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# MEMORANDUM

TO: Lummi Island Scenic Estates

FROM: Eric Hull, EIT, and Brian Smith, PE, Wilson Engineering, LLC

SUBJECT: Lummi Island Scenic Estates Community Club – Water System Capacity Analysis

JOB NO.: 2021-032

DATE: September 17, 2022


9/17/2022

The purpose of this memorandum is to analyze recent water production and demand data and summarize the current and projected needed capacity of the Lummi Island Scenic Estates Community Club (LISECC) water system. This analysis determines the following:

- Average day demand per Equivalent Residential Unit ($ERU_{ADD}$)
- Maximum day demand per ERU ($ERU_{MDD}$)
- Distribution System Leakage (DSL)
- Peak hour demand (PHD)
- Source capacity
- Source reliability
- Storage capacity
- Distribution capacity
- Capital Improvement Projects related to system capacity

The LISECC (System ID #43290W) is a Group A water system located on Lummi Island, in Whatcom County. The system consists of a single surface water source, Dickenson Lake, a surface water treatment plant (coagulation, rapid dual media filter, disinfection), two storage tanks, and a distribution system. A map of the distribution system is shown in Figure 1 (attached).

**System Demands**

Below is a graph of monthly water production for years 2016 to 2021. July and August are the most common months of peak production, with 2021 being an outlier. In 2021 LISECC experienced a significant distribution system leak which caused peak production to occur in June and a near peak production to occur in July. The significant leak was fixed in July 2021.

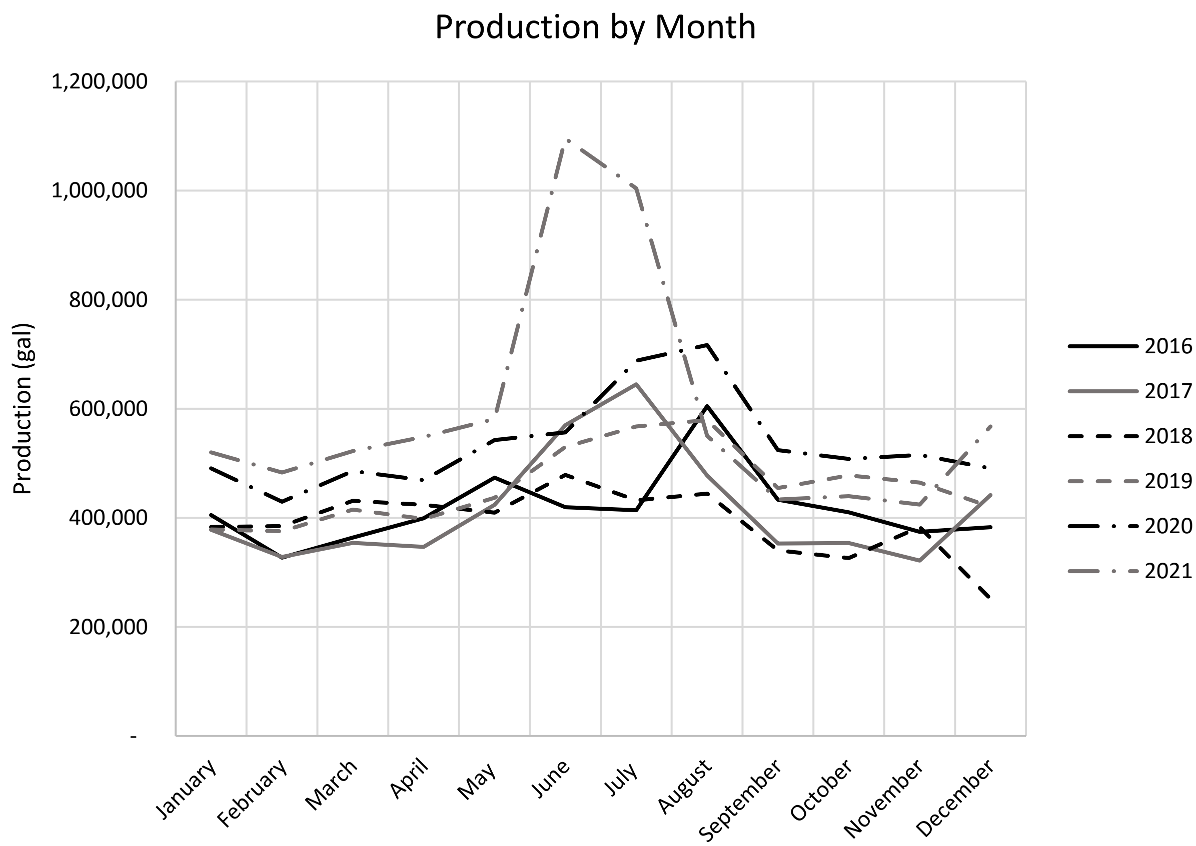


Table 1 summarizes the total annual production. During the data reporting period, 2016 to 2021, the maximum annual production occurred in 2021 with 7.17 million gallons produced. Production has steadily increased over the last four years from 4.69 million gallons in 2018 to 7.17 million gallons in 2021.

**Table 1 – Annual Water Production**

| Year | Production (gal) |
|---|---|
| 2016 | 5,007,500 |
| 2017 | 4,993,410 |
| 2018 | 4,688,700 |
| 2019 | 5,498,000 |
| 2020 | 6,417,500 |
| 2021 | 7,170,200 |
| **Avg** | **5,629,218** |

Equivalent Residential Units (ERUs)

An equivalent residential unit (ERU) is system-specific unit of measure used to express the amount of water consumed by a typical full-time single-family residence (WAC 246-290-010). The LISECC consists of mostly single-family residential users, as well as a small number of RV sites and a couple community buildings. According to records provided by LISECC, the total number of connections as of December, 2021 was 222. The breakdown of accounts by category is shown in Table 2.

**Table 2 – Connection Type and Quantity**

| Quantity | Type | Description |
|---|---|---|
| 199 | Residential | Single Family Residences |
| 18 | Recreational | Undeveloped lots with an active connection, often used for camping. Connections are available for future residential development. |
| 5 | Institutional | Community-owned connections |

All connections are metered, and water usage data was reviewed for a 6-year period from 2016 to 2021. This data was analyzed to determine the $ERU_{ADD}$, $ERU_{MDD,}$ and peak hour demand (PHD).

- **$ERU_{ADD}$:** the approximation of the average daily demand of a typical full-time single-family residence
- **$ERU_{MDD}$:** the approximation of the maximum daily demand of a typical full-time single-family residence

ERU Average Day Demand ($ERU_{ADD}$)

Because many LISECC residential properties are only occupied periodically, $ERU_{ADD}$ cannot be calculated using the total number of residential connections as it would be for a system with near 100% occupancy. $ERU_{ADD}$ was calculated by analyzing usage data and identifying which connections used more than 50 gallons per day on average throughout a given month – if a connection met this criterion, it was deemed to be an "active", or occupied, connection for that month. To calculate $ERU_{ADD}$, the monthly use of each active connection was summed over the year, and this total usage by active connections was divided by the number of active connections. A summary of the $ERU_{ADD}$ calculations for each year is shown in Table 3.

**Table 3 – ERU Average Day Demand ($ERU_{ADD}$)**

| Year | Total Number of Connections (No.) | Number of Residential Connections (No.) | Annual Average % Occupancy | Active Residential Connections (ERUs)[1] | $ERU_{ADD}$ (gpd/ERU)[2] |
|---|---|---|---|---|---|
| 2016 | 219 | 194 | 36% | 69 | 118 |
| 2017 | 219 | 194 | 35% | 67 | 106 |
| 2018 | 220 | 194 | 35% | 68 | 107 |
| 2019 | 221 | 196 | 36% | 70 | 106 |
| 2020 | 222 | 199 | 39% | 78 | 108 |
| 2021 | 222 | 199 | 39% | 78 | 118 |

[1] Active connections is based on average usage of more than 50 gals per day
[2] $ERU_{ADD}$ value does not include distribution system leakage

The average value for $ERU_{ADD}$ for the last six years is 111 gpd/ERU. However, to remain conservative a value of **120 gpd/ERU** will be used for water use projection calculations. To reiterate, this usage per ERU is for an active, occupied connection.

Table 3 shows that the percentage of active residential connections out of the total number of residential connections varies somewhat year-to-year, but is typically approximately 35-40% occupancy. Using an $ERU_{ADD}$ as calculated assumes 100% occupancy, unless occupancy is explicitly accounted for in the calculation.

ERU Maximum Day Demand ($ERU_{MDD}$)

The maximum month average day demand (MMADD) method was used to calculate the $ERU_{MDD}$. The MMADD was calculated the same way as the above $ERU_{ADD}$ except only for the maximum month of usage during the year. $ERU_{MDD}$ is calculated by multiplying the MMADD by the peaking factor of 1.65 for systems serving fewer than 1,000 people, according to Section 3.4.1 of the Water System Design Manual.

**Table 4 – ERU Maximum Day Demand ($ERU_{MDD}$)**

| Year | Month of Maximum Use | Active Residential Connections (ERUs)[1] | Max Month % Occupancy | Residential Max Month ADD, MMADD (gpd/ERU) | $ERU_{MDD}$ (gpd/ERU)[2] |
|---|---|---|---|---|---|
| 2016 | August | 96 | 49% | 155 | 255 |
| 2017 | July | 88 | 45% | 131 | 216 |
| 2018 | July | 86 | 44% | 137 | 227 |
| 2019 | August | 93 | 47% | 119 | 196 |
| 2020 | July | 91 | 46% | 125 | 207 |
| 2021 | July | 103 | 52% | 130 | 214 |

[1] Active connections are those that have an average usage of more than 50 gals per day during the given month

[2] $ERU_{MDD}$ value does not include distribution system leakage

The average value for $ERU_{MDD}$ for the last six years is 219 gpd/ERU. However, to remain conservative a value of **230 gpd/ERU** will be used for water use projection calculations.

As with average day demand calculations, the maximum day demand calculations in Table 4 shows maximum day demand for a fully occupied ERU. The number of active residential connections during the month of maximum use (Table 4) is higher than the annual average number of active connections (Table 3), but even during the month of maximum use, occupancy ranges from about 45% to 52%. Using an $ERU_{MDD}$ as calculated assumes 100% occupancy, unless occupancy is explicitly accounted for in the calculation.

Additional Use and Build-out

There are five institutional buildings that had an average $ERU_{ADD}$ of 16 gpd/Connection. This is 15% of the residential connection $ERU_{ADD}$ of 111 gpd/ERU. Therefore, the sum of these five connections is equal to 0.75 ERUs. To be conservative, these five connections will be treated as 1 ERU.

Projected build-out, based on septic system permit limitations placed on new construction, is 275 residential connections for the whole LISECC community. LISECC requires that all new water connections have a county building permit, so a septic system permit is a prerequisite for a water connection. Existing Recreational connections typically have lower usage than a Residential connection, but each existing Recreational connection could be converted to a Residential connection if/when the property owner constructs a residence. The 275 Residential connection build-out number assumes all Recreational connections are eventually converted to Residential connections.

For projections, build-out ERUs will be the 275 residential ERUs and 1 ERU for the community connections, for a total of 276 ERUs. Water demand and system capacity projections, described below, will also include projected distribution system leakage and non-revenue water.

Distribution System Leakage & Non-Revenue Water

Production requirements and consumptive demand of a water system can differ due to volumetric loss through distribution system leakage (DSL) and non-revenue water (NRW). NRW is often un-metered authorized consumption used for hydrant/line flushing, filter backwashing, street cleaning, watering of parks and landscapes etc. For the LISECC system, NRW primarily consists of filter backwashing and a small amount of flushing. DSL is found by comparing the volume of water metered coming out of the water storage tanks to the volume of water metered by individual users. The difference is considered DSL. Non-revenue water (NRW) is calculated by subtracting the water sent to the distribution system out of the water storage tanks from the total volume of water produced at the water treatment plant, plus the known volume of distribution flushing water.

Annual distribution system leakage and non-revenue water (DSL & NRW) for the years 2016 to 2021 are listed in Table 5.

**Table 5 – Distribution System Leakage & Non-revenue Water (DSL & NRW)**

| Year | DSL (%) | NRW (%) | DSL + NRW (%) |
|---|---|---|---|
| 2016 | 25% | 3% | 29% |
| 2017 | 23% | 14% | 36% |
| 2018 | 33% | -5% | 28% |
| 2019 | 34% | 4% | 38% |
| 2020 | 33% | 10% | 43% |
| 2021 | 41% | 4% | 44% |
| **Avg** | 31% | 5% | 36% |

DSL & NRW have an associated number of ERUs based both on $ERU_{ADD}$ and $ERU_{MDD}$. The number of ERUs based on $ERU_{ADD}$ is simply the number of ERUs multiplied by DSL + NRW as a fraction. For the build-out condition of 276 ERUs the number of ERUs associated with DSL and NRW based on $ERU_{ADD}$ is simply 276 x 0.36 (average percentage) = 99 ERUs.

The number of ERUs based on $ERU_{MDD}$ is discussed in the below section on peak hour demand.

These two different values for converting DSL+NRW into an ERU value depends on what demand value the calculation is using. If the calculation is based on $ERU_{ADD}$, the number of ERUs associated with DSL+NRW based on $ERU_{ADD}$ will be used, and if the calculation is based on $ERU_{MDD}$, the number of ERUs associated with DSL+NRW based on $ERU_{MDD}$ will be used.

**Table 6 – DSL & NRW ERUs**

| | |
|---|---|
| Build-out (ERUs) | 276 |
| ERUs associated with DSL & NRW based on $ERU_{ADD}$ | 99 |
| ERUs associated with DSL & NRW based on $ERU_{MDD}$ | 52* |

*Calculated in the section below

As tabulated above, the annual DSL & NRW equivalent is an additional 99 fully-occupied ERUs worth of water usage. This water system production is lost and no longer available for customer service. This reduces the water system's ability to serve customers. The Design Manual suggests taking significant action to decrease leakage when DSL is in excess of 10%. Recommendations for LISECC to decrease DSL are included in the Summary section of this memorandum.

Peak Hour Demand

The peak hour demand, for build-out condition, can be calculated from Equation 3-1 of the *2019 Water System Design (WSD) Manual*:

**Equation 3-1: Determine PHD**

$$PHD = (ERU_{MDD} / 1440)\,[(C)(N) + F] + 18$$

Where
- **PHD** = Peak Hourly Demand, total system (gallons per minute)
- **C** = Coefficient Associated with Ranges of ERUs
- **N** = Number of ERUs based on MDD
- **F** = Factor Associated with Ranges of ERUs
- **$ERU_{MDD}$** = Maximum Day Demand per ERU (gallons per day)

| Number of ERUs (N) | C | F |
|---|---|---|
| 15 – 50 | 3.0 | 0 |
| 51 – 100 | 2.5 | 25 |
| 101 – 250 | 2.0 | 75 |
| 251 – 500 | 1.8 | 125 |
| > 500 | 1.6 | 225 |

From Section 3.4.2 of the 2019 *WSD manual:*

- N is the number of ERUs supplied by all sources. DSL has an associated number of ERUs (see examples in Section 3.12 and Worksheet 4-1). Therefore, N includes DSL. "N" is the number of connections only if there is no distribution system leakage and all connections are single-family homes.

An equation for "N" was found by following the example in the WSD Manual and is listed below.

$$N = ERUs + \left(\frac{ERU_{ADD} * ERUs * DSL_{Fraction}}{ERU_{MDD}}\right)$$

The DSL & NRW fraction used is 0.39, which corresponds to the average DSL & NRW from 2016 to 2021. See the Table 5 for annual average DSL & NRW values. Therefore, the whole number value to be used for determining PHD is calculated below.

$$N = 276 + \left(\frac{120 * 276 * 0.36}{230}\right)$$

$$N = 328$$

At build-out, DSL & NRW is equivalent to 52 ERUs, when calculated based on $ERU_{MDD}$.

System-wide PHD is calculated using N found above and values for C and F in the table from Section 3.4.2 of the 2019 WSD *manual*, above.

$$PHD = \left(\frac{230}{1440}\right) * [(1.8)(328) + 125] + 18$$

$$\boldsymbol{System - Wide\ PHD\ at\ build - out\ with\ 100\%\ occupancy = 132\ gpm}$$

**<u>System Capacity</u>**

<u>Water Rights Capacity</u>

The LISECC holds one surface water right for Dickenson Lake, which is attached for reference and summarized in Table 7. Also attached to this memo is the Water Right Self-Assessment Form.

**Table 7 – Summary of Water Rights**

| Water Right Document Number | Certificate Number | Storage Allowance (Acre-Ft/Yr) | Instantaneous Withdrawal Allowance (cfs) |
|---|---|---|---|
| R1-*15782CCWRIS | 10702B R1*15782 C C | 49 | 2 |

*Annual Water Rights*

The LISECC surface water right has a specified storage allowance, but does not indicate an allowable annual use volume. This topic is discussed in the DOH-approved "LUMMI ISLAND SCENIC ESTATES WATER SYSTEM ANALYSIS" by Wilson Engineering dated 6-23-2014, page 5. That report indicates that:

> "the annual quantity associated with the right is determined by the historical use under the right. The Lummi Island right is municipal, so connections and population are not a limitation on the extent of the right. This means that as long as the system is diligently growing, it can increase its water use. However… the growth of this system is very likely limited by the physical availability of water in the stream. If the water isn't there, obviously it can't be used, and additional connections can't be served."

The physical availability of water is addressed below in the section on Source Reliability.

*Instantaneous Water Rights*

The LISECC water right has an instantaneous withdrawal allowance of 2 cfs. Based on the $ERU_{MDD}$ of 230 gpd/ERU (value does not include DSL or NRW) the instantaneous water right can supply the following number of ERUs at 100% occupancy:

$$N_{water\ rights,instantaneous} = \frac{instantaneous\ withdrawal\ limit * 7.48\frac{gal}{ft^3} * 60\ s/min * 1440\ min/day}{ERU_{MDD}}$$

$$= \frac{2\frac{ft^3}{s} * 7.48\frac{gal}{ft^3} * 60\ \frac{s}{min} * 1440\frac{min}{day}}{230\ gpd/ERU}$$

$$= \mathbf{5,619\ \textit{ERUs at}\ 100\%\ \textit{occupancy}}$$

The LISECC water rights have an excess capacity of 5,291 ERUs from an instantaneous withdrawal limit perspective when build-out is 276 ERUs and DSL & NRW based on $ERU_{MDD}$ have an associated 52 ERUs.

*Reservoir/Storage Water Rights*

The LISECC surface water right has an annual storage allowance of 49 acre-ft, or 15,970,000 gallons. Physical storage volume is discussed in the DOH-approved “LUMMI ISLAND SCENIC ESTATES WATER SYSTEM ANALYSIS” by Wilson Engineering dated 6-23-2014, page 6 and Appendix 2.

Source Reliability

Currently there is no data collection procedure in place to measure Dickenson lake’s level or discharge throughout the year. We recommend that a weir be installed upstream of the 36” culvert that conveys the discharge out of Dickenson Lake, and a data collection plan be developed to collect and record data that will be useful in assessing source reliability.

We understand that a weir was installed years ago, but it was destroyed by a large storm. A replacement weir should be designed and constructed to withstand the maximum anticipated storm flow.

In addition to the weir, we recommend that a meter be installed on the pump back system to quantify the total volume of water pumped back into Dickenson Lake from seepage through the dam. This meter should be read with sufficient frequency to be able to determine any seasonal fluctuations in volume pumped – monthly reading is anticipated. This data will allow for quantification of the physical availability of water for the system. It is known that there is additional groundwater seepage through the dam that is not captured by the pump back system, but since this quantity of water cannot currently be used, it is okay that it is not quantified. If/when LISECC pursues measures to decrease seepage through the dam (liner, grout injections, etc.), that will be quantified by the weir and pump back meter as data is collected over time after any improvements.

Treatment System Capacity

The existing Keystone KeyFloc HRR 60 Water Filter has a maximum production rate of 67-gpm. It is recommended in Section 3.10.4 of the Water System Design Manual to assume a limit to operating a pumped source to less than 20 hrs/day, which allows for sufficient plant downtime for backwashing, filter-to-waste operations, and a safety factor.

Based on this rate at $ERU_{MDD}$ the plant can supply:

$$= \frac{\left(67\ gpm * 20\,\frac{hr}{day} * 60\,\frac{min}{hr}\right)}{230\ gpd/ERU}$$

$$= \mathbf{349\ \boldsymbol{ERUs\ at}\ 100\%\ \boldsymbol{occupancy}}$$

The LISECC treatment system has an excess capacity of 21 ERUs when build-out is 276 ERUs and DSL & NRW ERUs, based on $ERU_{MDD}$ have an associated 52 ERUs.

However, there have been times when treatment plant operations have been challenged, and a solution to achieve sufficient plant performance has been to decrease plant production rate, sometimes down as low as approximately 30 gpm. This is one of many reasons LISECC is planning to replace the treatment plant, and points to the urgency of needing to complete this replacement.

Storage Tank Capacity

LISECC has two storage tanks located at the top of Dogwood Terrace. Each tank has a capacity of 94,000 gals (20 ft dia. x 40 ft ht.) for a combined storage capacity of 188,000 gallons. Figure 4 reflects the storage requirements based on the number of ERU's, MDD, PHD, operational storage of 1.5 ft, equalizing storage, single net source production rate of 67 gpm, and dead storage.

Standby storage Criteria #1 column of Figure 4 reflects the minimum value of 200 gallons per ERU. Standby storage Criteria #2 column of Figure 4 reflects two times the ADD. The larger of the two values is used for standby storage.

In addition to the allotted storage volumes, the tanks need to remain sufficiently full to provide adequate contact time for disinfection. Documentation indicates that both tanks must maintain a minimum level in both tanks of 35.8 ft to ensure adequate contact time. If circumstances require the use of standby storage in the tanks, LISECC has adopted a practice of isolating one tank so that it is no longer being fed by the source and drawing down that tank during the circumstances necessitating use of standby storage. Because it is not being fed by the source, the tank has already provided sufficient contact time for the water in the tank, and the level can therefore be drawn down below the 35.8 ft. In this way, standby storage can be nested within contact time volume. This is reflected in Figure 4.

Figure 4 reflects that buildout could be achieved in approximately 2038 based on anticipated growth of the community. The maximum number of ERUs the storage tanks can support given existing infrastructure is 340 ERUs where 54 are associated with DSL and NRW. The storage tanks have an excess capacity of 10 ERUs at a buildout of 276 ERUs with DSL and NRW, based on $ERU_{MDD}$.

Because the source treatment plant is slated for replacement, and as discussed later the likely recommended treatment capacity will be approximately 100 gallons per minute, that condition was analyzed and is shown in Figure 5. This shows that increasing source capacity to 100 gallons per minute increases the storage excess and allows for a larger safety factor or additional operational volume while providing capacity for the full build-out capacity of 276 ERUs with an additional 52 ERUs associated with DSL & NRW based on $ERU_{MDD}$.

Distribution System Capacity

Capacity of the distribution system is evaluated based on the ability to provide the PHD with a minimum service pressure of 30 psi, or the maximum daily demand concurrently with a fire flow rate while maintaining a minimum service pressure of 20 psi. Fire flow is not required for this system therefore PHD was analyzed as the worst-case scenario.

A hydraulic model was developed for the LISECC system in order to simulate the distribution system for full build-out at PHD (shown in Figure 1). Water use data from 2016 – 2021 and previous model demands were used to assign scaled demands to each of the junctions in the model.

The distribution analysis indicates that residual pressures are above the minimum 30-psi for all areas in the distribution system except for the area immediately adjacent to the tanks. Two junctions immediately adjacent to the tanks, J-01 and J-02, have a residual pressure of 21.96-psi and 20.16-psi respectively. A pressure map of the distribution system can be found in Figure 2 and all tables associated with the model inputs and outputs can be found in Figure 3.

The distribution system has capacity for at least build-out condition of 276 ERUs with an additional 52 ERUs associated with DSL & NRW based on $ERU_{MDD}$.

## Summary

Table 8 summarizes the existing demand criteria and service connections. Table 9 shows the system capacity for each component of the LISECC water system. Both the treatment plant capacity and storage capacity are limiting factors, although the treatment plant capacity impacts the storage capacity via the equalizing storage component, so increasing treatment plant capacity decreases required equalizing storage, therefore increasing storage capacity despite there being no change in the physical storage volume. These tandem limiting components are quantified in Table 9 where capacities are shown both with the current treatment plant capacity of 67 gpm and the future treatment planned capacity of 100 gpm.

**Table 8 – LISECC Demand and Connection Summary**

| Existing Water System Demand Data | |
|---|---|
| Average Day Demand | 120 gpd/ERU |
| Maximum Day Demand | 230 gpd/ERU |
| Peak Hour Demand (at build-out) | 132 gpm (for 328 ERUs, which represents 276 ERUs of usage and 52 ERUs of DSL and NRW) |

| Existing Water System Service Connections and ERUs | | | | | | |
|---|---|---|---|---|---|---|
| **Connection Type** | **Connections** | **Equivalent Residential Units** | **Equivalent Residential Units w/DSL+NRW based on $ERU_{ADD}$** | **Equivalent Residential Units w/DSL+NRW based on $ERU_{MDD}$** | **Average Day Demand w/DSL+NRW, GPD, if 100% occupancy** | **Maximum Day Demand w/DSL+NRW, GPD, if 100% occupancy** |
| Residential | 199 | 199 | 271 | 237 | 32,520 | 54,510 |
| Recreational | 18 | 18 | 24 | 21 | 2,880 | 4,830 |
| Institutional | 5 | 1 | 1 | 1 | 120 | 230 |
| **Total** | 222 | 218 | 296 | 259 | 35,520 | 59,570 |

**Table 9 – LISECC Capacity Summary**

| Specific System Capacity in Equivalent Residential Units | | | | | |
|---|---|---|---|---|---|
| **Water System Component Capacity** | **Maximum Capacity w/Current WTP (ERUs)** | **Maximum Capacity w/New WTP (ERUs)** | **Current Excess Capacity (ERUs)** | **Build-out Excess Capacity: w/Existing WTP (ERUs)** | **Build-out Excess Capacity: w/New WTP (ERUs)** |
| Water Rights: Instantaneous[1] | 5619 | 5619 | 5360 | 5,291 | 5,291 |
| Treatment System Capacity[1] | 349 | 521 | 90 | 21 | 193 |
| Storage-Related Capacity | 340 | 455 | 81 | 12 | 127 |
| Distribution System Capacity | >400 | >400 | >141 | >72 | >72 |

[1] Calculation uses $ERU_{MDD}$, therefore the ERUs associated with DSL used are based on $ERU_{MDD.}$ Build-out is 328 ERUs with DSL & NRW.

Table 9 shows that the existing water system has a capacity to serve up to 340 ERUs, which exceeds anticipated build-out of the system of 328 ERUs (including DSL and NRW). After subtracting 54 ERUs that represent DSL and NRW ERUs, the existing system can serve 286 ERUs.

LISECC's current Water Facilities Inventory (WFI) shows that the system is approved for up to 250 connections, 5 of which are institutional connections. Based on the analysis in this memorandum, we recommend that this number of approved connections could be increased to **290** connections, with 5 of those connections being institutional connections that have a combined demand of 1 ERU, and 285 connections that could be allocated to full time single family residences. As described previously in this memorandum, the 20 approved recreational connections could be converted to full time single family residences at some point in the future.

Note that the recommended number of approved connections in the paragraph above does assume full functionality of the treatment plant at 67 gpm – given the recent history of sometimes needing to run the treatment plant at a lower production rate, LISECC has made it a priority to replace the treatment plant as soon as is feasible. Also note that data is not available to assess source reliability, and this analysis assumes source reliability (water available from the watershed) is not the limiting factor in the water system's capacity.

Based on our review of the data provided and the analyses described above, we recommend that the LISECC Board consider the following Capital Improvement Projects:

1. Investigate and replace any components causing distribution system leakage (DSL). Decreasing DSL will increase the system's ability to serve customers. There are numerous companies that specialize in detecting, pinpointing, and fixing distribution system leaks. Some of these include:
    a. Utility Service Associates, https://www.leakdetectionservice.com/
    b. Leak Masters, https://www.leakmasters.net/
    c. American Leak Detection, https://www.americanleakdetection.com/water-purveyors/
    d. Clearwater Leak Detection, https://www.clearwaterleakdetection.com/water-leak-detection-seattle-wa/

2. Water Source Reliability:
    a. Install a weir on the Dickenson Lake outlet along with a meter on the pump back system to collect data to be able to determine water source reliability.
    b. Commission a bathymetric survey of Dickenson Lake to determine current available storage volume. This may prompt LISECC to consider lake dredging or dam improvements to increase raw water storage volume up to the water right storage allowance. The cost of a bathymetric survey is estimated to be approximately $5,000.
    c. Once a. and b. are complete and data has been collected for a period of time, analyze source reliability to determine whether it has the potential to limit the water system's capacity.

3. As LISECC is already planning to do, replace the existing surface water filter plant with a surface water treatment system that can reliably provide approximately 100 gpm of treated water to provide an additional safety factor over the current capacity of 67 gpm, and to decrease required equalizing storage so that more of the existing storage is available for operational storage.

Attachments:

- Figure 1 – Water System Map
- Figure 2 – Pressure Map – PHD
- Figure 3 – Pipe and Junction Data
- Figure 4 – LISECC Storage Table
- Figure 5 – LISECC Storage Table with Source/Treatment improvement to 100 gpm
- Certificate of GW Right
- Water Right Self-Assessment Form


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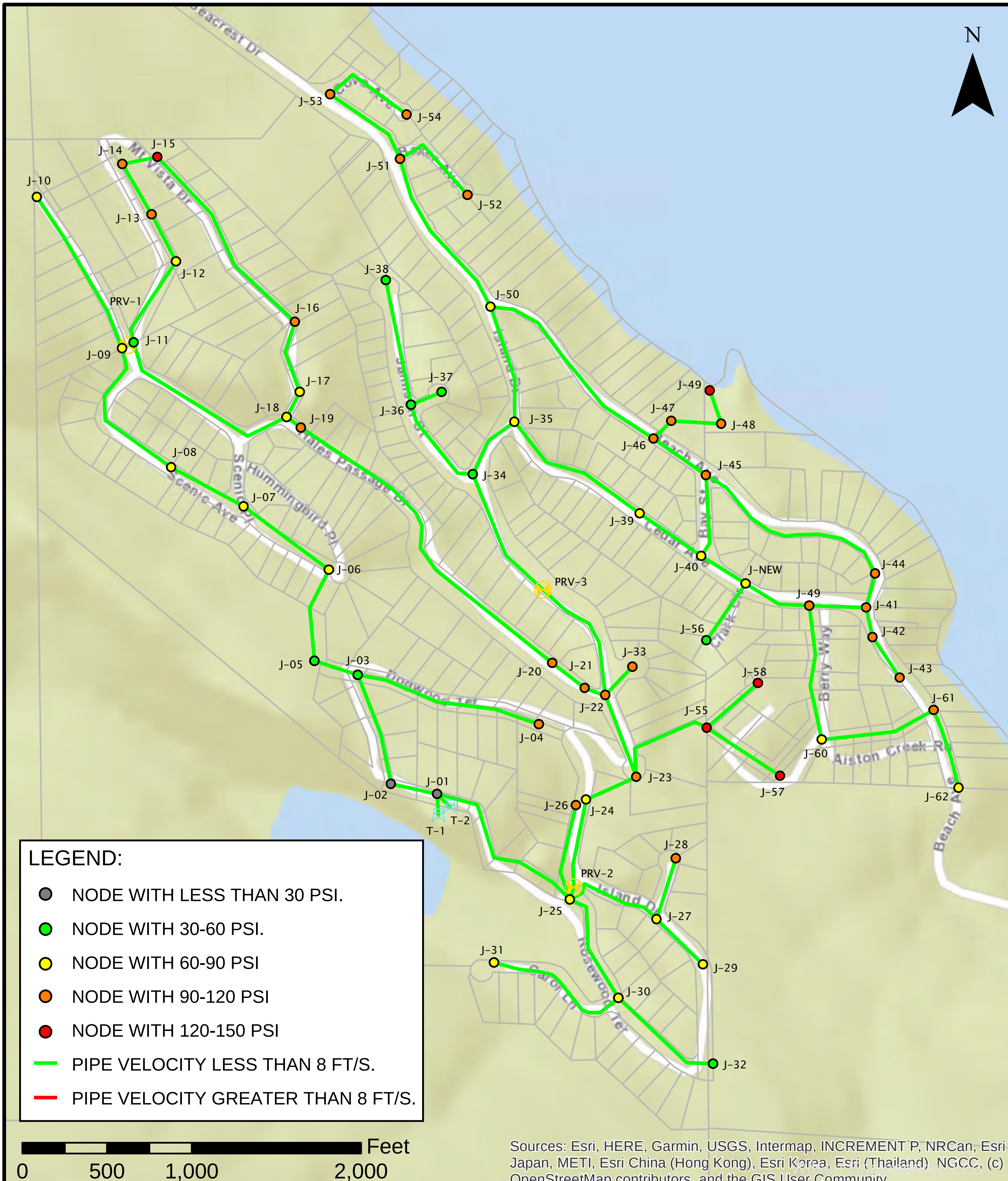
| | | |
|---|---|---|
| LUMMI ISLAND SCENIC ESTATES | DATE March 2022 | SHEET 1 |
| WHATCOM COUNTY WASHINGTON | SCALE AS SHOWN | |
| SYSTEM CAPACITY ANALYSIS FIGURE 1 | JOB NUMBER 2021-032 | OF 1 |

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| LUMMI ISLAND SCENIC ESTATES | DATE March 2022 | SHEET 1 |
|---|---|---|
| WHATCOM COUNTY WASHINGTON | SCALE AS SHOWN | OF |
| SYSTEM CAPACITY ANALYSIS FIGURE 2 | JOB NUMBER 2021-032 | 1 |

## Tank Report

| | ID | Flow (gpm) | Elevation (ft) | Head (ft) | % Full (%) | Level (ft) | Overflow Volume (ft3) | Total Overflow Volume (ft3) |
|---|---|---|---|---|---|---|---|---|
| 1 | T-1 | -70.50 | 613.00 | 648.42 | 88.41 | 35.42 | 0.00 | 0.00 |
| 2 | T-2 | -70.49 | 613.00 | 648.42 | 88.41 | 35.42 | 0.00 | 0.00 |

## Valve Report

| | ID | Diameter (in) | Elevation (ft) | Upstream Pressure (psi) | Downstream Pressure (psi) | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | Status | Setting |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PRV-1 | 4.00 | 467.06 | 78.34 | 50.15 | 0.00 | 0.00 | 0.00 | Closed | 40.00 |
| 2 | PRV-2 | 6.00 | 479.58 | 71.55 | 45.00 | 98.94 | 1.12 | 61.27 | Active | 45.00 |
| 3 | PRV-3 | 4.00 | 266.10 | 136.83 | 30.00 | 74.34 | 1.90 | 246.55 | Active | 30.00 |

# Junction Report

| | ID | Demand (gpm) | Elevation (ft) | Head (ft) | Pressure (psi) |
|---|---|---|---|---|---|
| 1 | J-01 | 1.03 | 597.59 | 648.28 | 21.96 |
| 2 | J-02 | 1.03 | 601.69 | 648.21 | 20.16 |
| 3 | J-03 | 4.10 | 549.31 | 648.09 | 42.80 |
| 4 | J-04 | 2.05 | 420.50 | 648.08 | 98.61 |
| 5 | J-05 | 0.00 | 569.39 | 648.06 | 34.09 |
| 6 | J-06 | 4.61 | 442.50 | 647.99 | 89.04 |
| 7 | J-07 | 3.08 | 451.59 | 647.93 | 85.07 |
| 8 | J-08 | 5.13 | 480.63 | 647.89 | 72.47 |
| 9 | J-09 | 6.66 | 474.52 | 647.87 | 75.11 |
| 10 | J-10 | 2.05 | 499.36 | 647.86 | 64.34 |
| 11 | J-11 | 0.00 | 463.86 | 582.79 | 51.53 |
| 12 | J-12 | 0.00 | 393.12 | 582.79 | 82.18 |
| 13 | J-13 | 0.00 | 366.74 | 582.79 | 93.61 |
| 14 | J-14 | 4.10 | 340.16 | 582.78 | 105.13 |
| 15 | J-15 | 0.00 | 282.74 | 582.78 | 130.01 |
| 16 | J-16 | 3.08 | 330.24 | 582.79 | 109.43 |
| 17 | J-17 | 0.00 | 391.70 | 582.79 | 82.80 |
| 18 | J-18 | 5.64 | 377.06 | 582.79 | 89.15 |
| 19 | J-19 | 0.00 | 362.38 | 583.05 | 95.62 |
| 20 | J-20 | 4.61 | 333.56 | 583.06 | 108.11 |
| 21 | J-21 | 0.00 | 331.48 | 583.07 | 109.01 |
| 22 | J-22 | 0.51 | 331.18 | 583.08 | 109.15 |
| 23 | J-23 | 2.56 | 362.70 | 583.20 | 95.54 |
| 24 | J-24 | 0.00 | 423.93 | 583.29 | 69.05 |
| 25 | J-25 | 3.08 | 487.03 | 644.73 | 68.33 |
| 26 | J-26 | 1.54 | 434.96 | 644.72 | 90.89 |
| 27 | J-27 | 2.05 | 442.34 | 644.72 | 87.69 |
| 28 | J-28 | 0.51 | 399.38 | 644.72 | 106.30 |
| 29 | J-29 | 0.51 | 477.75 | 644.72 | 72.35 |
| 30 | J-30 | 1.03 | 503.10 | 644.71 | 61.36 |
| 31 | J-31 | 1.54 | 488.35 | 644.70 | 67.75 |
| 32 | J-32 | 2.05 | 509.39 | 644.70 | 58.63 |
| 33 | J-33 | 0.51 | 321.58 | 583.08 | 113.31 |
| 34 | J-34 | 5.13 | 228.80 | 334.08 | 45.62 |
| 35 | J-35 | 7.69 | 194.51 | 333.66 | 60.29 |
| 36 | J-36 | 4.61 | 243.75 | 334.02 | 39.11 |
| 37 | J-37 | 0.00 | 247.92 | 334.02 | 37.30 |
| 38 | J-38 | 4.10 | 198.88 | 334.00 | 58.55 |
| 39 | J-39 | 7.18 | 140.64 | 333.42 | 83.53 |
| 40 | J-40 | 5.13 | 140.09 | 333.35 | 83.74 |
| 41 | J-41 | 4.61 | 86.99 | 333.31 | 106.73 |
| 42 | J-42 | 0.00 | 85.85 | 333.31 | 107.22 |
| 43 | J-43 | 1.54 | 72.52 | 333.31 | 113.00 |
| 44 | J-44 | 0.00 | 74.59 | 333.31 | 112.10 |
| 45 | J-45 | 4.10 | 110.64 | 333.35 | 96.50 |
| 46 | J-46 | 3.08 | 106.31 | 333.35 | 98.38 |
| 47 | J-47 | 0.00 | 89.91 | 333.35 | 105.48 |
| 48 | J-48 | 0.00 | 60.86 | 333.35 | 118.07 |
| 49 | J-49 | 0.51 | 20.68 | 333.35 | 135.48 |
| 50 | J-50 | 7.69 | 146.49 | 333.52 | 81.04 |
| 51 | J-51 | 4.10 | 99.20 | 333.49 | 101.52 |
| 52 | J-52 | 2.56 | 72.36 | 333.49 | 113.15 |
| 53 | J-53 | 0.00 | 99.13 | 333.49 | 101.55 |
| 54 | J-54 | 1.03 | 72.58 | 333.49 | 113.06 |
| 55 | J-55 | 0.00 | 255.64 | 583.19 | 141.93 |
| 56 | J-56 | 0.51 | 203.82 | 333.33 | 56.12 |
| 57 | J-57 | 1.03 | 249.50 | 583.19 | 144.59 |
| 58 | J-58 | 2.56 | 240.34 | 583.19 | 148.56 |
| 59 | J-59 | 3.08 | 113.08 | 333.31 | 95.43 |
| 60 | J-60 | 3.08 | 186.62 | 333.29 | 63.55 |
| 61 | J-61 | 2.56 | 66.93 | 333.28 | 115.41 |
| 62 | J-62 | 2.05 | 136.06 | 333.28 | 85.45 |
| 63 | J-NEW | 0.00 | 137.55 | 333.33 | 84.83 |

## Pipe Report

| | | ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status | Flow Reversal Count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | ☐ | P-42 | J-36 | J-38 | 228.48 | 3.00 | 140.00 | 4.10 | 0.19 | 0.02 | 0.07 | Open | 0 |
| 37 | ☐ | P-43 | J-22 | PRV-3 | 237.34 | 4.00 | 120.00 | 74.34 | 1.90 | 1.19 | 5.03 | Open | 0 |
| 38 | ☐ | P-44 | PRV-3 | J-34 | 248.57 | 4.00 | 120.00 | 74.34 | 1.90 | 1.25 | 5.03 | Open | 0 |
| 39 | ☐ | P-45 | J-35 | J-39 | 287.07 | 4.00 | 120.00 | 28.14 | 0.72 | 0.24 | 0.83 | Open | 0 |
| 40 | ☐ | P-46 | J-39 | J-40 | 134.24 | 4.00 | 120.00 | 20.96 | 0.54 | 0.06 | 0.48 | Open | 0 |
| 41 | ☐ | P-48 | J-41 | J-42 | 54.08 | 3.00 | 140.00 | 1.54 | 0.07 | 0.00 | 0.01 | Open | 0 |
| 42 | ☐ | P-49 | J-42 | J-43 | 88.03 | 3.00 | 140.00 | 1.54 | 0.07 | 0.00 | 0.01 | Open | 0 |
| 43 | ☐ | P-5 | J-03 | J-05 | 82.28 | 4.00 | 140.00 | 21.53 | 0.55 | 0.03 | 0.38 | Open | 0 |
| 44 | ☐ | P-50 | J-44 | J-41 | 63.41 | 3.00 | 120.00 | 4.00 | 0.18 | 0.01 | 0.09 | Open | 0 |
| 45 | ☐ | P-51 | J-45 | J-44 | 376.94 | 3.00 | 120.00 | 4.00 | 0.18 | 0.03 | 0.09 | Open | 0 |
| 46 | ☐ | P-52 | J-40 | J-45 | 150.28 | 3.00 | 120.00 | 2.40 | 0.11 | 0.01 | 0.04 | Open | 0 |
| 47 | ☐ | P-53 | J-46 | J-45 | 114.77 | 6.00 | 140.00 | 5.70 | 0.06 | 0.00 | 0.00 | Open | 0 |
| 48 | ☐ | P-54 | J-46 | J-47 | 45.13 | 6.00 | 140.00 | 0.51 | 0.01 | 0.00 | 0.00 | Open | 0 |
| 49 | ☐ | P-55 | J-47 | J-48 | 90.03 | 6.00 | 140.00 | 0.51 | 0.01 | 0.00 | 0.00 | Open | 0 |
| 50 | ☐ | P-56 | J-48 | J-49 | 63.12 | 2.00 | 100.00 | 0.51 | 0.05 | 0.00 | 0.02 | Open | 0 |
| 51 | ☐ | P-57 | J-50 | J-46 | 389.55 | 3.00 | 120.00 | 9.29 | 0.42 | 0.17 | 0.43 | Open | 0 |
| 52 | ☐ | P-58 | J-35 | J-50 | 213.90 | 4.00 | 120.00 | 24.67 | 0.63 | 0.14 | 0.65 | Open | 0 |
| 53 | ☐ | P-59 | J-50 | J-51 | 317.30 | 4.00 | 120.00 | 7.69 | 0.20 | 0.02 | 0.08 | Open | 0 |
| 54 | ☐ | P-6 | J-05 | J-06 | 172.23 | 4.00 | 140.00 | 21.53 | 0.55 | 0.07 | 0.38 | Open | 0 |
| 55 | ☐ | P-60 | J-51 | J-52 | 169.34 | 3.00 | 140.00 | 2.56 | 0.12 | 0.01 | 0.03 | Open | 0 |
| 56 | ☐ | P-61 | J-51 | J-53 | 176.02 | 4.00 | 140.00 | 1.03 | 0.03 | 0.00 | 0.00 | Open | 0 |
| 57 | ☐ | P-62 | J-53 | J-54 | 174.48 | 3.00 | 140.00 | 1.03 | 0.05 | 0.00 | 0.01 | Open | 0 |
| 58 | ☐ | P-63 | J-23 | J-55 | 193.65 | 3.00 | 140.00 | 3.59 | 0.16 | 0.01 | 0.06 | Open | 0 |
| 59 | ☐ | P-65 | J-55 | J-57 | 157.84 | 2.00 | 140.00 | 1.03 | 0.11 | 0.01 | 0.04 | Open | 0 |
| 60 | ☐ | P-66 | J-55 | J-58 | 122.14 | 3.00 | 140.00 | 2.56 | 0.12 | 0.00 | 0.03 | Open | 0 |
| 61 | ☐ | P-67 | J-40 | J-NEW | 94.41 | 4.00 | 120.00 | 13.43 | 0.34 | 0.02 | 0.21 | Open | 0 |
| 62 | ☐ | P-67B | J-NEW | J-59 | 125.03 | 4.00 | 120.00 | 12.92 | 0.33 | 0.02 | 0.20 | Open | 0 |
| 63 | ☐ | P-68 | J-59 | J-41 | 102.54 | 4.00 | 120.00 | 2.15 | 0.06 | 0.00 | 0.01 | Open | 0 |
| 64 | ☐ | P-69 | J-59 | J-60 | 244.43 | 4.00 | 120.00 | 7.69 | 0.20 | 0.02 | 0.08 | Open | 0 |
| 65 | ☐ | P-7 | J-06 | J-07 | 191.26 | 4.00 | 120.00 | 16.92 | 0.43 | 0.06 | 0.32 | Open | 0 |
| 66 | ☐ | P-70 | J-60 | J-61 | 212.20 | 4.00 | 120.00 | 4.61 | 0.12 | 0.01 | 0.03 | Open | 0 |
| 67 | ☐ | P-71 | J-61 | J-62 | 146.81 | 4.00 | 120.00 | 2.05 | 0.05 | 0.00 | 0.01 | Open | 0 |
| 68 | ☐ | P-72 | T-2 | J-01 | 39.39 | 4.00 | 140.00 | 70.49 | 1.80 | 0.14 | 3.43 | Open | 0 |
| 69 | ☐ | P-8 | J-07 | J-08 | 147.90 | 4.00 | 120.00 | 13.84 | 0.35 | 0.03 | 0.22 | Open | 0 |
| 70 | ☐ | P-9 | J-08 | J-09 | 291.27 | 4.00 | 120.00 | 8.71 | 0.22 | 0.03 | 0.09 | Open | 0 |

| | | ID | From Node | To Node | Length (ft) | Diameter (in) | Roughness | Flow (gpm) | Velocity (ft/s) | Headloss (ft) | HL/1000 (ft/k-ft) | Status | Flow Reversal Count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 71 | ☐ | P-NEW | J-NEW | J-56 | 124.10 | 3.00 | 140.00 | 0.51 | 0.02 | 0.00 | 0.00 | Open | 0 |

Figure 4

**Lummi Island Scenic Estates**
**Storage Table**
**9/17/2022**

| Year | Equivalent Residential Units (ERU) | Distribution System Leakage as ERUs (ERU) | Total ERUs, N (ERU) | Maximum Daily Demand (gpd/ERU) | Maximum Daily Demand (gpd) | Maximum Daily Demand (gpm) | Peak Hourly Demand (gpm) | Operational Storage (gal) | Equalizing Storage Required (gal) | Equalizing Storage (ft) | Standby Storage Criteria #1 | Standby Storage Criteria #2 | Standby Storage Required (gal), Max. Criteria #1 or #2 | Contact Time Storage (gal) | Dead Storage (gal) | Total Storage Required (gal) | Total Storage Available (gal) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2021 | 218 | 41 | 259 | 230 | 59,570 | 41.4 | 112 | 7,050 | 6,814 | 1.45 | 51,800 | 62,160 | 62,160 | 168,254 | 2,350 | 184,467 | 187,993 |
| 2022 | 222 | 42 | 264 | 230 | 60,720 | 42.2 | 114 | 7,050 | 7,030 | 1.50 | 52,800 | 63,360 | 63,360 | 168,254 | 2,350 | 184,683 | 187,993 |
| 2023 | 225 | 43 | 268 | 230 | 61,640 | 42.8 | 115 | 7,050 | 7,202 | 1.53 | 53,600 | 64,320 | 64,320 | 168,254 | 2,350 | 184,856 | 187,993 |
| 2024 | 228 | 43 | 271 | 230 | 62,330 | 43.3 | 116 | 7,050 | 7,332 | 1.56 | 54,200 | 65,040 | 65,040 | 168,254 | 2,350 | 184,985 | 187,993 |
| 2025 | 231 | 44 | 275 | 230 | 63,250 | 43.9 | 117 | 7,050 | 7,504 | 1.60 | 55,000 | 66,000 | 66,000 | 168,254 | 2,350 | 185,157 | 187,993 |
| 2026 | 235 | 45 | 280 | 230 | 64,400 | 44.7 | 118 | 7,050 | 7,720 | 1.64 | 56,000 | 67,200 | 67,200 | 168,254 | 2,350 | 185,373 | 187,993 |
| 2027 | 238 | 45 | 283 | 230 | 65,090 | 45.2 | 119 | 7,050 | 7,849 | 1.67 | 56,600 | 67,920 | 67,920 | 168,254 | 2,350 | 185,502 | 187,993 |
| 2028 | 242 | 46 | 288 | 230 | 66,240 | 46.0 | 121 | 7,050 | 8,065 | 1.72 | 57,600 | 69,120 | 69,120 | 168,254 | 2,350 | 185,718 | 187,993 |
| 2029 | 245 | 47 | 292 | 230 | 67,160 | 46.6 | 122 | 7,050 | 8,237 | 1.75 | 58,400 | 70,080 | 70,080 | 168,254 | 2,350 | 185,891 | 187,993 |
| 2030 | 249 | 47 | 296 | 230 | 68,080 | 47.3 | 123 | 7,050 | 8,410 | 1.79 | 59,200 | 71,040 | 71,040 | 168,254 | 2,350 | 186,063 | 187,993 |
| 2031 | 252 | 48 | 300 | 230 | 69,000 | 47.9 | 124 | 7,050 | 8,582 | 1.83 | 60,000 | 72,000 | 72,000 | 168,254 | 2,350 | 186,236 | 187,993 |
| 2032 | 256 | 49 | 305 | 230 | 70,150 | 48.7 | 126 | 7,050 | 8,798 | 1.87 | 61,000 | 73,200 | 73,200 | 168,254 | 2,350 | 186,451 | 187,993 |
| 2033 | 260 | 49 | 309 | 230 | 71,070 | 49.4 | 127 | 7,050 | 8,970 | 1.91 | 61,800 | 74,160 | 74,160 | 168,254 | 2,350 | 186,624 | 187,993 |
| 2034 | 263 | 50 | 313 | 230 | 71,990 | 50.0 | 128 | 7,050 | 9,143 | 1.95 | 62,600 | 75,120 | 75,120 | 168,254 | 2,350 | 186,796 | 187,993 |
| 2035 | 267 | 51 | 318 | 230 | 73,140 | 50.8 | 129 | 7,050 | 9,359 | 1.99 | 63,600 | 76,320 | 76,320 | 168,254 | 2,350 | 187,012 | 187,993 |
| 2036 | 271 | 51 | 322 | 230 | 74,060 | 51.4 | 131 | 7,050 | 9,531 | 2.03 | 64,400 | 77,280 | 77,280 | 168,254 | 2,350 | 187,184 | 187,993 |
| 2037 | 275 | 52 | 327 | 230 | 75,210 | 52.2 | 132 | 7,050 | 9,747 | 2.07 | 65,400 | 78,480 | 78,480 | 168,254 | 2,350 | 187,400 | 187,993 |
| 2038 | 276 | 52 | 328 | 230 | 75,440 | 52.4 | 132 | 7,050 | 9,790 | 2.08 | 65,600 | 78,720 | 78,720 | 168,254 | 2,350 | 187,443 | 187,993 |
| Max | 286 | 54 | 340 | 230 | 78,200 | 54.3 | 136 | 7,050 | 10,307 | 2.19 | 68,000 | 81,600 | 81,600 | 168,254 | 2,350 | 187,961 | 187,993 |

***Formulas & Definitions***

**Peak Hourly Demand (PHD)**

| Number of ERUs (N) | C | F |
|---|---|---|
| 0 | 3 | 0 |
| 51 | 2.5 | 25 |
| 101 | 2 | 75 |
| 251 | 1.8 | 125 |
| 501 | 1.6 | 225 |

***PHD=MDD/1440[C*N+F]+18***

***$N = ERUs + (ERU_{ADD} * ERUs * DSL_{Fraction} / ERU_{MDD})$***

**Source**

| Source | Status | Q, gpm | Q, gpd |
|---|---|---|---|
| Lake | Active | 898 | 1,292,544 |
| WTP Capacity | Active | 67 | 96,480 |
| WTP Operation (hrs/day) | | | |
| 20 | | | |
| Max Production | | 55.8 | 1,292,544 |

**Distribution System Leakage & Non-Revenue Water**

36%

**Tanks**

| Quantity | Volume, gal | Diameter, ft | Op. Stor., ft | Dead Stor., ft | CT stor, ft |
|---|---|---|---|---|---|
| 2 | 93,996 | 20 | 1.50 | 0.5 | 35.8 |

**Maximum Capacity Based on Water Rights**

| | | | | |
|---|---|---|---|---|
| Instant.= | 2 | cfs | | |
| | 898 | gpm, Capacity = | 5619 | ERU's |
| Annual= | 49 | ac-ft Capacity = | 364 | ERU's |

**Maximum Capacity Based on Water Treatment Plant**

| | | | | |
|---|---|---|---|---|
| Max Daily Rate = | 80,400 | gpd Capacity = | 349 | ERU's |

**Growth Rate**

1.45%

**Growth factor**

1.0145

*Reflects 2020 growth rate per state of Washington Office of Financial Management

**Average Daily Demand (ADD) & Maximum Daily Demand (MDD)**

ADD

**120** gpd per ERU *Does not include DSL

MDD

**230** gpd per ERU *Does not include DSL

**Standby Storage (SB)**

**Criteria #1:** ***SB = 200 gallons per ERU minimum***

**Criteria #2:** ***$SB = (N)(SB_i)(T_{days})$***

***$SB_i$ = ADD***

***$T_{days}$ = 2***

**Equalizing Storage (ESS)**

***ES=(PHD-Q)(150 min)***

where Q is the Total Flow rate of all active sources

**Figure 5**

**Lummi Island Scenic Estates**
**Storage Table with future Water Treatment Plant capacity of 100 gpm**
**9/17/2022**

| Year | Equivalent Residential Units (ERU) | Distribution System Leakage as ERUs (ERU) | Total ERUs, N (ERU) | Maximum Daily Demand (gpd/ERU) | Maximum Daily Demand (gpd) | Maximum Daily Demand (gpm) | Peak Hourly Demand (gpm) | Operational Storage (gal) | Equalizing Storage Required (gal) | Equalizing Storage (ft) | Standby Storage Criteria #1 | Standby Storage Criteria #2 | Standby Storage Required (gal), Max. Criteria #1 or #2 | Contact Time Storage (gal) | Dead Storage (gal) | Total Storage Required (gal) | Total Storage Available (gal) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2021 | 218 | 41 | 259 | 230 | 59,570 | 41.4 | 112 | 7,050 | 1,864 | 0.40 | 51,800 | 62,160 | 62,160 | 168,254 | 2,350 | 179,517 | 187,993 |
| 2022 | 222 | 42 | 264 | 230 | 60,720 | 42.2 | 114 | 7,050 | 2,080 | 0.44 | 52,800 | 63,360 | 63,360 | 168,254 | 2,350 | 179,733 | 187,993 |
| 2023 | 225 | 43 | 268 | 230 | 61,640 | 42.8 | 115 | 7,050 | 2,252 | 0.48 | 53,600 | 64,320 | 64,320 | 168,254 | 2,350 | 179,906 | 187,993 |
| 2024 | 228 | 43 | 271 | 230 | 62,330 | 43.3 | 116 | 7,050 | 2,382 | 0.51 | 54,200 | 65,040 | 65,040 | 168,254 | 2,350 | 180,035 | 187,993 |
| 2025 | 231 | 44 | 275 | 230 | 63,250 | 43.9 | 117 | 7,050 | 2,554 | 0.54 | 55,000 | 66,000 | 66,000 | 168,254 | 2,350 | 180,207 | 187,993 |
| 2026 | 235 | 45 | 280 | 230 | 64,400 | 44.7 | 118 | 7,050 | 2,770 | 0.59 | 56,000 | 67,200 | 67,200 | 168,254 | 2,350 | 180,423 | 187,993 |
| 2027 | 238 | 45 | 283 | 230 | 65,090 | 45.2 | 119 | 7,050 | 2,899 | 0.62 | 56,600 | 67,920 | 67,920 | 168,254 | 2,350 | 180,552 | 187,993 |
| 2028 | 242 | 46 | 288 | 230 | 66,240 | 46.0 | 121 | 7,050 | 3,115 | 0.66 | 57,600 | 69,120 | 69,120 | 168,254 | 2,350 | 180,768 | 187,993 |
| 2029 | 245 | 47 | 292 | 230 | 67,160 | 46.6 | 122 | 7,050 | 3,287 | 0.70 | 58,400 | 70,080 | 70,080 | 168,254 | 2,350 | 180,941 | 187,993 |
| 2030 | 249 | 47 | 296 | 230 | 68,080 | 47.3 | 123 | 7,050 | 3,460 | 0.74 | 59,200 | 71,040 | 71,040 | 168,254 | 2,350 | 181,113 | 187,993 |
| 2031 | 252 | 48 | 300 | 230 | 69,000 | 47.9 | 124 | 7,050 | 3,632 | 0.77 | 60,000 | 72,000 | 72,000 | 168,254 | 2,350 | 181,286 | 187,993 |
| 2032 | 256 | 49 | 305 | 230 | 70,150 | 48.7 | 126 | 7,050 | 3,848 | 0.82 | 61,000 | 73,200 | 73,200 | 168,254 | 2,350 | 181,501 | 187,993 |
| 2033 | 260 | 49 | 309 | 230 | 71,070 | 49.4 | 127 | 7,050 | 4,020 | 0.86 | 61,800 | 74,160 | 74,160 | 168,254 | 2,350 | 181,674 | 187,993 |
| 2034 | 263 | 50 | 313 | 230 | 71,990 | 50.0 | 128 | 7,050 | 4,193 | 0.89 | 62,600 | 75,120 | 75,120 | 168,254 | 2,350 | 181,846 | 187,993 |
| 2035 | 267 | 51 | 318 | 230 | 73,140 | 50.8 | 129 | 7,050 | 4,409 | 0.94 | 63,600 | 76,320 | 76,320 | 168,254 | 2,350 | 182,062 | 187,993 |
| 2036 | 271 | 51 | 322 | 230 | 74,060 | 51.4 | 131 | 7,050 | 4,581 | 0.97 | 64,400 | 77,280 | 77,280 | 168,254 | 2,350 | 182,234 | 187,993 |
| 2037 | 275 | 52 | 327 | 230 | 75,210 | 52.2 | 132 | 7,050 | 4,797 | 1.02 | 65,400 | 78,480 | 78,480 | 168,254 | 2,350 | 182,450 | 187,993 |
| 2038 | 276 | 52 | 328 | 230 | 75,440 | 52.4 | 132 | 7,050 | 4,840 | 1.03 | 65,600 | 78,720 | 78,720 | 168,254 | 2,350 | 182,493 | 187,993 |
| Max | 383 | 72 | 455 | 230 | 104,650 | 72.7 | 169 | 7,050 | 10,317 | 2.20 | 91,000 | 109,200 | 109,200 | 168,254 | 2,350 | 187,970 | 187,993 |

***Formulas & Definitions***

**Peak Hourly Demand (PHD)**

| Number of ERUs (N) | C | F |
|---|---|---|
| 0 | 3 | 0 |
| 51 | 2.5 | 25 |
| 101 | 2 | 75 |
| 251 | 1.8 | 125 |
| 501 | 1.6 | 225 |

***PHD=MDD/1440[C*N+F]+18***

***N=ERUs+(ERU $_{ADD}$ *ERUs*DSL $_{Fraction}$ /ERU $_{MDD}$ )***

**Source**

| Source | Status | Q, gpm | Q, gpd |
|---|---|---|---|
| Lake | Active | 898 | 1,292,544 |
| WTP Capacity | Active | 100 | 144,000 |
| WTP Operation (hrs/day) | | | |
| 20 | | | |
| Max Production | | 83.3 | 1,292,544 |

**Distribution System Leakage & Non-Revenue Water**

36%

**Tanks**

| Quantity | Volume, gal | Diameter, ft | Op. Stor., ft | Dead Stor., ft | CT stor, ft |
|---|---|---|---|---|---|
| 2 | 93,996 | 20 | 1.50 | 0.5 | 35.8 |

**Maximum Capacity Based on Water Rights**

| | | | | |
|---|---|---|---|---|
| Instant.= | 2 | cfs | | |
| | 898 | gpm, Capacity = | 5619 | ERU's |
| Annual= | 49 | ac-ft Capacity = | 364 | ERU's |

**Maximum Capacity Based on Water Treatment Plant**

| | | | | |
|---|---|---|---|---|
| Max Daily Rate = | 120,000 | gpd Capacity = | 521 | ERU's |

**Growth Rate**

1.45%

**Growth factor**

1.0145

*Reflects 2020 growth rate per state of Washington Office of Financial Management

**Average Daily Demand (ADD) & Maximum Daily Demand (MDD)**

ADD

**120** gpd per ERU *Does not include DSL

MDD

**230** gpd per ERU *Does not include DSL

**Standby Storage (SB)**

**Criteria #1:** ***SB = 200 gallons per ERU minimum***

**Criteria #2:** ***SB = (N)(SB $_i$ )(T $_{days}$ )***

***SB $_i$ = ADD***

***T $_{days}$ = 2***

**Equalizing Storage (ESS)**

***ES=(PHD-Q)(150 min)***

where Q is the Total Flow rate of all active sources

S. F. No. 369—OS—7-67.

CERTIFICATE RECORD NO. 22, PAGE NO. 10702

STATE OF WASHINGTON, COUNTY OF Whatcom

# CERTIFICATE OF SURFACE WATER RIGHT

(In accordance with the provisions of Chapter 117, Laws of Washington for 1917, and amendments thereto, and the rules and regulations of the Department of Water Resources thereunder.)

*This is to certify that* LUMMI ISLAND SCENIC ESTATES

*of* Seattle, *State of* Washington, *has made proof to the satisfaction of the Department of Water Resources of Washington, of a right to* store & ~~the~~ *use* ~~of~~ *the waters of* an unnamed stream, *a tributary of* Hale Passage, *with point* impoundment and point of diversion ~~or points of diversion~~ *within the* NE¼SE¼

*Sec.* 23, *Twp.* 37 *N., R.* 1 E., *W. M., under and subject to provisions contained in* Reservoir Appropriation *Permit No.* R-398 11979 *issued by the Department of Water Resources, and that said right to the use of said waters has been perfected in accordance with the laws of Washington, and is hereby confirmed by the Department of Water Resources of Washington and entered of record in Volume* 22, *at Page* 10702, *on the* 2nd *day of* June, 1969 *that the priority date of the right hereby confirmed is* November 25, 1959; *that the amount of water under the right hereby confirmed, for the following purposes is limited to an amount actually beneficially used and shall not exceed* 2.0 cubic feet per second of appropriation, and the storage of 49 acre-feet per year; for community domestic supply, continuously, during the entire year

*A description of the lands under such right to which the water right is appurtenant, and the place where such water is put to beneficial use, is as follows:*

Within the plats of Lummi Island Scenic Estates, Divisions No. 1 through 10, within Sections 14, 23 and 24, T. 37 N., R. 1 E.W.M.

Cert. Change
Place of Use #1088

*The right to the use of the water aforesaid hereby confirmed is restricted to the lands or place of use herein described, except as provided in Sections 6 and 7, Chapter 122, Laws of 1929.*

**This certificate of surface water right is specifically subject to relinquishment for nonuse of water as provided in Section 18, Chapter 233, Laws of 1967.**

*WITNESS the seal and signature of the Assistant Director, Division of Water Management, Department of Water Resources affixed this* 2nd *day of* June, 19 69

Glen H. Fiedler

*Assistant Director*
*Division of Water Management*
*Department of Water Resources*

ERING DATA

CERTIFICATE OF CHANGE OF PLACE OF USE OF WATER

In accordance with the provisions of Chapter 117, Laws of Washington for 1917, and amendments thereto and rules thereunder of the State Director of Water Resources.

THIS IS TO CERTIFY That Lummi Island Scenic Estates of Seattle, Washington, has complied with all of the requirements of the Revised Code of Washington 90.03.380 and is hereby granted the right to change the place of use of 2.0 cubic feet per second, 49 acre-feet per year, of waters of an unnamed stream, tributary of Hale Passage, as granted under Surface Water Certificate No. 10763.

That such water has been used for the purpose of community domestic supply on the following described lands:

The plats of Lummi Island Scenic Estates, Divisions 1 through 10, within Sections 14, 23 and 24, Township 37 North, Range 1 East W.M.

That the place of use of said waters has been changed to the following described lands:

The plats of Lummi Island Scenic Estates, Divisions 1, 2, 3, 4, 5, 6, 7, 9, and 10; AND the unplatted part of S½W½SE¼ of Sec. 23; AND the unplatted part of S 3/4 W½NE¼ of Sec. 23; ALL within Secs. 14, 23 and 24, T. 37 N., R. 1 E.W.M., Whatcom County, Washington.

WITNESS THE SEAL and SIGNATURE of the Assistant Director of the Division of Water Management, Department of Water Resources, State of Washington, affixed this 26th day of January, 1978.

Glen H. Fiedler

GLEN H. FIEDLER, Asst. Director
Division of Water Management

RECORDED:
Volume 3, page 1088
Records of Change of
Place of Use of Water.

# Water Right Self-Assessment Form for Water System Plan

Mouse-over any link for more information. Click on any link for more detailed instructions.

| Water Right Permit, Certificate, or Claim # *If water right is interruptible, identify limitation in yellow section below | WFI Source # If a source has multiple water rights, list each water right on separate line | Existing Water Rights Qi= Instantaneous Flow Rate Allowed (GPM or CFS) Qa= Annual Volume Allowed (Acre-Feet/Year) This includes wholesale water sold | | | | Current Source Production – Most Recent Calendar Year Qi = Max Instantaneous Flow Rate Withdrawn (GPM or CFS) Qa = Annual Volume Withdrawn (Acre-Feet/Year) This includes wholesale water sold | | | | 10-Year Forecasted Source Production (determined from WSP) This includes wholesale water sold | | | | 20-Year Forecasted Source Production (determined from WSP) This includes wholesale water sold | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Primary Qi Maximum Rate Allowed | Non-Additive Qi Maximum Rate Allowed | Primary Qa Maximum Volume Allowed | Non-Additive Qa Maximum Volume Allowed | Total Qi Maximum Instantaneous Flow Rate Withdrawn | Current Excess or (Deficiency) Qi | Total Qa Maximum Annual Volume Withdrawn | Current Excess or (Deficiency) Qa | Total Qi Maximum Instantaneous Flow Rate in 10 Years | 10-Year Forecasted Excess or (Deficiency) Qi | Total Qa Maximum Annual Volume in 10 Years | 10-Year Forecasted Excess or (Deficiency) Qa | Total Qi Maximum Instantaneous Flow Rate in 20 Years | 20-Year Forecasted Excess or (Deficiency) Qi | Total Qa Maximum Annual Volume in 20 Years | 20-Year Forecasted Excess or (Deficiency) Qa |
| R1-*15782CCWRIS<br><br>Certificate 10702B<br>R1*15782 C C<br><br>S1-CV3-P1088 | S01 | 2 cfs | | | | 0.149 cfs | 1.851 cfs | | | 0.223 cfs | 1.777 cfs | | | 0.223 cfs | 1.777 cfs | | |
| | TOTALS = | | | | | | | | | | | | | | | | |
| Column Identifiers for Calculations: | | A | | B | | C | =A-C | D | =B-D | E | = A-E | F | =B-F | G | =A-G | H | =B-H |

**PENDING WATER RIGHT APPLICATIONS**: Identify any water right applications that have been submitted to Ecology.

| Application Number | New or Change Application? | Date Submitted | Quantities Requested | | | |
|---|---|---|---|---|---|---|
| | | | Primary Qi | Non-Additive Qi | Primary Qa | Non-Additive Qa |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**INTERTIES**: Systems receiving wholesale water complete this section. Wholesaling systems must include water sold through intertie in the current and forecasted source production columns above.

| Name of Wholesaling System Providing Water | Quantities Allowed In Contract | | Expiration Date of Contract | Currently Purchased Current quantity purchased through intertie | | | | 10-Year Forecasted Purchase Forecasted quantity purchased through intertie | | | | 20-Year Forecasted Purchase Forecasted quantity purchased through intertie | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum Qi Instantaneous Flow Rate | Maximum Qa Annual Volume | | Maximum Qi Instantaneous Flow Rate | Current Excess or (Deficiency) Qi | Maximum Qa Annual Volume | Current Excess or (Deficiency) Qa | Maximum Qi 10-Year Forecast | Future Excess or (Deficiency) Qi | Maximum Qa 10-Year Forecast | Future Excess or (Deficiency) Qa | Maximum Qi 20-Year Forecast | Future Excess or (Deficiency) Qi | Maximum Qa 20-Year Forecast | Future Excess or (Deficiency) Qa |
| 1 | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| TOTALS = | | | | | | | | | | | | | | | |
| Column Identifiers for Calculations: | A | B | | C | =A-C | D | =B-D | E | =A-E | F | =B-F | G | =A-G | H | =B-H |

**INTERRUPTIBLE WATER RIGHTS**: Identify limitations on any water rights listed above that are interruptible.

| Water Right # | Conditions of Interruption | Time Period of Interruption |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

**ADDITIONAL COMMENTS:**

Note that the water right allows for the storage of 49 acre-feet per year, but does not specify an allowable annual use. See interpretation in DOH-approved "LUMMI ISLAND SCENIC ESTATES WATER SYSTEM ANALYSIS" by Wilson Engineering dated 6-23-2014, page 5.