MEMORANDUM

URBAN SYSTEMS

DATE	December 8, 2021	FROM	Glen Shkurhan
TO	Patrick Graham	FILE	2314.0028.06
CC	Liam Edwards, Annette Frischmann, Steve Brubacher	SUBJECT	Grafton Lake Water Supply and Water Conservation Considerations

This memo is to update the assessment of Grafton Lake as a sustainable water supply to support additional population, consider a changing climate, and review efforts that have been taken to advance water conservation.

Due to a lack of capacity in the existing Eagle Cliff water storage reservoir and concerns expressed by the Dam Safety Officer of the Province over the integrity of its containment structure, a strategic decision has been made by Bowen Island Municipality (BIM) to abandon the man-made reservoir currently serving the Eagle Cliff Local Service Area (LSA) in favour of connecting it to the Cove Bay LSA which draws its supply from Grafton Lake.

1.0 HISTORIC STUDY (2011)

In 2011, Bowen Island completed a study titled "Bowen Island – Cove Bay Water Conservation Plan" (Opus International Consultants, July 12, 2011). Considering the Cove Bay users alone, this study reported the average annual consumption from 2006-2010 being 342 Litres per capita per day (L/c/d) based on the estimated population of 1,990 in the Cove Bay service area. This equates to a total annual consumption of 248,411,700 Litres. For only 2010, the study also reported the total consumption of 237,309,091 Litres: a reduction from the five-year average. The 2011 study also projected the future Cove Bay service area population would grow to 2,992 by year 2030.

The 2011 study reported the following key observations:

1. It was predicted at the time that it was most likely that the live storage of the Grafton Lake reservoir would not be able to provide sufficient water to the Cove Bay service area beyond approximately 2025 (due to summer shortages).

2. Raising the dam height to increase the live storage capacity to its maximum legal amount would result in an adequate water supply well beyond 2030 (i.e. 2050), assuming a per capita daily demand of 342 L/c/d.

The study reported that water licenses allowed for a storage volume of 320,000 m3, while the lake's outfall control structure at the time provided only 222,000 m3 of "live" storage (ie. the volume of water that could discharge by gravity to Terminal Creek).

That 2011 study provided the following caveat: "*It should be recognized that the sustainable watershed yield calculations are based on information that, in many cases, was not known to be exact and therefore had to be approximated. Examples include watershed size, precipitation distribution, 1 in 10 year drought precipitation event, effects of climate change, infiltration rates, evapotranspiration rates, lake evaporation rates, population projections, and per capita*

consumption projections. Consequently, these values and projections should be used as an order of magnitude guide".

The 2011 study concludes in saying *"the issue is a predicted lack of Grafton Lake live storage volume to satisfy i) present summer consumption patterns, and ultimately ii) year round consumption patterns (given population growth). The solution therefore becomes relatively straight-forward:*

- *Reduce consumption per capita (and ultimately maintain a sustainable overall annual consumption regardless of population levels),*
- *Capture extra water year-round, either on-site (i.e. cisterns, rain barrels) or at the lake (raised dam),*
- *Cascade (reuse) water, or*
- *A combination thereof.*

The study provided recommendations on various consumption reduction strategies organized around:

- Legal Tools
- Economic Tools
- Operations and Management Tools
- Residential Tools
- Other (use of recycled water from wastewater treatment plan upgrade)
- Educational Tools

2.0 CURRENT STATE (2021)

In 2020, Urban Systems conducted a study titled "Grafton Lake Water Supply Sustainability Assessment" which looked at current trends of water consumption and developed a calibrated water balance model of Grafton Lake, along with continuous simulation of Grafton Lake water level performance to year 2100 using currently available climate data and projected water consumption. For reference, a copy of this 2020 study is attached.

In 2019 there were 647 total number of connections but with only 626 showing significant usage in the Cove Bay LSA (568 active residential service connections and 58 active non-residential service connections). These active properties have an estimated residential population equivalency of 2,160 persons. This is based on the number of active connections and an assumed 2.5 persons per dwelling. In the case of non-residential, total water consumption was converted to an equivalent residential population.

Current zoning and known development projects are projected to increase the Cove Bay LSA population in the foreseeable future to approximately 3,300 (equivalent population); 308 people higher than forecast by the 2011 study.

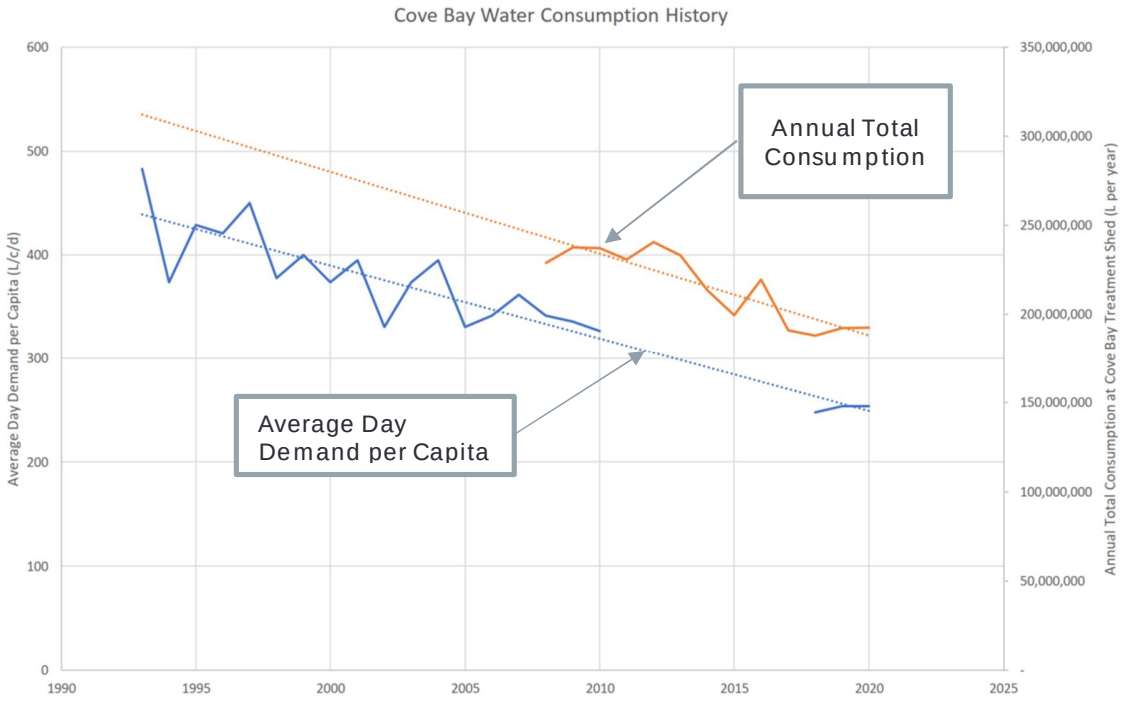
Water consumption records from the 2011 study (see Section 1.0 above) were combined with the consumption research completed for the 2020 study, resulting in *Figure 1 – Cove Bay Water*

Consumption History below. In this figure, both total annual consumption (as measured at the Cove Bay Water Treatment building) and estimated per capita demand from service meters are shown. Both show a steady and significant trend downward.

In its forecasting, the 2011 study assumed that an average per capita demand of 342 L/c/d would continue into the future, and as shown in Figure 1, the current actual consumption estimate is significantly less, at about 260 L/c/d. The cause for the decrease has not been explored but is assumed to be a change in user habits, not a decline in population. It may also relate to a change in unaccounted for water leakage, and the estimated population. As such, we suggest there is more confidence in the trend of the annual total consumption than the per capita trend. However, in this case the two trends are similar.

In 2020, the Grafton Lake Water Supply Sustainability Assessment projected the future consumption volume in the Cove Bay LSA to increase to 304,700 m3 per year, and with the addition of the Eagle Cliff LSA (current usage and no account of community growth), the total annual consumption was projected to rise to 341,900 m3 per year.

Figure 1 – Cove Bay Water Consumption History



BIM staff searched the Provincial water license records to discover five water licences for Grafton Lake in name of Bowen Island Municipality: C119753 and C119741, providing a total of 630,543 m3/year for the purpose of "waterworks" (consumption). This far exceeds the projected water

consumption in the future even with the connection of Eagle Cliff. Licenses C119754, C119749, and C119750 totalling 330,572 m3 (268 acre feet) for the purpose of "storage". This value is similar, but different from the value reported in the 2011 study (320,000 m3).

In 2012 and 2013, the Grafton Lake control structure was reconstructed to increase the "live" storage volume of the lake. Using best available information, the current "live" storage volume now offered by the current control structure appears similar to the water licenses, and as reported by the 2011 study; approximately 320,000 m3.

It appears that current water licenses in place are in alignment with the lake storage and are sufficient to meet future water demand projections.

3.0 FUTURE PROJECTIONS (2100)

The water balance of Grafton Lake is a very complex process which can not be accurately determined in absence of monitoring data. The 2020 Grafton Lake Water Sustainability assessment included model calibration using limited monitoring through spring and summary of 2020.

In 2021, the Bowen Island experienced an exceptional drought, both in duration and high temperatures. While a trace amount of precipitation did occur on one day in June 2021, the amount of precipitation was considered insignificant, and if discounted, the drought period was approximately 6 weeks in duration.

In Figure 2 below, the annual drought period duration from four different climate models (each coloured dot) as plotted, along with an "X" representing the actual summer of 2021. It demonstrates the expected rarity of this year's drought, with only two events of this magnitude to occur from now to year 2100. It should be emphasized that climate science is still evolving and not an exact representation of the future. And as the time frame expands, the confidence declines, and the range in results between the different climate models spreads. What these results demonstrate is that based on best available science today, the drought of 2021 is expected to be a rare event in the foreseeable future.

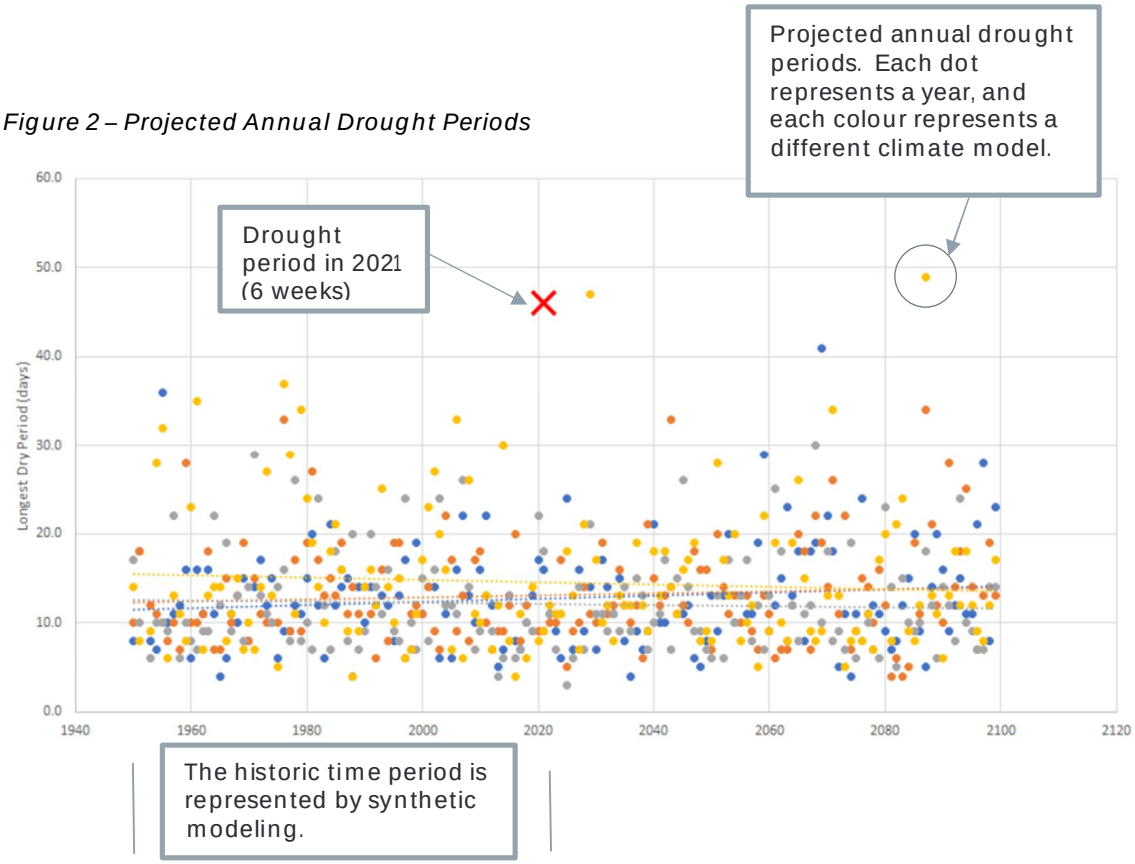
The 2021 drought period data was integrated into the previously calibrated 2020 lake model. While the model predicted that the Grafton Lake water level would drop to 105.75 m, the actual observed Lake level dropped to 105.35 m, about 0.4 m lower than projected. As noted above, there are many complex factors that are difficult to predict in absence of monitoring data. With this new drought data, it is recommended that additional effort be put to recalibrating the lake model and to update the future projections.

However, in absence of a newly calibrated model, let us use the observed low lake level of 105.35 m to represent an extreme and rare low with existing water demands.

Modeling of 2020 predicts that community growth within the Cove Base LSA in combination with the connection of Eagle Cliff LSA will cause a lake level decline of 0.2 m. As such, if this future demand were added to the rare lake level low of 105.35 m caused by a 6 week drought, the Grafton

Lake level would become 105.15 m, still approximately 0.55 m above the invert of the control structure (104.6 m). This provides a residual contingency for uncertainty.

Figure 2 – Projected Annual Drought Periods



As noted above, domestic consumption has a relatively small influence on resulting lake levels, with community growth and connection of the Eagle Cliff LSA only representing a 0.2 m decline. The current average annual consumption rate of Cove Bay (at 260 L/c/d) is considered a good rate for a metered community. Universal municipal standards (MMCD) recommend 300 L/c/d, inclusive of non-residential like the Cove Bay LSA, so Cove Bay users water consumption is not considered excessive.

4.0 SUMMARY AND RECOMMENDATIONS

In summary the following points are raised:

1. Since the 2011 Cove Bay Water Conservation Plan was complete, water consumption has continuously declined from an average of 342 L/c/d in 2010 to 260 L/c/d currently.

2. Since the 2011 Cove Bay Water Conservation Plan was complete, the Grafton Lake control structure has been reconstructed, offering significantly more lake live storage.

3. All evidence of water licenses issued to BIM for consumption and storage suggest they are sufficient to meet current and future demands, with or without the connection of Eagle Cliff.

4. The drought of 2021 is expected to be a rare event, and one that provides very valuable information about future system performance. Observations showed a lower than previously expected low lake level. It is recommended that this new data be used to recalibrate the lake model and update the predictions for the future. But in absence of recalibration, evidence suggests that the lake will have sufficient storage to meet future demands, assuming water consumption habits stay the same or get even better.

4.1 WATER CONSERVATION EFFORTS

While the Cove Bay LSA users have improved and achieve an acceptable average annual daily demand, it remains wise to strive for further improvement. We recommend there are three actions that could be taken by BIM:

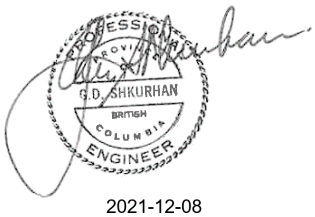
1. Ongoing education and communication – As a metered community, data is available for users to be aware of their consumption. For about the last two years, BIM not only reports current consumption on its user bill's, but also a graph showing consumption for the three previous years. We recommend adding the LSA total average usage to the bill so owners can see how their consumption compares to others, and also state a desired target to strive to.

2. Rate Structure – We recommend revisiting the water rate structure, establishing a new base fee for a lower base volume, and a graduated inclined rate for consumption above the new base volume. In 2017 BIM established a new rate structure for Tunstall Bay LSA. It's recommended that the effectiveness of that be reviewed to inform whether further modifications are warranted and to consider broader application to other LSA's.

3. Rainwater Capture – Extending the issue beyond Cove Bay, water scarcity is expected to worsen over time across Bowen Island. There may be other LSA's that may be dependant on alternate supply sources over time. Outdoor use represents a significant portion of annual water consumption and comes at a time of year when supply is scarcer. It is recommended that BIM consider a universal requirement for all future construction to include rainwater capture as a non-potable outdoor water supply. Policy and criteria must include a minimum storage volume based on land use and lot size.

Sincerely,

URBAN SYSTEMS LTD.



2021-12-08

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