



AECOM  
200 – 415 Gorge Road East  
Victoria, BC, Canada V8T 2W1  
www.aecom.com

250 475 6355 tel  
250 475 6388 fax

5 February, 2014

**Project No: 60285876 Task #3**

Jeff Ward, MCIP, RPP  
Manager, Planning, Resource Management and Development  
Capital Regional District  
Parks Department  
490 Atkins Avenue  
Victoria BC V9B 2Z8

Dear Jeff:

**Re: Gardom Pond Dam Evaluation – North Pender Island  
Additional Investigations, January 2014  
Subsequent to Report Submission June 2013  
Alternative Spillway/Breach Evaluation**

## **1. Introduction**

On January 9<sup>th</sup>, 2014, Capital Regional District Regional Parks (CRD) requested AECOM to investigate the feasibility and costs of using the current spillway location on the northwest shoreline of Gardom Pond when considering the rehabilitation and decommissioning of Gardom Pond Dam.

The CRD would like to have a cost comparison between spillway facilities located as noted above and spillway works located at the southern end of Gardom Pond, near the left abutment of the existing dam, as proposed in AECOM's Gardom Pond Dam Evaluation Report submitted to the CRD on 19<sup>th</sup> June, 2013.

Spillway channel routing downstream of Gardom Pond and siphon location were also to be evaluated and costed as part of the additional investigations.

CRD also requested AECOM to consider the ramifications of using the current location of the spillway as a possible location for a "pond breach" as compared to a traditional breach through the actual dam as proposed in AECOM's earlier report. Once again, relative costs of this alternative approach were to be developed.

## **2. Rehabilitation Scenario Gardom Pond Dam – Upgrade Current Spillway**

Under this scenario the dam is upgraded and the existing spillway channel is used to convey overflows. To dewater the reservoir, a siphon system would need to be constructed at the south end of Gardom Pond.

### **2.1 General**

As part of the rehabilitation works required for Gardom Pond Dam and related facilities, it is necessary to upgrade the present spillway facilities as discussed in AECOM's report of June 2013.

The AECOM report proposed a new spillway structure located to the east of the east abutment of Gardom Pond Dam and discharging to a channel which would convey spillway flows to the ocean. The aforementioned spillway structure would lie on properties 6606 and 6604 Harbour Hill Road, and the spillway channel would pass through 6606, 6604 and 6602 Harbour Hill Road; and 6621 and 6618 Razor Point Road. The spillway structure would cross beneath Gardom Lane and the spillway channel would be culverted beneath Razor Point Road. In addition, a siphon was proposed to replace the existing low-level outlet. The siphon pipe was to be constructed as part of the spillway structure and would discharge into the spillway channel.

Relocation of the spillway structure to the same location of the existing spillway requires re-evaluation of the spillway structure, the downstream spillway channel and the siphon works. The results of this re-evaluation are discussed in the following sections and depicted on **Figure 1**, attached.

## 2.2 Spillway Structure

A new concrete spillway structure with a width of 4 m and weir crest set at the current nominal top water elevation of the pond, El.99.1 m, is proposed. Top wall height would be set at El. 100.1 m, the crest of the dam.

Earth berms would tie the new structure into existing ground to the north and south.

## 2.3 Spillway Channel

The existing spillway channel would be upgraded to convey the Inflow Design Flood (IDF) to the ocean. The route proposed is discussed in the following text. An HDPE liner with trapezoidal cross section would be used across residential properties and a concrete flume would be used within the right-of-way along Harbour Hill Road.

### 2.3.1 Spillway Structure to Gardom Lane

The preferred gradient of this section of channel would be such that normal channel flows would be supercritical to minimize back-watering the spillway structure weir, which would reduce the design capacity of the spillway structure. This would require a channel gradient of approximately 2%, in concert with a 600 mm deep trapezoidal HDPE liner (as manufactured by "Smart Ditch") with constraining LocBlocks, as shown in **Figure 1**, Type II channel. From the limited survey information available, it appears that there is sufficient elevation drop between the proposed spillway structure location and the top of the downhill slope immediately below the downstream end of the existing Gardom Lane 500 mm dia. culvert, a distance of 113 m.

At Gardom Pond Lane the spillway channel would be conveyed within a 2000 mm x 1600 mm arch culvert to maintain the channel cross section unimpeded beneath the roadway.

A 4-m wide right-of-way (ROW) will be required for this section of spillway channel.

### 2.3.2 Gardom Lane to Harbour Hill Road

This 145 m section of spillway channel would pass through 6610 and 6608 Harbour Hill Road within a 4-m wide ROW and would be lined with a 600 mm trapezoidal Smart Ditch HDPE liner, as shown in **Figure 1**, Type I channel. It would terminate in a concrete energy dissipation basin/head pond, located on 6608 Harbour Hill Road and Harbour Hill Road ROW, which would redirect spillway flows through an angle of 90°± to permit flow to continue along Harbour Hill Road ROW. Given the

steepness of the gradient (20%+) of the spillway channel above the basin, the basin must be of sufficient size and strength to dissipate the significant energy contained within the spillway design flows. Protective fencing would be required around the perimeter of the basin

### **2.3.3 Harbour Hill Road to Razor Point Road**

Upon leaving the Harbour Road head pond, the flows would be conveyed through a concrete channel flume within the Harbour Road ROW for some 144 m. It would be constructed on the uphill slope between the existing road ditch and the northern property line of the Harbour Hill ROW. It would be necessary to excavate completely into the existing slope to a depth that would ensure that spillway channel flows were conveyed in a channel constructed in natural ground, and not in fill nor partly in fill and partly on existing ground. The concept is shown in cross section on **Figure 1**, Type IV channel, and utilizes a 0.7 m x 0.7 m concrete flume to minimize excavation.

Using topographic data from the CRD Atlas, it appears that the existing ditch along Harbour Hill Road services a large upstream catchment area, greater than the area contributing to Gardom Pond. It is therefore expected that this ditch would have its capacity fully utilized at the time when a major rainfall event is generating the design flood flows being conveyed by the spillway channel. A local stormwater management study would be required to confirm whether or not there could be some residual capacity within the ditch to convey a portion of the spillway flows, which could potentially reduce the size of the dedicated spillway channel.

The spillway channel route would leave the Harbour Hill Road ROW approximately 5 m to the north of the southern property line of 6604 Harbour Hill Road. It would then enter the property of 6604 Harbour Hill Road and follow the route proposed in AECOM's 19<sup>th</sup> June, 2013 report to Razor Point Road; conveying flows by means of a Type I channel shown on **Figure 1**. This route lies within a proposed 4 m ROW paralleling the eastern property line of the Harbour Hill Road ROW for the majority of its length, and crossing properties at 6604 and 6602 Harbour Hill Road and 6621 Razor Point Road. A transition basin would be required between the proposed concrete flume and the Smart Ditch channel section near the southern property line of 6604 Harbour Hill Road.

The reason for returning the spillway channel to the previously proposed route and not continuing within the Harbour Hill Road ROW, is the presence of the Razor Point Improvement District (RPID) watermain between the road ditch and the ROW property line. Without detailed survey and pipeline location confirmation, it has to be assumed that the pipeline location would conflict with the excavation for the spillway channel.

It should be noted that the capital costs of the rehabilitation of Gardom Pond Dam and related facilities include an allowance for residential road access across the 1.9 m wide spillway channel for properties 6604 and 6602 Harbour Hill Road.

### **2.3.4 Razor Point Road to Ocean**

There are no changes proposed for this section of the route with respect to the routing selected in the 19<sup>th</sup> June, 2013 report.

Spillway flows would enter a localized riprapped head pond, which would feed a 1000 mm dia. CSP culvert running beneath Razor Point Road. Thereafter, the channel would be constructed in a 4-m wide ROW following the eastern property line of 6618 Harbour Hill Road to the ocean. The channel would be lined with a 600 mm HDPE Smart Ditch liner, as shown in **Figure 1**, Type II channel.

## 2.4 Siphon

The siphon proposed to replace the existing low-level outlet was previously incorporated into the spillway structure design for the June 2013 report. It discharged into a small rock pit, which discharged into the new spillway channel.

The proposed relocation of the spillway structure to the northwest shoreline of Gardom Pond requires a re-evaluation of the proposed works. The relative elevations of the invert of the low-level outlet and the natural ground along the route of a spillway channel from a relocated spillway structure to Gardom Lane could require a siphon length in excess of 100 m. This is not considered to be good design practice due to the operating instabilities that can occur.

Therefore, it is proposed to retain the location and the control works of the 300 mm dia. siphon proposed in the earlier AECOM report. The siphon would be installed within a 750 mm dia. culvert beneath Gardom Lane to enable inspection and to contain any possible leakage, would have its control chamber located on the north side of Gardom Lane and would discharge to a small rock pit. From the rock pit, the siphon flows would enter a 300 mm dia. HDPE or PVC buried pipe, which would follow the ROW of the RPID watermain until it discharges to the spillway channel on property at 6604 Harbour Hill Road.

It might be possible to construct the pipe within the RPID ROW, however, detailed survey would be required to confirm this possibility. Alternatively, a ROW of 1 – 2 m immediately adjacent to the existing ROW would be required for the new pipeline.

## 2.5 Adjusted Cost

Costs have been developed to an accuracy commensurate with the scope of the study. Unit prices from previous contracts within the AECOM database have been used together with some discussion with a local contractor. The costs below have been prepared for a spillway structure and channel located at the northwest end of Gardom Pond and the siphon works located at the south end of the pond.

Quantities have been derived from the conceptual sketches of the location and size of the upgraded facilities presented in **Figure 1**.

At this stage of conceptual design, a contingency factor of 35% has been applied.

These costs have been integrated into Table 5.1 – Capital Cost of Rehabilitating Gardom Pond Dam and Related Facilities, which was included in AECOM's original report and is shown as **Table 2.1** of this letter report.

For reference, a cost comparison is provided below:

Rehabilitation Costs - Spillway at Dam (19 <sup>th</sup> June, 2013 Report)	\$938,025
Rehabilitation Costs - Spillway at Existing Location (this Report)	\$1,120,950

**Table 2.1 – Capital Cost of Rehabilitating Gardom Pond Dam and Related Facilities**

Item	Quantity	Unit	Unit Cost	Amount
<i>Mobilization and Demobilization</i>	1	L.S.	\$60,000	\$60,000
<i>Environmental Monitoring</i>				
Initial Environmental Assessment	1	L.S.	\$10,000	\$10,000
Construction Monitoring	1	L.S.	\$5,000	\$5,000
<i>Dam Construction Upgrades</i>				
Grout Low Level Outlet	1	L.S.	\$12,000	\$12,000
Downstream Stabilization - Toe berm	1	L.S.	\$130,000	\$130,000
Upstream Stabilization - Riprap	1	L.S.	\$85,000	\$85,000
Spillway Entrance Channel Excavation	150	m <sup>3</sup>	\$18	\$2,700
Spillway Structure Excavation	50	m <sup>3</sup>	\$18	\$900
Concrete Spillway Structure	30	m <sup>3</sup>	\$1,500	\$45,000
Spillway Structure Earth Tie-in Berms	200	m <sup>3</sup>	\$25	\$5,000
Contractor's care of water management	1	L.S.	\$10,000	\$10,000
Rock Blasting	25	m <sup>3</sup>	\$200	\$5,000
<i>Siphon</i>				
300 mm HDPE Siphon Pipe w/anchors	70	m	\$250	\$17,500
Siphon Inlet Cage and check valve	1	ea.	\$5,000	\$5,000
Control chambers and valving; control valves	1	L.S.	\$13,000	\$13,000
750 mm dia. Culvert beneath Gardom Lane	7	m	\$300	\$2,100
Fill Siphon and Test System	1	L.S.	\$1,500	\$1,500
Pressure Pipe/Siphon Transition Rock Pit	1	L.S.	\$4,000	\$4,000
300 mm HDPE Pressure Pipe - Rock Pit to Spillway Channel	150	m	\$210	\$31,500
Tree clearing - Spillway construction	20	ea	\$200	\$4,000
Brush removal - Spillway construction	600	m <sup>2</sup>	\$2	\$1,200
<i>Spillway Channel to Ocean</i>				
Tree clearing - Spillway construction	20	ea	\$200	\$4,000
Brush removal - Spillway construction	1100	m <sup>2</sup>	\$2	\$2,200
Channel Excavation	500	m <sup>3</sup>	\$18	\$9,000
Spillway erosion liner - w/ "SmartDitch Trapezoid" and LocBlocks (Type II channel)	130	m	\$430	\$55,900
Spillway erosion liner - w/ "SmartDitch Trapezoid" (Type I channel)	350	m	\$180	\$63,000
Concrete Flume (Type IV channel)	145	m	\$600	\$87,000
Box Culvert (2 m x 1.6 m) at Gardom Lane	1	L.S.	\$19,000	\$19,000
Energy Dissipation Basin (Harbour Hill Road)	1	L.S.	\$8,000	\$8,000
Transition Basin (Lot 6604 approx)	1	L.S.	\$10,000	\$10,000
Protective Fencing	40	m	\$120	\$4,800
<i>Culvert Construction - Razor Point Road</i>				
Supply & Install 1.0 m dia. CSP	20	m	\$300	\$6,000
Supply & Install precast headwall.	1	LS	\$5,000	\$5,000
Excavation (bury pipe & regrade road)	600	m <sup>3</sup>	\$10	\$6,000
Gravel Base (depth to be specified)	200	m <sup>2</sup>	\$25	\$5,000
Asphalt (depth to be specified)	200	m <sup>2</sup>	\$60	\$12,000
			Subtotal	\$747,300
			35% Contingency*	\$261,555
			15% for Engineering	\$112,095
			Construction Total	\$1,120,950

**Additional Costs:**

- A. Costs associated with acquiring the necessary easements, which will have to be added to the above total. These costs will include legal surveys, negotiating costs, acquiring and registering costs and final staking costs.
- B. Costs associated with the removal of RPID water services from the dam.
- C. There will be ongoing operation, maintenance, surveillance and reporting costs to the BC Dam Safety Branch.

\* **Contingency Factor Allowances:**

- 1. Field investigations: geotechnical drilling, topographical survey and pond bathymetry
- 2. Dam improvements: extent of upstream slope protection, condition of upstream face, unknown seepage issues during toe berm construction, unknown siphon length, presence of rock
- 3. Low-level Outlet: unknown pipe condition and grout volume anticipated to fill unforeseen voids
- 4. Spillway Alignment to Ocean: adjustments to minimize impacts to trees, sections of steep grades (>25%), gradient transitions, sourcing of any riprap, required alterations to Razor Point Rd. crossing

### 3. Dam Breaching Scenario Gardom Pond Dam – Breach at Existing Spillway Location

Under this scenario the dam is left in place and the existing spillway channel is excavated significantly to dewater the reservoir.

#### 3.1 Dam Breaching Requirements

##### 3.1.1 Logistics

In AECOM's report of 19<sup>th</sup> June, 2013, the breach design consisted of a 4-m wide vertical breach at the centre of the dam and a breach channel lined with a 600 mm Smart Ditch HDPE trapezoidal liner to convey the future natural flows to the ocean. This is the traditional, and commonly accepted method of taking a dam out of service.

The proposed revised location for the spillway channel is a non-traditional method of dam breaching which leaves the dam intact but lowers the existing reservoir and spillway channel located some 110 m upstream of the dam at the northwest end of Gardom Pond. Discussions would be required with the BC Dam Safety Branch to determine their acceptance of this approach.

##### 3.1.2 Breach Design

The 200-year period design flow of 0.36 m<sup>3</sup>/s and the breach design used for AECOM's earlier report have been selected. A 4-m wide breach would be cut at El. 96.50 m from Gardom Pond to the invert of the downstream end of the existing culvert beneath Gardom Lane. Cut depths would taper from approximately 3.0 m at the spillway entrance to around 1 m at the upstream end of the Gardom Lane culvert. Cut walls would be lined with LocBlocks. Excavated material would be windrowed on one side of the cut. The cut would pass beneath Gardom Lane and would be spanned by a new precast/prestressed concrete bridge resting on the LocBlocks, which support the side walls of the breach channel. The entire breach channel, spillway to bridge, would be riprapped with a 225 mm thick layer of 150 mm nominal riprap over a geotextile filter cloth. Protective fencing would be required on either side of the cut. The cut would terminate at a concrete weir which would direct flow to the breach flow channel head pond. The concept is shown in **Figure 1**, Type III channel.

#### 3.2 Breach Flow Channel

##### 3.2.1 Routing and Sizing

Below the downstream end of the proposed breach cut, the terrain slopes steeply towards the ocean. A head pond constructed of the 225 mm thick riprap used for the breach cut would be provided at the entrance to the breach channel, which would be trapezoidal and lined by a 600 mm Smart Ditch HDPE liner. See **Figure 1**, Type I channel.

The breach channel would follow the same route as the spillway discussed in Section 2 of this report. It would require the same 4.0 m ROW and be approximately 490 m long. It would be culverted beneath Razor Point Road, however a 900 mm dia. CSP culvert, instead of the spillway's 1000 mm dia. culvert, would suffice. As well, the concrete flume alongside Harbour Hill Road could have its cross section reduced in size from 0.7 m x 0.7 m to 0.6 m x 0.6 m.

**3.3 Adjusted Cost**

Costs have been developed to an accuracy commensurate with the scope of the study. Unit prices from previous contracts within the AECOM database have been used together with some discussion with a local contractor. The costs shown below include the cost of cutting the breach between Gardom Pond and Gardom Lane, a bridge over the cut for Gardom Lane, a head pond to feed the breach channel, and a breach channel from the end of the breach cut to the ocean.

Quantities have been derived from the conceptual sketches of the location and size of the upgraded facilities presented in **Figure 1**.

At this stage of conceptual design, a contingency factor of 35% has been applied.

These costs have been integrated into Table 6.1 – Capital Cost of Breaching Gardom Pond Dam, which was included in AECOM's original report and are shown as **Table 3.1** of this letter report.

For reference, a cost comparison is provided below:

Breach Costs - Breach at Dam (19 <sup>th</sup> June, 2013 Report)	\$421,763
Breach Costs - Breach at Existing Location (this Report)	\$801,900

**Table 3.1 –Cost of Breaching Gardom Pond Dam**

Item	Quantity	Unit	Unit Cost	Amount
<i>Mobilization and Demobilization</i>	1	L.S.	\$40,000	\$40,000
<i>Environmental</i>				
Initial Environmental Assessment	1	L.S.	\$10,000	\$10,000
Construction Monitoring	1	L.S.	\$10,000	\$10,000
<i>Dam Decommissioning</i>				
Excavate breach and grade surplus material	2200	m <sup>3</sup>	\$15	\$33,000
Riprap Channel Invert	125	m <sup>3</sup>	\$300	\$37,500
Precast concrete bridge slab w/ guardrails	1	L.S.	\$25,000	\$25,000
Concrete LocBlocks	550	ea	\$200	\$110,000
Protective Fencing	250	m	\$70	\$17,500
Weir and Head Pond D/S Gardom Lane	1	L.S.	\$5,000	\$5,000
Grout Low-Level Outlet	1	L.S.	\$12,000	\$12,000
Contractor's care of water management	1	L.S.	\$10,000	\$10,000
<i>Breach Spillway Channel to Ocean</i>				
Tree clearing - Breach spillway construction	30	ea	\$200	\$6,000
Brush removal - Breach spillway construction	2400	m <sup>2</sup>	\$2	\$4,800
Channel Excavation	400	m <sup>3</sup>	\$18	\$7,200
Breach spillway erosion liner - w/ "SmartDitch Trapezoid" (Type I channel)	360	m	\$180	\$64,800
Concrete Flume (Type IV channel)	145	m	\$600	\$87,000
Energy Dissipation Basin (Harbour Hill Road)	1	L.S.	\$10,000	\$10,000
Transition Basin (Lot 6604 approx)	1	L.S.	\$8,000	\$8,000
Protective Fencing	40	m	\$70	\$2,800
<i>Culvert Construction - Razor Point Road</i>				
Supply & Install 900 mm dia. CSP	20	m	\$300	\$6,000
Supply & Install precast headwall.	1	LS	\$5,000	\$5,000
Excavation (bury pipe & regrade road)	600	m <sup>3</sup>	\$10	\$6,000
Gravel Base (depth to be specified)	200	m <sup>2</sup>	\$25	\$5,000
Asphalt (depth to be specified)	200	m <sup>2</sup>	\$60	\$12,000
			Subtotal	\$534,600
			35% Contingency*	\$187,110
			15% for Engineering	\$80,190
			Construction Total	\$801,900

**Additional Costs:**

- A. Costs associated with acquiring the necessary easements, which will have to be added to the above total. These costs will include legal surveys, negotiating costs, acquiring and registering costs and final staking costs.
- B. After the dam has been breached it is no longer considered a dam by the BC Dam Safety Branch, thereby avoiding the need for annual reporting on its condition. However, normal maintenance of the bridge over the breach on Gardom Lane, the breach cut and channel, including the head pond, energy dissipation basin, transition basin, and the culvert beneath Razor Point Road.

\* **Contingency Factor Allowances:**

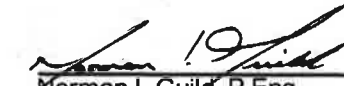
- 1. Field investigations: geotechnical drilling, topographical survey and pond bathymetry
- 2. Low-level Outlet: unknown pipe condition and grout volume anticipated to fill unforeseen voids
- 3. Spillway Alignment to Ocean: adjustments to minimize impacts to trees, sections of steep grades (>25%), gradient transitions, sourcing of any riprap, required alterations to Razor Point Rd. crossing.



#### 4. Partial Dam Breach

It has been proposed by the Gardom Pond Stakeholders to breach the dam to an unknown reduced height and still maintain a reservoir behind the Gardom Pond Dam. Maintaining a water source behind a man-made structure made of concrete or earth fill, defines a dam, which could still have significant downstream consequences in the event of a failure. This is not a traditional approach to breaching a dam and further discussions would be required with BC Dam Safety Branch as to what, if at all, minimum height would be allowed.


Report Prepared by:



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

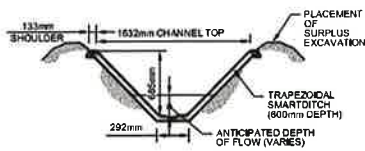
Report Reviewed by:



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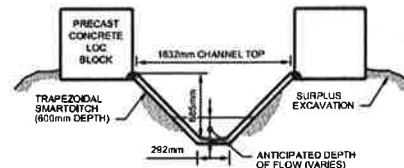
Daryl Henry, P.Eng.  
Senior Engineer

NIG/DH/MB/bi  
Atch.



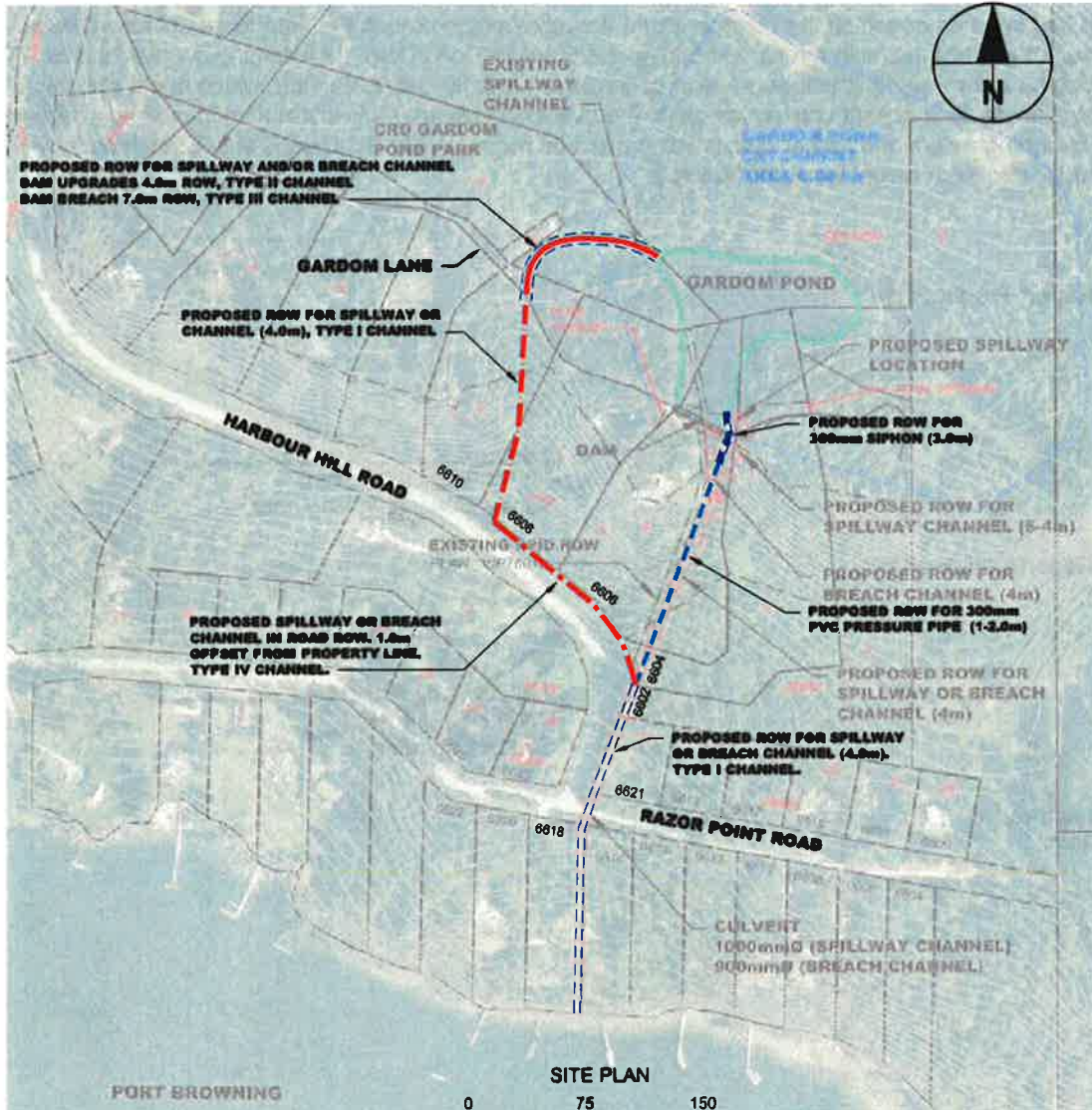
**TYPE I - TYPICAL CROSS SECTION OF SPILLWAY CHANNEL**

SCALE 1:50



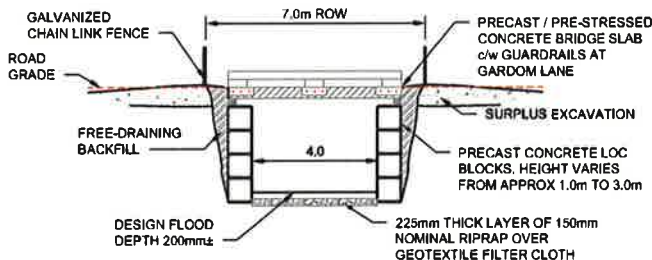
**TYPE II - TYPICAL CROSS SECTION OF SPILLWAY CHANNEL - POND TO GARDOM LANE**

SCALE 1:50



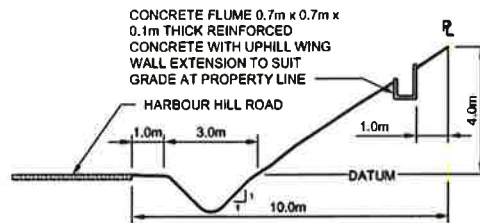
**SITE PLAN**

0 75 150 m  
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**TYPE III - TYPICAL CROSS SECTION OF BREACH CHANNEL - POND TO GARDOM LANE**

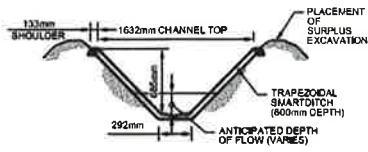
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**TYPE IV - TYPICAL CROSS SECTION OF SPILLWAY OR BREACH CHANNEL IN HARBOUR ROAD ROW**

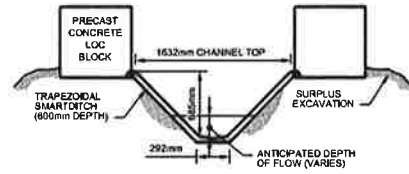
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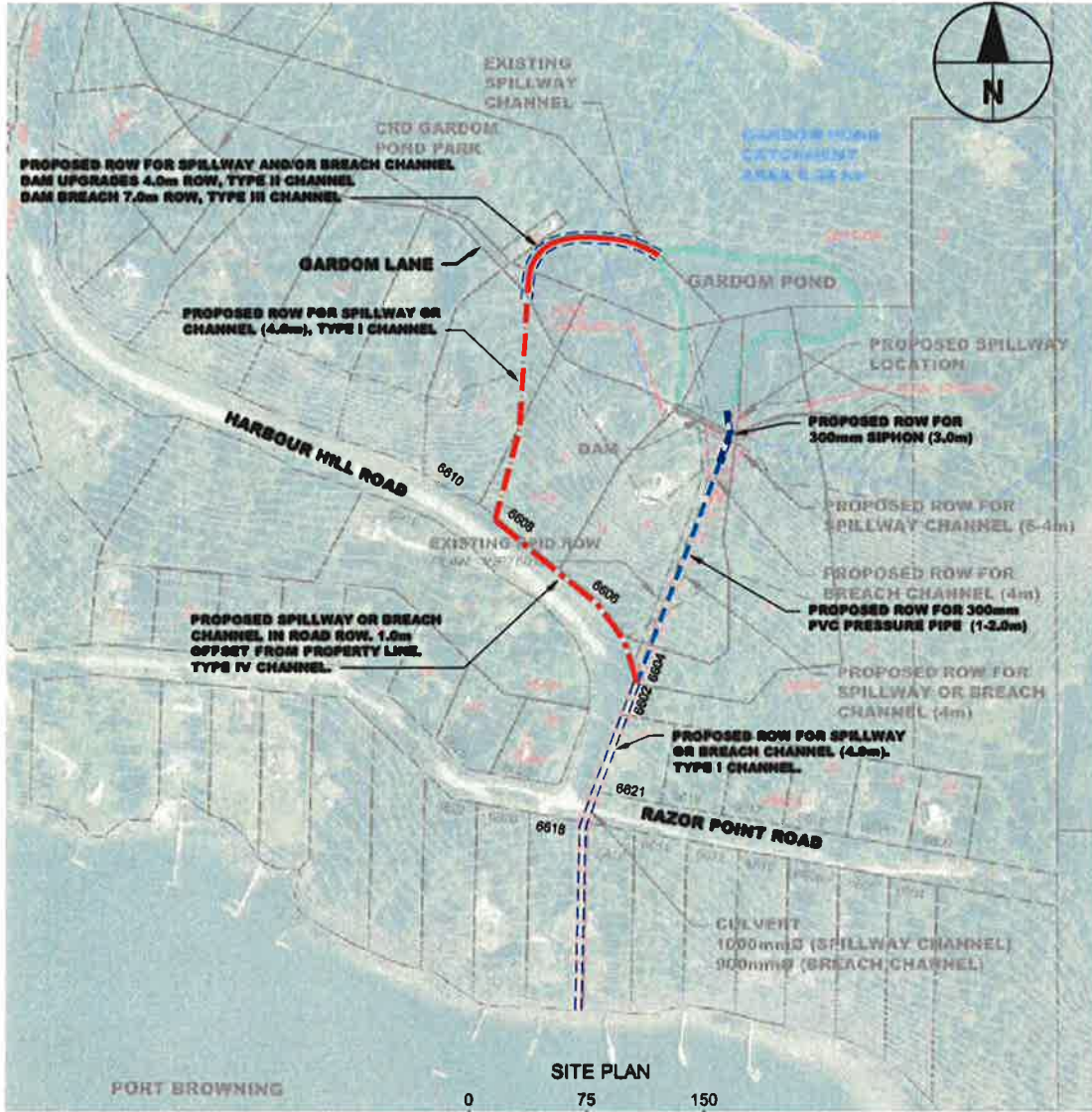
**TYPE I - TYPICAL CROSS SECTION OF SPILLWAY CHANNEL**

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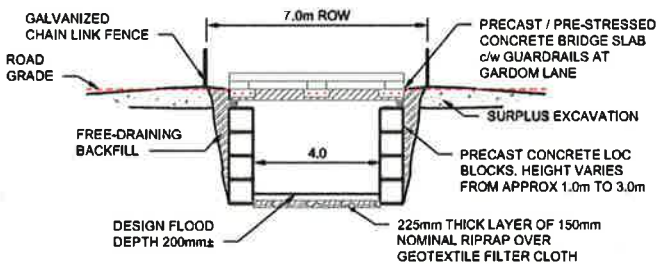
**TYPE II - TYPICAL CROSS SECTION OF SPILLWAY CHANNEL - POND TO GARDOM LANE**

SCALE 1:50



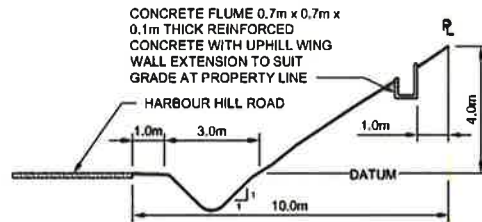
**SITE PLAN**

0 75 150 m  
 1:3000



**TYPE III - TYPICAL CROSS SECTION OF BREACH CHANNEL - POND TO GARDOM LANE**

SCALE 1:150



**TYPE IV - TYPICAL CROSS SECTION OF SPILLWAY OR BREACH CHANNEL IN HARBOUR ROAD ROW**

SCALE 1:150