Restoration of the West Branch of the St. Mary's River

Report prepared for the Atlantic Salmon Endowment Fund of Fisheries and Oceans Canada

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St. Mary's River Association
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Contents

Executive Summary

- The Atlantic Salmon Endowment Fund of Fisheries and Oceans Canada supplied the St. Mary's River Association (SMRA) with $25,000 for project planning and management in 2014. This funding has enabled the SMRA to prepare a feasible restoration plan for a portion of the West branch of the St. Mary's River. As a result, the SMRA has secured over $275,000 to complete restoration work over 3 years on a portion of the upper third of the river (which encompasses approximately half of the watershed).
- The St. Mary's River, including the West branch has been identified as critical fish habitat.
- The West River has been severely degraded, due to historical forestry practices and log driving in the river. This has resulted in over-widened, shallow channels and back channels. In the summer, water temperatures become lethal for fish and they can become trapped in shallow back channels. In the winter, the river channel freezes to the bottom, causing ice scour and damage to any fish eggs in the sediments.
- The river channel is over-simplified in the West branch. There is a lack of organic debris in the river channel, due primarily to past clearing for agriculture and forestry on the floodplain.
- To date, the sections of river requiring work have been identified, the type of work needed has been defined, the cost of work has been determined, funding has been secured (for about 3km on the upper third of the West Branch), and restoration work began in 2014.
- Within the overall project area on the West branch, eleven sites have been identified as needing restoration work. Five sites (sites 1,2,3,4,5) have been partially funded, detailed plans are completed, and restoration work will be completed over two years (2014-2015).
- Fully implementing the entire restoration plan (eleven sites) will require at least ten years (based on current funding levels). Further restoration plans for the lower portions of the West Branch will be completed upon funding approval.
- It is critical that the upper reaches of the West branch be fully restored prior to addressing issues in the lower reaches. This is primarily due to the tremendous amount of ice production in the upper portions, which need to be controlled first. Restoration in lower reaches, before addressing issues in the upper reaches, would be ineffective.
- Rock sills along with supporting structures, such as channel blockers, deflectors, and bank rocking are the key structures being used in this restoration project.

1. Introduction

The St. Mary's River Association

The St. Mary's River Association (SMRA) is a charitable, non-profit organization. The primary vision of the SMRA is to achieve a healthy river ecosystem, salmon population, and surrounding community. The SMRA works toward this vision by providing leadership and engaging its partners to enhance, protect, and promote the health of the St. Mary's River. Additionally, the SMRA runs an Interpretive Centre and education programs to perform outreach and advance their vision.

The St. Mary's River has long been recognized as one of the most attractive and greatest salmon producing rivers in Nova Scotia. At approximately 250 kilometres, it is one of Nova Scotia's longest rivers running through Pictou, Antigonish and Guysborough Counties (Mitchell, 2009). The St. Mary's River also provides riparian habitat which serves as critical habitat and corridors for imperiled wildlife; however, it faces increased pressures from many activities, which impact the river's ecological integrity. It is one of the last salmon rivers on the Atlantic shores of Nova Scotia with substantial runs of 3SW salmon. The stock has been declining in numbers for decades, along with other salmon stocks in the Atlantic Provinces. Both the commercial and recreational fisheries for salmon are now closed.

Since 1979, the SMRA has conducted research, monitoring and management projects, collaborating with both government and non-governmental agencies. Examples of successful past projects include the St. Mary's River Forestry/Wildlife Project (1984-1992), a River-Specific Management Program (1985-1994), collaboration with DFO to determine juvenile and adult Atlantic salmon abundance and distribution (1990-current), and conducting river restoration projects (1995-current). In 2013, the SMRA developed a comprehensive St. Mary's River Recovery Strategy (Hunter and Mitchell, 2013).

A Brief History of the St. Mary's River

The St. Mary's River was used prior to European contact by the Miq'maq First Nation for sustenance and inland travel. The area was originally settled by the French who built Fort St. Marie in 1654 (from which the river took its name), and then changed hands to the British in 1669.

The watershed remained relatively lightly exploited until the 19th Century. The commercial salmon fishery, abundant timber, and rich soil for agriculture attracted settlers from Great Britain in the early 1800's and throughout the 19th century. During this time the watershed was an important part of regional economics, contributing its forests to England as lumber and Atlantic salmon for food to Europe and elsewhere.

The St. Mary's River has a long history of agriculture, forestry and log drives. By the mid-1800's the impact of exploitation on the river had become apparent. Veith (1868, as cited by SMRA, 2014) comments the St. Mary's river salmon fishery was second to none in Nova Scotia but had declined to almost nothing due to spearing and netting of salmon, and the use of the watershed and river for the export of logs and lumber. Knight (1867, as cited by SMRA, 2014) also blames mill dams as being very abundant on most rivers of the province, preventing access to upstream areas by anadromous fishes.

This Project

This document is a planning and restoration report. It reviews the restoration project that is in progress on the upper reaches of the West branch of the St. Mary's River, and outlines future work that requires funding. All plans and current restoration work are being completed to specifically address recommendations that have been made in the Recovery Strategy, produced by the SMRA (Hunter and Mitchell, 2013).

To date, the sections of river requiring work have been identified, the type of work needed has been defined, the cost of work has been determined, funding has been secured (for about 3km on the upper third of the West Branch), and restoration work has begun. Within the project area on the West branch, eleven sites have been identified as needing restoration work (see descriptions and pictures in section 5).

Five sites (sites 1,2,3,4,5) have been partially funded, detailed plans are completed, and restoration work will be carried out over two years. However, fully implementing the entire restoration plan (eleven sites) will require at least ten years (based on current funding levels). Additional areas requiring restoration will be identified in the lower portion of the West Branch pending approval of additional funding.

The current contributors to this project include Fisheries and Oceans Canada (DFO) – Small Craft Harbours (SCH), Atlantic Salmon Endowment Fund (ASEF) and Recreational Fisheries Conservation Partnerships Program (RFCPP), as well as Nova Scotia Liquor Commission's Adopt-a-Stream. It should be duly noted that $25,000 of funding from DFO's Atlantic Salmon Endowment Fund for project management and planning has enabled the St. Mary's River Association to secure approximately $275,000 to conduct restoration work over the next three years. Therefore, funding provided for the planning and design of restoration efforts is critical for projects such as this.

2. Project Location

This project focuses on restoration of the West branch of the St. Mary's River located in Guysborough County. The St. Mary's River drains approximately 1,350 sq. km of land and consists of three branches, the East, West, and North branches, with the Main branch extending to the estuary (Figure 1). The West branch of the St. Mary's River is approximately 56 km long and drains approximately 470 sq. km of land (Mitchell, 2009). The objective of this river restoration project is to conserve, rebuild, and restore the habitat of wild Atlantic salmon on the upper third (draining about 250 sq. km of land) of the West branch. Currently funded restoration work begins at the entrance of Upper Bryden Brook and ends at Crooked Lake Brook (Figure 2).

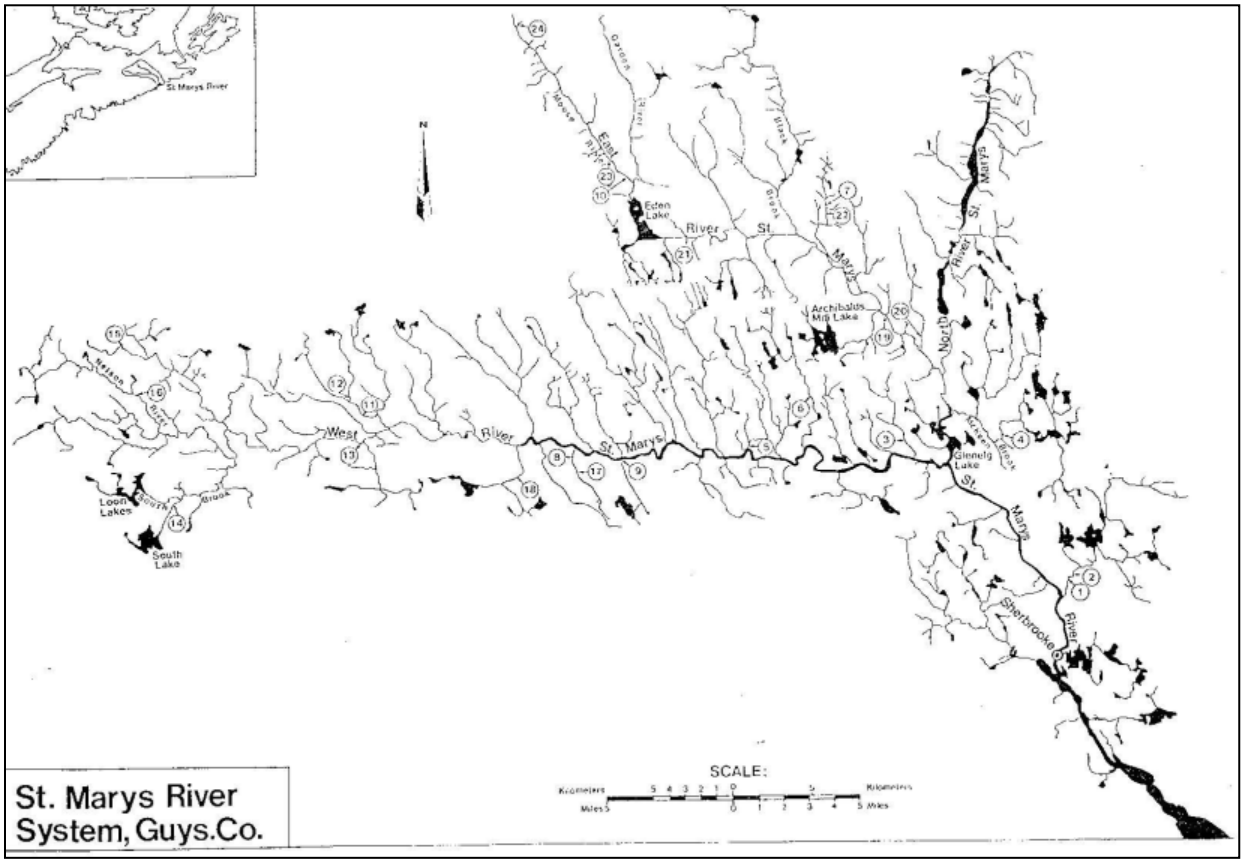

Figure 1. Map of the St. Mary's watershed, with West, East, North and Main branches labelled.

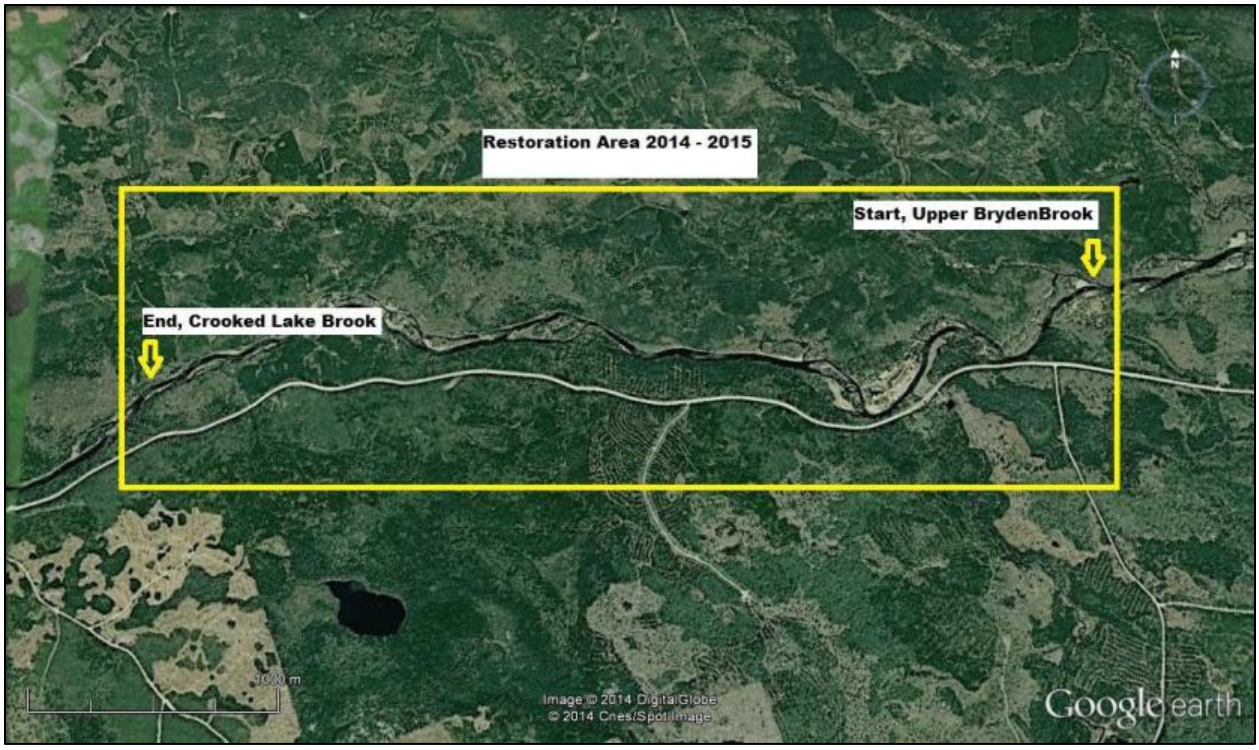

Figure 2. Area designated for restoration work in 2014-2015.

It is critical that the upper third of the West branch be restored prior to pursuing restoration of the middle and lower reaches (Figures 3, 4, and 5). The reason for this is excessive ice production in the upper third of the river. It would not be reasonable to begin restoration on the middle and lower portions of the West branch without addressing ice issues in the upper reaches, as restoration efforts in this case would be ineffective. Even the work that has been completed in the upper third of the river during 2014 will have to be closely monitored, and perhaps adjusted in the future, due to excessive ice production in upstream regions.

To pay for adjustments/maintenance, 5% should be set aside from the budget each year in a separate account. Spending for adjustments/maintenance will need to be monitored in order to judge whether 5% is an accurate amount to set aside.

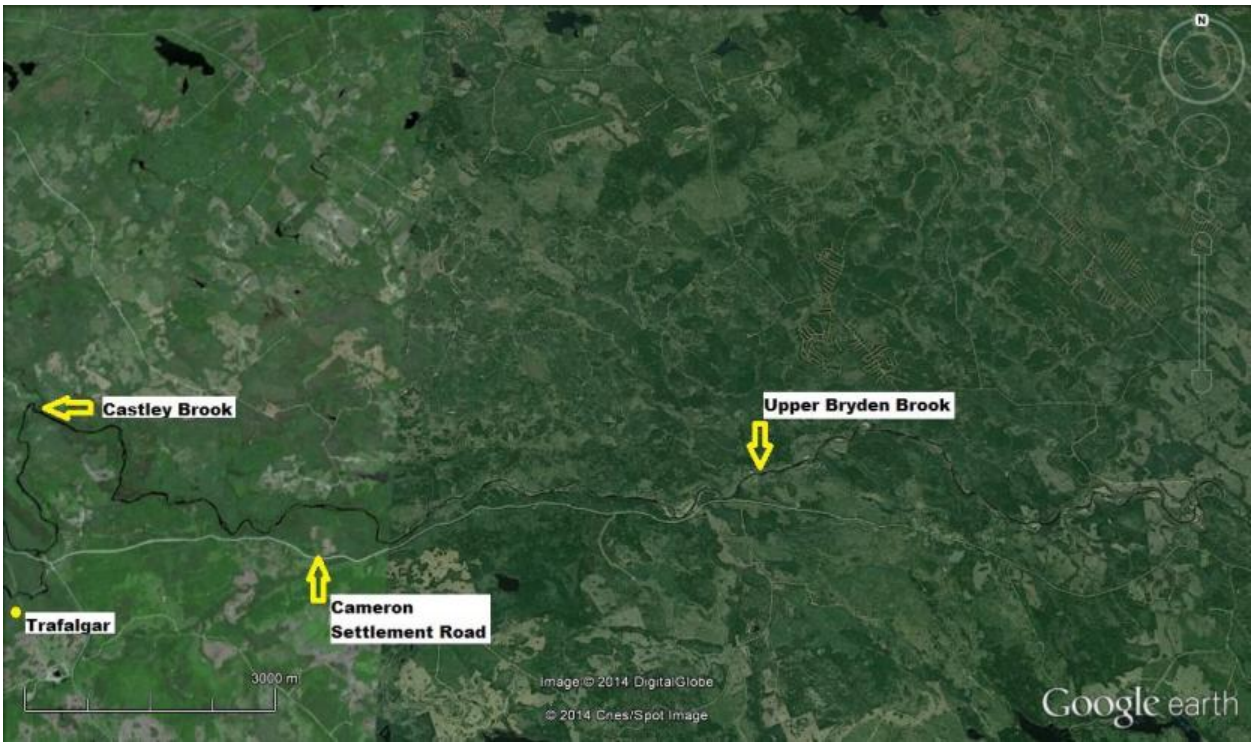

Figure 3. Overview map of the upper third of the West branch of the St. Mary's River.

Figure 4. Overview map of the middle third of the West Branch of the St. Mary's River.

Figure 5. Overview map of the lower third of the West branch of the St. Mary's River.

The middle and lower thirds of the West branch of the St. Mary's River comprise approximately 40km of the river. Based on the expenses from this year's work and expected costs for next year, the estimate is that it will cost $250 – 300, 000 per kilometre for these lower two sections.

However, some of the more severely degraded areas of the middle and lower sections of the river could cost as high as $500-600,000 per kilometre. Therefore, as a starting point, $10-12 million is required to restore the entire West branch. The $10-12 million estimate is based on current costs and conditions, and given that it will likely take a number of years to complete the work on the upper section, the costs for the lower two sections will likely escalate by the time the work is started. This year's costs per square metre were approximately $4.00 and will rise to $8.00 - 10.00 in following years, which is comparable to similar restoration projects.

The Atlantic Salmon Endowment Funding for this study was based on a three year project. The first year was providing a detailed description of the costs and the work required at each site on the upper section and an overall cost estimate for the lower two sections of the river. The next two phases of this project is intended to provide the same detail for both the middle and lower sections, which will help refine the scope of work and the associated costs.

3. Current Conditions

The Recovery Strategy, developed by the SMRA, identified the need to address deteriorating habitat, resulting from past human activity, acidic precipitation, peak ice conditions, flood events, etc. The Association is using this Recovery Strategy as a blueprint to address the habitat issues and create conditions so that all flora and fauna can survive and thrive. This Strategy concluded that there has been significant habitat degradation on the St. Mary's River that has had a negative impact on salmon habitat. While low pH is a concern on some tributaries, the effects of peak rain and ice events has caused wide spread damage along much of the West branch and various locations on the East branch and main stem of the River.

Particularly on the West branch, flood and ice events have eroded the river banks creating wide, shallow flows along long sections of the river. The hydrology dictates that the bank-full width of the river should be about 28-30m for the study area (in the upper third of the West branch); however, it is actually about 60m. The current, summertime wetted width is 25-45m, which is double or triple what it should be at this time of year. Additionally, pools make up only about 2% of the river in the project area, and are only a maximum of one metre deep; they should make up 25% of the river and be at least 3m deep. These summertime, shallow conditions provide a large surface area that allows the sun to heat the water temperature to levels that make it difficult for juvenile salmon to survive. Not only can the temperature reach lethal levels, as water levels fall, large portions of beach are exposed, which often result in the small fish being trapped in small pools and back waters. In the summer of 2014 temperatures reached 28 degrees Celsius and many dead and dying fish were observed. The goal of this restoration project is to narrow the channel and lower water temperatures in the entire West branch.

During the fall, with higher water levels, adult salmon may spawn on beach areas. In winter, the water levels decrease and the wide thalweg freezes to the bottom. Not only can this pose a risk for the salmon eggs deposited in these shallows, but during the spring thaws, when water levels increase, the ice often floats, lifting the gravel and eggs with it. This can result in additional erosion and gravel being deposited in areas where other salmon eggs may have been laid. Ice scour in many areas of the floodplain has also resulted in unnatural vegetation patterns with lack of shrubbery (Figure 5 and 6). This lack of large organic debris has resulted in simplified channel morphology, contributing to a lack of good fish habitat. Juvenile density data for salmon indicate that population levels are well below conservation targets (Table 1).

Figure 6. A) Ice scour in the floodplain has resulted in unnatural vegetation patterns that appear almost "park-like". B) Picture taken just 30cm higher than picture A and in the same area, represents what the vegetation should look like.

Figure 7. Ice scour on a tree in the upper West branch.

Table 1. Juvenile salmon density data from the West Branch of the St. Mary's River from DFO, 2009-2013.

West Branch, St. Mary's River, 2009-2013				
N	**0+ Parr**	**1+ Parr**	**2+ Parr**	**Total**
9	13.1	2.0	0.0	2.0
7	6.9	8.3	0.2	8.4
7	9.8	3.7	0.2	3.9
5	9.3	5.0	1.3	6.3
9	2.2	2.9	0.2	3.2

Back channels in the project area should be major players in sediment and ice storage. However, back channels are currently contributing tremendous bed load to the river from down-cutting and erosion, and its storage function is lost. Therefore, channel blockers have been designed slightly lower than the bank-full width so that bed load and ice can still access these areas (for storage).

Bedrock outcrops occur frequently in the project area. These bedrock outcrops make it necessary to adjust restoration designs on the ground.

It should be noted that the conditions described here for the upper third of the West branch are exacerbated in the lower reaches, where the channel width is much larger and even more over-widened. In these sections, detailed surveys will be required for each restoration site, including cross-sectional profiles. Restoration methods will in many cases require complete reconstruction of the channel and floodplain (to provide relief areas for ice coming down the river) in order to achieve a stable river.

4. Descriptions of Structures Used in Restoration

The structures used in this restoration project are described below. The goals of this restoration project focus on stabilizing banks in some areas and blocking back channel breeches, narrowing the channel, and creating pool-riffle habitat. Most of the degradation on the West branch of the St. Mary's River has been caused by past forestry, land clearing for agriculture, log driving, and ice scour of the river bed and banks. This river system has a low to moderate gradient (0.3 - 0.8%).

Rock Sills

Rock sills support the riffle upstream of the structure and dig pools on the downstream side (DFO, 2006, Figure 7). They can also be constructed with deflectors and side sloping for the purpose of narrowing and deepening rivers that have become over-widened and shallow (DFO, 2006, Kennebecasis Watershed Restoration Committee, 2013). Rock sills act much like digger logs; however, digger logs are used in small streams where rock sills can be used in large rivers. These structures will blend into the natural flow of the river after they have been constructed (Kennebecasis Watershed Restoration Committee, 2013). Additionally, rock sills act as gradient controls (DFO, 2006).

Rock sills are constructed at the head of a pool site, every six channel widths and on alternating sides of the river. Rocks used should be double the size of the largest boulders in the stream. Sills should be rotated 30 degrees from straight across when looking downstream, towards the desired pool location (DFO, 2006). Rock sills are combined with other in-stream structures (i.e. bank rocking, deflectors, etc.) to achieve desired results.

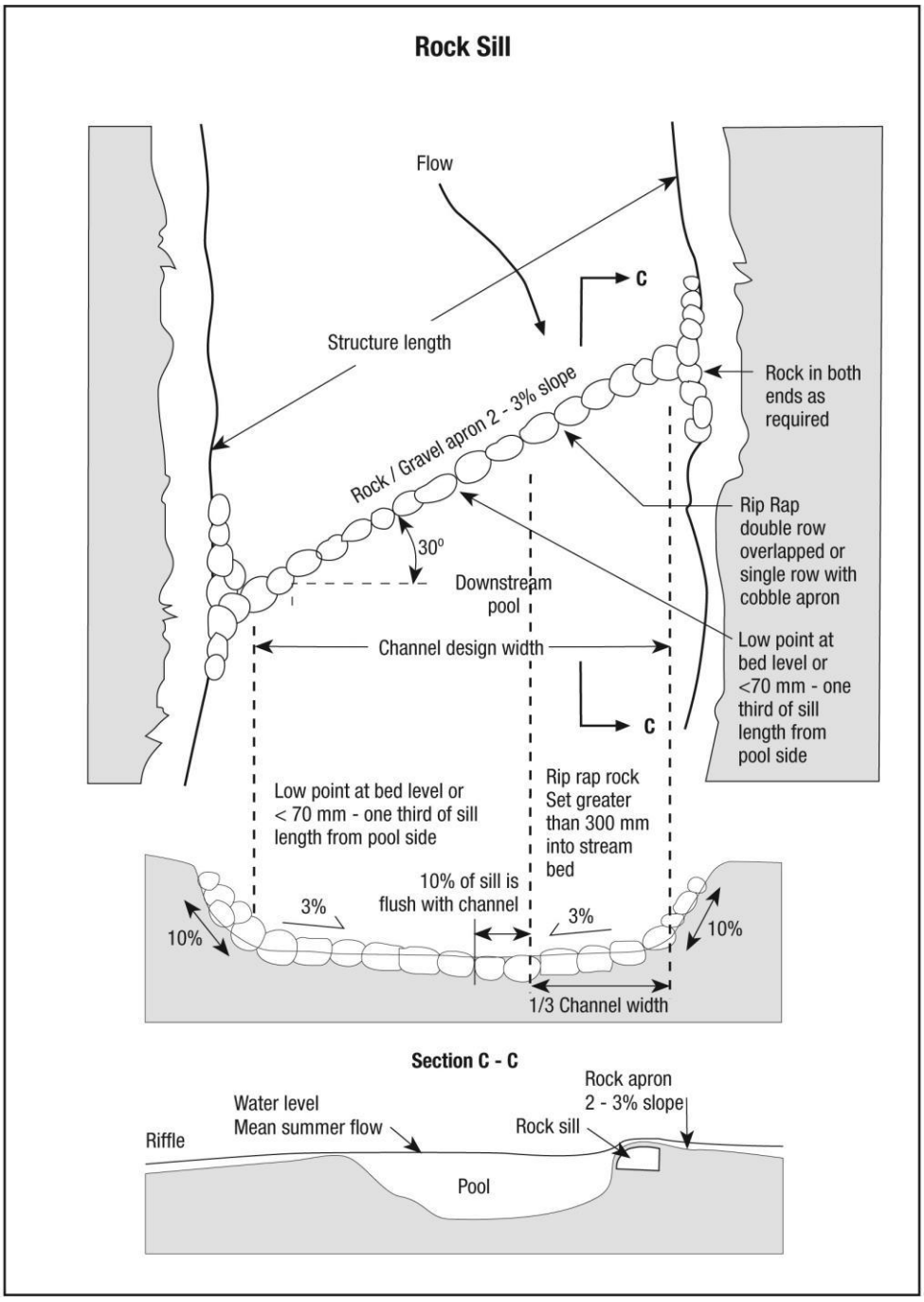

Figure 8. Adapted from DFO, 2006.

Deflectors or Groynes

Deflectors or groynes are similar to constructing a rock sill, but only part way across the river channel (Figure 8). They serve to deflect water away from eroding banks and are often coupled with bank protection on the opposite bank. Sediment will collect around and between deflectors to further stabilize the bank (Kennebecasis Watershed Restoration Committee, 2013).

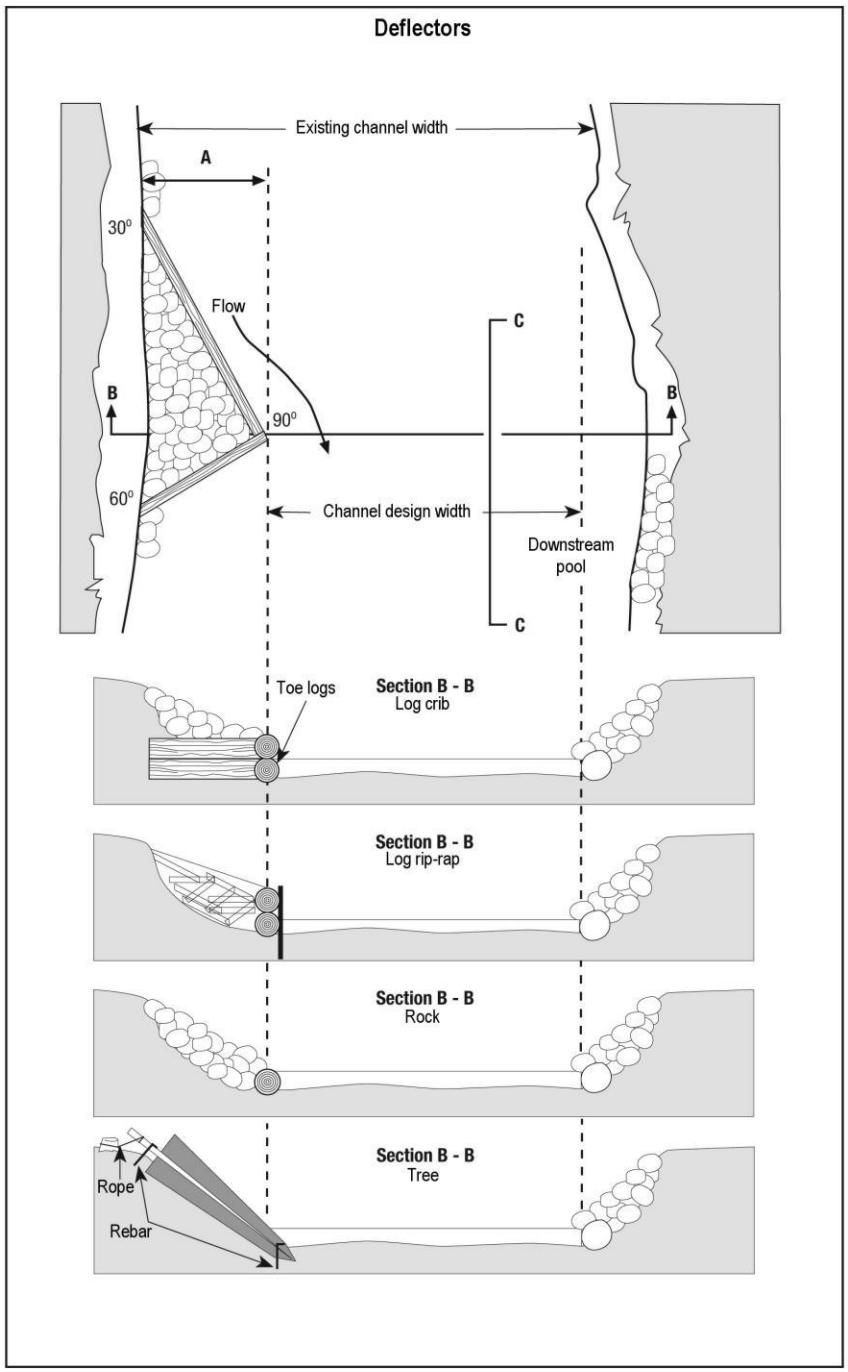

Figure 9. Adapted from DFO, 2006.

Rock Riprap for Bank Protection or Stabilization

Bank protection or stabilization is utilized on eroding banks with little bank vegetation. Bank protection will also prevent sediment and nutrients from washing into the water course from the bank (Kennebecasis Watershed Restoration Committee, 2013). Very large rocks are used to key in the structures and stabilize the bank (Figure 9 and 10).

Figure 10. Some bank protection installed at Site 5 of this project.

Figure 11. Example of two ton rock used at Site 4 to key in bank protection.

Kickers

Kickers and strategically placed boulders are used to create habitat instream and to reduce bank erosion. As you can see in Figure 11, the kickers are used along with bank protection.

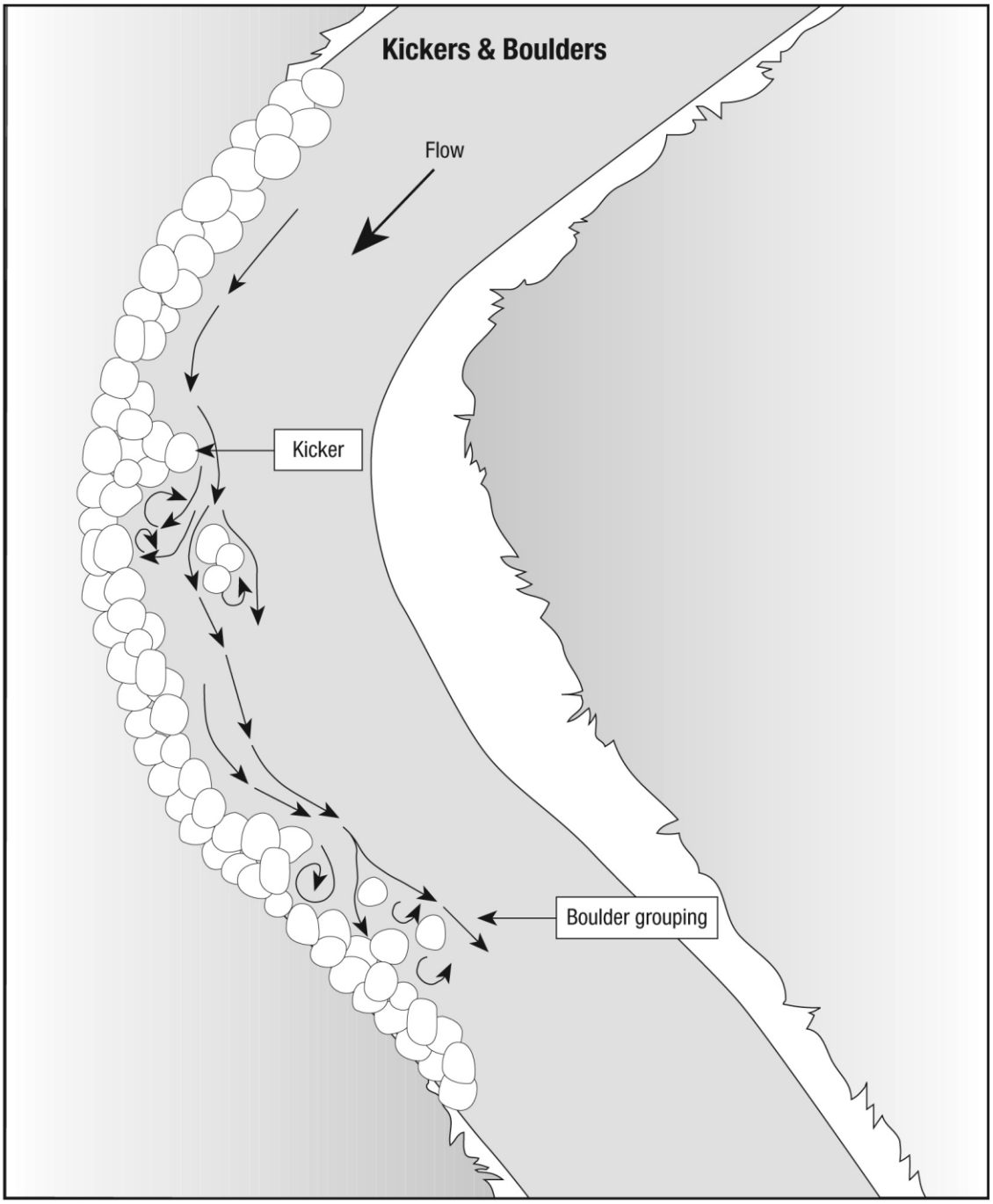

Figure 12. Adapted from DFO, 2006.

Channel-blockers

Channel-blockers are constructed in areas where there has been a channel breech, causing the river to become unnaturally braided or producing back channels. Channel blockers will block those areas where the channel has been breeched and the structure will tie into the bank on either side for stability. The blocker should contain a 1 in 2 year flood so that the bank full discharges will still reach the floodplain. Each channel blocker is custom designed to fit the restoration needs.

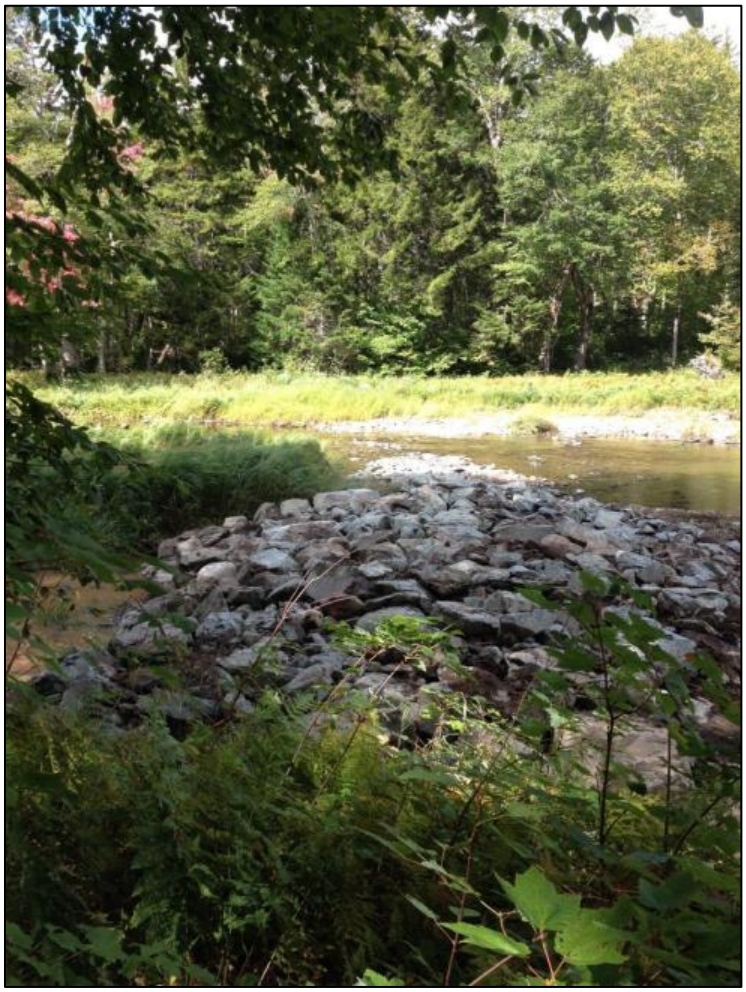

Figure 13. Rock sill with channel blocker site 5.

5. Work Plans and Completed Work to Date

Within the project area on the West branch, eleven sites have been identified as needing restoration work (see descriptions and pictures below). Site 2 has been funded and almost all of the required work has been completed this year. Three of the six structures planned for site 4 have been completed and all structures at site 5 have been completed. Work on sites 0, 1, 3, 6, 7, 8, 9, and 10 have not yet begun.

Overview of Eleven Sites

Figure 14. Overview of all eleven sites with detailed plans. Landmarks are labelled with arrows.

Site 0

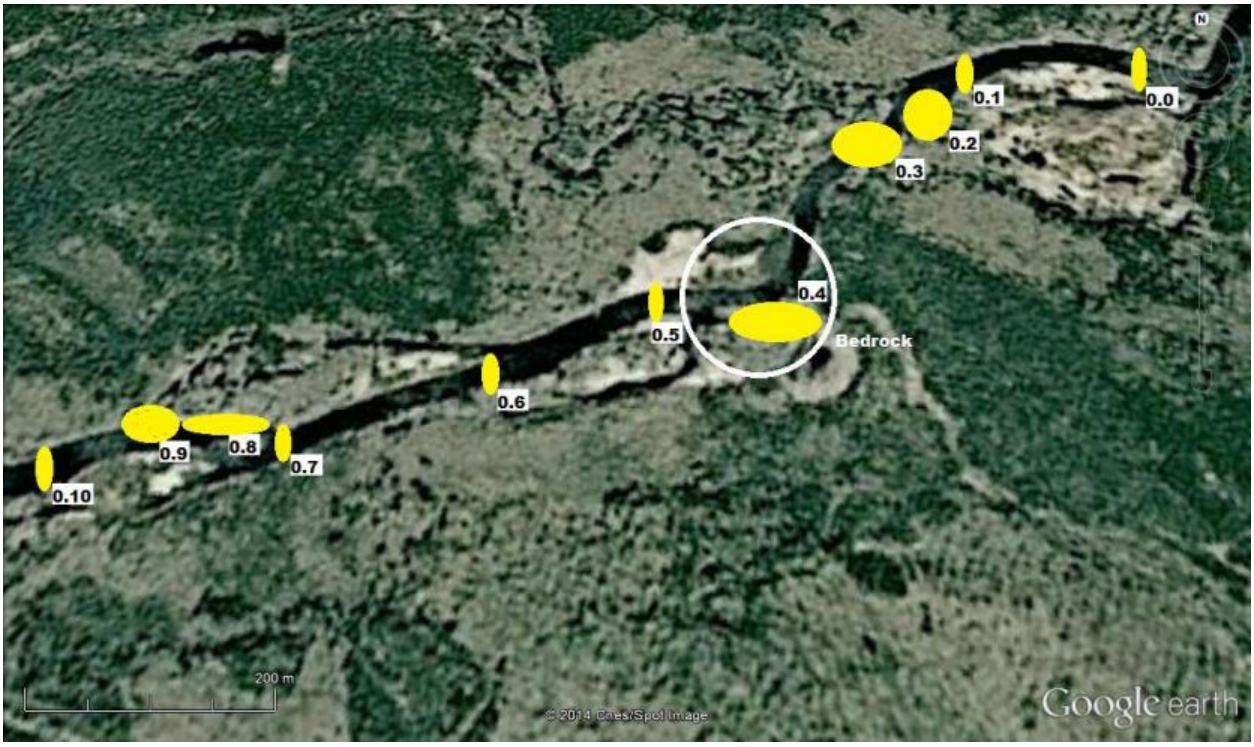

Figure 15. Site 0 with planned structures labelled.

Site 1

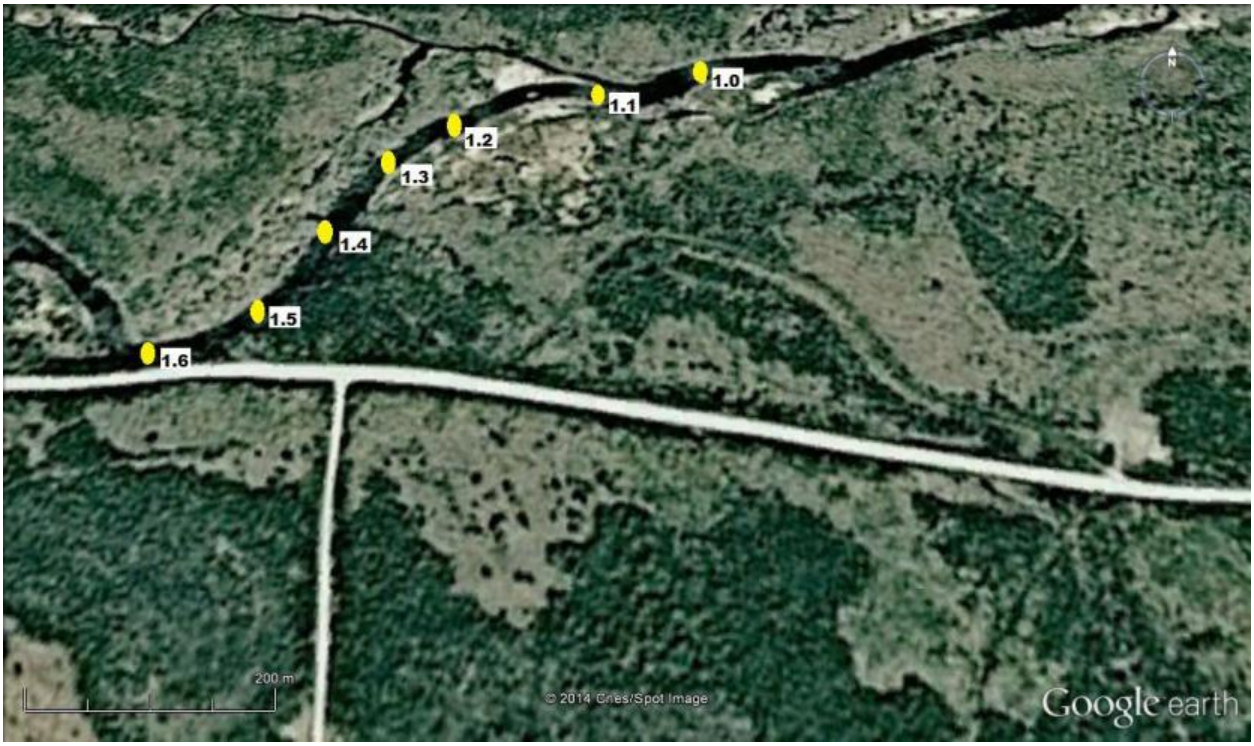

Figure 16. Site 1 with planned structures labelled.

Site 2 (Mackay Site)

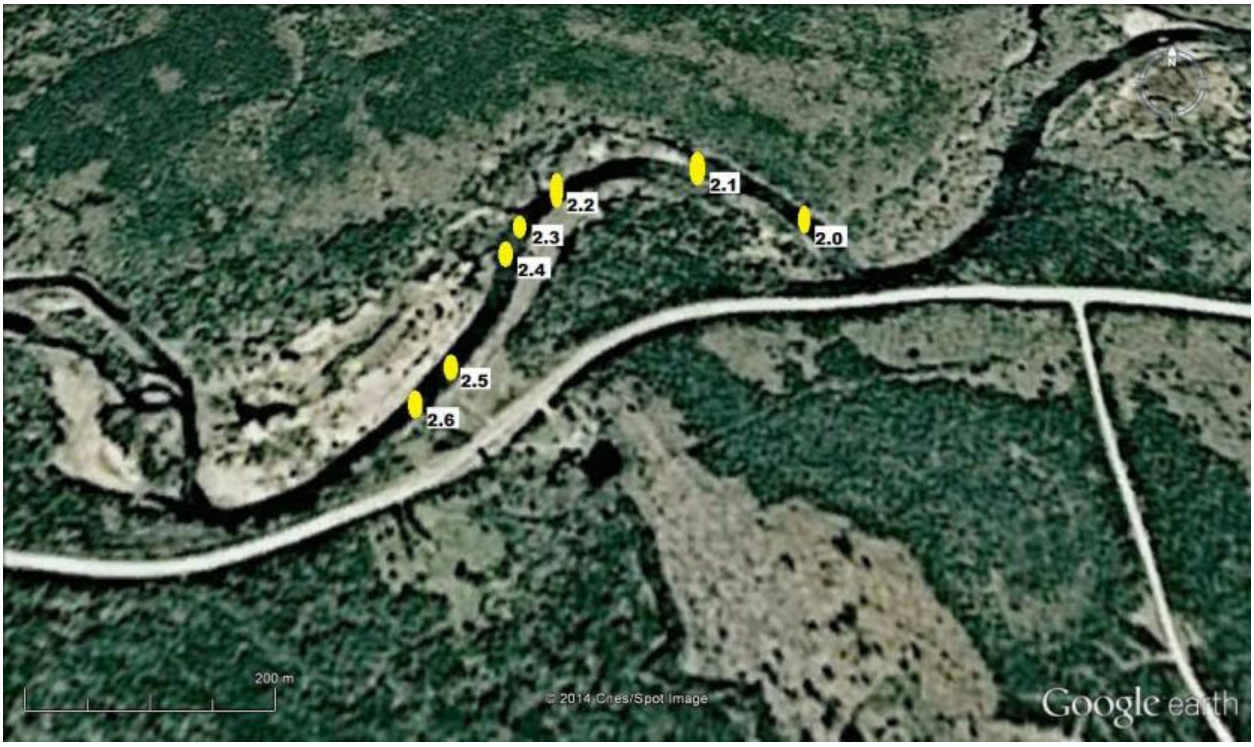

Figure 17. Site 2 with structures labelled.

Site 3

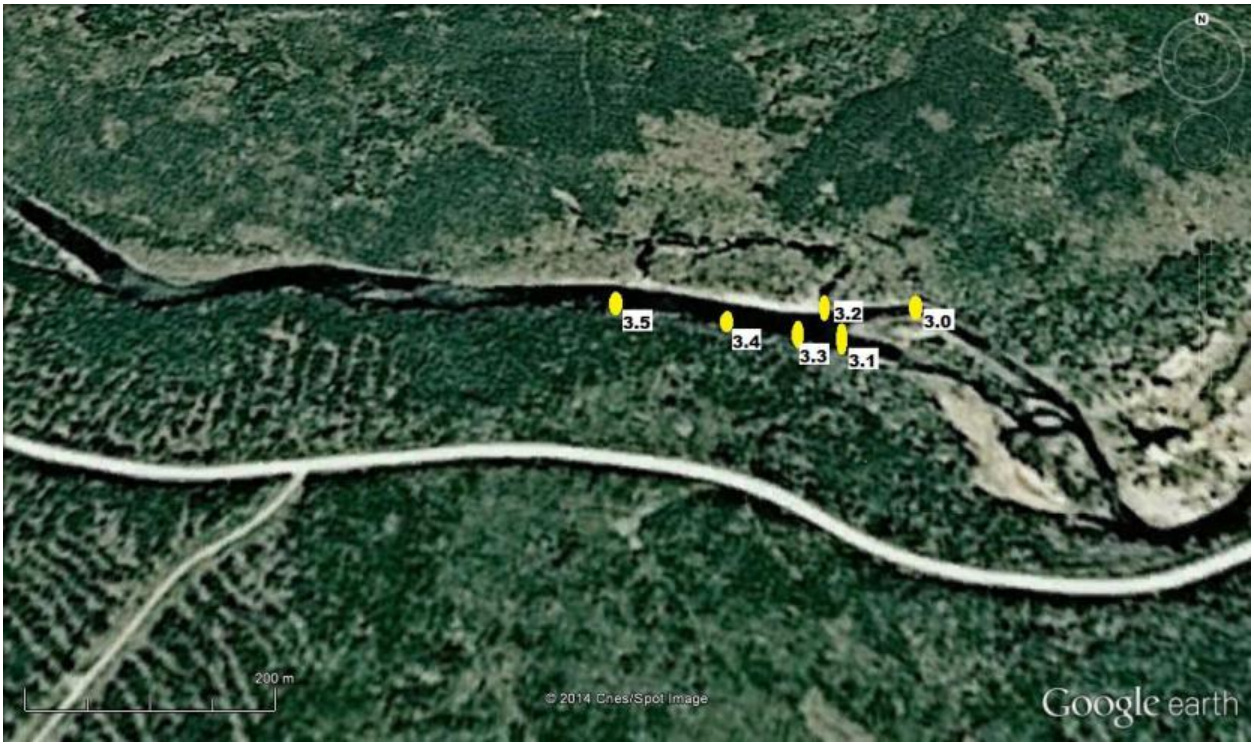

Figure 18. Site 3 with planned structures labelled.

Site 4a

Figure 19. Site 4a with structures labelled.

Site 4b

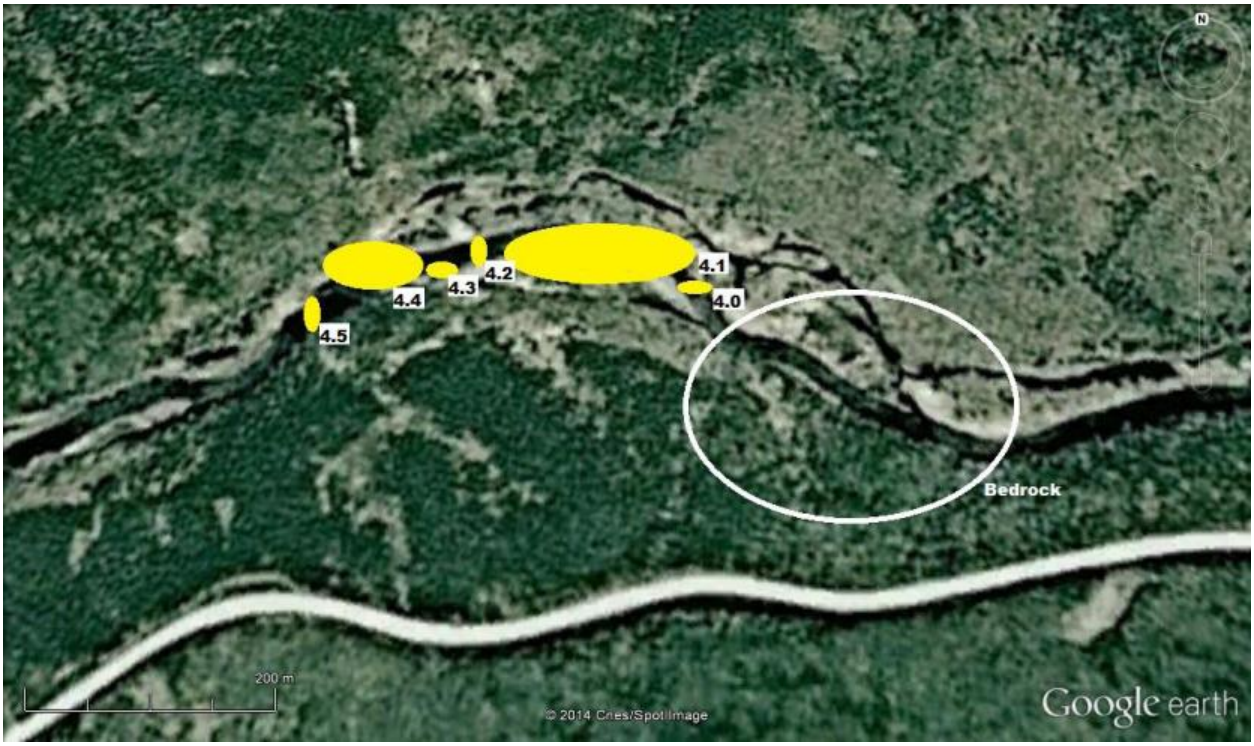

Figure 20. Site 4b with structures labelled.

Site 5

Figure 21. Site 5 with structures labelled.

Site 6

Figure 22. Site 6 with planned structures labelled.

Site 7

Figure 23. Site 7 with planned structures labelled.

Site 8

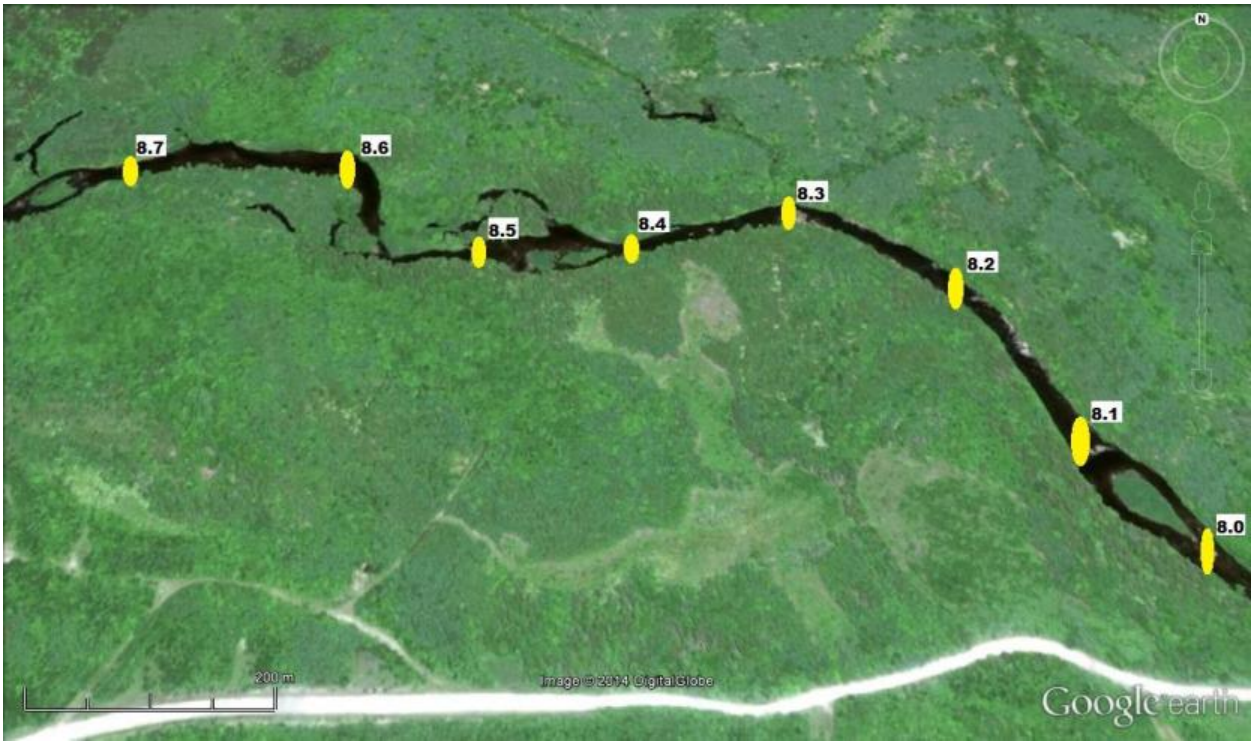

Figure 24. Site 8 overview of site.

Site 9

Figure 25. Site 9 overview of site.

Site 10

Figure 26. Site 10 with planned structures labelled.

Table 2. Descriptions of sites and structures (labelled on maps above).

Site	Coordinates	River Conditions	Enhancement Requirements
SITE 0			
0.0	N/A	Wide channel and lack of pool.	Sill
0.1	N/A	Wide channel and lack of pool.	Sill
0.2	N/A	Bank erosion.	Deflector
0.3	N/A	Bank erosion.	Bank treatment
0.4	N/A	Bank erosion.	Bank treatment
0.5	N/A	Wide channel and lack of pool.	Sill
0.6	N/A	Wide channel and lack of pool.	Sill
0.7	N/A	Wide channel and lack of pool.	Sill
0.8	N/A	Bank erosion.	Bank treatment
0.9	N/A	Channel breech.	Repair channel breech, with a channel blocker.
0.10	N/A	Wide channel and lack of pool.	Sill
SITE 1 (Work to be completed next year)			
1.0	N/A	Wide channel, lack of pool, and bank erosion.	Possibly install a couple of sills and bank protection (dependent on access ability and river conditions)
1.1	00537624 E 05015123 N	Wide channel, lack of pool, and bank erosion.	35m rock sill and bank protection to be constructed
1.2	00537501 E 05015090 N	Wide channel and lack of pool.	Sill required here, about 125m upstream from the sill at 1.1
1.3	00537461 E 05015066 N	Bank erosion.	Bank protection required here
1.4	00537404 E 05015035 N	Bank erosion.	Bank protection and deflector required, also cut back the bank at the lower end
1.5	00537362 E 05014953 N	Braided channel.	Channel blocker required
1.6	00537256 E 05014826 N	Wide channel and lack of pool.	Possibly install a sill here (dependent on access ability and river conditions)
SITE 2 (Mackay Site) (Most work complete)			
2.0	00537161 E 05014866 N	Wide channel, lack of pool, and bank erosion.	Sill and bank protection (30m) to be installed next year possibly – this is unfunded and access is an issue
2.1	00536991 E 05014936 N	Channel breech, wide channel, lack of pool, and bank erosion.	Back channel and main channel sill completed here as well as bank protection
2.2	00536929 E 05014932 N	Bank erosion.	Bank protection completed
2.3	00536890 E 05014915 N	Bank erosion.	Bank protection and deflector completed
2.4	00536870 E 05014892 N	Braided channel and bank erosion.	Channel blocker and bank work completed

Site	Coordinates	River Conditions	Enhancement Requirements
2.5	00536843 E 05014814 N	Wide channel, lack of pool, and bank erosion.	Rock sill, 40m of bank protection and a deflector completed
2.6	00536766 E 05014651 N	Bank erosion, wide channel, and lack of pool.	15m of bank work and a rock sill just above it completed
SITE 3 (Work to be completed next year)			
3.0	Not yet recorded	Bank erosion.	Deflector
3.1	Not yet recorded	Braided channel.	Channel blocker
3.2	Not yet recorded	Channel breech.	Channel blocker
3.3	Not yet recorded	Bank erosion.	Deflector
3.4	Not yet recorded	Bank erosion.	Deflector
3.5	Not yet recorded	Bank erosion.	Deflector
SITE 4a (Structures 4.2, 4.3, 4.4, 4.5 completed, remaining structures to be completed next year)			
4.0	00535355 E 05014937 N	Wide channel and lack of pool.	Possibly construct a rock sill here (dependent on access ability and river conditions)
4.1	00535477 E 05014889 N	Wide channel, lack of pool, and bank erosion.	40m rock sill and a deflector to be installed
4.2	00535213 E 05014988 N	Bank erosion.	Bank protection completed here
4.3	00535174 E 05014966 N	Braided channel.	Channel blocker completed
4.4	00535148 E 05014968 N	Channel breech.	Back channel blocker completed
4.5	00535146 E 05014967 N	Wide channel and lack of pool.	Sill completed
4.6	00535021 E 05014916 N	Wide channel, lack of pool, and bank erosion.	Rock sill and 20m of bank protection to be installed here
4.7	00535002 E 05014878 N	Braided channel.	Large channel blocker (8-10m wide base, 1.4m high, 4:1 slope, 30m long) required here
4.8	00534895 E 05014877 N	Wide channel, lack of pool, and bank erosion.	40m sill, bank protection below and above (about 40m total), vertical kicker above to be constructed
Site 4b (Work to be completed next year)			
4.0	N/A	Wide channel and lack of pool.	Sill
4.1	N/A	Bank erosion and channel breech.	Reconstruct bank and fix channel breech
4.2	N/A	Wide channel and lack of pool.	Sill
4.3	N/A	Bank erosion and channel breech.	Reconstruct bank and fix channel breech
4.4	N/A	Bank erosion and channel breech.	Reconstruct bank and fix channel breech
4.5	N/A	Wide channel and lack of pool.	Sill

Site	Coordinates	River Conditions	Enhancement Requirements
SITE 5 (Work complete)			
5.0	00533997 E 05014850 N	Wide channel and lack of pool.	Sill #1 (furthest downstream)
5.1	00534005 E 05014884 N	Bank erosion.	Bank protection
5.2	00533988 E 05014883 N	Braided channel.	Channel blocker
5.3	00533965 E 05014880 N	Bank erosion.	Deflector and bank protection
5.4	00533941 E 05014871 N	Bank erosion.	Deflector
5.5	00533921 E 05014844 N	Wide channel, lack of pool, and braided channel.	Sill #2 and channel blocker
5.6	00533891 E 05014830 N	Braided channel.	Channel blocker
5.7	00533871 E 05014821 N	Bank erosion.	Bank protection and kicker
5.8	00533814 E 05014800 N	Wide channel, lack of pool, and unstable bank.	Sill #3 (add 5m of bank protection next year)
5.9	00533786 E 05014791 N	Bank erosion and undefined curve in the river.	Bank protection and re-profiled the curve
5.10	00533661 E 05014768 N	Wide channel and lack of pool.	Sill #4 (1-1.5m pool has developed below sill)
5.11	00533629 E 05014715 N	Bank erosion.	Bank protection
5.12	00533626 E 05014701 N	Bank erosion.	Deflector
5.13	00533611 E 05014691 N	Channel breech	Breech repair
5.14	00533575 E 05014683 N	Wide channel, lack of pool, braided channel, and bank erosion.	Sill #5, channel blocker, bank protection, and deflector
5.15	00533420 E 05014617 N	Wide channel, lack of pool, and bank erosion.	Sill #6 and a small deflector (1.6m pool has developed below sill)
5.16	00533445 E 05014603 N	Braided channel.	Channel blocker
SITE 6			
6.0	N/A	Lack of point bar, erosion, overwidened channel, and lack of pool.	Reconstruct the point bar on approximately 200m using deflectors and rock sills to tie them together
6.1	N/A	Wide channel and lack of pool.	Sill (access permitting)
6.2	N/A	Bank erosion.	Bank work and deflectors (access permitting)
6.3	N/A	Wide channel and lack of pool.	Sill (access permitting)
6.4	N/A	Wide channel and lack of pool.	Sill
6.5	N/A	Bank erosion.	3 rock deflectors. Channel is 55m wide.
6.6	N/A	Wide channel and lack of pool.	2 rock sills and deflectors.
SITE 7 (plans may change slightly due to bedrock in the area and access issues)			
7.0	N/A	Wide channel, lack of pool, and	Sill

Site	Coordinates	River Conditions	Enhancement Requirements
		erosion.	
7.1	N/A	Wide channel, lack of pool, and erosion.	Sill
7.2	N/A	Wide channel, lack of pool, and erosion.	Sill
7.3	N/A	Wide channel, lack of pool, and erosion.	Sill
7.4	N/A	Wide channel, lack of pool, and erosion.	Sill
SITE 8 (plans may change slightly due to bedrock in the area and access issues)			
8.0	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Sills will be used in this section at approximately 150m intervals (these are labelled as the yellow dots on the map). Each sill will be about 25m wide, and the remaining channel (in most places the channel is wider than 25m) will be blocked using a channel blocker. Each sill will be coupled with three deflector groynes below it.
8.1	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 8.0.
8.2	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 8.0.
8.3	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 8.0.
8.4	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 8.0.
8.5	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 8.0.
8.6	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 8.0.
8.7	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 8.0.
SITE 9 (plans may change slightly due to bedrock in the area and access issues)			
9.0	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Sills will be used in this section at approximately 150m intervals (these are labelled as the yellow dots on the map). Each sill will be about 25m wide, and the remaining channel (in most places the channel is wider than 25m) will be blocked using a channel blocker. Each sill will be coupled with three deflector groynes below it. Areas in the upper portion will need a channel adjustment (elevation and

Site	Coordinates	River Conditions	Enhancement Requirements
			gradient control), which will require surveying.
9.1	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 9.0.
9.2	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 9.0.
9.3	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 9.0.
9.4	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 9.0.
9.5	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 9.0.
9.6	N/A	Wide channel, mid-channel islands, lack of point bars, lack of pools, and erosion.	Same as 9.0.
SITE 10 (plans may change slightly due to bedrock in the area and access issues)			
10.0	N/A	Wide channel, lack of pool, and erosion.	Sill
10.1	N/A	Wide channel, lack of pool, and erosion.	Sill
10.2	N/A	Wide channel, lack of pool, and erosion.	Sill
10.3	N/A	Wide channel, lack of pool, and erosion.	Sill
10.4	N/A	Wide channel, lack of pool, and erosion.	Sill

Table 3. Description of costs for each site.

Site Number	Cost
Site 0	$150,000
Site 1	$75,000
Site 2	$45,000 (2014), $20,000 (2015)
Site 3	$50,000
Site 4a	$25,000 (2014), $50,000 (2015)
Site 4b	$200,000
Site 5	$60,000
Site 6	$200,000
Site 7	$300,000
Site 8	$300,000
Site 9	$300,000
Site 10	$200,000
Total	$1,975,000

6. Project Budget, Cash Flow, and Costs of Structures

The current project cost for this restoration project on the West branch of the St. Mary's River, Guysborough County, Nova Scotia is $333,000. This amount includes a $15,000 non-monetary contribution by the St. Mary's River Association, signifying the impressive amount of work completed by volunteers. An earlier draft of this planning report has garnered over $250,000 of this funding. Moving forward, the SMRA is hopeful that additional funding will be obtained to continue to implement this plan, and eventually move toward restoring lower reaches of the West branch.

Table 4. Budget.

		Project Partners					
Activity	**Fiscal Year**	**SCH**	**NS Adopt-a-Stream**	**RFCPP**	**ASEF**	**SMRA (in-kind)**	**Total**
Restoration work	2014/2015	$105,200	$20,000	$23,000	0	0	$148,200
	2015/2016	$114,800	0	0	0	0	$114,800
Subtotal		$220,000	$20,000	$23,000	0	0	$263,000
Monitoring	2016/2017	$10,000	0	0	0	0	$10,000
	2017/2018	$10,000	0	0	0	0	$10,000
	2018/2019	$10,000	0	0	0	0	$10,000
Subtotal		$30,000	0	0	0	0	$30,000
Project Management	Overall	0	0	0	$25,000	$15,000	$40,000
Total		$250,000	$20,000	$23,000	$25,000	$15,000	$333,000

Throughout the summer of 2014, nine sills were constructed on the West River. Approximately $150,000 was spent to construct these sills. Sills include other supporting structures, such as bank protection, deflectors, and blockers, all of which contribute to making sure that the sill is able to do its job. Therefore, each sill with supporting structures is costing approximately $16,000-17,000. Approximately 100 tons of rock is used on a 40m sill; however some costs are being saved by excavating gravel from the surrounding river.

This year's costs were approximately $75,000 per kilometer restored. Next year's costs will be closer to $100,000-$150,000 per kilometer, due to more degraded river conditions and access issues.

Access to the river will add costs to this project. Private land and crown land access permits are required, as well as adherence to environmental requirements to prevent damage and siltation to the riparian zone.

Following completion of this project, we should embark on an aggressive floodplain restoration project, which would include tree and shrub planting.

7. References

DFO. (2006). Ecological Restoration of Degraded Aquatic Habitats: a Watershed Approach. Gulf Region Publication. 180pp.

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Appendix A

Before pictures of sites 0, 1, 2, 3, 4, 5 and 6. There are also a couple of pictures of the upper sections, around sites 7, 8, 9, and 10.

Site 0

Figure 1. Lower Bryden's Brook, below Site 1. This site has been identified as critical habitat to restore. Access to this site will be difficult as it is approximately 1400 m from the road to the site, 400 m of which is across old farm field, now scoured by floods. This site is similar to ones where there is a very wide channel and lack of pools.

Site 1(PID 37582855)

Figure 2. This site is at Upper Bryden Brook, about 600 metres downstream of Site 2. A holding pool will be created at this site as the existing pool is only a metre deep and 12 square metres. A series of rock sills will also be constructed and a breech will be repaired.

Figure 3. Outlet pool at Upper Bryden Brook.

Figure 4. This picture was taken about 400 metres downstream of Site 2. This is a typical over-widened channel, with a wetted width of about 45 metres. A series of rock sills will be installed here as well as a series of deflectors to help narrow the river and encourage it to stay in one channel downstream. There are also several breeches in this area, which will need to be repaired.

Site 2 (MacKay Property)

Figure 5. Site where deflector will be installed.

Figure 6. Erosion of the bank at the MacKay site.

Figure 7. A sill will be constructed here.

Figure 8. This is just below where the sill will be constructed. Note that the flow is directed toward the bank due to a diagonal bar; therefore, bank protection is required and a rock sill was installed to restore channel flow to the middle of the stream.

Site 3(PID37582806)

Figure 9. This is one of the channel breeches. It is on the left bank looking downstream. It is six metres wide and will require a channel blocker.

Figure 10. This picture is looking downstream towards the channel breech, which is on the true right side.

Site 4(PID 37582780)

Figure 11. A treatment will be required at this site, including a rock sill blended into some bank protection. The sill will be 28 metres wide.

Figure 12. This is a typical channel breech. A Newbury channel blocker will be constructed at this location. Around two hundred tons of rock will be required. The structure will tie into banks at both ends. The structure will only contain a 1 in 2 year flood, which will not prevent bank-full discharges from accessing the floodplain.

Figure 13. This picture was taken below Site 2. It is a typical bedrock outcrop, which dominates the channel between Site 1 and Site 2.

Site 5(PID 37582749)

Figure 14. Before picture. This is a site requiring a sill. It is at the end of the access road. Additional rock will be required here to tie the sill into the eroding bank. The wetted width is 28 metres here, which is about double what it should be.

Figure 15. Before picture of the channel breech below where sill two will be constructed.

Figure 16. Before picture of above where sill three is to be constructed. Bank needs recurving towards the sill.

Figure 17. This is just below where sill number three will be placed.

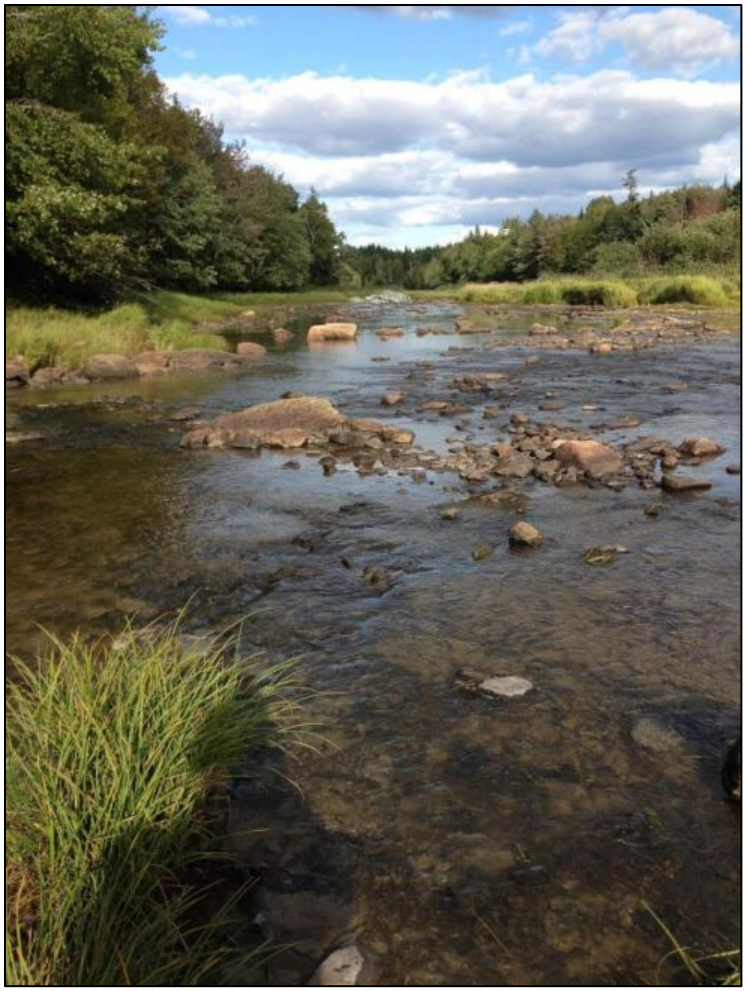

Figure 18. Before picture of below where sill four is to be constructed. Note that the large rock is buried in gravel.

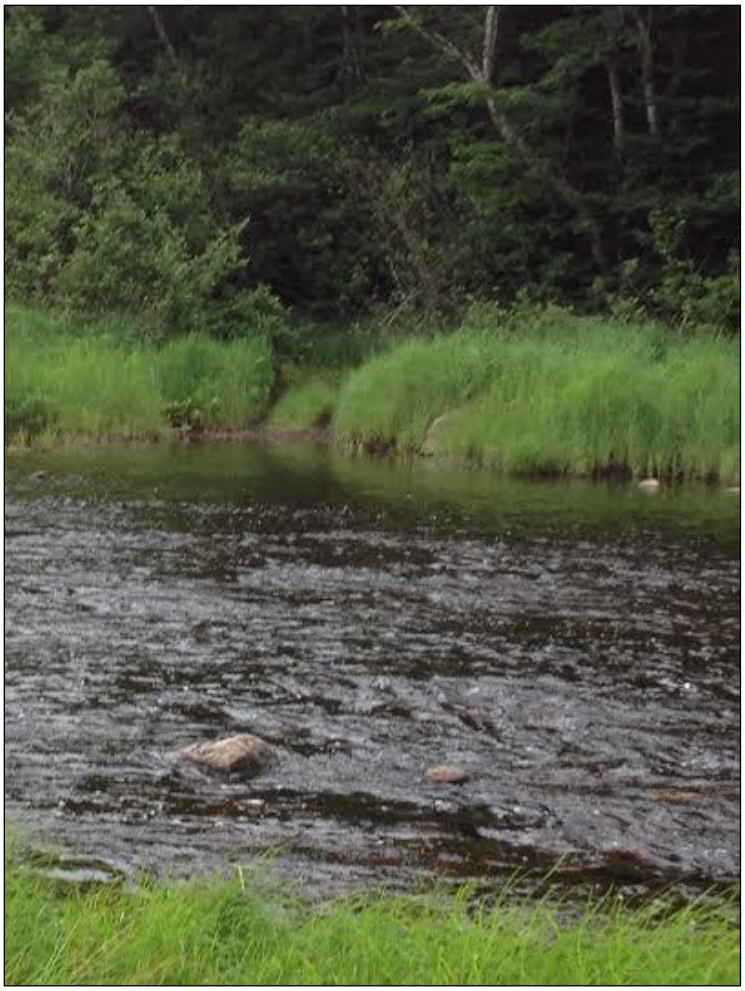

Figure 19. This is a Fording (crossing) site where access will need to be blocked. A rock sill will be constructed in this location.

Site 6

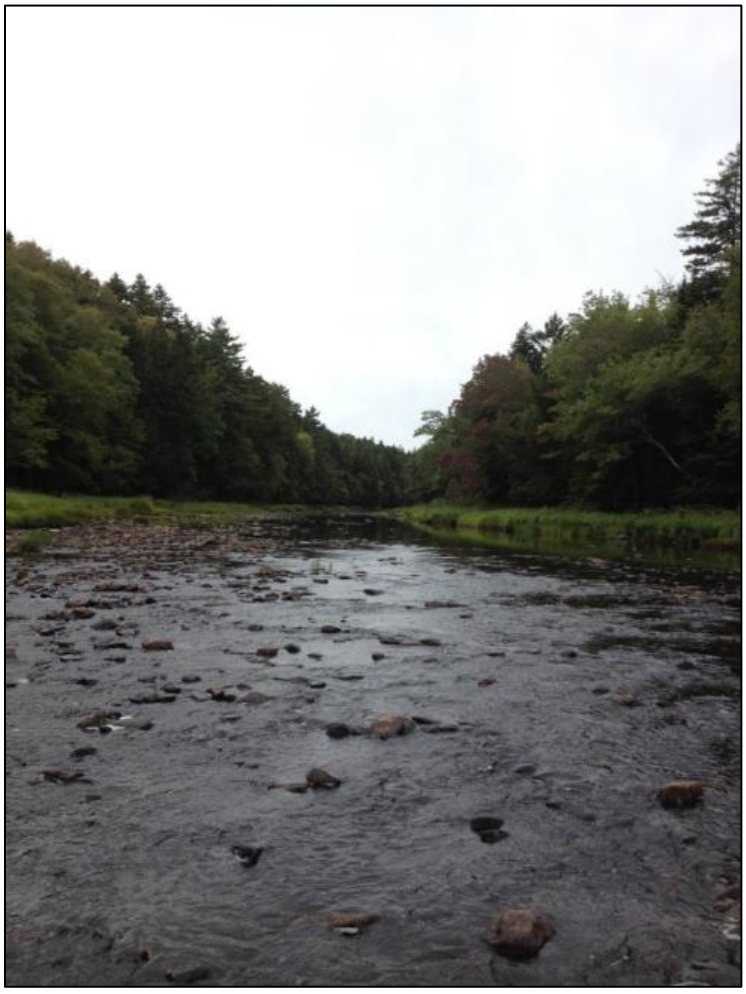

Figure 20. This site is 65 m wide at low flow. It will require a reconstructed point bar with groynes built into it. Major excavation will be required. Work on this site alone will likely cost $50,000. Much of the upper river looks like this the exception of areas with bedrock.

Upper Sections

Figure 21. Mid-channel islands, which are typical in the upper West branch. These complicate the restoration design process and increase costs. Sills and bank work will be required, with deflectors below each sill to develop point bars and help narrow the channel to its proper width. Due to the variable conditions in these upper sections, additional surveying will be required prior to restoration work.

Figure 22. This is the typical view below mid-channel islands. The river is scouring around the islands and depositing bed load below them, developing very wide channels. There are also very confined bedrock sections, which are contributing to this problem.

Appendix B

After pictures with structures installed (work done in 2014).

Site 4

Figure 1. Channel blocker at upper sill.

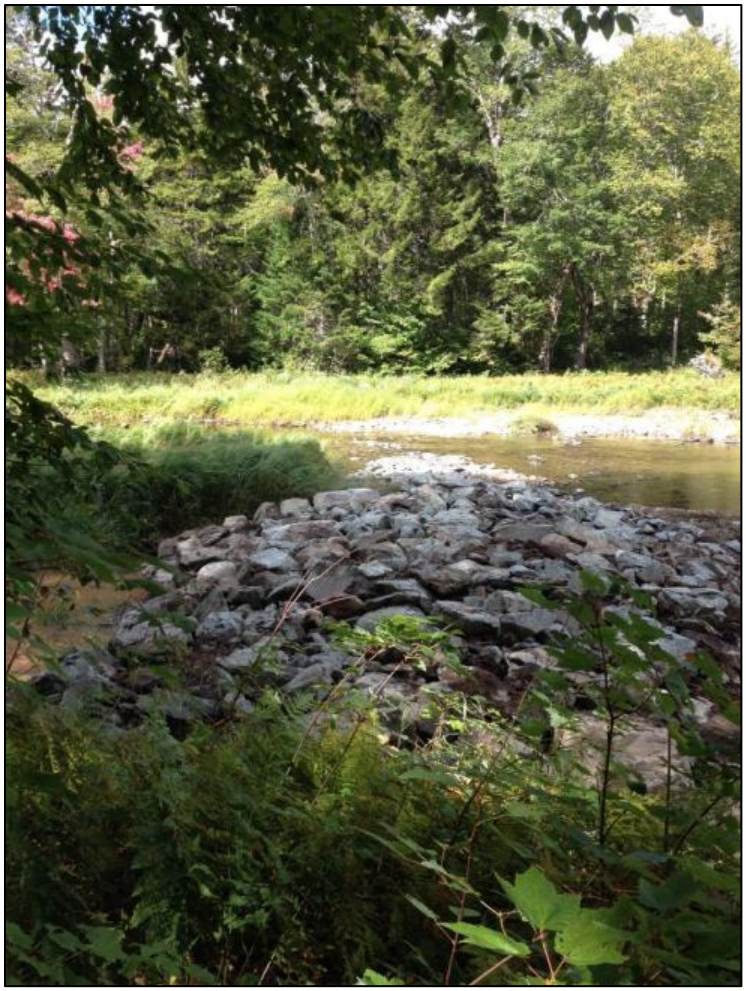

Figure 2. Rock sill with channel blocker at the upper sill (same as previous photo, but a different view).

Site 5

Figure 3. This is looking below sill number two, a deflector was constructed to re-profile the current to the middle of the river.

Figure 4. Channel breech repair below sill 2.

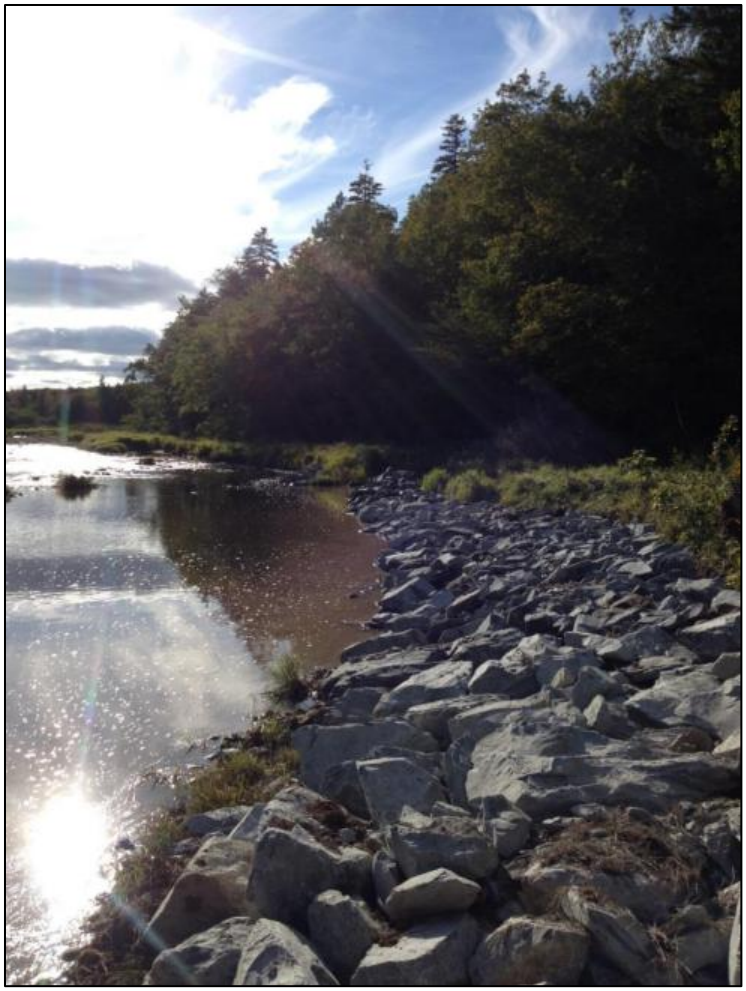

Figure 5. This is the bank work below sill two. Note the 4:1 slope on the bank instead of the normal 2:1 slope. This will assist in the planting of native trees and grasses later.

Figure 6. Deflector below sill 2.

Figure 7. Sill number three. This site required a repair to a channel breech and reshaping on the channel.

Figure 8. During construction, below sill five, looking downstream toward sill four.

Figure 9. Below sill five. The bank has been re-profiled and a 3 m deflector is tied into the bank.

Figure 10. The deflector below sill five.

Figure 11. View across sill 6. Filled cobble into rock sill.

Appendix C

Planning photos. Photos were taken using a drone (remote-controlled helicopter). This was the first year that drones have been used to assess pre- and post-restoration conditions and as a planning aid. They are a useful tool as you can get the view of the river that you want (i.e. can be close to the water for high resolution, or higher in the air for an overview image to see connectivity with the floodplain and pool-riffle sequence).

Site 2(before pictures)

Figure 1. 15m of bank protection required.

Figure 2. 30m rock sill required.

Figure 3. 40m of bank protection required.

Figure 4. 30m rock sill required.

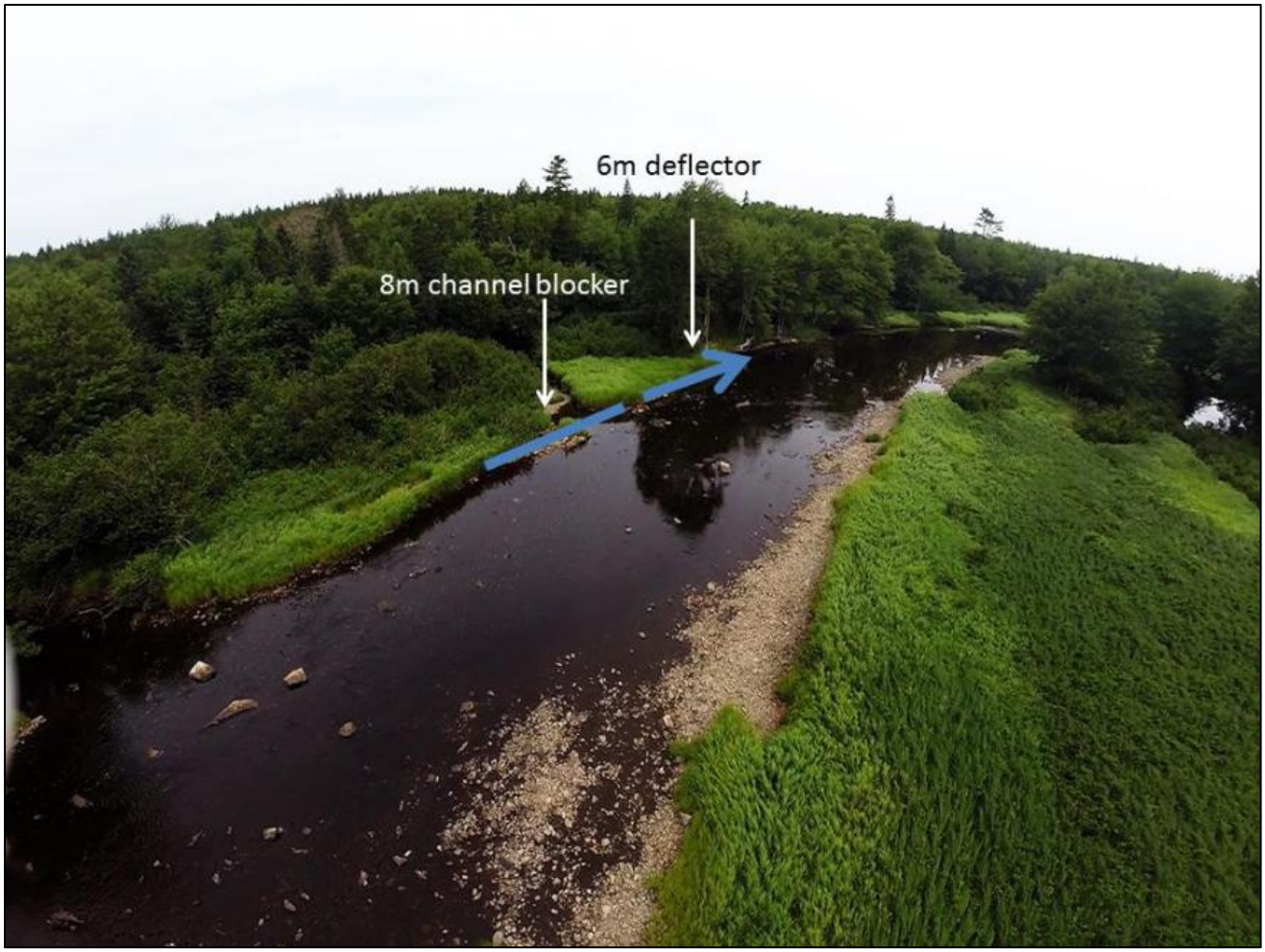

Figure 5. 8m channel blocker and a 6m deflector required.

Site 2 (after pictures)

Figure 6. 30m rock sill and bank work (looking downstream).

Figure 7. 30m sill and bank work (looking upstream).

Figure 8. Looking downstream toward bank protection and 30m rock sill.

Figure 9. 40m of bank protection.

Figure 10. 30m sill.

Figure 11. Channel blocker and deflector (looking downstream).

Figure 12. Channel blocker and deflector (looking upstream).

Site 4

Figure 13. July 2014.

Figure 14. Bank protection, November 2014.

Figure 15. Sill and channel blocker, November 2014.

Site 5

Figure 16. 30m rock sill required.

Figure 17. 30m rock sill required.