




<b>Document Type:</b>	<b>TECHNICAL APPRAISAL FORM Submerged Culverts</b>
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Issued by: Chris Dyck  
Name  
  
Signature

August 10, 2012  
Date

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## **1 Phase Description**

### **1.1 Name and Location of Structures**

This submission includes the structures comprising the Cahill Submerged Culvert Structure S-2.

### **1.2 Permitted Traffic Speed**

Posted speed for traffic on Highway 401 above the Cahill Submerged Culvert is 90km/h. Posted speed for traffic on the elevated section of Hwy 3 above the culvert is 60km/h. Posted speed for traffic on roads WBR6, EBR7 and EBR8 is to be determined by post-construction testing.

## **2 Proposed Structures**

### **2.1 Description of Structures**

The Cahill Submerged Culvert is composed of reinforced concrete inlet and outlet structures connected by pipes. The inlet and outlet structure top openings are protected by galvanized steel grating supported on galvanized steel beams bearing at recesses in the concrete walls with removable sections for maintenance access. A sediment trap is to be supplied at the inlet structure constructed of reinforced concrete. The outfall at the outlet will be onto a rip rap erosion control stone layer. All openings to the structure are to be protected by galvanized steel safety grating. For information on the drainage function of structure S-2, refer to Stormwater Management Report 285380-70-119-0004.

### **2.2 Structural Types**

The inlet and outlet are reinforced concrete structures that include continuous retaining walls positioned on concrete slabs at two elevations. The inlet and outlet pipes connecting the inlet and outlet control structures are flanked by concrete counterforts on the soil side of the retaining wall structures.

### **2.3 Foundation Type**

The foundation for the inlet and outlet is slab on grade. The foundation extends out past the walls to stabilize the walls against overturning and to prevent buoyancy uplift by engaging the vertical dead load of the adjacent fill. There are apron walls at the inlet and outlet connected to the slab foundations that extend below the frost line.

### **2.4 Proposed Means for Inspection and Maintenance**

Maintenance action required to clear grates of debris and ice is to be undertaken when grates are a maximum of 10% blocked by area. Frequency of maintenance monitoring of grates required to achieve this performance level to be determined during first year of operation. Additional inspection of grates required after all major storm events.

Interior surfaces of the inlet and outlet structures will be accessible for inspection by removal of the grating sections provided in the roof grating or by entering through the channel openings after removing one or more sections of the channel grating. The entry can be made during low water

conditions (upper slab area) or after water is pumped out of the control structure (lower sump area). Provision must be made for workers to be harnessed/tied off at all times while inside the structure due to the possibility of accidental entry into the submerged pipe system. Note that the submerged culvert is unprotected from entry when the channel or roof grating is removed and appropriate safety measures to protect the public and workers must be put in place whenever grates are removed. Duration of grate removal to be kept to a minimum.

## 2.5 Materials and Finishes

### 2.5.1 Concrete

Inlet/Outlet and Retaining Walls: Minimum 30 MPa compressive strength at 28 days

### 2.5.2 Reinforcing Steel

Plain and coated reinforcing steel bars: CAN/CSA G30.18-M92; Grade 400W

### 2.5.3 Structural Steel

Steel Beams: CSA G40.21 350W

Steel Grating Plate: CAN3-G312.1; Min  $F_y = 350\text{MPa}$

### 2.5.4 Finishes

Concrete finishes shall comply with the applicable requirements of Project Agreement, Schedule 15-2.

Reinforcing steel shall be black.

All structural steel and grating shall be hot-dip galvanized to CSA G164-M92. Field cuts/welds shall be kept to a minimum and shall be cold galvanized.

## 3 Design/Assessment Criteria

### 3.1 Live Loading and Clearances

#### 3.1.1 Design Live Loading on Culvert

To CAN/CSA-S6-06.

#### 3.1.2 Design Vehicle

To CAN/CSA-S6-06 as soil surcharge.

#### 3.1.3 Other Live Loading

Design live load on Roof Grating: 4.0kPa. To facilitate economy of design, WEMG agreed that roof grates would be designed for Pedestrian load only. Equipment for servicing interior of control structures/pipes to be lifted by boom truck and is not to be set down on the roof grating. Equipment may alternatively be taken through the inlet/outlet openings following removal of channel grating. Note the cautionary safety notes found at Section 2.4 of this report.

**3.1.4 Provision for Exceptional Abnormal Loads**

None

**3.1.5 Any Special Loading Not Covered**

None

**3.1.6 Minimum Clearance Provided**

Internal clear diameter for passage of water in culvert: 3000mm (Nominal)

**3.1.7 Authorities Consulted and Any Special Conditions Required**

Department of Fisheries and Oceans (DFO) restrictions for in-water works timing must be respected.

**3.2 List of Relevant Design Documents**

Design criteria in accordance with Part 2 of Project Agreement - Schedule 15-2:

Article 1 - Highway Geometrics Design Criteria

Article 3 - Structural Design Criteria

Article 5 - Geotechnical and Foundation Design Report (285380-04-119-0009)

In the event of discrepancy, the hierarchy of referenced documents shall be as instructed.

## **4 Structural Analysis**

**4.1 Method of Analysis**

For the design of the inlet and outlet, a combination of hand calculations and the finite element method was used to analyse and design the structures. The grating support beams were designed considering the anticipated pedestrian live loads to be encountered on top of the control structures (equipment to be lifted in by boom truck and will not sit on grating). The inlet and outlet safety grating systems were designed to withstand stream pressures developed against a 25% blocked grate (by area) following from consultation with WEMG.

**4.2 Calculation of Structural Stiffness**

Structural stiffness was calculated according to CAN/CSA-S6-06.

**4.3 Earth Pressure Coefficients**

An analysis was conducted using an angle of internal friction of 30° (At rest earth pressure coefficient,  $K_0 = 0.5$ ) assuming granular fill around the structures according to Geotechnical Report 285380-04-119-0009.

## **5 Ground Design Considerations**

### **5.1 Ground Conditions**

Refer to Geotechnical Design Report 285380-04-119-0009.

### **5.2 Geotechnical Design Parameters**

Refer to Geotechnical Design Report 285380-04-119-0009.

### **5.3 Differential Settlement**

Refer to Geotechnical Design Report 285380-04-119-0009.

### **5.4 Anticipated Ground Movements or Settlement**

Refer to Geotechnical Design Report 285380-04-119-0009.

### **5.5 Groundwater Conditions and Mitigative Measures**

Refer to Geotechnical Design Report 285380-04-119-0009.

### **5.6 Variance from Geotechnical Memo Recommendations**

None.

## **6 Construction Considerations**

Details of excavation, temporary cut slopes, backfilling, and pipe bedding is to be determined in accordance with the recommendations of the Geotechnical Design Report 285380-04-119-0009.



## 7 Drawings and Documents

### 7.1 List of Drawings (included in this submission)

Drawing No.	Sheet No.	Revision	Drawing Title
285380-03-060-SEG1-4200	S4200	0	COVER SHEET and SITE PLAN
285380-03-060-SEG1-4201	S4201	0	GENERAL ARRANGEMENT
285380-03-060-SEG1-4202	S4202	0	GENERAL NOTES
285380-04-090-SEG1-4203	S4203	0	BOREHOLE LOCATIONS & SOIL STRATA
285380-04-091-SEG1-4204	S4204	0	SOIL STRATIGRAPHY
285380-03-061-SEG1-4205	S4205	0	SUBMERGED CULVERTS PLAN AND PROFILE
285380-03-061-SEG1-4206	S4206	0	INLET PLAN AND ELEVATIONS
285380-03-061-SEG1-4226	S4207	0	INLET STRUCTURE WALL REINFORCEMENT I
285380-03-061-SEG1-4227	S4208	0	INLET STRUCTURE WALL REINFORCEMENT II
285380-03-061-SEG1-4228	S4209	0	INLET STRUCTURE SLAB REINFORCEMENT
285380-03-061-SEG1-4229	S4210	0	INLET STRUCTURE MISC REINFORCEMENT
285380-03-061-SEG1-4230	S4211	0	INLET STRUCTURE HEADER BEAM
285380-03-061-SEG1-4209	S4212	0	OUTLET PLAN AND ELEVATIONS
285380-03-061-SEG1-4231	S4213	0	OUTLET STRUCTURE WALL REINFORCEMENT I
285380-03-061-SEG1-4232	S4214	0	OUTLET STRUCTURE WALL REINFORCEMENT II
285380-03-061-SEG1-4233	S4215	0	OUTLET STRUCTURE SLAB REINFORCEMENT
285380-03-061-SEG1-4234	S4216	0	OUTLET STRUCTURE MISC REINFORCEMENT
285380-03-061-SEG1-4235	S4217	0	OUTLET STRUCTURE HEADER BEAM
285380-03-061-SEG1-4215	S4218	0	RETAINING WALL WCRW1
285380-03-061-SEG1-4216	S4219	0	RETAINING WALL WCRW2
285380-03-061-SEG1-4217	S4220	0	RETAINING WALL WCRW3
285380-03-061-SEG1-4218	S4221	0	RETAINING WALL WCRW4
285380-03-065-SEG1-4219	S4222	0	INLET ROOF AND CHANNEL GRATING
285380-03-061-SEG1-4212	S4223	0	INLET GRATING DETAILS
285380-03-065-SEG1-4220	S4224	0	OUTLET ROOF AND CHANNEL GRATING
285380-03-061-SEG1-4213	S4225	0	OUTLET GRATING DETAILS
285380-04-094-SEG1-4223	S4226	0	CULVERT EXCAVATION AND BACKFILL DETAILS
285380-04-094-SEG1-4214	S4227	0	CONSTRUCTION NOTES – BACKFILL AT STRUCTURES
285380-03-065-SEG1-4224	S4228	0	STANDARD DETAILS
285380-03-065-SEG1-4225	S4229	0	MISCELLANEOUS DETAILS

**7.2 List of Documents (included in this submission)**

<b>Document No.</b>	<b>Revision</b>	<b>Description</b>
285380-04-119-0009	0	Geotechnical Investigation and Design Report Submerged Culvert S-2 (Cahill Drain, Sta. 11+175 LaSalle) Geocres No. 40J3-18

**7.3 List of Reference Drawings and Documents (not included in this submission)**

<b>Document No.</b>	<b>Revision</b>	<b>Description</b>
285380-70-119-0004	Latest Issue	Wolfe, Cahill and Talbot Drains Stormwater Management Report

## **8 Checking and Review**

**8.1 Independent Check**

Independent check is not required as per Project Agreement - Schedule 15-2, Part 2, Article 3 3.2 (c) (i).

**8.2 Responsible Design Personnel**

Originator: Chris Dyck

Checker: Jan Fojt

Reviewer: Biljana Rajlic



**The above TAF is submitted for review**

Signed: Biljana Rajlic

Design Manager

Name: Biljana Rajlic

Engineering Qualifications: P.Eng.

Date: August 10, 2012

Professional Registration Number: 100041385

Affix Professional Seal:



Signed: Ivan Lasa

Project Co Representative

Name: Ivan Lasa

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