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3 March, 2015 **Project No: 60285876 Task #4**

Brad Drew, Planner RPP. MCIP.
Facilities and Capital Development
Capital Regional District
Parks Department
490 Atkins Avenue
Victoria, BC V9B 2Z8

Dear Brad:

Re: Gardom Pond Dam – Decommissioning of Low-Level Outlet
Subsequent to Reports: Gardom Pond Dam Evaluation (June 2013) and Additional Investigations (January 2014) Alternative Spillway Evaluation

1. Introduction

Following on from AECOM's previous Gardom Pond Dam Evaluation (June 2013) and Additional Investigations (January 2014), Capital Regional District Regional Parks (CRD) requested AECOM to develop a conceptual design and cost estimate for decommissioning of the low-level outlet pipe at Gardom Pond. The conceptual design was to be based on using a grouted plug to mitigate possible failure of the dam's aging pressurized low-level outlet constructed within the earth dam.

To obtain field data for design purposes, Advance Subsea Services dive team was engaged to locate the upstream pipe inlet and to conduct a video inspection of the pipe to determine the condition and amount of sediment buildup. Following the dive, Terra Remote Sensing conducted a limited topographical survey of Gardom Pond Dam and a bathymetric survey of the pond. The bathymetric survey will also provide a better understanding of the pond's volume of stored water and will assist in development of pond elevations for partial pond drawdowns.

2. Background

2.1 Dam Safety and Pender Island Fire Chief Discussions

AECOM met with the BC Dam Safety Officer, Mr. John Baldwin, who was supportive of Gardom Pond Dam's Licence Holders promptly addressing the safety concerns with the low-level outlet. Mr. Baldwin emphasized that all safety upgrades to the dam need to be completed in a timely manner.

AECOM's discussions with the Pender Island Fire Chief revealed the following:

- The low-level outlet has not been operated for at least 15 yrs. (to the best of his knowledge)
- The Fire Department would be willing to assist with the drawdown of Gardom Pond should the need arise for rehabilitation or decommissioning.

3. Site Investigation Observations

On January 13th, 2015 the divers located and conducted a video inspection of the low-level outlet. The surveyors followed with the bathymetric survey of Gardom Pond and a limited topographical survey of Gardom Pond Dam's features and existing infrastructure. Figure 1 is a compilation of both the dam's site plan and the pond's bathymetry. Key observations of the site investigation are summarized below:

3.1 Dive Investigation and Pipe Video:

- The dive investigation confirmed the location of the concrete low-level outlet's inlet structure as approximately 7 m from the upstream face of the dam. The top of the concrete inlet structure was 1.7 m below the water surface at the time of the survey and the low-level outlet's inlet invert was approximately 3.8 m below the water level.

- The location of the two 50 mm diameter water services and the emergency fire hydrant intake were also determined by the divers. The divers assisted the survey team to record the submerged assets.

- A make-shift plastic riser pipe (150 mm diameter, approximately 1.8 m in length), complete with a slotted intake screen, was at one point in time installed into the inlet pipe and wedged in place with various sized rocks.

- To conduct a video inspection of the low-level outlet, the riser pipe and foundation of rocks were removed by the divers in zero visibility conditions.

- The video of the low-level inlet pipe identified the following:

    - Overall integrity of pipe appears to be intact, circular and approximately 150 mm in diameter.
    - Short aquatic growth is present on the inside walls of the low-level inlet in conjunction with sediment buildup on the pipe invert.
    - At approximately 6.1 m into the video investigation, the pipe size is significantly reduced from approximately 150 mm to 75 mm in diameter as shown in Photo #1, on Figure 1. The reduction appears to be made of concrete, with a 75 mm diameter sleeve, and is approximately 0.5 m in length, after which the pipe diameter appears to return to 150 mm in diameter. This pipe reduction is believed to have been integrated into the low-level outlet's concrete collar during construction. It is possible that the reductions may occur every 6 m spacing (for three reductions in total).
    - The video equipment on-site was unable to advance through the pipe restriction and it is not certain if additional videos can be obtained through the pipe restrictions.

3.2 Bathymetry and Topographical Survey

- The bathymetry and topographical survey was tied to Geodetic Elevations. The survey control point was established as the top of the well head casing owned by property 6608 Harbour Hill Road with a geodetic elevation of 86.73 m. In previous reports, the well was given a nominal site elevation of 100.00 m ; a difference of 13.27 m.

- The Bathymetric Survey, Figure 1 attached, identifies two low-lying basins; one to the north-northeast and the second to the south areas of the pond. These low-lying basins would likely

only provide shallow ponds ranging in depths between 0.5 m to 1.0 m in the event the pond were drawn down to the low-level outlet's existing invert of 82.5 m (± 0.2 m).

- The figure also shows key infrastructure identified; the low-level outlet, Razor Point Improvement District's two 50 mm diameter water services and the 150 mm diameter fire intake line designated for emergency use only.

- The pond's surface water elevation was recorded to be 86.27 m on January 13th, 2015, the maximum water depth was approximately 4.3 m (pond floor @ 82.0 m) and the depth to the invert of the low-level outlet was approximately 3.8 m (Inlet elevation @ 82.5 m ± 0.2 m).

- The length of the low-level outlet is approximately 21 m.

4. Technical Review

4.1 Conceptual Grouting Design

Given the dam's High Classification with respect to Downstream Failure Consequences, the pipe restriction identified within the low-level outlet raised concerns with the ability to flush out debris, conduct pipe video inspections and grout the pipe with certainty that annular spaces would be plugged. AECOM consulted with Goal Engineering, specialists in grouting procedures, and discussed the possible flushing and grouting procedures given the pipe restrictions. A conceptual idea of how to grout the low-level outlet was developed and is attached in Appendix A. A simplified summary of the flushing and grouting concept is outlined below:

- Retain divers to conduct a second camera video of outlet to confirm presence of additional restrictions.

- Install a riser pipe on the upstream side of the outlet, via a face plate bolted to the concrete inlet structure

- Utilize the downstream valve chamber to tie-in the flushing and grouting apparatus and pumping equipment.

- To flush the low-level outlet, pressurized air entrained water would be pumped through the pipe. The flush water would be collected in a settlement pond.

- From the upstream riser pipe installed, re-inspect outlet pipe with a camera to confirm thorough flushing of debris is complete

- Upon confirmation that debris has been removed, proceed with grouting of low-level outlet from downstream side by pumping grout into the outlet pipe to displace the water column within the outlet.

The above procedures are simple in theory; however, major concerns were identified during review of the concept plan and are as follows:

- Ability and assurance to feed a camera through multiple pipe restrictions to identify initial pipe conditions and thoroughness of pipe flushing procedures

- Assurance of a secured sealed installation of the proposed riser pipe to the existing low-level outlet
- Existing condition of valve chamber fittings and possible fitting failures during pumping procedures
- Pressurization of existing low-level outlet to pump air entrained water through pipe to remove debris. The existing pipe condition may not be able to withstand induced pressures
- Assurance that the debris can be thoroughly removed between pipe reductions prior to grouting. Flushing may have to be conducted from both ends of low-level outlet pipe, but once again no assurance that flushing would be completely thorough due to pipe reductions
- Assurance that the grout pumped through pipe would not be impeded by restrictions, would not set prior to cure times if delayed, and that no annular spaces within the low-level outlet would be present. Grouting may have to be conducted from both ends of the low-level outlet if delays or complications arise, with no assurance the mid-section of pipe would be completely void of annular spaces
- Any remaining annular spaces within the low-level outlet could collapse over time and develop further into seepage paths within the dam's core structure
- Costs incurred to implement additional dive investigations, pipe videos and pipe flushing with no assurance that the concept would meet the objective of a sound, long-term grout solution, which would mitigate seepage path failure along the low-level outlet
- Overall accumulation of small incidental costs to implement and address unknowns could escalate to much larger costs and monies could be better spent on a more viable solution.

Estimated cost to prepare the pipe and undertake grouting would be in the order of $79,650, which includes engineering services, liaison with Dam Safety and a contingency of 35%. A breakdown of the anticipated costs is provided in the following table:

Advance Sub Sea Services: • Video inspection of Low Level Outlet • Installation of Riser Pipe	$10,000
Fabrication of low level outlet upstream riser pipe	$2,500
Construction of settlement pond with imported soils	$7,000
Western Grater: Flushing and grouting of low level pipe	$20,000
Goal Engineering: Grout design and site inspection	$3,500
AECOM Engineering: • Project administration, settlement pond design, Dam Safety Application and field inspections (tendering not included)	$16,000
Subtotal Contingency 35% **Total Estimated Costs**	$59,000 $20,650 **$79,650**

Upon a thorough evaluation of the concerns noted above and with no assurance that the grouting procedures would mitigate long-term seepage failure, AECOM cannot recommend the grouting of the low-level outlet. Alternatively, the low-level outlet could be replaced, which is discussed further in Section 4.2.

4.2 Replacement of Low-level Outlet

To mitigate the concerns identified with the aging low-level outlet and its condition, the existing low-level outlet could be removed and replaced as part of the proposed dam safety improvements, as outlined in AECOM's Gardom Pond Dam Evaluation report dated June 2013. Also, by doing this work simultaneously with the proposed dam safety improvements there would be a cost savings for construction and for administration of required approvals, assessments and/or permits by governing agencies.

In consultation with Thurber Engineering, it was discussed that the low-level outlet could be removed and the dam reinstated with either selected fine grained source materials (subject to local availability and costs) and/or a concrete core with surrounding suitable backfill.

To remove and replace the low-level outlet would require the drawdown of Gardom Pond by approximately 3.8 m, excavation and removal of the existing outlet pipe and replacement with a new, longer outlet, including a new control valve on the upstream side of the inlet. The dam would then be reinstated, followed by the construction of the proposed toe berm as outlined in AECOM's June 2013 report.

4.2.1 Low-Level Outlet Replacement Costs:

In consultation with Thurber Engineering, AECOM determined that a preliminary cost estimate to rebuild the dam would be between $100,000 and $130,000. This estimate is based on the removal and replacement of the low-level outlet occurring as part of other proposed dam safety improvements.

If the low-level outlet is replaced, these costs would be offset by the costs of the proposed siphon, which would no longer be required.

Based on the more conservative cost of $130,000 to rebuild the dam, a Class D Cost Estimate breakdown to replace the Low-Level Outlet is as follows;

Remove existing low level outlet	$5000
Reinstate dam	$130,000
Replace low-level outlet pipe	$5,000
Inlet structure	$10,000
Concrete collars	$4,000
Valves and fittings	$2,000
Offset costs – **delete siphon**	($37,000)
Offset costs – delete grouting	($12,000)
Total Additional Costs	**$107,000**

AECOM's June 2013 report to rehabilitate Gardom Pond Dam identified total construction costs of $938,025, including contingency and engineering fees. With additional costs of $107,000 to replace the low level outlet and subsequent contingency and engineering fees, the estimated total construction cost becomes $ 1,098,525. A cost summary comparison table is as follows:

	Dam Rehabilitation Costs: Comparison Summary	
	Original Cost Estimate June 2013 Report	**Adjusted Low-Level Outlet Replacement**
Subtotal Capital Costs	$625,350	$732,350
35% Contingency	$218,873	$256,323
15% for Engineering	$ 93,802	$109,853
Construction Total	**$938,025**	**$1,098,526**

It is worthy of note that the field information gained as part of this study identified additional capital costs that would have reduced the original contingency of 35% to 14%. Therefore we have maintained the 35% contingency allowance for our revised capital cost estimate.

5. Environmental Considerations:

Gardom Pond creates riparian and aquatic habitat for aquatic species, waterfowl and local wildlife. It also has aesthetic value as a pleasant locale for residents.

Gardom Pond also helps to some degree, in recharging groundwater that supplies local domestic wells. It also acts "unofficially" as emergency fire storage for the Razor Point Improvement District.

Construction activity in or about a water habitat necessitates the need to protect the local ecosystem through mitigation measures and best practices. The conceptual design for the work at this point has not been clearly defined due to complexities identified in the underwater video of the low-level outlet.

Appendix B contains a memorandum that reviews and comments on environmental considerations and possible impacts associated with the following three construction options:

- grout the low-level outlet from the downstream side, displacing the water in the outlet,
- replace low-level outlet and draw down reservoir, and
- construction of a coffer dam to work on upstream section of outlet.

6. Closing Statement

The objective of this report was to provide a methodology and cost estimate to decommission the low-level outlet at Gardom Pond Dam by providing a sound long-term solution with safety the utmost concern. As discussed within Section 4.1 of this report, grouting of the low-level outlet is not a recommended solution due to three possible pipe diameter reductions within the barrel of the pipe. The pipe reductions will inhibit additional videos, flushing out of all debris and there would be no assurance that grouting would fill all annular spaces and seal potential seepage paths along the low-level outlet.

The costs to administer and undertake grouting of the low level outlet is estimated at $79,650, including a 35% contingency. For the reasons presented in this report grouting of the low level outlet is not a recommended solution or approach.

AECOM reviewed the removal and replacement of the low level outlet with Thurber Engineering and it is considered to be a viable solution. This letter report includes costs to remove and replace the low level outlet and an updated total construction cost estimate.

Report Prepared by:

Daryl Henry, P.Eng.
Senior Engineer

Report Reviewed by:

Norman I. Guild, P.Eng.
Senior Consulting Engineer

DH/NIG/MB
Attch.

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The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

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- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to Consultant which has not been independently verified;
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- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
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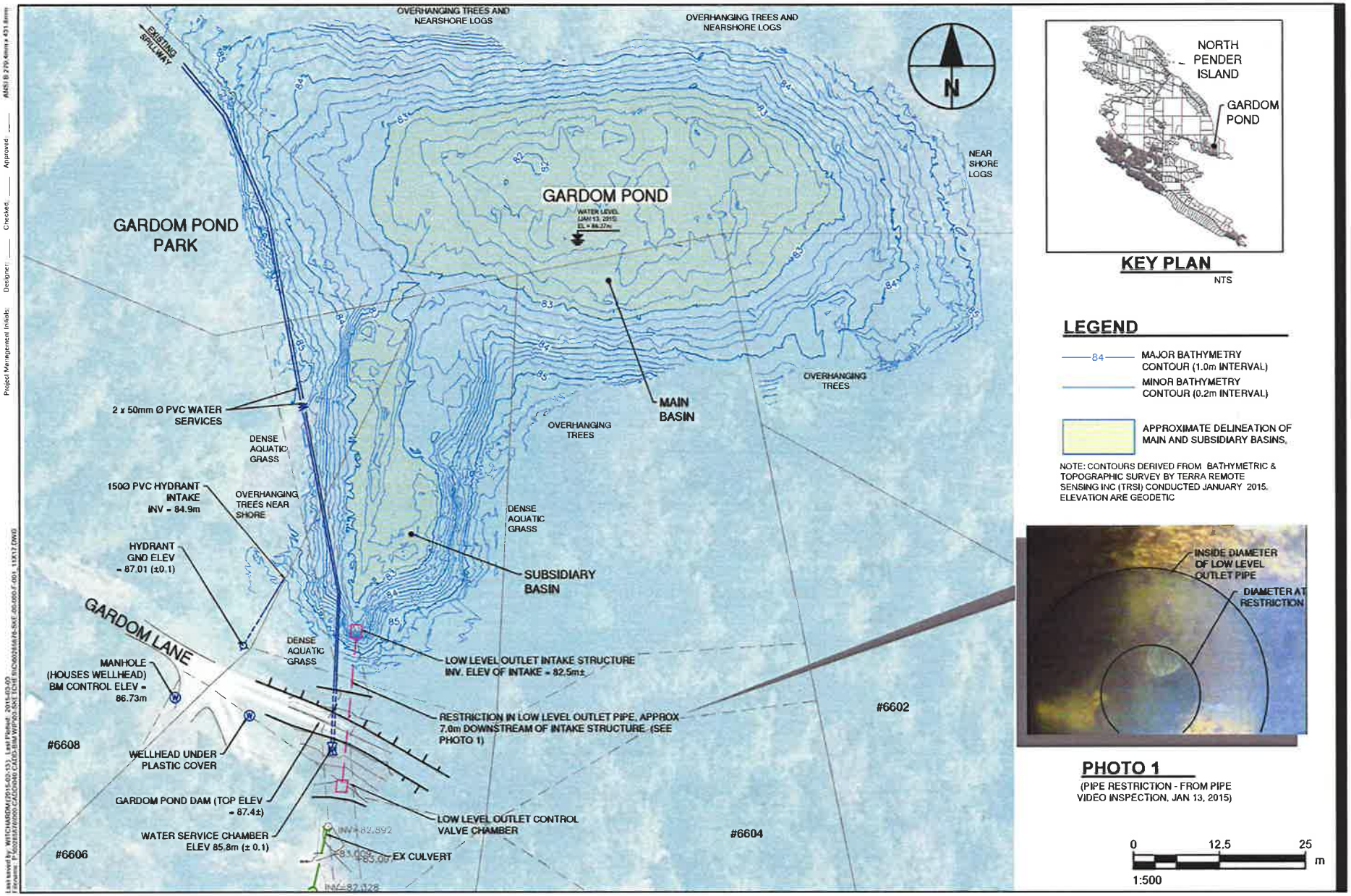

KEY PLAN
NTS

LEGEND

- 84 — MAJOR BATHYMETRY CONTOUR (1.0m INTERVAL)
- MINOR BATHYMETRY CONTOUR (0.2m INTERVAL)
- APPROXIMATE DELINEATION OF MAIN AND SUBSIDIARY BASINS.

NOTE: CONTOURS DERIVED FROM BATHYMETRIC & TOPOGRAPHIC SURVEY BY TERRA REMOTE SENSING INC (TRSI) CONDUCTED JANUARY 2015. ELEVATION ARE GEODETIC

PHOTO 1
(PIPE RESTRICTION - FROM PIPE VIDEO INSPECTION, JAN 13, 2015)

0 12.5 25 m
1:500

AECOM

Figure: 1

GARDOM POND BATHYMETRY AND EXISTING SITE PLAN

CRD REGIONAL PARKS
GARDOM POND DAM LOW LEVEL OUTLET DECOMMISSIONING
NORTH PENDER ISLAND
Project No.: 60285876 Date: 2015-02-13

Appendix A:
Proposed Conceptual Grouting Design

Henry, Daryl

From: Greg Ovstaas <govstaas@goalengineering.com>
Sent: Thursday, January 29, 2015 9:16 AM
To: Henry, Daryl; Jared Wells; Matt Floch
Subject: GE14106 Aecom Gardom Pond 29 Jan 2015
Attachments: GE14106 Aecom Gardom Outlet 28 Jan 2015.PDF

Daryl
Here is a DRAFT flushing and grouting procedure resulting from my discussion with Jared Wells and Matt Floch of Western Grater. Some items to consider:-

1. We still must try and get more camera inspection data for the AC pipe.
2. On reviewing the video of the first 20 ft or so, I believe I can see considerable sediment along the base of the pipe in addition to the aquatic growth.
3. Western Grater have suggested trying to clean the pipe by flushing with air and water. I think this is suitable as there is less chance of damaging the pipe if it has become weakened in service.
4. Western Grater have indicated that they would install the connection at the valve and then the subsequent flushing and grouting but they would not be performing any "underwater" work such as installing the packer and standpipe and the camera inspection. This would have to be completed by the Dive team. (Jared – I believe however you would be able to supply the Packer???). Having said that – I question the need for both a standpipe and a packer – Perhaps one of these items is sufficient??

Please review this and give me a call to discuss further. Please also forward to Norm as I do not have his email.

Greg

Greg Ovstaas, P.Eng
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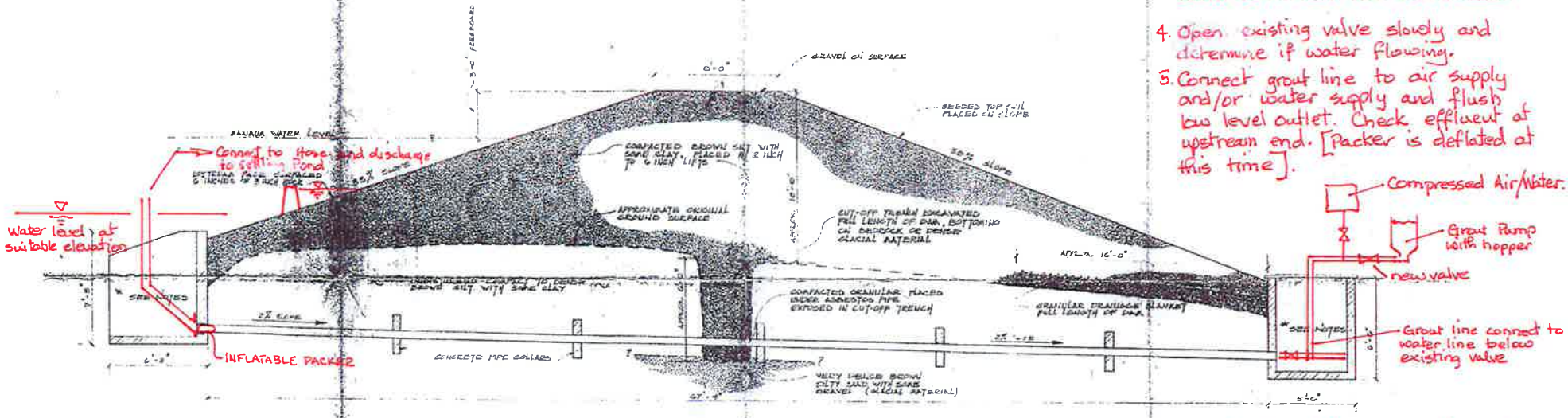
DRAFT FOR DISCUSSION

28 Jan 2015
G. Oystrac

LOW-LEVEL OUTLET DECOMMISSIONING

1. Install inflatable packer at upstream end of outlet.
2. Install standpipe as shown at upstream end of outlet. Connect to hose that discharges to settling pond on ground.
3. Connect grout line to existing waterline below valve. Keep new valve closed
4. Open existing valve slowly and determine if water flowing.
5. Connect grout line to air supply and/or water supply and flush low level outlet. Check effluent at upstream end. [Packer is deflated at this time].



6. Re-inspect with camera at upstream end to determine if outlet is clean.
7. If clean connect grout pump and proceed with grouting.
8. Grout is to be a Portland cement based grout. f'c ≈ 25 MPa at 28 days.
9. Re-inflate packer and close valve immediately after grouting.

NOTES:

1) THIS SECTION NOT INTENDED TO SHOW DETAILS OF OUTLET WORKS.
2) LOCATION OF CONCRETE PIPE COLLARS APPROXIMATE ONLY.
3) BOTH ABUTMENTS CONSIST OF BEDROCK WITH RIGHT ABUTMENT SOMEWHAT MORE FRACTURED THAN LEFT.
4) EMBANKMENT FLARED AGAINST RIGHT ABUTMENT.

TYPICAL SECTION OF EARTH FILL DAM
FOR THE
COMMUNITY RESERVOIR, NOFIELD SUBDIVISION
RAZOR POINT, NORTH PENDER ISLAND

ISLAND GEOTECHNICAL SERVICES
201-1615 BOWEN RD. NANAIMO, B.C.

REMARKS: AS BUILT (EARTHWORKS ONLY)
DATE: NOV. 30, 1970
DRAWN: D.P. CHECKED:
SCALE: 1"=50'-0"

SHEET 1 of
PROJECT

Appendix B:
Environmental Considerations

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Memorandum

To	Daryl Henry	Page	1 of 3
CC			
Subject	Environmental Considerations for Gardom Pond Low Level Outflow Decommissioning		
From	Mike Sanborn, R.P.Bio.		
Date	March 3, 2015	Project Number	60285876 (500)

The Capital Regional District (CRD) is considering options for safety improvements to the Gardom Pond Dam, located on Pender Island. Gardom pond is a small (7600 m^2) man made pond with a maximum depth of 4.3 meters. The pond consists of generally shallow margin with two basins. Aerial photographs reveal thick aquatic macrophyte communities around the margins of the pond.

This memorandum is intended to provide a qualitative preliminary consideration of potential environmental impacts and associated mitigative options. It is not intended as a replacement to an environmental impact assessment, construction environmental management plan and construction environmental monitoring, all of which will be will be required prior to performing work.

The conceptual design for the work is at this point not clearly defined due to complexities identified in underwater video of the low level outlet. However, three possible options being considered are:

- grout the low level outlet from the downstream side, displacing the water in the outlet;
- replace low level outlet and draw down reservoir; and,
- construct a coffer dam to work on upstream section of outlet.

Each of the potential options are expected to have environmental impacts that may be unique to that option. In addition, all three options will have a shared set of potential impacts that are typical of work conducted in or about a watercourse. Also, environmental monitoring and a comprehensive construction environmental management plan will be required.

Work Options

Option 1: Grouting from the Downstream Side:

The primary environmental impact anticipated as a result of this approach is the high potential for concrete or other Portland-cement containing construction materials to come into contact with aquatic habitat. Concrete, cement, mortars, grouts and other Portland cement or lime-containing construction materials are basic or alkaline materials which are highly toxic to fish and must only be used near water with extreme care. Injecting grout from the downstream side and displacing the water in the outlet would result in uncontrolled release of water which had been in contact with uncured grout. Best management practices recommend complete isolation of the work area to ensure that the pH of the surrounding waterbodies does not rise (become more alkaline) during works. This could be overcome

using an engineered solution (capturing water as it escapes the upstream side) however the potential for breach of any engineered solution should be carefully considered.

Option 2: Draw-down and Outlet Replacement
Environmental impacts associated with draw down and replacement of the outflow are expected to be moderate. Construction activities would require drawing the water level down to ~83 m asl. This would greatly decrease the wetted area and volume of water available for aquatic species. Fish salvage would be required as a result of drawdown, although fish presence has not been confirmed for this water body. Stocking/colonization activities of rainbow trout occurred up until 2006[1]. Anecdotal evidence suggests that these were diploid fish stocked for recreational fishing, and the continued presence of rainbow trout in Gardom pond is unknown. Fish presence must be confirmed prior to starting work. Excavation and replacement of the outlet structure may require clearing activities to remove vegetation from the dam. Clearing should be limited to only areas necessary for construction and maintenance of dam safety.

Option 3: Isolation and Work on Upstream Section
Environmental impacts associated with isolation (preferably through use of a coffer dam) are expected to be negligible. Installation and removal of sheet pile may increase turbidity in the immediate vicinity of the outlet structure temporarily. Installation and removal of sheet pile should be conducted in the presence of an environmental monitor. Once the work area is isolated, adverse environmental impacts resulting from work on the upstream outlet structure are unlikely. Use of concrete, grout or other cast in place cement construction techniques could be carried out.

Environmental Considerations

Other potential environmental impacts to consider include, but are not limited to the following:

Fugitive Sediment/Silt Control
All work must be undertaken and completed in such a manner as to prevent the release of silt, sediment, sediment-laden water, or any other deleterious substance into any ditch, watercourse, ravine, or storm sewer system.

Standards for sediment and erosion control outlined in BC Ministry of Environment "Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia"[2] must be adhered to. Contingency measures for prevention of introduction of suspended sediments, soils and other particulates may include installation of silt cloth and fencing, hay bales, runoff detention and settling features or other structures as appropriate for each activity and area.

Clearing
To the maximum extent practical, riparian vegetation should be protected during construction. If any clearing of trees is required within the bird nesting season, nesting bird surveys prior to clearing will should be considered. Project limits should be clearly marked to avoid unnecessary ground disturbance. Only vegetation within the construction limits should be removed. All other vegetation

[1] *http://www.env.gov.bc.ca/fish/fidq/queries.html*
[2] *http://www.env.gov.bc.ca/wld/documents/bmp/devwithcare/*

not within the construction area should be left in its current condition, unless the vegetation interferes with site access/egress. It required, any removal of mature trees providing shade or bank stabilization within the riparian area should be coordinated with appropriate regulatory agencies.

Construction Timing

- If required, any tree removal should be done outside of the bird nesting season (April 1 – July 31). If this season cannot be avoided, the environmental monitor would be required to coordinate a nesting bird survey of the area to be cleared.
- Construction should be pursued to completion as quickly as possible.
- Construction activities are not to occur during periods of heavy rain, or if there is a potential for flooding of the ponds during construction activities. In stream works window for protection of fish required work to be completed between August 15th and September 15th.

Permitting

Permitting requirements for the proposed works may include:

Fish Salvage Permit Application– If fish salvage is conducted, a permit for collection will be required under the BC Wildlife Act. Consultation with BC Ministry of Environment will be required.

A Development Permit may be required under the Riparian Areas Regulation, as Gardom Pond has been included as a Riparian and Aquatic Development Permit Area (DPA). A review of Section 5.2 of the North Pender Island Official Community Plan[3] indicates that "*repair, maintenance, alteration or reconstruction of existing legal or legal nonconforming buildings, structures or utilities provided there is no alteration of undisturbed land or vegetation*" would be exempt from this requirement. Further consultation with Island Trust BC is recommended.

Water Act Section 9 – Depending on the scope of work either a notification or approval will be required pursuant to the BC Water Regulation, which forms part of the BC Water Act (BC Reg 204/88).

DFO Review will not be required, as repair to existing dams is excluded from the requirement for DFO review; however proponents are still required to avoid causing serious harm to fish by following best practices.

[3] *http://www.islandstrust.bc.ca/ltc/np/pdf/npbylbaseocp0171.pdf*