater is converted to potable water most often by removing the salt using reverse osmosis (RO). Desalination provides a nearly unlimited long-term supply source; however, is typically a last resort option for most areas due to high capital and operation and maintenance costs. Desalination is also typically used where other sources of supply do not exist. Three Raw Water Intake options are evaluated as part of the desalination option: lateral screens, tunneling, and seawater wells.

3.2.1 Raw Water Intake Location and Capacity

The Raw Water Intake is assumed to be located near Gasman Road as shown on Figure 7. Raw water intakes serving desalination facilities need to be sized to approximately twice the potable water output due to the low recovery rate. Future Fairview Water System demands require 2.0 mgd, therefore, assuming a 45 percent recovery rate, the Raw Water Intake is sized for a capacity of 4.5 mgd.

3.2.1.1 Lateral Screens Intake Option

A typical lateral screen intake (also called radial collector well) is presented in Figure 8. A reinforced concrete caisson serves as the well casing. Lateral well screens project horizontally outward from the caisson into subsurface soils, which results in lower entrance velocities and in turn minimizes plugging of the screens.

It is assumed that pretreatment of the seawater is accomplished as the flow passes through the subsurface soils into the collector. A beach brine disposal is assumed. The brine will flow to a flow-splitting vault and then exit through laterals located below the sandy beach. Beach brine disposal is a possible solution where geologic and hydrogeologic conditions allow.
Figure 7

DESALINATION OPTION: POTENTIAL RAW WATER INTAKE AND DESALINATION FACILITY LOCATION AND DISTRIBUTION

FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY

Potential Raw Water Intake and Desalination Facility Location

Finished Water Pump Station

Transmission Piping = 7.2 miles (38,000 feet)

Option to Tie into Pressure Zone 1 or Continue to New Township Line Road Reservoir

New 1.5 MG Township Line Road Reservoir

Morse Creek Treatment Plant (for reference only)

Potential Booster Pump Station Location

Hwy 101
Lake Farm Rd
O'Brien Rd
Gasman Rd
Figure 8
DESALINATION FACILITY AND INTAKE:
LATERAL SCREENS OPTION
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY
The Raw Water Intake presented includes three constant-speed, vertical turbine pumps, (two duty and one standby). Each pump is estimated to be 100 hp and rated at 2.25 mgd to provide full pump station redundancy. The caisson diameter is estimated to be 9 feet to allow for pump spacing at grade and adequate intake hydraulics.

### 3.2.1.2 Tunneled Intake Option

A tunneled intake option is presented in Figure 9. Similar to the lateral screen intake, a reinforced concrete caisson will serve as the well casing. A tunnel will project horizontally outward from the caisson until it projects into the sea. The tunnel typically enters the sea at water depths of approximately 60 feet to provide safe ship passage, however, shallower depths with a warning buoy attached directly above may be acceptable where ocean bathymetry is shallow for long distances offshore. The tunnel includes an intake pipeline with a tee-shaped seawater intake screen. The tee-shaped intake is designed to limit tangential intake velocities to the National Marine Fisheries Service limit of 0.40 feet per second. To prevent clogging of the screen, the assembly is equipped with an automatic airburst system that will send a burst of air to the screen when high headloss across the screen is detected. There is no pretreatment of the seawater for this option, thus a pretreatment process is included in the Desalination Facility. The tunnel also includes brine disposal piping that extends approximately 1,000 to 1,500 feet beyond the intake to dispose of the brine through diffusers. The diffuser piping is typically anchored to the ocean floor. Both the intake and diffuser piping are assumed to be HDPE.

The Raw Water Intake presented includes three constant-speed, vertical turbine pumps, (two duty and one standby). Each pump is estimated to be 100 hp and rated at 2.25 mgd to provide full pump station redundancy. Similar to the lateral screens option, the caisson is estimated to be 9 feet in diameter.

### 3.2.1.3 Seawater Wells Intake Option

A conventional seawater well intake option is depicted in Figure 10. A steel pipe serves as the well casing. The steel casing is screened near the bottom to allow saline water to flow into the well. Similar to the lateral screens option, pretreatment of the raw seawater is by filtration through subsurface soils. This option is highly dependent on subsurface soil characteristics and will likely be the most difficult when dealing with permitting and regulatory issues due to the close proximity to fresh groundwater. A beach brine disposal is shown and will function similarly to the beach brine disposal discussed in the lateral screens option.

Three seawater wells, each including one constant-speed, vertical turbine pump, are presented. Each pump is estimated to be 100 hp and rated at 2.25 mgd to provide full well redundancy. Each well is estimated to be 20 inches in diameter (inside diameter of steel casing).
Figure 9
DESALINATION FACILITY AND INTAKE:
TUNNELING OPTION
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY

SECTION
NTS
Figure 10
DESALINATION FACILITY AND INTAKE:
SEAWATER WELL OPTION
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY
3.2.2 Pumping

Each desalination option above includes a different type of Raw Water Intake; however, once the raw seawater enters the Desalination Facility, all options use the same pumping system as shown on Figure 7. Finished water is pumped from the Desalination Facility to a Booster Pump Station located along OBrien Road. The finished water is then pumped to the new Township Line Road Reservoir where it is stored before distribution into the Fairview Water System. Both pump stations include one duty and one standby constant-speed, vertical turbine pump. Each pump is estimated to be 300 hp and rated at 2.0 mgd to provide full redundancy.

3.2.3 Piping

A potential pipeline route from the Desalination Facility to the new Township Line Road Reservoir is presented in Figure 7. The pipeline follows Lake Farm Road to Highway 101 and then OBrien Road to Township Line Road Reservoir. Transmission piping is estimated to be 38,000 feet long. Due to high pipeline pressures, 12-inch diameter cement mortar-lined ductile iron piping is assumed.

An option to tie into Pressure Zone 1 is also presented in Figure 7. It may be possible to connect directly to the distribution system; however, a higher connection pressure will be required to convey water to the Township Line Road Reservoir. Individual users near the point of connection may have to install pressure-reducing valves (PRVs) to alleviate high pressures. Existing rated pipeline pressures and newly induced pipeline pressures will dictate feasibility of this option.

3.2.4 Storage

Similar to the off-channel options, storage at the Township Line Road Reservoir will need to increase from 0.3 MG to 1.5 MG. It is assumed that the new reservoir will be an aboveground steel tank.

3.2.5 Treatment

The Desalination Facility is assumed to use reverse osmosis to convert the seawater to potable water. The facility will be rated at 2.0 mgd and will include a chemical and storage feed facility, clearwell, raw water intake and finished water pump station, all associated mechanical, electrical and instrumentation appurtenances, and pretreatment (per intake option). A facility footprint of 0.75 acres is assumed.

For this option, the Morse Creek Treatment Plant is assumed to be offline. The Desalination Facility will serve as the primary source for the Fairview Water System.
3.3 Interconnection with Port Angeles Water System Option

3.3.1 Water Resource Inventory Area 18 Constraints

Water Resource Inventory Area 18 (WRIA 18) currently recommends that Elwha River water should not be conveyed east of the Morse Creek watershed where a majority of the Fairview Water System is located, thereby currently precluding the use of an interconnection with the Port Angeles Water System as a feasible option. Therefore, the interconnection options presented below are feasible if the requirements of WRIA 18 are modified so that Elwha River water can be conveyed into the Fairview Water System.

3.3.2 Interconnection Options

An interconnection with the Port Angeles water system is a potential option to supply the Fairview Water System with potable water to meet future demands. As previously discussed, two emergency interconnections with the Port Angeles system exist on the west end of the Fairview Water System. The 484-Pressure Zone, 10-inch intertie will be used for the purpose of this analysis.

The Port Angeles water system includes fluoride, which is not used in the Fairview Water System. Therefore, fluoride removal is assumed prior to flow entering the Fairview Water System. Two potential options for fluoride removal are evaluated: point-of-use and full system fluoride removal.

3.3.2.1 Point-of-Use Fluoride Removal

Point-of-use fluoride removal includes a fluoride filter system located on the main water line of each user. Fluoride filters are typically installed in the basement or garage. The total space required is approximately 12 inches by 24 inches by 66 inches tall. The unit is self-backwashing, using a microprocessor with electronic control valve to flush trapped filter bed contaminants. The system requires a nearby power outlet and drain source (usually the washing machine drain). The influx of backwash water does not appear to negatively impact septic systems.

This option presents competitive initial costs, however, life cycle costs increase dramatically due to required equipment replacement. Filter cartridges and tank resin are estimated to be replaced every 18 to 24 months based on single-family household use. Filter cartridges are approximately 4 percent of the entire unit cost while tank resin is approximately 40 percent of the entire unit cost. Installation in a basement or garage is assumed for cost estimating, however; space requirements may be an issue for some residents and potentially increase costs for this option.

3.3.2.2 Full System Fluoride Removal

Full system fluoride removal as shown in Figure 11 is a complete fluoride removal treatment process at the source of supply. The treatment process uses a highly porous activated
Figure 11
INTERTIE WITH PORT ANGELES WATER SYSTEM OPTION:
FULL SYSTEM FLUORIDE REMOVAL FACILITY
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY

Reference: Water Online, Pureflow Filtration Division
alumina media to adsorb the fluoride. The media is physically and chemically stable and is resistant to abrasion and disintegration. Water will enter from the Port Angeles water system where it is chemically pretreated to adjust the pH level. The pH level is controlled automatically to ensure optimum chemical pretreatment.

When an optimum pH level for fluoride removal is reached, fluoride ions attach to the pores of the activated alumina and fluoride removal is achieved. Regeneration of the activated alumina bed is required when the bed has removed the maximum amount of fluoride from the water. Suspended solids are removed from the bed by a backwash cycle and then the bed is treated with caustic solution to dissolve the fluoride from the media. Finally, raw water is used to flush the bed to remove excess caustic solution and neutralize the bed.

### 3.3.2.3 Treatment

The fluoride removal facility will have a design capacity of 2.0 mgd to meet future water demands. The facility includes all controls and equipment needed to operate the system. The system includes two treatment vessels, one duty and one standby such that while one is backwashing the other is available for treatment. Two pipelines exit the system including a backwash line and a filtered water line. The backwash line containing caustic solution and suspended solids is assumed to be discharged to a settling pond. The filtered water line enters a pump station where it is pumped to the top of the Fairview Water System. The facility is assumed to be located at the 10-inch existing Port Angeles/Fairview emergency intertie near South Hemlock Lane.

### 3.3.2.4 Common Elements of Interconnection Options

#### 3.3.2.4.1 Pumping

A Booster Pump Station is required near the Port Angeles/Fairview Interconnection to pump de-fluoridated water to the new Township Line Road Reservoir. Due to the large change in elevation in the Fairview Water System, a second Booster Pump Station located along Deer Park Road is required to complete pumping to the Township Line Road Reservoir. Each pump station includes one duty and one standby constant-speed, vertical turbine pump. Each pump is estimated to be 300 hp and rated at 2 mgd to provide full redundancy.

#### 3.3.2.4.2 Piping

Transmission piping from the interconnection to the Township Line Road Reservoir is estimated to be 25,000 feet long, and is presented in Figure 12. Piping follows Deer Park Road and Township Line Road. Due to high pipeline pressures, piping is assumed to be 12-inch diameter cement mortar-lined ductile iron.

An option to tie into Pressure Zone 1 is also presented in Figure 12. This tie-in presents similar conflicts and feasibility to the tie-in for the desalination option discussed in Section 3.2.3.
Figure 12
INTERTIE WITH PORT ANGELES WATER SYSTEM
OPTION: POTENTIAL BOOSTER PUMP STATION
LOCATIONS AND DISTRIBUTION
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY
3.3.2.4.3 **Treatment**

The interconnection options are sized to supply all demand (year 2038) during the 2.5-month period of low Morse Creek flows. The Morse Creek Treatment Plant and interconnection option will be used to supply the Fairview Water System during other time periods or when flows in Morse Creek allow the treatment plant to operate.

### 3.4 Groundwater Wells (New Bluffs Wells)

The use of additional groundwater wells was also studied and described in a report prepared by Robinson, Noble & Saltbush, Inc. (RNS) (Fairview Water System Supply Project, December 2008) as part of this project and is included in Appendix D. The report proposed drilling three new wells to a depth of 150 feet below sea level to penetrate production zones of the Bluffs Aquifer. The wells are projected to be located approximately a half-mile inland and parallel to the coastline along Lemmon Road. Production capacities are estimated between 100 and 400 gpm (0.14 and 0.58 mgd) per well depending upon subsurface soil characteristics. Based on the estimated production capacities, a minimum of three wells is required to stay within the maximum instantaneous water right (1,350 gpm) allocated to the Bluffs area. Actual production is subject to additional study and testing.

Current Bluffs Well water rights limit annual production to 187 acre-feet (61 MG). Based on maximum monthly production data presented in Figure 3, operating the New Bluffs Wells in the 2.5-month low Morse Creek flow period would currently (i.e. 2009) require approximately 114 acre-feet (37 MG) of the annual water right. After applying the projected demand factor, the required 2.5-month production for 2038 is estimated to be 237 acre-feet (77 MG).

For consistency with RNS analyses, the costs and analysis for the groundwater wells will be carried out assuming three groundwater wells. However, it should be noted that assuming each well is producing the maximum estimated production of 400 gpm, the combined capacity of this source is 1,200 gpm (approximately 1.7 mgd), which is less than the projected 2038 demand of 2.0 mgd. Actual production will be determined when the wells are constructed. Conveyance piping and pump stations will be sized for the 2038 demand should additional water rights be obtained in the future.

### 3.4.1 Pumping

Well pumps will be constant-speed, vertical turbine pumps. The well pump and equipment will be enclosed in a well house located at grade. The well house is fenced similarly to the existing Bluffs Well and includes gravel road access. The required footprint of each well including an access road is estimated to be approximately 1,500 square feet. Each well is assumed to be located on a standard sized lot (7,000 - 9,000 square feet). Each well pump is estimated to be 75 hp and rated at 400 gpm. The well is constructed with 12-inch diameter steel casing.
The wells pump to a common Booster Pump Station located between Lemmon Road and Highway 101, as shown on Figure 13. This pump station will convey all flow from the New Bluffs Wells to the future O'Brien Road Reservoir that will serve the lower Fairview service area. The pump station includes one duty and one standby constant-speed, vertical turbine pump. Each pump is estimated to be 200 hp and rated at 2.0 mgd to provide full redundancy. A second Booster Pump Station is required along O'Brien Road to pump water to the new Township Line Road Reservoir to supply the upper Fairview service area (approximately 25 percent of Fairview Water System demand). The pump station includes one duty and one standby constant-speed, vertical turbine pump. Each pump is estimated to be 125 hp and rated at 0.5 mgd to provide full redundancy.

3.4.2 Piping

Transmission piping from the Booster Pump Station near the New Bluffs Wells to Township Line Road Reservoir is estimated to be 31,000 feet long. Piping is assumed to follow O'Brien Road and Township Line Road, as depicted in Figure 13. Due to high pipeline pressures, cement mortar-lined ductile iron piping is assumed. Piping from the lower Booster Pump Station to the O'Brien Road Reservoir is assumed 10-inch diameter and piping from O'Brien Road Reservoir to Township Line Road Reservoir is assumed 6-inch diameter.

An option to tie into Pressure Zone 1 is also presented in Figure 13. This tie-in presents similar constraints as the tie-in for the desalination option discussed in Section 3.2.3.

3.4.3 Storage

Equalization

A 100,000 gallon Flow Equalization Tank located near the lower Booster Pump Station will be used to equalize flow between the New Bluffs Wells and the Booster Pump Station. The equalization tank will provide approximately one hour of supply if the New Bluffs Wells were offline.

O'Brien Road and Township Line Road Reservoir

Based on modeled flow demands for the upper and lower Fairview service areas, the required storage volume of the O'Brien Road Reservoir is estimated to be 0.9 MG to meet the 2038 demand. The required storage volume of the Township Line Road Reservoir is estimated to be 0.6 MG to meet the 2038 demand. It is assumed that both reservoirs will be aboveground steel tanks.
Figure 13
NEW BLUFFS WELLS OPTION: POTENTIAL BOOSTER PUMP STATION LOCATION AND DISTRIBUTION
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY
3.4.4 Treatment

Assuming the groundwater at the proposed well locations is similar in water quality to the existing Bluffs Well, hypochlorite addition will be required to achieve a disinfectant residual in the distribution system. A typical hypochlorite system includes a fiberglass reinforced plastic storage tank, feed pumps, and control system to inject the chemical into the transmission line. The injection point is assumed to be located at the lower Booster Pump Station.

The New Bluffs Wells are sized to supply all demand (year 2038) during the 2.5-month period of low Morse Creek flows. The Morse Creek Treatment Plant and New Bluffs Wells will be used to supply the Fairview Water System during other time periods or when flows in Morse Creek allow the treatment plant to operate.

4.0 ASR

The use of groundwater storage near Morse Creek to accomplish ASR using the Morse Creek surface water right was also studied and described in a report prepared by RNS (Fairview Water System Supply Project, December 2008) as part of this project and is included in Appendix D. The study examined using storage characteristics of the groundwater systems east of Morse Creek to overcome the interruptible nature of the Morse Creek surface water right. Several bedrock troughs along the eastern limb of the Morse Creek valley appear to hold some promise for an ASR program, but the evidence is too preliminary to justify any hard conclusion. In order to clarify the ASR potential, it is recommended that geophysical survey techniques be applied. Where bedrock configurations seem promising, test drilling to characterize the unconsolidated sediments should follow these surveys. Only after these proposed investigations can the economic and water resource management aspects of such a program be realistically assessed. The study estimates an ASR exploration, development, and permitting process will not realistically be achievable in less than 10 years and will involve a substantial investment. Given the unknowns, ASR does not address the short-term objectives of realizing a reliable water supply for the District; however, ASR remains a long-range option that the District may want to consider as future demands and constraints become more clear.

5.0 HYDRAULIC MODEL

A water system model of the Fairview Water System was developed and maintained over the years for master planning and system analysis. The model is currently in WaterCAD 7 format. The existing system model is used to determine the minimum required system improvements to convey water from the new source input into the system (i.e. to the Township Line Road Reservoir). The Township Line Road Reservoir is the primary system storage tank, from which water is delivered to the system. The distribution system
performance, operations, and fire flow capabilities were not evaluated as this type of analysis is performed as part of the Water Comprehensive Plan update on a regular basis.

The model used for the 2001 Capital Improvements Plan (CIP), with the system in the 2001 configuration was used for this study. The demands from the Year 2021 MDD scenario were converted to the 2038 MDD by multiplying the demand at each node by 1.2731 to have a 2.0 mgd total system demand.

Four scenarios were modeled:

- Scenario 1: New supply flow input at the current Morse Creek Treatment Plant location.
- Scenario 2: New supply flow input on the east side of Pressure Zone 1, near the PRV between Pressure Zone 1 and 2. See Figure 7 for illustration.
- Scenario 3: New supply flow input on the west side of Pressure Zone 1, near the PRV between Pressure Zone 1 and 2. See Figure 12 for illustration.
- Scenario 4: New supply flow input on the southeast side of Pressure Zone 4 and near the PRV between Pressure Zone 1 and 2. See Figure 13 for illustration.

The Bluffs Well was turned off for all scenarios, as it probably will not be used in its current configuration in 2038. The model simulation was for 72 hours for each scenario and the Township Line Road Reservoir level was monitored to ensure that the system was able to refill the reservoir over a 72-hour period with the system operating at MDD.

For all model scenarios, the system required 1.2 MG of additional storage to meet peak demand during the simulation. This value may increase during the more detailed analysis as part of the District’s next water system plan update.

Scenario 1 evaluated introducing flow to the system at the Morse Creek Treatment Plant. This condition requires the firm pumping capacity be increased to 1,390 gpm from 780 gpm. The 2,580-foot transmission main to the distribution system needs to be increased from an 8-inch diameter line to a 12-inch diameter line. The pumps will require an additional 75 feet of pump head to overcome transmission line losses. The pressure into the distribution system ranges from 97 to 107 pounds per square inch (psi) during MDD for this scenario.

Scenarios 2 and 3 evaluated introducing flow near the east and west side PRVs into Pressure Zone 1. The inflow at each of these locations requires a high hydraulic grade line (1,260 feet) and additional piping upgrades between the point of connection and Township Line Road. Pipeline pressures ranged from 120 to 170 psi in these two scenarios. Based on the required pipeline upgrades and induced system pressures, it was assumed to route transmission piping to the new Township Line Road Reservoir as shown in Figures 7 and 12 for the various water supply alternatives.
Scenario 4 evaluated introducing flow from the New Bluffs Wells into the upper and lower service areas to determine the distribution of storage between the two service areas. The modeling showed that approximately 300,000 gallons of additional storage is required in the upper service area and an additional 900,000 gallons of storage in the lower service area. Upper service area transmission piping is routed to the new Township Line Road Reservoir shown in Figure 13 based on similar pipeline upgrades and induced system pressures discussed in Scenarios 2 and 3 above.

6.0 ENVIRONMENTAL SCREENING AND PERMITTING REVIEW

This section summarizes the environmental and permitting considerations associated with the various alternatives proposed for the Fairview Water System Supply Project. The information included in this section summarizes potential environmental constraints to the proposed alternatives and can be used to help avoid or minimize environmental impacts when a preferred alternative and specific sites are selected. A detailed discussion of environmental considerations, including the estimated timeframe to obtain a particular permit, for each of the alternatives as well as federal, state, and local permit requirements is provided in Appendix E.

The discussion is based on the description of the alternatives presented in the previous sections of this report and on a review of existing information about sensitive environmental areas within the project area. No field work was conducted to evaluate conditions at a specific site. Site analysis and additional environmental review would be required when a preferred alternative and specific sites are selected. The permit requirements described are general requirements for the types of water supply projects proposed in this report. A specific list of permits will be developed in future phases of the project as the project is defined and sites are selected.

6.1 Critical Areas

Based on preliminary project information, all of the alternatives may require wetland fill and crossing of streams. The greatest potential for impacts is at facility sites located outside of existing developed areas and road rights-of-way (e.g., the Desalination Facility site). Federal, state, and local regulatory agencies require applicants to show that impacts to aquatic areas have been avoided and minimized to the greatest extent possible. Unavoidable impacts typically require mitigation, which involves mitigation siting, design, and several years of maintenance and monitoring. In addition, obtaining permits from the U.S. Army Corps of Engineers triggers several related requirements such as Endangered Species Act (ESA) review, compliance with the National Historic Preservation Act (NHPA), and DOE permits. Therefore, locating and designing the water supply facilities to avoid and minimize impacts to streams and wetlands would substantially reduce the time and costs associated with permitting and mitigation.
6.2 Endangered Species Act

If the alternatives require federal permits or use federal funding, then they would be subject to ESA Section 7 consultation, which involves preparation of a Biological Assessment (BA). Mapping from the WDFW indicates the presence of several listed fish and wildlife species in the vicinity that will need to be addressed in the BA. The agencies may require construction timing restrictions (work windows) or other measures to protect these species. Minimizing and avoiding impacts to natural habitats such as forested areas and wetlands would reduce the potential for affecting listed species.

6.3 Cultural Resources

Federal permits or funding would also trigger review under Section 106 of the NHPA. A review of historic and cultural resources in the vicinity was not conducted as part of this report. In general, alternatives that would locate facilities within existing developed areas with disturbed soils would have the lowest potential to affect buried archaeological resources. Areas along streams and the Puget Sound shoreline would likely have a higher potential to contain cultural resources.

6.4 Work in Puget Sound

Only the Desalination Facility would require work in and near Puget Sound (Strait of Juan de Fuca) for the placement of intake/outfall pipes. This would entail an additional set of permit requirements, including U.S. Coast Guard Review, a state aquatic use permit, and a discharge permit for waste brine from the DOE. Requirements for the brine discharge permit would need to be established with DOE; they are likely to include detailed studies such as a mixing zone assessment.

6.5 Water Rights

The off-channel storage, New Bluffs Wells, and ASR alternatives will require changes to the existing water rights or in some cases new water rights. The administrative process for changing an existing right or obtaining a new right does not guarantee a positive outcome and can take several years to complete. The Qi and Qa for the two existing sources are shown earlier in Table 2. A general summary of the process is discussed below.

6.5.1 Off-Channel Storage or ASR Alternatives

If the District is interested in keeping the off-channel storage or ASR option open for immediate or future implementation, the Qi and Qa flows for the interruptible Morse Creek supply need to be changed so that additional water can be taken from the Creek during periods when flows are available to meet the increased seasonal needs of the District and still supply other users and habitat needs. The process for changing and acquiring a new water right for the Morse Creek source involves a two-phase process. Because of reductions in the DOE staff processing applications, it is advisable to use the cost
reimbursement program to facilitate the process. This involves paying the DOE to hire a consultant to perform the work. Phase 1 involves the definition of the area and developing a list of other applications that are already in the application queue. Phase 2 involves the development of the report of examination by the DOE consultant. The report of examination is then reviewed and processed by the DOE as if they had prepared it internally. If the finding is positive, a new water right could be expected to be issued in about a two-year time frame. The water right would still be interruptible and limited by timing of withdrawal and availability. It could also involve some mitigation.

The ASR alternative would have additional state permitting requirements for storage of water, water quality, etc.

6.5.2 Desalination or Interconnection Alternatives

While no new or changed water rights are likely to be needed for the desalination or interconnection alternatives, both of these alternatives are impacted by other cost and environmental constraints that severely limit their application at this time.

6.5.3 New Bluffs Wells Alternative

Two steps are involved in the water rights process to implement the New Bluffs Wells alternative. The first step is developing and processing an application for a change in the point of withdrawal for the existing water right. Assuming the cost reimbursement process described above is used to expedite the process, the change should be processed within a period of 6 months (at the earliest) to one year. As noted earlier, the benefits to this change are that the existing water right could be exercised to a greater extent and provide the District with some or all of the backup water supply to meet current needs relatively quickly (i.e. within a period of two years) if the flow on Morse Creek is interrupted. The caveat to, and unknowns in this process are the flow that can be generated by the new wells. This will not be known until one or more of the wells are sited, designed, drilled, and tested. Well implementation can move forward in parallel to the administrative change in point of withdrawal process, but at some risk to the District as the water right at the new location(s) cannot be exercised until DOE processes the change.

The second step is to apply for an increase in both Qi and Qa of the groundwater right to meet future water demand. This two-phase process is similar to that described above (again assuming cost reimbursement is used) for the off-channel and ASR alternative, and it is possible that a new water right could be issued in about two years depending on the requirements of the DOE.

Nuances exist to the application process and a meeting with DOE staff prior to applying is recommended to determine the best approach.
6.6 Reservoir Permit

The Buchanan Drive Quarry Reservoir, Deer Park Road Reservoir, and ASR alternatives would require a reservoir permit from DOE.

6.7 NEPA and SEPA Review

All of the alternatives would require State Environmental Policy Act (SEPA) review through Clallam County. Use of federal funds or federal permits would also entail National Environmental Policy Act (NEPA) review. If impacts are minimized through project location and design, then a SEPA checklist and NEPA Environmental Assessment (EA) are likely to be adequate. Significant impacts would bring the project to the level of requiring an Environmental Impact Statement (EIS), which is substantially more time consuming and expensive. The issue of fluoridation arising from the interconnection alternative is likely to be a point of public comment during the SEPA/NEPA review process.

6.8 Shoreline Permit

With the exception of the New Bluff Wells alternative, all of the alternatives are likely to need a shoreline permit from Clallam County. Limiting work within shorelines to that which is unavoidable, such as placement of water intake or outfall pipes, would reduce shoreline permitting time and costs.

6.9 Other Clallam County Permits

When more information is known about the design and location of the project, the District can apply to Clallam County for a Project Review process that will provide guidance on the specific local permits that will be required. With any of the alternatives it is likely that several special studies will be required, such as a wetland delineation report; geotechnical reports to address erosion, landslide, and seismic hazard areas, frequently flooded areas, and critical aquifer recharge areas; a drainage plan; and engineering reports and site plans.

7.0 COST ANALYSIS

The cost analysis includes total estimated construction costs, project costs, and 30-year life cycle costs. The costs are conceptual level costs with an expected accuracy of 50 percent over the estimate to 30 percent under the estimate. For comparison, the costs of each option are presented in Table 3 and graphically in Figure 14.

Based on 30-year life cycle costs, the lowest cost options include New Bluffs Wells and Off-Channel Storage Option 2 - Deer Park Road Reservoir. Competitive cost options include the Off-Channel Storage Option 1 - Buchanan Drive Quarry Reservoir and interconnection options. The highest cost option is desalination. Detailed cost summaries for each option are appended at the end of this report (Appendix A).
Table 3 Water Supply Alternative Cost Summaries (2008 Dollars)
Fairview Water System Supply Project
PUD No. 1 of Clallam County

<table>
<thead>
<tr>
<th>Supply Alternative</th>
<th>Total Estimated Construction Cost ($M)(^{(5)})</th>
<th>Total Estimated Project Cost ($M)(^{(6)})</th>
<th>Total Estimated 30-Year Life Cycle Cost ($M)(^{(7)})</th>
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<td>New Bluffs Wells(^{(4)})</td>
<td>15.9</td>
<td>19.7</td>
<td>21.4</td>
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</table>

Notes:

1. Life cycle costs for Off-Channel Storage option assume 2.5-month operation. Costs outside of 2.5-month period not included. Expanded Morse Creek Treatment Plant costs other than pumping costs not included. Existing Morse Creek Treatment Plant costs not included.
2. Life cycle costs for Desalination options assume this is primary supply source for the Fairview Water System. Morse Creek Treatment Plant is assumed offline. Costs based on average yearly production flows.
3. Life cycle costs for Interconnection options assume 2.5-month operation. Costs outside of 2.5-month period not included. Costs do not include connection fee.
4. Life cycle costs for New Bluffs Wells option assume 2.5-month operation. Costs outside of 2.5-month period not included.
5. Includes the following percentage additions: general conditions = 5 percent, contingency = 30 percent, contractor overhead, profit, and risk = 15 percent, sales tax = 8.3 percent.
6. Includes the following percentage additions: engineering, legal and administration fees = 20 percent, owners reserve for change orders = 5 percent. Land acquisition fees included based estimations from recently sold Fairview estate. Permitting and water right acquisition assumed included in legal and administration fees. Right of way and easement costs not included. Distribution system upgrades beyond what has been presented in the figures of this report are not included.
7. Discount factor of 5.5 percent assumed. Mechanical, electrical, and instrumentation equipment life assumed 25 years. Electrical power costs assumed $0.07/kW-hr. Assumed 75 percent pump efficiency.
8. Costs are reduced by approximately $200,000 for every 1,000 feet closer Deer Park Road Reservoir is located to Morse Creek Treatment Plant.

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor’s means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.
Figure 14
WATER SUPPLY ALTERNATIVE COST SUMMARIES
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
CLALLAM COUNTY
8.0 WATER SUPPLY ALTERNATIVES SCREENING

The alternatives were compared using qualitative ranking criteria of positive (+), neutral (0), or negative (-) for the screening criteria (listed in alphabetical order) described below:

- Cost: overall capital and operating costs for a 30-year life cycle.
- Environmental/Permitting: number of required permits and environmental impacts.
- Phasing: ability to phase project to increase capacity as demands increase.
- Public Opinion: the perceived opinion by the public.
- System Complexity: technical and physical complexity of the option.
- Use of Existing Assets: potential for existing facilities to be used.
- Water Rights: assumed difficulty obtaining water rights based on historical data.

The rankings are shown in the summary comparison table in Table 4. The rankings for relative cost are based on estimated costs previously presented in this report.

9.0 RECOMMENDATIONS

Based on the analyses and investigations performed during the study, the New Bluffs Wells alternative is recommended for implementation to act as a backup and complementary water supply to meet the short and long-term water supply needs of the Fairview Water System. It is one of the least expensive options, has the fewest permitting and implementation constraints, and the best probability of securing additional water rights.

In February 2009 during the review of the Draft Feasibility Study Report with District staff, the District received a BCA (Appendix B) from the DOH addressing its concerns about the lack of a reliable back-up water source to support the upper Fairview service area in the event of low flows in Morse Creek. The District requested that the New Bluffs Wells alternative be modified to address the short-term concerns listed in the BCA, as well as the 2038 supply needs. The short and long-term issues and solutions for the District are presented in Table 5 below.

It is recommended to implement the New Bluffs Wells alternative in three phases, with the first two phases addressing short and mid-term supply concerns, and the third phase meeting the 2038 project MDD of 2.0 mgd. The three phases are:

- Phase 1: Construct new infrastructure (i.e. a new dedicated water supply line and booster pump station) to convey flow to the upper portion of the Fairview Water System from the existing Bluffs Well. Size and design the new infrastructure
components with the flexibility to meet future demand, storage, and piping requirements.

- Phase 2: Site, permit, and install two of three recommended New Bluffs Wells and associated infrastructure, and increase the capacity of the booster pump stations as required.

- Phase 3: Seek additional water rights for the New Bluffs Wells and modify the existing Morse Creek water right to increase the instantaneous withdrawal rate and annual volume. Install the third New Bluffs Well, increase the capacity of the booster pump stations, and add additional conveyance capacity and distribution storage as required to optimize system operation and meet future demands.

Future predesign studies and design work will include a more detailed analysis to optimize the required infrastructure modifications described in the three phases.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Off Channel Storage Option 1 - Buchanan Drive Quarry Reservoir</th>
<th>Off Channel Storage Option 2 - Deer Park Road Reservoir</th>
<th>Desalination</th>
<th>Interconnection - Point of Use Fluoride Removal</th>
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<th>New Bluffs Wells</th>
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<tr>
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<td>Cost</td>
<td>Environmental/Permitting</td>
<td>Phasing</td>
<td>Public Opinion</td>
<td>System Complexity</td>
<td>Use of Existing Assets</td>
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Notes:
"+1" connotes: positive, more, or more desirable attributes
"-1" connotes: negative, fewer, or less desirable attributes
"0" connotes: neutral determination
Table 5  
Short and Long Term Issues and Solutions  
Fairview Water System Supply Project  
PUD No. 1 of Clallam County

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Issue</th>
<th>Recommendation</th>
<th>Benefit to District</th>
</tr>
</thead>
</table>
| Short Term| No water supply redundancy in upper Fairview Water System due to minimum Morse Creek streamflow restrictions and existing design system. | • Phase 1: Construct infrastructure to use water available from the existing Bluffs Well to convey water into upper Fairview Water System when the Morse Creek Treatment Plant may be out of operation due to low flows in Morse Creek.  
• Phase 2: Relocate Bluffs Well water right and site, permit, and construct two New Bluff Wells and booster pump station. | • Addresses immediate concern discussed in DOH Bilateral Compliance Agreement by supplying some water to the upper Fairview Water System, and sets stage for future expansion as demands increase.  
• Phase 1 design and construction can occur in relatively short timeframe.  
• Phase 2 increases system capacity and redundancy. |
| Long Term | Water Rights                                                          | • Obtain additional annual and instantaneous water rights for Morse Creek and New Bluffs Wells.  
• Phase 3: Install third New Bluffs Well, increase capacity of booster pump stations, and add additional conveyance capacity and distribution storage as required. | • Phase 3 nearly meets 2038 projected demands - final flow determined when wells are installed.  
• Meets full system redundancy criteria. |
10.0 REFERENCES


## Off Channel Storage Option 1 - Buchanan Drive Quarry Reservoir Cost Summary (2008 Dollars)

<table>
<thead>
<tr>
<th>Cost Factors</th>
<th>Total Direct Cost</th>
<th>General Conditions</th>
<th>Contingency</th>
<th>Contractor OH&amp;P and Risk</th>
<th>Sales Tax (Gross Receipts Tax)</th>
<th>Bid Market Allowance</th>
<th>Total Estimated Construction Cost</th>
<th>Engineering, Legal and Admin. Fees</th>
<th>Owner's Reserve for Change Orders</th>
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### Notes:
1. Seattle CCI Index = 8794.
2. General Conditions include bonds, insurance, mobilization, demobilization, and site supervision.
3. Current market conditions indicate sufficient number of bidders for a project thus the adjustment is not currently applicable.

### Project Components

- **Estimated Construction Cost**: $25,500,000
- **Total Project Cost**: $30,600,000
- **30 Year Life Cycle Cost**: $33,300,000

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.
## Off Channel Storage Option 2 - Deer Park Road Reservoir Cost Summary (2008 Dollars)

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<th>Total Direct Cost</th>
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<th>Contractor OH&amp;P and Risk</th>
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<th>Bid Market Allowance&lt;sup&gt;(2)&lt;/sup&gt;</th>
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<td>$4,348,500</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
<td>5%</td>
<td>0%</td>
<td>$6,048,500</td>
<td>$1,700,000</td>
<td>$47,000</td>
<td>$8,808,000</td>
</tr>
<tr>
<td>WTP to Township Res Piping</td>
<td>$552,300</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
<td>5%</td>
<td>0%</td>
<td>$939,100</td>
<td>$187,900</td>
<td>$47,000</td>
<td>$1,174,000</td>
</tr>
<tr>
<td>New Township Line Rd Res</td>
<td>$888,100</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
<td>5%</td>
<td>0%</td>
<td>$1,510,100</td>
<td>$302,100</td>
<td>$75,600</td>
<td>$1,887,800</td>
</tr>
<tr>
<td>Land Acquisition Option 2</td>
<td>$431,400</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
<td>5%</td>
<td>0%</td>
<td>$607,500</td>
<td>$0</td>
<td>$0</td>
<td>$607,500</td>
</tr>
</tbody>
</table>

**Estimated Construction Cost** | $17,500,000 |
**Total Project Cost** | $20,700,000 |
**30 Year Life Cycle Cost** | $23,100,000 |

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

**Notes:**
1. Seattle CCI Index = 8794.
2. General Conditions include bonds, insurance, mobilization, demobilization, and site supervision.
3. Current market conditions indicate sufficient number of bidders for a project thus the adjustment is not currently applicable.
### Desalination - Lateral Screens Option Cost Summary (2008 Dollars)

<table>
<thead>
<tr>
<th>Project Components</th>
<th>Total Direct Cost</th>
<th>General Conditions (%)</th>
<th>Contingency</th>
<th>Contractor OH&amp;P and Risk</th>
<th>Sales Tax (Gross Receipts Tax)</th>
<th>Bid Market Allowance (%)</th>
<th>Total Estimated Construction Cost</th>
<th>Engineering, Legal and Admin. Fees</th>
<th>Owner’s Reserve for Change Orders</th>
<th>Total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lat Screen Collector Well</td>
<td>$7,329,400</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$12,460,500</td>
<td>$2,492,100</td>
<td>$623,025</td>
<td>$15,575,700</td>
</tr>
<tr>
<td>2 MGD RO Desal Facility</td>
<td>$20,837,600</td>
<td>1%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$35,425,000</td>
<td>$7,085,000</td>
<td>$1,771,250</td>
<td>$44,281,300</td>
</tr>
<tr>
<td>Transmission Piping</td>
<td>$8,232,100</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$13,995,200</td>
<td>$2,799,100</td>
<td>$699,760</td>
<td>$17,494,100</td>
</tr>
<tr>
<td>Booster Pump Station</td>
<td>$273,100</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$1,246,600</td>
<td>$249,400</td>
<td>$62,330</td>
<td>$1,558,400</td>
</tr>
<tr>
<td>New Township Line Rd Res</td>
<td>$888,100</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$1,510,100</td>
<td>$302,100</td>
<td>$75,505</td>
<td>$1,887,800</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>$215,700</td>
<td>0%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$303,800</td>
<td>$0</td>
<td>$0</td>
<td>$303,800</td>
</tr>
</tbody>
</table>

**Estimated Construction Cost** $65,000,000

**Total Project Cost** $81,200,000

**50 Year Life Cycle Cost** $108,500,000

---

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---

**Notes:**

1. General Conditions include bonds, insurance, mobilization, demobilization, and site supervision.
2. Current market conditions indicate sufficient number of bidders for a project thus the adjustment is not currently applicable.
# Desalination - Tunneling Option Cost Summary (2008 Dollars)

<table>
<thead>
<tr>
<th>Project Components</th>
<th>Total Direct Cost</th>
<th>General Conditions(1)</th>
<th>Contingency</th>
<th>Contractor OH&amp;P and Risk</th>
<th>Sales Tax</th>
<th>Bid Market Allowance(2)</th>
<th>Total Estimated Construction Cost</th>
<th>Engineering, Legal and Admin. Fees</th>
<th>Owner's Reserve for Change Orders</th>
<th>Total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunnel Collector Well</td>
<td>$11,437,400</td>
<td>$571,900</td>
<td>$3,602,800</td>
<td>$2,341,900</td>
<td>$1,490,200</td>
<td>$0</td>
<td>$19,444,200</td>
<td>$3,888,900</td>
<td>$972,210</td>
<td>$24,305,400</td>
</tr>
<tr>
<td>2 MGD RO Desal Facility</td>
<td>$20,837,600</td>
<td>$1,041,900</td>
<td>$6,563,900</td>
<td>$4,266,600</td>
<td>$2,715,000</td>
<td>$0</td>
<td>$35,425,000</td>
<td>$7,085,000</td>
<td>$1,771,250</td>
<td>$44,281,300</td>
</tr>
<tr>
<td>Transmission Piping</td>
<td>$8,232,100</td>
<td>$411,700</td>
<td>$2,593,200</td>
<td>$1,072,600</td>
<td>$0</td>
<td>$0</td>
<td>$13,995,200</td>
<td>$2,799,100</td>
<td>$699,760</td>
<td>$17,494,100</td>
</tr>
<tr>
<td>Booster Pump Station</td>
<td>$733,100</td>
<td>$36,700</td>
<td>$231,000</td>
<td>$95,600</td>
<td>$0</td>
<td>$0</td>
<td>$1,246,600</td>
<td>$249,400</td>
<td>$62,330</td>
<td>$1,558,400</td>
</tr>
<tr>
<td>RO Pretreatment</td>
<td>$1,119,500</td>
<td>$56,000</td>
<td>$352,700</td>
<td>$229,300</td>
<td>$145,900</td>
<td>$0</td>
<td>$1,903,400</td>
<td>$380,700</td>
<td>$95,170</td>
<td>$2,379,300</td>
</tr>
<tr>
<td>New Township Line Rd Res</td>
<td>$888,100</td>
<td>$44,500</td>
<td>$279,800</td>
<td>$115,800</td>
<td>$0</td>
<td>$0</td>
<td>$1,510,100</td>
<td>$302,100</td>
<td>$75,505</td>
<td>$1,887,800</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>$215,700</td>
<td>$0</td>
<td>$64,800</td>
<td>$23,300</td>
<td>$0</td>
<td>$0</td>
<td>$303,800</td>
<td>$0</td>
<td>$0</td>
<td>$303,800</td>
</tr>
</tbody>
</table>

| Notes:                        |                   |                       |             |                          |           |                         |                                   |                                   |                                 |                   |
|-------------------------------|                   |                       |             |                          |           |                         |                                   |                                   |                                 |                   |
| (1) General Conditions include bonds, insurance, mobilization, demobilization, and site supervision. | | | | | | | | | | |
| (2) Current market conditions indicate sufficient number of bidders for a project thus the adjustment is not currently applicable. | | | | | | | | | | |

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.
### Desalination - Seawater Wells Option Cost Summary (2008 Dollars)

<table>
<thead>
<tr>
<th>Project Components</th>
<th>Total Direct Cost</th>
<th>General Conditions(1)</th>
<th>Contingency</th>
<th>Contractor OH&amp;P and Risk</th>
<th>Sales Tax</th>
<th>Bid Market Allowance(2)</th>
<th>Total Estimated Construction Cost</th>
<th>Engineering, Legal and Admin. Fees</th>
<th>Owner’s Reserve for Change Orders</th>
<th>Total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seawater Wells</strong></td>
<td>$1,683,400</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td><strong>$2,862,000</strong></td>
<td><strong>$572,400</strong></td>
<td>20%</td>
<td><strong>$3,577,500</strong></td>
</tr>
<tr>
<td><strong>2 MGD RO Desal Facility</strong></td>
<td>$20,837,600</td>
<td>20%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td>$35,425,000</td>
<td>$7,085,000</td>
<td>$1,771,250</td>
<td>$44,281,300</td>
</tr>
<tr>
<td><strong>Transmission Piping</strong></td>
<td>$8,232,100</td>
<td>20%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td>$13,995,200</td>
<td>$2,799,100</td>
<td>$699,760</td>
<td>$17,494,100</td>
</tr>
<tr>
<td><strong>Booster Pump Station</strong></td>
<td>$733,100</td>
<td>10%</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
<td></td>
<td>$1,246,600</td>
<td>$249,400</td>
<td>$62,330</td>
<td>$1,558,400</td>
</tr>
<tr>
<td><strong>New Township Line Rd Res</strong></td>
<td>$888,100</td>
<td>20%</td>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td>$1,510,100</td>
<td>$302,100</td>
<td>$75,505</td>
<td>$1,887,800</td>
</tr>
<tr>
<td><strong>Land Acquisition Wells Opt</strong></td>
<td>$339,000</td>
<td>0%</td>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td>$477,300</td>
<td>0</td>
<td>0</td>
<td>$477,300</td>
</tr>
</tbody>
</table>

**Notes:**
(1) General Conditions include bonds, insurance, mobilization, demobilization, and site supervision.
(2) Current market conditions indicate sufficient number of bidders for a project thus the adjustment is not currently applicable.

**Estimated Construction Cost** $55,600,000
**Total Project Cost** $69,300,000
**30 Year Life Cycle Cost** $94,300,000

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### Interconnection With Port Angeles - Point of Use Fluoride Removal Cost Summary (2008 Dollars)

<table>
<thead>
<tr>
<th>Project Components</th>
<th>Total Direct Cost</th>
<th>General Conditions(1)</th>
<th>Contingency</th>
<th>Contractor OH&amp;P and Risk</th>
<th>Sales Tax (Gross Receipts Tax)</th>
<th>Bid Market Allowance(2)</th>
<th>Total Estimated Construction Cost</th>
<th>Engineering, Legal and Admin. Fees</th>
<th>Owner’s Reserve for Change Orders</th>
<th>Total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point of Use</td>
<td>$4,024,100</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$6,841,500</td>
<td>$1,368,300</td>
<td>$342,100</td>
<td>$8,551,900</td>
</tr>
<tr>
<td>Booster Pump Station</td>
<td>$730,000</td>
<td>36,500</td>
<td>$230,000</td>
<td>$149,500</td>
<td>$95,200</td>
<td>0%</td>
<td>$1,241,200</td>
<td>$248,300</td>
<td>$62,100</td>
<td>$1,551,600</td>
</tr>
<tr>
<td>Transmission Piping</td>
<td>$5,490,200</td>
<td>36,500</td>
<td>$230,000</td>
<td>$149,500</td>
<td>$95,200</td>
<td>0%</td>
<td>$9,333,900</td>
<td>$1,866,800</td>
<td>$466,700</td>
<td>$11,667,400</td>
</tr>
<tr>
<td>New Township Line Rd Res</td>
<td>$888,100</td>
<td>44,500</td>
<td>$279,800</td>
<td>$181,900</td>
<td>$115,800</td>
<td>0%</td>
<td>$1,510,100</td>
<td>$302,100</td>
<td>$75,600</td>
<td>$1,887,800</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>$184,900</td>
<td>0%</td>
<td>$55,500</td>
<td>$20,000</td>
<td>$200,400</td>
<td>0%</td>
<td>$260,400</td>
<td>0%</td>
<td>0%</td>
<td>$260,400</td>
</tr>
</tbody>
</table>

**Notes:**

1. General Conditions include bonds, insurance, mobilization, demobilization, and site supervision.
2. Current market conditions indicate sufficient number of bidders for a project thus the adjustment is not currently applicable.

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment, nor services provided by others, contractor’s means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.

**Cost Factors** --- 5% 30% 15% 8.3% 0% --- 20% 5% ---

---

**Estimated Construction Cost** $20,500,000

**Total Project Cost** $25,500,000

**30 Year Life Cycle Cost** $36,800,000
### Interconnection With Port Angeles - Full System Fluoride Removal Cost Summary (2008 Dollars)

<table>
<thead>
<tr>
<th>Project Components</th>
<th>Total Direct Cost</th>
<th>General Conditions(1)</th>
<th>Contingency</th>
<th>Contractor OH&amp;P and Risk</th>
<th>Sales Tax (Gross Receipts Tax)</th>
<th>Bid Market Allowance(2)</th>
<th>Total Estimated Construction Cost</th>
<th>Engineering, Legal and Admin. Fees</th>
<th>Owner's Reserve for Change Orders</th>
<th>Total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full System Fluoride Removal</td>
<td>$7,343,100</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$12,483,800</td>
<td>$248,300</td>
<td>$624,200</td>
<td>$13,108,000</td>
</tr>
<tr>
<td>Booster Pump Station</td>
<td>$730,000</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$1,241,200</td>
<td>$248,300</td>
<td>$624,200</td>
<td>$1,551,600</td>
</tr>
<tr>
<td>Transmission Piping</td>
<td>$5,490,200</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$9,333,900</td>
<td>$1,866,800</td>
<td>$466,700</td>
<td>$11,667,400</td>
</tr>
<tr>
<td>New Township Line Rd Res</td>
<td>$888,100</td>
<td>5%</td>
<td>30%</td>
<td>15%</td>
<td>8.3%</td>
<td>0%</td>
<td>$1,510,100</td>
<td>$302,100</td>
<td>$75,600</td>
<td>$1,887,800</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>$184,900</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>$200,400</td>
<td>$0</td>
<td>$0</td>
<td>$200,400</td>
</tr>
</tbody>
</table>

| Estimated Construction Cost            | $26,100,000       |
| Total Project Cost                     | $30,100,000       |
| 30 Year Life Cycle Cost                | $38,000,000       |

Notes:

1. General Conditions include bonds, insurance, mobilization, demobilization, and site supervision.
2. Current market conditions indicate sufficient number of bidders for a project thus the adjustment is not currently applicable.
3. Engineering, legal, and administration fees included in Total Direct Cost for Full System Fluoride Removal component.

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment, nor services provided by others, contractor's means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.
## New Bluffs Wells Cost Summary (2008 Dollars)

<table>
<thead>
<tr>
<th>Project Components</th>
<th>Total Direct Costs</th>
<th>General Conditions(1)</th>
<th>Contingency</th>
<th>Contractor OH&amp;P and Risk</th>
<th>Sales Tax (Gross Receipts Tax)</th>
<th>Bid Market Allowance(2)</th>
<th>Total Estimated Construction Cost</th>
<th>Engineering, Legal and Admin. Fees</th>
<th>Owner’s Reserve for Change Orders</th>
<th>Total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Bluffs Wells</td>
<td>$1,641,700</td>
<td>$82,100</td>
<td>$517,200</td>
<td>$336,200</td>
<td>$214,000</td>
<td>$0</td>
<td>$2,791,200</td>
<td>$558,300</td>
<td>$139,600</td>
<td>$3,489,100</td>
</tr>
<tr>
<td>Transmission Piping</td>
<td>$4,859,900</td>
<td>$243,000</td>
<td>$1,530,900</td>
<td>$995,100</td>
<td>$633,200</td>
<td>$0</td>
<td>$8,262,100</td>
<td>$1,652,500</td>
<td>$413,200</td>
<td>$10,327,800</td>
</tr>
<tr>
<td>Flow Equalization Tank</td>
<td>$159,500</td>
<td>$8,000</td>
<td>$60,300</td>
<td>$32,700</td>
<td>$20,800</td>
<td>$0</td>
<td>$271,300</td>
<td>$54,300</td>
<td>$13,600</td>
<td>$339,200</td>
</tr>
<tr>
<td>Booster Pump Station</td>
<td>$548,100</td>
<td>$27,500</td>
<td>$172,700</td>
<td>$112,300</td>
<td>$71,500</td>
<td>$0</td>
<td>$932,100</td>
<td>$186,500</td>
<td>$46,700</td>
<td>$1,165,300</td>
</tr>
<tr>
<td>Booster Pump Station</td>
<td>$548,100</td>
<td>$27,500</td>
<td>$172,700</td>
<td>$112,300</td>
<td>$71,500</td>
<td>$0</td>
<td>$932,100</td>
<td>$186,500</td>
<td>$46,700</td>
<td>$1,165,300</td>
</tr>
<tr>
<td>New Township Line Rd Res</td>
<td>$611,100</td>
<td>$30,600</td>
<td>$192,600</td>
<td>$125,200</td>
<td>$79,700</td>
<td>$0</td>
<td>$1,039,200</td>
<td>$207,900</td>
<td>$52,000</td>
<td>$1,299,100</td>
</tr>
<tr>
<td>New O'Brien Road Reservoir</td>
<td>$574,100</td>
<td>$28,800</td>
<td>$180,600</td>
<td>$117,600</td>
<td>$74,900</td>
<td>$0</td>
<td>$976,300</td>
<td>$195,300</td>
<td>$48,900</td>
<td>$1,220,500</td>
</tr>
<tr>
<td>Hypochlorite Feed System</td>
<td>$102,700</td>
<td>$5,200</td>
<td>$32,400</td>
<td>$21,100</td>
<td>$13,400</td>
<td>$0</td>
<td>$174,800</td>
<td>$35,000</td>
<td>$8,800</td>
<td>$218,600</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>$308,100</td>
<td>$0</td>
<td>$92,500</td>
<td>$0</td>
<td>$33,300</td>
<td>$0</td>
<td>$433,900</td>
<td>$0</td>
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<td>$433,900</td>
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</table>

### Notes:

1. General Conditions include bonds, insurance, mobilization, demobilization, and site supervision.
2. Current market conditions indicate sufficient number of bidders for a project thus the adjustment is not currently applicable.

---

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. Carollo Engineers have no control over variances in the cost of labor, materials, equipment; nor services provided by others, contractor’s means and methods of executing the work or of determining prices, competitive bidding or market conditions, practices or bidding strategies. Carollo Engineers cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented as shown.
February 2, 2009

CERTIFIED MAIL

Michael Kitz  
Clallam County PUD #1  
Post Office Box 1090  
Port Angeles, Washington 98362-0207

Subject: Port Angeles Composite Water System, ID #432960, Clallam County; BCA #2009-BCA-0010

Dear Mr. Kitz:

The Port Angeles Composite Water System experiences seasonal water shortages in the Fairview service area. This is a concern to the Office of Drinking Water (ODW).

In order to address this issue and stay in compliance with the drinking water regulations, ODW requests that a Bilateral Compliance Agreement (BCA) be entered into. Please sign both copies of the enclosed BCA. Keep one for your records and return the other copy to ODW in the enclosed postage paid envelope by February 27, 2009.

For technical questions please contact Regional Engineer, Jozsef Bezovics at (360) 236-3034.
For questions regarding this BCA contact me at (360) 236-3027.

Sincerely,

Gael Kantz  
Compliance Program Manager

Enclosures

cc: Belinda Pero, Clallam County Health & Human Services  
Mary Peter, Department of Ecology  
Jozsef Bezovics, ODW
BILATERAL COMPLIANCE AGREEMENT
PORT ANGELES COMPOSITE WATER SYSTEM AND
WASHINGTON STATE DEPARTMENT OF HEALTH

DOCKET #2009-BCA-0010

The following compliance agreement is hereby established between the Washington State Department of Health (hereinafter, Department) and Clallam County PUD #1, the purveyor of the Port Angeles Composite Water System, ID #432960, a Group A community water system in Clallam County (hereinafter, purveyor).

This Bilateral Compliance Agreement (BCA) is based on Department of Health's concern about the lack of a reliable backup water source to support the upper Fairview service area. During low creek flows when the quantity of surface water from Morse Creek is limited, there may not be adequate supply to meet customer needs. WAC 246-290-420 stipulates that “all public water systems shall provide an adequate quantity and quality of water in a reliable manner at all times”.

The purpose of this compliance agreement is to:

- Outline actions the purveyor will take to address seasonal water shortages in the Fairview area.
- Afford the purveyor the opportunity to correct the problem.

The purveyor agrees to:

1. Feasibility Study. Submit a feasibility study no later than March 31, 2009. This study should evaluate possible options for eliminating seasonal water shortages in the Fairview area.

2. Select Option. Select an option to correct the seasonal water shortage by July 30, 2009.

3. Submit a proposed timeline. Submit a proposed timeline for project completion and implementation by July 30, 2009. The timeline should include:
   - Date for submittal of project documents for review and approval.
   - A construction schedule.
   - An implementation date.

A new BCA will be issued once the Department has accepted the timeline.
It is understood that failure to comply with this agreement without reasons acceptable to the Department may result in restricting system expansion at Fairview service area (1150, 1027, 989, 877, 847, 677, 667, and 607 Pressure Zones).

The Department agrees to:

1. **Respond to Submittals.** The Department shall review the purveyor’s submittal(s) on the above items and develop any new agreement(s) needed in response to those submittals.

2. **Renegotiate agreement.** The Department agrees to renegotiate the level of activity and/or schedules identified in this agreement if requested by the purveyor.

3. **Terminate agreement.** The Department agrees to terminate this agreement if requested by the purveyor.

All documents or reports required by this agreement, questions about compliance, and requests to modify this agreement shall be directed to Gael Kantz, Southwest Drinking Water Operations, Post Office Box 47823, Olympia, Washington 98504-7823.

Please include the docket number (2009-BCA-0010) in any submittals or correspondence regarding this BCA.

WASHINGTON STATE DEPARTMENT OF HEALTH

(Signature)

Clark Halvorson, Regional Office Manager
(title)

date: 2-3-2009
(phone: 360) 236-3025

CLALLAM COUNTY PUD 1 PORT ANGELES COMPOSITE WATER SYSTEM

(Signature)

(title)

date
(phone)
Public Utility District (PUD) No. 1 of Clallam County

Fairview Water System Supply Project

WATER REQUIREMENTS

REVISED DRAFT
October 2008
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## APPENDIX A - SAMPLE CALCULATIONS

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<tr>
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<td>Fairview Zoning</td>
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</table>
1.0 PROJECT OVERVIEW

The purpose of this project is to assess the Clallam County Public Utility District (District) Number 1’s water supply and water infrastructure needs for the Fairview Water System for a 30-year planning horizon. This will be accomplished by:

1. Analyzing the water demands over the 30-year planning horizon.

2. Investigating the feasibility of ground water resources around the Bluffs well, near the Agnew Well, and the southern portion of the area near Morse Creek as a potential aquifer storage and recovery (ASR) site to meet the projected 30-year water demands.

3. Investigating the feasibility of other water supply alternatives including: off-channel storage and treatment options, desalinized water from the sea, and an interconnection with the Port Angeles system to meet the 30-year water demands.

2.0 INTRODUCTION

The purpose of this memo is to present an analysis of historical water use in the project area from 2001 to 2007, and provide future water demand projections for the planning period of 2008 to 2038. Historical consumption and supply data are used to develop the value of an Equivalent Residential Unit (ERU) and the maximum-day peaking factor. These data are then used to convert the population projections into projected average and maximum day future demands for the planning period. The future water demand projections are used to analyze the Fairview Water Systems future water supply and infrastructure needs.

3.0 STUDY AREA AND SOURCES

The Fairview Water System is part of the Port Angeles Composite Water System, which includes: Gales Addition, Monroe Road (Local Utility District (LUD) No. 2), Mount Angeles (LUD No. 3), Four Seasons Park (LUD No. 6), Fairview (LUD No. 1), and Bluffs (LUD No. 11). The Fairview system includes both LUD No. 1 and LUD No. 11 and is approximately bounded by Morse Creek to the west, Shore Road to the east, the Olympic Mountains to the south, and the straight of Juan de Fuca to the north (Figure 1.1).

The District produces all of the water to supply the Fairview service area from three sources: the Morse Creek Water Treatment Plant (WTP), Township Line Road Well, and the Bluffs Well. The annual quantity of water produced is summarized in Table 1.1 below. These data were provided by the District as yearly averages.
Figure 1.1
Fairview Water System
Fairview Water Supply System Project
PUD No 1 of Clallam County
Table 1.1  Total Water Produced  
Fairview Water System Supply Project  
PUD No. 1 of Clallam County

<table>
<thead>
<tr>
<th>Year</th>
<th>Bluffs Well</th>
<th>Morse Creek</th>
<th>Township Line Rd. Well</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001(1)</td>
<td>18</td>
<td>112</td>
<td>0.13</td>
<td>130</td>
</tr>
<tr>
<td>2002(1)</td>
<td>21</td>
<td>116</td>
<td>0.14</td>
<td>137</td>
</tr>
<tr>
<td>2003(1)</td>
<td>25</td>
<td>124</td>
<td>0.12</td>
<td>149</td>
</tr>
<tr>
<td>2004(1)</td>
<td>16</td>
<td>127</td>
<td>0.10</td>
<td>143</td>
</tr>
<tr>
<td>2005(1)</td>
<td>17</td>
<td>100</td>
<td>0.18</td>
<td>117</td>
</tr>
<tr>
<td>2006(1)</td>
<td>40</td>
<td>84</td>
<td>0.09</td>
<td>124</td>
</tr>
<tr>
<td>2007</td>
<td>25</td>
<td>87</td>
<td>0.11</td>
<td>112</td>
</tr>
</tbody>
</table>

Note:  
(1) Until May 2006, water from Fairview was used to supplement Gales Addition. The amount was not metered and is included in the unaccounted-for water in Fairview.

4.0 EQUIVALENT RESIDENTIAL UNITS

The demand of each customer class can be expressed in terms of ERUs for forecasting and planning purposes. One ERU is defined as the average quantity of water beneficially used by one average, full-time, single-family residence. The quantity of water used by other customer classes, and by the whole system, can be expressed in terms of equivalent ERUs. The ERU calculation does not include non-revenue water or distribution leakage (discussed below in Section 4.0). Table 1.2 summarizes the average annual number of residential and commercial water connections while Figure 1.2 shows the historical annual average water consumption by customer classification.

Table 1.2  Historical Average Annual Number of Meters and Water Sales by Customer Class  
Fairview Water System Supply Project  
PUD No. 1 of Clallam County

<table>
<thead>
<tr>
<th>Classification</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Yearly Meter Connections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>1,239</td>
<td>1,271</td>
<td>1,307</td>
<td>1,345</td>
<td>1,398</td>
<td>1,442</td>
<td>1,466</td>
</tr>
<tr>
<td>Commercial</td>
<td>32</td>
<td>32</td>
<td>35</td>
<td>37</td>
<td>38</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>1,271</td>
<td>1,303</td>
<td>1,342</td>
<td>1,382</td>
<td>1,436</td>
<td>1,481</td>
<td>1,506</td>
</tr>
</tbody>
</table>

| Water Sales, MG | | | | | | | |
| Residential | 91 | 98 | 104 | 104 | 93 | 102 | 95 |
| Commercial | 10 | 13 | 9 | 10 | 10 | 10 | 9 |
| Total | 101 | 111 | 113 | 114 | 103 | 112 | 104 |
HISTORICAL ANNUAL WATER CONSUMED (MG)

FIGURE 1.2

PUD NO. 1 OF CLALLAM COUNTY
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
Based on the data from 2001 through 2007, the average quantity of water used by one typical, full-time single-family residence ERU is equal to 200 gallons per day (gpd). This number was arrived at by dividing the average annual residential demand by the average number of residential water connections. Sample calculations are provided in Appendix A. The average annual number of connections was used instead of year-end numbers because this value was more representative of the average condition and thus would provide a more accurate estimate of the average yearly ERU value. For demand forecasting, the average ERU value is typically not used since half of the yearly demand exceeds 200 gpd per ERU and thus the District would be dipping into their storage too frequently. However, the peak yearly demand is likely too conservative, as there is a possibility that the District may not see this demand in the future. So as to be more conservative than the average demand value but more realistic than the peak, a typical planning assumption is to select the 75th percentile average annual demand. For the District, the 75th percentile average demand is 212 gpd/ERU. The commercial planning value was also selected by determining the 75th percentile. Table 1.3 summarizes these data and shows that there are approximately 3.7 ERUs per account for the commercial customers.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Gallons per day per account</th>
<th>ERUs per Account</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>202 212 218 212 183 194 178 200</td>
<td>212</td>
</tr>
<tr>
<td>Commercial</td>
<td>822 1102 680 762 709 724 603 772</td>
<td>792</td>
</tr>
</tbody>
</table>

This is based on the planning value of 212 gallons per ERU. The planning values of 212 gpd/ERU and 3.7 ERUs per commercial account are consistent with the values used in the Port Angeles Composite Water System Plan (EES 2000) of 212 gpd/ERU and 3.6 ERUs per commercial account.

### 5.0 HISTORICAL WATER DEMANDS

The average and maximum water demands on the entire water system also significantly influence the system and supply analyses. Table 1.4 illustrates the historical average day demand (ADD), maximum day demand (MDD), and peaking factors from 2004 to 2007. For 2004 to 2007, the ADD varied from a low of 0.31 million gallons per day (mgd) in 2007 to a high of 0.39 mgd in 2004.

MDD is used for storage and fire flow analyses. Determination of MDD is critical because it is the benchmark for supply capability, pump station discharge rates, reservoir capacity, and pump sizes. The MDD represents the largest demand day for the system. The
calculated MDD from 2004 to 2007 fluctuates from year to year between 0.65 mgd and 0.91 mgd.

The peaking factor, shown in Table 1.4, is the relative magnitude of calculated MDD compared to ADD. Like the MDD, the peaking factor fluctuates. The recommended peaking factor for this planning period is calculated by using the 75th percentile of the peaking factor values between 2004 and 2007, which is 2.47. This planning value is higher than the peaking factor used in the Port Angeles Composite Water System Plan (EES 2000) of 1.92. Figure 1.3 provides a representation of the average monthly peak factor, which depicts the variation in the total system consumption throughout the year.

<table>
<thead>
<tr>
<th>Table 1.4 Historical Annual ADD, MDD, Peak Day, and Peaking Factor</th>
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<tbody>
<tr>
<td>Fairview Water System Supply Project</td>
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<td>PUD No. 1 of Clallam County</td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>ADD, mgd</td>
</tr>
<tr>
<td>MDD, mgd</td>
</tr>
<tr>
<td>Max Day</td>
</tr>
<tr>
<td>Peaking Factor(2)</td>
</tr>
</tbody>
</table>

Notes:
(1) Includes water distributed to Gales.
(2) Peaking factor is equal to the maximum day demand divided by the average day demand (MDD/ADD).

6.0 DISTRIBUTION LEAKAGE

Distribution leakage is calculated as the difference between the total amount of water produced and the sum of water sold and other authorized water usage. The Water Use Efficiency (WUE) Rule requires that the three-year average of distribution leakage be maintained at less than 10% of the supply. Distribution leakage does not include other authorized water usage such as water used for fire protection, flushing, construction, and other maintenance and operation practices. However, to be credited, this must be accounted for by metering or by estimating using credible means. All water that is not accounted for is considered distribution leakage.

Water purchased, water sold, and total distribution leakage for 2001 through 2007 are shown in Table 1.5. Over the past seven years from 2001 to 2007, distribution leakage averaged 16%. The distribution leakage has decreased since 2004. The distribution leakage has decreased in recent years due to the District’s aggressive leak detection and prevention program. Additionally, until May of 2006, water produced in Fairview was used to serve the Gales addition.
AVERAGE MONTHLY CONSUMPTION PEAK FACTORS FOR 2001 TO 2007

FIGURE 1.3
### Table 1.5

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>'05-'07 Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Produced, MG</td>
<td>130(1)</td>
<td>137(1)</td>
<td>149(1)</td>
<td>143(1)</td>
<td>117(1)</td>
<td>123(1)</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td>Total Sold, MG</td>
<td>101(2)</td>
<td>111(2)</td>
<td>113(2)</td>
<td>114(2)</td>
<td>103(2)</td>
<td>112(2)</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>Accounted-for Non-revenue, MG</td>
<td>0.09</td>
<td>0.07</td>
<td>0.44</td>
<td>0.12</td>
<td>0.16</td>
<td>0.43</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Distribution Leakage, MG</td>
<td>29(3)</td>
<td>26(3)</td>
<td>36(3)</td>
<td>28(3)</td>
<td>14(3)</td>
<td>10(3)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Distribution Leakage (% of Total Produced)</td>
<td>22(3)</td>
<td>19(3)</td>
<td>24(3)</td>
<td>20(3)</td>
<td>12(3)</td>
<td>8(3)</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

**Note:**

(1) Includes water distributed to Gales.
(2) Does not include any water sold to Gales.
(3) Artificially high, due to unaccounted for water distributed to Gales.

This water use was unmetered and thus was reported as un-accounted for water use, resulting in a falsely high distribution leakage value for 2001 through 2006. The three-year average was calculated using the years 2005 through 2007 at 9% of the supply, which is less than the WUE rule requirement of 10%. Since the distribution leakage was artificially elevated in previous years, the three-year average value of 9% was used for planning purposes. This planning value is less than the value used in the Port Angeles Composite Water System Plan of 16% (EES 2000).

### 7.0 PROJECTED GROWTH RATES

Many factors influence population growth. The state of the economy, interest rates, annexation of adjacent areas and up-zoning all influence new development and population growth. Growth management policies, along with coordination between local governments, should make development more predictable and growth projections more accurate than they have been historically. However, significant changes to the regional economy will continue to affect growth timing and patterns. It is not uncommon for actual growth rates within the County to vary from those predicted. In addition, growth rates will vary between different parts of the County based on the availability of services and the costs to develop the land for the zoned use. Although these factors were considered in developing the information included within this technical memorandum, it should be noted that the rates of future growth will likely vary from those described here due to the shifting of growth between areas within the County and between the County and adjoining jurisdictions.
Four different growth scenarios were evaluated in this memorandum: (1) the current growth rate based on historical data from 2001 though 2007, (2) the overall rural population growth rates (from County Code [CC] 31.02.230 Table 6), (3) the Port Angeles population growth rate (from CC 31.02.230 Table 3), and (4) the Carlsborg population projection (from CC. 31.02.230 Table 4). For each of these scenarios, the data presented was best fit with a linear growth assumption. However, based on discussions with the District staff, a more conservative compound growth rate was assumed. The following sections describe each of these growth scenarios.

### 7.1 Historical Growth

Figure 1.4 shows the historical residential and commercial growth from 2000 through 2007 and the projected growth assuming a compound growth rate based on the average yearly growth rate from 2000 through 2007 (2.84% for residential and 3.57% for commercial). Assuming that the commercial and residential populations can grow without any zoning restrictions (discussed in Section 7.5), the residential population could grow to approximately 3,492 connections by the year 2038 and the commercial population would grow to approximately 118 connections by the year 2038.

### 7.2 Rural Growth Rate

CC 31.02.230 Table 6 presents the rural population estimates for Clallam County for 1990, 2000 and 2010 as summarized in Table 1.6. The population estimate equates to an annual compound growth rate of 0.94%. Applying this growth rate to the 2007 residential meter connections yields 1,959 residential meter connections by the year 2038.

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>2000</th>
<th>2010</th>
<th>Compound Growth Rate, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>29,536</td>
<td>32,684</td>
<td>35,590</td>
<td>0.94%</td>
</tr>
<tr>
<td>Port Angeles</td>
<td>17,710</td>
<td>18,382</td>
<td>19,053</td>
<td>0.37%</td>
</tr>
<tr>
<td>Carlsborg</td>
<td>655</td>
<td>885</td>
<td>1,120</td>
<td>2.72%</td>
</tr>
</tbody>
</table>

### 7.3 Port Angeles Growth Rate

CC 31.02.230 Table 3 presents the City of Port Angeles population estimates for 1990, 2000 and 2010 based on a linear projection model. These populations estimates are summarized in Table 1.6 and equate to an annual compound growth rate of 0.37%. Applying this growth rate to the 2007 residential meter connections yields 1,644 residential meter connections by the year 2038.
FIGURE 1.4
FAIRVIEW WAER SUPPLY SYSTEM PROJECT
PUD NO 1 OF CLALLAM COUNTY

HISTORICAL GROWTH RATE

Residential Meter Connections

Commercial Meter Connections

Residential Compound Growth Rate Projection

Commercial Compound Growth Rate Projection

0 500 1,000 1,500 2,000 2,500 3,000 3,500
0 20 40 60 80 100 120 140

Residential

Commercial
7.4 Carlsborg Growth Rate

CC 31.02.230 Table 4 presents the Carlsborg population estimates for 1990, 2000 and 2010 based on the observed average growth rate over the 10 years prior (1980 through 1990). These populations estimates are summarized in Table 1.6 and equate to an annual compound growth rate of 2.72%. Applying this growth rate to the 2007 residential meter connections yields 3,369 residential meter connections by the year 2038.

7.5 Selected Growth Rate and Timing of Saturation

The four residential meter connection growth rate curves are presented in Figure 1.5. As can be seen from this figure, the residential meter connection projections using the historical and Carlsborg growth rates are quite similar and significantly higher than the residential projections using the Port Angeles or Rural population growth rates. The 2038 residential connection numbers range from 1,644 using the Port Angeles projected growth rate to 3,492 using the historical growth rate. So as to be conservative, the historical growth rate of 2.8% was selected for planning purposes. This growth rate is significantly higher than the 1% per year growth rate assumed for the Port Angeles Composite Water System Plan (EES 2000).

The current and saturation projections were obtained from the Clallam County Department of Community Development based on zoning classification in August of 2008. The distribution system achieves saturation when the number of actual connections (either commercial or residential) equals the number of connections allowed per County zoning for that type of connection.

It was assumed that the current zoning numbers are representative of 2008 and thus the average yearly number of residential and commercial connections for 2008 was estimated by extrapolating the 2007 yearly value (from Table 1.2) by historical growth rates summarized in Section 7.1). The saturation projections are assumed to represent the number of connections at the year the Fairview water system reaches saturation and can grow no further without changing zoning requirements. A map of the zoning classifications are presented in Figure 1.6 along with the projections presented in Table 1.7. The County is currently evaluating their zoning densities for Growth Management Act (GMA) compliance and has established interim zoning densities to allow for development during the evaluation period. These interim zoning densities were used to establish the saturation population. Additionally, the zoning numbers do not account for encumbrances from critical areas and other zoning requirements.
Table 1.7  Saturation Projections
Fairview Water System Supply Project
PUD No. 1 of Clallam County

<table>
<thead>
<tr>
<th>Customer Class</th>
<th>Current Zoning (2008)(^{(1)})</th>
<th>Projected 2008 Connections(^{(2)})</th>
<th>Difference</th>
<th>Saturation Zoning(^{(1)})</th>
<th>Saturation Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1,764</td>
<td>1,508</td>
<td>85%</td>
<td>3,072</td>
<td>3,072</td>
</tr>
<tr>
<td>Commercial</td>
<td>31</td>
<td>41</td>
<td>132%</td>
<td>82</td>
<td>109(^{(3)})</td>
</tr>
</tbody>
</table>

Notes:
(1) Based on zoning information obtained from the County.
(2) Based on customer connection data, presented in Table 1.2. The number of connections was extrapolated to 2008 by the average compound growth rate of the meter connections over the 2001 to 2007 period (2.84% for residential and 3.57 for commercial). Calculations shown in Appendix A.
(3) So as to be conservative, the number of commercial saturation connections was increased by 132% (or the ratio of the 2008 projected meter connections to the 2008 zoning numbers).

It is assumed that the current and saturation commercial customers include the general commercial (GC), rural limited commercial (RLC) and rural neighborhood commercial (RNC) zoning classifications. Likewise, the current and saturation residential customers include the rural (R1), rural moderate (R2), rural low (R5), rural character conservative 3 (RCC3) and rural character conservative 5 (RCC5) zoning classifications.

The Current Zoning estimate from the County for the Residential Customer Class exceeds the number of the District’s projected connections in 2008. This is not unreasonable, as not all residential areas in the service area may be serviced by District water. For example, some households may be connected by private wells. On the other hand, the Commercial Customer Class has more projected connections in 2008 than the County zoning estimate. It is assumed that the existing commercial class customers may not be located in commercial zoned areas. However, for the future saturation condition, the commercial connections were increased by the ratio of the 2008 connections to the current zoning to account for the increased commercial connections.

Based on the selected historical growth rates for commercial and residential connections, saturation occurs in the year 2033 for the residential population and in the year 2036 for the commercial population. The calculation for commercial saturation used 109 connections at saturation instead of 82.
8.0 PROJECTED WATER DEMAND

Projecting future water demand is one of the key elements of the comprehensive water system planning process. Identification of system improvements such as supply, pumping, storage and piping requirements are all related to demand projections.

Future water system demands are based on projected ERUs, which in turn are based on the projected water consumption by customer classification and the projected number of accounts discussed earlier in this memo. Based on the previous analysis, it is assumed that one residential connection equals 1 ERU and one commercial connection equals 3.7 ERUs. Table 1.8 summarizes projected ERUs over the planning period and for the anticipated saturation demand (calculations shown in Appendix A). Since saturation is reached within the planning period we assume that growth halts without a zoning change, and thus the number of ERUs estimated for the year 2038 equal the projected saturation number of ERUs.

<table>
<thead>
<tr>
<th>Table 1.8 ERU Projections</th>
<th>Fairview Water System Supply Project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PUD No. 1 of Clallam County</td>
</tr>
<tr>
<td>Customer Class</td>
<td>2008 Connections</td>
</tr>
<tr>
<td>Residential</td>
<td>1,507</td>
</tr>
<tr>
<td>Commercial</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>1,549</td>
</tr>
</tbody>
</table>

The future demand projections for 2038 and saturation ADD and MDD are calculated based on a water use scenario that assumes continued water use practices without additional conservation.

The daily customer demand for each service area is based on multiplying the projected ERUs in its corresponding service area by the planning value of 212 gpd per ERU. The customer demand (revenue water) accounts for 91% of the total ADD water demand with 9% assumed for system leakage. The projected ADD to MDD peak factor is 2.47. The total projected ADD and MDD are summarized in Table 1.9.

The 2038 ADD demand is projected at 0.81 mgd while the 2038 MDD is projected at 2.00 mgd. Both projections represent an increase of 109% over the calculated 2008 demands.
Table 1.9  ADD and MDD Projections
Fairview Water System Supply Project
PUD No. 1 of Clallam County

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2038 Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERUs</td>
<td>1,661</td>
<td>3,480</td>
</tr>
<tr>
<td>Average daily retail water use, mgd(^{(1)})</td>
<td>0.35</td>
<td>0.74</td>
</tr>
<tr>
<td>Average daily leakage, mgd(^{(2)})</td>
<td>0.04</td>
<td>0.07</td>
</tr>
<tr>
<td>ADD, mgd</td>
<td>0.39</td>
<td>0.81</td>
</tr>
<tr>
<td>MDD, mgd(^{(3)})</td>
<td>0.96</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Notes:
(1) Assumes 212 gpd/ERU.
(2) Assumes the leakage is 9% of the ADD.
(3) Calculated by multiplying the ADD by the peak factor of 2.47.

9.0 CONCLUSIONS

Based on the analysis for water supply and sales data from 2001 though 2007 and current water system growth rates over the same period, ADD and MDD were calculated for the year 2038. The projected 2038 ADD is 0.81 mgd while the projected 2038 MDD is 2.00 mgd.
Table 1.3: 2001 Residential ERU Calculations

2001 average yearly residential Water sales / 2001 average yearly meter connections

91.2 MG / 1239.1 Connections / 365 days * 1,000,000 (gal/MG) = 201.6 gpd/ERU

Table 1.7: Projected 2008 Residential Connections

Average yearly 2007 residential connections * (1 + residential growth rate)

1,465.8 + (1+0.0284) = 1,507.4

Table 1.7: Projected 2008 Commercial Connections

Average yearly 2007 commercial connections * (1 + commercial growth rate)

39.7 + (1+0.0357) = 41.1

Table 1.8: 2008 ERUs

Projected 2008 residential connections + projected 2008 commercial connections * ERU/connection for commercial accounts

1,507.4 + 41.1 * 3.74 = 1661.1

Table 1.8: 2038 ERUs

Projected 2038 residential connections + projected 2038 commercial connections * ERU/connection for commercial accounts

3,072 + 109 * 3.74 = 3,480
Table 1.9: 2008 ADD

2008 ERU * gpd/ERU + Leakage rate * 2008 ADD = 2008 ADD

2008 ADD (1 - leakage rate) = 2008 ERU * gpd/ERU

2008 ADD = 2008 ERU * gpd/ERU / (1 - leakage rate)

2008 ADD = 1661 * 212 / (1 - 0.09) / 1,000,000 (gal/MG) = 0.39 mgd

Table 1.9: 2008 MDD

2008 MDD = 2008 ADD * MDD/ADD peak factor

2008 MDD = 0.39 * 2.47 = 0.96
PUBLIC UTILITY DISTRICT NO. 1
OF CLALLAM COUNTY, WASHINGTON
FAIRVIEW WATER SYSTEM SUPPLY PROJECT

December 2008

by

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PUBLIC UTILITY DISTRICT NO. 1
OF CLALLAM COUNTY, WASHINGTON
FAIRVIEW WATER SYSTEM SUPPLY PROJECT
December 2008

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APPENDIX A
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APPENDIX B
Cross Section Well Log Information Table
Ecology & Robinson, Noble & Saltbush Well Logs
Executive Summary

As part of a larger planning study, Robinson, Noble & Saltbush was retained to determine what options the Clallam County PUD No. 1 (PUD) has with regard to the use of ground water to enhance their source water availability for the Fairview Water System. The evaluation quickly settled on the examination of three basic concepts: the improvement of the Bluffs source by moving the withdrawal inland, the drilling of a deep well or wells to tap ground water of the area east of Agnew, and the use of groundwater storage near Morse Creek to accomplish aquifer storage and recovery (ASR) using the Morse Creek surface water right.

Each of these concepts was investigated, and hydrogeologic settings were defined to the degree possible with existing information. No field efforts or original data generation was accomplished as part of this investigation. Publications from the Washington Department of Natural Resources, the US Geological Survey, and the Washington Department of Ecology were particularly helpful in defining the geologic and hydrogeologic aspects of the studied areas. Well logs from Department of Ecology and Robinson & Noble files helped to provide site-specific information in some cases. Possible approaches for each of the three concepts were identified. The most practical approach to achieving the desired source enhancement was assessed for practical applicability for each of the concepts. A recommendation was ultimately developed for each of the three sub areas of the investigation. Additionally, basic impact assessments were done to identify significant impact implications of each considered source enhancement.

The best solution to the Bluffs Well problem is clearly to move the production authorized by the water right to points farther inland. The most practical approach appears to be the placement of three wells at an approximate distance of a half-mile inland. This would place a line of wells parallel to the coastline near Lemmon Road, Gasman Road, and the Old Olympic Highway. Such wells can be expected to make between 100 and 300 gpm under the acceptable pumping constraints imposed by the setting. Provided the aquifer characteristics encountered are similar to those exhibited at the current Bluffs Well, over 400 gpm per well may be possible. At that rate, the three wells should provide sufficient production potential to exercise the water right. At that production rate, an additional annual allocation will be needed to produce at full capacity for more than 35 days per year. A well capable of producing 400 gpm drilled to the Middle Aquifer (Bluffs Aquifer) is estimated to cost $230,000. At a minimum, three such wells would be needed to achieve the instantaneous capacity allocated in the Bluffs water right.

The production of deep ground water in the Agnew area appears to be likely. However, deep exploration drilling will be needed to confirm and define that availability. The area appears to have two deep aquifers beneath it, the Lower Aquifer (defined by Thomas, 1999) found between 250 and 400 feet below sea level and a deeper aquifer herein named the Deep Aquifer which lies between 600 and 800 feet below sea level. The two aquifers are separated by a substantial layer of silt and clay that is at least locally 250 feet thick. Production potential of a properly constructed production well in the Lower Aquifer is estimated to be about 300 gpm. The single well completed in the Deep Aquifer may have a production potential of around 700 gpm.

An 8-inch diameter mud-rotary exploration well drilled to at least 800 to 1,000 feet below sea level is recommended to define the full groundwater potential of the site. A drilling site east of Agnew and north of the Old Olympic Highway is recommended. The farther east the better from a hydrogeologic perspective since the bedrock surface becomes steadily deeper to the east. The cost of a 1,000-foot deep, 8-inch diameter, mud-rotary test well is estimated to be $280,000. This
includes the costs for the drilling contractor, the hydrogeologic services, and a geophysical survey of the borehole.

The third aspect of the source enhancement assessment examined the possibility of using storage characteristics of the groundwater systems east of Morse Creek to overcome the interruptible nature of the Morse Creek surface water right. In practice, the diversion would take additional water out of Morse Creek when flows are sufficiently high and use that water to surcharge a groundwater system capable of storing the water long enough to make it available to serve the Fairview Water System during low-flow periods. The preliminary investigation found sufficient promise, using sediment-filled bedrock structures east of Morse Creek, to suggest this concept is worthy of further consideration. However, there is insufficient information regarding the site-specific bedrock configuration or the nature of the filling sediments to discuss specific areas where the concept could be applied. Previous testing of sediments tapped by the PUD’s Deer Park Road Well (DPRW) indicate that site may be marginally acceptable, though a more permeable site would be preferred. A more detailed analysis of this area is warranted areas further north may also hold some potential.

If an ASR program were to be considered by the PUD, it will require substantial regional characterization including geophysical surveys and test drilling to determine whether areas with sufficient potential exist in reasonable proximity to the Morse Creek facility to be worth pursuing. If promising areas were located, extensive studies will be required to verify its suitability and to provide the necessary information required for the ASR regulatory process. An ASR exploration, development, and permitting process could not realistically be achievable in less than 10 years and would involve a substantial investment.

Though all three possible avenues for enhancing the Fairview water source situation were found to show at least some promise, the placement of inland wells to exercise the Bluffs Well water right seems the most cost effective in the short term. It is also likely that exploratory drilling east of Agnew will result in additional groundwater production. This requires deep drilling and an up-front cost for exploratory drilling. The deeper sources will require more than two years to develop by following a normal schedule of deep test drilling and subsequent production well drilling. The possibility of using ASR techniques to enhance the timing of the Morse Creek surface water facility is speculative at this point and will require significant time and expense before any real-world advantages could be achieved.
1.0 Introduction

The Fairview Water System currently has two primary water sources, Morse Creek and the Bluffs Well. In addition, the Fairview system has an intertie with the City of Port Angeles water system. Clallam County Public Utility District Number 1, herein referred to as the PUD, would like to develop new sources to provide non-interruptible, sustainable production. More important, however, is the PUD’s desire to obtain new annual water rights to meet the future needs of the Fairview area.

Three alternatives have been proposed for providing additional water resources for the Fairview Water System. The first is to fully develop the Bluffs Well water right through a replacement well and/or additional points of withdrawal. The second is to develop a new, deep well source northeast of Agnew and obtain a new water right for the source. The third is to develop an aquifer storage and recovery (ASR) program, including obtaining ASR water rights, in the Morse Creek region.

The first alternative is to replace the existing Bluffs Well and/or construct additional points of withdrawal to fully use the existing water right. These wells would be drilled along a line parallel to the coastline, inland by at least one-half mile. This distance from the shoreline should be sufficient to make seawater intrusion into the Bluffs Aquifer much less likely than is present for the existing well.

The Agnew test well, drilled for the PUD in 1992, penetrated to a depth of 608 feet but did not result in a usable, deep water source. However, several other deep wells east and northeast of Agnew have shown more positive results. The second alternative is, therefore, to establish an additional, new source of water in a deeper aquifer system at a location east of the original Agnew exploration site. If successful, a new water right will be required.

The third alternative involves identifying an area along Morse Creek to act as an underground reservoir for winter flow from the creek. Such an ASR program, if appropriate, would look for sediments with sufficient storage capability to hold surplus wet season water from Morse Creek. Stored water could later be used to reduce supply interruptions during low flow periods. An ASR water right and a reservoir storage right would have to be obtained for this project prior to developed ASR facilities becoming operational.

1.1 Background

The primary source of water for the Fairview System is the surface water of Morse Creek. The Morse Creek water right allows diversions of up to 1.5 cubic feet per second (cfs), equal to 673 gallons per minute (gpm). However, the water right is interruptible and the water is not available when the flow of Morse Creek at the Department of Ecology’s (Ecology) gauging station (18C150) falls below 25 cfs. Average use is about 0.84 cfs (375 gpm) and peak use is reported to be 1.34 cfs.
The Morse Creek water treatment plant was upgraded with a new membrane filter in 2006. Two reservoirs of 300,000 and 200,000 gallons capacity help to distribute water north toward the Strait of Juan de Fuca by gravity flow.

The Bluffs Well ground water right allocates 1,350 gpm of instantaneous supply and 187 acre-feet per year (afy) of annual volume (61 million gallons per year). One acre foot of water is equal to 325,851 gallons. Pumping at a rate of 400 gpm, the Bluffs Well would produce its authorized annual volume in 105 days of continuous operation. The existing well was drilled in 1973 to a depth of 214 feet, at a location roughly 800 feet from the shoreline. It is completed with 10 feet of stainless steel well screen between 196 and 206 feet below ground surface (about 25 feet below mean sea level). On one occasion the well was pumped continuously for two months at a rate of 400 gpm. This pumping episode induced salt water into the aquifer. The Bluffs Well is not used as a primary supply well due to its limited annual water rights but is used as a back-up supply to meet peak system demands. Additional annual water rights would likely be needed were this source to be fully utilized through the expanded well field as proposed in this report.

The PUD invested in exploration of deeper aquifer options in 1992. This effort involved placement of a deep test well near the community of Agnew that was unsuccessful in identifying water of suitable quantity or quality. This test well is not used as a source, and further exploration at this site has not been attempted. It is possible that deeper aquifers, such as those penetrated by the Weyerhaeuser Seed Farm Well nearly a mile east of the Agnew site, might have sufficient production potential to be of interest to the PUD. The probability of encountering such deep sources increases to the east, where this study found unconsolidated sediments to thicken and exhibit improved aquifer characteristics compared to sediments nearer to Agnew.

One mechanism whereby the interruptible Morse Creek right might be made more reliable during low-flow periods would be to allow the annual quantity to be removed during high-flow periods with surplus diversion routed to an aquifer storage facility within proximity to the Morse Creek Treatment Facility. If aquifer storage is demonstrated to be of sufficient duration and volume, stored water could be recovered during the low-flow, restricted periods. Ideally, this could make the source reliable throughout the year (or at least not subjected to interruption as frequently).

1.2 Fairview Study Area

Robinson, Noble & Saltbush hydrogeologists reviewed available documents related to the geology and hydrogeology of the Fairview study area, shown on Figure 1 located in Appendix A. The study area is bounded on the north by the Strait of Juan de Fuca, on the west by Morse Creek, by the Dungeness River to the east, and to the south by Tertiary bedrock exposed at land surface south of Highway 101. Analyses of the three specific areas of interest were performed to identify the potential for achieving additional production capacity and reliability for the Fairview System.

Water well logs for the study area were downloaded and reviewed from Ecology’s well database. Well logs were used to develop conceptual cross sections for the Bluffs Well aquifer and for the lower aquifer system near the Agnew area. The conceptual hydrogeologic cross sections are shown on Figures 3, 4, 5, and 7 and are included in Appendix A. Copies of well logs used for the cross sections are included in Appendix B.

The potential for an ASR program to enhance the effectiveness and reliability of the Morse Creek surface-water source was assessed using existing published geologic and hydrogeologic reports, and other existing non-published reports by consultants to the PUD.
1.3 Geology and Hydrogeology

The geology of the study area is thoroughly described in several Washington State Department of Natural Resources (DNR) open file reports: the *Geologic Map of the Carlsborg 7.5-minute Quadrangle* (Schasse and Weghmann, 2000), the *Geologic Map of the Morse Creek 7.5-minute Quadrangle* (Schasse and Polenz, 2002), and the *Geologic Map of the Sequim 7.5-minute Quadrangle* (Schasse and Logan, 1998). Geologic cross sections published in the DNR reports are presented as Figures 2 and 6 in Appendix A. These cross sections (A-A’, B-B’, and F-F’) display the general trend of the bedrock geology and show the bedrock surface declines steeply to depths considerably below sea level north of Highway 101. The bedrock surface also becomes deeper eastward and is substantially below sea level at locations north and east of Agnew.

The hydrogeology of the study area is described in Water Supply Bulletin No. 11, “A Preliminary Report on the Geology and Ground-Water Resources of the Sequim-Dungeness Area, Clallam County, Washington”, by John B. Noble (1960). The *Hydrogeologic Assessment of the Sequim-Dungeness Area, Clallam County, Washington*, USGS Water-Resources Investigations Report 99-40-48 (Thomas and others, 1999) expands Noble’s report to a larger area. The USGS Water-Resources Investigations Report 83-4227 by B.W. Drost (1983), *Water Resources of Clallam County, Washington*, lists well and water data for the entire county. In 1985 Robinson & Noble, Inc. wrote a report for the PUD entitled *Ground Water Studies—McDonald Creek Deep Aquifer*. This report evaluated in more detail the aquifers west of Siebert Creek and east of McDonald Creek. Currently a three-dimensional numerical model is being developed for the study area using the USGS MODFLOW code. Though this model was to be available to the project, the model was delayed by calibration issues and was not ready for application to this effort. Delivery of the model is predicted to occur within a few months, and Ecology’s use of that model in assessing some aspects of the PUD’s projects is likely.

The available reports listed above indicate that multiple glaciations deposited a complex series of sediments upon the consolidated rock comprising the north flank of the Olympic Mountains. Noble describes a wedge of the sediments deposited east of the Dungeness River. This description is also conceptually valid for deposits west of the river in the Fairview study area. The underlying bedrock in the area is shown in the DNR reports to be sloping north and east. Therefore, the thickness of potentially water-bearing sediments increases to the north and east. For example, bedrock is seen at the surface where Highway 101 crosses Siebert Creek, but a Standard Oil test well penetrated more than 2,000 feet of sediments overlying bedrock northeast of Sequim, nine miles east of the Highway 101 Siebert Creek exposure.

Thomas and others (1999) describe the three aquifers found in the area as Shallow, Middle, and Lower. The Shallow Aquifer is usually found within 100 feet of the surface and is unconfined to semi-confined. It may have locally perched zones where it occurs nearer land surface. The Middle Aquifer is generally found from about 50 feet above to 150 feet below sea level. Though the Middle Aquifer is believed to be continuous along the coast eastward from the Bluffs Well to beyond the Agnew area, we have assigned the name Bluffs Aquifer to the position of the Middle Aquifer in the Bluffs area. This allows discussion of specific aquifer characteristics in the Bluffs area without implications that those conditions are applicable to all areas where the Middle Aquifer exists. The Lower Aquifer system is found between 300 and 500 feet below sea level. Thomas and others (1999) do not specifically discuss the yet deeper water-bearing sediments occurring around 600 to 750 feet below sea level. They identify these sediments in their cross sections as undifferentiated unconsolidated deposits. These deeper water-bearing sediments, penetrated by only one well in the study area (reference number 9L1), are herein referred to as the Deep Aquifer.
The study area receives an average of less than 17 inches of precipitation annually due to its position in the rain shadow of the Olympic Mountains. However, Noble (1960) found that the availability of ground water was quite high. He theorized that the source of additional recharge is the large amount of precipitation falling in the mountains. He contends runoff from the mountains recharges shallow groundwater systems through losing reaches of streams and rivers as they cross the coastal plain before discharging into the Strait of Juan de Fuca. A secondary source of recharge is from irrigation water diverted to the coastal plain from the creeks and rivers through a system of open channel canals and ditches. Leakage from the irrigation canals and ditches is speculated by both Noble and Thomas to be substantial. That leakage provides recharge to the groundwater system. Recent work by the Dungeness River Management Team, as expressed in public meetings, has pressed for lining of irrigation conveyances (or the tight lining of them altogether). The implications of the proposed irrigation leakage reduction are not fully defined, but it is expected that the resultant reduction in recharge would be sufficient to require its consideration in future groundwater management.

2.0 Bluffs Well

In 1977, Robinson & Noble was asked by the PUD to provide an analysis of the potential safe yield of the Bluffs Well. John Robinson’s March 1st letter report concluded that:

“There is no possibility that a well or wells at this location could safely yield enough water to satisfy the requirements estimated to be between 1,000 and 1,350 gpm for the proposed water district. The ultimate answer to the water supply for this district would involve a series of 3 or more widely spaced wells placed at least ½-mile inland to minimize the risk of drawing in salt water to the system. The best location for these wells would depend on a thorough study of the geology and existing wells before outlining drilling areas.”

2.1 Conceptual Model of the Bluffs Aquifer

Thomas and others (1999) provide a detailed look at the Middle Aquifer (and, therefore, at the Bluffs Aquifer which is a sub-unit of the Middle Aquifer). They report the Middle Aquifer is found from Morse Creek to Sequim Bay. We have created a conceptual model for the Bluffs portion of the study area using well logs collected from Ecology’s database. Most domestic wells in the area were drilled into the Shallow or Middle (Bluffs) Aquifers and did not fully penetrate those aquifers. We have created three conceptual hydrogeologic cross sections, presented as Figures 3 through 5, to provide a visual representation of the Bluffs Aquifer. These cross sections are described below.

Section C – C’ (Figure 3) starts with the Bluffs Well and trends south to a bedrock high located south of Highway 101. The Shallow Aquifer is not very well defined by the cross-section wells in the sub area, however, the Bluffs Aquifer (Middle Aquifer) appears consistent through the section and is tapped by at least one well (10P1) near the southern bedrock boundary of the aquifer. The conceptual cross-section indicates the Bluffs Aquifer exists at elevations of approximately 10 feet above to 80 feet below sea level.

Section D – D’ (Figure 4) is a southwest to northeast cross section starting in the northeast quarter of section 16 near Bagley Creek Road and ending beyond the northeast corner of section 11 along the Strait of Juan de Fuca. The Bluffs Aquifer is shown in the conceptual cross section ranging from 30 feet above sea level on the eastern end to 90 feet below sea level on the western end.
Section E – E’ (Figure 5) is oriented north to south on the east side of the Bluffs sub area. The section starts just west of Green Point at the Strait of Juan de Fuca and ends southeast near the point where Highway 101 crosses Siebert Creek. The conceptual cross section indicates the elevation of the Bluffs Aquifer ranges from 16 feet above sea level to 20 feet below sea level near Green Point and 40 to 70 feet below sea level near Siebert Creek Road.

The Bluffs Aquifer is generally found from a few feet above sea level to approximately 90 feet below sea level. It disappears to the southwest where the slope of the bedrock intercepts the sediments at these depths. Bedrock becomes deeper to the north and east. Several well logs indicate the bottom of the Bluffs Aquifer is bounded by clay sediments, although the log of well 10 P1 indicates some water-bearing sand and gravel are interbedded with layers of clay. If the PUD drills new wells targeting the Bluffs Aquifer, they should be drilled to sufficient depth to be sure of full penetration of the aquifer.

The Bluffs Well log (reference number 10 F1) shows the aquifer is 30 feet thick at that location. The well is completed about 25 feet below sea level. We know from the PUD’s operation of the well that the aquifer is capable of providing at least 400 gpm of good quality water with about 4.5 feet of drawdown over the short term. However, the duration of pumping must be limited to less than 60 days to prevent seawater intrusion. Another well (10 B1) located about ¼ mile to the northeast is also reported to be very productive with a pumping test showing 2.5 feet of drawdown at 170 gpm. Its log shows only 16 feet of aquifer thickness. Because it is located close to the shoreline, it is also susceptible to seawater intrusion if it is pumped too long at too high a pumping rate. No other wells had adequate test information to justify comparison. Static water level elevations are critical to the safe operation of near-shore production wells and should be surveyed with reference to a known datum. Ideally, pumping water levels should be maintained above mean tide level (MTL) to prevent seawater intrusion.

2.2 Potential Drilling Areas

We reviewed well logs in the south half of sections 10 and 11 and the full areas of sections 14 and 15 west of Siebert Creek in an effort to define the Bluffs Aquifer at a distance of at least one-half mile from salt water. This is the closest advisable distance to move the Bluffs withdrawal to achieve a more reliable source. Though it is possible that the withdrawal could be achieved from the Middle Aquifer further inland, this would require moving the point of withdrawal substantially eastward. The movement of the withdrawal to points east of Siebert Creek would likely complicate the water right change process. For that reason the analysis of source potential and potential impacts was performed for the half-mile distant line of wells discussed below. If water right change issues and the expense of transmission lines do not make such a change impractical, there is no reason that the Bluffs water right could not be exercised at a point farther east and farther from the coast. The nearby wells completed in the Bluffs Aquifer in this area did not show high production potentials (based on information presented on the well logs). However, these wells were drilled as domestic sources and typically only penetrated enough of the aquifer to obtain sufficient water for a single household.

We propose drilling, depending upon property availability, along Lemmon and Gasman Roads, or along the Old Olympic Highway between Gasman Road and Siebert Creek. The selected location should be north of U.S. Highway 101 as Figures 3 and 5 display the Bluffs Aquifer intercepting bedrock south of the highway. Test/production wells, constructed with 12-inch casing, should be drilled to a depth of 150 feet below sea level in order to assure the wells fully penetrate the variable production zones of the Bluffs Aquifer. We expect a production well will be capable of
producing between 100 and 400 gpm depending upon the thickness and permeability of the Bluffs Aquifer at the selected well site. The recommended search area for the well sites is indicated on Figure 1.

If the District were to desire to move the Bluffs water right eastward, property in the north half of section 13 in the vicinity of Shore Road would be a reasonable place to search for property. This may complicate the processing of a water right change given the fact that the withdrawal might then include potential impacts to the lower reaches of McDonald Creek where the Middle Aquifer may have continuity. If the District were to pursue additional annual allocation for the water right and were willing to mitigate any identified impact to the surface waters of the area, the pursuit of source wells further east and inland would be worth considering. This option is sufficiently speculative and dependent upon decisions not yet made that it has not been thoroughly investigated with regard to potential impact issues.

2.3 Analytical Aquifer/Well Response Modeling

For the sake of assessing the potential for impact from the proposed wellfield approach to production in the Bluffs sub area, three specific locations for new wells were speculated. The locations chosen for the analyses are shown on Figure 1 and should not be construed as specific recommendations for drilling sites. The sites were selected to be more than one-half mile from salt water. Basic aquifer characteristics were used to generate an analytical flow model to predict the response of the groundwater system under various production scenarios. The computer program AquiferWin32 (version 3.26) was used.

The analysis was performed in order to 1) predict the level of interference that might be imposed on senior wells as a result of the proposed production from the new wells under various production scenarios and to 2) examine the likely drawdown that would be imposed at the coastline. The model code is limited to a one-layer homogeneous aquifer. Since the analysis was performed to define the drawdown distribution, aquifer gradient and recharge were not applied in this analysis. The drawdown distribution was used to predict the likely interference at three specified points along the shoreline. These shoreline points are represented in the model as observation wells and their locations on the shoreline are shown on Figure 1 as locations A, B, and C. These are theoretical points with no known physical characteristics. Therefore, we do not know the thickness of the aquifer at these points, or elevation of the static water level relative to MTL. Determination of potential impacts from pumping of new Bluffs wells at existing local wells near points A, B, and C is beyond the scope of this report.

Calibration was accomplished by matching the drawdown calculated by the model with the Bluffs Well step-rate pumping test, run at rates of 220 and 380 gpm by John Robinson in 1977. Since the model presumes full penetration of the aquifer, the observed 24-hour drawdown in the Bluffs Well was corrected for partial penetration and the corrected drawdown was used as the calibration target in the modeling effort.

The aquifer transmissivity of 200,000 gpd/ft defined from the testing of the Bluffs Well was used in the model. An aquifer thickness of 29 feet as defined in the well log was assigned for the model layer. These values define a hydraulic conductivity of 6,500 gpd/ft². The storage coefficient value for the model was estimated based on the hydrogeologic setting. The storage coefficient value was a primary tool in reaching calibration, and the resultant value of 0.01 seems reasonable for the described setting. The aquifer has been described as semi-confined, and a storage coefficient of 0.01 is consistent with both that description and the hydrologic conditions observed at the Bluffs Well.
The model was run under various production scenarios and drawdown values at the shoreline were predicted for each. The first scenario used a single well pumped at 400 gpm from Proposed Well 2 (model point PW2). A run was then performed by modeling 400 gpm being produced at each of two wells (Proposed Wells 1 and 3 - PW1 and PW3 respectively). A final model configuration simulated 400-gpm production at each of the three specified well locations. Each of these production scenarios was evaluated at the one-day, ten-day, and 100-day continuous pumping conditions.

The results of this suite of model runs (the predicted drawdown within the wellfield and predicted drawdown at the shoreline for a fully penetrating well) are presented in Table 1.

**Table 1: Semi-confined Model Runs (storage coefficient 0.01)**

<table>
<thead>
<tr>
<th>Run No.</th>
<th>PW1</th>
<th>PW2</th>
<th>PW3</th>
<th>Duration of Pumping (days)</th>
<th>Predicted Drawdown in Wells (ft)</th>
<th>Predicted Drawdown in feet at three Points Along the Coastline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PW1</td>
<td>PW2</td>
<td>PW3</td>
<td>PW1</td>
<td>PW2</td>
<td>PW3</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>400</td>
<td>0</td>
<td>1</td>
<td>0.19</td>
<td>4.46</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>400</td>
<td>0</td>
<td>10</td>
<td>0.68</td>
<td>5.02</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>400</td>
<td>0</td>
<td>100</td>
<td>1.23</td>
<td>5.58</td>
</tr>
<tr>
<td>4</td>
<td>400</td>
<td>0</td>
<td>400</td>
<td>1</td>
<td>4.49</td>
<td>0.42</td>
</tr>
<tr>
<td>5</td>
<td>400</td>
<td>0</td>
<td>400</td>
<td>10</td>
<td>5.41</td>
<td>1.41</td>
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<td>6</td>
<td>400</td>
<td>0</td>
<td>400</td>
<td>100</td>
<td>6.50</td>
<td>2.52</td>
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<tr>
<td>7</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>1</td>
<td>4.68</td>
<td>4.88</td>
</tr>
<tr>
<td>8</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>10</td>
<td>6.09</td>
<td>6.43</td>
</tr>
<tr>
<td>9</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>100</td>
<td>7.73</td>
<td>8.09</td>
</tr>
</tbody>
</table>

2.3.1 Saltwater Intrusion Potential

We estimate at least ten feet of drawdown will be available above MTL at the three modeled pumping locations. The Bluffs Aquifer model suggests that after pumping 400 gpm from a single well (PW2) for 100 days, the predicted drawdown in the pumping well would be 5.58 feet, with less than one foot of drawdown at the three coastline positions. With two pumping wells (PW1 and PW2) producing 400 gpm each for 100 days, the drawdown in each of the pumping wells was predicted by the model to be 6.5 feet, while drawdown at the coast (points A, B, and C) was predicted to be less than 1.5 feet.

When production from three wells (PW1, PW2, and PW3), each pumping at 400 gpm, is considered, the cumulative drawdown for a pumping duration one day was estimated to be approximately five feet within the pumping wells and less than one-tenth of a foot in the observation wells at the shoreline. After 100 days of continuous pumping, the model predicted eight feet of drawdown at the well field and two feet at the coast.

The impact from three wells pumping for 100 days at 1,200 gpm from the Bluffs Aquifer may lower the water elevation close to sea level at the three simulated points along the shoreline (A, B, and C). However, the resultant water level must be below MTL to cause a gradient reversal and allow inland movement of saline water within the aquifer at those points. To determine the likelihood of a gradient reversal, an accurate measurement of water level elevations between the well field and the shoreline is required. Provided the water levels at some point between the well
field and the shore are above sea level during pumping events, the potential for lateral seawater migration into the wells will not be created. Likewise, if the pumping water level in the production wells themselves remains above sea level, there is no potential for seawater to enter the well through upconing.

Upconing can occur in an aquifer that has fresh water floating on top of saline water. As a well is pumped, a cone of influence expands around the well. Research has shown that an upward reaching cone is also induced if a fresh-water/saltwater interface exists in the aquifer beneath the well. The degree to which the pumped water will turn saline depends on several factors including: the discharge rate, the duration of pumping, recharge, the local hydrogeologic conditions, and the position and density of the fresh-water and saltwater regimes.

Locally, the aquifer is believed to extend to a depth of about 100 feet below sea level. To determine the elevation of the fresh/salt water interface beneath a well, the Gryben-Herzberg method can be applied. The Gryben-Herzberg formula is:

\[ H = \frac{\rho_f}{\rho_s - \rho_f} \times h \]

where:
- \( H \) = depth to interface below sea level
- \( \rho_f \) = density of freshwater
- \( \rho_s \) = density of seawater
- \( h \) = height of static water level above sea level

This formula predicts how far the weight of fresh water above sea level pushes the surface of the saltwater below sea level. The density of fresh water is generally presumed to be 1.000 g/cm³. The density of seawater varies depending on temperature, pressure, and salinity from 1.022 to 1.028 g/cm³ (Ven Te Chow, 1964). Typically the density of seawater in the Puget Sound Region is 1.025 g/cm³, using this value the Gryben-Herzberg method may be presented as:

\[ H = h \times 40 \]

The interface is likely positioned at a depth relative to the average static water level in the aquifer expressed as feet above sea level. This describes a non-pumping hydrogeologic setting with a wedge of fresh water overlying a layer of saline water. The interface will move upward at a given point under pumping conditions at the 1:40 Gryben-Herzberg ratio for each foot of imposed water level change. The change is, of course, not immediate, meaning that if the water level in the aquifer drops one foot, there is not an instantaneous 40-foot rise in the vertical position of the interface. The actual time for this change is not easily determined and varies according to pumping rate and duration, well location, and local hydrogeology.

Figures 3, 4, and 5 are hydrogeologic conceptual cross sections based on well logs used to characterize the study area. Not all of the wells fully penetrate the Bluffs Aquifer, but several show that a clay silt aquitard underlies the aquifer at an elevation of approximately 50 feet below mean sea level deepening to as much as 80 feet below sea level to the south toward the bedrock. Since
the predicted level at which a fresh-water/saltwater interface would form is below this elevation, there is no saltwater in the aquifer beneath the proposed production sites. Therefore, upconing of sea water from below is not an issue.

It is assumed that the movement of the withdrawal to points a half mile inland will not significantly alter the nature or magnitude of impacts to surface water bodies. This is due to the confined nature of the aquifer and the fact that the long-term cone of depression from the withdrawal will be essentially the same. It is possible that Ecology through the application of their newly available numerical model will define a small difference in potential impact and require some mitigation due to potential increases in effects at Siebert Creek and Bagley Creek.

If points farther east and south were considered, then the impacts to the near-surface hydrology may change significantly. Further, if additional annual allocation were sought in order to provide the 1,350 gpm over longer periods (or even year-round), the potential impacts are likely to become more significant. It is probable that an additional allocation, regardless of the new point of withdrawal, will require some mitigation as a condition of the new water right. The removal of water from the Shallow Aquifer through induced leakage resulting from the drawdown in the underlying Middle Aquifer cannot occur where the Shallow Aquifer is perched. Definition of the relationship between the Shallow and Middle Aquifers in the Bluffs area indicate a perched condition, and our current interpretation suggests this is a regional relationship. Under that interpretation, the only avenue of impact to stream base flow is where the Middle Aquifer is exposed at the lower reaches of the streams (if indeed such exposure exists). No calculation of induced leakage is appropriate given the hydrogeologic relationship between these aquifers.

3.0 Agnew Study Area

In May 1985 Robinson & Noble, Inc. published Ground Water Studies—McDonald Creek Deep Aquifer, which evaluated the aquifers west of Siebert Creek and east of McDonald Creek. The purpose of the project was to identify constraints on groundwater resources for future planning efforts of the PUD. In 1992, the PUD drilled the Agnew Well 1 into the Lower Aquifer. Pacific Groundwater Group details the effort in their September 1992 report Well and Aquifer Evaluation, Agnew Test Well, Clallam County, Washington. The 8-inch well was drilled to a depth of 608 feet and found the Lower Aquifer between 426 and 563 feet below land surface. Only 28 feet (430 to 458 feet) of the 128 feet of identified water-bearing sediments were screened and tested.

There is at least one aquifer in the area that is deeper than the Lower Aquifer. A well drilled by the Weyerhaeuser Company in 1973 was taken much deeper than the PUD’s Agnew Well and found this deeper aquifer. For the purpose of this report, this deeper system is named the Deep Aquifer. It is distinctive and separated from the Lower Aquifer that was encountered in the Agnew Well. These two aquifers were the focus of our analysis of the Agnew sub area because it is presumed that acquisition of a new water right will be needed. New rights for water from shallower aquifers are not likely to be granted given current regulatory policies.

3.1 Conceptual Model of the Lower and Deep Aquifers

Our conceptual model for the Lower and Deep Aquifer systems was developed for the area between the PUD’s Agnew test well and Matriotti Creek to the east. The deepest well in the area (9 L1) is the Weyerhaeuser Seed Farm well, drilled in 1973-74 under the direction of Robinson & Noble to a depth of 970 feet. At the time of our 1985 report, only one other deep well was found

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1 With an assumed average static water level, the fresh-water/saltwater interface, according to the Gryben-Herzberg ratio, would be 400 feet below sea level.
in the area. Well 4 R2 was drilled to a depth of 607 feet for Blue Ribbon Farms Water System to supply Dungeness Estates. Since that time, the PUD drilled the 610-foot deep Agnew test well (7 Q), Dungeness Golf Course (3 Q1) drilled to 571 feet, Lora Lee Estates (8 F1) drilled to 558 feet, and the Alderwood Homeowners (8 B1) drilled to 555 feet.

Cross section F-F’ (Figure 6) is a roughly north-south section developed from Schasse and Weghmann (2000, Plate 2, B-B’). This section shows that the bedrock surface, which is exposed at land surface two miles inland from the coast, dives to more than 600 feet below sea level approximately one mile further north, at a point equivalent to that of the Old Olympic Highway. The depth of the bedrock surface at the coastline has not been defined but is likely greater than 1,000 feet below sea level. It is also known from regional descriptions that the bedrock surface deepens significantly in an eastward direction. That trend, however, is not as significant to the hydrogeologic interpretation of the Agnew sub-area as it was for the Bluffs area.

Cross section G-G’ (Figure 7) was developed using the logs of those wells within the Agnew study area completed in the Lower or Deep Aquifers. The cross section shows the Lower and Deep Aquifers are distinctly different. Five of the six wells used for the cross section are completed at various levels between 250 and 500 feet below sea level within the Lower Aquifer as described by Thomas (1999). These logs show the Lower Aquifer consists primarily of sand with some silty sand layers. The Deep Aquifer is defined by a single well (the Weyerhaeuser Seed Farm Well), is found approximately between 600 and 800 feet below sea level and consists predominantly of sand and gravel deposits.

Table 2 summarizes available production information for the wells completed in the Lower and Deep Aquifers in the area near Agnew.

<table>
<thead>
<tr>
<th>Well</th>
<th>Discharge Rate (gpm)</th>
<th>Drawdown (feet)</th>
<th>Specific Capacity (gpm/ft)</th>
<th>Completion Aquifer</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 L1</td>
<td>715</td>
<td>29</td>
<td>25</td>
<td>Deep</td>
</tr>
<tr>
<td>4 R2</td>
<td>200</td>
<td>17</td>
<td>11.7</td>
<td>Lower</td>
</tr>
<tr>
<td>3 Q1</td>
<td>500+</td>
<td>NA</td>
<td>NA</td>
<td>Lower</td>
</tr>
<tr>
<td>8 B1</td>
<td>100</td>
<td>NA</td>
<td>NA</td>
<td>Lower</td>
</tr>
<tr>
<td>8 F1</td>
<td>178</td>
<td>53.5</td>
<td>3.3</td>
<td>Lower</td>
</tr>
<tr>
<td>7 Q</td>
<td>106</td>
<td>111</td>
<td>1</td>
<td>Lower</td>
</tr>
</tbody>
</table>

NA – information not available

The unconsolidated deposits of the Agnew Area are a complex sequence of water-bearing units of sand, or sand and gravel, separated by lower permeability materials consisting of silts and clays (which serve as confining layers). On a regional scale, all of these unconsolidated sediments can be considered as part of a single groundwater regime with separate aquifer and confining layers being possibly discontinuous. However, within the Agnew area, there is a 100- to 200-foot thick confining layer of clay above the Lower Aquifer, and there is a similar silty clay unit that separates the Lower Aquifer from the Deep Aquifer. This confining unit between the Lower and Deep systems is nearly 250 feet thick at the Weyerhaeuser Seed Farm Well site.

Recharge to these lower aquifers is from vertical leakage from above, particularly at the regional scale, and from the groundwater flow from the fractured bedrock south of the study area. There is not enough information available to determine a gradient in either the Lower or the Deep Aquifers. However, conceptually it is highly likely that the groundwater flow is from south to north (from the...
mountains to the sea). The static water level elevation in the Lower Aquifer wells in the Agnew area is about 50 feet above sea level. Locally, the static water levels on the western edge of the Agnew study area are somewhat lower than those to the east. This is interpreted to be a function of proximity to the coastline. The coastline trends more northerly (away from the study area) at the eastern edge of the Agnew study area. This creates a greater distance between the study area and the aquifers’ saltwater discharge points. This greater distance requires a larger head drive to get the groundwater to flow to the discharge point; higher head drives equals higher water levels. The static water level in the Weyerhaeuser Well, the only observation of water level in the Deep Aquifer, is approximately 60 feet.

Water quality in the Lower and Deep Aquifers generally meets drinking water standards. However, the PUD’s Agnew test well and the Weyerhaeuser Seed Farm well both exceed the secondary maximum contaminant level (MCL) for manganese (0.05 milligrams per liter - mg/L) with levels of 0.11 and 0.08 mg/L respectively. As a secondary contaminant, manganese is not a health hazard, but it can cause operational problems with the system transmission infrastructure and can result in gray to black discoloration of white laundry and porcelain fixtures. The reported water quality for the Lora Lee Estates well indicates that the water meets all drinking water standards.

3.2 Potential Drilling Areas

Figure 1 shows the positions of cross section F-F’ (south to north from the bedrock towards the Strait of Juan de Fuca) and G-G’ (west to east-northeast across the Agnew test study area). Based on these cross sections, the preferred drilling area to access the Lower and Deep Aquifers can be defined. The geologic conditions indicated in Figure 6, section F-F’, suggests that deep test holes within the Agnew study area should be completed north of the Old Olympic Highway, as it is much more likely that bedrock will be encountered above the aquifers’ depths south of the highway. The potential to encounter both the Lower and Deep systems increases the farther north drilling occurs. Bedrock as indicated in Figure 6 to be approximately 650 feet below sea level at the Old Olympic Highway. At the Weyerhaeuser well (9 L1), just north of the Old Olympic Highway, the depth to bedrock is greater than 800 feet below sea level and both the Lower and the Deep aquifer systems are present.

Additionally, well sites further to the east are more favorable than those to the west. At locations farther east, the bedrock is likely to be deeper and the static water level is likely to be somewhat higher. Both of these factors are favorable. It is, however, recognized that this pushes the potential source well farther from the service area and makes transmission infrastructure more expensive. Finding the balance between the probability of a successful well and the increased expense of transmission lines requires discussion beyond the intent of this investigation.

Once a specific location is selected, we propose drilling an 8-inch mud-rotary test well to determine whether the Lower and Deep Aquifers are present and to define their characteristics if found. The drilling should have a target depth of at least 800 feet below sea level. The exploration should include geophysical logging of the borehole to assist in defining the nature of the materials encountered and to provide insights into the water-bearing characteristics of any aquifers found. Since the understanding of the hydrogeologic conditions in the area is a fundamental value to the PUD, it may be worthwhile to drill to bedrock with the exploration well to determine where that contact is and whether yet deeper aquifers exist. Geophysical logs were previously conducted at the Weyerhaeuser Seed Farm, Dungeness Estates, and Dungeness Golf Course wells. These records can be used for comparison and will assist in the identification and evaluation of the Lower and Deep Aquifers (provided they are encountered in the test well).
If the test well identifies the site as a suitable location for production, several possible approaches to constructing a production well should be considered. The test well itself should not be used as a production well because mud-rotary drilling methods make it very difficult to achieve desired well efficiencies. It may be possible to ream the 8-inch test well to a diameter that could accept up to 12-inch casing. Diameters larger than 8-inches, though possible, would likely be beyond the capability of the test-well contractor’s equipment. Another option would be to contract the drilling of a separate production well. The test well could possibly be used as an observation well in the target aquifer.2 Drilling of a production well specifically designed using the findings of the test-drilling program should provide a higher value production source than reaming out the test well. However, drilling a separate production well could be very expensive given the depths involved. Based on the current level of knowledge of these aquifers, we expect a properly designed well completed in the Lower Aquifer would likely have a production capability greater than 300 gpm and a well completed in the Deep Aquifer a greater potential, possibly about 700 gpm. At this juncture, however, the only recommendation is that the mud-rotary test well be drilled.

3.3 Analytical Aquifer/Well Response modeling

The proposed area within which one or more new wells should be considered is shown on Figure 1. Basic aquifer characteristics were used to generate a flow model to predict the response of the groundwater system under various production scenarios. The same model code used to evaluate well hydraulic responses in the Bluffs sub area was employed here (AquiferWin32 -version 3.26). An analysis was performed for each of the aquifers of interest in order to predict the level of interference that might be imposed on senior wells as a result of the proposed production from a new well completed in either of the deeper aquifers. In order to accomplish this, a specific production point within the recommended search area was designated for analysis and a model was created for each of the two aquifers. The models were each limited to a one-layer homogeneous aquifer. Since the analyses were to limited to definition of the drawdown distribution, aquifer gradient and recharge were not used. Model runs predicted drawdown interference at various distances from the pumping wells.

Calibration was accomplished by matching the modeled drawdowns with the observed drawdown in the Lora Lee Estates well (for the Lower Aquifer) and the Weyerhaeuser Well (for the Deep Aquifer) after 24 hours of pumping 178 and 715 gpm respectively. Since the model presumes full penetration of the aquifer by modeled production wells, the observed 24-hour drawdowns, corrected for partial penetration, were the calibration targets. The calculated aquifer transmissivities for the Lower and Deep Aquifers were obtained from published reports of well tests conducted on the Agnew test well and Weyerhaeuser well and are 9,000 and 160,000 gpd/ft, (hydraulic conductivity of 14.3 and 252 ft/day) respectively. The modeled aquifer thickness for the Lower Aquifer was 84 feet and 85 feet for the Deep Aquifer. Storage coefficient values were the primary tool in reaching calibration, and a resultant value of 0.00001 was used for both aquifers. Both aquifers are highly confined, and a storage coefficient of 0.00001 is consistent with the conditions observed in these aquifers.

The models were run under various production scenarios, and the drawdown values at specified “observation wells” were predicted. The models were used to define interference drawdown from a single well pumping 300 gpm from the Lower Aquifer and from a single well producing 700 gpm from the Deep Aquifer. These pumping conditions were run for the one-day, ten-day and 100-day periods.

2 If the testing of more than one aquifer occurred as part of the test drilling program, the final completion zone of the test well may or may not be in the target aquifer.
The results of these various runs for each aquifer and the predicted drawdown (for a presumed fully penetrating well), at distance of ½ and one mile from the pumping well, are presented in Table 3.

**Table 3: Confined Model Runs (storage coefficient 1.0 x 10^-5)**

<table>
<thead>
<tr>
<th>Run No.</th>
<th>Pumping well gpm</th>
<th>Duration (days)</th>
<th>System</th>
<th>Drawdown modeled in pumping well (ft)</th>
<th>Drawdown modeled at distance from well (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>½ mile</td>
</tr>
<tr>
<td>1</td>
<td>300</td>
<td>1</td>
<td>Lower</td>
<td>31.67</td>
<td>6.40</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>10</td>
<td>Lower</td>
<td>34.81</td>
<td>9.54</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>100</td>
<td>Lower</td>
<td>37.96</td>
<td>12.68</td>
</tr>
<tr>
<td>4</td>
<td>700</td>
<td>1</td>
<td>Deep</td>
<td>11.86</td>
<td>3.11</td>
</tr>
<tr>
<td>5</td>
<td>700</td>
<td>10</td>
<td>Deep</td>
<td>12.94</td>
<td>4.20</td>
</tr>
<tr>
<td>6</td>
<td>700</td>
<td>100</td>
<td>Deep</td>
<td>14.03</td>
<td>5.29</td>
</tr>
</tbody>
</table>

The Lower Aquifer model estimates approximately 32 feet of drawdown at the pumping well after one day of 300-gpm production. This result is consistent with the result of testing at the Lora Lee Estates production well, which observed approximately 19 feet of drawdown after eight hours of pumping at an average rate of 178 gpm. The analytical model and the pump test results from the Lora Lee Estates well both indicate the specific capacity for a well in the Lower Aquifer is likely to be about 9.0 gpm/ft. The model suggests approximately 4.5 feet of drawdown at a distance of one mile.

Modeling suggests that the potential for impairment from a production well in the Lower Aquifer of other wells (water rights) within the aquifer is not likely to be an issue. The drawdown at distance does not appear to rise to the definition of impairment as normally considered under the law. Given the amount of available drawdown in any well completed at the depth of the Lower Aquifer, the imposition of even 20 feet of extra drawdown does not constitute impairment. There is insufficient information available for this aquifer to realistically address the potential for seawater intrusion along the coast. However, since there are no known wells completed at the depth of the Lower Aquifer in proximity to the coast, the issue is regulatory and not related to direct impact to water users. State law does not allow the inducement of the flow of seawater into an otherwise usable portion of an aquifer regardless of whether or not there are currently wells within the impacted area. Therefore, a theoretically derived definition of such changes in the salinity of aquifer water along the coast line could be sufficient for Ecology to raise the issue. It is recommended that the numerical model being developed by the Department of Ecology be employed to assess this potential further before the expenditure for the recommended test well is made.

The Deep Aquifer model estimates approximately 14 feet of drawdown within a pumping well producing 700 gpm continuously for 100 days. At these conditions, the model estimates less than five feet of drawdown would be experienced at an observation well one mile away. The model results, as well as the information available for the Weyerhaeuser well, suggest that the Deep Aquifer is capable of producing at rates greater than 700 gpm.

Since there is only the single well to define the nature of the Deep Aquifer, discussion of potential for impacts is limited. The distance-drawdown relationships suggested by the analytical modeling
effort show that the amount of drawdown in neighboring wells is not likely to be sufficient to impair the ability of other wells to access water. It is recommended that a distance of a half-mile from the Weyerhaeuser Well be maintained if practical. As with the Lower Aquifer, the ability to address the potential for seawater intrusion is quite limited. The seawater intrusion issue for the Deep Aquifer should be revisited using the Ecology numerical model once it becomes available (provided that model specifically defines the Deep Aquifer flow system). The potential to impact any actual user is quite low since there are no known Deep Aquifer users along the coast. No definition of aquifer budget or gradient is practical using analytical modeling tools. It is known that there will be some drawdown at the coastline. It is not known how that drawdown will relate to the gradient of the Deep Aquifer.

If present, the Lower and Deep Aquifers could both be developed using two production wells drilled on the same site. There is sufficient vertical hydraulic separation (aquitard) between the aquifers to prevent any significant interference between the Lower and Deep wells. The potential yield from a single site, with such a two-well approach, could be as high as 1,000 gpm.

The analytical model is not suited to analysis of the potential for the withdrawal of water from the Lower or Deep Aquifers to induce additional leakage from the overlying aquifers and, thereby have the potential to impact surface water flows. However, given an estimate of the drawdown that would be imposed at a given site, it is possible to apply the Darcy relationship between changes in head and changes in leakage. This calculation method was applied to each of the two target aquifers to provide a rough estimate of the quantity of additional water that might leak through the overlying confining layer. The calculation is accomplished in a spreadsheet that defines the leakage through successively larger annular rings around a pumping well given the aquifer transmissivity and storage coefficient, the confining layer thickness and hydraulic conductivity, and the production rate of the well. Reflection of the effects of that additional leakage through progressively shallower aquifers and ultimately to the surface waters of the area is much more speculative but each intervening hydrostratigraphic unit serves to attenuate and diminish the effect.

By applying the technique described, it is indicated that production of 300 gpm from the Lower Aquifer for a continuous 100-day period would result in an aquifer condition that would induce an additional 1,200 gallons per day (gpd) of leakage from the Middle Aquifer to the Lower Aquifer. When this is reflected through the confining layer separating the Middle and Shallow Aquifers, the potential to impact stream flows would be substantially less than that value.

Likewise, for a well pumping 700 gpm from the Deep Aquifer continuously for 100 days, the indicated additional leakage from the Lower Aquifer is indicated to be less than 500 gpd. This effect would then be reflected to the Middle Aquifer by a buffered effect across the 200 feet of silt/clay confining unit that separates the Lower and Middle Aquifers. Effects in the Middle Aquifer may then be reflected in the Shallow Aquifer by induced leakage through its basal unit that separates the Middle and Shallow Aquifers. In the case of the relationship between the Middle and Shallow Aquifers, the effect will only be reflected upward where the Shallow Aquifer is not perched. When the Shallow Aquifer is perched, the hydraulic continuity is broken and the upward reflection stops in the Middle Aquifer.

Though these induced leakage calculations are rough and somewhat speculative, they do provide insight into the likely magnitude of the induced leakage phenomena related to the hydrogeologic setting near Agnew.
4.0 Morse Creek ASR Evaluation

This investigation looked at the possible use of groundwater systems in proximity to Morse Creek to store surplus surface water during the high flow periods for recovery during periods where the 25-cfs minimum flow is not met. Such aquifer storage and recovery (ASR) programs have been used elsewhere to overcome similar timing issues with water sources. If the PUD could find a place where Morse Creek water could be recharged and retained for at least 4 months, such a system could greatly enhance the reliability of the Morse Creek source.

The PUD recognized the need for a supplemental source of supply to the Morse Creek diversion and in 1965 contracted consulting geologist Richard J. Rongey to conduct a geophysical investigation along Morse Creek. The intent of the project was to determine if there was a possibility of developing a groundwater source close to the creek that could be used to supplement the surface-water diversion. Rongey surveyed both sides of the creek, south through sections 8, 17 and 20 of Township 30 North, Range 5 West, (see Figure 1). He found that there were only thin deposits of potentially water-bearing sediments at places along the creek. He noted that production from these sediments, if accomplished, would essentially be taking surface water from the creek. Although some production capability was assumed from his findings, the areas and thickness of sediments above bedrock were small. Water produced would likely deplete existing storage, reverse the gradient in the aquifer, and induce recharge from the creek to the sediments. These sediments are not suitable for ASR.

The ideal location for an aquifer storage and recovery site would be a basin of permeable sediments that can be depleted of stored water during the summer months and refilled with available water from Morse Creek during the winter months. If a full 360-degree depression in the bedrock surface could be located, and that depression were filled with sufficiently permeable sediments to readily accept recharge and support recovery wells, it would assuredly be suitable for an ASR program. No such bedrock controlled feature was located during this preliminary evaluation. However, the presence of bedrock troughs running east-west and incised by the Morse Creek Valley appear to be possibilities. Such a system, though not completely closed, would tend to have its outflow serve as a baseflow source for Morse Creek. The water lost by the ASR program would provide some relief by serving to maintain Morse Creek flows and, at least in theory, diminish the amount of time that the Creek flows drop below the 25-cfs trigger.

The PUD owns the Deer Park Road Well (DPRW), which is in an area pertinent to the management assessment of the Morse Creek source. This well is located near the intersection of Deer Park Road and Frog Creek in section 4, Township 29 North, Range 5 West. A detailed analysis of this source is available in the July, 2007 Aspect Consulting report: Evaluation of Effects of Deer Park Road Well for Drought Relief Use. The aquifer is characterized as a 70-foot thick layer of glacial advance outwash underlain by bedrock and confined above by a 50-foot thick sequence of glacial till and clay. Located at an elevation of just over 1,000 feet on the west side of Malletti Hill (top elevation at 1,600 feet), the aquifer likely discharges westward to Surveyor Creek (a tributary to Morse Creek) 2,000 feet west of the well at an elevation of approximately 750 feet. The DPRW is about 4,000 feet east of Morse Creek and was tested at a pumping rate of 48 gpm for nine days. Ecology has granted the DPRW a supplemental water right permit as an additional point of withdrawal to the PUD surface water right on Morse Creek. The well can only be used during those periods when Morse Creek flows are less than the minimum 25 cfs identified in the PUD’s surface water right.

The DPRW aquifer has some of the characteristics needed for a successful ASR program. The calculated aquifer transmissivity of 4,000 gallons per day per foot (gpd/ft) is quite low and does not
provide for large producing wells. However, this same characteristic means that water injected into the DPRW aquifer during the winter would not move down gradient as quickly and could possibly be recovered with a series of down-gradient wells during low-flow events before it reached Surveyor Creek. Un-recovered water would be lost to Surveyor Creek and would ultimately discharge back into Morse Creek (just below the Port Angeles diversion dam near the middle of section 5). It is possible that Ecology could credit the PUD with some or all of this returned water in the context of the 25-cfs criteria.

Prior to planning on such an ASR program, additional study of the bedrock configuration would be necessary to define the bedrock surface beneath the DPRW area. Hydrogeologic definition, particularly of the hydraulic characteristics, of the unconsolidated materials filling this trough would also have to be accomplished. The bedrock as mapped and presented in Figure 2 (Sections A-A' and B-B') indicates that a series of east-west trending troughs may exist. The bedrock configuration would have to be clarified either by test drilling or by the application of geophysical techniques (likely seismic or microgravity surveys). If favorable structures were to be found, test wells to define the materials filling the target structure would be needed before a specific ASR application could be evaluated.

Preliminary assessments of the amount of storage needed to overcome the problems from interruption of the Morse Creek surface water supply is 58 million gallons. Such storage would be available in a 2,000-foot long segment of a 2,000-foot wide trough, provided it had a porosity of 20% or greater and the water table of an unconfined system could be raised 10 feet. The trough geometry implied in the cross sections presented in Figure 2 suggests that such conditions may exist in the Morse Creek study area.

The potential for artificially recharged water to have adverse impacts is always present. In this case the greatest potential impact results from the surcharging of ground water in shallow aquifers along the Morse Creek valley wall. A significant rise in the groundwater level near valley slopes could destabilize these slopes, potentially impacting property and/or causing serious turbidity events in the Morse Creek drainage. Another aspect that needs to be considered is the compatibility of the two water sources. The surface water is generally much less mineralized than ground water and, therefore, quite aggressive chemically when introduced into a groundwater setting. This could mean dissolution of aquifer materials or adverse chemical reactions within and near the wells used for both storage and recovery phases.

Though the possibility of ASR being applied may exist in the Morse Creek study area, no specific area for its application could be identified in this preliminary assessment. If the PUD chooses to pursue the ASR possibility, that effort should start with a geophysical survey similar to, but more intensive than, the Rongey effort of 1965. Geophysics technology has advanced far since 1965 and much more can be accomplished, more quickly, and for relatively lower cost. ASR could be a long-range planning answer for the PUD and should be considered as likely to require at least ten years to become operational.

5.0 Conclusions

It appears the most reliable use of the Bluffs water right could be achieved by moving the point of withdrawal inland and by spreading the production along a line parallel to the coastline. We recommend that three wells be used, and those wells be placed on a line a half mile inland from the coast. Given such a production configuration, the likelihood of lateral seawater intrusion at the production wells will be greatly diminished. Further, the probability of upconing of saltwater into
production wells should be eliminated due to basal clay that appears to confine the aquifer from below.

The cost of a well drilled to the base of the Bluffs Aquifer and capable of producing 400 gpm is estimated to be $230,000, including the hydrogeologic services associated with such a drilling project. The cost per well is likely similar whether the wells are drilled individually or as one contract.

The Agnew study area may have the potential for substantial production from either the Lower Aquifer or the Deep Aquifer. The first effort in pursuing that potential should be the drilling of a test well to as deep as 1,200 feet, approximately 1,000 feet below sea level (at a bare minimum, the target depth should be at least 800 feet below sea level). This would demonstrate the presence or absence of these two aquifers beneath the Agnew study area and hopefully find the depth of bedrock. The recommended area for drilling is immediately north of the Old Olympic Highway and east of the community of Agnew. The farther east the selected site is, the deeper the bedrock surface is likely to be. Likewise, the farther north the selected site, the deeper the bedrock will be. However, proximity to the coastline is a consideration for both hydraulic and regulatory reasons.

For the test well, an 8-inch diameter mud-rotary well is recommended. Such a well is estimated to cost $280,000, including the performance of borehole geophysics and the hydrogeologic services associated with the project. Though the small-bore exploration well could be expanded to receive larger casing, it is likely that the placement of a deep production well will be required if the exploration were successful. The cost of a production well is quite speculative at this point but is likely to be between $430,000 (low end of Lower Aquifer completion) and $580,000 (high end of Deep Aquifer completion) including the associated hydrogeologic services. Production rates of 300 gpm and 700 gpm are suggested for the Lower and Deep Aquifers respectively.

The possibility of an ASR program capable of making the Morse Creek surface water right more dependable during low flow events may exist. However, no specific area was found during this preliminary investigation to have all needed favorable characteristics. Several bedrock troughs along the eastern limb of the Morse Creek valley appear to hold some promise for an ASR program, but the evidence is too preliminary to justify any hard conclusion. In order to clarify the potential, it is recommended that geophysical survey techniques be applied. Where bedrock configurations seem promising, these surveys should be followed by test drilling to characterize the unconsolidated sediments. Only after these proposed investigations can the economic and water resource management aspects of such a program be realistically assessed.

Though all three possible avenues for enhancing the Fairview water source situation were found to show at least some promise, the placement of inland wells to exercise the Bluffs Well water right seems the most cost effective in the short term. It is also likely that exploratory drilling east of Agnew will result in additional groundwater production. This requires deep drilling and an up-front cost for exploratory drilling. The deeper sources will require more than two years to develop by following a normal schedule of deep-test drilling and subsequent production well drilling. Acquisition of water rights will be difficult and could require substantial time and expense. The cost of water right acquisition cannot be addressed at this point since there are too many different scenarios to make speculation worthwhile. The possibility of using ASR techniques to enhance the timing of the Morse Creek surface water facility is speculative at this point and will require significant time and expense before any real-world advantages could be achieved.
6.0 Closing

Questions regarding the content of this report should be addressed to the project manager. Thank you for allowing us the opportunity to be of service to you. If you have questions regarding this report or require further discussion of any portion of this project, please contact us.

The statements, conclusions, and recommendations provided in this report are to be exclusively used within the context of this document. They are based upon generally accepted environmental and hydrogeologic practices and are the result of analysis by Robinson, Noble & Saltbush, Inc. staff. This report, and any attachments to it, is for the exclusive use of Clallam County PUD No. 1. Unless specifically stated in the document, no warranty, expressed or implied, is made.
7.0 References


Robinson, John, 1977, Letter report on the Bluffs Well, prepared for Clallam County PUD No. 1

Robinson & Noble, Inc., 1985, *Ground water studies—McDonald Creek deep aquifer*, prepared for Clallam County PUD No. 1

Rongey, R., 1975, *Geophysical survey of Morse Creek*, prepared for Clallam County PUD No. 1


Clallam County PUD No. 1: Fairview Water Supply Project

Figure 1

Legend:
- Modeled Well Location
- Modeled Observation Points
- Existing Well Location
- Proposed Drilling Area
- Alternative Drilling Area

Note: Basemap taken from USGS Morse Creek, Carlsborg Quadrangles

PM: FMK
Clallam County
T 30 N R 04,05 W
Scale 1" = 4000'

December 2008

1174-005A

Agnew Study Area

Bluffs Well Study Area

Morse Creek Study Area

Modeled Well Location
Modeled Observation Points
Existing Well Location
Proposed Drilling Area
Alternative Drilling Area
Figure 2

GEOLOGIC CROSS SECTIONS

Cross sections may show detail not shown on map for undivided units.

QUATERNARY SEDIMENTS

Nonglacial Deposits

- Fill and modified land (Holocene)
- Beach deposits (Holocene)
- Alluvium (Holocene)
- Peat and marsh deposits (Holocene)
- Landslide deposits (Holocene)
- Alluvial fan deposits (Holocene to Pleistocene?)
- Sediments of the Olympia (?) nonglacial interval (Pleistocene)

TERTIARY SEDIMENTARY AND VOLCANIC ROCKS

- Basalt, basalt breccia, diabase, and rhyolite (early to middle Eocene)
- Marine sedimentary rocks (early to Middle Eocene)
- Blue Mountain unit, sandstone facies (Eocene to Paleocene?)
- Blue Mountain unit, conglomerate and pebbly sandstone facies (Eocene to Paleocene)

GLACIAL DEPOSITS

Fraser Glaciation, Vashon Stade

- Qgsdm - Glaciomarine drift (Pleistocene)
- Qgo - Recessional outwash (Pleistocene)
- Qgl - Glaciolacustrine deposits (Pleistocene)
- Qti - Till (Pleistocene)
- Qop - Advance outwash (Pleistocene)
- Qgpc - Drift, undivided (Pleistocene)

Pre-Fraser Glaciation

- Qpre - Possession Drift (?) (Pleistocene) (sea cliff section only)

GLACIAL AND NONGLACIAL DEPOSITS

Fraser and pre-Fraser events

- Qgl - Glacial and nonglacial deposits, undivided (Pleistocene)

Pre-Fraser events

- Glacial and nonglacial deposits, undivided (Pleistocene) (Cross sections and sea cliff section only)

TERILLARY DEPOSITS

- Fill and modified land (Holocene)
- Beach deposits (Holocene)
- Alluvium (Holocene)
- Peat and marsh deposits (Holocene)
- Landslide deposits (Holocene)
- Alluvial fan deposits (Holocene to Pleistocene?)
- Sediments of the Olympia (?) nonglacial interval (Pleistocene)

Note:

- Section provided by:
  - Crescent Formation and the Blue Mountain Unit
  - Blue Mountain unit, sandstone facies (Eocene to Paleocene?)
  - Blue Mountain unit, conglomerate and pebbly sandstone facies (Eocene to Paleocene)
Matriotto Creek

Geologic Cross Section F-F'

Clallam County PUD No. 1: Fairview Water Supply Project

PM: FMK
December 2008
Scale 1" = 3000'
Clallam County
T 30 N/R 04,05 W

QUATERNARY SEDIMENTS

NONGLACIAL DEPOSITS
- Fill and embankment fill (Holocene)
- Beach deposits (Holocene)
- Alluvium (Holocene)
- Peat and marsh deposits (Holocene)

GLACIAL DEPOSITS
- Fraser Glaciation, Vashon Stade
- Glaciomarine drift (Pleistocene)
- Recessional outwash (Pleistocene)
- Glaciolacustrine deposits (Pleistocene)
- Till (Pleistocene)
- Advance outwash (Pleistocene)
- Drift, undivided (Pleistocene)
- Possession Drift (Pleistocene) (sea cliff section only)

GLACIAL AND NONGLACIAL DEPOSITS
- Fraser and pre-Fraser events
- Glacial and nonglacial deposits, undivided (Pleistocene)
- Pre-Fraser events
- Glacial and nonglacial deposits, undivided (Pleistocene)

TERTIARY SEDIMENTARY AND VOLCANIC ROCKS
- Pysht Formation (Miocene to Oligocene)
- Makah Formation (Oligocene to Eocene)
- Twin River Group
- Hoko River Formation (late Eocene)
- Aldwell Formation (middle Eocene)
- Crescent Formation and the Blue Mountain Unit
- Basalt, basalt breccia, diabase, and rhyolite (early to middle Eocene)
- Marine sedimentary rocks (early to middle Eocene)
- Blue Mountain Unit, sandstone facies (Eocene to Paleocene)
- Blue Mountain Unit, conglomerate and pebbly sandstone facies (Eocene to Paleocene)

Note:
Section provided by 1174-005A
Scale 1" = 3000'
Vertical exaggeration 4x

Cross section C-C

Atterberry Road
U.S. Highway 101
Old Olympic Highway

Figure 6

Geologic Cross Section F-F'
## Cross Section Well Log Information Table

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*Verification Methods:
A - Address
F - Field Visit
G - USGS Maps
P - Parcel
RNS - RNS Files
U - Unverified
The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Record.

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Address: P.O. Box 161, Sequim, Washington
Method of Drilling: Date: Jan. 3, 1966
Owner: PUD No. 1 of Grays Harbor County
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Land surface datum: above

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<td>14</td>
<td></td>
</tr>
<tr>
<td>Clay, gravelly, hard</td>
<td>14</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Hardean, brown</td>
<td>19</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Clay, brown</td>
<td>32</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Hardpan, brown</td>
<td>36</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Clay, brown, small stones</td>
<td>60</td>
<td>68</td>
<td></td>
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<tr>
<td>Hardean, brown</td>
<td>68</td>
<td>175</td>
<td></td>
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<tr>
<td>Gravel &amp; sand, clean,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water bearing</td>
<td>175</td>
<td>206</td>
<td></td>
</tr>
<tr>
<td>Clay, light tan</td>
<td>206</td>
<td>214</td>
<td></td>
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<tr>
<td>Casing: 8&quot; from 0-195'</td>
<td>206</td>
<td>214</td>
<td></td>
</tr>
<tr>
<td>Screens installed from 195-200'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and from 200-205'</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Turn up (over) Sheet: of 3 sheets
PARCEL NO 05381032/000
EL 285
WATER WELL REPORT
STATE OF WASHINGTON
Unique Well Log No. 10692
Water Right Permit No.

(1) OWNER: NAME: HAGEMANN, JAMES M.
Address: 154 EASTERLY WAY ASHLAND, OR 97520

(2) LOCATION OF WELL: County CLACKAM
(3) STREET ADDRESS OF WELL (or nearest address) 154 EAST
(4) PROPOSED USE: DOMESTIC

(5) DIMENSIONS: Diameter of well 8 inches
Drilled 316 ft. Depth of completed well 314 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Dia. from 65 ft. to 309 ft.
Welded " Dia. from ft. to ft.
Perforations: NO
Type of perforator used in by in.
perforations from ft. to ft.

(7) SCREENS: YES
Manufacturer's Name RM
Type of screen Model No.
Diam. & slot size 20 from 309 ft. to 314 ft.
Diam. slot size from ft. to ft.

Gravel packed: NO
Size of gravel from ft. to ft.

Surface seal: YES
To what depth? 20 ft.
Material used in seal BENTONITE
Did any strata contain unusable water? NO
Type of strata Depth of strata ft.
Method of sealing strata off NMX

(8) CEMENT: Manufacturer's Name RM
Type of cement Type of sand Type of binder

(9) WATER LEVELS:
Static level 279 ft. below top of well Date 07/26/05
Artesian Pressure lbs. per square inch Date
Artesian water controlled by NMX

(10) WELL TESTS: Drawdown is amount water level is lowered below
static level.
Was a pump test made? NO
Yield: gal./min. ft. drawdown after hrs.

Recovery data
Time Water Level Time Water Level

Date of test 1/1/05
Bailer test gal./min. ft. drawdown after hrs.
Air test 7 gal./min. with test set at 300 ft. for 2.5 hrs.
Artesian flow g.p.m.

Temperature of water Was a chemical analysis made? NO

RECEIVED
AUG 29 2005
Washington State Department of Ecology

Work started 07/26/05
Completed 07/28/05

WELL CONSTRUCTOR CERTIFICATION:
I constructed and/or accept responsibility for con-
struction of this well, and its compliance with all
Washington well construction standards. Materials used
and the information reported above are true to my best
knowledge and belief.

NAME TILLIAM WELL DRILLING
Address 367 S BARR PORT ANGELES
[Address]
License No. 0368
Contractor's Registration No. TILLIAM64380 Date 08/11/05
WATER WELL REPORT

STATE OF WASHINGTON

(1) OWNER: Eugene E. and Dolly Annis

(2) LOCATION OF WELL: Clallam

(3) PROPOSED USE: Domestic

(4) TYPE OF WORK: New well

(5) DIMENSIONS: Diameter of well: 910.0

(6) CONSTRUCTION DETAILS: Drilled: 910.0

(7) PUMP: Size: 910.0

(8) WATER LEVELS: Level at which water is lowest: 910.0

(9) WELL TESTS: Downflow rate: 910.0

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION:

MATERIAL FROM TO

Brown Soil Some cobbles 0 70
Some cobbles 20 80
Blue Clay 80 180
Gravel Some cobbles 180 215
Blue Clay 180 280
Sand Gravels 280

CONTRACTOR CERTIFICATION:

[Signature]

ADDRESS: 1017 Homestead Ave

LICENSE NO: 2473

CUSTOMER: X000405307 Date 3/1/97

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at 206-457-6930. The TDD number is 206-457-6098.
**PARCEL No. 053010340020**

**WATER WELL REPORT**

STATE OF WASHINGTON

**189450**

**EL. 340**

**STATE: WASHINGTON**

**Unique Well I.D. #: LIX934**

**Start Card No.: 217764**

**WATER RIGHT Permit No:**

---

**[1] OWNER:** NAME: [REDACTED] ADDRESS: 220 DOGWOOD PL, PORT ANGELES, WA 98362-

**[2] LOCATION OF WELL:** County: CLALLAM

Street Address of Well (or nearest address): 551 LAKONAN RD, PORT ANGELES

---

**[3] PROPOSED USE:** DOMESTIC

---

**[4] TYPE OF WORK:** Owner's Number of well

(if more than one)

---

**[5] NEW WELL**

---

**[6] DIMENSIONS:** Diameter of well 6 inches

Drilled 396 ft. Depth of completed well 396 ft.

---

**[7] CONSTRUCTION DETAILS:**

Casing installed: 6 ft. *Dia. from 0 ft. to 391 ft. WELDED

*Dia. from ft. to ft.

*Dia. from ft. to ft.

Perforations: No

- Type of perforator used
- Diameter of perforations

Drilled ft. to ft.

Drilled ft. to ft.

Drilled ft. to ft.

---

**Screws:** YES

- Manufacturer's Name
- Model No.
- Type & SLOT
- Dia.
- Slot size
- Dia.
- Slot size

---

**Gravel packed:** No

- Type of gravel
- Drilled ft. to ft.

---

**Surface seal:** YES

- To what depth? 19 ft.
- Material used in seal: [REDACTED]
- Did any strata contain unusable water? NO
- Type of water:
- Depth of strata ft.

---

**[7] PUMP:** Manufacturer's Name

- Type: [REDACTED]

---

**[8] WATER LEVELS:**

- Static level 323 ft. below top of well Date 11/28/05
- Artesian Pressure lbs. per square inch Date
- Artesian water controlled by

---

**[9] WELL TESTS:** Drawdown is amount water level is lowered below static level.

- Was a pump test made? NO
- If yes, by whom?
- Yield: gal./min
- With ft. Drawdown after hrs.

---

**Recovery data**

- Time Water Level Time Water Level Time Water Level

---

**Date of test**

- Driller test 4 gal./min 67 ft. Drawdown after 2 hrs.
- Air test gal./min w/ stem set at ft. for hrs.
- Artesian flow gpm Date
- Temperature of water
- Was a chemical analysis made? NO

---

**WELL CONSTRUCTOR CERTIFICATION:**

I constructed and/or accept responsibility for con-
struction of this well, and its compliance with all
Washington well construction standards. Materials used
and the information reported above are true to my best
knowledge and belief.

**NAME:** [REDACTED] [REDACTED] [REDACTED] License No. 2374

**CONTRACTOR'S**

- Registration No. TILLW000140 Date 01/08/05

---

**Work started 11/21/05**

**Completed 11/28/05**
WATER WELL REPORT

[Address]

[State of Washington]

[Unique Well ID: AX6925]

[Water Right Permit No.:]

[Owner's Name: BRENDA TANABEE]

[Address: 803 LAMMON RD, PORT ANGELES, WA 98362]

[Location of Well: County: CLAIRM]

[Street address of well (or nearest address): 803 LAMMON RD, PORT ANGELES]

[Proposed Use: DOMESTIC]

[Type of Work: Owner's Number of well]

[If more than one]

[Diameter: 6 inches]

[Drilled: 35 ft.]

[Depth of completed well: 449 ft.]

[Construction Details:]

[Casing installed: Dia. from 0 ft. to 411 ft.]

[In: Dia. from 412 ft. to 414 ft.]

[In: Dia. from 415 ft. to 419 ft.]

[Perforations: NO]

[Type of perforator used:]

[Size of perforations: in. by in.]

[Perforations from: ft. to ft.]

[Perforations from: ft. to ft.]

[Screen: Y/N]

[Manufacturer's name:]

[Model No.:]

[Gravel packed: Y/N]

[Size of gravel:]

[Gravel placed from: ft. to ft.]

[Surface seal: Y/N]

[To what depth?: ft.]

[Material used in seal: MORTAR]

[Did any strata contain unsuitable water?: NO]

[Type of water?:]

[Method of sealing strata off: N/A]

[Pump: Manufacturer's name:]

[Type: NONE]

[Water Levels:]

[Static level: 378 ft. below top of well]

[Date: 09/28/06]

[Artesian pressure: lbs. per square inch]

[Date: 09/28/06]

[Well Tests:]

[Drawdown is amount water level is lowered below static level.]

[Was a pump test made?: NO]

[If yes, by whom:]

[Yield: gal./min with ft. drawdown after hrs.]

[Recovery data:]


[Date of test: 09/28/06]

[Battery test: gal./min.]

[ft. drawdown after hrs.]

[Air test at 5 gal./min. with stem set at 400 ft. for 2.5 hrs.]

[Artesian flow: g.p.m.]

[Date: 09/28/06]

[Was a chemical analysis made?: NO]

[Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change in formation.]

[MATERIAL]

[BROWN SAND & GRAVEL]

[FROM TO]

[396 419]

[SHANK OF CLAY]

[396 419]

[RECEIVED]

[NOV 03 2006]

[Washington State Department of Ecology]

[Work started: 09/28/06]

[Completed: 09/28/06]

[WELL CONSTRUCTION CERTIFICATION:]

[I, the undersigned, hereby certify that the well was constructed in accordance with all applicable regulations concerning well construction and that the information on this form is true within my best knowledge and belief.]

[NAME TILLIA WELL DRILLING]

[Person, firm, or corporation:]

[Type or print:]

[ADDRESS 367 S BARR PORT ANGELES]

[License No. 0468]

[Contractor's]

[Registration No. TILLIW004130]

[Date: 11/17/06]
**WATER WELL REPORT**

**STATE OF WASHINGTON**

**WATER WELL PERMIT NO. W 217850**

**Address:** 84 Wyckham Rd., Port Angeles, WA 98363-

- **NS 1/4 SW 1/4 Sec 15 T 30 N., R S WM**

**LOCATION OF WELL:** County Clallam

**STREET ADDRESS OF WELL (or nearest address):** N/A

**PROPOSED USE:** DOMESTIC

**TYPE OF WORK:** Owner's Number of Well

**NEW WELL:** Method: ROTARY

**DIMENSIONS:**
- Diameter of well: 6 inches
- Depth of completed well: 156 ft.

**CONSTRUCTION DETAILS:**
- Cutting installed: 6 in. Dia. from 31 ft. to 32 ft.
- Welding: 6 in. Dia. from 31 ft. to 32 ft.
- Perforations: YES

**Type of perforator used:** SAM CUT

**SIZE of perforations:** in. by in.

100 perforations from ft. to 31 ft.
perforations from ft. to 31 ft.
perforations from 31 ft. to 32 ft.

**Screens:**
- Manufacturer's Name
- Model No.

**Diam.:**
- Slot size from ft. to ft.
- Slot size from ft. to ft.

**Gravel packed:** NO

**Gravel placed from ft. to ft.**

**Surface seal:** YES

**To what depth:** 18 ft.

**Material used in seal:** NEW YORK

**Did any strata contain unuseable water:** NO

**Type of water:**

**Depth of strata:** ft.

**PUMP:**
- Manufacturer's Name
- Type: MONO

**WATER LEVELS:**
- Static level: 6 ft. below top of well
- Artesian Pressure: lbs. per square inch
- Artesian water controlled by MONO ARTESIAN

**WELL TESTS:**
- Drawdown: 150 ft. Water level is lowered below static level.
- Was a pump test made: NO
- If yes, by whom:
- Yield: gal./min
- Data: Date

**Recovery Data:**
- Time: Water Level: Time: Water Level

<table>
<thead>
<tr>
<th>Date of test</th>
<th>1/1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>gal./min.</td>
</tr>
<tr>
<td>Drawdown after</td>
<td>7.5</td>
</tr>
<tr>
<td>Air test</td>
<td>1.59</td>
</tr>
<tr>
<td>Water level</td>
<td>156 ft.</td>
</tr>
<tr>
<td>Artesien flow</td>
<td>62 g.p.m.</td>
</tr>
<tr>
<td>Date</td>
<td>1/1</td>
</tr>
</tbody>
</table>

**WELL CONSTRUCTION CERTIFICATION:**
- I, [contractor's name], am the person responsible for the construction of this well.

**NAME:** OVER'S WELL DRILLING INC

**ADDRESS:** 341 S BAKER RD, PORT ANGELES

**LICENSE NO.:** 30813

**Date of execution:** 03/30/07
**WATER WELL REPORT**

**STATE OF WASHINGTON**

**ONRHO:** Home QUANTUM ENTERPRISES INC  
Address: 145 SKY VIEW DRIVE PORT ANGELES, WA 98362-

**LOCATION OF WELL:** County: CLALLAM  
\(2a\) Street Address of Well (or nearest address): 145 SKY VIEW DRIVE, PORT ANGELES

**PROPOSED USE:** DOMESTIC

**TYPE OF WORK:** Owner's Number of well  
(if more than one)

**NEW WELL:** Method: BORE

**DIMENSIONS:** Diameter of well 6 inches  
Drilled 40 ft., Depth of completed well 40 ft.

**CONSTRUCTION DETAILS:**

- **Clinching:** Installed: 6  
  Dia. from 6 ft. to 30 ft.

- **WELDED:**  
  Dia. from 36 ft. to 40 ft.

- **Dia. from ft. to ft.**

- **Perforations:** NO

- **Type of perforator used**

- **No. of perforations**
  in. by in.

- **Perforations from ft. to ft.**

- **Perforations from ft. to ft.**

- **Perforations from ft. to ft.**

**Screens:** YES

- **Manufacturer's Name:**

- **Model No.:**

- **Size:**
  Slot size 12 from 30 ft. to 35 ft.

- **Diam.:**
  Slot size from ft. to ft.

- **Gravel packed:** NO

- **Size of gravel:**

- **Gravel placed from ft. to ft.**

- **Gravel:**

- **Surface seal:** YES  
  To what depth? 19 ft.

- **Material used in seal:**

- **Did any strata contain usable water?** NO

- **Type of water:**

- **Depth of strata:**

- **Method of sealing strata off:**

**PUMP:** Manufacturer's Name  
Type WORK: H.P.

**WATER LEVELS:**

- **Land-surface elevation:**

- **Above mean sea level:**

- **Static level:**
  15 ft. below top of well Date 09/11/03

- **Artesian Pressure:**
  lbs. per square inch Date

- **Artesian water controlled by:**

**WELL TESTS:**

- **Drawdown in amount water level is lowered below static level:**

  Was a pump test made? NO

  Field: gal./min. Total ft. drawdown after hrs.

  Recovery data:

  Time Water Level Time Water Level

  Date of test____/____/____

  Bailer test gal./min. ft. drawdown after hrs.

  Air test 7 gal./min. Water level set at 30 ft. for 7 hrs.

  Artesian flow g.p.m. Date

  Temperature of water

  Was a chemical analysis made? NO

**WELL CONSTRUCTOR CERTIFICATION:**

I, the undersigned, do certify that I constructed or supervised this well and this work, and that all materials, equipment, and work have been done to the best of my knowledge and belief.

**NAME & ADDRESS:**

(EIFL, acknowledgments) (Name or firm, or corporation) (Type of print)

**SIGNED:**

License No. 0866

**CONTRACTOR'S REGISTRATION NO.:**

TI 500464XK0 Date 08/22/03

**RECEIVED**

JUN 15 2005

**DEPARTMENT OF ECOLOGY**
# WATER WELL REPORT

STATE OF WASHINGTON

[Start Card No.: W045940
UNIQUE WELl ID: A4A-111]

[Owner: Debbie Fischer
Address: 9485 Holly Farm Lane, Bellingham, WA

 владение: Clallam

[Proposed Use: Domestic ☐ Industrial ☐ Municipal ☐

[Type of Work: Owner's number of well (from more than one)

[Dimensions: Diameter of well [in inches] 60

[Construction Details:
Casing installed: Yes ☐ No ☐

[Screening: Yes ☐ No ☐

[Type of perforator used: MILLS

[Size of perforations: 0.019 in. by 0.019 in.

[Well Tests:
Water level: 605 ft. below top of well Date: 11/14/99

[Well Constructor Certification:
I hereby certify that this well has been constructed in accordance with the regulations of the Department of Ecology.

[Well Log or Abandonment Procedure Description:

<table>
<thead>
<tr>
<th>Material</th>
<th>FROM</th>
<th>TO</th>
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</thead>
<tbody>
<tr>
<td>Clay Bar Sand Floc Cryst Размер</td>
<td>0</td>
<td>411&quot;</td>
</tr>
<tr>
<td>HPCL 471 Grad Sand Floc Cryst</td>
<td>10</td>
<td>379&quot;</td>
</tr>
<tr>
<td>Brackish Prom Sand Floc Cryst</td>
<td>392&quot;</td>
<td>411&quot;</td>
</tr>
<tr>
<td>HPCL 471 Grad Sand Floc Cryst</td>
<td>70</td>
<td>379&quot;</td>
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<td>Brackish Prom Sand Floc Cryst</td>
<td>395&quot;</td>
<td>411&quot;</td>
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<tr>
<td>HPCL 471 Grad Sand Floc Cryst</td>
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<tr>
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<td>Clay Bar Sand Floc Cryst</td>
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<tr>
<td>Brackish Prom Sand Floc Cryst</td>
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<tr>
<td>Clay Bar Sand Floc Cryst</td>
<td>500&quot;</td>
<td>500&quot;</td>
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[Water Level Measurements:

<table>
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<tr>
<th>Date</th>
<th>Time</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 4, 1997</td>
<td>10:15</td>
<td>1115 9</td>
</tr>
</tbody>
</table>

[Additional Notes:
Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6500. The TDD number is (206) 407-6006.
WATER WELL REPORT
STATE OF WASHINGTON

(1) OWNERS NAME: KENNETH S川

(2) LOCATION OF WELL: County CLALLAM

(2a) STREET ADDRESS OF WELL [or nearest address] same

(3) PROPOSED USE: DOMESTIC

(4) TYPE OF WELL: Owner's Number of well (if more than one)

HIGH WELL Method: ROTARY

(5) DIMENSIONS:
Drilled 180 ft., depth of completed well 38 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6

Well casing: same

Perforations: none

Type of perforator used

Sizes of perforations in. by in.

4 ft. from 32 ft. to 33 ft.

4 ft. from 32 ft. to 33 ft.

4 ft. from 32 ft. to 33 ft.

Screws: yes

Manufacturer's Name: JOHNSON

Type Screen: Model No.

Diam. 6 slotted 10 ft. 32 ft. to 38 ft.

Diam. 6 slotted 10 ft. 32 ft. to 38 ft.

Gravel packed: none

Size of gravel

Gravel placed from ft. to ft.

Surface seal: yes

to what depth? 28 ft.

Material used in seal PENETRATIONS
Did any strata contain unusable water? yes

Type of water? Depth of strat

(7) PUMP: Manufacturer's Name: KEN

Type Pump: R.P.

(8) WATER LEVELS:

Land-surface elevation above mean sea level. ft.

Static level 4 ft. below top of well. Date 09/16/96

Artesian pressure lbs. per square inch. Date

Artesian water controlled by ROY MARTIN

(9) WELL TESTS: Drawdown is amount water level is lowered below static level.

Was a pump test made? yes. if yes, by whom:

Yield: gal./min with ft. drawdown after hrs.

Recovery date

Time Water Level Time Water Level Time Water Level

Date of test: / / Doler test gal./min. ft. drawdown after hrs.

Dry test 20 gal./min. w/ stem set at 21 ft. for 2 hrs.

Artesian flow g.p.m.

Temperature of water was a chemical analysis made? no

RECEIVED
OCT 2 5 2006
Washington State
Department of Ecology

Mark Started 09/14/96
Completed 09/16/96

WELL CONSTRUCTION CONCLUSION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Louis's WELL DRILLING INC

(Signature) [Signature]

License No. 2842

Contractor's Registration No. LO646618W Date 03/30/06
Water Well Report

Current Notice of Intent No. W107/23
Unique Ecology Well ID Tag No. AKB 804

Property Owner Name: Jerry Falls
Well Street Address: 205 Northwoods Ln
City: Port Angeles County: Clallam
Location: 51°14'11" N 122°30'15" W
Lat/Long (s, t, r) Lat Deg. 51 Lat Min/sec 11 Long Deg. 122 Long Min/sec 30

Tax Parcel No. 

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation: Depth, by color, character, size of material and structure; and the kind and value of the material is such stratum penetrated, with list test data entry for such charge of information (unless all water consumed

MATERIAL FROM TO
Br Gravel Clay 0 4
Br Firm Clay 4 8
Br Fine Sand Saturated 38 50
Br Fine Silty Sand with Gravel 50 70
Br Fine Sand Dirty 70 86
Br Gravel Clay 86 90
Br Poorly Graded Fine Sand & Gravel with 90 95

RECEIVED
NOV 24 2004
Washington State
Department of Ecology

Driller/Engineer/Trainer Name (Print): Keith Winter
Driller/Engineer/Trainer Signature: [Signature]
Driller's License No.: 05365240050

Drilling Company: Oasis Well Drilling
Add. 236 Craig Rd, Sequim, WA 98382

Driller’s Registration No.: 0515C-0720DN Date: 10/13/04
**WATER WELL REPORT**

**STATE OF WASHINGTON**

---

### (1) OWNER:
Name: Paulson
Address: 1745 N. 22nd Ave.

---

### (2) LOCATION OF WELL:
County: Skagit
Address: 1745 N. 22nd Ave.

---

### (3) PROPOSED USE:
- Domestic
- Irrigation

---

### (4) TYPE OF WORK:
- Owner's number of well: [4251]
- Method: Drilled
- Depth: 262 ft.
- Material: Clay, 6 in. above top of well

---

### (5) DIMENSIONS:
- Diameter of well: 6 in.
- Depth of completed well: 262 ft.

---

### (6) CONSTRUCTION DETAILS:
- Casing installed: Threaded, 6 in. above top of well
- Perforations: Yes
- Type of perforator used: Drilled
- Number of perforations: 12
- Material used for sealing: Type of sealing strata off: n/a

---

### (7) PUMP:
- Manufacturer's Name: n/a
- Type: n/a
- HP: n/a

---

### (8) WATER LEVELS:
- Land-surface elevation: 21.2 ft. below top of well
- Artesian pressure: n/a
- Artesian water is controlled by: n/a

---

### (9) WELL TESTS:
- Was a pump test made: Yes
- Yield: gal/min.
- Time water level: Time water level

---

### (10) WELL LOG:

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>FROM</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Clay</td>
<td>12</td>
<td>45</td>
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<tr>
<td>Hardpan</td>
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<td>Clay</td>
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<tr>
<td>Clay</td>
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<td>193</td>
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<tr>
<td>Gravel</td>
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<td>135</td>
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<tr>
<td>Sand</td>
<td>135</td>
<td>143</td>
</tr>
<tr>
<td>Gravel</td>
<td>143</td>
<td>159</td>
</tr>
<tr>
<td>Rock</td>
<td>159</td>
<td>162</td>
</tr>
</tbody>
</table>

---

**RECEIVED**

DEP 6 1982

DEPARTMENT OF ECOLOGY
SOUTHWEST REGIONAL OFFICE

---

**WELL DRILLER'S STATEMENT:**

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

**[Signature]**

**Address:** 1652 Bear East Rd., Port Angeles

---

**[License No.]:** 0848

---

THE DEPARTMENT OF ECOLOGY does NOT WARRANT the Data and/or the Information on this Well Report.
WATER WELL REPORT
STATE OF WASHINGTON

(1) OWNER: MILLER, JOHN E.
ADDRESS: 350 NORTHWOOD LANE, PORT ANGELES, WA 98362

(2) LOCATION OF WELL: COUNTY CLAIBORN
STREET ADDRESS OF WELL (OR NEAREST ADDRESS) SAME

(3) PROPOSED USE: DOMESTIC

(4) TYPE OF WORK: NEW WELL

(5) DIMENSIONS:
Diameter of well: 6 inches
Depth of completed well: 132 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Dia. from 1 ft. to 91 ft. 
Hedged

Perforations:
Type of perforator used
Size of perforations

Screen:
Manufacturer's Name
Type
Diam. slot size
Diam. slot size

Gravel packed: No
Size of gravel
Gravel placed from:

Surface seal:
Yes
Material used in seal:
Bentonite

Did any strata contain unusable water? No
Type of water:
Depth of strata:

Method of sealing strata off:
None

(7) PUMP: Manufacturer's Name

(8) WATER LEVELS:
Static level: 261 ft. below top of well
Artesian pressure: lbs. per sq. inch
Artesian water controlled by:

(9) WELL TESTS:
Was a pump test made? No
If yes, by whom?
Yield:
gal/min with
ft. drawdown after hrs.

Recovery data:
Time Water Level Time Water Level Time Water Level

Date of test: / / 
Warmer test: gal/min.
ft. drawdown after hrs.

Air test: gal/min. with stem set at 130 ft. for 2 hrs.
Artesian flow: g.p.m.
Date

Temperature of water: F

(10) WELL LOG

Formation: Describe by color, character, size of matrix and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated. With at least one entry for each change in formation.

MATERIAL
TOUCHELE
BROWN CLAY
BROWN SAND
SAND AND MUD
BROWN SAND AND GLEYSER
GRAY CLAY
BROWN SAND
GRAVEL WATER MARKING
GRAVELLY GRAY

RECEIVED
APR 4 1970
Washington State Department of Ecology

Work started 03/05/77
Completed 03/14/77

WELL CONSTRUCTION CERTIFICATION:
I, the undersigned, the contractor of the above well, hereby certify that this well was constructed in accordance with the requirements of the Washington State Department of Ecology and that the information provided above is true to the best of my knowledge and belief.

NAME: JOHNSON'S WELL DRILLING INC.
(Person, firm, or corporation) (Signature) (License No. 0040)

ADDRESS: 1499 E. SABIN RD. PORT ANGELES
(Date 04/01/77)
Water Well Report

Construction/Decommission

Current Notice of Intent No. W17744

Notice of Intent No. W17744

Unique Ecology Well ID Tag No. AKB 821

 Property Owner Name: HANK LEIS

Well Street Address: 453 GEHLKE RD

City: Port Angeles County: CLALLAM

Location: NE 1/4, NW 1/4, Sec. 11, T03 N, R05 E, M.W.T.

Lat/Long (s, t, r) Lat Deg Lat Min Sec

still REQUIRED ) Long Deg Long Min Sec

Tax Parcel No.

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Descriptive units, characters, type, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information indicate all wells completed. (ALL ADDITIONAL ITEMS IF NEEDED)

MATERIAL

Topping Soil 0 2

Cemented Sandy Clay Brown 2 20

Sandy Clay Brown 20 45

Sandy Clay Brown 85 85

Gravel Sand 11B 85 98

Gravel 85 105

Grey Clay 105 106

RECEIVED

APR. 18 2005

Washington State

Department of Ecology

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Driller/Engineer/Trader Name (First) KEITH WINTER T.D.

Driller/Engineer/Trader Signature 1978

Driller's or Tester License No.

UP DATE

Driller's License No.

Driller's Signature

WATER WELL REPORT

Proposed Use: Domestic
Type of Work: New Well
Method: Drilled
Dimensions: Diameter of Well 4"; Dep: 15 ft.

Property Owner Name: Dick Adams
Well Street Address: End of E Bluff Dr
City: Port Angeles
County: Clallam
Location: SW/4 NW/4 Sec 2 T23N R30E
Lat/Long (s, t, r): Lat Deg 43.09; Lat Min 33 Sec; Long Deg 123.85; Long Min 27 Sec
Still Required: Long Deg

Tax Parcel No.: 05-3002-3000-0000

Construction Details
Sheet: Yes
Plastic: Yes

Pump Manufacturer: No

WATER LEVELS: Land surface elevation above sea level

Start level 122 ft. below top of well Date 13-04-07
Anesthetic pressure: 0.25 psi

Anesthetic water supplied by:

WELL TESTS: Water level is lowered below static level

Was a pump test made? Yes
Yield: 2.2 gpm
Recovery data (time to achieve zero when pumped off):

Date: 13-05-07

Driller/Engineer/Trader/Name (Sign) Keiton Winter
Driller/Engineer/Trader License No. 1279

The Department of Ecology does NOT warranty the Data and/or Information on this Well Report.
## WATER WELL REPORT

**Notice of Intent No.:** W224426

**Unique Ecology Well ID Tag No.:** APQ 207

**Property Owner Name:** Dave Baker

**Well Street Address:** Approx 140 Shamrock Ln

**City:** Port Angeles

**County:** Clallam

**Location:** WET-141516 Sec 14 Twn 30R 5

**Lat/Long (s, t):** Lat Deg Min / Lat Min/Sec

**Still REQUIRED:** Long Deg Min/Sec

**Tax Parcel No.:** 05301451000700000

### CONSTRUCTION DETAILS

- **Casing:** Welded 6 in. Diam. from 1 to 313 ft.
- **Stringer:** 12.5 ft. from 313 to 518 ft.
- **Gravel/Filters:** Yes
- **Surface Seal:** Yes
- **Material used in screen:** Dry 38 Chip Bentone 77
- **Depth of screen:** 18 ft.
- **Type of water:** Depth of static
- **Method of sealing up:** Depth of static

### PUMP

- **Manufacturer's Name:** Johnson
- **Model No.:** 312

### WATER LEVELS

- **Static Level:** 273 ft. below top of well
- **Artesian pressure:** lbs. per square inch
- **Artesian water is controlled by:**

### WELL TESTS

- **Drawdown is amount water level is lowered by static level:**
- **Yield:** 10 gpm, with 35 ft. drawdown after 1 hr.
- **Recovery time:** 1 hr.
- **Temperature of water:**

### WELL CONSTRUCTION CERTIFICATION

I, Keith Winter, as the Chief Engineer of OASIS WELL DRILLING INC., hereby certify that the well(s) described above were constructed in accordance with the specifications outlined in this report. The use of materials and procedures adhered to the best knowledge and belief.

**Driller/Engineer/Trainee:** Keith Winter

**Driller/Engineer/Trainee Signature:**

**Driller's License No.:** RE0225

**Driller's Signature:**

The Department of Ecology does not guarantee the data and/or information on this Well Report.

**August 22, 2007**

ECY 050-4-20 (Rev 2015)
## Water Well Report

**Location of Well:**
- Owner: David Miller
- Address: 1234 Elm St, Burlington, WA 98215
- Designated Use: Residential
- Elevation: 300 feet above sea level

### Construction Details:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
<th>Depth (ft)</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown Clay</td>
<td>Brown sand</td>
<td>30-50</td>
<td>Gravel</td>
</tr>
<tr>
<td>Gray Sand</td>
<td>Gray sand</td>
<td>70-80</td>
<td>Clay</td>
</tr>
<tr>
<td>Gravel</td>
<td>Gravel</td>
<td>90-100</td>
<td>Concrete</td>
</tr>
</tbody>
</table>

### Pump Information:
- Make: John Deere
- Model: JD500
- Type: Submersible

### Water Quality:
- pH: 7.2
- TDS: 150 ppm
- Asbestos: Yes

### Ground Water Levels:
- Recent: 23 ft
- Previous: 24 ft

### Well Logs:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
<th>Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown Clay</td>
<td>Brown sand</td>
<td>30-50</td>
</tr>
<tr>
<td>Gray Sand</td>
<td>Gray sand</td>
<td>70-80</td>
</tr>
<tr>
<td>Gravel</td>
<td>Gravel</td>
<td>90-100</td>
</tr>
</tbody>
</table>

### Additional Information:
- USEPA-RE-136, Date: 9/30/20
- Well Construction Certification: 123-45-6789
- Well Log and Arrangement Procedure Description: 01/02/20

---

**Note:** This report is for informational purposes only and does not guarantee the quality or safety of the water. For more detailed information, contact the Department of Ecology at (360) 753-2185.
WATER WELL REPORT
STATE OF WASHINGTON

(1) OWNER: PUD #1 of Clallam County
Address: P.O. Box 1090, Port Angeles, WA 98362

(2) LOCATION OF WELL: Clallam
County
Agnew area, WA

(3) PROPOSED USE: [ ] Domestic [ ] Irrigation [ ] Industrial [ ] Underground [ ] Municipal [ ] Other

(4) TYPE OF WORK: [ ] New well [ ] Completed [ ] Reconditioned [ ] Drilled

(5) DIMENSIONS: Diameter of well: 8 inches
Drilled: 606 feet, Depth of completed well: 468 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: [ ] 8 ft, Drilled: 606 ft, Depth of completed well: 468 ft
Wells lined: [ ] 8 ft, Drilled: 606 ft, Depth of completed well: 468 ft
Perforations: [ ] Yes [ ] No (Yes, size required)
Type of perforator used: [ ] Yes
SIZE of perforations: [ ] Yes, size required
Type of screen used: [ ] Yes, size required
Screen installed: [ ] Yes [ ] No
Manufacturer's Name: Houston

(7) PUMP: Manufacturer's Name

(8) WATER LEVELS: Static level: 136 ft. below datum level...approx 175 ft.
Artesian pressure: 136 ft. above static level...Data: 8/21/92
Artesian water is controlled by: (Ref. Sec. 60)

(9) WELL TESTS: Water is pumped from well...Test pump report...Work started: 5/7/92...12:00 Comp. 11/20...12:00

WELL CONSTRUCTION CERTIFICATION:
I certifi...accept responsibility for construction of this well and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME: Schneider Equipment, Inc.
Address: 21881 Silver Road NW

(10) WELL LOG or ABANDONMENT PROCEDURE:
See attached log

Screen assembly also consists of:
7" OD x 188 wall liner from 458 to 468 and from 416 to 428.

Bottom most 7" liner is equipped with plate bottom & bail.

Top most 7" Liner is equipped with two K-packers.

Borehole from 468 to 608 is backfilled with gravel & bentonite.
<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>
| 10   | 18 | Clay, brown, sandy, w/some gravel, 1/2"
| 18   | 22 | Gravel, 1/2"- , w/some clay, brown, sandy |
| 22   | 40 | Gravel, 1/2"- , clay, brown |
| 40   | 50 | Sand, gravel, med-coarse, & gravel, 2"
| 50   | 57 | Gravel, 1/2"- , & sand, coarse, w/ some clay, brown |
| 57   | 62 | Sand, coarse, w/some clay, brown, sandy |
| 62   | 82 | Gravel, 1/2"- , & sand, med-coarse, brown |
| 82   | 92 | Clay, blue-gray, soft |
| 92   | 102| Sand, fine-med, gray |
| 102  | 108| Gravel, 1-1/4"- , & sand, coarse |
| 108  | 115| Gravel, 1-1/4"- , & clay, brown, sandy |
| 115  | 125| Gravel, 3"- , & clay, brown |
| 125  | 131| Gravel, 3"- , & clay, gray |
| 131  | 133| Gravel, 1-1/4"- , & sand, brown |
| 133  | 155| Gravel, 3"- , w/some clay, gray, fine, sandy |
| 155  | 162| Clay, gray, w/some gravel |
| 162  | 165| Clay, brown, fine, sandy, w/gravel, 1"
| 165  | 191| Clay, brown, very sandy, & gravel, 1-1/4"
| 191  | 201| Gravel, 2"- , w/some clay, gray, sandy |
| 201  | 207| Clay, brown, & gravel, 1"
| 207  | 216| Clay, gray, sandy, w/some gravel, 1-1/4"
| 216  | 228| Gravel, 2"- , & clay, brown, sandy |
| 228  | 233| Clay, gray, w/some gravel |
| 233  | 240| Clay, gray, w/some sand, coarse, & gravel |
| 240  | 253| Clay, gray, w/layers of sand & gravel, small |
| 253  | 268| Clay, gray, sandy, w/some sand, med, & gravel, small |
| 268  | 272| Gravel, 2"- , & clay, gray |
| 272  | 278| Gravel & clay, brown, conglomerate |
| 278  | 280| Clay, brown, red, & gray, & gravel conglomerate |
| 280  | 283| Gravel, 1"- , & sand, med-coarse |
| 283  | 289| Gravel, 1"- , & sand, w/layers of cly, sandy, brn, gry |
| 289  | 298| Sand, gray, med-coarse, & gravel, 1-1/4"
<p>| 298  | 299| Sand, gry, md-crse, &amp; grvl, 1-1/4&quot;- , tr. of cly, gry |
| 299  | 304| Sand, gry &amp; brn, md-crse, &amp; grvl, tr. of clay, brn |
| 304  | 305| Clay, tan |
| 305  | 313| Sand, brn &amp; gry, md-crse, w/sme cly, tn, &amp; grvl, sml |
| 313  | 355| Clay, gray, sticky |
| 355  | 371| Clay, gray, med-soft |
| 371  | 373| Sand, gray, silty, fine |
| 373  | 376| Gravel &amp; clay, gray, conglomerate |
| 376  | 379| Clay, gray, w/small gravel, very sticky |
| 379  | 386| Clay, w/small gravel, sticky |
| 386  | 391| Gravel, w/layers of sand &amp; clay |</p>
<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>391</td>
<td>Clay, gray, soft, sticky</td>
</tr>
<tr>
<td>402</td>
<td>Sand, med-fine, hard, compacted</td>
</tr>
<tr>
<td>405</td>
<td>Clay, gray, soft</td>
</tr>
<tr>
<td>406</td>
<td>Clay, gray, silty-med, sandy, compacted</td>
</tr>
<tr>
<td>416</td>
<td>Clay, gray, w/some brown, sticky</td>
</tr>
<tr>
<td>419</td>
<td>Clay, gray, silty-med, sandy, compacted</td>
</tr>
<tr>
<td>422</td>
<td>Clay &amp; claystone, gray, fine, sandy</td>
</tr>
<tr>
<td>426</td>
<td>Sand, md-crse, brn &amp; gry, &amp; grvl, 3/4&quot;-, w/some clay, gray &amp; brown</td>
</tr>
<tr>
<td>432</td>
<td>Sand, med-coarse, brown, &amp; gravel, 3/4&quot;-</td>
</tr>
<tr>
<td>435</td>
<td>Sand, md-crse, brn, &amp; grvl, 3/4&quot;-, w/lyrs of cly, brn, &amp; sandy</td>
</tr>
<tr>
<td>437</td>
<td>Sand, md-crse, brn, &amp; grvl, 3/4&quot;-, w/lyrs of clay</td>
</tr>
<tr>
<td>449</td>
<td>Sand, med-crse, brn, &amp; grvl, 3/4&quot;-, w/ tr. of clay</td>
</tr>
<tr>
<td>454</td>
<td>Gravel, 2-1/2&quot;-, &amp; sand, med-coarse, brown</td>
</tr>
<tr>
<td>459</td>
<td>Sand, med, w/some gravel, small</td>
</tr>
<tr>
<td>468</td>
<td>Clay, brown, sticky</td>
</tr>
<tr>
<td>474</td>
<td>Sand, med-fine, w/some gravel, 1&quot;-</td>
</tr>
<tr>
<td>475</td>
<td>Clay, brown, fine, sandy</td>
</tr>
<tr>
<td>477</td>
<td>Sand, med, brn, w/some sand, coarse, &amp; grvl, small</td>
</tr>
<tr>
<td>484</td>
<td>Sand, med-fine, w/trace of cly, &amp; some grvl, small</td>
</tr>
<tr>
<td>488</td>
<td>Sand, med-fine, w/some gravel, small</td>
</tr>
<tr>
<td>490</td>
<td>Sand, med-fine, w/some gravel, crse &amp; small, tr. of cly</td>
</tr>
<tr>
<td>491</td>
<td>Sand, fine, w/some med-crse, &amp; some clay, tan, sandy</td>
</tr>
<tr>
<td>503</td>
<td>Sand, brn, fine, w/sme md-crse, w/tr of cly, tn, sandy</td>
</tr>
<tr>
<td>521</td>
<td>Sand, brown, fine, w/some med-coarse</td>
</tr>
<tr>
<td>536</td>
<td>Sand, brown, med-fine, w/some gravel, 1&quot;</td>
</tr>
<tr>
<td>537</td>
<td>Sand, brown, fine w/some gravel, 1&quot;</td>
</tr>
<tr>
<td>540</td>
<td>Sand, gray, med-fine, w/some clay, gray</td>
</tr>
<tr>
<td>550</td>
<td>Sand, med, gray, w/some coarse, &amp; some gravel</td>
</tr>
<tr>
<td>555</td>
<td>Sand, med, gray &amp; brown, w/some coarse, &amp; some grvl</td>
</tr>
<tr>
<td>563</td>
<td>Clay, brown, sticky</td>
</tr>
<tr>
<td>564</td>
<td>Clay, blue-green, sticky, w/pea gravel</td>
</tr>
<tr>
<td>570</td>
<td>Clay, gray, w/streaks of gravel, 1/2&quot;-, cemented</td>
</tr>
<tr>
<td>579</td>
<td>Clay, gray</td>
</tr>
<tr>
<td>601</td>
<td>Gravel, 3/4&quot;-, &amp; sand, coarse, black</td>
</tr>
<tr>
<td>603</td>
<td>Clay, gray, sticky</td>
</tr>
<tr>
<td>607</td>
<td>Clay, gray, firm</td>
</tr>
</tbody>
</table>
WATER WELL REPORT

STATE OF WASHINGTON

PARCEL 04300850170

OWNER: Alderwood Homeowners

LOCATION OF WELL: Clallam

STREET ADDRESS OF WELL: 824 NEW PARKWAY, PORT ANGELES, WA 98362

PROPOSED USE: Residential

TYPE OF WORK: Owner's number of well (if more than one)

DIMENSIONS: Diameter of well 10 in.

CONSTRUCTION DETAILS:

Perforations: Yes
Type of perforations

Screen: Yes
Material: V Silt

WATER LEVELS:

Well constructed and acceptable. Water level is covered below static level

WELL TESTS:

Date of test: 12/30/96

Temperature of water: Yes

WELL CONSTRUCTOR CERTIFICATION:

NAME: Latha Well Drilling

Address: 3725 S. BARR 

License No: 1868

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 06/21/00 (B030) 11
Layered and Laminated
Tan, Gray, Green, Gray Silt
and Clay with occasional Sand
and Gravel.

Olive Colored Clay.

Layered Gray and Brown
Silty Clay, Gravel, and
Sand, and Silty Sand
Some Water-logging
Layers.

Layered Gray Clay
and Brown Silt with
some Gravel, Sand,
and Very Fine Gravel
Silk Laminated.

Gray Clay, Silt, Gravel and Fine Sand
Some Gravel, and
Sand.
WATER WELL REPORT

STATE OF WASHINGTON

(1) OWNER: Name: DEWALT ESTATE
(2) LOCATION OF WELL: County: YAKIMA

(3) PROPOSED USE: Domestic [ ] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well (if more than one) /
Now well [ ] Replacement [ ] Bored [ ]
Drilled [ ] Cable [ ] Driven [ ]
Reconditioned [ ] Rotary [ ] Jetted [ ]

(5) DIMENSIONS:
Diameter of well: ______ ft. Depth of completed well: ______ ft.

(6) CONSTRUCTION DETAILS:
Casing installed: Diam. from ______ ft. to ______ ft.
Threaded [ ] Diam. from ______ ft. to ______ ft.
Welded [ ] Diam. from ______ ft. to ______ ft.

Perforations:
Yes [ ] No [ ]
Type of perforation used:
GRAN [ ] PB [ ] S/S [ ]
Size of perforations: ______ in. by ______ in.
Perforations from ______ ft. to ______ ft.
Perforations from ______ ft. to ______ ft.

Screen:
Yes [ ] No [ ]
Manufacturer's Name: ______
Type: ______
Diam. that size: ______ ft. to ______ ft.
Plugs of sealing strata given: ______ ft.

Gravel packed:
Yes [ ] No [ ]
Size of gravel: ______
Gravel placed from ______ ft. to ______ ft.

Surface seal:
Yes [ ] No [ ] To what depth: ______ ft.
Material used in seal: ______
Did any strata contain usable water? Yes [ ] No [ ]
Type of water: ______ Depth of strata: ______
Method of sealing strata given:

(7) PUMP: Manufacturer's Name: ______
Type: ______

(8) WATER LEVELS:
Land-surface elevation above mean sea level: ______ ft.
State level: ______ ft. below top of well Date: ______
Artesian pressure: ______ lbs. per square inch Date: ______
Artesian water is controlled by: ______

(9) WELL TESTS:
Was a pump test made? Yes [ ] No [ ]
Date of first test: ______
Yield: gal./min. at ______
Drawdown after ______

(10) WELL LOG:
Material FROM TO
GRAY CLAY 90 110
SILTY SAND W/CLAY LAYERS 110 160
MORE GRAVEL Layers 160 180
PRODUCING A SMALL NATURAL 180 182
SILT & CLAY LAYERS 182 210
THIN LAYERS OF SAND IN 210
THIN BLUE CLAY 210
SAND, GRAVEL & CLAY LAYERS 220 230
MUDSY SAND & GRANUL 230 240
SAND & SANDY FINE GRANUL 240 245
CONSOLIDATED SAND & FINE GRANUL 245 248
PAVEMENT SAND & FINE 248 320
YELLOW CLAY W/ LAYERS 320 320
COAL TOWELLING 320 320
LESS CLAY, MUDY SAND & GRANUL 320 325
CHAP DONALD 325 475
L.B. FINE MUDY SAND 475 475
CHAP CLAY & GRANUL 475 475
L.B. GRAVEL SAND & GRANUL 475 475
EW NARROW SAND & FINE 475 475
GRANUL W/LESS SAND LAYERS 475 475
SANDY CLAY L/LESS GRANUL 475 475
CHAP DONALD 475 475
BLUE CLAY 475 475
LESS CLAY, MUDY SAND & GRANUL 475 475
SAND, GRANUL & CLAY LAYERS 475 475
CLAY 475 475
BLUE CLAY 475 475
GREENISH TOWELLING SAND & GRANUL 475 475
SAND, CLAY & CLAY LAYERS 475 475

Well started AUG. 31, 1951. Completed ______.

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME: SYLWESTER CORPORATION
(Parson, firm, or corporation)
(2953)
Address: PO. BOX 167, SECTION 6, N., A. 8538
(TIX PERFECT) [Signed]: ______
[Well Driller] ______

License No. ______ Date: 12-3-______

(USE ADDITIONAL SHEETS IF NECESSARY)
WATER WELL REPORT

STATE OF WASHINGTON

(1) OWNER: Name: DUNHILL ESTATE
Address: 1727 Lane, Eatonville, WA 98328

(2) LOCATION OF WELL: County: Eatonville

(3) PROPOSED USE: Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: New well ☐ Method dug ☐ Bored ☐ Deepened ☐ Cable ☐ Driven ☐ Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6" x 6" inches. Depth of completed well 80 ft.

(6) CONSTRUCTION DETAILS: Casing installed: 12" Diam, from 0 to 24 ft. to 80 ft.

Perforations: Yes ☐ No ☐

Screens: Yes ☐ No ☐ See Diagram D-12967

Gravel packed: Yes ☐ No ☐ Size of gravel: 2" to 3" gravel.

Surface seal: Yes ☐ No ☐ To avoid deposit of sediments.

(7) PUMP: Manufacturer's Name: PERKIN
Type: Submersible

(8) WATER LEVELS: Land surface elevation above mean sea level: 11.29 ft.
Static level: 5.0 ft. below base of well Date: 11-29-XX
Artificial pressure: No. per square inch Date: 
Artificial water is controlled by: (Cap, valve, etc.)

(9) WELL TESTS: Drawdown in amount of water level is lowered below static level: YES ☐

Yield: gal/min with 8 ft. drawdown after hrs.

Recovery data (time taken to pump water, pump turned off) (water level measured from well top to water level)

Date of test: 11-29-XX

Bacteriological test: Yes ☐ No ☐

(10) WELL LOG:

MATERIAL FROM TO
Gravel Screen 5 ft. 8 ft.
Silty Fine Clay-Sandy Gravel 5 ft. 8 ft.
Gravel L.W. 5 ft. 8 ft.
Blue Clay L.W. Sandy Gravel 5 ft. 8 ft.

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME: Stican, Drilling, Inc.
Address: 1001 3rd St., SU 1
(Signed) J. Stican
(Well Driller)

License No. 147
Date: 12-3-XX

(USE ADDITIONAL SHEETS IF NECESSARY)
WATER WELL REPORT

STATE OF WASHINGTON

Application No. GZ-20390

Permit No. GZ-20390

(1) OWNER: Name: Bob Mohn, 7777

Address: R & Y Box 300, Sequim WA 98382

(2) LOCATION OF WELL: County: Clallam

Section: 5

T 36N, R 40E, W 3

8000' W of SE 4th, Cor. of Sec. 4

(3) PROPOSED USE: Domestic [ ] Industrial [ ] Minisinoal [ ]

Irrigation [ ] Test Well [ ] Other [ ]

(4) TYPE OF WORK: Owner's number of well: 7

New well [ ] Method: Dug [ ] Bored [ ]

Depressed [ ] Cable [ ] Driven [ ]

Reconditioned [ ] Rotary [ ] Jetted [ ]

(5) DIMENSIONS:

Drilled: 30 ft. Diameter of completed well: 8.56 ft.

Inch

(6) CONSTRUCTION DETAILS:

Casing installed: 8 3/4 Diam. from 0 to 76 ft.

Threaded [ ] " Diam. from 76 ft. to 8.56 ft.

Welded [ ] " Diam. from 8.56 ft. to 8.56 ft.

Perforations: Yes [ ] No [ ]

Type of perforator used:

SRR of perforations: in. by in.

perforations from ft. to ft.

perforations from ft. to ft.

(7) SCREENS: Yes [ ] No [ ]

Manufacturer's Name: Smith

Type: STAINLESS

Screened: from ft. to ft.

Gravel packed: Yes [ ] No [ ]

Size of gravel:

Gravel placed from ft. to ft.

Surface seal: Yes [ ] No [ ]

To what depth:

Material used in seal:

Did any strata contain usable water? Yes [ ] No [ ]

Type of water:

Depth of strata:

Method of sealing strata:

(8) WATER LEVELS:

Land surface elevation:

Above mean sea level:

Stale level: ft. below this at well Date:

Artesian pressure:

ft. per square inch Date:

Artesian water is controlled by:

(Cap. valve, etc.)

(9) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? Yes [ ] No [ ]

If yes, by Whom? Driller

Test:

gal/min.

ft. drawdown after hrs.

REF. TO PUMPING LOG EXTENDED

Recovery data (time taken as zero when pump turned on) (water level measured from well top to water level)

Time Water Level Time Water Level

Date of test

Bailier test:

gal/min.

ft. drawdown after hrs.

Artesian flow:

Temperature of water:

Artesian analysis made: Yes [ ] No [ ]

(10) WELL LOG:

MATERIAL FROM TO

SURFACE SOIL 0 3

BROWN SANDY CLAY 3 55

BROWN CLAY 55 57

WATER GRAY SAND 57 74

BROWN CONCRETE 74 84

Brown SAND 84 86

(11) WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME: STOICAN DRILLING CO. INC

Address: 901 Box 161, Sequim WA 98382

(Signed): Driller

Date: Jan. 3, 1975

License No. 0473 Date: Jan. 3, 1975

USE ADDITIONAL SHEETS IF NECESSARY

OK Claim

2-7-75
<table>
<thead>
<tr>
<th>TIME</th>
<th>GPM</th>
<th>Pumping Level</th>
<th>Flow</th>
<th>Water Level</th>
<th>Time</th>
<th>Recovery Level</th>
<th>Water Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:30 PM</td>
<td>157</td>
<td>75'</td>
<td>150</td>
<td>72'</td>
<td>5:15 PM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:31</td>
<td>180</td>
<td>75'</td>
<td>150</td>
<td>72'</td>
<td>5:15 PM</td>
<td></td>
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<tr>
<td>12:32</td>
<td>210</td>
<td>75'</td>
<td>150</td>
<td>72'</td>
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<tr>
<td>12:33</td>
<td>240</td>
<td>75'</td>
<td>150</td>
<td>72'</td>
<td>5:15 PM</td>
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<td>12:34</td>
<td>270</td>
<td>75'</td>
<td>150</td>
<td>72'</td>
<td>5:15 PM</td>
<td></td>
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</tr>
</tbody>
</table>
WATER WELL REPORT
STATE OF WASHINGTON

OWNER: 4 Plus/Longview Golf Corporation

LOCATION OF WELL: 1965 Woodcock Rd

STREET ADDRESS OF WELL: 1965 Woodcock Rd

PROPOSED USE: Residential

TYPE OF WORK: New well

DIMENSIONS: Diameter of well: 8 inches, Depth of completed well: 565 ft

CONSTRUCTION DETAILS:
- Gravel packed: Yes
- Gravel placed from: 0 to 298 ft
- Screen type: Pressagell

WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION:
- Top Soil
- Brown Fine Sand
- Brown Sandy Clay
- Brown WB Sand+Gravel
- Gray Clay, Seams of
  - WB Silt+Gravel
  - Gray Clay
  - Gray WB, Course Sand
  - Course Sand
  - gravel Seams of Clay
  - gravel, WB sand, 15 to 20 ft
  - sand of gravel
  - Gray Clay, and Cobble
  - Gray WB Sand
  - Gray Clay, Seams of WB, Silt+Gravel
  - Gray Clay

WELL CONSTRUCTOR CERTIFICATION:
- Drilled and/or completed by: Tilla Well Drilling
- Address: 369 S. East Rd, Port Angeles, WA 98362
- Licenses No. 0005

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6800. The TDD number is (206) 407-6060.
WELL CONSTRUCTED BY TELLA WELL DRILLING IN MARCH 1995
WELL LOCATION: SW1/4, SE1/4, SECTION 3,
TOWNSHIP 30 NORTH, RANGE 4 WEST, WM, CLALLAM COUNTY
PUMP TESTED @ 515 GPM FOR 25 HOURS W/ 86 FT DRAWDOW
CAPACITY 1200 GPM
1.0 ENVIRONMENTAL SCREENING AND PERMITTING REVIEW

This appendix includes a detailed discussion of environmental considerations for each of the alternatives as well as federal, state, and local permit requirements. Because it is possible that federal funding will be used for the water supply project, the permits required for such funding are included.

1.1 Environmental Considerations

1.1.1 Critical Areas

Environmentally critical areas are defined in Chapter 27.12 of the Clallam County Code (CCC). The purpose of the code is to identify and protect critical areas as required by the Washington State Growth Management Act, implement the goals and policies of the County’s Comprehensive Plan, protect public health, safety, and welfare, and maintain or enhance the biological and economic resources of the County while respecting legally established private property rights. The code regulates the following types of critical areas:

- Wetlands,
- Aquatic and wildlife habitat conservation areas,
- Geologically hazardous areas,
- Frequently flooded areas, and
- Critical aquifer recharge areas.

The locations of critical areas discussed below are based on Clallam County online mapping and Priority Habitats and Species mapping from the WDFW. These locations have not been verified in the field. Additional critical areas may be present that are not identified in these mapping sources.

This Section assesses environmental issues in the generalized Morse Creek ASR study area used by RNS (2008). Similarly, the generalized Agnew study area used by RNS (2008) is discussed with a focus on the areas identified for well drilling. No locations for facilities or transmission lines have been identified for these alternatives, so the discussion of critical areas is generalized for the overall study areas.

Clallam County and other regulatory agencies require that impacts to critical areas should first be avoided and minimized through changes in project design and layout. Remaining impacts that are unavoidable typically require mitigation.
In addition, Clallam County requires that land disturbing activities within or near critical areas must provide for stormwater quality and quantity control consistent with the DOE Stormwater Management Manual for the Puget Sound Basin.

1.1.1.1 Wetlands

Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Artificial wetlands created from non-wetland sites are not regulated by Clallam County (CCC 27.12.210).

Wetlands within Clallam County are classified according to a four-tier system based on their functions, with Class 1 the highest functioning and Class IV the lowest functioning (CCC 27.12.210). The wetland buffer widths range from 25 feet to 200 feet depending on the wetland class and type of proposed development (CCC 27.12.215).

A certificate of compliance is required for activities within 200 feet of a regulated wetland. Alterations to wetlands and buffers are allowed only through the County’s variance process (CCC 27.12.205). Construction of utilities within wetlands and buffers may be allowed through a variance and subject to performance standards (CCC 27.12.215.16).

Numerous freshwater wetlands are mapped in the vicinity of the water supply alternatives. The water transmission lines will cross through or near mapped wetlands or wetland buffers; however in most cases the pipeline will be located within existing road rights-of-way. Wetlands are also mapped at some of the proposed Booster Pump Station sites and in the vicinity of the Desalination Facility. See Table 1 for a listing of wetlands mapped in the area of each alternative.

1.1.1.2 Aquatic and Wildlife Habitat Conservation Areas

Aquatic habitat conservation areas include streams, lakes, marine waters, and associated wetlands and floodplains defined as shorelines of the state, and those which meet the criteria for Type 1 - 5 waters (CCC 27.12.310). Buffer widths for aquatic habitat conservation areas range from 50 to 150 feet (CCC 27.12.315).

Wildlife habitat conservation areas include habitats that support federal and state listed endangered, threatened, and sensitive species; habitats targeted for preservation by government agencies; and priority habitats such as wetlands, marine bluffs, stream ravines, snag-rich areas, and others (CCC 27.12.310).

A certificate of compliance is required for activities within the jurisdiction of a regulated habitat area. Alterations to a habitat conservation area are allowed only through the County’s variance process (CCC 27.12.305).
<table>
<thead>
<tr>
<th>Permitting Agency/ Potential Permits</th>
<th>Regulated Activity</th>
<th>Estimated Permit Review Timeline</th>
<th>Permit Considerations and Issues</th>
<th>Off-Channel Storage Options</th>
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<th>Interconnection with Port Angeles Water System</th>
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<tbody>
<tr>
<td><strong>FEDERAL</strong></td>
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</tbody>
</table>
| U.S. Army Corps of Engineers - Section 404 Clean Water Act Permit | Discharge of dredge or fill material into streams or wetlands or other "waters of the U.S." | 2 – 3 months for routine Nationwide Permit applications; 12 months or longer for more complex projects or for individual Permits | • Mitigation required for unavoidable impacts.  
• Corps relies on joint mitigation guidance with Ecology and EPA for wetlands.  
• Individual Permit requires public notification and an alternative analysis under Section 41(b) to demonstrate why other feasible alternatives with less impact to aquatic areas were not selected. | • Wetlands are mapped in area of alternative and 404 permit would be required for wetland fill.  
• Wetlands are mapped in area of alternative and 404 permit would be required for wetland fill.  
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• Wetlands are mapped in area of alternative and 404 permit would be required for wetland fill. | | | | | | |
| National Marine Fisheries Service (NMFS) – Section 7 Endangered Species Act (ESA) Consultation and potentially US Fish and Wildlife Service (USFWS) – Section 7 ESA Consultation | Federal funding or federal permit. Section 7 of the ESA requires all federal agencies to insure that any actions they authorize are not likely to jeopardize a listed species or adversely modify its critical habitat. U.S. Army Corps of Engineers must consult with NMFS and possibly USFWS for this project. | Up to 120 days after submittal to USACE, and then up to 180 days after submission to NMFS and/or USFWS. | • The Biological Assessment (BA) must be reviewed by the appropriate regulatory agency (NMFS or USFWS), and conservation measures may be necessary for the project to avoid negative impacts on listed species. | • Likely required due to need for federal permits and/or funding.  
• Likely required due to need for federal permits and/or funding.  
• Likely required due to need for federal permits and/or funding.  
• Likely required due to need for federal permits and/or funding. | | | | | | |
| National Historic Preservation Act Section 106 Cultural resources protection | Projects with federal permits (e.g., Corps Section 404). | Submit information with Section 404 permit application. | • Coordinate with Department of Archaeology and Historic Preservation.  
• May require detailed cultural resource survey. | • Likely required due to need for federal permits and/or funding.  
• Likely required due to need for federal permits and/or funding.  
• Likely required due to need for federal permits and/or funding.  
• Likely required due to need for federal permits and/or funding. | | | | | | |
| National Environmental Policy Act (NEPA) | Federal funding or federal permit. NEPA requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. | Varies depending whether EA or EIS is required; typically at least several months. | • Determine whether there is a federal permit or federal funding that would trigger NEPA review.  
• If a Corps wetland permit is the only federal permit required and there is no federal funding, then NEPA would not be triggered. | • If NEPA review is required, an EA would likely be the appropriate level of documentation.  
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• If NEPA review is required, an EA would likely be the appropriate level of documentation. | | | | | | |
| U.S. Army Corps of Engineers and U.S. Coast Guard Section 10 Rivers and Harbors Act | Construction of structures within navigable waters. | Similar to Section 404 permit. | • The Coast Guard reviews proposed underwater structures to ensure they do not pose hazards to navigation. | • Not applicable.  
• Intake and outfall pipelines to Puget Sound would require permit.  
• Not applicable.  
• Not applicable.  
• Not applicable. | | | | | | |
<table>
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<tr>
<td>Washington State Department of Ecology – National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Permit</td>
<td>Construction activities, including clearing, grading, and excavation, that disturb 1 acre or more of land.</td>
<td>Construction site operators must apply for a permit 60 days prior to discharging stormwater during construction.</td>
<td>• Stormwater Pollution Prevention Plan. • Public notification.</td>
<td>• Construction stormwater permit likely needed due to disturbance of more than one acre of land.</td>
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</tr>
<tr>
<td>Washington State Department of Ecology – National Pollutant Discharge Elimination System (NPDES) Discharge Permit</td>
<td>Discharge of wastewater to surface waters.</td>
<td>To be determined; may be lengthy if an individual permit is required.</td>
<td>• Requirements to be established with Ecology. • Detailed studies such as a mixing zone assessment likely required.</td>
<td>• Discharge permit needed to discharge waste brine to Puget Sound.</td>
<td>• Not applicable.</td>
<td>• Not applicable.</td>
<td>• Not applicable.</td>
<td>• Not applicable.</td>
</tr>
<tr>
<td>Washington Department of Natural Resources (DNR) Forest Practices Approval Chapter 222 WAC</td>
<td>Required to be obtained by the property owner before beginning any forest practice (i.e., harvesting).</td>
<td>30 days</td>
<td>• Triggered by removal of 5,000 board feet or more of merchantable timber.</td>
<td>• Potentially required if Deer Park Road Reservoir site or portions of pipelines outside of existing road right of way are forested.</td>
<td>• Potentially required if desalination facility site or portions of pipelines outside of existing road right of way are forested.</td>
<td>• Potentially required if fluoridation facility site or portions of pipelines outside of existing road right of way are forested.</td>
<td>• Potentially required if well sites or portions of pipelines outside of existing road right of way are forested.</td>
<td>• Potentially required if injection/infiltration sites or portions of pipelines outside of existing road right of way are forested.</td>
</tr>
<tr>
<td>Washington Department of Natural Resources (DNR) Aquatic Use Permit RCW 79.9, Chapter 332-30 WAC</td>
<td>Any entity that wants to use state-owned aquatic lands must obtain authorization from the WDNR. State-owned aquatic lands include bedlands of Puget Sound, navigable rivers, lakes, and other waters. It includes much of the tidelands and shores of lakes and other fresh waters.</td>
<td>To be determined.</td>
<td>• Not applicable.</td>
<td>• Required for intake/outfall structures on Puget Sound.</td>
<td>• Not applicable.</td>
<td>• Not applicable.</td>
<td>• Not applicable.</td>
<td>• Not applicable.</td>
</tr>
<tr>
<td>Washington State Department of Ecology – Section 401 Water Quality Certification</td>
<td>In-water activities; triggered through application for 404 permit from Corps.</td>
<td>Typically 3 to 6 months.</td>
<td>• Processed after approval of the Corps permit.</td>
<td>• Wetlands are mapped in area of alternative; 404 and 401 permits would be required for wetland fill.</td>
<td>• Wetlands are mapped in area of alternative; 404 permit and CZM consistency required for wetland fill.</td>
<td>• Wetlands are mapped in area of alternative; 404 permit and CZM consistency required for wetland fill.</td>
<td>• Wetlands are mapped in area of alternative; 404 permit and CZM consistency required for wetland fill.</td>
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</tr>
<tr>
<td>Washington State Department of Ecology – Coastal Zone Management Consistency</td>
<td>Activities that affect resources in any of the 15 coastal counties in the state and require a federal permit. Triggered by 404 permit.</td>
<td>2 to 6 months</td>
<td>• Public notification is done by Ecology/Cors during 404/401 permit processing.</td>
<td>• Wetlands are mapped in area of alternative; 404 permit and CZM consistency required for wetland fill.</td>
<td>• Wetlands are mapped in area of alternative; 404 permit and CZM consistency required for wetland fill.</td>
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<tr>
<td>Washington Department of Fish and Wildlife - Hydraulic Project Approval (HPA)</td>
<td>In-stream work (e.g., culvert replacement or alteration of stream channels).</td>
<td>30 to 45 days</td>
<td>SEPA determination must accompany permit application. Mitigation measures may be required.</td>
<td>HPA needed for intake/outfall in Morse Creek, and for pipeline stream crossings.</td>
<td>HPA needed for pipeline stream crossings.</td>
<td>HPA needed for pipeline stream crossings.</td>
<td>HPA needed for pipeline stream crossings and any in-stream withdrawal structures.</td>
<td></td>
</tr>
<tr>
<td>Washington State Department of Ecology – Water Rights Permit</td>
<td>Use of surface or groundwaters.</td>
<td>Varies from months to years.</td>
<td>Obtaining a change to an existing water right would take less time than obtaining a new water right.</td>
<td>May require a change to the existing water right if the point of diversion or point of use changes.</td>
<td>No water right required for water from Puget Sound.</td>
<td>No new water right or change required.</td>
<td>Relocating Bluffs Well would be a change to an existing water right.</td>
<td>May require a change to the existing water right if the point of diversion or point of use changes. Must meet the requirements of Chapter 173-157 WAC (Underground Artificial Storage and Recovery).</td>
</tr>
<tr>
<td>Washington State Department of Ecology – Reservoir Permit</td>
<td>Construction of a dam or dike that is capable of impounding surface water to a depth of 10 feet or more at any point, or will impound a volume of 10 acre-feet or more at normal pool level.</td>
<td>To be determined.</td>
<td>Required for Buchanan Drive Quarry and Deer Park Road reservoirs.</td>
<td>Not required.</td>
<td>Not required.</td>
<td>Not required.</td>
<td>Required to store water in an underground aquifer.</td>
<td></td>
</tr>
</tbody>
</table>

**CLALLAM COUNTY**

| Clallam County – SEPA Threshold Determination WAC 197-11 Clallam County Code Chapter 27.01 | Prepare environmental checklist to determine if a project will have significant adverse environmental impacts and as a result will require a SEPA EIS. | To be determined during County Project Review. | SEPA checklist may be required. | SEPA checklist required. | SEPA checklist required. | SEPA checklist required. | SEPA checklist required. |

<p>| Clallam County Shoreline Permit Chapter 35.01 Clallam County Code | Activities within shorelines of the state (e.g., 200-foot shoreline of Morse Creek, McDonald Creek, Puget Sound and associated floodplains/wetlands). | To be determined during County Project Review. | Update of Clallam County SMP is required by 2011. Regulations may change at that time. | Buchan Drive Quarry Reservoir: Intake pipes cross Rural shoreline of Morse Creek. Morse Creek shoreline (Conservancy designation) crosses western portion of WTP site. | Conservancy designation along Puget Sound shoreline. | Depending on proximity to Morse Creek, fluoride removal facility could be within Morse Creek Rural designated shoreline (at the existing intertie facility). | Not applicable. No mapped shorelines in Bluffs Well area; wells are unlikely to be located near streams. | Morse Creek shoreline (location of water intake facilities) is regulated throughout ASR study area. |</p>
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<tbody>
<tr>
<td>Clallam County</td>
<td>Proposed alterations to the following critical areas or their buffers:</td>
<td>To be determined during County Project Review.</td>
<td>• Mitigation plan required for unavoidable impacts.</td>
<td>• Large wetland mapped in vicinity of facility site; other scattered wetlands along transmission pipe route.</td>
<td>• Same as Buchanan Drive Quarry alternative for transmission pipe south of fluoride removal facility (near S. Hemlock Ln.).</td>
<td>• Same as desalination for transmission route south of Hwy. 101.</td>
<td>• Wetlands mapped at Frog Creek headwaters; several large wetlands between Bear Meadow Rd. and Deer Run.</td>
<td>• Wetlands mapped at south of McDonald Creek and near Woodcock/Kitchen-Dick Rd.</td>
</tr>
</tbody>
</table>
| Critical Areas Permit Review Clallam County Code Chapter | • Wetlands, | | • Special reports may be required (e.g., geotechnical report, wetland report, habitat management plan). | • Type 5 stream mapped in facility site vicinity; transmission pipe crosses several other Type 5 streams and Bagley Creek. | • Depending on proximity to Morse Creek, fluoride removal facility could be within Morse Creek stream buffer as well geologic hazard areas and frequently flooded areas along the creek. | • Wetland mapped near mouth of McDonald Creek and near Woodcock/Kitchen-Dick Rd. | • Several streams mapped (Morse, Frog, Bagley, Lake, Surveyor, and Type 5 tributaries). | • Geologic hazards mapped along McDonald Creek and Puget Sound shoreline.
| 27.12             | Aquatic and wildlife habitat conservation areas, | | • Pre-application meeting highly recommended. | • Numerous special-status wildlife species/habitats mapped in vicinity. | • CARA may encompass fluoride removal facility. | • Numerous special-status wildlife species/habitats mapped in vicinity. | • Numerous special-status wildlife species/habitats mapped in vicinity. | • CARA mapped along major streams. |
|                   | Geologically hazardous areas, | | | • Geologic hazard areas and CARA mapped in area of intake and drain. | | | | |
|                   | Frequently flooded areas, and | | | | | | | |
|                   | Critical aquifer recharge areas (CARAs). | | | | | | | |
|                   | | | | | | | | |
Construction of new utilities within aquatic habitat conservation areas or buffers may be allowed through a variance and subject to performance standards (CCC 27.12.315.19). Replacement or alteration of existing utilities within aquatic habitat conservation areas or buffers requires a certificate of compliance, mitigation plan, and compliance with minimum development standards (CCC 27.12.315.18).

Numerous aquatic habitat conservation areas are located in the vicinity of the water supply alternatives including wetlands, streams, and Puget Sound. Major streams in the vicinity of the alternatives include Morse Creek, Bagley Creek, Siebert Creek, and McDonald Creek (Figure 1). Water intake and drain pipes for the reservoir alternatives will be located on Morse Creek. Bagley Creek crosses a portion of the Buchanan Drive Quarry Site. McDonald Creek is located in the Agnew area. The water transmission lines will require crossings of smaller streams, but many of these crossings will be located within existing road rights-of-way.

Several state and federally listed species, and state priority species and habitats, are mapped in the project vicinity by Clallam County and the WDFW (2008). In and near Puget Sound are mapped occurrences of bald eagle, shellfish, gray whale, waterfowl concentrations, and habitat types such as cliffs/bluffs and lagoons. Between Puget Sound and Township Line Road are scattered mapped occurrences of bird species such as pileated woodpecker, wood duck, and harlequin duck. South of Bear Meadow Road are numerous mapped occurrences of species associated with mature forest, such as marbled murrelet, gray wolf, and northern spotted owl. These species and habitats will be regulated as Class I or Class II wildlife habitat conservation areas (CCC 27.12.310).

1.1.1.3 Geologically Hazardous Areas

Geologically hazardous areas regulated by Clallam County include landslide hazard areas, erosion hazard areas, and seismic hazard areas (CCC 27.12.410). A certificate of compliance is required for activities within the jurisdiction of a geologically hazardous area.

The standard minimum buffer for a landslide hazard area is 50 feet from the top, toe, and all edges of the hazard area (CCC 27.12.415). Alterations to a landslide hazard area or its buffer are allowed only through the County’s variance process (CCC 27.12.405). Placement of utilities within landslide hazards and their buffers may be allowed through a variance and subject to performance standards (CCC 27.12.415.10).

Critical facilities, including municipal water facilities, are prohibited within seismic hazard areas (CCC 27.12.425.1). Construction of commercial, industrial, or publicly owned buildings within a seismic hazard area requires submittal of a geotechnical report (CCC 27.12.425.4).
Erosion and landslide hazard areas are mapped along most of the streams in the vicinity of the alternatives. These hazard areas are also prevalent in the steep areas near the headwaters of streams in the south part of the project area. Seismic hazards are mapped in the vicinity of the Desalination Facility (generally corresponding with a mapped wetland) and where the transmission line from the New Bluffs Wells will cross Highway 101. See Table 1 for a listing of geologic hazards mapped in the area of each alternative.

1.1.1.4 Frequently Flooded Areas

Frequently flooded areas regulated by Clallam County include floodways, floodplains, and special flood hazard areas (CCC 27.12.510). A certificate of compliance is required for activities within frequently flooded areas (CCC 27.12.505).

Critical facilities, including municipal water facilities, are prohibited within frequently flooded areas (CCC 27.12.515.1). Land disturbing activities are prohibited within floodways unless a civil engineer certifies the activities will not increase flood levels to unacceptable levels as specified in CCC 27.12.515.3.a. Protection standards for structures in frequently flooded areas also apply (CCC 27.12.515.6).

Mapped frequently flooded areas in the vicinity of the project alternatives are limited to the lower portion of Morse and McDonald Creeks, and the Puget Sound shoreline. See Table 1 for a listing of frequently flooded areas mapped in the area of each alternative.
1.1.1.5 Critical Aquifer Recharge Areas

Critical aquifer recharge areas are land and shorelands that have a critical recharging effect on aquifers used for potable water (CCC 27.12.600). A certificate of compliance is required for regulated uses within critical aquifer recharge areas (CCC 27.12.615).

Critical aquifer recharge areas are mapped throughout much of the project vicinity including alternative facility and transmission line sites. See Table 1 for a listing of critical aquifer recharge areas mapped in the area of each alternative.

1.1.2 Endangered Species

Section 7 of the Endangered Species Act (ESA) directs all federal agencies to conserve threatened and endangered species and to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat. Section 7 applies to management of federal lands as well as other federal actions that may affect listed species, such as federal funding or the issuance of federal permits.

1.1.2.1 Fish

Federally listed fish species in the project vicinity are listed below:

<table>
<thead>
<tr>
<th>Listed Species</th>
<th>Scientific Name</th>
<th>Federal Status</th>
<th>Jurisdiction</th>
<th>Designated Critical Habitat?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puget Sound Chinook salmon</td>
<td><em>Oncorhynchus tshawytscha</em></td>
<td>Threatened</td>
<td>NMFS</td>
<td>Yes</td>
</tr>
<tr>
<td>Puget Sound Steelhead</td>
<td><em>O. mykiss</em></td>
<td>Threatened</td>
<td>NMFS</td>
<td>Under development</td>
</tr>
<tr>
<td>Coastal-Puget Sound DPS Bull Trout</td>
<td><em>Salvelinus confluentus</em></td>
<td>Threatened</td>
<td>USFWS</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The lower reaches of Morse Creek are documented to support Chinook, chum, coho, and pink salmon, steelhead, and cutthroat trout. It is unclear whether the stream supports bull trout although they have been reported by local anglers. Anadromous fish are limited to the portion of the stream below the impassable falls at River Mile 4.9. Resident cutthroat trout are documented above the falls (Elwha-Dungeness Planning Unit, 2005).

Bagley Creek historically supported coho and chum salmon, steelhead, cutthroat and rainbow trout, and dolly varden. However, a long culvert under Highway 101 is now considered a complete barrier to upstream fish passage (Elwha-Dungeness Planning Unit, 2005).

McDonald Creek also historically supported coho and chum salmon, steelhead, cutthroat and rainbow trout, and dolly varden. A fishway installed upstream of Highway 101 to allow fish passage at all flow conditions may not provide effective passage for all anadromous salmonid species (Elwha-Dungeness Planning Unit, 2005).
1.1.2.2 Wildlife

The WDFW (2008) maps several wildlife species in the project vicinity that are listed under the federal Endangered Species Act. Gray whale (endangered) is mapped just offshore in the Strait of Juan de Fuca. In the southern portion of the project vicinity, species associated with mature forest are mapped including marbled murrelet (threatened), gray wolf (endangered), and northern spotted owl (threatened).

1.1.3 Land Use

The water supply alternatives are located in unincorporated Clallam County, just outside of the urban growth areas for Port Angeles (to the west) and Carlsborg (to the east). The alternatives are within two County regional planning areas: Sequim-Dungeness Planning Region and Port Angeles Planning Region. These areas are discussed below.

1.1.3.1 Comprehensive Plan

The Clallam County Comprehensive Plan is contained in Title 31 of the CCC. The Comprehensive Plan includes provisions for water supply facilities and other essential public facilities (EPFs). CCC 31.02.285.8 states:

> Essential public facilities are public capital facilities of a County-wide or State-wide nature which are typically difficult to site. Essential public facilities may be located in designated commercial forest or rural lands provided the County finds that such facilities cannot otherwise be located in urban areas, are largely self-contained or served by urban governmental services in a manner that adjacent rural or urban development is not promoted, and the facility does not cause nuisances (noise, dust, light, etc.) on adjacent properties that cannot be adequately mitigated. The siting of essential public facilities in resource lands should not interfere with resource management on adjacent resource lands.

Policies related to water supply systems are provided in the County-wide Comprehensive Plan and the plans for the two planning regions (Sequim-Dungeness and Port Angeles). These policies generally state that water systems should be limited in rural areas to areas with water supply issues. They also state that extension of public water service in rural areas should not be used to justify a higher density of development than has been anticipated in land use plans. The Comprehensive Plan includes additional policies specific to individual neighborhood areas within the two planning regions.

1.1.3.2 Zoning

Title 33 CCC contains the County’s zoning code. The zoning within the general areas of the supply alternatives is largely rural (R1 – Rural, R5 – Rural Low, R20 – Rural Very Low, RCC3 – Rural Character Conservation 3, RCC5 – Rural Character Conservation 5, RLC – Rural Limited Commercial, RNC – Rural Neighborhood Commercial). Portions of the Agnew
area contain agricultural zoning (AR - Agricultural Retention). The southern portions of the Morse Creek ASR study area are zoned for forestry (CF – Commercial Forest and CFM20 – Commercial Forest/Mixed Use 20).

The major aboveground water supply facilities for the alternatives will be located in areas zoned RCC5 (Deer Park Road Reservoir); RCC5 and R1 (Buchanan Drive Quarry Reservoir); RCC3 and RCC5 (Desalination Facility); and R1 (fluoride removal facility). Existing aboveground facilities that will be enlarged or expanded are located in zones R5 (Township Line Road Reservoir) and R20 (Morse Creek Treatment Plant). Aboveground water supply facilities are not specifically prohibited in any of these zones.

Open space corridors are mapped along most of the streams and wetlands in the project vicinity (OS – Open Space Overlay/Open Space Corridors). The purpose of the Open Space Overlay Corridor is to identify areas that have development rights that may be transferred in order to further protect critical areas. The underlying zoning governs the allowable land uses (CCC 33.13.070).

For some portions of the county, the Board of County Commissioners has adopted interim zoning controls in response to a finding of invalidity of certain zoned areas by the Washington State Growth Management Hearings Board. The finding applies to rural lands and urban growth areas. The Hearings Board also directed the County to reassess its local areas of more intensive rural development (LAMIRDs) (Clallam County, 2008). The County’s online geographic information system (GIS) mapping page indicates that portions of the water supply alternatives that were previously zoned R5 are currently designated as Interim Rural Low. These areas include portions of the transmission lines from the Buchanan Drive Quarry Reservoir and desalination sites; areas along the eastern part of Lemmon Road near the Bluff wells site; the Booster Pump Station for the intertie alternative; and the northern portion of the ASR Morse Creek study area.

As an essential public facility, it is likely that the water supply project will be allowed in the mapped zoning areas, particularly since above-ground water supply facilities are not specifically prohibited in any of these zones. Specific zoning requirements will need to be determined by Clallam County during project permitting.

1.1.4 Shorelines

The Clallam County Shoreline Master Program (SMP) (1992) and CCC Chapter 35.01 regulate shorelands of the County. Within the vicinity of the water supply alternatives, the shorelines of Morse Creek, McDonald Creek, and Puget Sound are regulated under the SMP. In addition to regulating the shoreland within 200 feet of the ordinary high water mark, the SMP regulates associated wetlands, floodways, and 100-year floodplains.

Shoreline environment designations in the project vicinity include Rural and Conservancy. (See Table 1 for a listing of shoreline designations for each alternative). Utilities are permitted in all shoreline environments in the County subject to policies and regulations.
For example, utility lines are to be placed underground whenever practical, and shorelines must be restored and revegetated following construction.

1.2 Permitting Considerations

All of the project alternatives will require a combination of federal, state, and local permits for construction and operation of water supply facilities. This Section provides a general overview of the federal, state, and local permitting requirements that will be anticipated for a project of this nature. Table 1 summarizes the permits that may be required for each alternative, based on the environmental considerations discussed above, and preliminary descriptions of each alternative in Section 3.

1.2.1 Federal Permits

A number of federal permits may apply to the water supply alternatives as discussed below. Some of these permits will in turn trigger other federal review requirements. Use of federal funding will also have related federal regulatory requirements.

1.2.1.1 Section 404 Permit

The U.S. Army Corps of Engineers (USACE) regulates discharges of dredged or fill materials into waters of the United States, including wetlands, under Section 404 of the Clean Water Act. The purpose of the Clean Water Act is to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.” A Section 404 permit may be required if a proposed project involves filling wetlands or altering streambeds or other waters of the U.S.

A Nationwide Permit (NWP) is a type of general permit issued by the USACE Chief of Engineers that is designed to regulate, with a minimal amount of delay or paperwork, certain activities having minimal impacts. The proposed construction activities may fall under a NWP 12, NWP 33, and/or a NWP 39. An Individual Permit may be triggered by placing a structure, excavating (including land clearing), or discharging dredged or fill material into waters of the United States, including wetlands. The difference between the trigger for a NWP and an Individual Permit is the amount of wetland fill.

The NWP 12 regulates those activities required for the construction, maintenance, and repair of utility lines and associated facilities (including substations, access roads, and intake/outfall structures) in waters of the U.S. This includes the associated excavation, backfill, or bedding for utility lines, in all waters of the U.S., provided there is no change in preconstruction contours. The excavation side-cast may be temporarily placed in waters (wetlands) of the U.S. for a period of up to three months, provided that these materials are not exposed to erosive forces such as currents. In wetlands, the top 12 inches of trench should be stockpiled separately from subsurface soils and used as the final layer of backfill. Trenches cannot be built in such a manner as to drain waters of the U.S.
The NWP 33 regulates temporary structures, work, and discharges, including cofferdams, necessary for construction activities, access fills, or dewatering of construction sites, provided that the associated primary activity is authorized by the USACE or U.S. Coast Guard regulations. Regional conditions, applicable to this project, allow temporary fills to be in place for up to six months only, and stipulate that the permittee must avoid or minimize discharge into waters of the U.S. to the maximum extent possible.

The NWP 39 regulates the discharges of dredged or fill materials into non-tidal waters for the construction or expansion of residential, commercial, and institutional building foundations and building pads and attendant features that are necessary for the use and maintenance of the structures.

In addition, the USACE Seattle District regional conditions do not permit the use of NWPs in mature forested wetlands, bogs, or bog-like wetlands. No construction activity may occur within 0.25 mile or 0.5 mile by line of sight of an occupied bald eagle nest, nocturnal roost site, or wintering concentration area within selected seasonal work windows.

The application for a Section 404 permit is a Joint Aquatic Resource Permit Application (JARPA). Coordination with the Washington DOE is required in order to obtain a 401 Water Quality Certification and/or certificate of compliance with Coastal Zone Management. Tribal entities and the U.S. Environmental Protection Agency (EPA) must be contacted if work is to occur on tribal lands. When the USACE has completed their review process, they will issue "verification." Following the appropriate approvals, work may proceed. Every permittee who receives verification from USACE receives a “Certificate of Compliance” stating that the work and any required mitigation has been completed in compliance with the NWP. This certificate must be signed and returned to the USACE.

Individual permits are required when the threshold for a NWP permit is exceeded or all of the conditions of the NWP are not met. Individual permits require compliance with the National Environmental Policy Act (NEPA) and 40 CFR Part 230 Section 404(b)(1) Alternatives Analysis. A NEPA Environmental Assessment (EA) or Environmental Impact Statement (EIS) is typically prepared by the USACE as part of their internal review process; an alternatives analysis is typically prepared by the permittee and considered by the USACE prior to making a permit decision. The individual permit process can be lengthy, typically taking one year or longer to complete the process.

1.2.1.2 Endangered Species Act Section 7 Consultation

Section 7 of the ESA requires all federal agencies to ensure that any actions they authorize are not likely to jeopardize a listed species or adversely modify its critical habitat. These actions can include issuance of a federal permit or use of federal funding. For example, as described above, if a Section 404 permit is required, the USACE must consult with NOAA Fisheries and USFWS who have the authority to administer Section 7 of the ESA.
To ensure compliance with the ESA, a Biological Assessment (BA) will need to be prepared and submitted to the USACE. A BA evaluates any ESA-listed species that could potentially occur in the area, and assesses the impacts that the project may have at any stage in the species' life history, or impacts on the species' habitat (both beneficial and negative impacts). Based upon the project impacts, an “effect determination” is made for each species. The determination may be “no effect”, “may affect but not likely to adversely affect”, or “may affect and likely to adversely affect” a listed species. Depending upon the effect determination, certain conservation measures, mitigation, or best management practices must be applied to lessen impacts.

1.2.1.3 Section 106 National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires that all federal agencies take into account the affect of their actions on historic properties. Projects that require Section 106 review include any federal undertaking, funding, license, or permit. The Department of Trade and Economic Development, Department of Archaeology and Historic Preservation (DAHP) must be consulted when projects are subject to review under Section 106 of the NHPA. Federal agencies must also consult with affected tribes through a government-to-government consultation process.

The DAHP is consulted to determine if the project area has been surveyed, if there are any identified historical resources along the alignment, and if an identified property is listed or eligible for listing on the National Register of Historic Places. The federal agency involved is generally responsible for initiating and completing Section 106 review; however, the project applicant may make direct contact with the DAHP. Since the water supply project will likely require federal permits and the excavation of soils, there is a potential to alter or remove cultural resources or Native Indian grave sites and Section 106 review will be necessary.

1.2.1.4 National Environmental Policy Act

NEPA requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions. NEPA’s procedural requirements apply to a federal agency’s decisions for actions, including financing, assisting, conducting, or approving projects or programs; agency rules, regulations, plans, policies, or procedures; and legislative proposals (CEQ, 2007).

Once the federal lead agency has developed a proposed action, the agency will determine whether a Categorical Exclusion (CE), an EA, or an EIS is required. A CE is a category of actions that the agency has determined does not individually or cumulatively have a significant effect on the quality of the human environment. The purpose of an EA is to determine the significance of the proposal’s environmental effects, examine alternative means to achieve the agency’s objectives, and determine whether an EIS is required. The EA process concludes with either a Finding of No Significant Impact (FONSI) or a determination to proceed with preparation of an EIS (CEQ, 2007).
NEPA compliance is likely to be required for all of the water supply alternatives since they will probably involve obtaining federal permits and potentially federal funding. An EA is likely to be adequate unless unexpected significant impacts are found during the analysis of alternatives. However, if a USACE Section 404 permit is the only federal permit required and the project has no federal funding, then NEPA will not be triggered.

1.2.1.5 Section 10 Permit

Under Section 10 of the Rivers and Harbors Act, the U.S. Army Corps of Engineers and U.S. Coast Guard regulate obstructions to navigable waters. The Coast Guard reviews proposed underwater structures such as intake and outfall pipelines for desalination facilities to ensure they do not pose hazards to navigation.

1.2.2 State Permits

Depending upon the alternative selected and the location, the project will likely require permits from state agencies including the DOE, Washington Department of Health, WDFW, and Washington Department of Natural Resources (WDNR).

1.2.2.1 National Pollutant Discharge Elimination System (NPDES) Permit

The discharge of pollutants into the state’s surface waters is regulated through NPDES permits. DOE issues these permits under authority delegated by the EPA in accordance with the federal Clean Water Act as amended, Chapters 90.48 RCW, Chapters 173-224 Washington Administrative Code (WAC) (fees), and Chapters 173-226 WAC (general permits). Under the NPDES permitting process, different permits exist.

An NPDES stormwater permit is triggered by construction activities that have an area of disturbed soil of 1 acre or more and when there is a discharge of stormwater to a surface water (e.g., wetlands, creeks, rivers, marine waters, ditches, estuaries) and/or storm drains that discharge to a surface water. Application for the permit is made by completing a form called a Notice of Intent for Construction Activity (NOI). NOIs are usually processed within 30 days of receipt but may take up to 180 days depending on project complexity. Prior to initiation of construction, the applicant must have prepared a Stormwater Pollution Prevention Plan (SWPPP) and verify that State Environmental Policy Act (SEPA) and public notice requirements have been met.

During construction, dewatering activities could be required. Dewatering water will need to meet state water quality standards prior to discharge (Chapter 173-201A WAC), and will likely be coordinated through the NPDES permit process.

All of the water supply alternatives will likely require an NPDES construction stormwater permit. In addition, the Desalination Facility will need an NPDES wastewater discharge permit to discharge waste brine into Puget Sound. Requirements for the brine discharge permit will need to be established with DOE; they are likely to include detailed studies such as a mixing zone assessment.
1.2.2.2 Forest Practices Approval

The Forest Practices Rules establish standards for forest practices such as timber harvest, pre-commercial thinning, road construction, fertilization, and forest chemical application (Title 222 WAC). A forest practice permit from the WDNR is required whenever more than 5,000 board feet of merchantable timber is harvested from an area or property. See Table 1 for discussion specific to each alternative.

1.2.2.3 Aquatic Use Authorization

Any entity that wants to use state-owned aquatic lands must obtain authorization from the WDNR in accordance with 79.9-79.96 RCW and Chapter 332-30 WAC. State-owned aquatic lands include bedlands of Puget Sound, navigable rivers, lakes, and other waters. It includes much of the tidelands and shores of lakes and other fresh waters. Facilities such as marinas, docks, and land/water connectors are often authorized activities. Projects that commonly require authorization include: geoduck harvest, shellfish harvest, aquaculture leases, dredge disposal, and easements for utility crossings.

Installation of an outfall/intake on the Puget Sound shoreline for the Desalination Facility will occur on state-owned aquatic lands and will require an aquatic use authorization from the state.

1.2.2.4 Section 401 Water Quality Certification

A Section 401 Water Quality Certification is required of any applicant for a USACE permit in order to conduct any activity that may result in any discharge into surface waters, in accordance with the federal Clean Water Act, Section 401, and Chapters 173-225 of the WAC. Typically, the EPA is given jurisdiction for processing requests for Water Quality Certification. However, in the State of Washington, the EPA has delegated this authority to DOE.

The timing of the 401 certification is tied to the USACE Section 404 permit and is usually requested by the USACE on behalf of the applicant. The USACE is then provided a certification from DOE that the discharge complies with the discharge requirements of federal law and the aquatic protection requirements of state law. Only then will the Corps permit be valid.

Water Quality Certification for this project will require the submittal of a JARPA to DOE to demonstrate what measures will be taken to protect water quality.

1.2.2.5 Coastal Zone Management (CZM) Certification

Activities and development affecting coastal resources in Washington State that involve federal activities, licenses or permits, or federal funding require a written CZM decision by DOE. For example, if a Section 404 permit is granted, DOE will require a certification that the project is consistent with Washington’s Coastal Zone Management Program. Legal
authority is set forth in Title 16, Chapter 33, Section 1456; Title 15, Chapter 9, Part 930; and Title 15, Chapter 9, Part 923 of the United States Code.

1.2.2.6 Hydraulic Project Approval

Any form of work that uses, diverts, obstructs, or changes the natural flow or bed of any fresh water or saltwater of the state requires a Hydraulic Project Approval (HPA) from the WDFW. Legal authority is found in Chapter 77.55.100 RCW; Chapters 220-110 WAC, and Second Substitute House Bill 2879. For example, stream crossings requiring installation or replacement of culverts, or installation of pipes below the mean higher high water line of Puget Sound, will require an HPA.

A complete application package for an HPA must include a JARPA form, general plans for the overall project, and complete plans and specifications of the proposed work within the mean higher high water line in salt waters or within the ordinary high water line in fresh waters of the state, complete plans and specifications for the proper protection of fish life, and notice of compliance with any applicable requirements of the SEPA.

1.2.2.7 Water Rights Permit

The DOE regulates the use of surface and ground waters in the state through a system of water rights. The District has an existing water right to withdraw water from Morse Creek. The water supply alternatives will require either a change to this existing right or a new water right (see Table 1). Water rights are issued by DOE’s regional offices. The date when DOE receives the application becomes the priority date, which establishes the seniority of a water right application. A legal notice of the application must be published. A decision by DOE on a new water right may take months to years. Changes to existing water rights can be processed by local water conservancy boards and submitted to DOE for an accelerated review. DOE generally considers changes to the place of use, point of withdrawal or additional points of withdrawal, or purpose of use (for surface water rights) (DOE, 2008a). There are limitations on changes that may be made, such as whether the right is to surface or groundwater (DOE, 2008b).

1.2.2.8 Reservoir Permit

Construction of a dam or dike that is capable of impounding surface water to a depth of 10 feet or more at any point, or will impound a volume of 10 acre-feet or more at normal pool level, requires a reservoir permit from DOE (RCW 90.03.370; DOE, 2005).

The state’s definition of a “reservoir” also includes underground aquifers where water is collected and stored for subsequent use. DOE may therefore issue reservoir permits to authorize ASR projects. The projects must meet the requirements of Chapter 173-157 WAC (Underground Artificial Storage and Recovery). Water to be stored in an aquifer for an ASR project must meet state groundwater quality standards, and injection wells must be
registered with the DOE in accordance with Chapter 90.48 RCW (Water Pollution Control Act) and Chapter 173-218 WAC (Underground Injection Control Program) (DOE, n.d.).

For both above-ground and aquifer storage facilities, the reservoir permit application must include the water rights for the source waters as well as plans prepared by a professional engineer.

### 1.2.3 Clallam County Permits

#### 1.2.3.1 SEPA

Any proposal that requires a state or local agency decision to license, fund, or undertake a project, or the proposed adoption of a policy, plan, or program, can trigger environmental review under the SEPA. The lead agency will evaluate the proposal and make a “threshold determination” by deciding whether the proposal is likely to have a significant adverse environmental impact. If no significant impacts are identified or the impacts can be mitigated to a nonsignificant level, a determination of nonsignificance can be issued. If significant impacts are likely, the lead agency will issue a determination of significance and start the preparation of an environmental impact statement.

#### 1.2.3.2 Critical Area Review

Clallam County performs a critical area review for development proposal permit applications or other requests for permission to proceed with an alteration on a site that includes a critical area or is within the critical area buffer. The County determines if any critical areas exist on the property and whether a special study is required, evaluates the study, determines whether the development proposal is consistent with CCC Chapter 27.12, determines whether the proposed alterations are necessary, and determines whether or not the mitigation plans, monitoring plans, and bonding measures proposed by the applicant are sufficient to protect public health, safety, and welfare, consistent with those goals, purposes, and objectives set forth in CCC Chapter 27.12.

#### 1.2.3.3 Shoreline Substantial Development Permit

A Shoreline Substantial Development Permit is required for projects proposed within regulated shorelands. State law provides exemptions for certain types of projects as listed in WAC 173-27-040. Non-exempt project activities associated with the regulated shorelines of Morse or McDonald Creek or Puget Sound will require a Shoreline Substantial Development Permit from Clallam County. Shoreline Substantial Development Permits are reviewed against the criteria in the local SMP and state criteria in WAC 173-27-150. Exempt projects still require a written statement of exemption from the County (CCC 35.01.050).
1.2.3.4 Other Local Permits

The alternatives will require other types of approvals from Clallam County in order to obtain building permits. For example, projects that result in increased stormwater runoff must have an approved drainage plan. Clearing and grading and right-of-way permits are also likely to be needed. For complex projects that may require multiple permits, the County provides for a Project Review process. Applicants submit a Project Review Request along with preliminary project information, and County representatives from applicable departments provide guidance on the specific permits that will be required.

1.3 Permitting Summary

Table 1 summarizes the anticipated permitting requirements associated with the water supply alternatives. A specific list of permits will be developed in future phases of the project as the project is defined and sites are selected.