Watercourse Crossing Restoration Using a Modular Open Bottom Culvert System

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Earthmaster Environmental Strategies Inc.





A Canadian environmental technologies company:

- Based in Calgary, Alberta.
- Founded in 1998.
- Specializes in providing all types of environmental services to the commercial/industrial and upstream oil and gas industry in Western Canada.
- Team of environmental consultants consisting of professional agrologists, biologists, chemists, ecologists, engineers, geoscientists, soil scientists, plant scientists, aquatic specialists, and foresters.
- Also co-developed commercial phytoremediation systems to treat contaminated soil in an eco-friendly and responsible manner.







Goals for replacement:

- Restore fish passage
- Emulate natural stream flow
- Create natural streambed
- Increase the diameter of the culvert
- Construct a natural stream bed in the culvert

Solution:

Arched open bottom modular culvert system

Source:

- Enviro-Span modular resin culverts
- Atlantic Industries has a corrugated steel version







Resin vs. Steel

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Feature	Resin	Steel	
Weight	light weight – can move and lift by hand	requires equipment to move and lift	
Cost of installation	n minimal equipment required	compaction equipment required	
Resistance to corros	ion yes	~30 years	
Leaching	no	yes	
Strength	good	good	
Integrity	resistant to cracking and breaking	can crack, distort, and collapse	
Damage from UV radiation	yes	no	
Abrasion	resistant to abrasion by sand and rock in flowing water	prone to breakdown of coatings due to abrasion by sand and rock	

Modular vs. Single Units

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Characteristic	Modular	Traditional Culvert
Ease of installation	short pieces	long lengths
Follow curve of streambed	yes no	
Follow elevation changes of stream bed	yes straight line	
Longitudinal bending stress on culvert	no	yes
Slope of installation	unlimited	<3.5%
Speed of installation	fast	slow
Rip rap	place as culvert is assembled	difficult to get inside

Site Location



Walton Creek:

- Located 21 km west of Sundre
- Tributary to Smith and Bearberry Creeks
- Small permanent and fluvial
- Average bankfull width of 2.9 m







Inlet End:

- Ripping and cutting of the structure was observed.
- Minor erosion was present.

Outlet end:

- Erosion of road subgrade was present.
- End was perched 0.54 m.
- Scour pool measuring 1.18 m in depth was present.

Overall:

- Culvert was 1.2 m x 17 m corrugated steel pipe.
- Culvert was partially collapsed most likely due to poor installation practices.
- Culvert was not embedded.
- No substrate was observed inside culvert.
- Horizontal gradient of culvert was more than 7% causing increased water velocity.







Inlet End – October 2016

Inlet End – October 2016-

Outlet End – October 2016

Outlet End – October 2016

Fish Review



AEP Fish & Wildlife Internet Mapping Tool indicated the presence of:

- brook stickleback
- lake chub
- Iongnose dace
- white sucker
- stocked inventory of brown trout

Restricted Activity Period

- September 1 to April 30
- Designated times of the year where instream work should be avoided to prevent impacts to fish during sensitive life stages such as migration, spawning, egg incubation and fry emergence.



Culvert installation requirements:

- Maintain stream flow
- Facilitate natural stream alignment
- Minimize instream work
- Minimize stream turbidity
- Minimize road closure
- Increase the diameter of the replacement culvert
- Remove the steel culvert
- Complete work outside
 of the RAP





Proposed Culvert Replacement





Soil Handling:

- 1,200 m³ of mineral and aggregate removed
- Stockpiled on the west and east side of the crossing

Water Management:

• Work area isolated from watercourse with steel plate dams

Water Monitoring:

- Water turbidity monitored at 12 locations
 - Pre-, during, and post-construction
 - Tested at least twice a day
 - Minor precipitation occurred during the project





Remove Road and Subgrade

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Isolate Work Space

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Finalize Excavation Size

Excavate New Stream Bed



Recommended Footings:

- Best footings are flexible and allow for movement in the structure
- Locally sourced log are acceptable
- Pressure treated poles

Other Options:

- Concrete grade beam
- Pre-cast half cylinder grade beam
- Concrete filled steel pipe

Project regulation:

• May require concrete/steel footings







Step 2 – Footings

Lay Out the Footings

6

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DEERE



Lay Out the Footings

Lay Out the Footings

Structure:

- Size of modules 1070 mm x 2150 mm
- Weight 64 kg / 141 lbs per module
- Number 17 modules to construct a length of 18.2 m

Placement:

- Sling into excavation and maneuver by hand
- Slide connectors on top of flanges
- Cover with geotextile
- Install rip rap





Place Modules on the Footings

Place Modules on the Footin



Link Modules DEERE

Link Modules

Link Modules

June 201

Cover with Geotextile



Backfill:

- Compacted backfill in 15 cm lifts
- >1 m fill was required on finished product

Purge:

- Purged the new stream bed to remove sediment
- Catch purge water and pump away from creek
- Decrease water turbidity



Usually hoe tamp soil





Backfilling

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Backfilling

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Purge Streambed

Purge Streambed

Culvert Implementation



When Removing the Culvert:

- Safety is paramount
- If possible separate into smaller sections for removal
- Debris and sediment will be inside, so keep it out of the creek





Culvert Removal

Culvert Removal

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Backfilling

Backfilling

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Step 6 - Reclamation

Details:

- Maintain 2:1 slope of road shoulders
- Place topsoil
- Use class 1M rip rap on ends
- Native seeding of disturbed soils
- Final water monitoring event





Reclamation and Road Completion



Reclamation and Road Completion





Reclamation

Streambed



Follow-up Visits



Field Inspections:

- Completed annually
- Use GoA inspection form
- Other crossing details:
 - Road running surface condition
 - Abutment condition
 - Vegetation recovery
 - Bankfull width up & down stream
 - Riffle crest
 - Condition of pipeline crossing

	Field Inspect	ion Form	
Alberta = Government	24	Environment an	
	Waterc	ourse Crossing Inspection Form	
Road	iway Watercou	urse Crossing Inspection Manua	
Vater Crossing Name of ID (ex. #spray ulvert)	painted on or around		
vatercourse Name:		Disposition No.	
SPS Co-ordinates (UTM):	casting:	Northing:	
Stream Classification: D Ephemera	I D Non-Fluvial (in non-fluvial, omit shaded section)	
C Fluvial & either: C Intermittent	or D Permanent	- Small, or D Permanent - Large	
Ranktull width:m (□ measured	i or 🗆 estin	nated to nearest metroj	
Crossing Type: 🛛 Bridge - Perm	anent 🗆 Bridg	e – Temporary 🛛 Culvert - Single	
D Culvert - Multi	ert - Muitiple D Culvert - Open Bottom		
C Fill - Log	Fill - Log D Ford D Suspended D Recisimed		
Erosion at site? 🗆 Yes 🗆 Pote	ntiar Li No	innet i outret i sotn	
If Yes or Potential, identify source (che Ditch Cully Bank Slump Other	ck all that apply): D Fill Slope	Road Surface Bridge Deck	
Extent: C Low C Mg	unalistaciony	Total Erosion Area (m°)	
ulvert(s) dlameter:m	_m	mm (primary)	
Greater than 10 % of diameter blocked	Dy Georea D Yes	No (note cause in commenta)	
Substrate in the culvert? Yes		wn	
if yes, what type?	avel Cobble C	Boulder D Other:	
For what length of culvert? 25% of	riese 1 50% 1	75% 0 100%	
Curver slope: Li Lever and Uniform	L slope > or vertic	ary Bont	
Dutlet Gap:m (for lowest, if more	than one culvert)	Embedded	
Pool Depth:m = Score:	Scour pool ap	parent? 🗆 Yea 🔲 No	
ish Passage Assessment (use 10.1: Fi	sh Passage Evaluation	Criteria for Culvert Stream Crossings)	
I No Concerna I Some Concern		Sec. (Sec.)	
inspector's Name.		Inspection Date:	
omments: (if photostaken of inlet	and outlet, please r	eoord image numbers)	



Follow-up

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Follow-up



Conclusions



Modular culvert system is:

- Suitable for:
 - Crossings with elevation change
 - Replacement of hanging culverts
 - Permanent and temporary installations
 - Fish or non-fish bearing watercourses
 - Where deep excavation is not an option
- Unsuitable for:
 - Watercourses requiring >2150 mm crossing
 - Low profile roads





Questions?





