Cows and Fish Report

2014 Riparian Health Inventory Project (Year 4): Westslope Cutthroat Trout Priority Streams

A Summary of the Riparian Health Status and Habitat Improvement Needs for 14 Priority Westslope Cutthroat Trout Sites in the South Eastern Slopes of Alberta

Alberta Riparian Habitat Management Society (Cows and Fish)
Report No. 044

Cows and Fish

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About the Alberta Riparian Habitat Management Society

The Alberta Riparian Habitat Management Society (known as "Cows and Fish") is a non-profit, charitable society that strives to promote improved management and stewardship of riparian areas. As the transition zone between our uplands and waterways, protecting riparian corridors and improving riparian health provides numerous benefits including stormwater filtration, reduced erosion, flood mitigation, groundwater recharge, and fish and wildlife habitat. Cows and Fish has worked with landowners, land managers, livestock producers and community groups across Alberta since 1992 on riparian awareness, stewardship and monitoring projects.

Cows and Fish Supporters and Members: Alberta Environment and Sustainable Resource Development, Alberta Agriculture and Rural Development, Alberta Beef Producers, Trout Unlimited Canada, Alberta Conservation Association, Department of Fisheries and Oceans, Agriculture and Agri-Food Canada Agri-Environment Services Branch, the Canadian Cattlemen's Association, producers and community groups.

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- *Riparian health inventories of small stream systems do not address in-stream, hydrological parameters (i.e. issues associated with water flow regimes, water diversions, extractions, dam impacts). Water quality testing/ monitoring is* ***not*** *conducted as part of riparian health inventories.*

- *The objective of completing riparian health inventories is to provide a coarse filter review of the status of riparian health within the project area. Riparian health scores provide a general status of riparian health, not an absolute one. Riparian areas are dynamic and are constantly changing. Because of this natural variability, the range of possible scores in each category is broad and one assessment is only an approximation of health. Inventories over a period of years at the same locations will provide a better picture of whether current management is maintaining, improving or negatively impacting riparian health.*

EXECUTIVE SUMMARY

In 2014, the Alberta Riparian Habitat Management Society (Cows and Fish) conducted 14 riparian health inventories (RHIs) in priority native Westslope Cutthroat Trout stream reaches along 12 stream systems, primarily in the Upper Oldman River Sub-basin. This project builds on prior riparian health inventories conducted by Cows and Fish since 2005 on 42 priority Westslope Cutthroat Trout streams in the Eastern Slopes within the Bow and Oldman River basins. Project partners and/or primary sponsors include the Government of Canada (Environment Canada's Habitat Stewardship Program), Alberta Environment and Sustainable Resource Development (AESRD), Fisheries and Oceans Canada (DFO), the Alberta Conservation Association (ACA) and Trout Unlimited Canada (TUC). Riparian health data collected as part of this project will be used to help further Westslope Cutthroat Trout habitat stewardship and recovery efforts in Alberta. Westslope Cutthroat Trout, a *Threatened* native fish species under Canada's *Species At Risk Act* and Alberta's *Wildlife Act,* has been reduced to less than 10% of its historic range in the province.

The 2014 project area encompassed approximately 5 km of bank length and 13 ha of riparian habitat. In 2014, an important aspect of included assessing 6 short 'hotspot' reaches at stream crossings (including sites where streambank riparian plantings or bridge installation has been done or are pending). In addition to riparian health inventories, stream crossing assessments were also done for these 'hotspot' reaches. 'Hotspot' stream crossing reaches encompass riparian habitat 40 m up and downstream from the crossing. Longer reaches were also assessed (from 460 m to 830 m) in other native pure Westslope Cutthroat Trout streams with multiple land use pressures (e.g. from recreation, cattle grazing, logging or a combination of these uses).

The average riparian health rating for the 14 stream sites assessed in 2014 is 77% (*healthy, with problems*). Five of the six 'hotspot' reaches rated *healthy, with problems*, and one (GRE1) rated *unhealthy*. Of the 8 longer riparian reaches evaluated, all rated *healthy* except for DUT1 where riparian health has been degraded primarily due to intensive recreation (random camping and motorized vehicle trails). Vegetation health concerns in the project area include encroachment of invasive plant species (in all but the SMT1 site), high cover from disturbance-caused species in 5 sites, and reduced vegetation cover in 6 sites mainly due to human-caused bare ground from recreational trails. Invasive species observed include 6 *noxious weeds* and a *prohibited noxious weed* (Orange Hawkweed). The most widespread and abundant invasive species in the project area are Canada Thistle, Ox-eye Daisy and Tall Buttercup. Orange Hawkweed is presently limited in occurrence to a few sporadic plants in the VIC1 and ALL3 sites. The most severely impacted 'hotspot' stream crossing reaches with human-caused bare ground, soil compaction and soil alteration impacts that extend beyond the immediate crossing are SMT2, GOL2 and GRE1. Other sites where these types of impacts from recreational use (primarily) are also a concern are BVR42 and DUT1.

Of the stream crossings, SMT2 is the most severely impacted crossing with unstable, eroding soils due to continued fording of the stream here by trucks and all terrain vehicles despite recent efforts to install a bridge and place access obstructions on either side of the bridge. Localized riparian planting was done at the SMT2 crossing and at the ALL3 (Allison Creek) crossing in October, 2014 as part of volunteer collaborative efforts co-ordinated by Cows and Fish. This planting complements similar work done at ALL3 in the fall of 2013.

A brief review of next steps and management recommendations for riparian health improvements are provided in Section 5 of this report. Cows and Fish is continuing to engage with its project partners, landowners, grazing disposition holders, watershed groups, industry and recreational users and others to promote Westslope Cutthroat Trout habitat protection and improvement projects. Funding supported weed management, bridge costs and off-site watering development to benefit riparian health.

1 BACKGROUND

1.1 Project Overview

Reduced to less than 10% of its historic range, native pure strains of Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisii*) are now confined to a few, isolated headwater reaches in Alberta's eastern slopes (Costello 2006). As such, native pure stocks of Westslope Cutthroat Trout are designated as *Threatened* under Alberta's *Wildlife Act* and the federal *Species At Risk Act* (The Alberta Westslope Cutthroat Trout Recovery Team 2013). Given the importance of riparian areas to this species, maintaining riparian health in these remaining reaches is a priority for its continued survival.

In 2011, the Alberta Riparian Habitat Management Society (Cows and Fish) initiated a multi-year riparian health inventory (RHI) project focused on streams and rivers with native pure strains of Westslope Cutthroat Trout populations in the south eastern slopes of Alberta. The main intent of this project is to assess the current condition of priority native Westslope Cutthroat Trout riparian habitat and offer suggestions to land managers for ways to maintain or improve this habitat. This project was initiated by Cows and Fish in collaboration with Alberta Environment and Sustainable Resource Development (AESRD), Fisheries and Oceans Canada (DFO), the Alberta Conservation Association (ACA) and Trout Unlimited Canada (TUC). Primary funding for this project was provided through grants administered by ACA and through financial support provided by the Government of Canada (Environment Canada's Habitat Stewardship Program). This initiative has and will continue to involve close collaboration with fisheries biologists, Public Land managers, grazing disposition holders, private landowners, industry and recreational user groups. Since 2011, a key component of this project has been the coordination of annual multi-stakeholder workshops, educational field days and restoration demonstration days aimed at building awareness about the threats facing Westslope Cutthroat Trout, identifying solutions and encouraging collaborative management actions to promote habitat improvement.

This report describes the riparian health results for 14 Westslope Cutthroat Trout priority sites assessed during the 2014 field season by Cows and Fish on Public Land primarily in the Upper Oldman River sub-basin (most of the sites are located north of Highway 3 and west of Highway 22). Individual site scores and details are provided in individual RHI summary reports submitted to AESRD and grazing disposition holder participants.

1.2 Summary of Westslope Cutthroat Trout RHI Sites Assessed Prior to 2014

To date (excluding 2014 sites), 42 RHIs have been conducted on 30 priority Westslope Cutthroat Trout stream systems, encompassing a total of approximately 29 km of bank length and 97 ha of riparian habitat (Table 1, Maps A to D – Appendix B). This includes 15 sites inventoried in 2011, 17 sites inventoried in 2012 and 5 sites inventoried in 2013 specifically as part of this project. Five additional sites were coincidentally inventoried on priority stream reaches prior to 2011 as part of other watershed health evaluation projects led by Cows and Fish.

Table 1 Westslope Cutthroat RHI Sites 2005, 2010 to 2013

RHI Site ID	Watercourse	Date of RHI	Bank Length Inventoried (m)	Approximate Riparian Area Inventoried (ha)	ACA/AESRD Record No.	WSCT Purity
GHOST RIVER SUB-BASIN (MAP A – APPENDIX B)						
WAZ1	Unnamed tributary to Waiparous Creek	2010	560	0.3	J-G3	>=0.99
JON1	Johnson Creek	2010	1000	4.0	AFW-JC	>=0.99
WAI9	Waiparous Creek	2010	300	0.2	AFW-WC	>=0.99
ELBOW RIVER SUB-BASIN (MAP B – APPENDIX B)						
SIL1	Silvester Creek	2012	400	1.0	AFW-SiC	≥0.99
SIL2			410	1.5		
SIL3			410	1.0		
HIGHWOOD RIVER SUB-BASIN (MAP C – APPENDIX B)						
GOR1	Gorge Creek	2012	740	0.5	J-S17a	>=0.95 but <0.99
CTH1	Cutthroat Creek	2012	620	1.0	AFW-CuC	≥0.99
DEE1	Deep Creek	2011	1130	1.8	J-H11	>=0.99
FLA1	Flat Creek	2012	680	0.8	J-H7b	>=0.95 but <0.99
PEK15	Pekisko Creek	2012	710	0.7	AFW-PeC	>=0.95 but <0.99
PEK17			550	0.6	AFW-PeC	>=0.95 but <0.99
ZEP1	Zephyr Creek		550	1.0	J-H18	>=0.99
LOWER OLDMAN RIVER SUB-BASIN (MAP D – APPENDIX B)						
COL1	Corral Creek	2011	690	2.5	J-C1	≥.99
COL2		2011	450	1.1	D-W4	≥.99
JOH3	Johnson Creek	2011	890	3.6	D-W2	<0.95
JOY1	Unnamed Tributary to Johnson Creek	2011	660	0.9	D-W1	<0.95
WIL15	Willow Creek	2011	730	3.3	No data point	N/A*
UPPER OLDMAN RIVER SUB-BASIN (MAP E – APPENDIX B)						
Livingstone River Watershed						
LIV1	Livingstone River	2013	1430	15.9	(downstream from AFW-LR; but still above falls)	>=0.99
Oldman River Watershed						
HID1	Hidden Creek	2011	750	1.9	AFW-HC	>=0.99
HID2		2011	690	1.6	above D-04	>=0.99
OLD37	Oldman River (above falls)	2011	930	1.6	AFW-Ora	>=0.95 but <0.99
Callum Creek Watershed						
SHA1	Sharples Creek	2011	890	0.5	D-O3	>=0.99
Todd Creek Watershed						
TCT1	Unnamed Tributary to Todd Creek	2012	30	<0.1	ACA-Crow-8	>=0.95 but <0.99
TCT2		2012	510	0.8		
TCT3		2012	230	0.4		
Crowsnest River Watershed						
ALL1	Allison Creek	2012	1730	3.5	D-Cr2	>=0.95 but <0.99
ALL2			470	0.5	ACA-Crow-24	>=0.95 but <0.99
BLC1	Blairmore Creek	2005	90	0.1	BCA	0.95-0.99
GOL1	Gold Creek	2013	560	0.8	(between GC13BP and GC18BP)	>=0.99
RCK1	Rock Creek	2013	820	0.8	(upstream of AFW-RoC1)	>=0.99
Castle River Watershed						
CRT1	Carbondale River Tributary	2005	50	0.2	D-C4	>=0.99
CRB1	Carbondale River	2012	990	2.5	AFW-CaR	≥0.99
CRB2			690	2.1	ACA-59	>=0.95 but <0.99
LST1	Lost Creek	2011	870	5.5	AFW-LoC	>=0.95 but <0.99
LYX1	Lynx Creek	2011	880	1.1	ACA-83	>=0.99
LYX2		2011	1000	8.1	AFW-LyC	>=0.99
LYX3		2013	1390	11.2	(upstream of AFW Lyc and the Lynx Creek falls)	>=0.99
LYX4		2013	820	4.9		>=0.99
NLS1	North Lost Creek	2011	670	2.7	ACA-51	>=0.99
OHA1	O'Hagen Creek	2012	830	3.4	D-C4	≥0.99
SYN1	Syncline Brook	2012	520	0.4	ACA-44	≥0.99

Sites are listed alphabetically by sub-watershed based on geographic location from north to south.

Riparian health results for the RHI sites listed in Table 1 are described in previous summary reports compiled by Cows and Fish (Cows and Fish 2011; 2012; and 2013).

2 2014 RHI PROJECT AREA DESCRIPTION

Site Selection and 2014 Project Area Description

As was done in 2011 to 2013, RHI locations for this project were identified and selected in consultation with a collaboration of fisheries experts from AESRD, DFO, ACA and TUC. RHI sites were strategically selected on watercourses where recent fisheries assessments have confirmed the presence of genetically pure (95% purity or higher) Westslope Cutthroat Trout populations. To assist with site selection, AESRD provided Cows and Fish with a database of Westslope Cutthroat Trout population surveys and genetic purity for the Southern Rockies. Final site selection was determined based on access considerations, field scouts and/or consultation with the appropriate regional AESRD Fisheries Biologist and AESRD Public Lands, Rangeland Agrologist. In 2014, priority was given to assessing 6 short 'hotspot' reaches at stream crossings including several crossings where streambank riparian plantings or bridge installation has been done or is pending. Riparian health inventories and stream crossing assessments were done for these 'hotspot' reaches which vary in length from 70 m to 100 m (Table 2). 'Hotspot' stream crossing reaches include the stream crossing itself and immediately adjacent riparian habitat 40 m up and downstream from the crossing. Longer reaches were assessed (from 460 m to 830 m) in other native pure Westslope Cutthroat Trout stream reaches with multiple land use pressures from either recreational activities, cattle grazing, logging or a combination of these land uses.

In total, 14 sites were assessed from June to September, 2014 along 12 stream systems in the Upper and Lower Oldman River Sub-basins (Table 2, Maps D and E – Appendix B). The bulk of assessments were completed from July 9 to 18, 2014. Approximately 5.4 km of bank length and 13 ha of riparian habitat were assessed as part of the 2014 project area (Table 2).

Table 2 Westslope Cutthroat Trout 2014 Project Area RHI Sites

RHI Site ID	Watercourse	2014 RHI Assessment Date	Streambank Length Inventoried (m)	Approximate Riparian Area Inventoried (ha)	ACA/AESRD Record No.	WSCT Purity	Stream Crossing Assessment Done?
LOWER OLDMAN RIVER SUB-BASIN (MAP D – APPENDIX B)							
BVR42	Beaver Creek	July 17	800	0.8	D-01	>=0.95 but <0.99	-
TRO1	Trout Creek	July 10	490	1.98	AFW-TrC1	>=0.95 but <0.99	-
UPPER OLDMAN RIVER SUB-BASIN (MAP E – APPENDIX B)							
ALL3	Allison Creek	July 15	70	0.03	DCR2	>=0.95 but <0.99	YES
DUT1	Dutch Creek	July 14	830	6.33	DVN-DCH1	>=0.95 but <0.99	-
GOL2	Gold Creek	July 15	100	0.07	between GC13BP and GC18BP	>=0.99	YES
GOL3		September 2	80	0.1		>=0.99	YES
GRE1	Green Creek	September 2	80	0.25	Between GC13BP and	>=0.99	YES

RHI Site ID	Watercourse	2014 RHI Assessment Date	Streambank Length Inventoried (m)	Approximate Riparian Area Inventoried (ha)	ACA/AESRD Record No.	WSCT Purity	Stream Crossing Assessment Done?
					GC18BP		
MOR1	Morin Creek	July 16	90	0.03	between GC13BP and GC18BP	>=0.99	YES
NRC1	North Racehorse Creek	June 27	660	0.34	AFW-NRC	>=0.99	-
SHA3	Sharples Creek	July 10	550	0.39	D-O3	>=0.99	-
SMT1	Smith Creek	July 9	610	0.62	DVN-SRAC2	>=0.99	
SMT2		July 15	90	0.05	DVN-SRAC2	>=0.99	YES
STA1	Star Creek	July 9	460	1.86	ACA-Crow-21	>=0.99	-
VIC1	Vicary Creek	July 18	470	0.47	AFW-VC	>=0.99	-
		TOTAL	5380	13.33			

Sites are listed based on geographic location from north to south.

Land Use and Land Management

All of the 2014 RHI sites are located in headwater stream reaches in multi-use Public Land Forest Reserves managed by AESRD (Table 3). Except for sites on Gold Creek, Green Creek and Morin Creek in the CO2 Forest Management Unit (FMU), the remainder of the 2014 project area is within the C5 FMU (Table 3). The majority of sites fall within the M.D. of Ranchland No. 66 except for sites on Beaver Creek (in M.D. of Willow Creek) and Star Creek (in the Municipality of Crowsnest Pass). The entire 2014 project area is located within the Montane Natural Subregion of Alberta's Rocky Mountain Natural Region (Natural Regions Committee 2006).

The project area is used for livestock grazing, recreation and industrial land uses (i.e. logging, oil and gas exploration) in the Forest Reserves. There are various grazing dispositions in the project area (Table 3). Many of the sub-basins within the project area are popular with both non-motorized (horseback riding, hiking, biking, random camping) and motorized recreational users (various types of off-highway vehicles [OHVs]). Several of these activities have increased in recent years (recreation) or are likely to increase (i.e. logging and oil and gas development). The need for comprehensive management planning in these headwater reaches is critical to ensure all land uses continue in a planned way, while ensuring the protection of riparian health, Westslope Cutthroat Trout habitat, water quality and other ecological goods and services that those within and downstream of the watershed rely on.

Table 3 Administrative Land Management Units within the 2014 Project Area

RHI Site ID	Watercourse	AESRD Disposition No.	Disposition Name	Municipality	Forest Management Unit (FMU)
LOWER OLDMAN RIVER SUB-BASIN (MAP D – APPENDIX B)					
BVR42	Beaver Creek	PNT940113	Beaver Creek Grazing Allotment	MD of Willow Creek	C5 FMU
TRO1	Trout Creek	PNT930170	West Trout Creek Grazing Allotment	MD Ranchland No. 66	C5 FMU

RHI Site ID	Watercourse	AESRD Disposition No.	Disposition Name	Municipality	Forest Management Unit (FMU)
			(near East Trout Allotment Boundary)		
UPPER OLDMAN RIVER SUB-BASIN (MAP E – APPENDIX B)					
ALL3	Allison Creek	PNT 930200	Allison / McGillvary Creek Grazing Allotment	MD Ranchland No. 66	C5 FMU
DUT1	Dutch Creek	PNT930299	GAP Grazing Allotment (North Fork Livestock Association)	MD Ranchland No. 66	C5 FMU
GOL2	Gold Creek	GRP 870052	Grazing Permit	MD Ranchland No. 66	CO2 FMU
GOL3		GRP 870052	Grazing Permit	MD Ranchland No. 66	CO2 FMU
GRE1	Green Creek	GRL38170	Grazing Lease	MD Ranchland No. 66	CO2 FMU
MOR1	Morin Creek	GRP 870052	Grazing Permit	MD Ranchland No. 66	CO2 FMU
NRC1	North Racehorse Creek	PNT930299	GAP Grazing Allotment (North Fork Livestock Association)	MD Ranchland No. 66	C5 FMU
SHA3	Sharples Creek	PNT940143	Sharples Creek Grazing Allotment	MD Ranchland No. 66	C5 FMU
SMT1	Smith Creek	PNT930299	GAP Grazing Allotment (North Fork Livestock Association)	MD Ranchland No. 66	C5 FMU
SMT2		PNT930299	GAP Grazing Allotment (North Fork Livestock Association)	MD Ranchland No. 66	C5 FMU
STA1	Star Creek	PNT930175	Star Creek Grazing Allotment	Municipality of Crowsnest Pass	C5 FMU
VIC1	Vicary Creek	PNT930299	GAP Grazing Allotment (North Fork Livestock Association)	MD Ranchland No. 66	C5 FMU

Sites are listed based on geographic location from north to south.

3 METHODS

3.1 Riparian Health Inventory (RHI)

Riparian Health Inventories provide comprehensive information about the diversity, structure and health of plant communities and physical site integrity within the project area. This information will assist AESRD, ACA, TUC and DFO in recovery planning for Westslope Cutthroat Trout by:

- creating a baseline of riparian habitat status in priority reaches;
- identifying habitat degradation issues and concerns; and
- providing land managers and other stakeholders with an engagement tool to promote awareness and take action toward habitat improvement.

During a RHI, 79 health parameters are examined to provide comprehensive and detailed information on riparian function. For streams and small rivers, an overall riparian health rating is derived from six vegetation and five soil/hydrology parameters (i.e. key indicators of riparian function). A description of these parameters and how they are evaluated is provided in Appendix E. By objectively examining each of these health parameters, we can determine where best to concentrate management efforts aimed at improving riparian health. For a more detailed review of the RHI method, refer to Cows and Fish (2012). Riparian health ratings fall into one of three categories as described in Table 4.

Table 4 Description of Riparian Health Ratings

Health Category	Score Ranges	Description
Healthy	80-100%	Little to no impairment to any riparian functions
Healthy with problems	60-79%	Some impairment to riparian functions due to management or natural causes
Unhealthy	<60%	Severe impairment to riparian functions due to management or natural causes

Healthy riparian areas have the following pieces intact and functioning properly (Fitch *et al.* 2001):

- successful reproduction and establishment of seedling, sapling and mature trees and shrubs (if site has potential to grow them);
- lightly browsed trees and shrubs (by livestock or wildlife);
- floodplains and banks with abundant plant growth;
- banks with deep-rooted plant species (trees and shrubs);
- very few, if any, invasive weeds (e.g. Canada Thistle [*Cirsium arvense*]);
- not many disturbance-caused plant species (e.g. Kentucky Bluegrass [*Poa pratensis*], Common Dandelion [*Taraxacum officinale*]);
- very little bare ground or altered banks; and
- the ability to frequently (i.e. every few years) access a floodplain at least double the channel width.

3.2 General Inventory Protocol

Riparian health parameters are visually assessed by trained observers in the field. A health rating is derived from this field data using a computer software program (FileMaker Pro).

A hand-held Garmin GPS60^{TM} Global Positioning System (GPS) receiver is used to record the locations of the upstream and downstream ends of the site. For monitoring purposes, benchmark photographs looking upstream and downstream are taken at each end of the site. Additional photographs are taken where warranted to document features of interest or concern (e.g. weed infestations, bank erosion, etc.). The lateral extent (outer boundary) of the riparian area is determined in the field and traced by hand on an airphoto. The inner RHI boundary includes the portion of the wetted channel with persistent emergent vegetation (e.g. cattails and sedges). In situations where there is no emergent vegetation, the wetted channel (aquatic zone) is not included in the assessment. A combination of indicators, including vegetation change to predominantly upland species, topographic breaks and flood evidence, are used to delineate the outer boundary of the riparian area.

On creeks and small rivers, both sides of the waterbody are inventoried, as these generally have the same ownership and type of management. Landmarks such as fence lines, tributaries or other identifiable features are used, where possible, to delineate the ends of the site in order to facilitate

monitoring the same section of stream in the future. Inventory sites encompass a minimum of two meander cycles (Fitch *et al.* 2001). A complete meander cycle has equal inside and outside curvature.

3.3 Classification of Riparian Plant Communities

The Range Plant Community Type Guide for the Montane Subregion (Willoughby *et al.* 2008) was used to classify riparian plant communities in the project area. This Montane guide is based on field sampling of over 1,800 sites in the Montane Subregion in Alberta. Plant community types that did not fit with any of the types in this guide were described as "Unclassified" and assigned a conditional plant community name based on dominant plant species in one or more life form layers (as appropriate).

3.4 Additional Westslope Cutthroat Trout Habitat Data

To describe in-stream habitat characteristics, measurements were taken of channel width; channel bottom substrate composition; and "embeddedness" and "cementedness" as described in detail in Cows and Fish (2012). "Embeddedness" and "cementedness" refer to course estimates that were taken to assess the degree to which small cobble and gravel substrate were "embedded" or "cemented" by the long-term accumulation of fine sediment. Additional photographs and waypoints were also taken to document any potential barriers to fish movement (e.g. headcuts >50 cm vertical height, hanging culverts etc.) encountered along the entire RHI reach.

3.5 Stream Crossing Monitoring

Stream crossing assessments for six 'hotspot' reaches were done using methods adapted from those described and developed by ACA (Fitzsimmons and Fontana 2004). At each monitoring site quantitative and qualitative data was recorded to document the current condition of the crossing, including:

- representative digital photography of left and right banks;
- UTM location of the stream crossing;
- width of the active linear disturbance on the left and right bank at the crossing location measured as a straight line distance (0.1 m) and shoreline contour distance (0.1 m) from transect 3 (at the downstream edge of the crossing) to transect 5 (at the upstream edge of the crossing) (Figure 1);
- wetted width (0.1 m) measured at seven transects as the width of the water surface measured at a right angle to the direction of flow;
- rooted width (0.1 m) measured at six of the seven transects (excluding the crossing disturbance) as the distance at a right angle to the direction of flow from woody rooted vegetation to woody rooted vegetation;
- streambed substrate composition (see Table 5) estimated from three areas at each transect;

- approach erosion rating for left and right approaches according to the guidelines in Table 6;
- bank stability rating for the stream banks between transects #1-2, 2-3, 5-6 and 6-7 (Figure 1) according to the guidelines in Table 7;
- stream bank root mass protection rating for the stream banks between transects #1-2, 2-3, 5-6 and 6-7 (Figure 1) according to the guidelines in Table 8;
- overall stream crossing impact rating based on the guidelines in Table 9; and
- combined ranking score (i.e. minimally, moderately or highly impacted) (Table 10) calculated as the average of the left and right bank approach erosion ratings and the impact ratings.

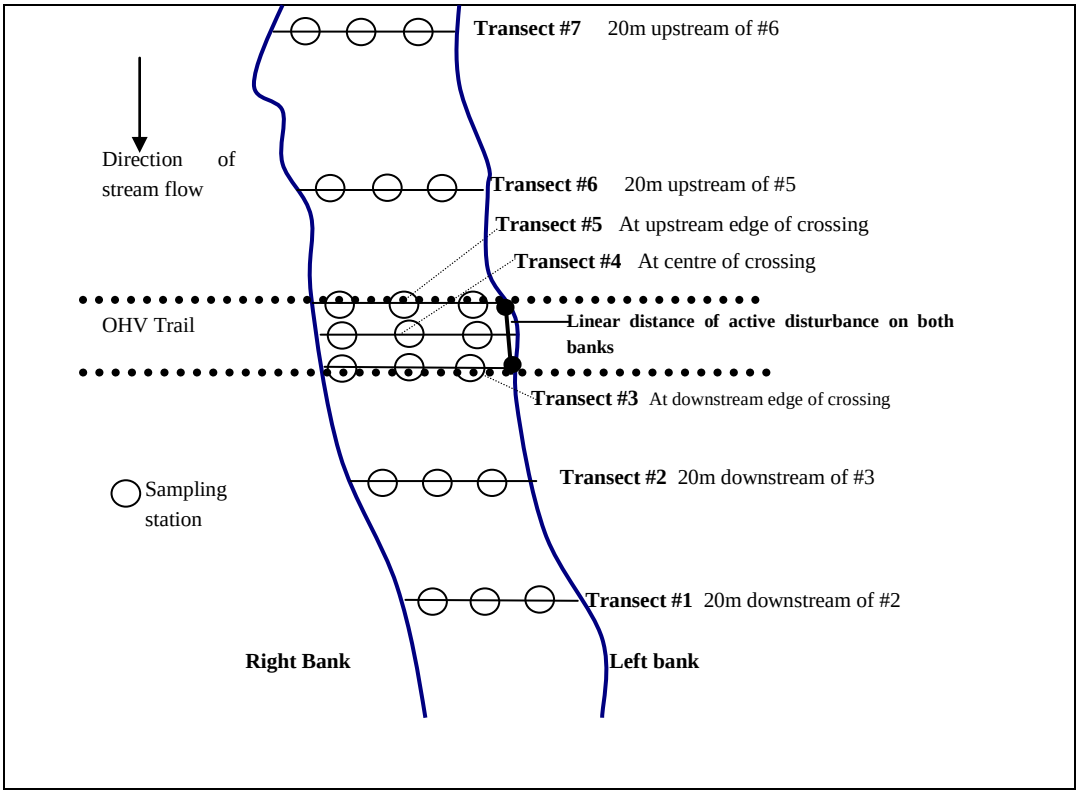


Figure 1 Schematic of Stream Crossing Sampling Protocol

Table 5 Classification of Substrate Size

Substrate Size	Classification*
<2 mm	Fines
2 – 16 mm	Small Gravel
17 – 64 mm	Large Gravel
65 -256 mm	Cobble
>256 mm	Boulder
Bedrock	Bedrock

**Adapted from Fitzsimmons and Fontana 2004*

Table 6 Approach Erosion Potential Rating Guidelines

Approach Erosion Potential Rating	Rating Criterion*
1	**Unerodable** (e.g. bedrock substrates on gentle to steep slopes and hard-packed rock with no loose sediments on gentle slopes).
2	**Little to no erosion** (e.g. stable, hard-packed rock with little to no loose sediments on gentle to moderate slopes and gravel with loose sediments on gentle slopes).
3	**Moderate erosion** (e.g. hard-packed rock with little to no loose sediments on steep slopes, gravel with loose sediments on gentle to moderate slopes and loose fines and soft sediments on gentle slopes)
4	**Extensive erosion** (e.g. gravel with loose sediments on steep slopes and loose fines and soft sediments on gentle to steep slopes)

**Adapted from Fitzsimmons and Fontana 2004*

Table 7 Bank Stability Rating Guidelines

Bank Stability Rating	Bank Considered to be:	Rating Criterion*
1	**Stable**	Banks not susceptible to erosion.
2	**Slightly Unstable**	>50% of banks in section are stable, limited indication of erosion and stream sedimentation.
3	**Moderately Unstable**	>50% of bank instability, some indications of stream sedimentation from bank instability.
4	**Highly Unstable**	Massive bank slumping, large deposits of substrates in stream.

**Adapted from Fitzsimmons and Fontana 2004*

Table 8 Streambank Root Mass Protection Rating Guidelines

Streambank Root Mass Protection Rating	Rating Criterion*	*Type of Waterbody*	*Evaluation Zone*
1	**>85%** of streambank has deep binding root mass	Intermittent drainage (<1 m rooted width)	Up to 1 m on floodplain
2	**65-85%** of streambank has deep binding root mass	Small stream (1 – 3 m rooted width)	Up to 3 m on floodplain
3	**35-65%** of streambank has deep binding root mass	Large stream (3 -5 m rooted width)	Up to 5 m on floodplain
4	**<35%** of streambank has deep binding root mass	Small river (<5 m rooted width)	Up to 10 m on floodplain

**Adapted from Fitzsimmons and Fontana 2004*

Table 9 Overall Impact Rating Guidelines

Overall Impact Rating	Rating Criterion
1	**Stable** crossing with little potential for further erosion. **Minimally disturbed** streambanks and streambed, no alterations to the surrounding riparian area and little sediment input into stream from crossing activity.
2	**Slightly unstable** crossing with moderate potential for further erosion. **Slight disturbance** of streambanks, streambed and surrounding riparian area. **Stream receives slight input of sediment from crossing activity**.
3	**Highly unstable** crossing with potential for considerable erosion. **Moderately disturbed** streambanks, streambed and surrounding riparian area. **Stream receives moderate input of sediment from crossing activity.**
4	**Extremely unstable crossing** with potential for excessive erosion. **Severe disturbance** of stream banks, streambed and vast alterations to surrounding riparian area. **Stream receives severe input of sediment from crossing activity.**

**Adapted from Fitzsimmons and Fontana 2004*

Table 10 Combined Ranking Score Guidelines

Combined Ranking Score Range	Crossing considered to be:
1.0 – 2.0	Minimally impacted from crossing activity
2.3 -3.0	Moderately impacted from crossing activity
3.3 -4.0	Highly impacted from crossing activity

*Adapted from Fitzsimmons and Fontana 2004

4 RESULTS AND DISCUSSION

4.1 Overview of Riparian Health Results

The average riparian health rating for the 14 stream sites assessed in 2014 is 77% (*healthy, with problems*). Since 6 'hotspot' stream crossings[1] were deliberately selected as part of the project area, these results are not representative of stream reach or watershed conditions. Five of the six 'hotspot' reaches rated *healthy, with problems*, and one (GRE1) rated *unhealthy* (Figure 2). Of the 8 longer riparian reaches evaluated, all rated *healthy* except for DUT1. Recreational land use impacts primarily contributed to a *healthy, with problems* rating for DUT1 within a reach of Dutch Creek popularly used for random camping and motorized recreation. By area, given the disproportionately large size of the DUT1 site (6.3 ha, almost half of the total 2014 project area), by area 69% (9.3 ha) of riparian habitat evaluated rated *healthy, with problems* (Figure 3).

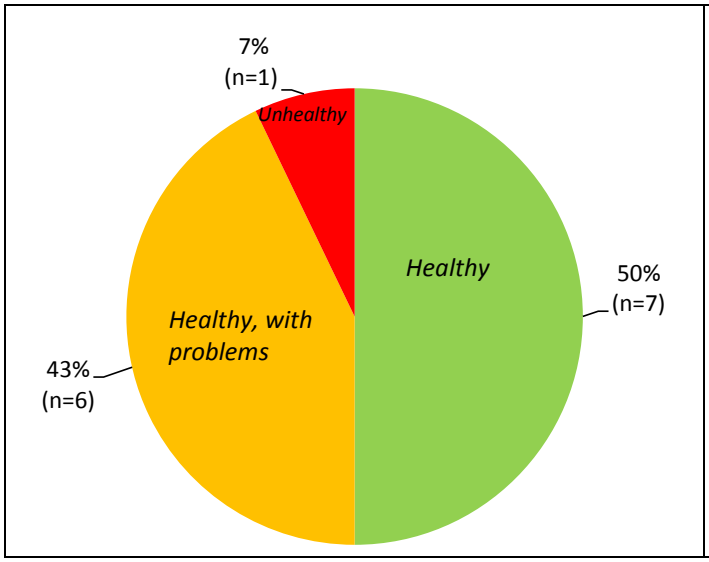


Figure 2 2014 Riparian Health Results

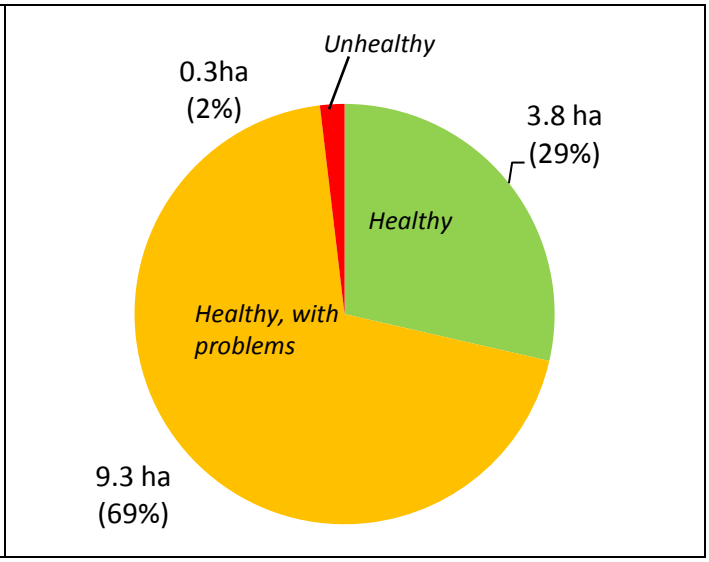


Figure 3 2014 Riparian Health Results by Area

The average riparian health rating for the entire 2005-2014 Westslope Cutthroat Trout project area (n=56) is 82% (*Healthy*) (excluding the SHA2 reach within former native pure Westslope Cutthroat

[1] "Hotspot" stream crossing reaches encompass riparian habitat 40 m up and downstream from the crossing.

Trout habitat). Of the 56 native pure Westslope Cutthroat Trout RHI sites within this overall project area, 36 (64%) rate as *Healthy*, 18 (32%) rate as *Healthy, with problems* and 2 (4%) rate *Unhealthy.*

4.2 Riparian Plant Communities in the Project Area

Twenty three community types were described for the 2014 project area using the 2008 Montane Range Plant Community Guide (Willoughby *et al.* 2008) (Table 11). The majority (approximately 77%) of the project area is characterized by coniferous tree community types (Table 11). Native willow types form the dominant shrub cover, with typical occurrence along streambanks.

Table 11 Plant Community Types in the Project Area

Plant Community*	AESRD Range Plant Community Guide Plant Community Code*	RHI Sites Where Found	Frequency of Occurrence in RHI Sites	Area Occupied (ha)**	Area Occupied (%) **
Tree Communities					
White Spruce / Common Horsetail	E12A	BVR42, DUT1, NRC1, SHA3, SMT2, STA1, TRO1,VIC1	57%	5.01	37.5%
Lodgepole Pine /Common bearberry - Juniper	E3	DUT1	7%	2.53	19.0%
Aspen / Timothy - Kentucky Bluegrass	G7	TRO1	7%	0.79	5.9%
White Spruce / Thimbleberry	E16	SMT1	7%	0.60	4.5%
Balsam Poplar - Aspen / Red-osier Dogwood / Kentucky Bluegrass	G16	STA1	7%	0.37	2.8%
White Spruce / Moss	E12	SHA3, NRC1	14%	0.29	2.2%
White Spruce - Lodgepole Pine / Green Alder - Common Bearberry	E4	VIC1	7%	0.24	1.8%
White Spruce - Balsam Poplar / Buckbrush	F11	GRE1	7%	0.15	1.1%
White Spruce / Ground Juniper - Common Bearberry	E24	GOL3	7%	0.09	0.7%
White Spruce - Aspen / Scouring Rush	F12	MOR1, GOL2, NRC1	21%	0.11	0.9%
Lodgepole Pine /Thimbleberry	E13	ALL3	7%	0.01	0.1%
Balsam Poplar - White Spruce / Rose / Forb	F14	GOL3	7%	0.01	0.1%
			Total	**10.20**	**76.5%**
Shrub Communities					
Beaked Willow / Hairy Wild Rye	D3	DUT1	7%	1.90	14.3%
Drummond's Willow	D2A	ALL3, SMT2, STA1, VIC1	29%	0.50	3.8%
Beaked Willow / Kentucky Bluegrass - Timothy	D4	BVR42	7%	0.32	2.4%
Beaked Willow / Marsh Reed Grass	D16	NRC1	7%	0.03	0.3%
River Alder - Beaked Willow / Beaked Sedge	Unclassified	GRE1	7%	0.03	0.2%
River Alder / Marsh Reed Grass	D22	ALL3		0.00	0.0%

Plant Community*	AESRD Range Plant Community Guide Plant Community Code*	RHI Sites Where Found	Frequency of Occurrence in RHI Sites	Area Occupied (ha)**	Area Occupied (%) **
			Total	**2.79**	**20.9%**
Herbaceous (Non-Woody) Communities					
Kentucky Bluegrass - Timothy	H23	BVR42, SHA3, TRO1	21%	0.26	1.9%
Kentucky Bluegrass - Tufted Hair Grass	C16	GRE1	7%	0.05	0.4%
Unclassified herbaceous community (includes Spangletop)	Unclassified	ALL3	7%	0.00	0.0%
Disturbance weedy Unclassified Community	Unclassified	SMT2, VIC1	14%	0.06	0.4%
			Total	**0.37**	**2.8%**
Other Ground Cover Types					
Gravel Surface	-	GRE1	7%	**0.03**	**0.2%**

Based on Willoughby et al. 2008. Listed in order of decreasing size by area.* * All values are approximate*

Tree Communities

There are five White Spruce (*Picea glauca*) dominant coniferous tree communities in the project area and three mixed wood communities where White Spruce is co-dominant with either Balsam Poplar (*Populus balsamifera*) or Aspen (*Populus tremuloides*) (Table 11). By area the White Spruce / Common Horsetail (*Equisetum arvense*) community is most abundant (**Photo a**, page 14), occupying almost 40% of the project area and occurring in 8 of the 14 RHI sites (Table 11). This community is typical of moist, nutrient rich soil conditions and is often associated with seepage areas and high water tables. This community is rated as non-use for livestock as it has little palatable forage (Willoughby *et al*. 2008). Lodgepole Pine (*Pinus contorta*) is the second dominant tree cover type in the project area, comprising 40% of the large DUT1 riparian site in association with coarse-textured soils and south exposures (**Photo b**, page 14). Deciduous Aspen or Balsam Poplar – Aspen communities are less common, occurring primarily in the TRO1 (**Photo c**, page 14) and STA1 sites. Deciduous communities in these sites have modified herbaceous understories with high cover from Kentucky Bluegrass and/or Timothy (*Phleum pretense*), making them more desirable for livestock grazing.

Shrub Communities

There are six shrub communities in the project area, primarily willow types (Table 11). A native Beaked Willow (*Salix bebbiana*) / Hairy Wild Rye (*Elymus innovates*) type has the greatest cover by area, but it occurs exclusively in the DUT1 site. Of note, in this instance, for DUT1, Dusky Willow (*Salix melanopsis*) and Firm Leaf Willow (*Salix pseudomyrsinites* syn. *Salix myrtillifolia* var. *cordata*) are in fact dominant, not Beaked Willow, although similar in composition otherwise to this D3 Montane reference plant community type. Drummond's Willow (*Salix drummondiana*) dominant communities occur along the streambanks in ALL3 (**Photo d**, page 14), SMT1, STA1 and VIC1 (Table 11). River Alder (*Alnus tenuifolia*) is the dominant or co-dominant shrub type in ALL3 and GRE1 (Table 11). Most shrub communities have native graminoid understories with multiple sedge, rush or native grass species (primarily Beaked Sedge [*Carex utriculata*] and Marsh Reed Grass

[*Calamagrostis canadensis*]), except for a disturbed Beaked Willow / Kentucky Bluegrass – Timothy community in BVR42 with non-native understory grasses.

Herbaceous Communities

Most of the project area has tree and shrub canopy cover. Small patches of herbaceous cover within tree and shrub complexes were not separately mapped or classified. Localized open clearings with herbaceous vegetation and no overstory tree cover occur in association with disturbed portions of the ALL3, BVR42, GRE1, SHA3, SMT2, TRO1 and VIC1 sites near access trails, roads, disturbed open meadows or historically converted seeded pasture. These herbaceous communities represent either modified grasslands dominated by Kentucky Bluegrass and Timothy (Photo **e**, page 14) or unclassified types with a mix of disturbance-caused grasses and forbs. In sites with localized or more recent disturbance, such as in GRE1, native graminoids (i.e. Tufted Hair Grass [*Deschampsia cespitosa*]) are co-dominant with non-native grasses.

Plant Species Diversity in the Project Area:

There is a high diversity of native plant species in the project area. Greater plant species diversity creates more robust and steady primary productivity over the long term and enhances resilience to natural year-to-year environmental fluctuations, climate change, pest outbreaks and disease.

- A total of 249 plant species were recorded in the project area (Appendix D), including 7 tree, 49 shrub, 48 grass/grass-likes and 145 forb species (Appendix D). Of these species, 211 (85%) are confirmed native species and 33 (13%) are introduced (non-native) forbs or grasses (including invasives). Four other plants could not be positively identified to species. One other, Red Fescue (*Festuca rubra*), has both native and non-native strains known to occur in the Montane region of Alberta.
- Dominant trees and shrubs (with approximately 5% or greater cover in the project area) include White Spruce, Lodgepole Pine, Firm Leaf Willow, River Alder, Canada Buffaloberry (*Sheperdia canadensis*), Buckbrush (*Symphoricarpos occidentalis*), Common Bearberry (*Arctostaphylos uva-ursi*) and Dusky Willow (Appendix D).
- Dominant grass and grass-like species (with approximately 2% or greater cover in the project area) include three non-native species (Kentucky Bluegrass, Timothy and Smooth Brome [*Bromus inermis*]) and two native species (Hairy Wild Rye and Wire Rush [*Juncus balticus*]) (Appendix D).
- Dominant forbs (with approximately 2% or greater cover in the project area) include Common Horsetail, Wild Strawberry (*Fragaria virginiana*), Common Dandelion, Wild Vetch (*Vicia americana*), White Clover (*Trifolium repens*), Yellow Angelica (*Angelica dawsonii*), Cow Parsnip (*Heracleum lanatum*), Common Yarrow (*Achillea millefolium*) and White Angelica (*Angelica arguta*). Of these, Common Dandelion and White Clover are non-native species.

Photo a: An example of the dominant tree community type in the project area, a White Spruce / Common Horsetail community. Although it has little palatable forage for livestock, this native plant community has high fish and wildlife habitat value. (*Photographer: A. Sarrazin, Catalogue No: RHIP01NRC017*)

Photo b: A Lodgepole Pine / Common Bearberry - Juniper community is associated with south exposures and coarse-textured soils on the south bank of Dutch Creek (to the left). White spruce and willow types occur on north exposures and moist streambank or point bar features of this creek (to the right). (*Photographer: J. Melsted, Catalogue No: RHIP01DUT017*)

Photo c: An Aspen / Timothy-Kentucky bluegrass community occurs along the upstream reach of Trout Creek (TRO1). Human-caused ecosystem modifications (e.g. logging roads, livestock grazing, recreation use, etc.) have contributed to an influx of non-native disturbance-caused grasses and forbs in the understory. (*Photographer: A. Sarrazin, Catalogue No: RHIP01TRO020*)

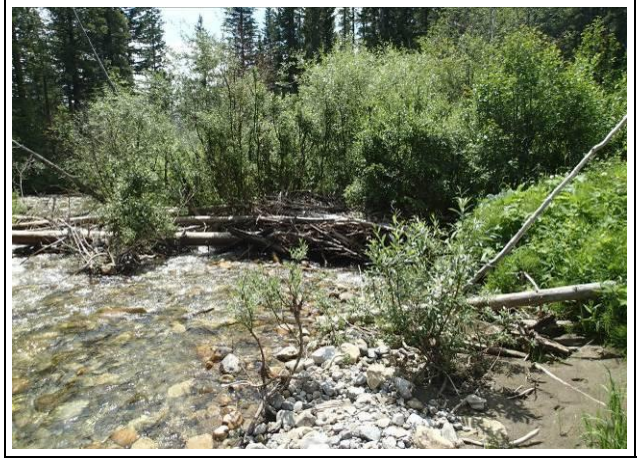


Photo d: Drummond's Willow is commonly occurring in the project area where it forms dense, tall stands along the streambank. (*Photographer: A. Sarrazin, Catalogue No: RHIP03ALL004*)

Photo e: A modified Kentucky Bluegrass - Timothy community along Sharples Creek in SHA3. Historic conversion of adjacent lands to seeded pasture has contributed to proliferation of non-native grasses in this watershed. (*Photographer: A. Sarrazin, Catalogue No: RHIP03SHA005*)

EXAMPLES OF RIPARIAN PLANT COMMUNITY TYPES IN THE PROJECT AREA

4.3 Vegetation Health Parameter Results

The average vegetation health rating for the 2014 RHI sites is 75% (*healthy, with problems*). On average, most sites have healthy amounts of native tree and shrub regeneration, minimal woody cover removal by humans or beavers and few dead or decadent trees or shrubs (Figure 4). Vegetation cover has been reduced in the stream crossing 'hotspot' sites and in DUT1 mainly due to recreational use impacts. Other vegetation health concerns include encroachment of disturbance-caused and / or invasive plant species (Figure 4). Although browse utilization is apparent it is not a management concern in most sites given the overall high density, cover and regeneration of preferred woody plants.

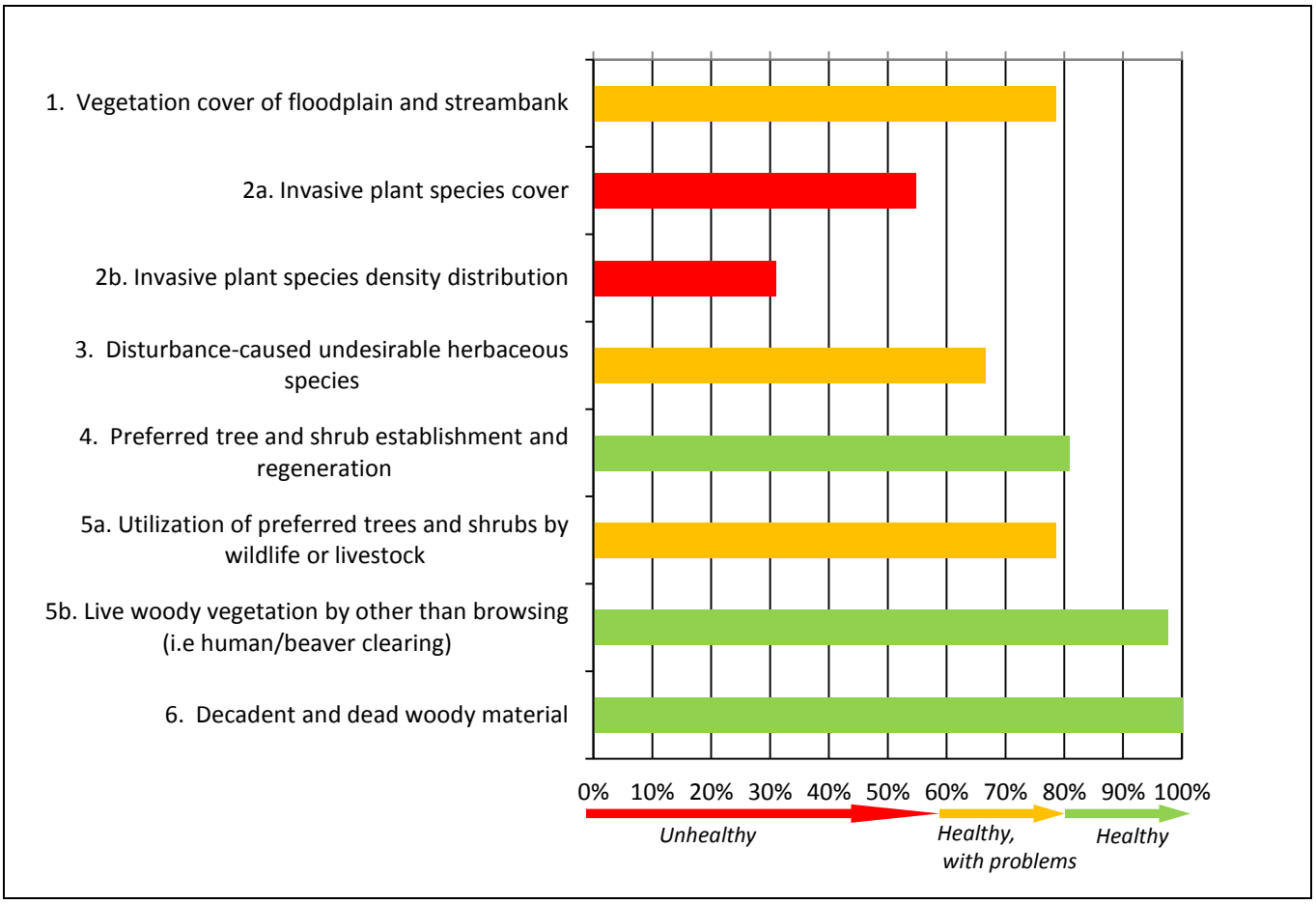


Figure 4 Vegetation Health Parameter Results

Herbaceous (Non-Woody) Riparian Health Parameters

Invasive plant species occur in all of the 2014 RHI sites except for SMT1. Disturbance-caused plant species are prevalent in 5 of the 14 RHI sites. Invasive plants are introduced species that are listed on Alberta's *Weed Control Act* as *prohibited noxious* and *noxious weeds* and others known to be problematic in riparian areas. They are non-native species that spread rapidly and are difficult to control. Disturbance-caused plants are typically non-native grasses and forbs that aggressively displace native plants once the soil surface has been disturbed.

An influx of shallow-rooted invasive and disturbance-caused plants can negatively impact Westslope Cutthroat Trout habitat by reducing overhanging woody cover and accelerating bank erosion, thereby contributing to increased sedimentation and degraded water quality. These undesirable plants also contribute to degraded rangeland health and productivity. Livestock avoid many invasive species (e.g. ox-eye daisy [*Chrysanthemum leucanthemum*] and tall buttercup [*Ranunculus acris*]) as they are highly unpalatable and have poor forage value. Tall buttercup is particularly problematic as it contains high concentrations of an irritant, protoanemonin, which causes inflammation of the throat and digestive tract in livestock and can be fatal if large quantities are ingested (Tannas 2004). Widespread incursion of invasive and non-native disturbance-caused plants may also alter the dynamics of natural food webs due to displacement of preferred native plant species that have evolved with the local fauna.

- **The prevalence of invasive plants is a concern.** Six *noxious weeds* were observed in the project area: Blueweed (*Echium vulgare*), Canada Thistle, Hound's-Tongue (*Cynoglossum officinale*), Ox-eye Daisy (*Chrysanthemum leucanthemum* syn. *Leucanthemum vulgare*), Perennial Sow-Thistle (*Sonchus arvensis*) and Tall Buttercup (*Ranunculus acris*). **Of note, Orange Hawkweed (*Hieracium aurantiacum*), a *prohibited noxious weed* was observed in trace amounts in the VIC1 and ALL3 sites.** Detailed location information for these weeds has been given to AESRD and is described in the individual report summaries for these sites. There is a legal requirement to 'destroy' weeds in the *prohibited noxious* category. Unlike many *noxious weeds*, *prohibited noxious weeds* are presently not yet widespread in Alberta, and a priority for the Alberta government is to prevent further invasion by these species.
- **The most widespread and abundant invasive species in the project area are Canada Thistle, Ox-eye Daisy and Tall Buttercup.** Canada Thistle occurs in trace amounts in 7 sites, but it has 1-5% cover in BVR42. Ox-eye Daisy occurs in 9 sites. It is especially abundant along Gold Creek, Green Creek and Allison Creek. Tall Buttercup occurs in 6 sites, with above trace levels in the MOR1 and GOL2 stream crossing 'hotspot' reaches.
- **Collectively, invasive plants comprise approximately 0.7% of the 2014 project area.** Combined weed canopy cover and density distribution is highest (approximately 1 to 5%) for the GOL2, GOL3, GRE1, ALL3 and MOR1 stream crossing 'hotspot' reaches and for BVR42.
- **Invasive plants are absent from SMT1 and are limited to a few sporadic plants in SMT2, SHA3 and VIC1.** A priority for weed management is to eliminate invasive species from sites where they are not yet widespread before infestations worsen.
- **Non-native disturbance-caused plants have more than 50% cover in BVR42 and TRO1; 25% to 50% cover in GRE1, DUT1 and GOL2; and 5% to 25% cover in SHA3 and STA1**. Disturbance-caused plants in these sites are associated with historic and recent human and natural-caused disturbance factors, mainly recreational use impacts, livestock grazing and access roads. The remainder of the project sites have less than 5% disturbance-caused plants, localized to road ditches or access trails (e.g. VIC1 – **Photo g**, page 18).

- **Of the 21 disturbance-caused plants present, 6 are grasses and 15 are forbs.** Most of these are introduced species such as Timothy and Clover, but four are native species that naturally colonize areas of exposed soil (e.g. Wild Strawberry). The most abundant disturbance-caused plants are Kentucky Bluegrass, Timothy, Smooth Brome and Common Dandelion.

Total Vegetation Cover and Woody Canopy Cover

A high level of vegetation cover in the riparian area, in particular cover from native trees and shrubs, provides soil stabilization and minimizes potential for erosion and sediment runoff into trout bearing streams. Riparian habitats in the moist foothills and montane regions of Alberta typically all have potential to support tree and shrub community types. A diversity of native woody plants provides short, medium, and tall wildlife habitat layers and a diversity of rooting depths across the site.

- Most sites (8 of 14), have more than 95% vegetation cover from dense, multi-structured and floristically diverse native tree and shrub communities.
- Sites where vegetation ground cover is lacking by at least 10% are the GRE1, SMT2 and ALL3 stream crossings. Sites with slight amounts of reduced vegetation (5%-10%) include BVR42, DUT1 and GOL2. Natural deposition of sediment from recent flooding has created areas of natural bare ground in the BVR42 site. Reduced vegetation cover in DUT1 and GOL2 is mainly due to recreational impacts.
- A wide variety of native trees and shrubs, in combination, cover approximately 80% of the project area (**Photo f**, page 18). Refer to page 12 and Appendix D for a listing of dominant tree and shrub species in the project area.

Woody (Tree and Shrub) Riparian Health Parameters:

- ***Establishment and Regeneration***

A good indicator of ecological stability of a riparian reach is the presence of woody plants in all age classes, especially young age classes. To maintain age class structure, at least 15% of the total cover of preferred trees and shrubs should be comprised of seedlings and saplings. Preferred woody plants include deeply rooted native species and/or preferred browse species for livestock or wildlife such as red-osier dogwood and willows.

- Most sites have healthy amounts of native tree and shrub regeneration (**Photo i**, page 18), except for ratings of 4/6 for GOL2, GOL3, SHA3, TRO1 and VIC1. These sites have 5% to 15% canopy cover from seedling or sapling preferred trees and shrubs.
- The SMT2 stream crossing reach rated 2/6 for regeneration, indicating that there is less than 5% canopy cover here from seedling or sapling preferred trees and shrubs. Riparian planting was done at SMT2 in the fall of 2014 (after the riparian health inventory was conducted).
- Of note, riparian plantings done in the fall of 2013 in the ALL3 site could not yet be counted toward seedling or sapling cover. Human plantings need to have survived for at least one full growing season before they can be counted as successfully established.

Photo f: Dense native tree and shrub communities along this reach of Star Creek (STA1) provide high amounts of ground stabilization and cover and sheltering habitat for fish and wildlife. (*Photographer: J. Melsted, Catalogue No: RHIP01STA008*)

Photo g: Disturbance-caused plant communities are concentrated in many sites to disturbed road ditches, such as the Highway 40 crossing at the upstream end of VIC1 on Vicary Creek. (*Photographer: J. Melsted,, Catalogue No: RHIP01VIC007*)

Photo h: Natural regeneration of native trees and shrubs is occurring along this old access road on the north side of Vicary Creek. Continuing to minimize human-caused disturbance here will help ensure successful vegetation establishment, benefitting reduced erosion. (*Photographer: J. Melsted, Catalogue No: RHIP01VIC015*)

Photo i: There is abundant cover from seedling and sapling aged willows, native shrubs and white spruce along Dutch Creek (DUT1) (*Photographer: J. Melsted, Catalogue No: RHIP01DUT009*)

Photo j: Browse utilization is minimal in most sites, but moderate along North Racehorse Creek (NRC1) as indicated by flat-topped willows like these. (*Photographer: A. Sarrazin, Catalogue No: RHIP01NRC004*)

Photo k: Human-cut stumps in a random campsite adjacent to Beaver Creek (BVR42). (*Photographer: A. Sarrazin, Catalogue No: RHIP42BVR005*)

VEGETATION HEALTH PARAMETER PHOTOGRAPHS

- Of note, natural recovery of tree and shrub seedlings is occurring along an old access road leading to the north side of Vicary Creek (**Photo h**, page 18). Permanent closure of this access road will continue to allow this process to occur, reducing erosion risks.

- ***Browse Pressure and Woody Plant Removal***

- 6 of the 14 sites have minimal amounts of browse utilization from livestock or wildlife.
- 7 of the 14 sites have light amounts of browse utilization from a combination of wildlife and livestock use. Woody plants can sustain low levels of use, but greater browse pressure can deplete root reserves and inhibit establishment and regeneration.
- Highest amounts of browse use were observed in NRC1 which has moderate browse use (**Photo j**, page 18), much of which is due to wildlife use as there is little to no sign of livestock alterations otherwise in this site. Despite moderate browse the NRC1 site has healthy amounts of preferred tree and shrub regeneration and more than 95% cover from woody plants. This indicates that browse levels are likely sustainable and not a management concern.
- Live woody vegetation removal unrelated to browse (e.g. human cutting, clearing or beaver use) is minimal, with most sites showing limited or no signs of this type of removal. The only exception is BVR42 where tree clearing at random campsites has removed more than 5% of the tree canopy cover (**Photo k**, page 18). Some evidence of this is also apparent in DUT1, but here less than 5% of the live woody vegetation expected on the site is lacking due to cutting.
- No recent beaver activity was observed in any of the sites.

- ***Woody Canopy Dead and Decadence***

Tree and shrub communities in the project area show minimal amounts of dead and decadent branches in the upper canopy. This indicates there is sufficient moisture within the system, and that disease is not a problem in maintaining these communities.

4.4 Soil and Hydrology Health Parameter Results

The average soil and hydrology health rating for the 2014 RHI sites is 79% (*healthy, with problems*) (Figure 5). This average rating is strongly affected by lower scores for 'hotspot' stream crossings. The most severely impacted 'hotspot' stream crossing reaches with human-caused bare ground, soil compaction and soil alteration impacts that extend beyond the immediate crossing are SMT2, GOL2 and GRE1. Other sites with reduced soil / hydrology ratings are BVR42 and DUT1, mainly due to high amounts of recreational use impacts.

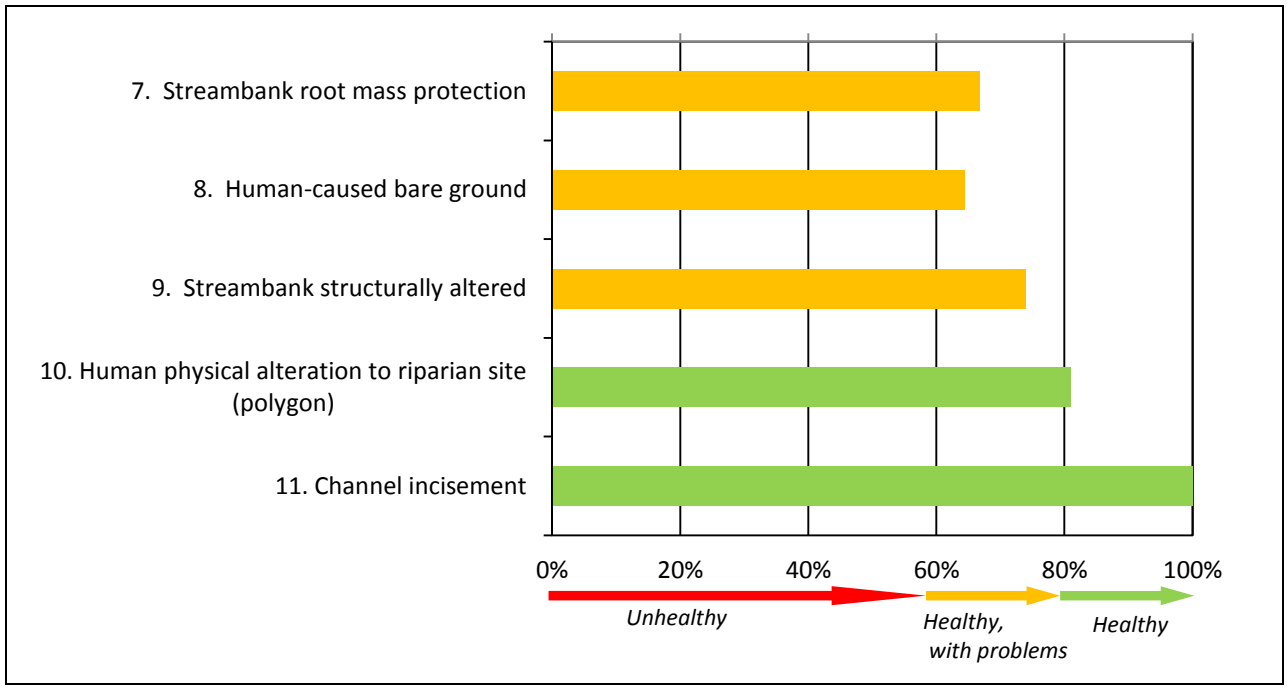


Figure 5 Soil and Hydrology Health Parameter Results

Streambank Stability and Root Mass Protection

The role of streambank vegetation is to maintain the integrity and structure of the bank by dissipating energy, resisting erosion and trapping sediment to build and restore banks. Healthy, well vegetated riparian areas slow the rate of erosion and balance erosion in one spot with bank increases through deposition elsewhere. If unstable banks are occasional, limited to a few outside meander bends and the banks revegetate within a year, erosion rates are likely minor. Accelerated bank erosion and removal of streambank vegetation can lead to rapid loss of riparian function, including degradation of habitat for Westslope Cutthroat Trout due to sediment inputs, loss of overhead cover, depleted water quality and degraded spawning and rearing habitat.

- Most of the 'hotspot' stream crossing reaches have few impacts to vegetation beyond the immediate crossing width except for GRE1 and GOL2 where root mass protection is also lacking 40 m up and downstream from the crossing. Both GRE1 and GOL2 have high cover from disturbance-caused plants within the assessed reach. The upstream half of the GRE1 reach is within a cleared powerline corridor. The ALL3, GOL3 and SMT2 stream crossing reaches are missing deeply rooted vegetation at the crossing, but otherwise have intact deeply rooted trees, shrubs and other native plants within 40 m up and downstream from the crossing.
- High cover from disturbance-caused plants has reduced streambank root mass protection ratings to 2/6 for both the TRO1 (**Photo m**, page 23) and BVR42 sites. A rating of 2/6 indicates that root mass protection is lacking in more than 35% of the streambank length.
- With the exception of DUT1, all other sites have cover from deeply rooted plants along more than 85% of their bank length (i.e. a rating of 6/6) (e.g., **Photo l**, page 23). Root mass

protection is slightly reduced (i.e. 65-85% of the reach has deep, binding root mass along the bank) for the DUT1 site due to clearing along all terrain vehicle trails, stream crossings and random campsites.

Human-caused Bare Ground

Bare ground is unprotected soil that is capable of being eroded by rain drops, overland flow and wind. Bare ground in riparian areas is often present due to natural processes (e.g. sediment deposition from recent flood events). Bare ground can also result from activities such as vehicle traffic, livestock hoof shear and trailing, recreational trails, timber harvest and landscaping. Areas of natural or human-caused bare ground are susceptible to the encroachment of invasive and disturbance-caused species. Elevated levels of exposed soil due to human-causes can also contribute to abnormally high sediment inputs into trout bearing streams with negative consequences to the availability of suitable spawning habitat and degraded water quality concerns.

- For the 'hotspot' stream crossing riparian polygons, human-caused bare ground varies from 20% for ALL3 and SMT2, to 10% for GRE1 and GOL2, to less than 5% for MOR1 and GOL3. Those sites with higher amounts of human-caused bare ground have wider access road crossings along decommissioned logging roads compared to smaller quad trail crossings.
- For the other riparian sites (excluding 'hotspots'), DUT1 has the highest amount of human-caused bare ground (approximately 10%) due mainly to recreational use impacts from random camping and all terrain vehicle trails (**Photo q**, page 23). Bare ground from cattle trails and hoof shear contributes to a small relative proportion of the overall area of exposed soil in this site.
- All other sites have less than 1% human-caused bare ground (i.e. ratings of 6/6) except for SHA3 where livestock use has contributed to slightly elevated amounts of bare ground above 1% cover.

Human-caused Alterations to the Streambank and Floodplain

A key function of riparian areas is to filter and trap sediment. This builds a soil layer of moist, fine-textured material. Associated with this, roots and underground fauna create soil structure and macropores that allow water infiltration and storage. These types of soils are very susceptible to vehicle traffic, hoof action and compaction. When a streambank is physically altered, erosion may increase, mobilizing channel and bank materials. As a consequence, water quality may deteriorate and instability can increase within the reach as well as downstream, with negative consequences to Westslope Cutthroat Trout habitat and downstream water users.

Streambank Alterations -

- Similar to results described above, the ALL3 and SMT2 'hotspot' stream crossing reaches with the widest relative crossing widths associated with former logging roads had among the highest amount of altered total bank length. These sites rated 2/6 for bank alterations.

- The 'hotspot' site with the most extensively altered streambank is GRE1 that rated 0/6 for this parameter. The upstream half of the GRE1 reach has bank alterations due to motorized recreation vehicle trails, not confined to one crossing location. The downstream half of this reach has evidence of livestock trailing and trampling.
- For the other riparian sites (excluding 'hotspots'), BVR42 has the most extensive bank alterations (i.e. about 20% of altered bank length, a rating of 2/6) due to recreation use impacts from all terrain vehicle trails and random campsites. Livestock trailing and trampling bank alterations are apparent along 10% of the SHA3 site.
- All other sites have more localized bank impacts limited to a few stream crossings representing less than 5% of their bank length. It is important to keep in mind, however, that although minor in spatial extent, streambank alterations such as heavily used stream crossings can have a major impact on water quality. Steeply sloping braided trails present a particular concern to water quality.

Floodplain Alterations -

- The most extensively altered sites (excluding streambanks) are GRE1 and DUT1. Approximately 70% of the GRE1 site (i.e. a score of 0/3) is altered due to recreational use impacts in the upstream half of the site and livestock trampling impacts in the downstream reach. Approximately 20% of the DUT1 site (i.e. a score of 1/3) is altered similarly due to a combination of recreational use and livestock soil compaction impacts (**Photos o** and **p**, page 23).
- Sites with moderate amounts (i.e. 10%) of recreational use impacts in the floodplain are SMT2, GOL2 and BVR42 (all of which have ratings of 2/3 for this parameter). The remaining sites all have minimal amounts of floodplain structural alterations (i.e. <5%, ratings of 3/3).
- Overall, about 12% (1.6 ha) of the total 2014 project area, has human-caused floodplain alterations. Most of this is due to soil compaction associated with motorized vehicle trails, random camping and livestock trampling / trailing. Unpaved gravel or dirt roads impact portions of the ALL3, GOL2, GRE1, MOR1, SMT2 and TRO1 sites.

Channel Incisement

Periodic flood events disperse moisture in the riparian are, helping to maintain riparian vegetation. Flooding also spreads the energy of moving water over the riparian area, allowing sediment to be deposited and creating new areas for seedling tree and shrub establishment. Channel incisement, or downcutting, can limit the ability of a river to access its floodplain during high water events. Streams are incised when downcutting has significantly lowered the channel so that the average two-year flood event cannot escape the existing channel.

All sites rate healthy for this parameter. This means that high water events can periodically access the highest terraces of the floodplain, indicating that these stream reaches are not incised.

Photo l: This reach of North Racehorse Creek has high amounts of root mass protection from a combination of willows, spruce and sedges (*Photographer: A. Sarrazin, Catalogue No: RHIP01NRC003*)

Photo m: Stream reaches like this portion of Beaver Creek (BVR42) have high amounts of bank slumping and accelerated erosion where disturbance-caused shallow-rooted grasses are the primary streambank vegetation cover. (*Photographer: A. Sarrazin, Catalogue No: RHIP42BVR017*)

Photo n: A logging access road running parallel to Trout Creek has created a source of sediment and contributed to soil compaction and loss of vegetation cover. (*Photographer: A. Sarrazin, Catalogue No: RHIP01TRO033*)

Photo o: Random camping is a major contributor to soil compaction, bare ground and native vegetation disturbance in the meadows along the Dutch Creek valley. (*Photographer: J. Melsted, Catalogue No: RHIP01DUT007*)

Photo p: All terrain vehicle trail rutting, soil compaction and erosion along a tributary of Dutch Creek. (*Photographer: J. Melsted, Catalogue No: RHIP01DUT011*)

Photo q: Human-caused bare ground is a concern for the 'hotspot' stream crossing reaches and along portions of Dutch Creek with recreational use impacts such as all-terrain vehicle trails. (*Photographer: J. Melsted, Catalogue No: RHIP01DUT015*)

SOIL AND HYDROLOGY HEALTH PARAMETER PHOTOS

4.5 Additional Westslope Cutthroat Trout Habitat Data

Channel Substrate Data

Not including the 'hotspot' sites, the 2014 RHI stream channel reaches are mainly comprised of a mix of large cobbles (34%), small cobbles (26%), coarse gravel (19%) and small boulders (12%) (Table 12, Figure 6). Substrate composition data for the 'hotspot' stream crossing reaches is given in Appendix C.

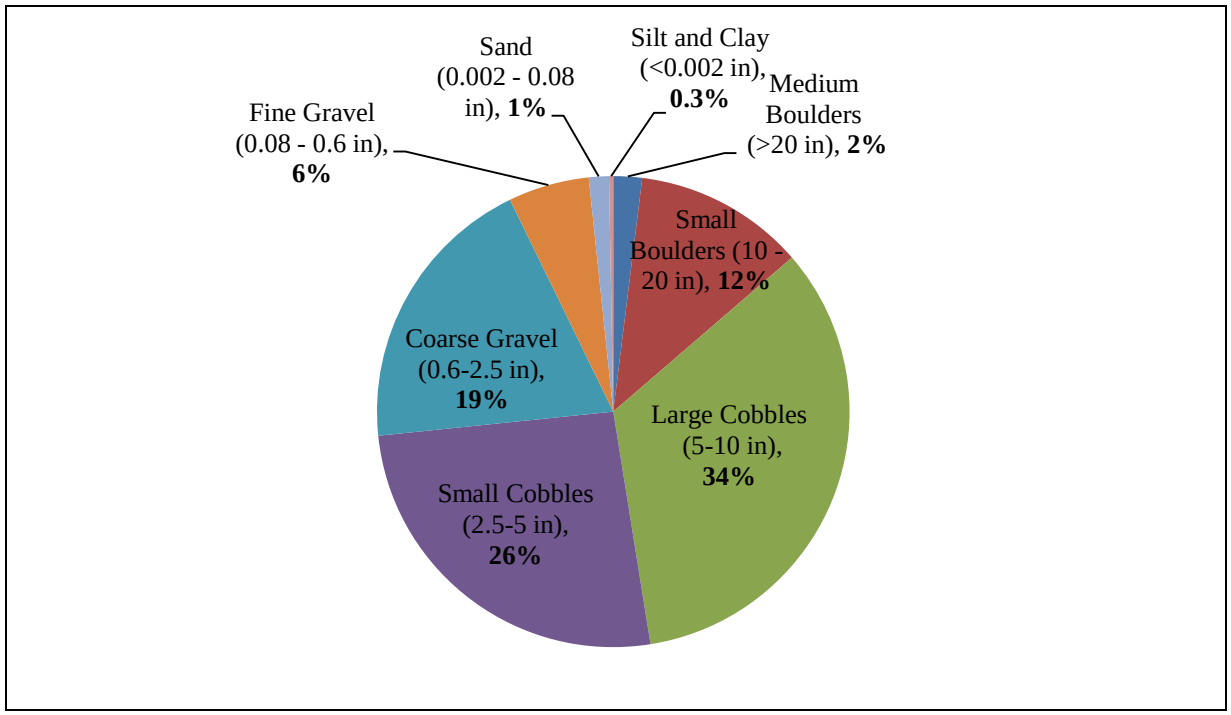


Figure 6 Average Channel Substrate Composition in the 2014 RHI Project Area (Excluding 'Hotspot' Stream Crossing RHIs)

Table 12 Average Channel Substrate Composition for the 2014 RHI Stream Reaches (Excluding 'Hotspot' Stream Crossing RHIs)

RHI Site ID	>20 in. (med. Boulders +)	10-20 in (sm. boulders)	5-10 in (lg. cobbles)	2.5-5 in (sm. cobbles)	0.6-2.5 in (course gravel)	0.08 - 0.6 in (fine gravel)	0.062- 2mm (sand)	<0.062 mm (silt and clay)
BVR42	0.1%	13.2%	40.7%	19.5%	18.0%	4.0%	4.1%	0.5%
DUT1	7.7%	19.6%	24.4%	26.1%	14.7%	5.1%	2.0%	0.4%
NRC1	3.1%	12.0%	45.5%	21.5%	7.9%	7.9%	1.1%	1.1%
SHA3	0.7%	11.8%	27.2%	27.2%	19.5%	11.8%	1.5%	0.4%
SMT1	3.1%	23.7%	32.3%	18.3%	21.6%	0.9%	0.1%	0.0%
STA1	0.1%	10.0%	23.7%	35.5%	21.7%	8.0%	1.0%	0.0%
TRO1	0.1%	0.3%	8.7%	41.4%	43.3%	6.1%	0.1%	0.0%
VIC1	0.4%	2.3%	70.1%	17.5%	8.4%	1.0%	0.3%	0.0%

Embeddedness and Cementedness

Coarse approximations of embededdness and cementedness provide a rough indication of the quality of available spawning habitat for Westslope Cutthroat Trout[2]. Not including the 'hotspot' sites, the 2014 RHI stream channel reaches have variable 'embeddedness' from 21% (STA1) to 48% (SHA3) (Table 13). None of the sites have evidence of highly cemented riffle reaches, with most reaches rated as 'loose' (uncemented) or "intermediate" for this parameter (Table 13). Recent large flood events may have contributed to flushing out fine sediment. Results for the hotspot' stream crossing reaches is discussed in Section 4.6 (see also Appendix C).

Embeddedness refers to the "extent to which the larger substrate particles, such as boulder, cobble, or gravel, are surrounded or covered by fine sediment" (Hunter 1991). Studies show that when the substrate becomes more than 30% to 40% embedded, there is an accompanying loss of spawning habitat for most trout species (Hunter 1991). Substrate embeddedness is effected by all land use activities in the watershed that increase the delivery of fine sediment to the stream such as exposed roads, trails and disturbed ground or vegetation removal from industrial, forestry, recreational and livestock grazing activities. The infilling of interstitial gravel spaces with fine sediment over time can 'cement' gravels and small cobbles, impeding trout from creating spawning redds. It can also lead to the creation of a cemented layer, resistant to average flushing flood flows and impermeable to the vertical percolation of upwelling, oxygen rich ground water (Hunter 1991).

Table 13 Average "Embeddedness" and "Cementedness" Results (Excluding 'Hotspot' Stream Crossing RHIs)

		Average "Cementedness"		
RHI Site ID	**Average Embeddedness (%)**	**Loose (%)**	**Intermediate (%)**	**Cemented (%)**
BVR42	24%	70%	30%	0%
DUT1	25%	50%	50%	0%
NRC1	43%	48%	48%	4%
SHA3	48%	80%	24%	0%
SMT1	34%	56%	44%	0%
STA1	21%	76%	24%	0%
TRO1	46%	60%	40%	0%
VIC1	36%	44%	56%	0%

Potential Barriers to Fish Movement

No obstructions to fish passage were observed within any of the 2014 RHI sites.

[2] Of note, more robust techniques than used in this study have recently been field tested by AESRD, Fish & Wildlife to more accurately monitor sedimentation of spawning gravels in Westslope Cutthroat Trout stream reaches. This includes the use of freeze-core sampling techniques to quantitatively collect and measure the percentage of fine sediment (silt and clay <0.063 mm) in the total mass of a streambed soil core.

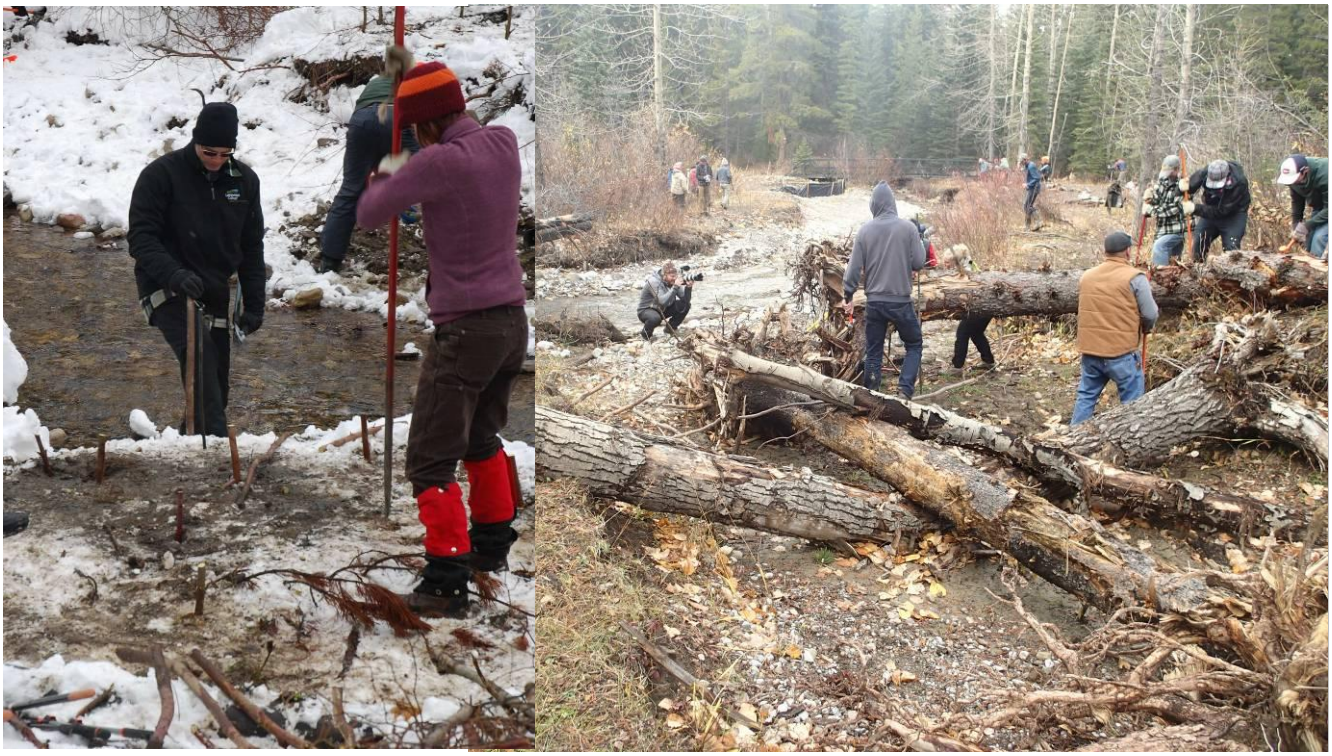
4.6 "Hotspot" Stream Crossing Assessment Results

Of the six stream crossings assessed, all of them are currently forded by all terrain vehicles (ATVs) and / or trucks (SMT2 and GOL2), except for GOL3 and GRE1 where all terrain vehicles are restricted to using newly installed bridges. However, there is a wide forded truck crossing upstream of the new GRE1 quad bridge. The quad bridges installed at the GOL3 and GRE1 crossings were installed by the Crowsnest Pass Quad squad with funding from grants secured for this Westslope Cutthroat Trout initiative supporting the cost of bridges in 2013-14. Despite existing bridges at ALL3 and SMT2, fording of the creek continues at these sites despite efforts (particularly at SMT2) to block forded access by placement of large boulders and logs. At SMT2 these deterrents were moved aside by recreational users to facilitate continued passage through the creek by all terrain vehicles and trucks (see photos on page 35). There are no functional bridges at the GOL2 and MOR1 sites.

The GOL2, GOL3, GRE1 and MOR1 crossings were rated as "Stable" overall and "Minimally impacted by the crossing activity" due to stable bridge crossings at GOL3 and GRE1 and low slope approaches with minimal potential for additional erosion at the GOL2 and MOR1 sites (Table 14). The ALL3 crossing was rated as "Slightly unstable" and "Moderately impacted by the crossing activity". Steep approach slopes and erodible soils contribute to a rating of "Highly unstable" and "Highly impacted by the crossing activity" for the SMT2 crossing (Table 14). Stream crossing photographs are shown on pages 30 to 35 and detailed stream crossing data forms are given in Appendix C.

Streambank root mass protection is lacking in particular downstream of the GOL2 and GRE1 crossings (i.e. <35%) (Table 14) and could be improved within ALL3 and upstream of GRE1 (where there is 35% to 65% deep root mass protection). Embeddedness ratings are above the 30% acceptable threshold (Hunter 1991) for the entire GOL3 reach in particular (Table 14). There was also an apparent increase in fine sediment channel substrate material at and downstream of the GRE1 crossing and downstream from the ALL3 crossing (within the forded stream reach) (Appendix C). Ongoing monitoring of forded stream crossings is recommended in conjunction with efforts to improve signage and educational outreach with recreational users. Regular monitoring and maintenance of all bridge structures is also a priority to ensure they remain stable and safe to use.

Of note, localized riparian planting was done at the ALL3 and SMT2 crossings in November, 2013 (ALL3 only) and/or in October, 2014 (as part of a volunteer collaborative effort co-ordinated by Cows and Fish) (see photos, page 27). Willow, balsam poplar, and red-osier dogwood stakes and fascines were installed as part of these efforts. Only those plantings installed 2013 at ALL3 were in place at the time of the riparian health inventory and crossing assessment. Continued OHV impacts had resulted in destruction of some 2013 planted material, despite the presence of silt fences and logs in place to act as barriers. More detailed follow-up monitoring of these planting projects is suggested to assess survival rates of riparian plantings and contribution toward improved bank stability and root mass protection.



Allison Creek (ALL3) riparian planting project – November 8, 2013 (Left) and October 24, 2014 (Right).
Balsam poplar, willow and red-osier dogwood live stakes were installed in both years. In 2013 and 2014, large woody debris was placed on the left bank by Spray Lake Sawmills to prevent OHVs from fording through the creek.

Smith Creek (SMT2) riparian planting project, October 24, 2014. Live willow and balsam poplar stakes were installed on the steep approach slopes adjacent to the quad bridge to help stabilize and reduce bank erosion.

Table 14 Stream Crossing Results Summary

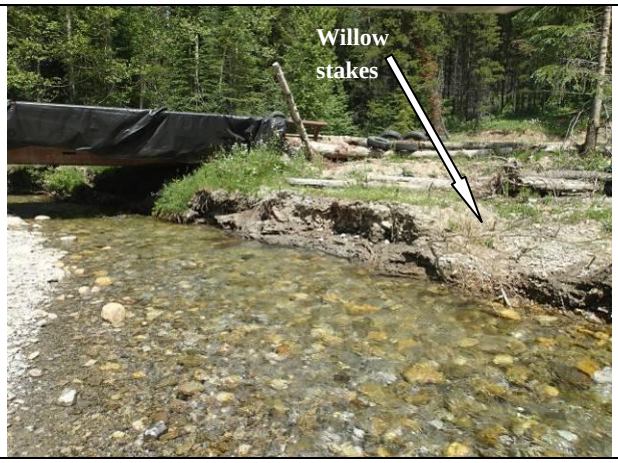
	ALL3 (Allison Creek)	GOL2 (Gold Creek)	GOL3 (Gold Creek)	GRE1 (Green Creek)	MOR1 (Morin Creek)	SMT2 (Smith Creek)
STREAM CROSSING SUMMARY (Transects #3 - downstream edge of crossing, T#4 -center of crossing, and T#5 - upstream edge of crossing)						
Stream Crossing Type (at T3 to T5)	Forded ATV crossing immediately downstream from a temporary logging bridge (removed in fall of 2014)	Forded ATV/truck crossing	Recently installed quad bridge	Recently installed quad bridge	Forded ATV crossing	Quad bridge and forded ATV crossing
Existing Bridge Structure (s)	Yes - recently installed quad bridge upstream from temporary logging bridge	There is a wooden ATV bridge between T5 and T6 (upstream of the forded crossing), but it is in disrepair and not safe for vehicle passage.	Recently installed quad bridge	Recently installed quad bridge	None	Recently installed quad bridge
Restoration Notes	Riparian planting (willow, red-osier dogwood, balsam poplar stakes) installed in fall 2013 and 2014.	Nothing done as yet	Quad bridge installed by the Crowsnest Pass Quad Squad with funding support from this project	Quad bridge installed by the Crowsnest Pass Quad Squad with funding support from this project	Nothing done as yet	Riparian planting (willow, red-osier dogwood, balsam poplar stakes) installed in fall 2014 AFTER stream crossing assessment was done.
Disturbed Shoreline Contour Distance	LB - 6.7 m, RB - 18.5 m	LB - 8.0 m, RB - 6.6 m	LB - 2.0 m, RB - 2.2 m	LB -1.8 m, RB - 2.0 m	LB -3.2 m, RB - 3.3 m	LB -9.4 m, RB - 13.7 m
Disturbed Shoreline Straight-Line Distance	LB - 6.6 m, RB - 18.3 m	LB - 8.3 m, RB - 5.5 m	LB - 2.0 m, RB - 2.0 m	LB -1.6 m, RB - 1.8 m	LB -2.7 m, RB - 3.1 m	LB -8.9 m, RB - 13.5 m
Left Bank (LB) Approach Rating	**3 - Moderate erosion**	1 – Un-erodable	2 - Little to no erosion	2 - Little to no erosion	2 - Little to no erosion	**4 - Extensive erosion**
Right Bank (RB) Approach Rating	2 - Little to no erosion	2 - Little to no erosion	**3 - Moderate erosion**	2 - Little to no erosion	**3 - Moderate erosion**	**4 - Extensive erosion**
Overall Rating (Crossing Stability)	2 - Slightly unstable crossing with moderate potential for further erosion)	1 - Stable crossing with little potential for further erosion	1 - Stable crossing with little potential for further erosion	1 - Stable crossing with little potential for further erosion	1 - Stable crossing with little potential for further erosion	**3- Highly unstable crossing with potential for considerable erosion**
Combined Impact Ranking	**2.3 - Moderately Impacted from Crossing Activity**	1.3 - Minimally impacted from crossing activity	2- Minimally impacted from crossing activity	1.7 - Minimally impacted from crossing activity	2- Minimally impacted from crossing activity	**3.7 Highly impacted from crossing activity**
Average Embeddedness Rating at Crossing	20% (within acceptable threshold)	27% (within acceptable threshold)	**38% (ABOVE acceptable threshold)**	29% (within acceptable threshold)	21% (within acceptable threshold)	23% (within acceptable threshold)
Average Cementedness Rating at Crossing[1]	Ave L: 78% Ave I: 22% Ave C: 0%	Ave L: 67% Ave I: 33% Ave C: 0%	Ave L: 67% Ave I: 33% AveC: 0%	Ave L: 100% Ave I: 0% Ave C: 0%	Ave L: 78% Ave I: 22% Ave C: 0%	Ave L: 63% Ave I: 38% Ave C: 0%

	ALL3 (Allison Creek)	GOL2 (Gold Creek)	GOL3 (Gold Creek)	GRE1 (Green Creek)	MOR1 (Morin Creek)	SMT2 (Smith Creek)
UPSTREAM BANK STABILITY, ROOT MASS, AND SUBSTRATE SUMMARY (FROM T#5 upstream edge of crossing to T#7, 40 m upstream of T#5)						
Average Upstream Bank Stability	Stable	Stable	<Slightly Unstable	Stable	Slightly unstable	Stable
Average Upstream Root mass Protection	35-65%	65%-85%	>85%	35-65%	65%-85%	65%-85%
Average Upstream Embeddedness Rating	28% (within acceptable threshold)	26% (within acceptable threshold)	**35% (ABOVE acceptable threshold)**	23% (within acceptable threshold)	**33% (ABOVE acceptable threshold)**	18% (within acceptable threshold)
Average Upstream Cementedness Rating	Ave L: 67% Ave I: 33% Ave C: 0%	Ave L: 50% Ave I: 50% Ave C: 0%	Ave L: 50% Ave I: 50% Ave C: 0%	Ave L: 100% Ave I: 0% Ave C: 0%	Ave L: 50% Ave I: 50% Ave C: 0%	Ave L: 50% Ave I: 50% Ave C: 0%
Are there additional forded crossings in this upstream reach (from T5 to T7)?	NO	NO	NO	YES (forded truck crossing between T5 and T6)	YES (forded ATV crossing, immediately upstream of T6)	NO
DOWNSTREAM BANK STABILITY, ROOT MASS, AND SUBSTRATE SUMMARY (FROM T#3 downstream edge of crossing to T#1, 40 m downstream of T#3)						
Average Downstream Bank Stability	<Slightly Unstable	Slightly unstable	Stable	Stable	Stable	Slightly unstable
Average Downstream Root mass Protection	65%-85%	<35%	65%-85%	<35%	>85%	65%-85%
Average Downstream Embeddedness Rating	16% (within acceptable threshold)	**36% (ABOVE acceptable threshold)**	**33% (ABOVE acceptable threshold)**	21% (within acceptable threshold)	27% (within acceptable threshold)	26% (within acceptable threshold)
Average Downstream Cementedness Rating	Ave L: 67% Ave I: 33% Ave C: 0%	Ave L: 33% Ave I: 67% Ave C: 0%	Ave L: 50% Ave I: 50% Ave C: 0%	Ave L: 100% Ave I: 0% Ave C: 0%	Ave L: 67% Ave I: 33% Ave C: 0%	Ave L: 50% Ave I: 50% Ave C: 0%
Are there additional forded crossings in this downstream reach (from T3 to T1)?	NO	NO	NO	NO	NO	NO

[1]Cementedness Ratings: L -Loose, I-Intermediate, C- Cemented
LB - Left Bank; RB - Right Bank (**as viewed facing downstream**)

ATV – All Terrain Vehicle

NOTE: 30% = Embeddedness threshold above which there is a higher likelihood of accompanying loss of trout spawning habitat (Hunter 1991)

Allison Creek – ALL3 Quad Bridge Crossing and Riparian Planting Project (Fall 2013, 2014)	
	
FORDED STREAM CROSSING LEFT BANK DOWNSTREAM OF TEMPORARY LOGGING BRIDGE (*Photographer: A. Sarrazin, Catalogue No: RHIP03ALL008*)	FORDED STREAM CROSSING RIGHT BANK DOWNSTREAM OF TEMPORARY LOGGING BRIDGE (*Photographer: A. Sarrazin, Catalogue No: RHIP03ALL007*)
	
FORDED STREAM CROSSING (YELLOW-DASHED LINE)VIEW DOWNSTREAM, DOWNSTREAM OF TEMPORARY LOGGING BRIDGE (*Photographer: A. Sarrazin, Catalogue No: RHIP03ALL009*)	FORDED STREAM CROSSING VIEW TO RIGHT BANK DOWNSTREAM OF TEMPORARY LOGGING BRIDGE (*Photographer: A. Sarrazin, Catalogue No: RHIP03ALL010*)
	
WILLOW PLANTINGS IN FOREGROUND, VIEW UPSTREAM TO TEMPORARY LOGGING BRIDGE (*Photographer: A. Sarrazin, Catalogue No: RHIP03ALL002*)	WILLOW PLANTINGS IN FOREGROUND NEAR TIRES, ADJACENT TO TEMPORARAY LOGGING BRIDGE (*Photographer: A. Sarrazin, Catalogue No: RHIP03ALL012*)

NOTE: There is a recently installed quad bridge immediately upstream of the logging bridge (not visible in the above photos). Willow stakes shown here were installed in November 2013 as part of a volunteer event led by Cows and Fish.

Gold Creek – GOL2 Forded Stream Crossing

FORDED STREAM CROSSING LEFT BANK
(*Photographer: J. Melsted, Catalogue No: RHIP02GOL005*)

FORDED STREAM CROSSING RIGHT BANK
(*Photographer: J. Melsted, Catalogue No: RHIP02GOL006*)

FORDED STREAM CROSSING (VIEW FROM RIGHT BANK TO LEFT BANK)
(*Photographer: J. Melsted, Catalogue No: RHIP02GOL009*)

QUAD BRIDGE IN NEED OF REPAIR, UPSTREAM FROM FORDED STREAM CROSSING
(*Photographer: J. Melsted, Catalogue No: RHIP02GOL007*)

RHI UPSTREAM END BENCHMARK (LOOKING DOWNSTREAM INTO RHI POLYGON)
(*Photographer: J. Melsted, Catalogue No: RHIP02GOL002*)

RHI DOWNSTREAM END BENCHMARK (LOOKING UPSTREAM INTO RHI POLYGON)
(*Photographer: J. Melsted, Catalogue No: RHIP02GOL004*)

Gold Creek – GOL3 – New Bridge Installation Crossing

LEFT BANK, AT NEW QUAD BRIDGE CROSSING
(*Photographer: J. Melsted, Catalogue No: RHIP03GOL005*)

RIGHT BANK, AT NEW QUAD BRIDGE CROSSING
(*Photographer: J. Melsted, Catalogue No: RHIP03GOL006*)

NEW QUAD BRIDGE APPROACH (VIEW FROM LEFT BANK TO RIGHT BANK)
(*Photographer: J. Melsted, Catalogue No: RHIP03GOL010*)

VIEW DOWNSTREAM FROM QUAD BRIDGE
(*Photographer: J. Melsted, Catalogue No: RHIP03GOL007*)

VIEW UPSTREAM FROM QUAD BRIDGE
(*Photographer: J. Melsted, Catalogue No: RHIP03GOL008*)

Green Creek – GRE1 – New Bridge Installation Crossing	
	
LEFT BANK, AT NEW QUAD BRIDGE CROSSING (*Photographer: M. Plemel, Catalogue No: RHIP01GRE008*)	RIGHT BANK, AT NEW QUAD BRIDGE CROSSING (*Photographer: M. Plemel, Catalogue No: RHIP01GRE009*)
	
NEW QUAD BRIDGE APPROACH (VIEW FROM LEFT BANK TO RIGHT BANK) (*Photographer: M. Plemel, Catalogue No: RHIP01GRE006*)	A forded truck trail crossing upstream of the new quad bridge. (*Photographer: M. Plemel, Catalogue No: RHIP01GRE005*)
	
VIEW UPSTREAM TO QUAD BRIDGE Disturbed herbaceous vegetation in foreground and bank slumping. This area is a primary use area for livestock. (*Photographer: M. Plemel, Catalogue No: RHIP01GRE012*	VIEW DOWNSTREAM TO QUAD BRIDGE (*Photographer: M. Plemel, Catalogue No: RHIP01GRE016*

Morin Creek – MOR1 Forded Stream Crossing

FORDED STREAM CROSSING LEFT BANK
(*Photographer: A. Sarrazin, Catalogue No: RHIP01MOR007*)

FORDED STREAM CROSSING RIGHT BANK
(*Photographer: A. Sarrazin, Catalogue No: RHIP01MOR008*)

FORDED STREAM CROSSING VIEW FROM LEFT BANK TO RIGHT BANK
(*Photographer: A. Sarrazin, Catalogue No: RHIP01MOR009*)

RHI UPSTREAM END BENCHMARK (LOOKING DOWNSTREAM INTO RHI POLYGON)
(*Photographer: A. Sarrazin, Catalogue No: RHIP01MOR002*)

RHI DOWNSTREAM END BENCHMARK (LOOKING UPSTREAM INTO RHI POLYGON)
(*Photographer: A. Sarrazin, Catalogue No: RHIP01MOR004*)

Smith Creek SMT2 Quad Bridge Crossing and Riparian Planting Project (Fall 2014)

STREAM CROSSING LEFT BANK
Rip rap has been placed to prevent erosion where there was formerly a forded crossing, downstream of the new quad bridge. (*Photographer: J. Melsted, Catalogue No: RHIP02SMT009*)

STREAM CROSSING RIGHT BANK
(*Photographer: J. Melsted, Catalogue No: RHIP02SMT008*)

STREAM CROSSING LEFT BANK.
Damaged silt fence, approach slope erosion and recent evidence of stream fording. (*Photographer: J. Melsted, Catalogue No: RHIP02SMT013*)

STREAM CROSSING RIGHT BANK
Logs and boulders were originally placed to prevent fording of the creek and encourage use of the bridge. These obstructions have since been moved away, allowing fording use to continue. (*Photographer: J. Melsted, Catalogue No: RHIP02SMT012*)

STREAM CROSSING LEFT AND RIGHT BANK, VIEW DOWNSTREAM FROM BRIDGE
(*Photographer: J. Melsted, Catalogue No: RHIP02SMT016*)

STREAM CROSSING LEFT AND RIGHT BANK, VIEW UPSTREAM FROM BRIDGE. (*Photographer: J. Melsted, Catalogue No: RHIP02SMT016*)

5 STAKEHOLDER ENGAGEMENT, HABITAT IMPROVEMENT PROJECTS AND NEXT STEPS

This 2014 riparian health dataset represents the fourth year of data collection as part of this project. Cows and Fish hopes to continue this initiative over the next year (at a minimum) to continue to fill in key riparian health data gaps within priority (i.e. ≥95% native pure) Westslope Cutthroat Trout stream reaches as well as monitoring sites where management or restorative actions are proposed and supporting and promoting further riparian habitat management improvements. Cows and Fish continues to actively engage with our project partners (AESRD, DFO, ACA and TUC) in communicating study results, planning and prioritizing future RHI sites and conducting annual multi-stakeholder consultation workshops and field days. Another continued focus for Cows and Fish has been to work closely with RHI participants to date (including private landowners, Public Land Agrologists and their respective grazing disposition holders) to help plan and facilitate range improvements that will benefit Westslope Cutthroat Trout habitat. All project participants have received detailed site specific reports detailing the results of the RHI work to date. Each report contains a management summary that highlights recommended steps to be taken to maintain and/or improve riparian health, including addressing specific riparian health parameters of concern.

The following is a summary of stakeholder engagement and habitat improvement projects completed as part of this project in 2014:

- Hidden Creek interpretive walk to examine and find solutions to address watershed issues and challenges within this sub-basin that continue to threaten local pure populations of Westslope Cutthroat Trout.
- October 2014 riparian planting projects along Allison Creek and Smith Creek (refer to Section 4.6, for details).
- February 24, 2015, fourth annual multi-stakeholder workshop at Chain Lakes Provincial Park, M.D. of Ranchland Administrative Building. This workshop, attended by 44 people, included presentations on riparian health results and issues found, showcased examples of successful actions and relevant research, as well as asked participants to provide input on needs and locations for future work. M.D. of Ranchland graciously provided the facilities at no cost.
- During 2014, bridge installation by the Crowsnest Pass Quad Squad along Gold and Green Creeks as part of the Ed Gregor Memorial Stewardship Day as well as a spring development to provide off-site water to cattle along Rock Creek were the completion of commitments made in 2013-14.
- Habitat management improvements and reduction of human impacts were also supported with Habitat Stewardship Program funding via:
    - Supporting weed control along Gold Creek (2 sites)
    - Contributing to the cost of bridges at 8 sites (5 on Carbondale River, 1 on South Lost Creek, 1 on Goat Creek, 1 associated with 4-Mile Creek). Installation of these bridges

will be completed as part of the Backcountry Trails program, led by ESRD, in spring/summer 2015.

Next Steps

Ongoing monitoring and stakeholder engagement is needed to reduce impacts associated with forded stream crossings in the 2014 project area. AESRD is encouraged to continue with efforts aimed at improving access management within watersheds with native pure Westslope Cutthroat Trout. In the short-term, additional signage and enforcement is needed to direct users onto designated trails (where designated trails exist) and to prevent continued fording of stream crossings where bridges have recently been installed. Where no designated trail network is in place, considerable effort in signage, education, stakeholder engagement, and enforcement are needed to reduce direct in-stream impacts, and to reduce overall impacts in riparian habitats and the rest of the landscape. Efforts also need to be directed toward minimizing, monitoring and better managing random camping land uses in proximity to sensitive streams and tributaries. Impacts associated with random camping are a particular concern in the Dutch Creek and Beaver Creek watersheds. Other management follow-up recommended as a result of this work should include continued efforts to monitor and control invasive weeds, particularly where weeds are not yet widespread. Of particular importance is to prioritize removal of Orange Hawkweed, a prohibited noxious weed that was observed in the ALL3 and VIC1 sites. Livestock management improvements should be closely investigated for sites where livestock use is contributing to soil compaction and bare ground or erosion impacts such as SHA3. Interventions such as installation of off-stream watering systems, localized fencing of high use hotspots, and strategic use of range riders to direct cattle away from sensitive areas may be beneficial in these sites. Integrating multiple land uses, particularly OHV use and livestock grazing management and infrastructure (eg. fences or watering systems), does pose significant challenges, but finding opportunities that benefit riparian health and westlope cutthroat trout and work for both these land uses is important for long-term positive impact.

General management suggestions for the 2014 RHI sites:

- Maintain and carefully manage existing native riparian plant communities.
- Maintain the health and vigour of native trees and shrubs by carefully managing livestock use and avoiding new clearing of woody plants in the active riparian zone.
- Control and monitor invasive weeds (with due care to native plants and water resources) in collaboration with local municipalities and watershed groups.
- Prevent further encroachment of disturbance-caused plants. It is unrealistic to completely remove these plants once they are well established in riparian areas; however, efforts to minimize new ground disturbance will help prevent further spread of undesirable disturbance-caused plants.

- Allow for rest and recovery of structurally altered portions of the streambank and floodplain where possible.
- Where already doing so, continue to maintain relatively low stocking rates and livestock utilisation that minimises and avoids causing riparian health impacts.
- Further apply livestock distribution tools to avoid concentrated livestock use in sensitive riparian areas and carefully manage livestock stocking rates to sustain productive, healthy riparian plant communities.
- Avoid livestock use in permanently saturated wet meadow habitats that are especially vulnerable to trampling impacts. Willow/sedge communities with fine-textured, fully saturated soils all growing season are particularly susceptible to trampling impacts and should be excluded from use as much as possible.
- Minimize new ground disturbance from human activities. This will reduce the potential for weed or disturbance-caused plant infestations. It will also help prevent soil compaction or erosion in the active floodplain and streambank. Seasonal timing restrictions may be required to avoid impacts during the early, wet spring season when recreational trail braiding, run-off, soil compaction and damage to new growth is likely to be most severe.
- Monitor and limit further disturbance from recreational use in proximity to native pure Westslope Cutthroat Trout streams. Collaborative efforts are needed with individuals, local user groups and AESRD to reduce impacts from motorized vehicles in riparian areas and adjacent steep slopes. Forded stream crossings and highly erodible trails are of particular concern to Westslope Cutthroat Trout.
- Collaborate with forestry and industrial user groups to prevent new disturbance in priority Westslope Cutthroat Trout habitats. AESRD, Fish and Wildlife and DFO are encouraged to continue their work with forestry and industry groups to better inform them of cumulative effects management and land use planning in watersheds with remaining native pure Westslope Cutthroat Trout populations.
- Improve public education and awareness about Westslope Cutthroat Trout and potential impacts from recreational, agricultural and industrial activities.

6 CLOSING

Our emphasis is to help individuals, resource managers, municipalities and local communities address riparian management issues on a watershed basis by increasing awareness, obtaining baseline riparian health information and offering realistic, practical management options and alternatives. Riparian health assessment enables local communities and managers to identify and effectively develop and implement approaches to address specific land use issues, using our recommendations. Working locally to develop common goals and objectives for entire watersheds is rewarding – it helps keep people invested in natural landscapes.

To inquire about additional references for riparian health monitoring and management and for further information on any aspect of this report, please contact:

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GLOSSARY

Bankfull channel width – width of a stream channel at the point where high water will begin to escape the channel during floods. This point may be determined by: the elevation at the top of depositional features like sand, silt or gravel bars; changes in bank material from coarse substrate within an active channel to deposited material of a smaller size; or exposed roots below an intact, vegetated soil layer indicating erosion.

Canopy cover – the ground area covered by vegetative growth. Different plant species can provide varying degrees of cover depending on their overall size and abundance. Total canopy cover can be greater than the area being studied due to overlap in plant structural layers.

Community type – An aggregation of all plant communities distinguished by floristic and structural similarities in both overstory and undergrowth layers. For the purposes of this document, a community type represents seral vegetation, and is never considered to be climax.

Disturbance-caused undesirable herbaceous species – native or introduced non-woody plant species that are well adapted to disturbance or an environment of continual stress. This term *does not* include invasive plant species.

Floodplain – the land base alongside a stream that has the potential to be flooded during high water events.

Habitat type – the land area that supports, or has the potential to support, the same primary climax vegetation. It is based on the potential of the site to produce a specific plant community (plant association).

Human-caused bare ground – areas devoid of vegetation as a result of human activity. This can include vehicle roads, recreational trails and livestock trampling.

Invasive plant species – plant species that are designated by the *Weed Control Act* of Alberta as *restricted* or *noxious* weeds, as well as some additional species identified by Cows and Fish and/or Public Lands (Alberta Sustainable Resource Development) to be invasive within riparian areas.

Lotic – this term means *flowing water* (i.e., streams and rivers).

Lentic – this term means *standing* or *still water* (i.e., lakes, ponds and sloughs).

Pointbar – areas along the stream edge where sediment has been naturally deposited by moving water. These typically occur on the inside portion of a channel bend. Also known as a *sandbar*.

Polygon – term used to describe a riparian inventory site. On lotic systems, a polygon has an upstream and downstream end along a reach of a stream and an associated riparian width. The lateral extent (width) of the riparian area is subjectively determined in the field based on vegetation and terrain clues indicating the flood prone area.

Reach – section of a stream or river with similar physical and vegetative features and similar management influences.

Riffle –*A riffle is a short, relatively shallow and coarse-bedded reach where the stream flows at higher velocity and higher turbulence than it normally does in comparison to a pool* (source: http://en.wikipedia.org/wiki/Riffle)

Stream channel incisement – the degree of downward erosion within the channel bed.

Structural alteration – physical changes to the shape or contour of the streambank caused by human influences. Some examples are livestock crossings, culverts and 'riprap'

Tree and shrub regeneration – the presence of seedlings and saplings, or the 'new growth'.

Woody plant species – simply refers to trees and shrubs. These plants serve different riparian functions than grasses and broad-leaf plants.

APPENDIX A

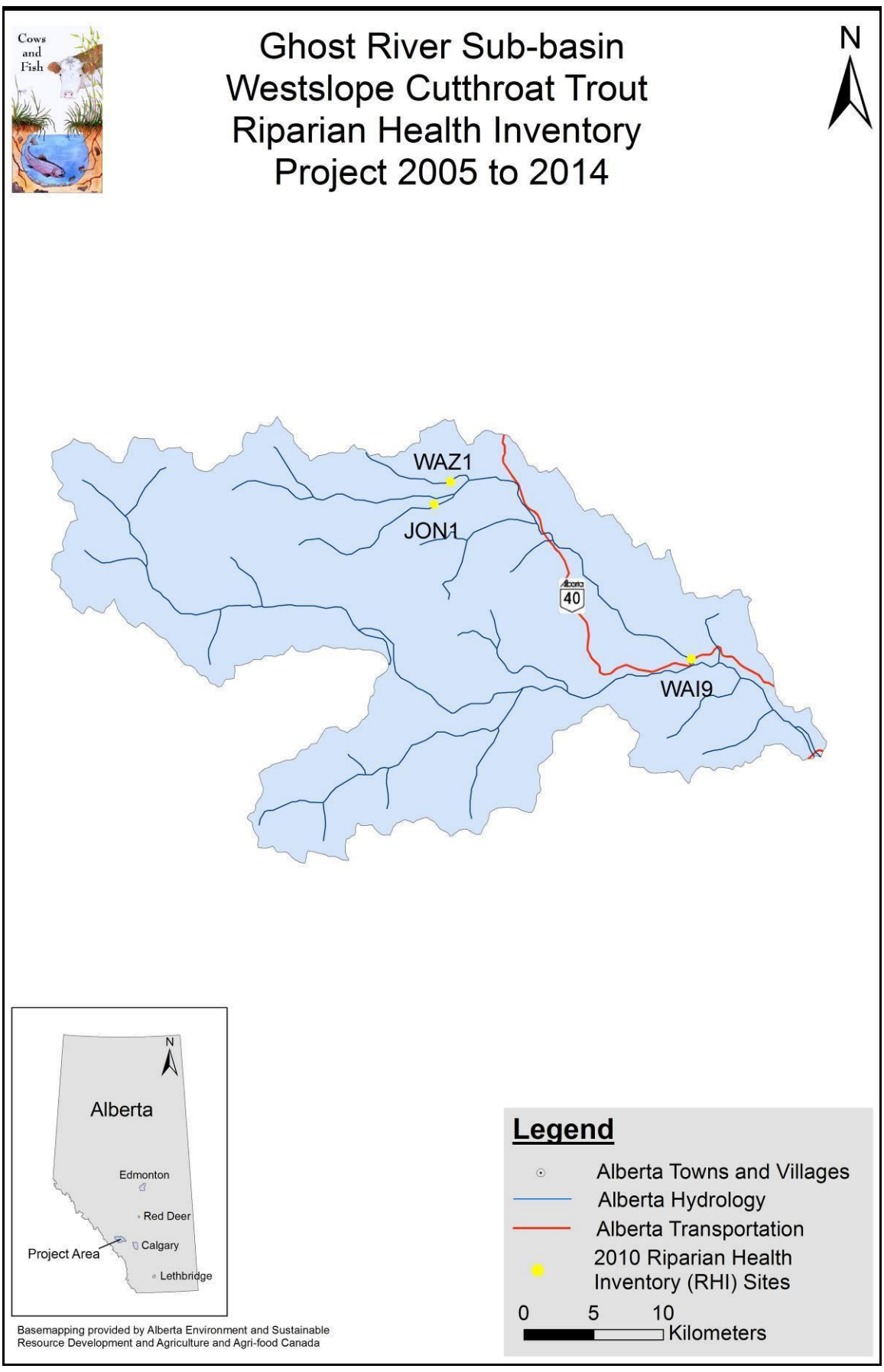
RHI UPSTREAM AND DOWNSTREAM UTM LOCATIONS

RHI Site ID	Zone	UPSTREAM UTM COORDINATE		DOWNSTREAM UTM COORDINATE	
		Easting	Northing	Easting	Northing
ALL3	11U	672473	5507748	672455	5507700
BVR42	12U	287310	5523777	286987	5523180
DUT1	11U	679674	5531723	680336	5531610
GOL2	11U	688326	5502357	688380	5502329
GOL3	11U	688804	5501611	688806	5501533
GRE1	11U	688867	5501422	688786	5501401
MOR1	11U	688071	5503001	688007	5502967
NRC1	11U	674063	5524467	674384	5524039
SHA3	11U	713804	5530176	713297	5529997
SMT1	11U	674962	5519921	675325	5519509
SMT2	11U	674893	5519920	674975	5519906
STA1	11U	677415	5499116	677790	5499251
TRO1	11U	710151	5546717	710551	5546485
VIC1	11U	680794	5514262	681177	5514257

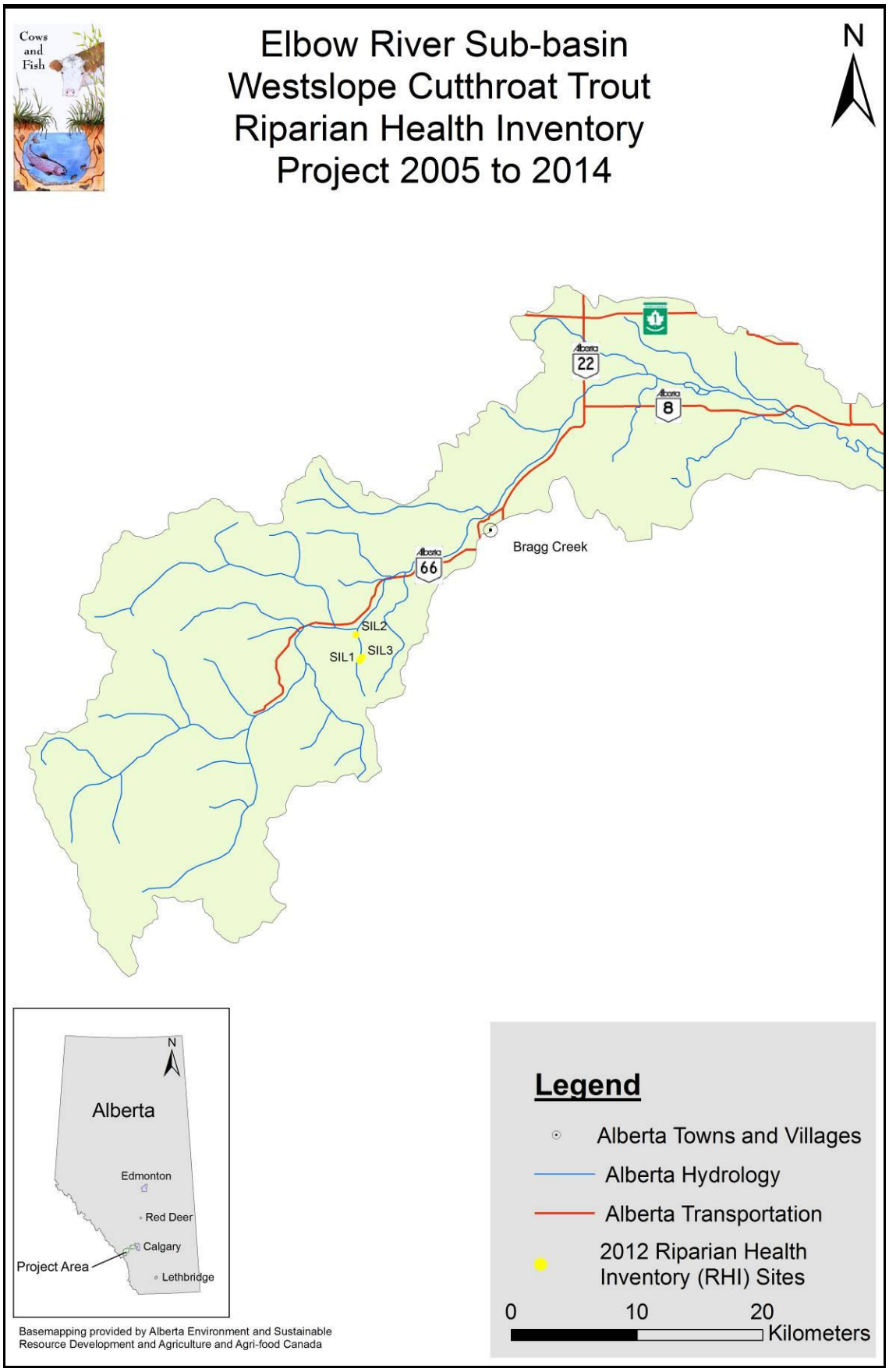
APPENDIX B

2005-2014 WESTSLOPE CUTTHROAT TROUT RHI SITE LOCATIONS

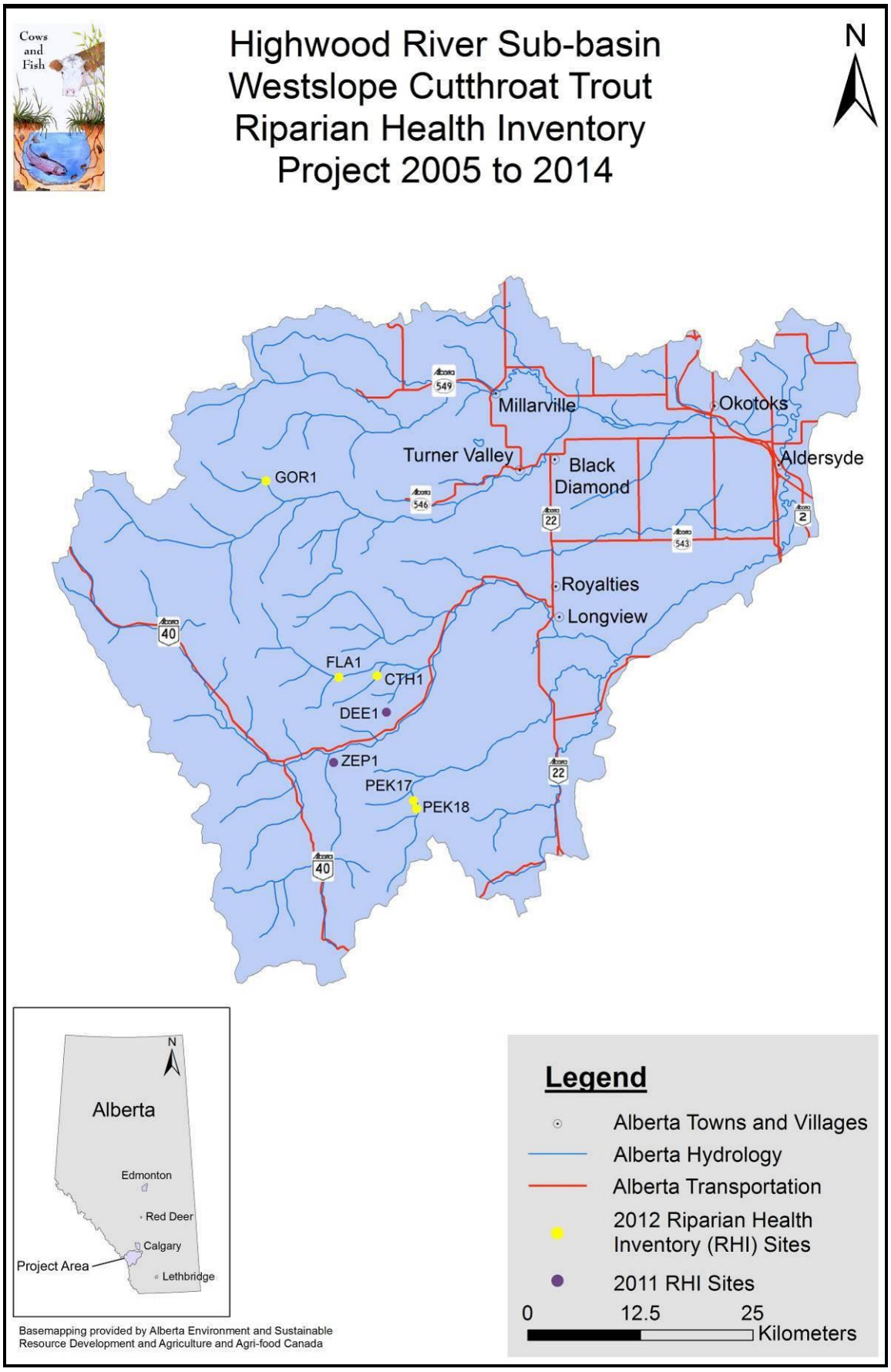
MAP A – GHOST RIVER SUB-BASIN



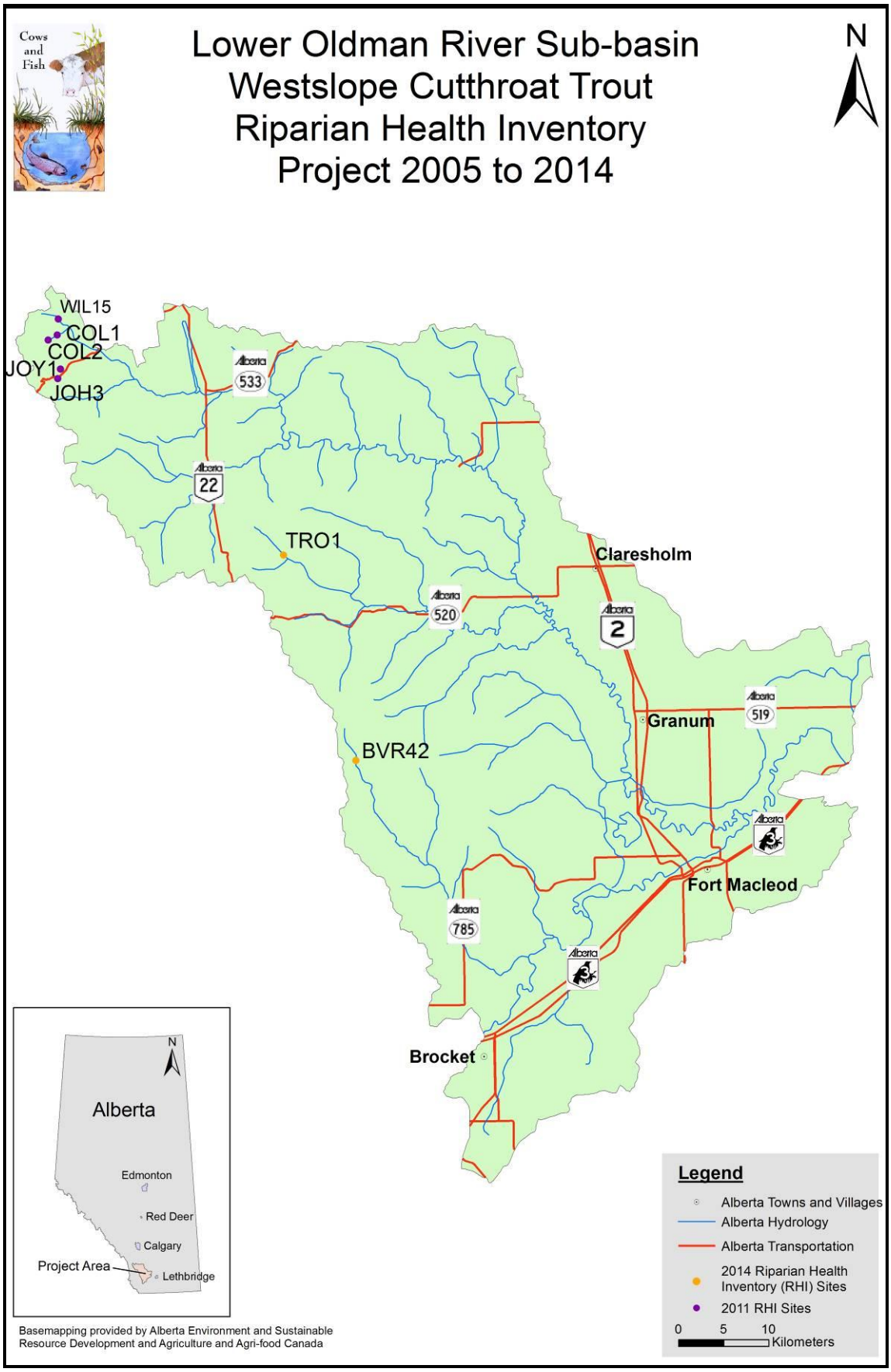
MAP B – ELBOW RIVER SUB-BASIN



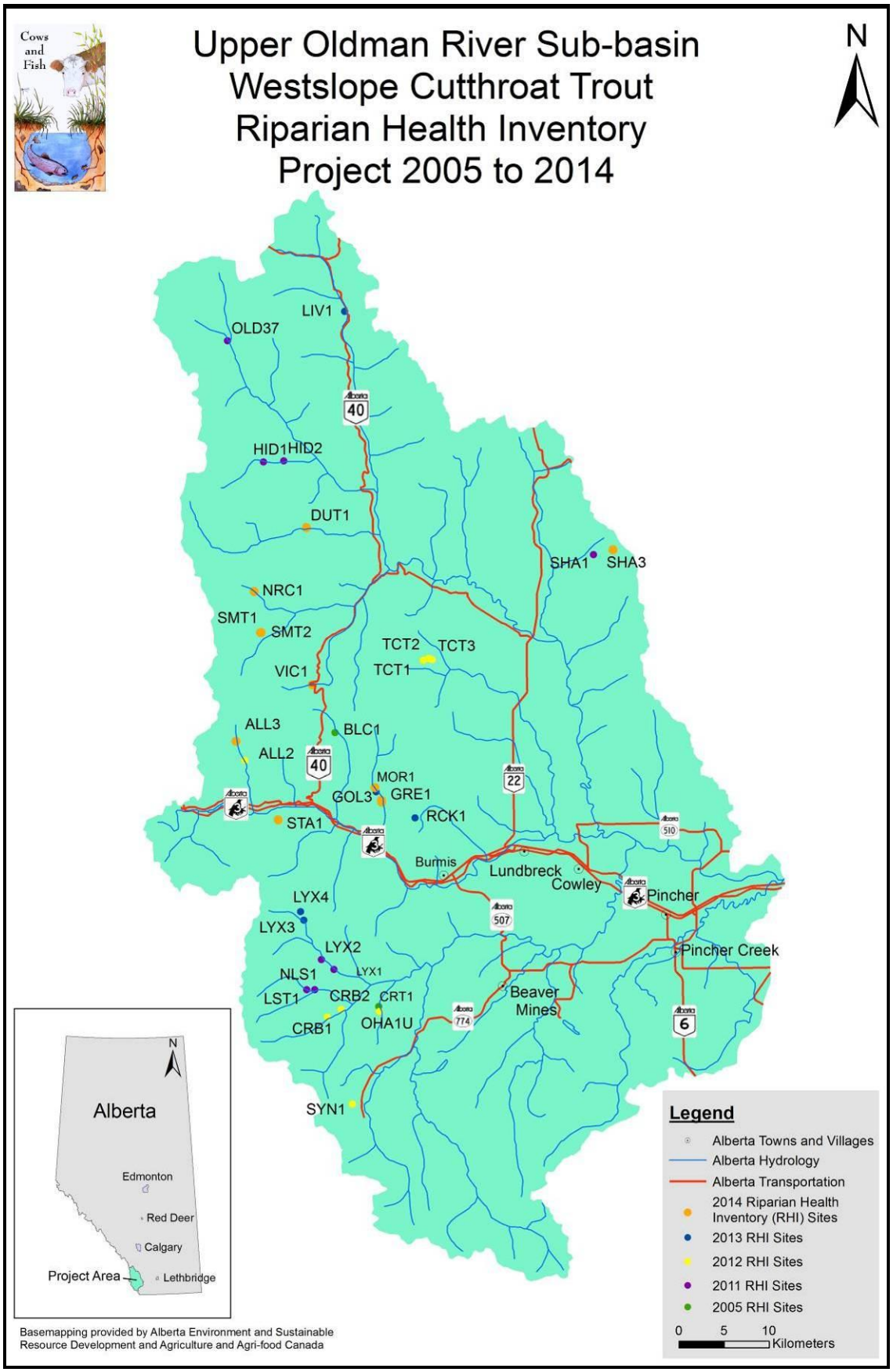
MAP C – HIGHWOOD RIVER SUB-BASIN



MAP D – LOWER OLDMAN RIVER SUB-BASIN



MAP E – UPPER OLDMAN RIVER SUB-BASIN



APPENDIX C

STREAM CROSSING DATA FORMS
(ALL3, GOL2, GOL3, GRE1, MOR1 AND SMT2)

ALL3 Stream Crossing Data Form

Surveyers	Waterbody name	Activity Date	Photo Numbers and Description		Waterbody Code
JM, AS	Allison Creek	14-Jul-14	LB (taken from RB): 47	RB (taken from LB): 48	ALL3
UTM Easting	**UTM Northing (11U)**	**Way Point Name and Site Location Notes**		**Additional Photos**	
672472	5507751	ALL3, 11U		see ALL3 RHI photos	
Existing structure	NONE	Comments: Stream crossing data was collected for a FORDED OHV CROSSING immediately downstream from a logging bridge (decommissioned and removed in the fall of 2014). Of note, there is an existing ATV bridge upstream of this forded crossing below transect T6.			
Type of Use	ATV/quad				
Active Linear Disturbance Distance of Ford (m)	LB Shoreline: 6.7 m	LB T3-T5: 6.6 m	RB shoreline: 18.5m	RB T3-T5: 18.3m	

Transect #	Wetted width (m)	Rooted width (m)	Station #	Depth (cm)	Water Velocity (m/s)	%fines(< 2mm)	%small gravel (2-16 mm)	%large gravel (17-64 mm)	%cobble (65-256 mm)	%boulders (>256 mm)	E[1] %	C (L/I/C)[2]	Ave E%	Ave C	Substrate Composition	
T1	2.8	4.9	2	8		70	20	10	0	0	10	L			%FINE - 25%	
			3	29		0	60	40	0	0	5	L		Ave L: 67%	%Small Gr -32%	DOWNSTREAM
			4	42		0	20	30	50	0	20	I	16	Ave I: 33%	%Large Gr-18%	
T2	4.4	4.4	2	17		0	0	20	80	0	20	I		Ave C: 0%	%Cobble -25%	
			3	34		0	80	0	20	0	20	L			%Boulder - 0%	
			4	27		80	10	10	0	0	20	L				
T3	4.1	9	2	16		0	90	10	0	0	25	L				
			3	28		0	0	30	60	10	10	I			%FINE -0%	
			4	23		0	10	10	80	0	10	I			%Small Gr -38%	STREAM CROSSING
T4	4.2		2	11.8		T	80	10	0	10	70	L		Ave L: 78%	%Large Gr-14%	
			3	16		0	20	60	10	10	10	L	20	Ave I: 22%	%Cobble -27%	
			4	13		0	10	10	80	0	10	L		Ave C: 0%	%Boulder - 21%	
T5	3.3	6.2	2	11		0	70	0	10	20	10	L				
			3	28		0	20	0	0	80	25	L				
			4	38		0	40	0	0	60	10	L				
T6	4.3	4.8	2	20		0	0	20	80	0	30	I			%FINE -0%	
			3	15		0	0	0	90	10	10	L			%Small Gr -2%	
			4	16		0	10	80	10	0	60	L	28	Ave L: 67% Ave I: 33% Ave C: 0%	%Large Gr-40%	UPSTREAM
T7	3.4	5.1	2	20		0	0	90	10	0	20	L			%Cobble -57%	
			3	23		0	0	30	70	0	25	I			%Boulder -2%	
			4	26		0	0	20	80	0	25	L				

Channel Profile:	planar														
	DOWNSTREAM				STREAM CROSSING		UPSTREAM								
Ratings (1-4)	**T1-T2**		**T2-T3**		**T3-T5**		**T5-T6**		**T6-T7**		**AVERAGE**		**Descriptive Score**		
	LB	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**Down-stream**	**Up-stream**	**Down-stream**	**Up-stream**	
Approach					3	2									
Bank stability	3	1	2	1			1	1	2	2	**1.8**	**1.5**	<Slightly Unstable	Stable	
Root Mass	4	1	3	1			4	4	2	3	**2.3**	**3.3**	65%-85%	35-65%	

OVERALL IMPACT RATING:	**2 - Slightly unstable crossing with moderate potential for further erosion.**
COMBINED RANKING:	**2.3 - MODERATELY IMPACTED FROM CROSSING ACTIVITY**

	LB gradient	**LB distance**	**RB gradient**	**RB distance**
Sediment input from trail	flat	10.5m	moderate	4.1

Other notes:

Transect T5-T6 includes both the logging bridge and the ATV bridge described in the comments section above.

[1]E=embeddedness; [2]C=cemented (**L**oose/**I**ntermediate/**C**emented)

Note: Localized riparian planting was done along this forded OHV crossing in the fall of 2013 and 2014 (as part of a volunteer collaborative effort co-ordinated by Cows and Fish). Willow, balsam poplar, and red-osier dogwood stakes and fascines were installed. Only those plantings installed in the fall of 2013 were in place at the time of this crossing assessment.

GOL2 Stream Crossing Data Form

Surveyers	Waterbody name	Activity Date	Photo Numbers and Description		Waterbody Code
JM, AS	Gold Creek	16-Jul-14	LB (from RB): 82	RB (from LB): 83	GOL2
UTM Easting	**UTM Northing (11U)**	**Way Point Name and Site Location Notes**		**Additional Photos**	
688340	5502327	GOL2, 11U		see GOL2 RHI photos	
Existing structure	None	Comments: There is a wooden ATV bridge between T5 and T6, but it is in disrepair and not safe for vehicle passage. Stream crossing is a forded ATV/truck crossing.			
Type of Use	ATV/Quad; Truck				
Active Linear Disturbance Distance of Ford (m)	LB Shoreline: 8 m	LB T3-T5: 8.3 m	RB shoreline: 6.6 m	RB T3-T5: 5.5 m	

Transect #	Wetted width (m)	Rooted width (m)	Station #	Depth (cm)	Water Velocity (m/s)	%fines(< 2mm)	%small gravel (2-16 mm)	%large gravel (17-64 mm)	%cobble (65-256 mm)	%boulders (>256 mm)	E[1] %	C (L/I/C)[2]	Ave E%	Ave C		Substrate Composition		
T1	6.0	9.7	2	21		0	0	0	0	100	50	I				%FINE -	0	DOWNSTREAM
			3	24		0	0	0	0	100	25	L		Ave L	33%	%Small Gr -	17	
			4	36		0	0	0	10	90	50	I	36	Ave I	67%	%Large Gr-	18	
T2	3.4/5.1	8.6/7.7	2	15		0	90	10	0	0	75	I		Ave C	0%	%Cobble	17	
			3	66		0	0	10	90	T	10	L				%Boulder -	58	
			4	30		0	10	90	0	0	5	I						
T3	14.4	15.9	2	10		0	40	60	0	0	50	L						
			3	19		0	0	90	10	0	50	L				%FINE -	3	STREAM CROSSING
			4	27		0	T	10	90	0	5	L				%Small Gr -	43	
T4	16.8		2	17		0	50	50	0	0	15	L		Ave L	67%	%Large Gr-	29	
			3	27		0	0	20	80	0	25	I	27	Ave I	33%	%Cobble	30	
			4	30		10	80	10	0	0	15	L		Ave C	0%	%Boulder -	0	
T5	11.3	11.5	2	12		10	80	10	0	0	5	L						
			3	27		0	0	10	90	0	25	I						
			4	28		10	90	0	0	0	50	I						
T6	6.5	6.5	2	19		0	60	10	30	0	40	I				%FINE -	0	UPSTREAM
			3	37		0	80	10	10	0	25	I				%Small Gr -	73	
			4	45		0	90	0	10	0	15	I	26	Ave L	50%	%Large Gr-	10	
T7	6.0	6.0	2	20		0	60	30	0	0	15	L		Ave I	50%	%Cobble	15	
			3	35		0	70	0	30	0	20	L		Ave C	0%	%Boulder -	0	
			4	28		0	80	10	10	0	40	L						

Channel Profile: planar

	DOWNSTREAM				STREAM CROSSING		UPSTREAM							
Ratings (1-4)	**T1-T2**		**T2-T3**		**T3-T5**		**T5-T6**		**T6-T7**		**AVERAGE**		**Descriptive Score**	
	LB	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**Down-stream**	**Up-stream**	**Downstream**	**Upstream**
Approach					1	2								
Bank stability	1	4	1	4			1	2	1	1	**2.5**	**1.3**	Slightly Unstable	Stable
Root Mass	4	4	4	4			1	4	4	1	**4.0**	**2.5**	<35%	65%-85%

OVERALL IMPACT RATING:	**1**	**Stable crossing with little potential for further erosion.**
COMBINED RANKING:	**1.3**	**Minimally impacted from crossing activity**

	LB gradient	LB distance	RB gradient	RB distance
Sediment input from trail	flat	7.6 m	moderate	8 m

Other notes:

[1]E=embeddedness; [2]C=cemented (**L**oose/**I**ntermediate/**Ce**mented)

GOL3 Stream Crossing Data Form

Surveyers	Waterbody name	Activity Date	Photo Numbers and Description		Waterbody Code
JM, MP	Gold Creek	02-Sep-14	LB (from RB): 1728	RB (from LB): 1729	GOL3
UTM Easting	**UTM Northing (11U)**	**Way Point Name and Site Location Notes**		**Additional Photos**	
688812	5501571	GOL3A		see GOL3 RHI photos	
Existing structure	Quad Bridge	**Comments:** Recently installed bridge by the Crowsnest Pass Quad Squad			
Type of Use	ATV/Quad				
Active Linear Disturbance Distance of Ford (m)	LB Shoreline: 2 m	LB T3-T5: 2 m	RB shoreline: 2.2 m	RB T3-T5: 2 m	

Transect #	Wetted width (m)	Rooted width (m)	Station #	Depth (cm)	Water Velocity (m/s)	%fines(< 2mm)	%small gravel (2-16 mm)	%large gravel (17-64 mm)	%cobble (65-256 mm)	%boulders (>256 mm)	E[1] %	C (L/I/C)[2]	Ave E%	Ave C		Substrate Composition		
T1	7.2	7.3	2	25		0	0	0	90	10	20	I				%FINE -	5	DOWNSTREAM
			3	27		30	30	30	10	0	40	L		Ave L	50%	%Small Gr -	27	
			4	15		0	30	40	20	10	30	L	33	Ave I	50%	%Large Gr-	27	
T2	7.1	7.4	2	33		0	30	10	30	30	40	L		Ave C	0%	%Cobble	33	
			3	30		0	40	40	20	0	30	I				%Boulder -	8	
			4	14		0	30	40	30	0	40	I						
T3	6.2	6.3	2	38		0	10	0	90	0	25	I						
			3	33		40	10	50	0	0	30	L				%FINE -	11	STREAM CROSSING
			4	39		60	10	20	10	0	60	L				%Small Gr -	43	
T4	6.2		2	24		0	25	5	70	0	30	L		Ave L	67%	%Large Gr-	17	
			3	30		0	50	25	25	0	40	I	38	Ave I	33%	%Cobble	27	
			4	36		0	80	10	0	10	40	L		Ave C	0%	%Boulder -	2	
T5	6.0	6.5	2	37		0	90	0	0	10	30	L						
			3	36		0	60	40	0	0	30	L						
			4	13		0	50	0	50	0	60	I						
T6	5.4	6.2	2	36		0	80	10	10	0	40	L				%FINE -	12	UPSTREAM
			3	38		40	10	40	10	0	40	L				%Small Gr -	28	
			4	42		30	0	40	30	0	20	L	35	Ave L	50%	%Large Gr-	38	
T7	5.8	6.4	2	28		0	80	10	0	10	40	I		Ave I	50%	%Cobble	17	
			3	34		0	0	50	40	10	50	I		Ave C	0%	%Boulder -	5	
			4	30		0	0	80	10	10	20	I						

Channel Profile: U-shaped

	DOWNSTREAM				STREAM CROSSING		UPSTREAM							
Ratings (1-4)	**T1-T2**		**T2-T3**		**T3-T5**		**T5-T6**		**T6-T7**		**AVERAGE**		**Descriptive Score**	
	LB	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**Down-stream**	**Up-stream**	**Down-stream**	**Up-stream**
Approach					2	3								
Bank stability	2	1	1	1			2	1	2	2	**1.3**	**1.8**	Stable	<Slightly Unstable
Root Mass	2	1	3	2			3	1	2	1	**2.0**	**1.8**	65%-85%	>85%

OVERALL IMPACT RATING:	**1**	**Stable crossing with little potential for further erosion.**
COMBINED RANKING:	**2.0**	**Minimally impacted from crossing activity**

	LB gradient	LB distance	RB gradient	RB distance
Sediment input from trail	moderate	6.3 m	moderate	6.9 m

Other notes:

[1]E=embeddedness; [2]C=cemented (**L**oose/**I**ntermediate/**C**emented)

GRE1 Stream Crossing Data Form

Surveyers	Waterbody name	Activity Date	Photo Numbers and Description		Waterbody Code
JM, MP	Green Creek	02-Sep-14	LB (taken on RB) 1764	RB (taken on LB) 1765	GRE1
UTM Easting	**UTM Northing (11U)**	**Way Point Name and Site Location Notes**		**Additional Photos**	
688822	5501414	GRE1B, 11U		see GRE1 RHI photos	
Existing structure	Quad Bridge	Comments: Recently installed bridge by the Crowsnest Pass Quad Squad			
Type of Use	ATV/Quads				
Active Linear Disturbance Distance of Ford (m)	LB Shoreline: 1.8 m	LB T3-T5: 1.6 m	RB shoreline: 2.0 m	RB T3-T5: 1.8 m	

Transect #	Wetted width (m)	Rooted width (m)	Station #	Depth (cm)	Water Velocity (m/s)	%fines(< 2mm)	%small gravel (2-16 mm)	%large gravel (17-64 mm)	%cobble (65-256 mm)	%boulders (>256 mm)	E[1] %	C (L/I/C)[2]	Ave E%	Ave C	Substrate Composition		
T1	1.8	1.9	2	9		100	0	0	0	0	0	L			%FINE -	85	DOWNSTREAM
			3	21		85	15	0	0	0	30	L		Ave L	100% %Small Gr -	10	
			4	26		65	5	0	30	0	15	L	21	Ave I	0% %Large Gr-	0	
T2	2.2	2.6	2	13		90	10	0	0	0	25	L		Ave C	0% %Cobble	5	
			3	15		90	10	0	0	0	25	L			%Boulder -	0	
			4	17		80	20	0	0	0	30	L					
T3	3.6	3.8	2	5		20	75	5	0	0	25	L					
			3	20		30	30	40	0	0	40	L			%FINE -	41	STREAM CROSSING
			4	10		10	65	25	0	0	30	L			%Small Gr -	49	
T4	3.4		2	17		90	10	0	0	0	0	L		Ave L	100% %Large Gr-	9	
			3	10		10	90	0	0	0	40	L	29	Ave I	0% %Cobble	1	
			4	2		20	80	0	0	0	40	L		Ave C	0% %Boulder -	0	
T5	3	3.6	2	20		50	30	10	10	0	40	L					
			3	9		50	50	0	0	0	30	L					
			4	1		90	10	0	0	0	15	L					
T6	12.8	13	2	5		0	100	0	0	0	10	L			%FINE -	0	UPSTREAM
			3	10		0	25	75	0	0	25	L			%Small Gr -	38	
			4	15		0	90	10	0	0	10	L	23	Ave L	100% %Large Gr-	46	
T7	7.9	8.2	2	10		0	10	80	10	0	30	L		Ave I	0% %Cobble	17	
			3	3		0	0	100	0	0	60	L		Ave C	0% %Boulder -	0	
			4	3		0	0	10	90	0	0	L					

Channel Profile: planar

	DOWNSTREAM				STREAM CROSSING		UPSTREAM							
Ratings (1-4)	**T1-T2**		**T2-T3**		**T3-T5**		**T5-T6**		**T6-T7**		**AVERAGE**		**Descriptive Score**	
	LB	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**Down-stream**	**Up-stream**	**Down-stream**	**Up-stream**
Approach					2	2								
Bank stability	2	1	1	1			1	1	1	2	**1.3**	**1.3**	Stable	Stable
Root Mass	4	4	4	4			4	4	4	2	**4.0**	**3.5**	<35%	35%-65%

OVERALL IMPACT RATING:	**1**	**Stable crossing with little potential for further erosion.**
COMBINED RANKING:	**1.7**	**Minimally impacted from crossing activity**

	LB gradient	LB distance	RB gradient	RB distance
Sediment input from trail	gentle	5.8m	gentle	5 m

Other notes:

Highly disturbed upstream and downstream of quad bridge crossing due to livestock and forded truck crossings. The actual quad bridge crossing is stable and minimally impacted, but the larger reach has more impacts. Refer to RHI results of entire reach for more details.

[1]E=embeddedness; [2]C=cemented (**L**oose/**I**ntermediate/**C**emented)

MOR1 Stream Crossing Data Form

Surveyers	Waterbody name	Activity Date	Photo Numbers and Description		Waterbody Code
AS, JM	Morin Creek	16-Jul-14	LB (from RB): 59	RB (from LB): 60	MOR1
UTM Easting	**UTM Northing (11U)**	**Way Point Name and Site Location Notes**		**Additional Photos**	
688029	5503004	MOR1, 11U		see MOR1 RHI photos	
Existing structure	None	Comments: Stream Crossing Data was collected from a high use forded stream crossing. A second forded all terrain vehicle crossing is located between T6 and T7.			
Type of Use	ATV/Quad; Truck				
Active Linear Disturbance Distance of Ford (m)	LB Shoreline: 3.2 m	LB T3-T5: 2.7 m	RB shoreline: 3.3 m	RB T3-T5: 3.1 m	

Transect #	Wetted width (m)	Rooted width (m)	Station #	Depth (cm)	Water Velocity (m/s)	%fines(< 2mm)	%small gravel (2-16 mm)	%large gravel (17-64 mm)	%cobble (65-256 mm)	%boulders (>256 mm)	E[1] %	C (L/I/C)[2]	Ave E%	Ave C		Substrate Composition		
T1	5.1	5.2	2	19		0	10	90	T	0	40	L				%FINE -	5	DOWNSTREAM
			3	17		10	30	60	T	0	15	I		Ave L	67%	%Small Gr -	22	
			4	15		20	50	30	T	0	10	L	27	Ave I	33%	%Large Gr-	53	
T2	2.9	2.9	2	18		0	30	40	30	T	15	L		Ave C	0%	%Cobble	40	
			3	25		0	10	20	70	0	30	L				%Boulder -	0	
			4	26		0	0	80	20	T	50	I						
T3	13.5	13.4	2	16		10	80	10	0	0	20	L						
			3	11		0	30	70	T	0	20	I				%FINE -	7	STREAM CROSSING
			4	10		0	40	60	T	0	30	L				%Small Gr -	49	
T4	15.5		2	12		10	80	10	T	0	20	L		Ave L	78%	%Large Gr-	44	
			3	15		0	30	70	T	0	10	I	21	Ave I	22%	%Cobble	0	
			4	24		10	90	0	T	0	70	L		Ave C	0%	%Boulder -	0	
T5	13.4	12.8	2	4		10	30	60	0	0	0	L						
			3	13		0	10	90	T	0	10	L						
			4	25		20	50	30	0	0	5	L						
T6	9.4	11	2	18		0	30	30	40	T	40	L				%FINE -	13	UPSTREAM
			3	20		0	10	60	30	T	20	I				%Small Gr -	27	
			4	8		0	40	60	T	0	15	L	33	Ave L	50%	%Large Gr-	45	
T7	2.2	3.5	2	21		20	40	40	T	0	50	I		Ave I	50%	%Cobble	27	
			3	19		30	30	30	10	0	50	L		Ave C	0%	%Boulder -	0	
			4	21		30	10	50	T	0	20	I						

Channel Profile: planar

	DOWNSTREAM				STREAM CROSSING		UPSTREAM							
Ratings (1-4)	**T1-T2**		**T2-T3**		**T3-T5**		**T5-T6**		**T6-T7**		**AVERAGE**		**Descriptive Score**	
	LB	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**Down-stream**	**Up-stream**	**Down-stream**	**Up-stream**
Approach					2	3								
Bank stability	1	1	1	1			3	3	1	1	**1.0**	**2.0**	Stable	Slightly unstable
Root Mass	1	1	1	1			4	4	1	1	**1.0**	**2.5**	>85%	65%-85%

OVERALL IMPACT RATING:	**1**	**Stable crossing with little potential for further erosion.**
COMBINED RANKING:	**2.0**	**Minimally impacted from crossing activity**

	LB gradient	**LB distance**	**RB gradient**	**RB distance**
Sediment input from trail	moderate	5.4 m	moderate	7.6 m

Other notes:

There has been already erosion of soil into the stream at this crossing, particularly from the steeper right bank. The trail has now eroded to what appears to be a more stable grade.

[1]E=embeddedness; [2]C=cemented (**L**oose/**I**ntermediate/**C**emented)

SMT2 Stream Crossing Data Form (Quad bridge and forded stream crossing)

Surveyers	Waterbody name	Activity Date	Photo Numbers and Description		Waterbody Code
AS, JM	Smith Creek	15-Jul-14	LB (from RB): 29	RB (from LB): 28	SMT2
UTM Easting	**UTM Northing (11U)**	**Way Point Name and Site Location Notes**		**Additional Photos**	
674931	5519928	SMT2A, taken at u/s side of bridge on right bank		see SMT2 RHI photos	
Existing structure	bridge	Comments: Decommissioned logging road with a quad bridge. All terrain vehicles are fording the creek up and downstream from the bridge. The T3-T4 reach includes the bridge and one of the forded crossings. The other forded crossing is in the T5 to T6 reach.			
Type of Use	ATV/Quad				

Active Linear Disturbance Distance of Ford (m)	LB Shoreline: 9.4 m	LB T3-T5: 8.9 m	RB shoreline: 13.7 m	RB T3-T5: 13.5 m

Transect #	Wetted width (m)	Rooted width (m)	Station #	Depth (cm)	Water Velocity (m/s)	%fines(<2mm)	%small gravel (2-16 mm)	%large gravel (17-64 mm)	%cobble (65-256 mm)	%boulders (>256 mm)	E[1] %	C (L/I/C)[2]	Ave E% (AUTO)	Ave C		Substrate Composition		
T1	2.5	4.1	2	14		20	80	T	0	0	15	L				%FINE -	43	DOWNSTREAM
measured on LB			3	13		100	0	0	0	0	NA	NA		Ave L	50%	%Small Gr -	42	
			4	8		100	0	0	0	0	NA	NA	26	Ave I	50%	%Large Gr-	27	
T2	4.9	5.6	2	20		30	70	T	0	0	50	L		Ave C	0%	%Cobble	2	
measured on LB			3	26		10	90	T	0	0	20	I				%Boulder -	0	
			4	24		0	10	80	10	0	20	I						
T3	5.2	7.6	2	12		0	20	80	T	0	40	L						
			3	17		0	30	70	T	0	20	I				%FINE -	18	STREAM CROSSING
			4	13		0	40	60	T	0	30	I				%Small Gr -	27	
T4	5.2		2	4		T	30	70	0	0	10	L		Ave L	63%	%Large Gr-	58	
			3	22		0	10	90	P	0	15	L	23	Ave I	38%	%Cobble	0	
			4	20		0	20	80	T	0	30	I		Ave C	0%	%Boulder -	0	
T5	3.4	6.5	2	19		10	20	70	T	0	30	L						
measured on RB			3	22		100	0	0	0	0	NA	NA						
			4	15		30	70	0	0	0	10	L						
T6	1.9	1.6	2	13		50	50	0	0	0	0	L				%FINE -	50	UPSTREAM
measured on RB			3	18		100	0	0	0	0	NA	NA				%Small Gr -	20	
			4	18		100	0	0	0	0	NA	NA	18	Ave L	50%	%Large Gr-	28	
T7	2.5	2.7	2	27		0	T	70	30	0	30	I		Ave I	50%	%Cobble	13	
			3	12		0	20	60	20	0	30	I		Ave C	0%	%Boulder -	0	
			4	10		T	30	40	30	0	10	L						

Channel Profile:	v-shaped, u-shaped

	DOWNSTREAM				STREAM CROSSING		UPSTREAM							
Ratings (1-4)	**T1-T2**		**T2-T3**		**T3-T5**		**T5-T6**		**T6-T7**		**AVERAGE**		**Descriptive Score**	
	LB	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**LB**	**RB**	**Down-stream**	**Up-stream**	**Down-stream**	**Up-stream**
Approach					4	4								
Bank stability	3	1	3	1			1	1	1	1	**2.0**	**1.0**	Slightly unstable	Stable
Root Mass	4	1	4	1			2	4	1	4	**2.5**	**2.8**	65%-85%	65%-85%

OVERALL IMPACT RATING:	**3**	**Highly unstable crossing with potential for considerable erosion.**
COMBINED RANKING:	**3.7**	**Highly impacted from crossing activity**

	LB gradient	**LB distance**	**RB gradient**	**RB distance**
Sediment input from trail	steep	10.6	steep	7.2

Other notes:

Efforts to curtail use of the forded stream crossing are being counteracted by recreational users, including removal of large boulders and logs that were placed after installation of the quad bridge. Silt fence installed at the base of the bridge on the left bank is also damaged and no longer effectively trapping silt. Riparian planting done here in October 2014 (co-ordinated by Cows and Fish).

[1]E=embeddedness; [2]C=cemented (**L**oose/**I**ntermediate/**C**emented)

Note: Localized riparian planting was done at this crossing in the fall of 2014 (as part of a volunteer collaborative effort co-ordinated by Cows and Fish), AFTER this stream crossing assessment was done. Willow, balsam poplar, and red osier dogwood stakes and fascines were planted in bare soil areas created by OHV traffic fording the creek up and downstream of the quad bridge.

APPENDIX D

WESTSLOPE CUTTHROAT TROUT PROJECT AREA, 2014 RIPARIAN PLANT SPECIES INVENTORY

Life Form[1]	Plant Status[2]	Area by Species (ha)	Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
			Avg	Min	Max		
TREES							
white spruce (Picea glauca)	native	5.3	39.7%	0.5%	90.0%	100.0%	39.7%
lodgepole pine (Pinus contorta)	native	2.5	35.6%	0.0%	40.0%	35.7%	19.1%
aspen (Populus tremuloides)	native	0.5	4.2%	0.0%	30.0%	50.0%	3.4%
balsam fir (Abies balsamea)	native	0.2	12.6%	0.0%	30.0%	42.9%	1.7%
balsam poplar (Populus balsamifera)	native	0.2	1.6%	0.0%	20.0%	78.6%	1.5%
jack pine (Pinus banksiana)	native	0.1	4.4%	0.0%	10.0%	14.3%	0.8%
Douglas-fir (Pseudotsuga menziesii)	native	0.0	3.0%	0.0%	3.0%	21.4%	0.1%
SHRUBS							
firm leaf willow (Salix pseudomyrsinites syn. Salix myrtillifolia var. cordata)	native	1.3	17.7%	0.0%	20.0%	21.4%	9.5%
river alder (Alnus tenuifolia)	native	0.9	8.6%	0.0%	30.0%	64.3%	6.4%
Canada buffaloberry (Shepherdia canadensis)	native	0.7	6.1%	0.0%	10.0%	85.7%	5.5%
buckbrush/snowberry (Symphoricarpos occidentalis)	native	0.7	15.2%	0.0%	30.0%	35.7%	5.2%
common bearberry (Arctostaphylos uva-ursi)	native	0.7	6.1%	0.0%	10.0%	35.7%	4.9%
dusky willow (Salix melanopsis)	native	0.7	8.4%	0.0%	20.0%	42.9%	4.9%
Saskatoon (Amelanchier alnifolia)	native	0.4	4.0%	0.0%	20.0%	42.9%	3.3%
Drummond's willow (Salix drummondiana)	native	0.3	2.8%	0.0%	20.0%	50.0%	2.0%
beaked willow (Salix bebbiana)	native	0.3	4.1%	0.0%	10.0%	64.3%	2.0%
prickly rose (Rosa acicularis)	native	0.2	7.3%	0.0%	10.0%	35.7%	1.7%
false mountain willow (Salix pseudomonticola)	native	0.2	4.9%	0.0%	20.0%	28.6%	1.7%
bunchberry (Cornus canadensis)	native	0.2	2.2%	0.0%	3.0%	57.1%	1.7%
red-osier dogwood (Cornus stolonifera)	native	0.2	8.5%	0.0%	10.0%	21.4%	1.4%
northern gooseberry (Ribes oxyacanthoides)	native	0.2	1.2%	0.0%	10.0%	92.9%	1.2%
bracted honeysuckle (Lonicera involucrata)	native	0.1	1.3%	0.0%	3.0%	50.0%	0.9%
ground juniper (Juniperus communis)	native	0.1	0.6%	0.0%	3.0%	78.6%	0.5%
twinflower (Linnaea borealis)	native	0.1	0.7%	0.0%	3.0%	28.6%	0.5%
white meadowsweet (Spiraea betulifolia)	native	0.1	2.7%	0.0%	3.0%	21.4%	0.4%
shrubby cinquefoil (Potentilla fruticosa)	native	0.1	0.5%	0.0%	0.5%	57.1%	0.4%
low-bush cranberry (Viburnum edule)	native	0.1	3.0%	0.0%	3.0%	7.1%	0.4%
common wild rose (Rosa woodsii)	native	0.1	0.6%	0.0%	3.0%	42.9%	0.4%
creeping juniper (Juniperus horizontalis)	native	0.04	0.6%	0.0%	10.0%	14.3%	0.3%
yellow mountain avens (Dryas drummondii)	native	0.04	0.6%	0.0%	10.0%	14.3%	0.3%
Farr's willow (Salix farriae)	native	0.03	10.0%	0.0%	10.0%	7.1%	0.3%
water birch (Betula occidentalis)	native	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
twining honeysuckle (Lonicera dioica)	native	0.02	0.8%	0.0%	3.0%	28.6%	0.2%
thimbleberry (Rubus parviflorus)	native	0.02	0.9%	0.0%	20.0%	28.6%	0.1%
wild red currant (Ribes triste)	native	0.02	2.8%	0.0%	3.0%	14.3%	0.1%
balsam willow (Salix pyrifolia)	native	0.02	3.0%	0.0%	3.0%	7.1%	0.1%

Life Form[1]	Plant Status[2]	Area by Species (ha)	Percent Canopy Cover[3] Avg	Min	Max	Constancy[4]	Percent of Project Area
Scouler's willow (Salix scouleriana)	native	0.02	3.0%	0.0%	3.0%	7.1%	0.1%
wild red raspberry (Rubus idaeus)	native	0.02	0.5%	0.0%	0.5%	35.7%	0.1%
choke cherry (Prunus virginiana)	native	0.01	0.5%	0.0%	0.5%	14.3%	0.1%
skunk currant (Ribes glandulosum)	native	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
green alder (Alnus crispa)	native	0.01	0.9%	0.0%	3.0%	14.3%	0.04%
yellow willow (Salix lutea)	native	0.01	0.5%	0.0%	0.5%	14.3%	0.04%
basket willow (Salix petiolaris)	native	0.005	0.5%	0.0%	0.5%	21.4%	0.03%
velvet-fruited willow (Salix maccalliana)	native	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
snowberry (Symphoricarpos albus)	native	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
grouseberry (Vaccinium scoparium)	native	0.004	0.5%	0.0%	0.5%	14.3%	0.03%
purple clematis (Clematis occidentalis)	native	0.004	0.5%	0.0%	0.5%	14.3%	0.03%
flat-leaved willow (Salix planifolia)	native	0.003	0.5%	0.0%	0.5%	14.3%	0.02%
red twinberry (Lonicera utahensis)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
false azalea (Menziesia ferruginea)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
willow (Salix spp.)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
Rocky Mountain juniper (Juniperus scopulorum)	native	0.001	0.5%	0.0%	0.5%	7.1%	0.01%
creeping mahonia (Berberis repens)	native	0.0005	0.5%	0.0%	0.5%	7.1%	0.004%
silverberry (Elaeagnus commutata)	native	0.0004	0.5%	0.0%	0.5%	7.1%	0.003%
northern black currant (Ribes hudsonianum)	native	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%
pussy willow (Salix discolor)	native	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%
GRASSES AND GRASS-LIKES							
Kentucky bluegrass (Poa pratensis)	disturbance, introduced	2.5	18.8%	0.0%	60.0%	92.9%	18.6%
timothy (Phleum pratense)	disturbance, introduced	0.9	15.6%	0.0%	30.0%	50.0%	6.4%
smooth brome (Bromus inermis)	disturbance, introduced	0.6	5.9%	0.0%	20.0%	50.0%	4.5%
hairy wild rye (Elymus innovatus)	native	0.3	2.3%	0.0%	3.0%	42.9%	2.1%
wire rush (Juncus balticus)	native	0.2	2.1%	0.0%	3.0%	42.9%	1.8%
fowl bluegrass (Poa palustris)	native	0.1	0.9%	0.0%	3.0%	35.7%	0.6%
small-winged sedge (Carex microptera)	native	0.1	0.7%	0.0%	3.0%	57.1%	0.6%
beaked sedge (Carex utriculata)	native	0.1	0.7%	0.0%	10.0%	35.7%	0.5%
marsh reed grass (Calamagrostis canadensis)	native	0.1	2.8%	0.0%	10.0%	42.9%	0.5%
Sprengel's sedge (Carex sprengelii)	native	0.04	0.5%	0.0%	0.5%	14.3%	0.3%
purple oat grass (Schizachne purpurascens)	native	0.04	0.5%	0.0%	0.5%	14.3%	0.3%
small-flowered wood-rush (Luzula parviflora)	native	0.04	0.5%	0.0%	0.5%	42.9%	0.3%
sweet grass (Hierochloe odorata)	native	0.03	0.5%	0.0%	0.5%	14.3%	0.3%
mountain timothy (Phleum commutatum)	native	0.03	0.5%	0.0%	3.0%	35.7%	0.3%
fowl manna grass (Glyceria striata)	native	0.03	1.3%	0.0%	3.0%	14.3%	0.3%
crested wheat grass (Agropyron pectiniforme)	disturbance, introduced	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
quack grass (Agropyron repens)	disturbance, introduced	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
water sedge (Carex aquatilis)	native	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
orchard grass (Dactylis glomerata)	introduced	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
redtop (Agrostis stolonifera)	introduced	0.03	10.0%	0.0%	10.0%	7.1%	0.2%

Life Form[1]	Plant Status[2]	Area by Species (ha)	Percent Canopy Cover[3] Avg	Min	Max	Constancy[4]	Percent of Project Area
small-fruited bulrush (Scirpus microcarpus)	native	0.02	3.0%	0.0%	3.0%	7.1%	0.2%
meadow brome (Bromus biebersteinii)	introduced	0.02	0.5%	0.0%	0.5%	28.6%	0.2%
reed canary grass (Phalaris arundinacea)	native	0.02	0.5%	0.0%	0.5%	21.4%	0.2%
tufted hair grass (Deschampsia cespitosa)	native	0.02	0.6%	0.0%	3.0%	21.4%	0.1%
common tall manna grass (Glyceria grandis)	native	0.01	0.5%	0.0%	0.5%	21.4%	0.1%
alpine bluegrass (Poa alpina)	native	0.01	0.5%	0.0%	0.5%	14.3%	0.1%
bluebunch fescue (Festuca idahoensis)	native	0.01	1.3%	0.0%	10.0%	14.3%	0.1%
Canada wild rye (Elymus canadensis)	native	0.01	3.0%	0.0%	3.0%	7.1%	0.1%
red fescue (Festuca rubra)	native or introduced	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
fescue (Festuca spp.)	unknown, not unique	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
perennial ryegrass (Lolium perenne)	introduced	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
western porcupine grass (Stipa curtiseta)	native	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
spangletop (Scolochloa festucacea)	native	0.005	1.5%	0.0%	10.0%	21.4%	0.04%
smooth wild rye (Elymus glaucus)	native	0.004	0.5%	0.0%	0.5%	14.3%	0.03%
western wheat grass (Agropyron smithii)	native	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
awned sedge (Carex atherodes)	native	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
sedge (Carex spp.)	native	0.004	0.5%	0.0%	0.5%	14.3%	0.03%
pine reed grass (Calamagrostis rubescens)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
narrow reed grass (Calamagrostis stricta)	native	0.003	3.0%	0.0%	3.0%	7.1%	0.02%
Bebb's sedge (Carex bebbii)	native	0.003	0.5%	0.0%	0.5%	21.4%	0.02%
graminoid (Graminoid)	unknown, not unique	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
mud rush (Juncus tracyi)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
spiked sedge (Carex pyrenaica)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
fragrant sedge (Carex nardina)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
slender wheat grass (Agropyron trachycaulum)	native	0.001	0.5%	0.0%	0.5%	7.1%	0.01%
two-seeded sedge (Carex disperma)	native	0.0002	0.5%	0.0%	0.5%	7.1%	0.002%
giant wild rye (Elymus piperi)	native	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%
Canada bluegrass (Poa compressa)	disturbance, introduced	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%
FORBS							
common horsetail (Equisetum arvense)	native, poisonous	1.1	9.1%	0.0%	50.0%	78.6%	8.4%
wild strawberry (Fragaria virginiana)	disturbance, native	0.7	5.2%	0.0%	10.0%	92.9%	5.2%
common dandelion (Taraxacum officinale)	disturbance, introduced	0.3	2.1%	0.5%	3.0%	100.0%	2.1%
wild vetch (Vicia americana)	native	0.3	2.2%	0.0%	3.0%	64.3%	2.0%
white clover (Trifolium repens)	disturbance, introduced	0.3	2.4%	0.0%	10.0%	71.4%	1.9%
yellow angelica (Angelica dawsonii)	native	0.2	2.7%	0.0%	10.0%	21.4%	1.7%
cow parsnip (Heracleum lanatum)	native	0.2	3.3%	0.0%	20.0%	85.7%	1.7%
common yarrow (Achillea millefolium)	native	0.2	1.7%	0.5%	3.0%	100.0%	1.7%
white angelica (Angelica arguta)	native	0.2	5.4%	0.0%	20.0%	50.0%	1.7%
silky perennial lupine (Lupinus sericeus)	native	0.2	2.8%	0.0%	3.0%	14.3%	1.4%
northern hedysarum (Hedysarum boreale)	native	0.2	3.0%	0.0%	3.0%	14.3%	1.4%

Life Form[1]	Plant Status[2]	Area by Species (ha)	Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
			Avg	Min	Max		
cream-colored vetchling (Lathyrus ochroleucus)	native	0.1	0.9%	0.0%	3.0%	50.0%	0.8%
common nettle (Urtica dioica)	native	0.1	2.6%	0.0%	3.0%	35.7%	0.6%
alsike clover (Trifolium hybridum)	disturbance, introduced	0.1	2.7%	0.0%	3.0%	21.4%	0.6%
common fireweed (Epilobium angustifolium)	native	0.1	0.7%	0.0%	3.0%	71.4%	0.6%
Canada anemone (Anemone canadensis)	native	0.1	0.6%	0.0%	3.0%	50.0%	0.5%
northern bedstraw (Galium boreale)	native	0.1	0.5%	0.0%	0.5%	85.7%	0.5%
red clover (Trifolium pratense)	disturbance, introduced	0.1	0.6%	0.0%	3.0%	42.9%	0.5%
veiny meadow rue (Thalictrum venulosum)	native	0.1	1.1%	0.0%	10.0%	64.3%	0.4%
star-flowered Solomon's-seal (Smilacina stellata)	native	0.1	0.5%	0.0%	0.5%	42.9%	0.4%
ox-eye daisy (Chrysanthemum leucanthemum syn. Leucanthemum vulgare)*	**invasive**, introduced	0.1	0.6%	0.0%	3.0%	64.3%	0.4%
clasping-leaved twisted-stalk (Streptopus amplexifolius)	native	0.1	0.7%	0.0%	3.0%	50.0%	0.4%
yellow columbine (Aquilegia flavescens)	native	0.1	0.5%	0.0%	0.5%	35.7%	0.4%
graceful cinquefoil (Potentilla gracilis)	native	0.1	0.5%	0.0%	0.5%	57.1%	0.4%
tall meadow rue (Thalictrum dasycarpum)	native	0.1	4.0%	0.0%	10.0%	14.3%	0.4%
Canada thistle (Cirsium arvense)*	**invasive**, introduced	0.05	0.9%	0.0%	3.0%	57.1%	0.4%
common red paintbrush (Castilleja miniata)	native	0.05	0.5%	0.0%	0.5%	35.7%	0.4%
twin arnica (Arnica sororia)	native	0.05	10.0%	0.0%	10.0%	7.1%	0.4%
western sweet cicely (Osmorhiza occidentalis)	native	0.05	0.7%	0.0%	3.0%	21.4%	0.3%
wild white geranium (Geranium richardsonii)	native	0.05	1.4%	0.0%	3.0%	28.6%	0.3%
yellow false dandelion (Agoseris glauca)	native	0.05	0.5%	0.0%	0.5%	21.4%	0.3%
cut-leaved anemone (Anemone multifida)	native	0.04	0.5%	0.0%	0.5%	28.6%	0.3%
wild licorice (Glycyrrhiza lepidota)	native	0.04	0.5%	0.0%	0.5%	21.4%	0.3%
three-flowered avens (Geum triflorum)	native	0.04	0.5%	0.0%	0.5%	14.3%	0.3%
early blue violet (Viola adunca)	native	0.04	0.5%	0.0%	0.5%	14.3%	0.3%
yellow hedysarum (Hedysarum sulphurescens)	native	0.04	0.5%	0.0%	0.5%	28.6%	0.3%
rosy everlasting (Antennaria rosea)	disturbance, native	0.04	0.5%	0.0%	0.5%	14.3%	0.3%
meadow horsetail (Equisetum anadens)	native	0.04	4.7%	0.0%	30.0%	21.4%	0.3%
heart-leaved Alexanders (Zizia aptera)	native	0.04	1.9%	0.0%	3.0%	35.7%	0.3%
late yellow locoweed (Oxytropis monticola)	native, poisonous	0.04	0.5%	0.0%	3.0%	21.4%	0.3%
smooth aster (Aster laevis)	native	0.04	0.7%	0.0%	3.0%	50.0%	0.3%
long-leaved chickweed (Stellaria longifolia)	native	0.03	0.5%	0.0%	0.5%	21.4%	0.3%
northern green bog orchid (Habenaria anadensis)	native	0.03	0.5%	0.0%	0.5%	21.4%	0.3%
small wood anemone (Anemone parviflora)	native	0.03	0.5%	0.0%	0.5%	7.1%	0.2%

Life Form[1]	Plant Status[2]	Area by Species (ha)	Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
			Avg	Min	Max		
Arctic aster (Aster sibiricus)	native	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
sparrow's-egg lady's-slipper (Cypripedium passerinum)	native	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
elephant's-head (Pedicularis groenlandica)	native	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
prairie groundsel (Senecio canus)	native	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
common blue-eyed grass (Sisyrinchium montanum)	native	0.03	0.5%	0.0%	0.5%	7.1%	0.2%
Canada goldenrod (Solidago anadensis)	native	0.03	0.5%	0.0%	0.5%	35.7%	0.2%
purple-stemmed aster (Aster puniceus)	native	0.02	1.4%	0.0%	3.0%	42.9%	0.2%
tall buttercup (Ranunculus acris)*	**invasive**, introduced	0.02	0.6%	0.0%	3.0%	42.9%	0.2%
brook ragwort (Senecio triangularis)	native	0.02	1.6%	0.0%	3.0%	35.7%	0.2%
yellow beardtongue (Penstemon confertus)	native	0.02	0.5%	0.0%	0.5%	21.4%	0.2%
sweet-scented bedstraw (Galium triflorum)	native	0.02	1.1%	0.0%	3.0%	42.9%	0.2%
large-leaved yellow avens (Geum macrophyllum)	native	0.02	0.5%	0.0%	0.5%	42.9%	0.1%
narrow-leaved puccoon (Lithospermum incisum)	native	0.02	0.5%	0.0%	0.5%	14.3%	0.1%
western Canada violet (Viola canadensis)	native	0.02	0.5%	0.0%	0.5%	28.6%	0.1%
red-stemmed saxifrage (Saxifraga lyallii)	native	0.02	3.0%	0.0%	3.0%	7.1%	0.1%
spreading sweet cicely (Osmorhiza depauperata)	native	0.02	0.5%	0.0%	3.0%	42.9%	0.1%
western lousewort (Pedicularis bracteosa)	native	0.02	0.5%	0.0%	0.5%	35.7%	0.1%
long-stalked chickweed (Stellaria longipes)	native	0.02	0.5%	0.0%	0.5%	28.6%	0.1%
swamp horsetail (Equisetum fluviatile)	native	0.02	0.6%	0.0%	3.0%	35.7%	0.1%
tall larkspur (Delphinium glaucum)	native, poisonous	0.02	0.5%	0.0%	0.5%	28.6%	0.1%
bluebur (Lappula squarrosa)	disturbance, introduced	0.01	0.5%	0.0%	0.5%	14.3%	0.1%
sticky purple geranium (Geranium viscosissimum)	native	0.01	0.5%	0.0%	0.5%	14.3%	0.1%
bronzebells (Stenanthium occidentale)	native	0.01	0.5%	0.0%	0.5%	21.4%	0.1%
northern willowherb (Epilobium ciliatum)	native	0.01	0.6%	0.0%	3.0%	14.3%	0.1%
common pink wintergreen (Pyrola asarifolia)	native	0.01	0.5%	0.0%	0.5%	21.4%	0.1%
dwarf scouring-rush (Equisetum scirpoides)	native	0.01	2.6%	0.0%	3.0%	14.3%	0.1%
prairie sagewort (Artemisia ludoviciana)	native	0.01	0.5%	0.0%	0.5%	21.4%	0.1%
leafy-bracted aster (Aster subspicatus)	native	0.01	3.0%	0.0%	3.0%	7.1%	0.1%
small bedstraw (Galium trifidum)	native	0.01	0.5%	0.0%	0.5%	14.3%	0.1%
pearly everlasting (Anaphalis margaritacea)	native	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
hound's-tongue (Cynoglossum officinale)*	**invasive**, introduced, poisonous	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
silvery cinquefoil (Potentilla argentea)	introduced	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
marsh skullcap (Scutellaria galericulata)	native	0.01	0.5%	0.0%	0.5%	7.1%	0.1%

Life Form[1]	Plant Status[2]	Area by Species (ha)	Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
			Avg	Min	Max		
ragwort (Senecio cymbalarioides)	native	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
common goat's-beard (Tragopogon dubius)	introduced	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
forb (Forb)	unknown, not unique	0.01	0.5%	0.0%	0.5%	14.3%	0.1%
white thistle (Cirsium hookerianum)	native	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
broad-leaved fireweed (Epilobium latifolium)	native	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
marsh yellow cress (Rorippa palustris)	native	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
white camas (Zigadenus elegans)	native, poisonous	0.01	0.5%	0.0%	0.5%	7.1%	0.1%
leafy arnica (Arnica chamissonis)	native	0.01	0.5%	0.0%	0.5%	28.6%	0.1%
blueweed (Echium vulgare)*	**invasive**, introduced	0.01	2.0%	0.0%	3.0%	21.4%	0.1%
black medick (Medicago lupulina)	disturbance, introduced	0.01	0.7%	0.0%	3.0%	28.6%	0.1%
bishop's-cap (Mitella nuda)	native	0.01	0.5%	0.0%	0.5%	21.4%	0.1%
narrow-leaved dock (Rumex triangulivalvis)	native	0.01	0.5%	0.0%	0.5%	14.3%	0.04%
northern valerian (Valeriana dioica)	native	0.01	0.5%	0.0%	0.5%	14.3%	0.04%
kidney-leaved violet (Viola renifolia)	native	0.01	0.5%	0.0%	0.5%	21.4%	0.04%
common plantain (Plantago major)	disturbance, introduced	0.01	0.5%	0.0%	0.5%	21.4%	0.04%
gaillardia (Gaillardia aristata)	native	0.01	0.5%	0.0%	0.5%	14.3%	0.04%
aster (Aster spp.)	unknown, not unique	0.01	0.5%	0.0%	0.5%	14.3%	0.04%
saline shooting star (Dodecatheon pulchellum)	native	0.005	0.5%	0.0%	0.5%	14.3%	0.04%
one-flowered wintergreen (Moneses uniflora)	native	0.004	0.5%	0.0%	0.5%	14.3%	0.03%
red and white baneberry (Actaea rubra)	native, poisonous	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
Lindley's aster (Aster ciliolatus)	native	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
striped coralroot (Corallorhiza striata)	native	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
purple avens (Geum rivale)	native	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
curled dock (Rumex crispus)	introduced	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
perennial sow-thistle (Sonchus arvensis)*	**invasive**, introduced	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
stinkweed (Thlaspi arvense)	disturbance, introduced	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
American brooklime (Veronica americana)	native	0.004	0.5%	0.0%	0.5%	7.1%	0.03%
showy aster (Aster conspicuus)	native	0.003	2.0%	0.0%	3.0%	21.4%	0.02%
blue columbine (Aquilegia brevistyla)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
American milk vetch (Astragalus americanus)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
marsh-marigold (Caltha palustris)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
Venus'-slipper (Calypso bulbosa)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
fairybells (Disporum trachycarpum)	native	0.003	0.5%	0.0%	0.5%	21.4%	0.02%
tall white bog orchid (Habenaria dilatata)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
bishop's-cap (Mitella pentandra)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
alpine bistort (Polygonum viviparum)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
senecio (Senecio spp.)	native	0.003	0.5%	0.0%	0.5%	7.1%	0.02%
orange hawkweed (Hieracium aurantiacum)**	**invasive**, introduced	0.003	0.5%	0.0%	0.5%	14.3%	0.02%

Life Form[1]	Plant Status[2]	Area by Species (ha)	Percent Canopy Cover[3]			Constancy[4]	Percent of Project Area
			Avg	Min	Max		
northern grass-of-parnassus (Parnassia palustris)	native	0.003	0.5%	0.0%	0.5%	14.3%	0.02%
few-flowered ragwort (Senecio pauciflorus)	native	0.003	0.5%	0.0%	0.5%	14.3%	0.02%
tall everlasting (Antennaria anaphaloides)	disturbance, native	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
wormseed mustard (Erysimum cheiranthoides)	disturbance, introduced	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
golden aster (Heterotheca villosa)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
yellow sweet-clover (Melilotus officinalis)	disturbance, introduced	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
marsh speedwell (Veronica scutellata)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.02%
harebell (Campanula rotundifolia)	native	0.002	0.5%	0.0%	0.5%	21.4%	0.02%
tall lungwort (Mertensia paniculata)	native	0.002	0.5%	0.0%	0.5%	14.3%	0.02%
Macoun's buttercup (Ranunculus macounii)	native	0.002	0.5%	0.0%	0.5%	14.3%	0.02%
greenish-flowered wintergreen (Pyrola chlorantha)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
small-flowered buttercup (Ranunculus abortivus)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
false Solomon's-seal (Smilacina racemosa)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
bog violet (Viola nephrophylla)	native	0.002	0.5%	0.0%	0.5%	14.3%	0.01%
heart-leaved arnica (Arnica cordifolia)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
avens (Geum spp.)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
alpine hedysarum (Hedysarum alpinum)	native	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
clover (Trifolium spp.)	introduced	0.002	0.5%	0.0%	0.5%	7.1%	0.01%
small-leaved everlasting (Antennaria parvifolia)	disturbance, native	0.001	0.5%	0.0%	0.5%	14.3%	0.01%
water-hemlock (Cicuta maculata)	native, poisonous	0.001	0.5%	0.0%	0.5%	7.1%	0.01%
bull thistle (Cirsium vulgare)	introduced	0.001	0.5%	0.0%	0.5%	7.1%	0.01%
tufted white prairie aster (Aster ericoides)	native	0.001	3.0%	0.0%	3.0%	7.1%	0.01%
spreading dogbane (Apocynum androsaemifolium)	disturbance, native, poisonous	0.0005	0.5%	0.0%	0.5%	7.1%	0.004%
mountain cinquefoil (Potentilla diversifolia)	native	0.0005	0.5%	0.0%	0.5%	7.1%	0.004%
showy locoweed (Oxytropis splendens)	native, poisonous	0.0004	0.5%	0.0%	0.5%	7.1%	0.003%
wild chives (Allium schoenoprasum)	native	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%
milk vetch (Astragalus eucosmus)	native	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%
Nuttall's larkspur (Delphinium nuttallianum)	native	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%
Philadelphia fleabane (Erigeron philadelphicus)	native	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%
hemp-nettle (Galeopsis tetrahit)	disturbance, introduced	0.0002	0.5%	0.0%	0.5%	7.1%	0.001%

ALL SPECIES LISTED IN ORDER OF DECREASING ABUNDANCE

**** Designates invasive, noxious weeds (in bold text)***

***** Designates invasive, prohibited noxious weeds (in bold text)***

[1] Our primary resource for plant species naming is Flora of Alberta by E.H. Moss (1994); for species not listed in Moss (1994), taxonomy follows the Integrated Taxonomic Information System (http://www.itis.gov/).

[2] Plant status is designated by Cows and Fish in association with Alberta Sustainable Resource Development (Public Lands), Alberta Agriculture, Food and Rural Development and the Alberta *Weed Control Act*. '*unknown*' = plant not identified to species; plant status unknown.

[3] Based on visual estimates of the amount of ground the canopy of the plant covers. The percent cover values presented are the mid-values for the following ranges: 0.5=less than 1%; 3.0=1%-5%; 10.0=5%-15%; 20.0=15%-25%; 30.0=25%-35%; 40.0=35%-45%; 50.0=45%-55%; 60.0=55%-65%; 70.0=65%-75%; 80.0=75%-85%; 90.0=85%-95%; 97.5=greater than 95%; — = not observed.

[4] Constancy is the number of times the species occurs divided by the total number of polygons.

APPENDIX E

DESCRIPTION OF RIPARIAN HEALTH PARAMETERS

This description of riparian health parameters is based on the Alberta Lotic Wetland Health Assessment for Streams and Small Rivers (Survey) User Manual (Cows and Fish, current as of April 18, 2014). The complete user manual can be found at: http://cowsandfish.org/riparian/documents/ALBLoticSurveyManual_000.pdf

Each riparian health parameter is rated according to conditions observed on the site at the time of evaluation. Parameters are assessed using ocular estimates by trained practitioners. The parameter breakout groupings and point weightings were developed by a collaboration of riparian scientists, fisheries biologists, range professionals and land managers.

1. Vegetation Cover of Floodplain and Streambanks

6 = More than 95% of the polygon area is covered by plant growth.
4 = 85% to 95% of the polygon area is covered by plant growth.
2 = 75% to 85% of the polygon area is covered by plant growth.
0 = Less than 75% of the polygon area is covered by plant growth.

2a. Total Canopy Cover of Invasive Plant Species

3 = No invasive plants (weeds) on site.
2 = Invasive plants present with total canopy cover less than 1% of the polygon area.
1 = Invasive plants present with total canopy cover between 1 and 15% of the polygon area.
0 = Invasive plants present with total canopy cover more than 15% of the polygon area.

2b. Density/Distribution of Invasive Plant Species (Table 1)

3 = No invasive plants (weeds) on site.
2 = Invasive plants present with density/distribution in categories 1, 2 or 3.
1 = Invasive plants present with density/distribution in categories 4, 5, 6 or 7.
0 = Invasive plants present with density distribution in categories 8 or higher.

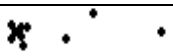
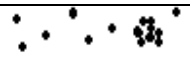
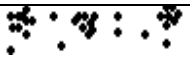
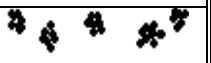
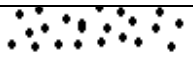
CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several sporadically occurring plants	
7	A few patches	
8	A few patches plus several sporadically occurring plants	
9	Several well spaced patches	
10	Continuous uniform occurrence of well spaced plants	
11	Continuous occurrence of plants with a few gaps in the distribution	
12	Continuous dense occurrence of plants	
13	Continuous occurrence of plants associated with a wetter or drier zone within the polygon	

Table 1. Density/distribution of invasive plant species.

3. Disturbance-Caused Undesirable Herbaceous Species

3 = Less than 5% of the site covered by disturbance-caused undesirable herbaceous species.

2 = 5% to 25% of the site covered by disturbance-caused undesirable herbaceous species.

1 = 25% to 50% of the site covered by disturbance-caused undesirable herbaceous species.

0 = More than 50% of the site covered by disturbance-caused undesirable herbaceous species.

4. Preferred Tree and Shrub Establishment and Regeneration

(N/A will appear in the Riparian Health Score Table if the polygon lacks potential for preferred trees or shrubs)

6 = More than 15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings.

4 = 5% to 15% of the total canopy cover of preferred trees/shrubs is seedlings and saplings.

2 = Less than 5% of the total canopy cover of preferred trees/shrubs is seedlings and saplings.

0 = Preferred tree/shrub seedlings and saplings absent.

5a.Utilisation of Preferred Trees and Shrubs

(N/A will appear in the Riparian Health Score Table if the polygon lacks potential for preferred trees or shrubs)

3 = None (0% to 5% of available 2nd year and older leaders of preferred species are browsed).

2 = Light (5% to 25% of available 2nd year and older leaders of preferred species are browsed).

1 = Moderate (25% to 50% of available 2nd year and older leaders of preferred species are browsed).

0 = Heavy (More than 50% of available 2nd year and older leaders of preferred species are browsed).

5b. Live Woody Vegetation Removal by Other than Browsing

(N/A will appear in the Riparian Health Score Table if the polygon lacks potential for trees or shrubs)

3 = None (0% to 5% of live woody vegetation expected on the site is lacking due to cutting and/or removal by beaver).

2 = Light (5% to 25% of live woody vegetation expected on the site is lacking due to cutting and/or removal by beaver).

1 = Moderate (25% to 50% of live woody vegetation expected on the site is lacking due to cutting and/or removal by beaver).

0 = Heavy (More than 50% of live woody vegetation expected on the site is lacking due to cutting and/or removal by beaver).

6. Standing Decadent and Dead Woody Material

3 = Less than 5% of the total canopy of woody species is decadent or dead.

2 = 5% to 25% of the total canopy of woody species is decadent or dead.

1 = 25% to 45% of the total canopy cover of woody species is decadent or dead.

0 = More than 45% of the total canopy cover of woody species is decadent or dead.

7. Streambank Root Mass Protection

6 = More than 85% of the streambank has deep, binding root mass.

4 = 65% to 85% of the streambank has deep, binding root mass.

2 = 35% to 65% of the streambank has deep, binding root mass.

0 = Less than 35% of the streambank has deep, binding root mass.

8. Human-Caused Bare Ground

6 = Less than 1% of the sites is human-caused bare ground.

4 = 1% to 5% of the site is human-caused bare ground.

2 = 5% to 15% of the site is human-caused bare ground.

0 = More than 15% of the site is human-caused bare ground.

9. Streambank Structurally Altered by Human Activity

6 = Less than 5% of the bank is structurally altered by human activity.

4 = 5% to 15% of the bank is structurally altered by human activity.

2 = 15% to 35% of the bank is structurally altered by human activity.

0 = More than 35% of the bank is structurally altered by human activity.

10. Human Physical Alteration to the Rest of the Polygon

3 = Less than 5% of the polygon is affected by human causes.

2 = 5% to 15% of the polygon is affected by human causes.

1 = 15% to 25% of the polygon is affected by human causes.

0 = More than 25% of the polygon is affected by human causes.

11. Stream Channel Incisement (Vertical Stability) (Figure 1)

9 = Not incised

6 = Slightly incised

3 = Moderately incised

0 = Severely incised

Incisement Severity	Channel Development Stage	Rosgen Types Included	Description of Incisement Situation
Not Incised (9 points)	A	A, B, C, E	Channel is vertically stable and not incised; 1-2 year high flows can begin to access a floodplain appropriate to the stream type. Active downcutting is not evident. Any old incisement is characterized by a broad floodplain inside which perennial riparian plant communities are well established. This category includes a variety of stream types in all land forms and substrates. The floodplain may be narrow or wide, depending on the type of stream, but the key factor is vertical stability. The system may have once cut down, and later become healed and is now stable again, with a new floodplain appropriate to its stream type. In this case, the erosion of the old gully side walls will have ceased and stabilised. A mature, or nearly mature, vegetation community will occupy much of the new valley bottom.
Slightly (6 points)	B/D	C, F, G	This category contains both degrading and healing stages. In either case, the extent of incisement is minimal. In Stage B, the channel is just beginning to degrade, and a 2 year flood event may still access some floodplain, either partially or in spots. Downcutting is likely progressing. In Stage D, the system is healing. Downcutting should have ceased at this stage. A new floodplain should be well established with perennial vegetation, although it may not yet be as wide as the stream type needs. This is indicated by continuing lateral erosion of the high side walls of the original incisement, as the system continues to widen itself at its new grade level.

Moderately (3 points)	B/D	C, F, G	This category also contains both degrading and healing stages. In both cases, the extent of incisement is significant. In Stage B, the channel has downcut to a level that floods of the 1-5 year magnitude cannot reach a floodplain. Downcutting is likely still progressing, but the channel may already have the appearance of a gully. In Stage D, the system has only just begun to heal. A small floodplain along the new meanders within the gully is forming, and perennial vegetation is starting to colonize the new sediment features. The high side walls of the gully are being actively eroded as the system widens, and much of the fallen material is being incorporated along the bottom.
Severely (0 points)	C	F, G	This is the worst case category, where the system has no floodplain in the bottom of a deep entrenchment, and small-to-moderate floods cannot reach the original floodplain level. Downcutting may, or may not, still be in progress. High side wall banks may have begun to collapse and erode into the bottom, but high flows typically just wash this material directly through the system, with none of it being trapped to build a new floodplain. At this stage, the system has lost practically all of its riparian function and habitat value.

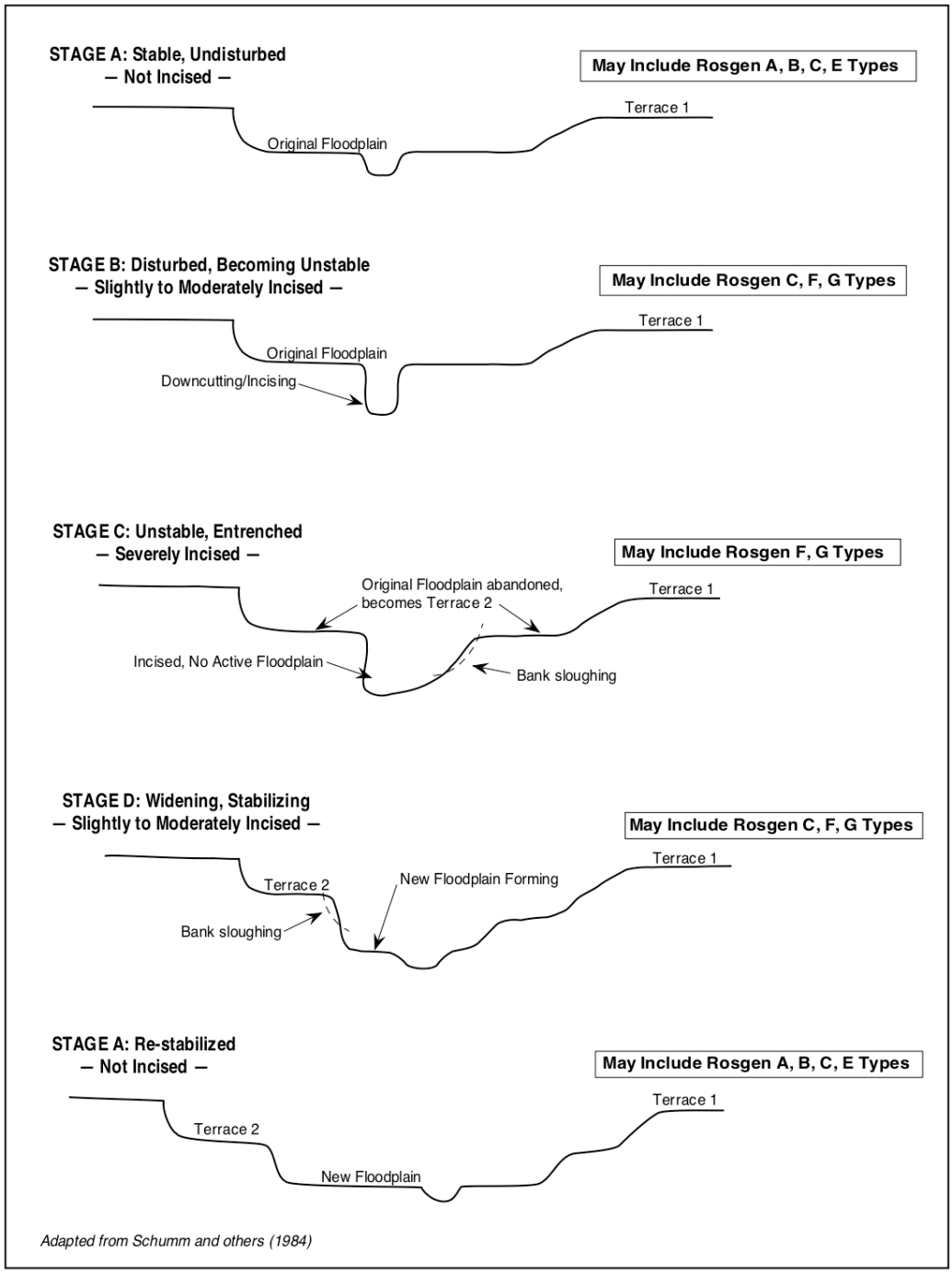


Figure 1. Guide for estimating channel incisement stage.