Stream Crossing Inventory and Assessment in the Shediac Bay Watershed

Prepared for:

New Brunswick Wildlife Trust Fund

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Cover picture: Culvert Assessment on the Shediac River, NB, July 2007.

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1 INTRODUCTION

1.1 Organisation

The Shediac Bay Watershed Association (SBWA) is a non-profit organization located in Shediac, New Brunswick. The SBWA was established in 1999 by a group of concerned residents and is now incorporated and a registered charity organisation. A Board of Directors, representing the various communities found within the 400 km^2 watershed boundaries, oversees its activities. The Association deals with issues related to water quality and habitat integrity.

The SBWA has a goal of ensuring ecosystem health through remediation, restoration projects, public education and community stewardship. Our vision is for a community working together to foster a healthy ecosystem that will sustain the quality of water for future generations. The SBWA has been involved in numerous projects and initiatives over the past seven years including water quality monitoring, habitat restoration, and awareness programs.

1.2 PROJECT INFORMATION

Migration barriers at stream crossings have been identified as a fish conservation concern in many areas of North America (McCleary et al., 2004). Stream crossings occur wherever roads or railways intersect streams. The installation of culverts is the most common method to provide access over small and medium sized streams. These road crossings can become barriers for fish migration, create habitat fragmentation and alter stream and riparian habitat integrity (Department of Fisheries and Oceans, 2006). Ensuring river systems and landscapes connectivity, as well as habitat integrity is a critical component for maintaining healthy fish populations (Parker, 2000).

Over the long-term, fish habitat fragmentation has the potential to reduce the productivity and distribution of various species. Many of the crossings occur on small streams that are not necessarily used for commercial or sport fishing purposes, but these watercourses may contribute to downstream productivity by providing juvenile rearing or other important habitats. These obstacles can prevent migratory and resident fishes from reaching their spawning habitats as well as reduce food availability and there ability to escape predators. Fish migrate to different locations in a watershed in order to meet a variety of needs as they develop (Whyte et al. 1997). It is the cumulative fragmentation effect that can create fish and wildlife segregation and significantly reduce their ability to reproduce and feed (Taylor, 2000). The ideal crossing allows passage to all aquatic and terrestrial species that use the stream or riparian zone habitats.

Hundreds or even thousands of culverts can be found in a watershed. The following culvert conditions are the most common issues contributing to habitat degradation: 1) Excess drop at the culvert outlet; 2) High velocity within the culvert; 3) Inadequate water depth within the culvert; 4) Turbulence within the culvert and 5) Debris and sediment accumulation in the culvert or at the culvert inlet (Washington State Department of Fish and Wildlife, 2003). A single barrier culvert can block access to kilometres of habitat (Washington Trout, 2004). Consequently, the restoration of fish passage at these impasses appears to be an efficient way to improve the overall stream productivity and habitat integrity.

An electro-fishing survey performed in 2005 revealed that Atlantic salmon parrs (*Salmo salar*) and other salmonids such as the brook trout (*Salvelinus fontinalis*) were present in both main river systems within the Shediac Bay watershed. According to local anglers, various fish species densities drastically decreased over the last two decades in Shediac and Scoudouc rivers. Over 200 public and private roads crossing over streams were identified in the watershed, among which an unknown number could contribute to habitat fragmentation and degradation. In addition, a general lack of information regarding culvert and surrounding habitat conditions in the Shediac Bay watershed warrants an investigation.

In order to identify potential fish passage barriers, a fish passage assessment at road crossings was performed within the Shediac Bay watershed in 2007. The project consisted in conducting overview assessments of habitat integrity, bank stability, and fish passage at all crossings within the watershed. This survey allowed for the identification of culverts that are either contributing to erosion and stream siltation or are barriers to passage of fish and other aquatic life.

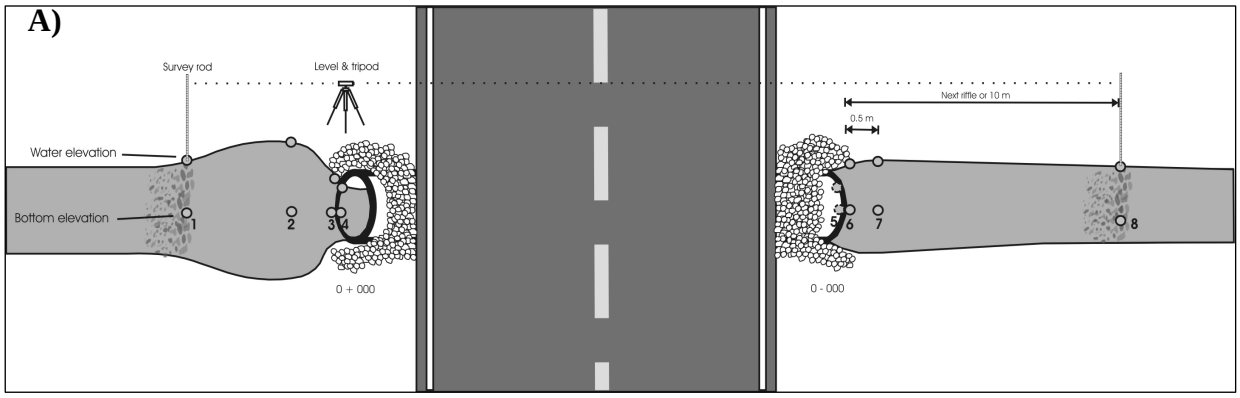
2 MATERIAL AND METHODS

2.1 Sampling Protocol

2.1.1 Culvert Assessment

The fish passage assessment took place from July to September, 2007, within the Shediac Bay watershed. The method used to perform the fish passage assessment was based on a protocol developed by the Department of Fisheries and Oceans (DFO) (Godin, 2007). Field training and quality control evaluations were conducted by the DFO. Watershed's culverts mapping was performed by the DFO using geographic information provided by the New Brunswick Department of Transportation (NBDOT). During crossing assessment, road safety measures were followed according to the NBDOT guidelines.

The survey was performed in a manner to prioritise culverts situated on major tributaries starting downstream of each river system. This allowed for the identification of fragmentation issues that are affecting fish passage from the estuarine level. Various culvert shape and elevation measurements were recorded using surveying equipment (Sokkia Surveying Instrument C3-30). A total of eight elevation measurements were taken at the water surface and stream bottom (or culvert bottom), at both culvert ends, as well as at the pools and riffles on each culvert side (Fig. 1 a) and b)). The culvert fallout drop height was also measured from the lip of the culvert to the water surface and all other measurements were omitted when the drop exceeded 60 cm. Distance from each data location to the fixed surveying level was measured to allow for elevation comparisons. The condition of the culvert was also evaluated and other potential blockages were identified.



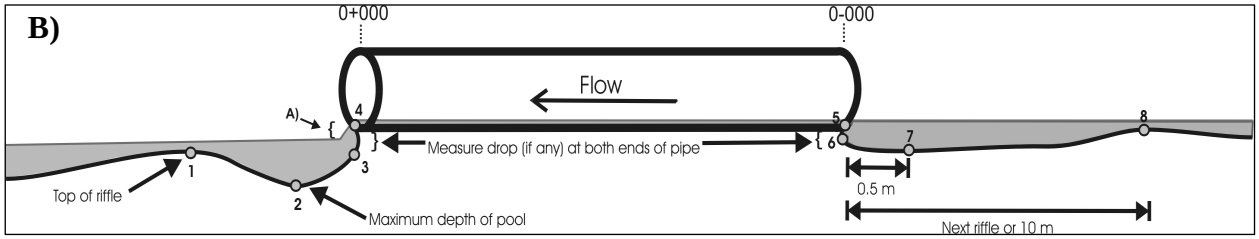


Figure 1. A) Aerial and B) lateral views of culvert assessments measurements' locations.

Information regarding stream and riparian zone condition was recorded (stream bankfull width, stream bottom type, erosion issues, fore slope type, riparian zone type and quality). Other potential barriers to fish migration, such as wood debris jams, rocks, or trash racks, were identified. In addition, a minimum of 6 pictures were required at each locations as reference material (Fig. 2).

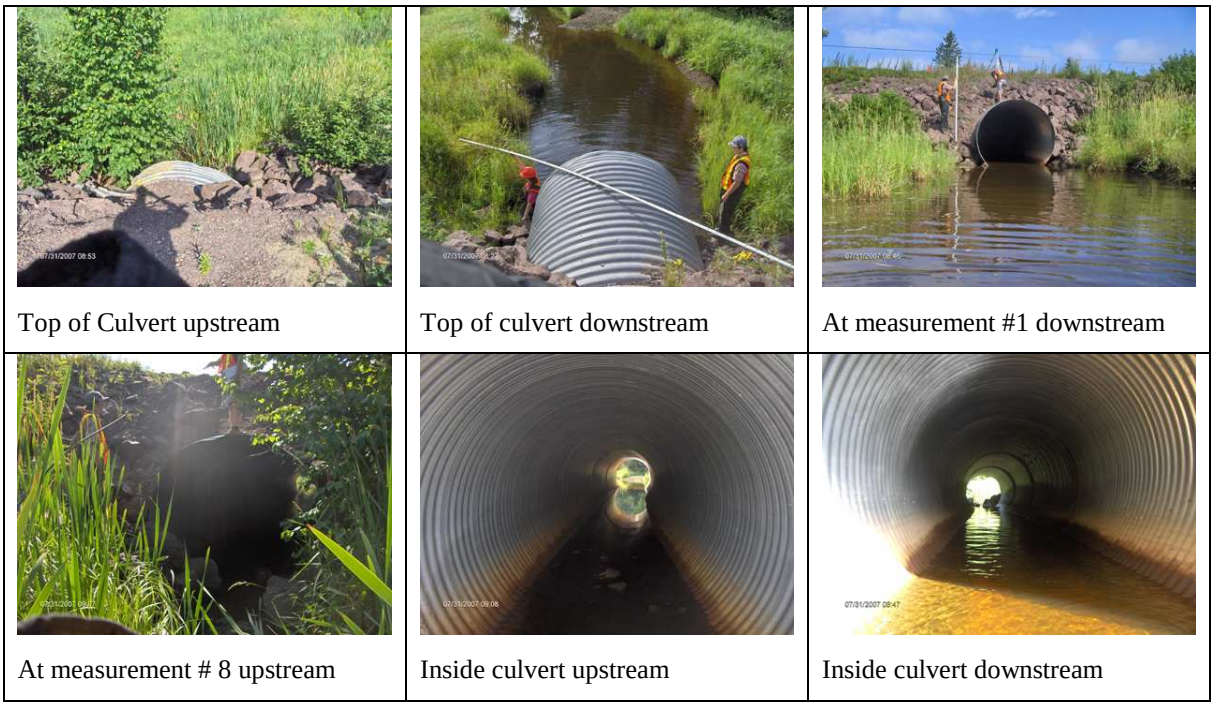


Figure 2. Example of picture views required during the culvert status evaluation process (pictures taken for the culvert # 17605).

3 RESULTS AND OBSERVATIONS

3.1 Study Site

The culvert status inventory took place in the Shediac and Scoudouc rivers, which are the main river systems in the Shediac Bay watershed. The Shediac and the Scoudouc rivers are characterized by dendritic patterns of small tributaries covering a watershed of 201.8 and 143.3 km^2, respectively (Henderson 1999). The Shediac River is composed of two major water arms. The northern water arm is created by the convergence of the McQuade Brook, the Weisner and the Calhoon Brooks. The southern large water arm of the Shediac River is the continuation of the Batemans Brook. Water velocity in both rivers is weak due to the gentle regional elevation (Henderson 1999).

3.2 Culvert Status Assessment

A total of 311 road crossings were identified within the Shediac Bay watershed. In 2007, a total of 100 crossings were visited and 76 culverts were assessed (Fig. 3). Most culverts were in good condition (35.14%) meaning that they were not heavily deformed, pierced or collapsed. However, some were heavily rusted (22.97%) or collapsed (14.86%) (Fig. 4). The majority were round (98.7%) constructed of corrugated steel pipes (70.3%) and some were tar covered (8.11%). Smaller sized culverts were occasionally made out of concrete (20.27%) and PVC (1.35%).

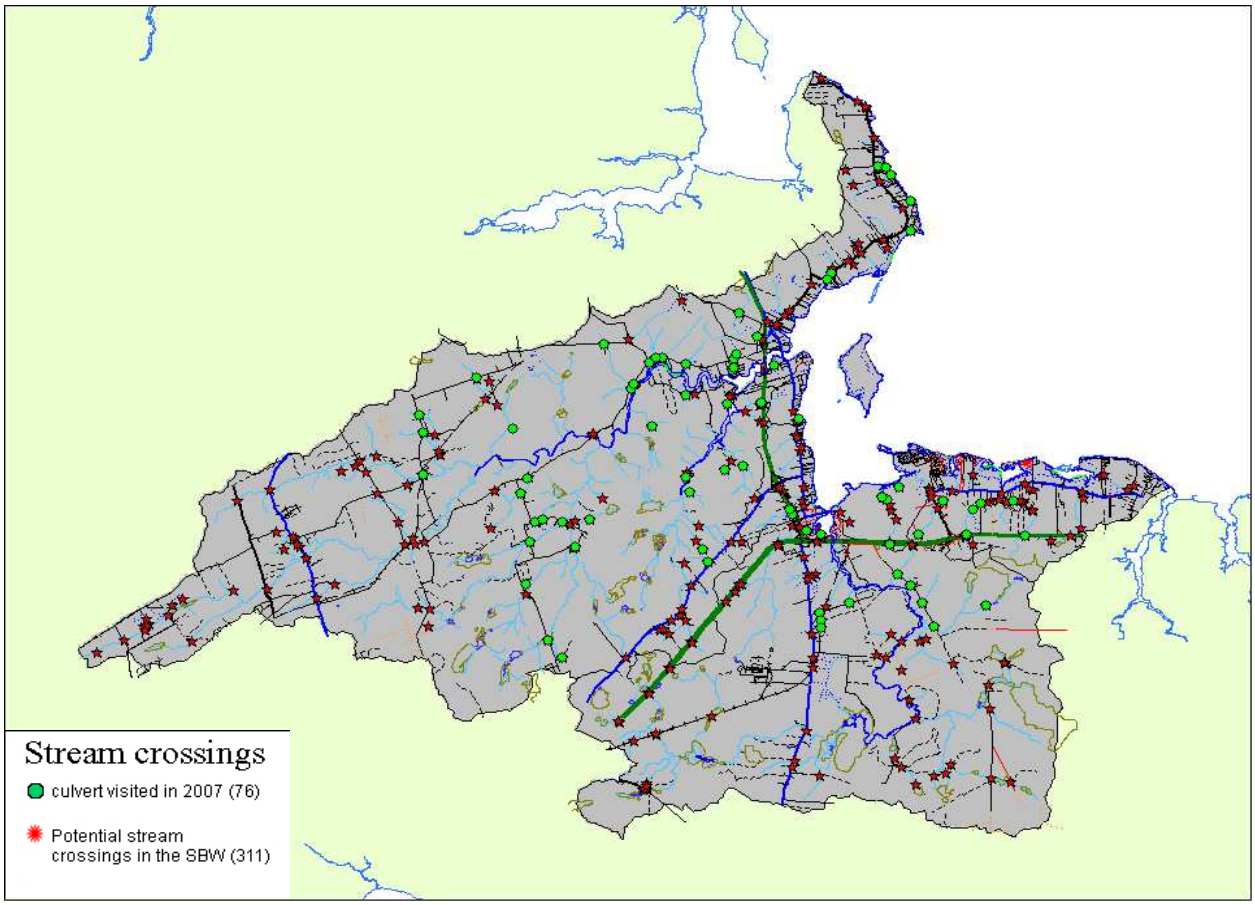


Figure 3. Scoudouc River and Shediac River stream crossings' positions (map produced by DFO).

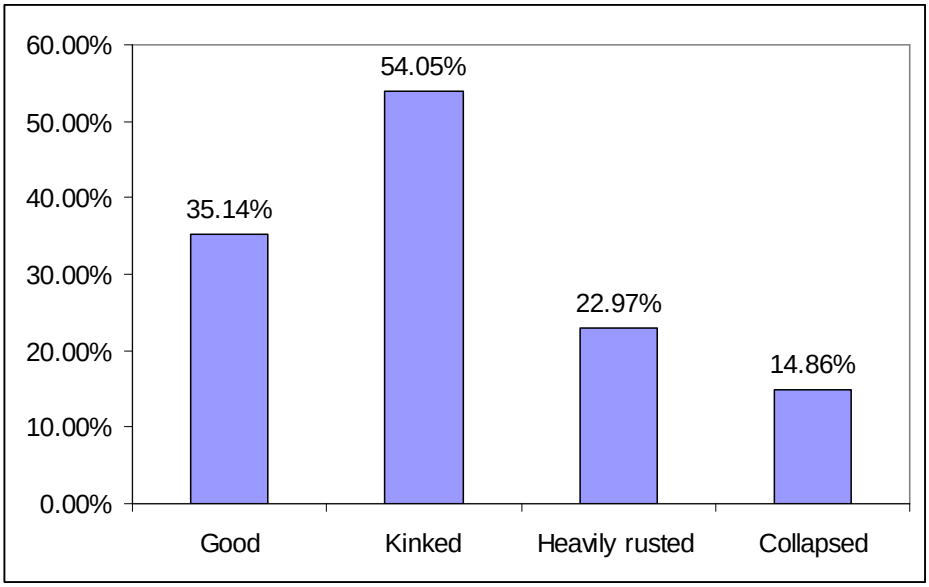


Figure 4. Scoudouc River and Shediac River stream crossings' positions (map produced by DFO).

Our study revealed that 25.6% (Fig. 5) and 30.8% (Fig. 6 A)) of culverts presented a downstream outfall drop and an upstream drop, respectively. Nine culverts showed a drop at both openings (Fig. 6 B)). Most culverts visited (64.5%) were installed at an adequate slope (<0.5%), however 26.9 % were positioned in an angle exceeding the 0.5% elevation proposed requirement (Fig. 7 A)). Other potential blockages for fish and wildlife migration were observed in 36.8% of visited culverts. Most were caused by debris accumulation (wood, silt and rocks) or du to the presence of a trash rack (Fig. 8).

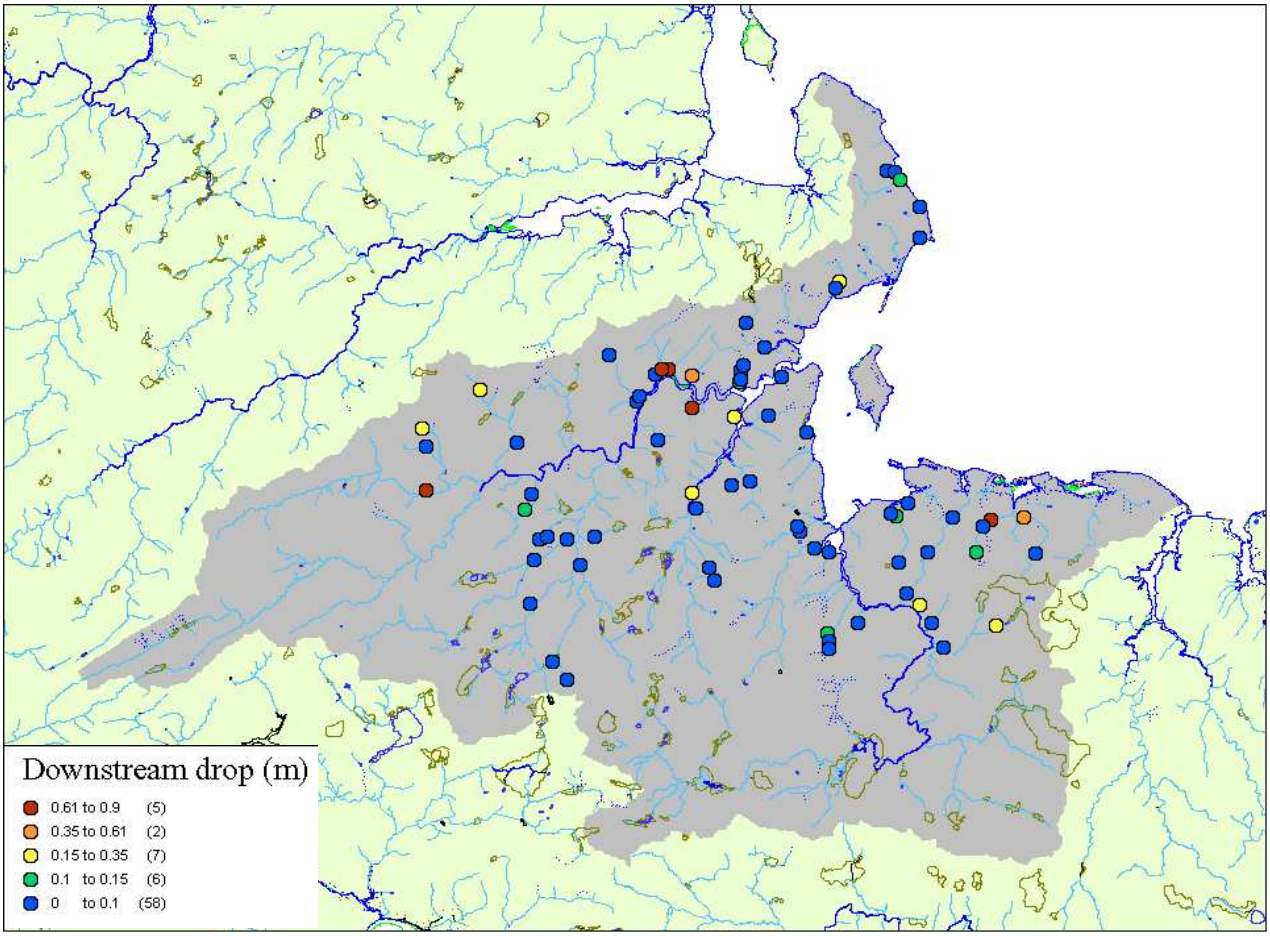


Figure 5. Culverts' classification relatives to the height (m) of the downstream drop. (Map produced by DFO).

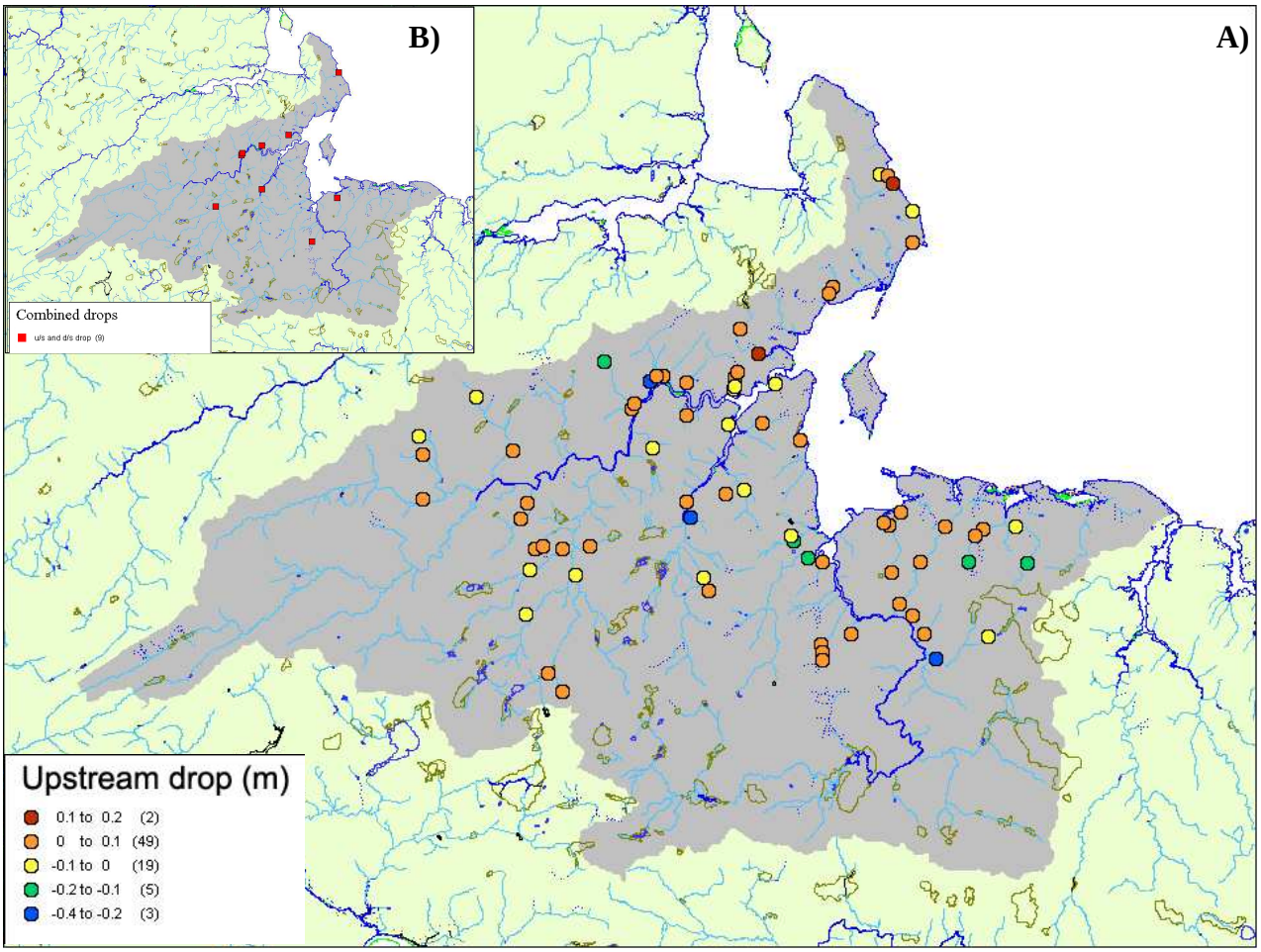


Figure 6. A) Culverts' classification relatives to the height (m) of the upstream drop. B) Culverts presenting both upstream and downstream drops. (Maps produced by DFO).

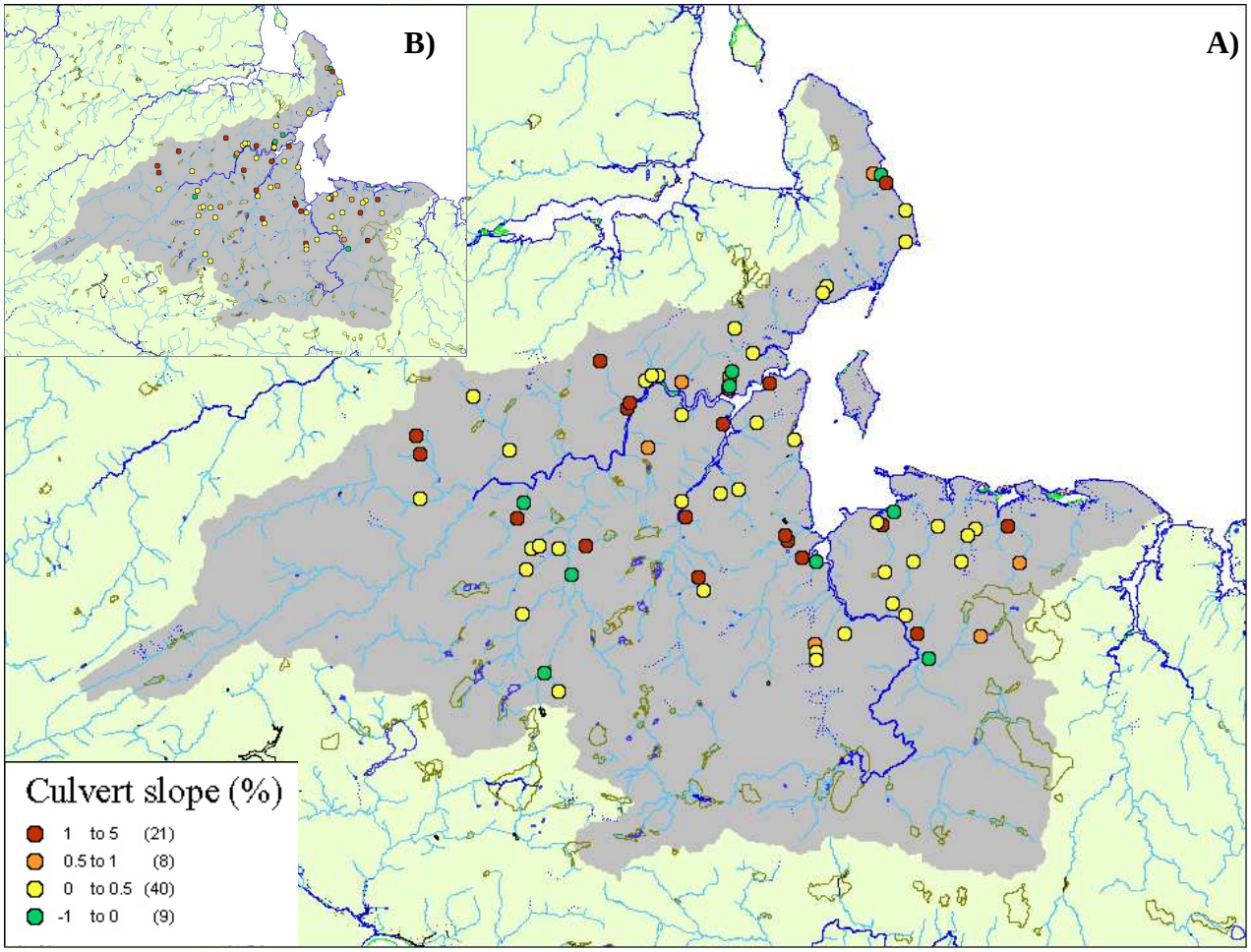


Figure 7. A) Classification relatives to the slope (%) of the culvert and B) classification relatives to the slope (%) of the stream. (map produced by DFO).

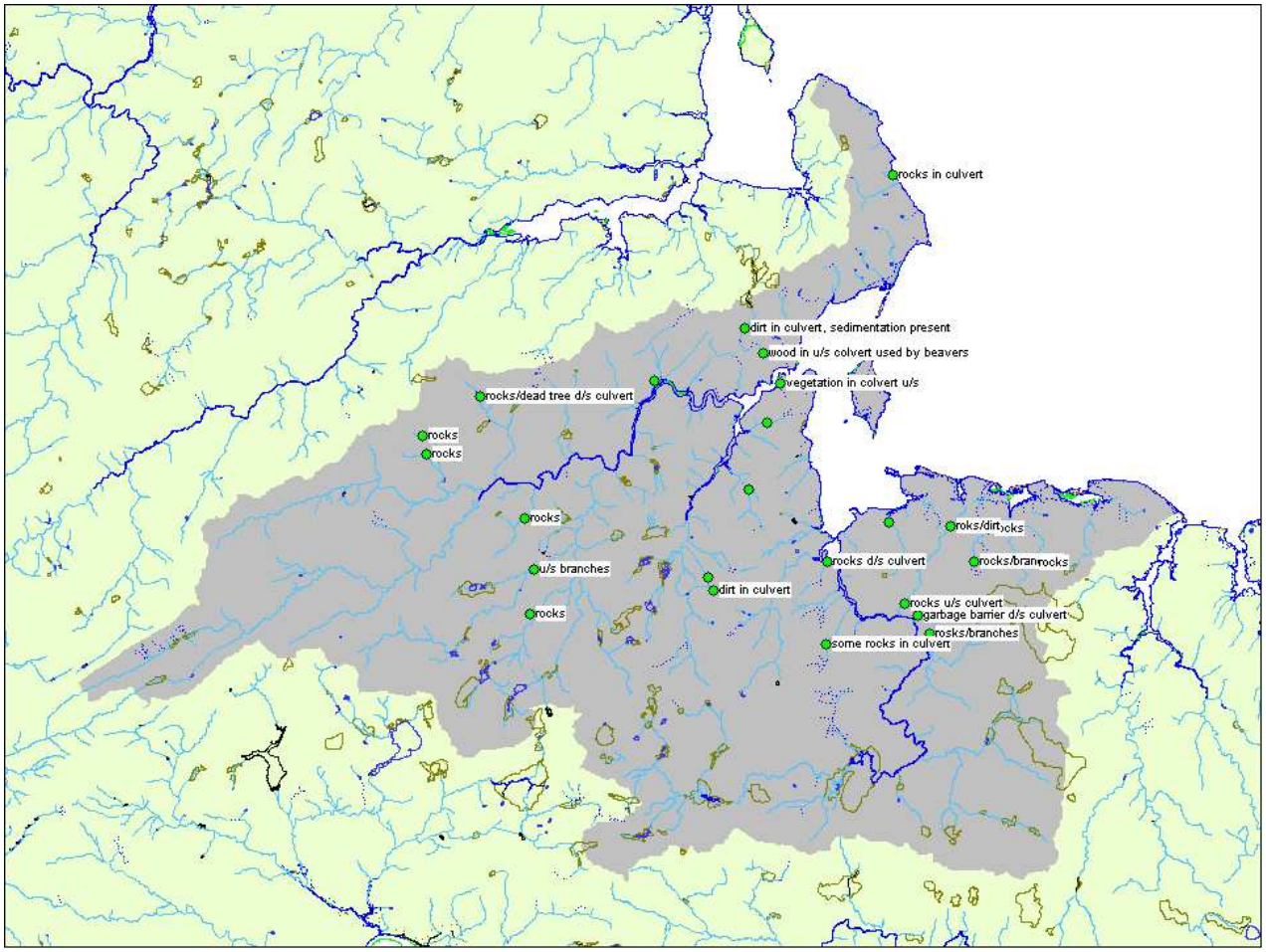


Figure 8. Other potential fish passage barriers in culverts or at culverts' openings (map produced by DFO).

4 DISCUSSION

All watercourse crossings should be designed in a way that will ensure minimal alteration to the flow and the natural stream morphology of the watercourse, and mainly preserve fish habitat and fish passage. Ideally, a culvert installation should not change the natural conditions of a stream prior to that installation. Therefore, current velocity, slope, width and depth should be maintained over time after the installation of a culvert (Baker and Votapka, 1990).

Culverts are generally constructed of corrugated steel pipe, concrete, PVC or tar covered corrugated steel pipe. The culvert material used in a project depends usually on cost, span, discharge, topography, soil chemistry and climate. Concrete and PVC pipes show greater tolerance to degradation than corrugated steel pipe that has a 30 year longevity lifespan. Main stream crossings were mostly constructed using corrugated steel pipe. Smooth culverts offer less resistance to water and create little turbulence, and are therefore more difficult for fish to pass through. Corrugated steel pipe appears to be a proper option for most stream crossings in the Shediac Bay watershed; however, some showed signs of premature degradation. A total of 26 (35.14%) culverts were considered in good condition. In few cases, culvert sections were rusted, detached, or pierced, but only 11 were collapsed and appeared to require replacement.

This survey allowed us to establish a general overview of culvert status within the SBW. This project was conducted in partnership with the DFO as part of a pilot initiative to enable the development of an assessment protocol and improve evaluation procedures. The objectives involved assessing fish habitat fragmentation and fish passage capacity to eventually be able to prioritize passage improvement projects and identify potential restoration sites.

The project consisted in conducting a general assessment of fish passage, habitat integrity, and bank stability, at all crossings within the watershed. During the project, we were able to determine the location of all culverts and the condition of main crossings within the watershed. Therefore, a general portrait of culverts' condition was established for the watershed. Data collected did not allow the DFO to specifically identify culverts causing fish fragmentation. The evaluation for fish habitat fragmentation potential is based on fish species ability to cross obstacles such as culvert outfall drop or increased water velocity. Culvert status evaluation criteria are under development and are still being reviewed by the DFO. Therefore, we are considering that all culverts not complying with the actual provincial installation guidelines could potentially be causing blockage for fish passage.

Provincial culvert installation guidelines, among other criteria, state that there should not be any outfall drop and that culvert must be buried at least 15 cm in the stream bed. In addition, it has been established that a culvert slope greater than 0.5% requires the installation of fish passage structures (Province of New Brunswick, 1989). Consequently, the survey revealed that 20 culverts (25.64%) are presenting an outfall drop and could potentially cause fish habitat fragmentation. A total of 29 culverts were installed at a slope greater than 0.5% and all culverts with an outfall drop were installed at an inadequate slope.

Other potential blockages were observed in or at a culvert opening during the survey. Most blockages were caused by an accumulation of wood debris, silt and rocks. However, trash racks, formerly used to prevent wildlife from entering culverts, were observed only at one location. SBWA's employees did not clear blockages during the survey, but critical wood debris and garbage blockages will be removed in 2008. Dykes and inadequate landscaping approaches were also observed as indirect potential blockages.

5 CONCLUSION

A large proportion of culverts were visited in 2007 and a general status portrait was established during the process. Additional culvert evaluations will be required to complete the assessment in future years. Pursuing this initiative in the watershed will allow the finalisation and enhancement of the culvert assessment protocol developed by the DFO. The protocol used will be simplified in order to target necessary data for the establishment of an objective statement and to allow community groups to perform the work with limited resource and time.

The objective of this assessment was to identify culverts causing fish habitat fragmentation in order to concretely rectify problematic structures. The assessment will be pursued in following years and information regarding culvert status will be provided to the NB Department of Transportation. Discussions will be entertained to obtain confirmation of repair for culverts causing fish fragmentation.

6 CLOSING STATEMENT

The Shediac Bay Watershed Association is confident that the Stream Crossing Inventory and Assessment project in the Shediac Bay watershed was completed successfully. It is clear that this project allowed us to better understand the fish habitat fragmentation situation in the SBWA as well as creating an assessment tool that can be used by other organisations.

We appreciate the honour of working with the New Brunswick Wildlife Trust Fund and thank you for your consideration.

Respectfully submitted by the Shediac Bay Watershed Association,

Dominique Audet
SBWA, Project Coordinator

7 LITERATURE CITED

Baker, Calvin O. and Votapka, Frank E. *Fish Passage Through Culverts*. US Department of Agriculture–Forest Service Technology and Development Center, prepared for US Department of Transportation Federal Highway Administration. Report No. FHWA-FL-90-006. 1990.

Fisheries and Oceans Canada. 2006. Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach. Fisheries and Oceans Canada. Gulf Region. ISBN: 0662-42818-8.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, B. Collins, R. Taylor, and M. Love. 2003. California salmonid stream habitat restoration manual. California Department of Fish and Game. Part IX: Fish Passage Evaluation at Stream Crossings. Sacramento, CA. **http://www.dfg.ca.gov/nafwb/pubs/2003/FishPassage.pdf**

Godin, C. 2007. Protocol for assessing culverts in a watershed – Draft document. Department of Fisheries and Oceans Canada. Moncton, NB.

Henderson, G. 1999. Analysis of factors that influence water quality in Shediac Bay, NB, Henderson Environmental Consulting Ltd.

McCleary, R., S. Wilson, C. Spytz. 2004. A stream crossings remediation planning process and example application in the Foothills Model Forest, Alberta. In Proceedings from the 2003 Access Management Conference. Edited by H. Epp. Alberta Society of Professional Biologists.

Parker, M.A. 2000. Fish Passage – Culvert Inspection Procedures [Electronic Source]. Watershed Restoration Technical Circular no. 11.

Province of New Brunswick, 1989. New Brunswick water alteration guidelines, Section 8. Department of the Environment and Local Government, Regional Service Branch, Fredericton, NB. Pp. 83-95.

Taylor, R. N. 2000. Culvert inventory and fish passage evaluation of the Humboldt County road system. Final report for CA. Dept. Fish and Game, Fortuna, CA. 37 p and appendices.

Washington State Department of Fish and Wildlife. 2003. Design of Road Culverts for Fish Passage.

Washington State Department of Fish and Wildlife Habitat Program Environmental Restoration Division. 2000. Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual.

Washington Trout. 2004. Island County Restoration Planning – Fish Passage. Retrieved October 4th, 2006 from **http://www.washingtontrout.org/islandco/fishpassage.html**

Whyte, I.W., S. Babakaiff, M.A. Adams, and P.A. Giroux. 1997. Restoring fish access and rehabilitation of spawning sites. Chapter 5 in Watershed Restoration Technical Circular No. 9. Ministry of Environment, Lands and Parks, Vancouver, British Columbia.

8 APPENDIX A : CULVERT ASSESSMENT – FIELD SHEET TEMPLATE

Culvert Field Survey Sheet 2007

Baseline Information

Crossing ID#: NB Services Culvert #:	Crew member(s):	Date (dd/mm/yyyy):	Time (24hr): Start: _____ End: _____
Latitude: (degrees, min., sec.)	Longitude: (degrees, min., sec.)	Watercourse Name:	Property Owner:

Culvert Information

Culvert Type:
- ☐ box
- ☐ arch
- ☐ round
- ☐ egg shaped
- ☐ other:
- ☐ double or more
- ☐ * open bottom
- ☐ * bridge

* If open bottom or bridge, do not fill out Sections A) to D).

Culvert Material: (check all that apply)
- ☐ corrugated steel/aluminium pipe (csp)
- ☐ concrete
- ☐ PVC
- ☐ wood
- ☐ tar covered csp
- ☐ csp re-lined with concrete
- ☐ other _____

Culvert condition: (check all that apply)
- ☐ good
- ☐ kinked
- ☐ pierced
- ☐ collapsed
- ☐ undermined
- ☐ other _____

Fore slope :
- ☐ rocks
- ☐ wood
- ☐ concrete
- ☐ gravel
- ☐ gabion
- ☐ other _____

Road Use:
☐ All-Terrain Vehicles ☐ Municipal ☐ Agriculture
☐ Forestry ☐ Cottage ☐ Other:

Road Type:
☐ Paved ☐ Gravel/Dirt ☐ Rail road

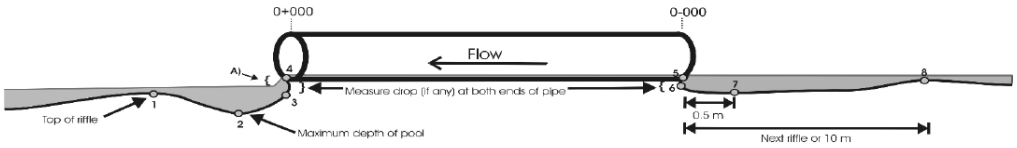
Measurements

A) Drop

Vertical distance between downstream end of pipe and surface of the water below.

____ m Note: 1 - If drop is > 0.6 m (2'), then do not fill out sections B) and D).

(Measurements must all be taken from same benchmark or based on same benchmark)



B) Longitudinal Profile

Bottom elevation #1 _____ m	Water elevation _____ m	Distance from culvert 0+___ m
Bottom elevation #2 _____ m	Water elevation _____ m	Distance from culvert 0+___ m
Bottom elevation #3 _____ m	Water elevation _____ m	Distance from culvert 0+000 m
Bottom elevation #4 _____ m	Water elevation _____ m	Distance from culvert 0+000 m
Bottom elevation #5 _____ m	Water elevation _____ m	Distance from culvert 0-000 m
Bottom elevation #6 _____ m	Water elevation _____ m	Distance from culvert 0-000 m
Bottom elevation #7 _____ m	Water elevation _____ m	Distance from culvert 0-___ m
Bottom elevation #8 _____ m	Water elevation _____ m	Distance from culvert 0-___ m

C) Culvert Measurements
(taken at d/s end of pipe)

Culvert height _____ m
Culvert width _____ m
Culvert length _____ m

If the pipe is corrugated, measure corrugation dimensions:

corrugation width _____ m depth _____m

D) Baffles

Presence		Condition		If yes to condition, explain :
Are there baffles inside culvert?	☐ Yes ☐ No	Are the baffles damaged?	☐ Yes ☐ No	_____
Are there baffles near culvert?	☐ Yes ☐ No			_____
Are there notches on baffles?	☐ Yes ☐ No	Are baffles missing?	☐ Yes ☐ No	_____
				_____
If notches present, measure the notch on one baffle:		Is there debris in the baffles?	☐ Yes ☐ No	_____

Width _____ m Depth _____ m

E) Other Barriers
- ☐ Trash rack
- ☐ Beaver dam in culvert
- ☐ Debris in culvert
- ☐ Beaver dam downstream Distance from culvert: _____ m
- ☐ Beaver dam upstream Distance from culvert: _____ m
- ☐ Signs of previous beaver presence Explain: _____
- ☐ Other _____

F) Stream Measurements

U/S bankfull width: _____ m
U/S bankfull depth: _____ m

D/S bankfull width: _____ m
D/S bankfull depth: _____ m

G) Photos

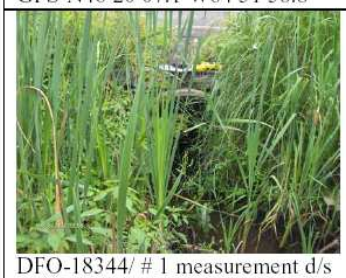
On top of structure, take picture looking u/s: _____
On top of structure, take picture looking d/s: _____
At measurement #1, take picture looking u/s: _____
At measurement #8, take picture looking d/s: _____
D/s of structure, take picture inside: _____
U/s of structure, take picture inside: _____

Other photo (describe): _____
Other photo (describe): _____
Other photo (describe): _____

Appendix B: - Culverts Visited during the 2007 Survey

 DFO-17590/ # 1 measurement d/s 2007-07-25 GPS- N46 16 14.6 W64 35 52.9	 SBWA-1/ # 8 measurement u/s 2007-07-25 GPS-N46 16 20.7 W64 35 49.1	 DFO-17588/ # 1 measurement d/s 2007-07-25 GPS-N46 16 04.8 W64 35 54.9
 DFO-17589/ # 1 measurement d/s 2007-07-25 GPS-N46 16 01.1 W64 35 56.6	 DFO-17600/ # 1 measurement d/s 2007-07-26 GPS-N46 16 08.6 W64 37 14.3	 DFO-17601/ Drop d/s 2007-07-26 GPS-N46 16 17.3 W64 37 54.6
 DFO-17593/ # 1 measurement d/s 2007-07-26 GPS-N46 16 16.7 W64 38 04.6	 DFO-17602/ # 8 measurement u/s 2007-07-26 GPS-N46 16 10.9 W64 38 15.7	 DFO-17606/ # 1 measurement d/s 2007-07-27 GPS-N46 15 20.9 W64 36 05.0
 DFO-17603/ # 1 measurement d/s 2007-07-27 GPS-N46 15 31.8 W64 37 14.9	 DFO-16863/ # 8 measurement u/s 2007-07-27 GPS-N46 14 54.2 W64 38 11.0	 DFO-16854 # 8 measurement u/s 2007-07-27 GPS-N46 13 33.5 W64 37 08.2

 DFO-17605/ # 1 Measurement d/s 2007-07-31 GPS-N46 15 44.8 W64 38 42.5	 DFO-16853/ Culvert d/s 2007-07-31 GPS-N46 13 52.0 W64 37 15.1	 DFO-16864/ Culvert u/s 2007-07-31 GPS-N46 14 01.1 W64 36 09.5
 DFO-16825/ # 1 measurement d/s 2007-07-31 GPS-N46 14 06.0 W64 35 38.8	 DFO-17586/ # 8 measurement u/s 2007-07-31 GPS-N 46 15 23.1 W64 35 09.1	 DFO-17572/ # 8 measurement u/s 2007-08-01 GPS-N46 16 07.5 W64 34 45.9
 DFO-16841/ # 1 measurement d/s 2007-08-01 GPS-N46 13 13.0 W64 34 20.4	 DFO-16819/ # 8 measurement u/s 2007-08-01 GPS-N46 13 06.8 W64 34 15.5	 DFO-16827/ # 1 measurement d/s 2007-08-01 GPS-N46 12 46.7 W64 33 52.6
 DFO-18339/ # 8 measurement u/s 2007-08-08 GPS-N46 20 09.0 W 64 31 51.4	 DFO-18340/ Top Culvert d/s 2007-08-08 GPS-N46 20 06.6 W 64 31 49.7	 SBWA-2/ Top Culvert u/s 2007-08-08 GPS-N46 20 06.9 W64 31 51.4

 DFO- 18338/ # 1 measurement d/s 2007-08-08 GPS-N46 20 07.1 W64 31 38.8	 SBWA-3/ # 1 measurement d/s 2007-08-08 GPS- N46 20 07.1 W64 31 38.8	 DFO-18341/ # 1 measurement d/s 2007-08-08 GPS-N46 19 58.0 W64 30 56.9
 DFO-18344/ # 1 measurement d/s 2007-08-08 GPS-N46 19 27.0 W64 30 56.9	 DFO-18351/ Top Culvert d/s 2007-08-10 GPS-N46 18 50.7 W64 30 56.9	 DFO-17578/ # 1 measurement d/s 2007-08-10 GPS-N46 17 58.7 W64 33 11.1
 DFO-17580/ # 8 measurement u/s 2007-08-10 GPS-N46 16 42.5 W64 35 14.7	 DFO-17573/ # 1 measurement d/s 2007-08-10 GPS-N46 15 02.0 W64 34 04.3	 DFO-16807/ # 1 measurement d/s 2007-08-10 GPS-N46 12 42.0 W64 33 28.6
 DFO-16881/ # 1 measurement d/s 2007-08-16 GPS-N46 13 55.4 W64 44 34.5	 DFO-15951/ # 1 measurement d/s 2007-08-17 GPS-N46 11 18.8 W64 32 39.8	 DFO-16954/ # 1 measurement d/s 2007-08-17 GPS-N46 13 33.5 W64 37 08.2

 DFO-15953/ # 8 measurement u/s 2007-08-17 GPS-N46 10 57.7 W64 33 27.9	 DFO-15956/ Top Culvert u/s 2007-08-17 GPS-N46 10 49.7 W64 33 28.3	 DFO-15934/ # 1 measurement d/s 2007-08-17 GPS-N46 11 54.4 W64 31 19.3
 DFO-15946/ # 1 measurement d/s 2007-08-17 N46 11 41.2 W64 30 57.7	 DFO-15939/ # 8 measurement u/s 2007-08-17 GPS-N46 11 19.9 W64 30 37.3	 DFO-15937/ # 8 measurement u/s 2007-08-17 GPS-N46 10 51.2 W64 30 16.8
 DFO-16799/ # 1 measurement d/s 2007-08-17 GPS-N46 12 29.9 W64 31 33.1	 DFO-16811/ # 8 measurement u/s 2007-08-20 GPS-N46 13 23.9 W64 31 37.5	 DFO-16813- 16814/ # 8 measurement u/s 2007-08-20 GPS-N46 13 27.2 W64 31 44.1
 DFO-16832-16833/ 2007-08-20 GPS-N46 13 40.3 W64 31 16.9	 DFO-16836/ # 8 measurement u/s 2007-08-20 GPS-N46 12 42.8 W64 30 44.6	 DFO-16771/ # 8 measurement u/s 2007-08-20 GPS-N46 12 43.0 W64 29 23.7

 DFO-16762/ # 1 measurement d/s 2007-08-20 GPS-N46 13 20.8 W64 28 59.5	 DFO-16837 A&B/ #8 measurement u/s 2007-08-21 GPS-N46 13 23.4 W64 30 03.0	 DFO-16775/ # 8 measurement u/s 2007-08-21 GPS-N46 13 54.2 W64 29 13.1
 DFO-16767/ #1 measurement d/s 2007-08-21 GPS-N46 13 22.7 W64 28 05.1	 DFO-16776/ # 8 measurement u/s 2007-08-21 GPS-N46 12 41.1 W64 27 44.1	 DFO-15931/ # 1 measurement d/s 2007-08-21 GPS-46 11 16.2 W64 28 51.1
 DFO-16862/ # 8 measurement u/s 2007-08-22 GPS-N46 13 20.8 W64 28 59.5	 DFO-16856/ #1 measurement d/s 2007-08-22 GPS-N46 12 24.9 W64 36 46.2	 DFO-16855/ # 1 measurement d/s 2007-08-22 GPS-N46 12 53.4 W64 36 53.8
 DFO-17581/ # 1measurement d/s 2007-08-23 GPS-N46 17 10.7 W64 35 44.8	 DFO-17604/ # 1measurement d/s 2007-08-23 GPS-N46 16 34.0 W64 39 33.0	 DFO-17616/ # 1measurement d/s 2007-08-23 GPS-N46 15 51.8 W64 43 06.0

 DFO-17609/ # 1measurement d/s 2007-08-23 GPS-N46 15 06.9 W64 44 41.8	 DFO-16886/ # 1measurement d/s 2007-08-23 GPS-N46 14 46.0 W64 44 36.2	 DFO-16875/ # 8 measurement u/s 2007-08-23 GPS-N46 13 32.1 W64 45 52.0
 SBWA-4/ # 1measurement d/s 2007-08-23 GPS-N46 14 50.1 W64 42 04.1	 DFO-16867/ # 1measurement d/s 2007-08-27 GPS-n46 13 32.3 W64 41 51.1	 DFO-16860/ # 8 measurement u/s 2007-08-27 GPS-N46 12 33.4 W64 41 37.3
 DFO-16850/ # 8 measurement u/s 2007-08-27 GPS-N46 12 57.2 W64 41 28.2	 DFO-16870/ # 1measurement d/s 2007-08-28 GPS-N46 13 00.0 W64 41 14.5	 DFO-16865/ # 1measurement d/s 2007-08-28 GPS-N46 12 57.9 W64 40 41.0
 DFO-16868/ # 8 measurement u/s 2007-08-28 GPS-N46 13 01.0 W64 39 56.9	 DFO-16858/ # 1measurement d/s 2007-08-28 GPS-N46 12 27.9 W64 40 20.8	 DFO-15980/ # 1measurement d/s 2007-08-28 GPS- N46 11 29.7 W64 41 42.2

		
DFO-15974 A&B/ Top Culvert u/s 2007-08-28 GPS-N46 10 34.6 W64 41 05.3	DFO-15975 A/ # 1 measurement d/s 2007-08-28 GPS-N46 10 12 .7 W64 40 42.9	DFO-15975 B/ # 8 measurement u/s 2007-08-28 GPS-N46 10 12 .7 W64 40 42.9