

**INFORMATION REPORT TO LYALL HARBOUR/BOOT COVE WATER LOCAL SERVICE COMMITTEE  
MEETING OF FRIDAY, 24 AUGUST 2007**

---

**SUBJECT      MONEY LAKE DAM ISSUES**

**BACKGROUND**

Very low water levels in Money Lake have been experienced in three of the past six years (2004, 2006, 2007) prompting an extended response from the committee and staff including imposition of water use restrictions, system monitoring to detect and correct leaks in the water system and evaluation of additional strategies to prevent similar situations from occurring in future. An extended analysis of the various events has been completed which indicates a continuing need to address water loss from the distribution system but also suggests that management of losses directly from or under the dam on Money Lake #1 is of critical importance to ensure the primary water supply is protected.

**Money Lake Dam System**

A basic description of the water balance for the supply system is in order. Money Lake, as we know it today, came about when the dam was raised in 1979. The dam was constructed over the original Money Lake #1 dam. Harris Road was relocated as part of the project and the road bed now forms a part of the west abutment and dam base. A culvert type spillway, installed through a portion of the dam as part of the 1979 work, was removed and replaced with a surface mounted structure made of concrete. The Dam was constructed with a downstream filter blanket to capture seepage while retaining fines within the dam core. Various works were installed to capture the seepage water which found its way into the filter blanket and in fact the seepage was designed to be used as the primary supply in the early days of operation with water from the intake used as make up water. The material on which Money Lake sits, being a shale type material will also contribute to leakage subsurface to the dam. A second collection system was installed further down the valley, at the upper treatment building as a consequence of subsurface flow found at that location.

Water is stored in Money Lake under several Water Licences. Money Family Projects is licenced to store ten acre feet (12.34 cubic decametres) for Lyall Harbour. CRD Licences to store water are as follows:

Licence 54808	23.5 acre feet
Licence 61500	23.5 acre feet
Licence 122422	<u>3.5 acre feet</u>
Total	50.5 acre feet

**Low Water Event Analysis**

As it has for most lakes in BC, the province has developed a depth volume relationship for Money Lake #1. Although there are some inherent inaccuracies (due to changes in the lake bottom from silting, variation in evaporation rates from year to year etc.) the information can be used to quantify the relative volume of water leaving the lake at any one time period. This data then allows the development of a rudimentary water balance model which can be used to compare supply volume on a year-by-year basis. Once the volume of water production of the lake is known for a particular period, one can then compare the known uses for that water during the same period and to then determine if a deficit exists and what volume is unaccounted for.

**Volumetric Analysis**

The following information was considered in the analysis:

- Water consumption data, i.e. water produced by the water plant for consumption by customers.
- Water production data or water consumed by the water plant for filter backwashing.
- Water system losses, a component of consumption, due to water lost from the system and customer services after the water plant.
- Water volume drawdown, as measured by manual gauge in the reservoir.
- Recharge of the lake, as measured by manual gauge.
- Water use through the Money water system, as metered.

Limitations of the analysis include:

- Water level recordings are made on a regular but random basis, and are read and transcribed by the water operator.
- Flow meter readings are understood to be inaccurate for certain periods, such as the summer of 2006.
- Evaporation was not considered as a variable.
- The output of the recycle pump has been estimated at 10 gallons per minute, but cannot be confirmed, nor can the running time for the pump be determined.

Some general trends emerge from the analysis:

- Reservoir water levels in the year 2001 to 2003 were sustained longer into the summer season than 2004, 2006 and 2007.
- The slope of the drawdown curve is similar for these years 2001 to 2003 indicating consumption trends and water losses were consistent from year-to-year.
- The drawdown curve in 2004 was much steeper than 2001 – 2003 indicating a change in the water loss rate during the initial April – June time period. Overnight production flow records indicated significant baseline use of water during this time period, and in fact the curves responded to loss detection work undertaken by staff in July, indicating a strong correlation to consumer side losses as a primary concern this year. Given that the following year, 2005 did not exhibit the same drawdown suggests that the losses were system related, corrected in 2004 and not from changes in losses from the reservoir.
- Spring 2006 was exceptionally dry. Lack of recharge of the reservoir by rainfall through late spring was the primary factor in the poor performance this year. The slope of the drawdown curve was not unlike what would be expected, however during this type of event there is an obvious need to conserve water through any and all methods available. A flow meter failure does not permit dam losses to be accurately calculated.
- Usage through the Money meter was not an issue in 2007 or for most years in the analysis.

Example Data:

Data for elevation 4.0 on staff gauge (2007 is for elevation 3.85m)

Date	Daily Drawdown	Recycle	Max Drawdown	Usage	Net Loss
2002 / Jul 18	57,037	15,000	72,037	49,162	22,875
2003 / Jul 17	75,490	15,000	90,490	48,570	41,920
2004 / May 14	88,000	15,000	103,000	43,890	59,110
2005 / June 13	62,857	15,000	77,857	29,728	48,129
2007 / June 4	118,462	0	118,462	26,138	92,324

- Drawdown in the lake is indicative of losses through dam plus usage. There is a wide variation in usage between 2004 and 2005. A number of leaks on household connections were located and repaired in 2004. The difference in usage amounts to about nine gallons per minute. Usage would be expected to be higher in 2002 and 2003 given the July dates.
- The net losses for 2007 appear to be considerably higher than other years. Although the actual values for years other than 2007 might be higher or lower due to the recycle pump, it is unlikely the daily recycle rate could explain the difference.
- While the increase in losses in 2007 offers a reason why the lake level dropped so quickly this year, the more important issue is that the rate of water loss from the reservoir is a much more critical issue than previously considered. Further that the present recycle system appears to be capable of intercepting only a small portion of the water being lost from the reservoir on any given day.
- The apparent increase in loss in 2007 may be due totally to the increased pressure head, as the water level was 150mm higher than normal, or may indicate a more direct seepage path is widening, permitting additional flow to pass or both.

Other Observations:

- The unit loss of water reduces with a declining pressure head or water level. What is of note is that the losses appear to reduce significantly at or about the local geodetic elevation (local construction datum) of 153m. The exception is 2007 where the losses appear to continue down to the 152m level.
- Elevation 152 – 153 lies within the boundary layer between the old and new dam cores. One area of interest is the original spillway elevation which, depending on how the dam core was repaired when the culvert was removed, is of the correct elevation to be a source of elevated loss.

### **Physical Inspection**

The dam and infrastructure were inspected to identify potential sources of water loss or evidence of changes to seepage. One area of concern was the intake line, which is routed through the dam core and is often a problem for water loss. A water valve, installed just downstream of the core, shows water in the valve stem access tube. The level was below the level of the lake, however its presence suggests the filter blanket may be somewhat surcharged. The tube offers an opportunity for continued measurements, which may provide some additional information on leakage along the intake line.

The dam was designed with a system to collect filtered seepage water. An inspection of the system indicates significant build up of fine solids in the collection manholes. It is likely the solids have migrated from the dam core and are too small to be trapped by the filter blanket. These structures need to be cleaned out and may form a component of a new recycle system to preserve water.

The dam was also constructed with additional infrastructure to permit the seepage water collected at the dam face to flow into the distribution system. As the valve system, as designed, would have provided a significant risk of draining the reservoir to the creek if the internal valving failed, it is understood the use of the system was discontinued in the early days of system operation. A bypass of the system is in place, however if work is done on other components of the system, this system should be isolated permanently to protect the reservoir from draining.

The recycle pump, located at the upper pump house was frozen during the winter event of 2006. Replaced in 2007, capacity was not as expected. The discharge line was evaluated and found to be significantly plugged with an organic peat type material. It is evident the line has taken some years to get to this stage, however to ensure maximum return of water at this location, the line should be flushed, or more likely replaced unless flushing can be done cost effectively.

### **Observations by Soils Consultants**

Staff have met with engineers and soils consultants from Thurber Engineering Ltd. The interview was to obtain a better understanding on the significance of the data presented, ie

- Is the increase in lost water seen on 2007 likely related to the increased elevation head, or does it show a tendency for increased flow at one location?
- Is the presence of fine material in the drainage system indicative of washout of the dam core or can it be explained by incorrect sizing of the filter media?
- What further investigations would be necessary to confirm a problem exists or not?

The consultants have suggested a recommended action plan which has been incorporated in the conclusions sections of this report and form the basis for the recommendations made by the report.

### **Continuing Distribution System Usage / Losses**

It appears that for a number of years, the losses from the lake are much higher than the consumption in the distribution system. As the slope of the drawdown curve is generally similar from year to year and one assumes the losses from the lake were reasonably consistent, then so was the general usage by the public. The year 2004 however demonstrated a considerable increase in usage which was largely corrected by leak detection work carried out that year. The system was again evaluated this August and again a 5 gallon per minute leak was found on a household service. While not particularly significant against the losses measured in the lake system early in the year, it becomes a very significant value at this time of year, when losses from the reservoir have been reduced due to elevation. The analysis also projected that the ongoing losses for regular flushing of the water filters averages around 2gallons per minute expressed as a continuous flow. During the leak detection exercise, nighttime use of the system by automatic sprinklers continued to be evident.

### **CONCLUSIONS**

As a result of the analysis of long term data for the water supply for the Lyll Harbour water system, the following conclusions are drawn.

1. The rapid drawdown of Money Lake in 2007, seen through the early summer period, appears to be due to higher than normal water loss directly from the lake. The low water levels seen in 2006 are related to uncharacteristically low recharge of the lake in the spring, no doubt exacerbated by water loss from the lake and from the distribution system. The low level in 2004 appears to be more related to system losses as the lake recharged normally.
2. The rate of loss from the lake in 2007 appears to be considerably higher than in previous years. The source of the loss or the increase in loss might be explained by the higher than typical operating level of the lake, or increased seepage from erosion or both. The loss of the recycle pump, given the typical pump output of about ten gallons per minute, did not explain the increase losses in 2007 over previous years.
3. Water lost from the system (leakage) was a contributing factor to the drawdown in 2007 and was considered to be a major factor in the 2004 drawdown. In both years the loss of water from leakage becomes more significant as the season progresses.
4. The loss of water in the lake appears to reduce significantly or be eliminated when the lake level reduces to elevation between 152 and 153m, local datum. This data may suggest leakage is primarily along the interface between the old and new dam cores or that at the lower elevation there is insufficient head to drive the water through, or may suggest some specific leakage point at or about this elevation is responsible for the primary losses.
5. The drainage infrastructure at the base of the dam has become silted, and needs to be remediated. Once

the work is completed, ongoing monitoring of the seepage water flow, solids migration and water levels in the valve stem tube should be undertaken to better evaluate in dam leakage sources.

6. Work carried out in item 5 will suggest the need for and size of an additional recycle system, or the need for dam remediation.

### **Previously Proposed Works**

The CRD, on behalf of Lyall Harbour, has made application for an infrastructure grant to install meters, recover backwash water, and to provide more appropriate water treatment. The dam evaluation and remediation works suggested should be considered complimentary to and additional to the proposed works. There remains some unfinished works related to increasing the dam elevation which has also not been funded to date.

### **Costs**

No design nor firm cost estimate has been prepared for remediation works to the dam drainage system nor improvements to the recycle system. The extent of work however, is expected to include a more thorough dam inspection by the consultants, Thurber Engineering Ltd., remediation and cleanout of the dam drainage system, making safe the drainage/intake system and design and installation of a leakage recycle system to minimize water loss from the dam structure (at dam and at upper plant). As equipment will be on-site, it is suggested the other requirements from the dam safety branch, namely no post barriers on the dam crest and a new log boom be done at the same time. Once the inspection is complete by Thurber Engineering Ltd., the works and timing can be priced.

### **RECOMMENDATION**

That the Lyall Harbour/Boot Cove Water Local Service committee receive the report for information.



---

Gary Hendren, ASCT  
Local Services Engineering Coordinator

GH:ls