WESTWOOD LAKE
SYPHON CONSTRUCTION AND OPERATIONS SUMMARY
FINAL REPORT

MARCH 2009

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WESTWOOD LAKE
SYPHON CONSTRUCTION AND OPERATIONS SUMMARY
FINAL REPORT

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and,

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1 Introduction

This report details the design and construction of the syphon water release at Westwood Lake which occurred in 2008. The purpose of the syphon is to augment low summer flows, via Darough Creek, to increase fish habitat values in the Millstone River and the recently constructed Millstone Falls bypass channel. Northwest Hydraulic Consultants Ltd. (NHC) was retained by the BC Conservation Foundation (BCCF) and Fisheries and Oceans Canada (DFO) to provide a detailed hydraulic design for a syphon water release at Westwood Lake (Winter/Spring 2008). The construction phase of the project was tendered as part of a larger project to seismically upgrade the Westwood Lake Dam (dam engineering by EBA Engineering Consultants Ltd.). The City of Nanaimo conducted the tendering process for the combined dam/syphon project. NHC conducted site inspections during the syphon component construction phase (Spring/Summer 2008) to ensure the project met the specifications.

The completed syphon has a screened intake in Westwood Lake, a 115 m long by 100 mm (4”) diameter High Density Polyethylene (HDPE) pipe over the dam, a fill fitting, an air release valve, an emergency valve, a discharge chamber, operating valve, and a v-notch weir. The maximum discharge through the syphon is approximately 14 L/s.
2  DESIGN

The City of Nanaimo commissioned a study by Water Management Consultants (WMC) to review the hydrology of Westwood Lake, estimate release requirements based on supplemental flow requirements of the Millstone River Bypass Channel, study the routing of released water, access dam safety issues related to any proposed release facility, and provide conceptual designs for the proposed release facility (WMC, 2008). WMC reported that a flow of 6.3 L/s is required for the fish enhancement project; this requirement was based on communications with Mel Sheng, project biologist with Fisheries and Oceans Canada. The report suggests that an additional 2.7 L/s is likely to be lost between Westwood Lake and the enhancement project as flow passes through Buttertubs Marsh. Subsequently, a design release value of 9 L/s was proposed for the syphon release at the head of Darough Creek.

EBA provided design drawings (N13101074 Rev A) of the proposed seismic upgrades for a topographic background for developing the syphon design. Based on these drawings and the hydraulic requirements presented by WMC, NHC developed the hydraulic design for the syphon.

The intent of the syphon design was to provide reliable, long-term operation with minimal infrastructure and costs. Hydraulic calculations were undertaken to determine requisite flow and pipe characteristics given the proposed lake inlet elevation and the outlet elevation after the dam upgrade. Considerations were taken to minimize vortexing and air transport into the syphon that could cause an “air lock” and interrupt the syphon operation. Pipe sizing and installation details also accommodated durability, negative pipe pressures and dam safety.

2.1  SYPHON DESCRIPTION

The syphon pipe is 100 mm (4”) diameter thermally-butt fused HDPE pipe. Flanged connections were required at some locations. The pipe and all fittings were specified to withstand 350 kPa (50 psi) pressure and 100 kPa (15 psi) vacuum, such as Schedule 40, ANSI 150, or approved equivalent. The pipeline runs over the dam and is bedded 0.5 m below the surface to protect the pipe from vandalism while avoiding disturbance to the core or drain of the dam. Adequate compaction of bedding around the pipe was important to minimize settlement and provide support for the pipe to withstand buckling under vacuum loading.

The inlet of the pipe is installed at a depth of 0.5 m above the reservoir bed and 6 m below the surface at approximate elevation 155 m. The depth of the intake allows cooler water to be released. Following DFO screen guidelines, the inlet is a stainless steel screen constructed of 0.7 mm mesh with 2.5 mm openings. The screen is 600 mm long and 500 mm in diameter. Sandwiched between the intake and pipe is a check-valve to prevent back flow through the screen. The check screen allows the syphon to be charged immediately before operating it. The valve and screen are attached to the pipe with flange connections to facilitate removal for future maintenance or replacement.
At the top elevation of the syphon pipe there is an air release valve, an emergency shut-off valve, and an intake valve to allow the syphon to be filled using an external trash pump. The valves are housed in a pre-cast reinforced concrete chamber with a locked lid to reduce the risk of vandalism/tampering.

The syphon outlet is a cast-in-place reinforced concrete discharge box/headwall combination. The syphon pipe enters the box below a lockable walkway grating which prevents tampering of the control valve. The syphon outlet is directed down into a stilling chamber; the pipe outlet is below the water surface. The chamber outlet is a 90° v-notch weir which facilitates discharge measurements. The syphon discharge flows over the weir and enters a rock lined channel for 10 m. The rock lined channel ends at the head of Darough Creek.

The as-built drawings are 34876-001-As-Built, -002-As-Built, and -003-As-Built.
3 CONSTRUCTION

The City of Nanaimo awarded the construction contract for the Westwood Lake Dam upgrade and syphon construction to Fournier Excavation. Streamline Environmental was the environmental monitor. NHC monitored the syphon construction to ensure compliance with the specifications. A preconstruction meeting was held on April 28, 2008 to review the project and schedule. A contact list is provided in Appendix A.

During the week of May 25th, the syphon discharge chamber location was identified at the base of the dam. The floor was formed and poured, and the wall forms and reinforcing were erected in preparation for pouring concrete the following week (Photos 1 and 10).

During the week of June 2nd, the syphon walls were poured and the forms were stripped. The concrete was very rough, but the surface was improved by grouting the voids and irregularities. A riprap lined trench was constructed between the syphon discharge chamber and the head of Darough Creek. The trench was approximately 10 m long and the riprap diameter was approximately 150 – 300 mm. The syphon inlet location was marked in the lake by sounding the deepest location near the dam, and installing a temporary buoy.

Most of the syphon construction occurred during the week of June 20th. The discharge chamber metalwork was completed and fixed to the concrete structure. The vault in the dam crest was installed such that it was level with the existing ground to reduce the tripping hazard (Photo 8). The syphon air removal, fill fitting, and emergency shut-off were installed in the vault (Photos 5 & 6). The 100 mm diameter HDPE syphon pipe and the 50 mm diameter HDPE electrical/sensor conduit was installed between the vault and discharge chamber and between the vault and lake inlet. In total, the syphon pipe is 115 m long. For the terrestrial installation, an excavator cut a 500 mm deep trench, installed the bedding material and pipe, then backfilled (Photos 3, 4 & 9). A strip of locater ribbon was installed 300 mm above the pipes. For the lake installation, commercial divers positioned the pipe and secured it on the lake bed with weighted collars (Photo 7). The intake screen was not available at the time of installation. On the lakeside face of the dam, 300 - 400 mm diameter riprap was installed over the pipe where it transitioned from underground to the lake bed. The purpose of the riprap blanket was to reduce the risk of vandalism to the pipe.

The intake screen was installed in early September by commercial divers.

3.1 TESTING

The pipe was hydrostatically pressure tested as per the KWH Pipe recommendations (KWH, 1990) to 350 kPa (50 psi) using a two stage method; pipe expansion and testing (Photo 6). The initial pressurization of the pipe resulted in several leaks at the pipe flanges and fittings. All bolts and fittings were tightened and the pipe was re-pressurized – no leaks were visible. At the end of the pressure stage the pipe had depressurize to 31 PSI which was within the allowable limits.
The syphon was primed and turned on for several minutes to ensure it worked after pressure testing. The water license had not been processed during this test on June 25, so the syphon was tested at low flow rates and water was not discharged to Darough Creek.

In September, the syphon was tested thoroughly after the intake screen was installed and the water license issued. The syphon delivered approximately 14 L/s of flow when fully opened. Air blocks in the pipe were not a problem. The syphon was operated without interruption for approximately one month in September/October 2008.

### 3.2 Costs

The cost of the syphon project was $90,322.37. A breakdown of the costs is provided in Appendix B.
4 OPERATION

The syphon is intended to operate mainly in the dry summer/early fall period to augment flow in the Millstone River, although it can operate year-round if required. To operate the syphon:

1. The intake, pipes, valves, and outlet should be visually inspected to ensure they are free of debris and damage.
2. The downstream control valve should be in the closed position. The emergency shut off valve in the vault should be in the open position.
3. The syphon should be filled from the hose inlet located in the vault in the top of the dam. A trash pump with a standard 50 mm (2”) cam and groove coupling can be used to withdraw water from the lake to fill the syphon.
4. Any air within the pipe is to be released through the air outlet valve.
5. Once the syphon is full of water the inlet valve and air release valve should be closed. At this point the syphon is charged and ready to be used.
6. The downstream control valve can slowly be opened until the desired discharge is obtained.
7. Discharge can be estimated based on the height of water flowing over the v-notch weir. Read the staff gauge and look up the corresponding flow on the stage discharge curve (Figure 1).
8. Record the start dates, stop dates, and flows (including all adjustments) in the operations log book.

The downstream control valve can be closed to stop the flow. This will temporarily leave the syphon charged. Whenever the valve is closed it should be done gradually, instead of suddenly, to prevent generating transient pressure waves (water hammer). The syphon can be restarted without external recharging if re-used prior to substantial draining which may result from check valve leakage.

When the syphon is not in use, it should be uncharged. This can be done by opening the downstream control valve and opening the fill valve in the vault at the crest of the dam.

Syphons are designed to be operated fully opened. An air lock may form if the syphon is operated at reduced flows.
5 MAINTENANCE

The syphon is designed to be a low maintenance facility. All materials were selected to be long wearing and corrosion resistant. Annual maintenance requirements include the following:

- Inspect the intake, pipe, metalwork, locking mechanisms, fittings and valves for damage or wear. Repair or replace as necessary.
- Inspect and replace missing riprap over the pipe where it emerges from the lake, or downstream of the discharge box.
- Clear debris/algae from the intake screen.
- Apply environmentally friendly lubrication to moving components (locks, grating hinges and valve mechanisms).
- Paint all corroding metal.
6 REFERENCES

KWH Pipe, 1990. ‘Sclairpipe Construction’


FIGURES
Figure 1. Stage discharge curve for the 90 degree v-notch.
PHOTOGRAPHS
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Photo 10. The syphon discharge box and the head of Darough Creek (left side.)
DRAWINGS
APPENDICES
# APPENDIX A: CONTACT LIST

<table>
<thead>
<tr>
<th>Contact</th>
<th>Title/Role</th>
<th>Company</th>
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<tr>
<td>Steve Ricketts</td>
<td>Construction Manager</td>
<td>City of Nanaimo</td>
<td>250-756-5321</td>
</tr>
<tr>
<td>James Hutchinson</td>
<td>Municipal Services Insp.</td>
<td>City of Nanaimo</td>
<td>250-756-5321</td>
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<tr>
<td>James Craig</td>
<td>Project Manager</td>
<td>BC Conservation Foundation</td>
<td>250-716-8776</td>
</tr>
<tr>
<td>Mel Sheng</td>
<td>Biologist</td>
<td>Fisheries and Oceans Canada</td>
<td>250-754-0357</td>
</tr>
<tr>
<td>Graham Hill</td>
<td>Engineer (syphon)</td>
<td>Northwest Hydraulics Consultants</td>
<td>250-758-6425</td>
</tr>
<tr>
<td>Duane Fournier</td>
<td>Equipment contractor</td>
<td>Fournier Excavating</td>
<td>250-754-7390</td>
</tr>
<tr>
<td>Bruce Grayson</td>
<td>Engineer (dam)</td>
<td>EBA Engineering</td>
<td>250-756-2256</td>
</tr>
<tr>
<td>John Loehr</td>
<td>Metal fabricator</td>
<td>Interkraft</td>
<td>250-753-2897</td>
</tr>
<tr>
<td>John Dekker</td>
<td>Commercial Diver</td>
<td>Westcoast Diving</td>
<td>250-468-1888</td>
</tr>
<tr>
<td>Heather Ziegler</td>
<td>Environmental monitor</td>
<td>Streamline Environmental</td>
<td>250-390-2627</td>
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## APPENDIX B: PROJECT COSTS

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<td><strong>Total</strong></td>
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