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Issued by: Chris Dyck  
Name  
  
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July 20, 2012  
Date

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## **1 Phase Description**

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

This submission includes the structures comprising the Lennon Submerged Culvert Structure S1.

### **1.2 Permitted Traffic Speed**

Posted speed for traffic on Highway 401 above the Lennon Submerged Culvert is 90km/h. Posted speed for traffic on the elevated section of Hwy 3 (SR2) above the culvert is 60km/h.

## **2 Proposed Structures**

### **2.1 Description of Structures**

The Lennon 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-1, refer to the Lennon Drain Stormwater Management Report 285380-70-119-0005.

### **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**

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

Minimum compressive strength at 28 days: 30 MPa

### 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: 2400mm Dia. (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 (285380-04-119-0019)

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 285380-04-119-0019.

## 5 Ground Design Considerations

### 5.1 Ground Conditions

Refer to Geotechnical Design Report 285380-04-119-0019.

### 5.2 Geotechnical Design Parameters

Refer to Geotechnical Design Report 285380-04-119-0019.

**5.3 Differential Settlement**

Refer to Geotechnical Design Report 285380-04-119-0019.

**5.4 Anticipated Ground Movements or Settlement**

Refer to Geotechnical Design Report 285380-04-119-0019.

**5.5 Groundwater Conditions and Mitigative Measures**

Refer to Geotechnical Design Report 285380-04-119-0019.

**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 285380-04-119-0019.

## 7 Drawings and Documents

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

Drawing No.	Sheet No.	Revision	Drawing Title
285380-03-060-SEG1-4100	S4100	0	COVER SHEET and SITE PLAN
285380-03-060-SEG1-4101	S4101	0	GENERAL ARRANGEMENT
285380-03-060-SEG1-4115	S4102	0	GENERAL NOTES
285380-04-090-SEG1-4102	S4103	0	BOREHOLE LOCATIONS & SOIL STRATA
285380-04-091-SEG1-4103	S4104	0	SOIL STRATIGRAPHY
285380-03-061-SEG1-4104	S4105	0	SUBMERGED CULVERTS PLAN AND PROFILE
285380-03-061-SEG1-4105	S4106	0	INLET STRUCTURE
285380-03-061-SEG1-4124	S4107	0	INLET STRUCTURE WALL REINFORCEMENT I
285380-03-061-SEG1-4125	S4108	0	INLET STRUCTURE WALL REINFORCEMENT II
285380-03-061-SEG1-4126	S4109	0	INLET STRUCTURE SLAB REINFORCEMENT
285380-03-061-SEG1-4127	S4110	0	INLET STRUCTURE MISC REINFORCEMENT
285380-03-061-SEG1-4128	S4111	0	INLET STRUCTURE HEADER BEAM
285380-03-061-SEG1-4108	S4112	0	OUTLET STRUCTURE
285380-03-061-SEG1-4129	S4113	0	OUTLET STRUCTURE WALL REINFORCEMENT I
285380-03-061-SEG1-4130	S4114	0	OUTLET STRUCTURE WALL REINFORCEMENT II
285380-03-061-SEG1-4131	S4115	0	OUTLET STRUCTURE SLAB REINFORCEMENT
285380-03-061-SEG1-4132	S4116	0	OUTLET STRUCTURE MISC REINFORCEMENT
285380-03-061-SEG1-4133	S4117	0	OUTLET STRUCTURE HEADER BEAM
285380-03-065-SEG1-4116	S4118	0	RETAINING WALL LRW1
285380-03-065-SEG1-4117	S4119	0	RETAINING WALL LRW2
285380-03-065-SEG1-4118	S4120	0	INLET ROOF AND CHANNEL GRATING
285380-03-065-SEG1-4111	S4121	0	INLET GRATING DETAILS
285380-03-065-SEG1-4119	S4122	0	OUTLET ROOF AND CHANNEL GRATING
285380-03-065-SEG1-4112	S4123	0	OUTLET GRATING DETAILS
285380-04-094-SEG1-4113	S4124	0	CULVERT EXCAVATION AND BACKFILL DETAILS
285380-04-094-SEG1-4114	S4125	0	CONSTRUCTION NOTES – BACKFILL AT STRUCTURES
285380-03-065-SEG1-4122	S4126	0	STANDARD DETAILS
285380-03-065-SEG1-4123	S4127	0	MISCELLANEOUS DETAILS



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

Document No.	Revision	Description
285380-04-119-0019	0	Geotechnical Investigation and IFC Design Report Submerged Culvert S-1 (Lennon Drain, Sta. 10+425 LaSalle), July 2012.

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

Document No.	Revision	Description
285380-70-119-0005	Latest Issue	Lennon Drain 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, P.Eng.

Checker: Jan Fojt, Ph.D.

Reviewer: Biljana Rajlic, P.Eng.



**The above TAF is submitted for review**

Signed: Biljana Rajlic  
Design Manager

Name: Biljana Rajlic

Engineering Qualifications: P.Eng.

Date: July 20, 2012

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Affix Professional Seal:



Signed: R. Noorbakhsh

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