URBAN systems

REPORT

Sediment Source Assessment on Peachland Creek

District of Peachland

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District of Peachland
5806 Beach Avenue
Peachland, B.C.V0H 1X7

Attention: Joe Mitchel, P. Eng. Director of Operation

RE: Sediment Source Assessment on Peachland Creek

Urban Systems is pleased to submit the DRAFT Sediment Source Assessment on Peachland Creek.

Please feel free to contact any of the undersigned should you wish to discuss any aspect of this report.

Sincerely,

URBAN SYSTEMS LTD.

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Project Manager

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Contents

Figures

Tables

Appendices

Acronyms

Above Mean Sea Level	amsl
Canadian Council of Ministers of the Environment	CCME
District of Peachland	DOP
Forest Service Road	FSR
Gorman Brothers Lumber	GBL
Ministry of Forests, Lands, and Natural Resource Operations	MFLNRO
Nephelometric turbidity units	NTU
Tolko Industries Ltd.	Tolko
Total maximum daily load	TMDL

1.0 Introduction

1.1 Project Background

Community watersheds in the province of British Columbia (BC) supply many local communities with their drinking water. These watersheds also have a variety of other uses including: forestry, mining, agriculture, urban development, and recreation, and are known as multi-use watersheds (BC Provincial Health Officer, 2001).

The District of Peachland's 2007 Water Master Plan identified Peachland Creek as the primary source of drinking water for Peachland. In addition to providing the community with drinking water, the Peachland Creek watershed is an important recreational resource in the area and multiple organizations are seeking to expand access to, and recreation within, this multi-use watershed.

Identifying sources of sediment and protecting Peachland Creek water quality has been a challenge for the District of Peachland (DOP) as it is a multi-use watershed and it is topographically challenging to access the creek upstream of the drinking water intake. The main concerns of sediment transport in relation to drinking water quality in the Peachland Creek watershed are increased turbidity and microbial organisms degrading the water quality, increasing health risks and increasing treatment and operational costs (Golder, 2010). Identification and mitigation of erosion and sediment sources are key aspects of source protection planning. For the purposes of this study, the area of interest is defined as the section of creek channel between the drinking water intake (Point of Interest: POI) upstream to Peachland Reservoir, and includes the lower ~ 5km of Greata Creek to the confluence with Peachland Creek (Appendix A).

In the Watershed Assessment Report for Drinking Water Source Protection for Peachland Creek and Trepanier Creek (Golder, 2010), one of the recommended Risk Management Action Plans to prevent, reduce and/or mitigate the hazards and risks identified in the watershed was to complete a sediment source assessment on Peachland Creek. Water quality data for Peachland has been collected for the past several years near the Peachland Creek intake (Appendix A) and indicates a significant increase in turbidity during the spring freshet and during rain storms. As a result, Peachland has been issuing a boil water advisory every year during high turbidity events for water users on the Peachland Creek water system.

Peachland Creek is an important tributary watershed within the Okanagan Basin, with high fisheries values for kokanee as well as rainbow trout. The aim of this project is to identify opportunities to improve the water quality of Peachland Creek at the District's intake that will result in reduced operational costs for the District. Improving water quality in the creek will also benefit the fish resources in the creek particularly in lower Peachland Creek that supports kokanee and rainbow trout from Okanagan Lake. Peachland Creek flows ultimately into Okanagan Lake and would discharge improved water quality into the lake.

In 2014 the District of Peachland received $30,000 from the Okanagan Basin Water Board 'Water Conservation and Quality Improvement Grant Program' to conduct a *Habitat and Sediment Source Assessment on Peachland Creek*. The application proposed to complete a channel assessment in the creek channel from Peachland Reservoir downstream to the drinking water intake (point of interest), following the spring freshet in 2014.

The objective of this assessment is to document the channel conditions, gradients, identify (and GPS) active and potential sources of sediment in the channel and any disturbances that could affect water quality, assign a level of risk to each sediment source, and identify sensitive habitat. Typically these projects include only an assessment and summary report. This assessment includes the prioritization of remediation opportunities to reduce risks with estimated costs for those sites that can be addressed. The benefit of developing this process and methodology is it's repeatability in other streams.

In undertaking this project the District proposed to have direct participation by providing one of its Operations staff to assist in the channel assessment in the field and continuing ongoing conversations as remedial plans were developed to address the moderate and high sources of sediment. Through this investment, the District will gain a hands-on understanding of the channel conditions and the procedure for undertaking this type of assessment that the District can apply in the future.

The initial methodology proposed to conduct a channel assessment of Peachland Creek from Peachland Reservoir downstream to the drinking water intake. However, the lower ~5 km of Greata Creek upstream of the confluence of Peachland Creek, was also included in the field assessment due to its channel condition (Dobson, 1999) and proximity to the drinking water intake.

This report has been prepared for the District of Peachland to identify sources of sediment to Peachland Creek that could impact turbidity and overall drinking water quality and the risk of sedimentation from each source. Specific objectives of this assessment include the following:

- Document and spatially locate sediment sources (hazards) associated with natural or anthropogenic activities;
- Identify sensitive habitat features;
- Characterize the risks for each sediment source;
- Identify parties responsible for activities associated with sediment sources; and,
- Provide recommendations for remediation efforts to addresses sources and associated costs.

1.2 Assessment Method

This habitat and sediment source assessment was guided by the work plan outlined in the Okanagan Basin Water Board Water Conservation and Quality Improvement Grant Program 2014-2015 Application Form. The following tasks were completed:

Task 1 – Background Review and Desktop Assessment

A literature review using a number of previous reports was undertaken to characterize the watershed. A list of resources consulted is included in the References section. This report utilizes extensive previously published materials on Peachland Creek watershed conditions, as well as ground inspections. Relevant background information was reviewed regarding previous watershed geography, orthophoto review and anthropogenic impacts.

Task 2 – Mapping

Using available GIS information relevant topographic information available from iMapBC, as well as relevant available imagery from Google Earth (2014), the following maps and diagrams were completed for the watershed:

- Topographic profile of Peachland Creek from Peachland Reservoir downstream to the drinking water intake.
- Topographic profile of Greata Creek from the confluence with Peachland Creek to upstream approximately 5 km; and,
- Watershed maps that included existing cutblocks (based on Google Earth 2012 imagery) and roads, detailed topography along the stream channels, and known anthropogenic activities.

Task 3 – Field Assessment

A reconnaissance level field assessment was conducted on August 13-15, 2014 to confirm the current condition of the stream channels and banks (e.g. Peachland Creek and Greata Creek) to identify potential sources of sediment associated with past and current activities within the watershed. The assessment was conducted from the outlet of Peachland Reservoir downstream to the intake and the lower ~5 km of Greata Creek, to the confluence with Peachland Creek. Sensitive habitat was also identified and mapped.

The field assessment included the following:

- Confirm the current stream channel conditions (i.e. peak flow impacts, channel conditions and sediment delivery to stream). This included an overview assessment of roads, channels, riparian areas, and issues that may have been identified in past assessment reports and have direct impacts to the water course;
- Identified sensitive areas or zones in and near the streams, that may have hydrologic, habitat and water quality concerns now or in the future; and
- Identified specific sites of concerns (e.g. road crossings, surface erosion issues and impacted channels, etc.) and assigned a site number to accommodate further review.

Task 4 – Risk Assessment

The physical hazards associated with erosion and sediment delivery were evaluated using a risk assessment framework similar to the principles outlined in the *Comprehensive Drinking Water Source to Tap Assessment Guidelines*. Under this approach risk is defined as the product of consequence and likelihood; however, since the primary resource value at stake is water quality, the consequence was considered moderate for all hydrologic hazards. Risk ratings were assigned for each hazard and mitigation strategies were developed based on the identified hazards and the likelihood (i.e. amount of sediment delivered to creek) of potential hazards causing impacts to water quality.

Hazard: "a source of potential harm to the functioning of any aspect of the drinking water system or to human health" (Canadian Council of Ministers of the Environment, 2004).

Risk: the product of the *likelihood* of a hazard occurring and the potential *consequences* to elements at risk (i.e. water quality).

Task 5 – Stakeholder Meeting

A stakeholder meeting was held on October 29th in Peachland. The purpose of this meeting was to provide stakeholders with an overview of the project, discuss the sources of sediment identified during the field assessment and initiate discussions on potential strategies and best management practices to mitigate erosion and sediment delivery sites.

The provincial agencies and licensed stakeholders in the watershed include:

- The District of Peachland (DOP)
- Tolko Industries Ltd.
- Gorman Brothers Lumber
- Interior Health Authority
- Ministry of Forest, Lands and Natural Resource Operations (MFLNRO)
- Recreation Sites and Trails BC (RSTBC), a branch of MFLNRO
- Okanagan ATV Tours

Participants at the stakeholder meeting included:

- DOP: Joe Mitchel, Director of Operations;
- Tolko: Frank Kaempf, Harvesting Superintendent, and Paul Rosher, Harvesting Supervisor – Roads;
- Gorman Brothers Lumber: Chris King, Logging and Roads Supervisor, and Jeff Hatch, Planning Technologist; and
- Urban Systems: Suzan Lapp and Don Dobson.

Task 6 – Reporting

Completed a sediment source assessment report to summarize the field assessment findings, assessed the risk of sediment delivery to the creek and provided recommendations for the past development to minimize or mitigate potential sediment hazards and sensitive habitats. Information included the following:

- The current channel condition, specifically focused on the risk to future water quality conditions from past and ongoing development and activity;
- Identification of sources of sediment and associated sensitive habitat;
- Recommendations and costs to mitigate ongoing and past development and activities within the watershed impacting water quality; and
- Map of the watershed, including community watershed waterworks infrastructure and any issues noted within the watershed or channel, and a topographic profile of the channel(s).

The underlying methodology for the field investigation was based upon the assessment components (i.e. sediment source survey, reconnaissance level channel assessment procedure and a riparian assessment) that are outlined in the Watershed Assessment Procedure, Guidebook (1999). Assessment of the condition of stream channels was based on the Channel Assessment Procedure Field Guidebook (1996). Although the *Forest and*

Ranges Practices Act has superseded the use of these guidebooks, these procedures are still considered relevant guidance for overview assessments of watersheds. The primary focus of this assessment was to qualitatively identify potential sources of sediment, natural and anthropogenic, that are, or have the potential, to impact water quality for fish and fish habitat or drinking water requirements (NTU > 1).

2.0 Background Information

2.1 Peachland Creek Watershed - General Watershed Characteristics

The Peachland Creek watershed is a ~145 km^2 community watershed located centrally on the west side of Okanagan Lake draining into Okanagan Lake about 4 km south of the Town of Peachland. Licenced storage within the Peachland Creek watershed includes Peachland Reservoir and Glen Lake Reservoir (Glen Lake is located within the Greata Creek sub-basin). Peachland Creek is a third order creek. It is flows southeast from Peachland Reservoir downstream ~18 km to the drinking water intake. Greata Creek flows out of Glen Lake Reservoir in a northeast to east direction joining (i.e. confluence) Peachland Creek ~12 km downstream of Peachland Reservoir. Greata Creek has a shallower gradient than Peachland Creek, with gradients ranging from 1% to 3% (Dobson, 1999), with the exception of the ~500 m reach immediately upstream of its confluence with Peachland Creek, where the stream gradient is 15% (Appendix B). Peachland Creek, from Peachland Reservoir to the intake, has channel gradients that range from 1% to 12% with an average channel gradient of 4.2% (Dobson, 1999).

The elevation at Okanagan Lake is 342 masl, the POI is 587 masl and the highest point in the watershed is 1,820 masl. The majority of Peachland Creek is deeply incised and flows within a V-shaped valley with moderately steep to steep sidewall slopes classified as Class II to Class V.

The snow sensitive zone in the Peachland Creek Watershed is defined as the area above the H_{40} elevation, 1,300 masl (the elevation above which is 40% of the watershed area) based on mapping provided by Dobson, 1999.

2.1.1 Land Use

Peachland Creek watershed is a multi-use watershed. The area upstream of the drinking water intake contributing to DOP water supply is primarily Crown land with the exception of some private lots along the Brenda Mines Road. Activity within the watershed includes forestry, recreation, and cattle grazing. Increased recreational pressure due to off-road vehicles, forestry and cattle grazing is evident throughout the watershed and impacting stream health.

2.1.2 Climate

The Okanagan Valley is a snow-dominated hydrologic system, which experiences peak flows typically in May to June (freshet) and is characterised as semi-arid and consists of hot, dry summers and cool, moderately moist winters. Summers are typically warm with the mean temperature of 20ºC in Peachland and winter mean temperature are 2ºC. Annual rainfall is approximately 310 mm and snowfall 84 cm near Okanagan Lake and up to 650 mm at 1500 m elevation (Granger, 2010). Moisture deficiencies occur during the summer and fall months due to low precipitation and high evaporation. June is the wettest month of the year, contributing to the highest runoff and sediment transport, however intense rainfall events also occur during the summer and fall periods and transport sediment and impact water quality.

Future climate change projections forecast increased winter temperatures and precipitation, resulting in a shift from the current snow-dominated system towards a characterised rain-dominated hydrologic system; this shift in hydrologic regime may result in increased erosion and sediment transport to the creek.

2.1.3 FISH

Fish status, as inventoried within Fisheries Information Summary System (FISS), include (brook trout, rainbow trout, kokanee, sucker) and are not currently listed as threatened/endangered or as species of concern. Peachland Reservoir is stocked annually with rainbow trout and measures to maintain fish habitat, fish enhancement and flow regulations have been initiated on Peachland Creek (Summit, 2004). It should be noted that Hardy Falls (1.2 km upstream of Okanagan Lake) forms a natural barrier to fish movement upstream from Okanagan Lake.

Fish species within the watershed include brook trout (Salvelinus fontinalis) and rainbow trout (Oncorhynchus mykiss) and kokanee (Oncorhynchus nerka) have been identified in the lower reaches of Peachland Creek. Table 2.1 shows the consequence rating based on fish species presence, importance and fish habitat quality as adopted from Grainer (2010).

Table 2.1. Stream Reach Fish Consequence Value Criteria

Consequence Rating	Criteria			
	Fish Species* Present	**Channel Width (m)**	**Channel Gradient (%)**	**Habitat Quality**
Very Low	Fish absence	<1.5	>20	fish absence confirmed, minimal fish habitat available, habitat degradation low risk to fish
Low	Presence of RB	0-5	16 – 19	fish absence confirmed and/or habitat with low rearing potential for the fish species present
Moderate	Presence of RB, EB	0-5	8 – 15	habitat quality low to moderate
High	Presence of RB, EB, MW	0-20	0 – 8	fish presence confirmed, habitat quality moderate to high
Very High	Presence of RB, EB, BT, KO, MW	0-20	0 – 8	fish presence confirmed, habitat quality high

* RB – rainbow trout; EB - eastern brook trout; BT – bull trout; MW – mountain Whitefish; KO – kokanee.

2.1.4 WATER QUALITY ANALYSIS

During conversations with the DOP operation staff it was noted that turbidity rapidly increased (within ~10-15 minutes) during intense rainfall events. Daily turbidity data (NTU) was available from May 18, 2008 to December 31, 2011 at the DOP intake, daily discharge data from Greata Creek station 08NM173 and daily precipitation data for Peachland from Environment Canada. Figure 2.1 shows continuous daily discharge and turbidity and Figure 2.2 shows continuous daily precipitation and turbidity.

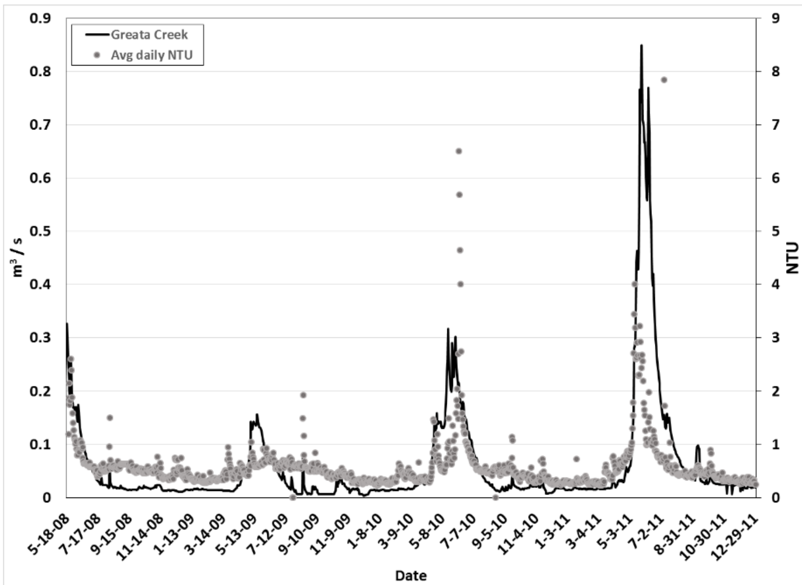

Figure 2.1. Daily discharge for Greata Creek (08NM173) and turbidity data (NTU) from the intake, May 18, 2008 to December 31, 2011

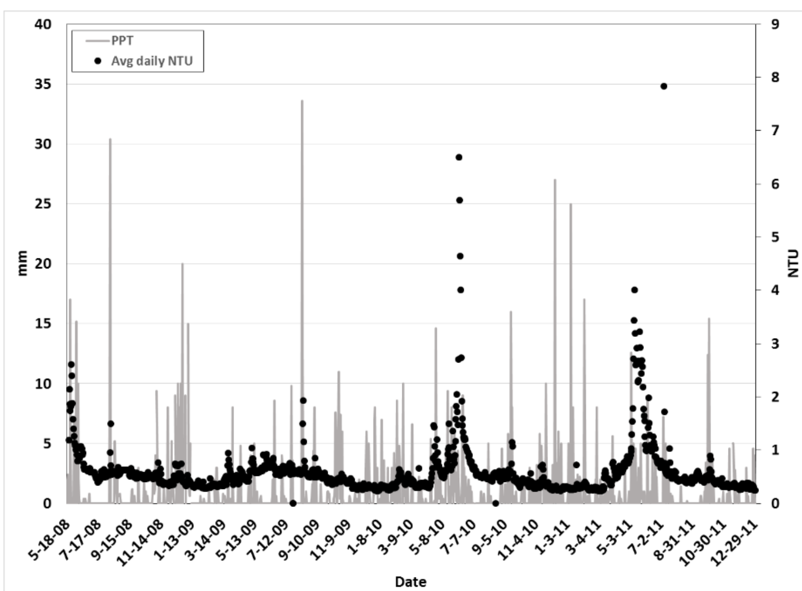

Figure 2.2. Daily precipitation for Peachland and turbidity data (NTU) from the intake, May 18, 2008 to December 31, 2011

These figures illustrate the variability of continuous turbidity observations during spring freshet and extreme precipitation events during the summer months, and demonstrates the close correlation between turbidity and sediment concentrations. Linear regression was used to establish the discharge-turbidity relationship at the intake.

3.0 Field Assessment

Existing channel conditions in Peachland Creek, including the lower ~5 km of Greata Creek, were derived from the field assessment and review of past reports. Peachland Creek upstream of Peachland Reservoir was not assessed as the reservoir acts as a settling pond. Channel conditions and photos from the field assessment are documented in Appendix C. The photos are spatial located on the figures shows in Appendix B and Appendix D.

3.1.1 Channel Stability

The natural and anthropogenic disturbances in the watershed are limited. As noted in the Field Assessment photos and notes (Appendix C) Peachland Creek is consistently stable from Peachland Reservoir downstream to the intake. The riparian zone along Peachland Creek throughout the watershed remains in a primarily undisturbed state (Photo 6, 9), except at a couple of stream crossing locations along Peachland Creek (Photo 35) and Greata Creek (Photo 14).   Natural and anthropogenic channel degradation and aggradation and slope instability was noted throughout the portion of Greata Creek assessed.

3.1.2 Forest Development

The watershed upstream of the intake is primarily Crown land. Active forest development is ongoing in the watershed by Tolko Industries Ltd. (Tolko) and Gorman Brothers Lumber (GBL). Westbank First Nation holds a Community Forest License in the upper watershed. Calculating equivalent clearcut area (ECA) was outside the scope of this project; however, in 2010 (Grainger, 2010) the watershed ECA was reported as low, at 16.6% for the watershed.

Research has determined that the source of the peak flows in the spring is the result of the melting snow in the upper 40% of the catchment. Changes in forest cover in this zone can have significant impacts on the magnitude of the peak flows and in turn can affect channel stability that will degrade water quality. Channel bank instability and channel morphologies are considered to be the most responsive to changes in peak flows that can affect water quality (Montgomery and MacDonald 2002).

Timber harvesting in the snow sensitive zone will reduce the forest cover thereby allowing more snow to accumulate on the ground that will increase water yields. Water yields will also increase after logging due to the decrease in transpiration. It has been estimated that as much as 75% of the annual precipitation is consumed by either evaporation or transpiration by the forest vegetation (evapotranspiration).

3.1.3 Cattle Grazing

Cattle grazing was evident in the watershed and is impacting channel stability and riparian conditions in Greata Creek (Photos 10, 12 and 14). Based on conversations at the stakeholder meeting, cattle are also entering

Peachland Creek at the Peachland Main FSR stream crossing (at ~6 km) and upstream of the drinking water intake at the Munro FSR stream crossing. Sediment delivery from cattle grazing was noted as low during the field assessment but likely higher during freshet and following intense precipitation events.

3.1.4 Mass wasting

Due to the steep terrain and channel gradients, natural and anthropogenic mass wasting was identified along both the Peachland and Greata Creek channels (Dobson, 1999; Grainger, 2010). Directly upstream of the confluence of Greata Creek with Peachland Creek, Greata Creek (0 – 500 m; Appendix B) has a gradient of ~10 – 15% and channel side slopes close to 100%. Fill slope failures were noted along the Peachland Main FSR at ~6 km at the crossing with Peachland Creek; the failures were connected to both streams and considered unstable (Photos 18, 27, 28, 29). Natural slumping was identified along the lower reach of Greata Creek (Photo 20). At these sites erosion and landslide activity may increase as a result of toe erosion in response to increased peak flows associated with climate change.

3.1.5 Surface Erosion from Roads

Evidence of sediment is being delivered to the channel was noted at the Peachland Main FSR (at ~6 km) and Munro FSR (~225 m upstream of the intake) at the stream crossings of Peachland Creek. Sediment delivery is most likely occurring during intense precipitation events and spring runoff resulting in overland flow. At the stream crossing on Peachland Main FSR (~6 km), sediment from the road is entering the mainstem channel both upstream and downstream of the crossing (Photos 32, 37 - 41). The crossing is ~7 km upstream of the intake and surface erosion from the road may affect water quality at the intake during freshet or high precipitation events.

Munro FSR was also identified as a source of sediment (Photos 46 – 48). Munro FSR was previous deactivated; however, during the field assessment it was discovered that GBL is reactivating the road to access timber west of Peachland Creek. Munro FSR sustains a constant grade for several hundred meters after crossing the creek resulting in ongoing accumulated runoff along the inside of the road causing rilling and erosion and sediment delivery to the creek.

3.1.6 Recreation Use

Because the watershed is primarily Crown land, recreation is not restricted. Historical forestry roads allow recreation users extensive access. The steep channel banks limit access to the creek. ATV crossings were identified at a number of sites along Peachland Creek (photos 14 and 45) and Greata Creek (photo 35). ATVs are also able to access Peachland Creek upstream of the water intake where the Munro FSR crosses Peachland Creek. During the field assessment six ATVs were encountered as part of the Okanagan ATV Recreation crossing the Munro FSR bridge at Peachland Creek. ATVs were observed during each of the three field visits to Munro FSR.

ZipZone Peachland, a commercial zip line business, is located ~4 km upstream of the intake, however there was no evidence of sediment impact to the water quality downstream from this operation.

3.1.7 Additional Sites of Concern

There were three stream crossings identified along Peachland Creek (i.e. Peachland Main FSR (photos 32, 37-41), Munro FSR (photos 45-48) and an ATV trail (photo 35)) and one stream crossing along Greata Creek (i.e. ATV trail; photo 14) during the field assessment. An old stream crossing was identified as an old wood culvert (photo 7) along Peachland Creek but was inaccessible for vehicles due to alder growth on the old road. The wood culvert was in an advanced state of decay but was not contributing sediment to the creek.

Upstream of the Peachland Main FSR crossing of Peachland Creek we identified what appears to be a berm used to divert the channel, likely for a historic placer mine. Bank erosion was identified at this location (photo 43 and 44).

Immediately upstream of the confluence of Peachland Creek and Greata Creek and downstream of the Peachland Main FSR crossing an active beaver dam was identified (photo 26). The pond measures approximately 50 m x 30 m x 1 m. Currently the dam is not a source of sediment to Peachland Creek; however if it were to break it could potentially damage the intake and contribute a significant source of sediment downstream.

We also noted three culverts at the Peachland Main FSR crossing on Peachland Creek. The invert of the east culvert is buried in the road fill (photo 30 and 31), however this is not a source of sediment to Peachland Creek. The risk to water quality would occur if the active culvers were to be blocked, the road could act as a dam and potentially back up Peachland Creek.

4.0 Sensitive Habitat

4.1 Stream Reaches

Stream reaches were identified as part of the field assessment and desktop analysis for both Peachland Creek and Greata Creek (Appendix B: Peachland and Greata Creek Topographical Profile). Reaches are stream segments or lengths where hydrological, geological, and adjacent watershed surface conditions remain sufficiently uniform that a reasonably homogeneous channel morphology can be identified. The longitudinal profiles, provide the channel gradient and inferences about the quality of fish habitat quality as shown in Table 2.1. Six reaches were defined for the lower 5 km of Greata Creek and four reaches were defined from Peachland Creek from Peachland Reservoir down to the intake. Impacts to fish habitat were not considered as part of this assessment.

Habitats were considered sensitive at sites with moderate to high sediment hazards (see Section 5.0 Risk Assessment). As noted in the field assessment photos and notes (Appendix C) excellent fish habitat was located along both Peachland Creek and Greata Creek (e.g. photo 3, 6, 14, and 25). Reach 2 (~15% slope) of Greata Creek and Reach 4 (~10% slope) of Peachland Creek provide the least favorable fish habitat.

5.0 Risk Assessment

5.1 Defining Risk

Hazard

For the purposes of this assessment a hazard is an event, condition, action or inaction that may pose a threat to human health or a sustainable supply of water.

Consequence

For the purposes of this assessment a consequence is defined as the nature and degree of impacts if a hazard does occur (Table 5.1).

Table 5.1. Qualitative Measures of Consequence

Descriptor	Description
Minor – 1	Minor impact to small population, none to mild illness possible, little or manageable operation disruption, little or no increase in operating cost.
Moderate - 2	Minor impact for larger population, mild to moderate illness probable, significant modification to normal operation but manageable, operating costs increase, increased monitoring.
Major - 3	Major impact for small population, severe illness probable, system significantly compromised and abnormal operation if at all, high-level monitoring required.

Note: the “Insignificant” and “Catastrophic” levels of consequence were removed from the Guideline table for simplicity.

Likelihood

Likelihood is an estimate of the probability that a hazard, a harmful event, condition, action or inaction would occur over a defined period of time, and the negative impacts that could result (Table 5.2). Likelihood in this assessment is considered the amount of sediment delivered to the creek and impacting water quality.

Table 5.2. Qualitative Measures of Likelihood Table

Descriptor	Description – Sediment delivery
Likely – 1	High sediment delivery
Possible – 2	Moderate sediment delivery
Unlikely - 3	Low sediment delivery

5.2 Characterizing Risk

Risk is the combination of the likelihood that a hazard will occur and cause harm, and the extent and degree of that harm (consequence) (Table 5.3).

Table 5.3. Qualitative Risk Analysis Matrix Table

Likelihood	Consequences (amount of sediment delivered)		
	Minor - 1	**Moderate - 2**	**Major - 3**
Likely – 1	Moderate	High	High
Possible – 2	Low	Moderate	High
Unlikely - 3	Low	Low	Moderate

5.3 Hazards in Peachland Creek Watershed

The hazards to drinking water quality in the watershed are, elevated turbidity and sediment loads due to both natural causes and anthropogenic activities (typically during runoff periods). The activities in the watershed area include recreation, resource road use, forestry activity, and range use.

Sediment - Suspended sediment/turbidity is not directly harmful but can compromise the disinfection process and therefore the consequence from all sources is assumed to be at least moderate. Water is diverted from the creek into an intake pond where some settling action can reduce the consequence from sediment and turbidity introduced upstream to water quality at the intake but remain rated as a moderate consequence.

Sediment from natural sources such channel erosion and slumping will continue to occur especially during periods of high flow.

Sediment from human activities has been identified throughout the watershed however overall it is limited; the primary sediment input concerns are located directly upstream of the intake ~225 m at the crossing of Munro FSR on Peachland Creek and at Peachland Main FSR crossing on Peachland Creek.

5.4 Risks to Drinking Water Quality

A qualitative risk assessment has been undertaken for the hazards identified. Risks were assessed based on the current state and use of the watershed. Some of these risks may increase over time as a result of such factors as climate change and anthropogenic uses; what is important is that measures are taken to prevent the risks to the watershed from increasing over time.

Table 5.4 provides a summary of the hazards (sources of sediment) related to Peachland Creek water quality and their associated likelihood, consequence and overall risk rating. Hazards not currently impacting water quality, were also rated as in the table (e.g. wood culvert, etc.).

Table 5.4. Peachland Creek Watershed Qualitative Risk Assessment

Sedimentation Hazard to Drinking Water	Likelihood	Consequence	Risk	Comment/Assumption
Wood culvert (Photo 7)	3	2	Low	Not properly function and no surface erosion evident. **Potential**.
Cattle grazing/crossing – Greata Creek (Photo 10, 12, 14)	2	2	Moderate	Directly connected to the creek and can be addressed with proper management techniques. **Active**.
Bank slumping – Greata Creek (Photo 11)	2	2	Moderate	Chronic sediment source. **Active**.
Failure on Peachland Main FSR – Greata Creek (Photo 18)	3	2	Low	Naturally occurring and has stabilized. **Potential**.
Slope instability - Greata Creek (Photo 20)	1	3	High	Naturally occurring, most input is rock. **Active**.
Beaver dam - Peachland Creek (Photo 26)	2	3	High	Potential risk of sedimentation and large woody debris downstream if dam breaks[1]. **Active**.
Bank failure – Peachland Creek (Photo 28, 29)	2	2	Moderate	Chronic sediment source. Bank failure was likely natural but erosion has increased the head scarp. **Active**.
Peachland Main FSR ~6 km - Culverts (Photo 30, 31)	3	3	Moderate	Upstream culvert is buried. **Potential**.
Peachland Main FSR ~6 km – Peachland Creek (Photo 32, 37-41)	1	2	High	A result of improper drainage and exposed fine grained soil. **Active**.
Motorized vehicle crossing – Peachland Creek (Photo 35)	3	2	Low	Boulder/cobble streambed. Unsure where the trail leads on the south side of Peachland Creek. **Active**.
Bank erosion – Peachland Creek (Photo 42)	2	2	Moderate	Erosion is most active during spring freshet and high flows. **Active**.
Peachland Main FSR ~6 km – Peachland Creek (Photo 44)	3	2	Low	Shallow failure, but no surface road runoff possible due to slope. **Potential**.
Munro FSR – Peachland Creek (Photo 45 - 48)	1	1	High	ATV's are crossing the creek under the Munro FSR bridge. Road is being reactivated for logging activity and actively used by ATV's and recreationalist. **Active**.

1. The presence of beaver in the creek upstream of the intake is also a HIGH risk of introducing Giardia cysts.

6.0 Stakeholders Meetings

In addition to the stakeholder meeting held in October, an on onsite field inspection, including the DOP and GBL, was conducted, the week following the field assessment, at the Munro FSR where it crosses Peachland Creek (~225 m upstream of the intake). GBL was in the process of reactivating the Munro FSR and the section of road on the west side of the creek to the top of the stream valley was a concern regarding sediment delivery off the reactivated road into the creek and Peachland's intake pond. The purpose of the field inspection was to discuss innovative means to address the erosion and sediment concerns, because of the close proximity to the intake.

7.0 Recommended Action Plan

The typical sources of sediment/turbidity are roads, and soil disturbance associated with forestry activities, cattle grazing and recreation. In moving recommendations forward a series of barriers are required for each activity that include: strategic planning, implementation, monitoring and revision. **We recommend implementing principles and practices for erosion and sediment control, this starts with erosion prevention, followed by sediment containment if possible.** It is easier to prevent erosion than to deal with sediment.

Strategies to Address Erosion and Sediment Risks

Erosion is caused by wind, flowing water, rain or gravity displacing loose soil or rocks. Sediment is the fine particles of eroded soil and rock that have been moved and deposited away from their origin. The goal for erosion control is prevention and the goal for sediment control is containment. Preventing erosion is the best approach to reducing/eliminating the source of sediment.

Strategies for preventing erosion include:

- Keeping the amount of exposed soil to a minimum;
- Maintaining soil and ground cover, including road surfaces; and,
- Managing water drainage.

Sediment control strategies are designed to slow or hold material in place with silt fences, etc.

7.1 Recommendations

Responsibilities

Licensed Stakeholder: It is the responsibility of the various licensed stakeholders to plan, implement, monitor and revise their works consistent with the legislation, regulations and policies established under their permits/licenses for the protection of soil and water. Planning should also consider best management practices where these are available.

Regulators: The ministries that provide the authorities to the licensed stakeholders are responsible, in accordance with the Drinking Water MOU, for compliance monitoring to ensure that activities are consistent with their respective policies for source protection.

Based on the review of the sediment sources in the Peachland Creek watershed, Urban Systems recommends addressing the following concerns:

1. High surface erosion sites along Munro FSR (Appendix B & C: Photo 45 - 48) and Peachland Main FSR (Appendix B & C: Photo 32, 37-41) be addressed by the permit holder:
   - The recent recreation and forestry activities along Munro FSR road will require immediate and ongoing maintenance. Gorman Brothers Lumber currently holds the permit, maintenance, and responsibility. We recommend that the DOP collaborate with GBL to identify activities to reduce erosion and sediment delivery to Peachland Creek
   - Once GBL no longer requires the Munro FSR for active industrial use, the section of road west of the creek that drains towards the creek should be deactivated and cross ditches installed to direct water off the running surface to reduce the risks of sediment delivery to the creek.
   - GBL will be responsible for the Munro FSR only during the time that it holds an active road permit for the road. Once GBL no longer requires the road for industrial use and it meets the MFLNRO requirements, the road permit will be cancelled. The responsibility for the road then reverts back to the MFLNRO unless there is another permit holder. Since there are sections of the FSR close to the creek and the intake pond that have the potential to impact the water quality, it is recommended that the District enter into an agreement with the MFLNRO that would provide legal authority for the District to monitor and maintain those sections of road that could impact the water quality in Peachland Creek.
   - Tolko currently holds the road permit on Peachland Main FSR from 0 to 19 km, Westbank First Nations and GBL are secondary road permit holders from 0 to 6 km, and 0 to 21 km, respectively. We recommend that the DOP collaborate with Tolko and the other road permit holders to identify mitigation activities to reduce erosion and sediment delivery to Peachland Creek and Greata Creek from Peachland Main FSR.

   Specific recommendations regarding the Munro FSR include:
   - Install a curb along the both side of the bridge deck to prevent sediment that accumulates on the bridge deck from spilling into the creek. [This has been done.]
   - Inslope the running surface on the section of road west of the creek that drains towards the creek to divert runoff to culverts. [This has been done.]
   - For the cross drain culverts on the section of road west of the creek that drains towards the creek, install geotextile socks over the culvert ends to collect sediment and reduce the sediment delivery towards the creek [Sediment tramps have been installed].
   - Install road surface runoff deflectors on the section of road west of the creek that drains towards the creek to deflect water off the running surface into the ditch to reduce erosion of the running surface.
   - Spread slash on exposed soils on the section of road west of the creek that drains towards the creek to reduce erosion. [This has been done.]
   - Once the area is snow free in the spring of 2015, hydro seed or hand grass seed exposed soils on the cut slopes and fill slopes along the sections of road both east and west of the creek that drain towards the creek.
   - Request that the Recreation Officer from MFLNRO meet with the local ATV club to implement measures to direct ATVs onto the Munro FSR bridge across Peachland Creek and prevent ATV access to the creek.

Specific recommendations to Peachland Main FSR (at ~6km) include:

   a. Inslope the road to divert road surface runoff into the ditch and away from the creek.
   b. Adjust the concrete barriers to direct flow to inside of road.
   c. Exposed soil on the cut and fill slopes should be grass seeded to reduce erosion.
   d. Where ditchlines are eroding during runoff events the ditchlines should be armoured or have a series of check dams installed to reduce erosion.
   e. Install an armoured sump on the west side of the creek to collect sediment being delivered by Peachland Main FSR. Remove accumulated sediment from sump as required to prevent spilling sediment into creek.
   f. Since Tolko may not have equipment in the area to maintain the sump on the Peachland Main FSR at Peachland Creek, the District should consider entering into an agreement with Tolko and the MFLNRO to allow the District to monitor and maintain the sump.

We also recommended monitoring of the Peachland Main FSR culverts at the Peachland Creek crossing to keep them clear of any obstructions.

2. Cattle grazing
   - We recommend that the District work with the Range Officer (MFLNRO) to implement best management practices to keep cattle away from the creek particularly along the reaches close to the intake.

3. Beaver Dam

The dam is not currently contributing sediment to Peachland Creek (Appendix B & C: Photo 26), however if the dam were to fail the downstream implications could result in damage to the intake. The presence of beaver in the creek upstream of the intake presents a high risk of Giardia at the intake.

- We recommend that the District contact the MFLNRO for authority to engage the local licensed trapper to remove the beaver.
- We recommend that once the beaver have been removed that the District notify the MFLNRO that it intends to remove the beaver dam and restore the natural flow in the creek.

4. Community Watershed / Drinking Water Signage
   - We recommend installing signs at stream crossing and at Peachland Lake Reservoir stating that is a community watershed and supplies drinking water to Peachland.
      i. The District Recreation Officer from the Okanagan Recreation District will provide Provincial logos and contact numbers to include on the signs
      ii. 60 cm x 75 cm reflective, anti-graffiti metal signs cost ~$200.00 (estimate provided by Stacy Screen Print Ltd. of Kelowna)

Following the stakeholder meeting GBL, Tolko and the District agreed to collaborate to implement best management practices. The three parties agreed to enter into a written collaborative agreement that would summarize each party's responsibilities.

8.0 References

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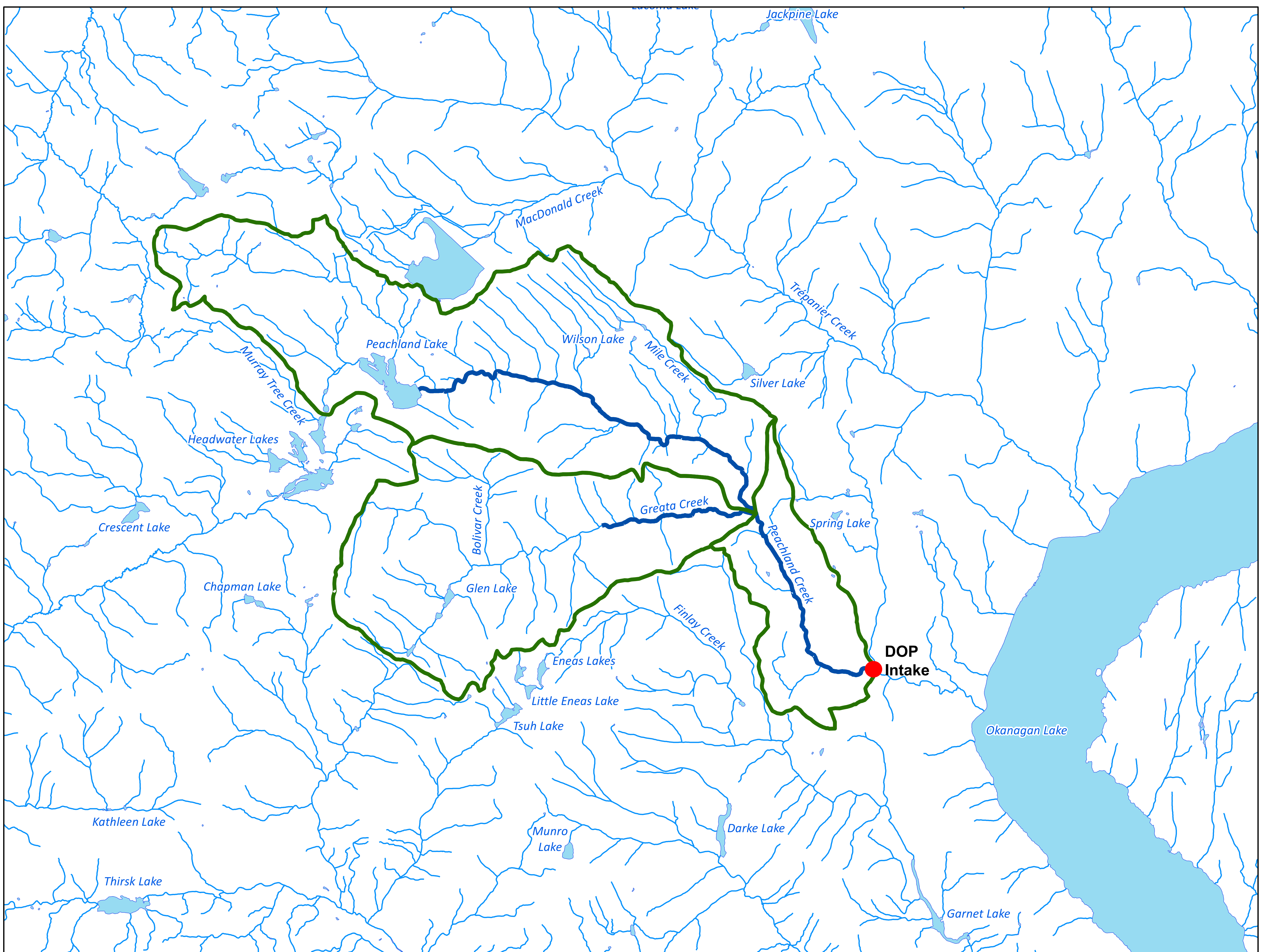
Appendix A

Watershed Map



Peachland Creek
Profile Location Map

Legend

Lake
TRIM Stream
Profile
Intake

N
W E
S

Projection: BC Albers
Datum: NAD83

1:100,000

0 625 1,250 2,500 3,750 5,000

metre

URBAN systems

Map produced for:
Urban Systems Ltd.
304-1353 Ellis Street, Kelowna, BC V1Y 1Z9

FPS Drafting & Geomatics Ltd.

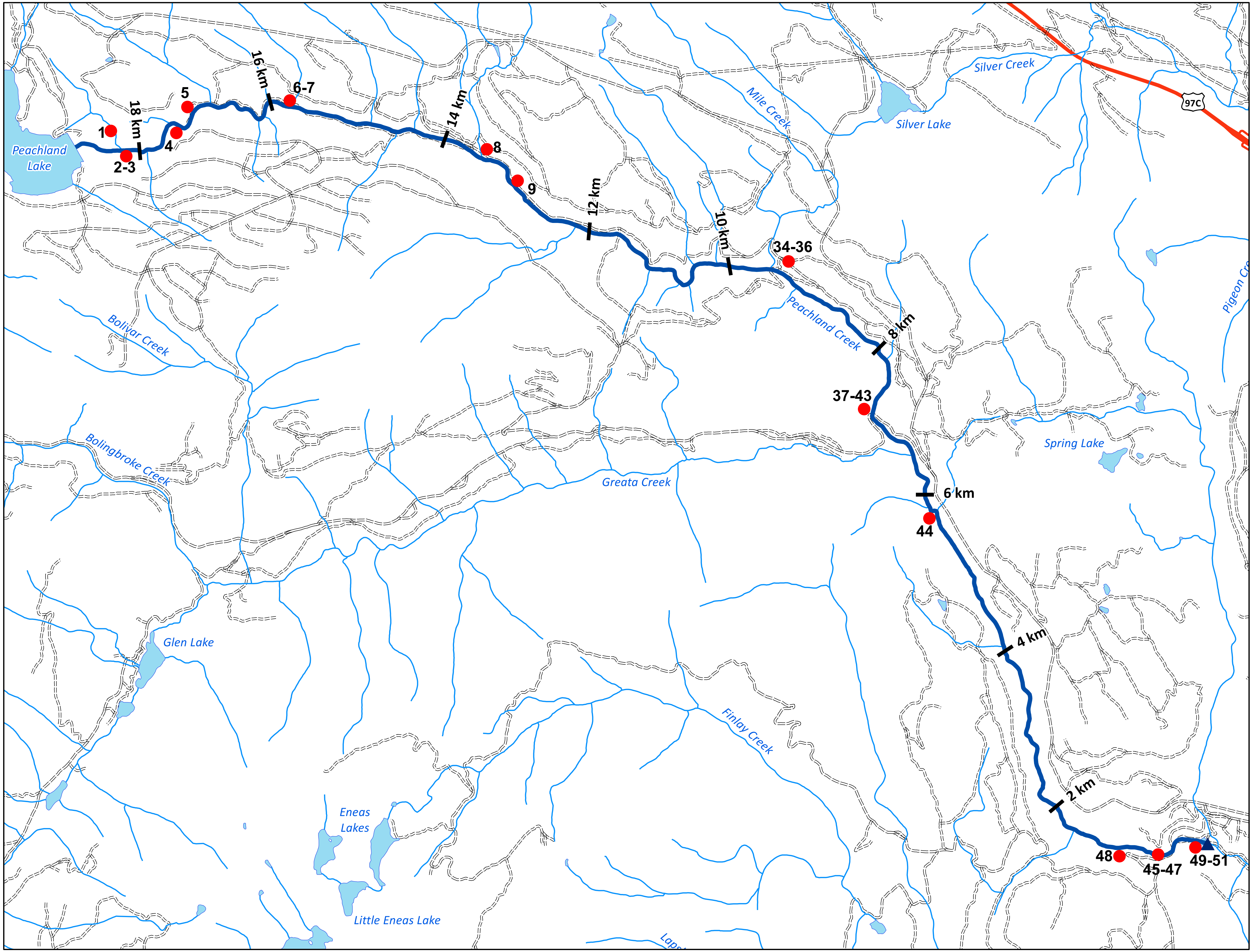
Map Produced by:
FPS Drafting & Geomatics Ltd.
2784 Paris Street, Penticton, BC, V2A 8G2

Source
Land and Resource Data Warehouse
National Resources Canada

0655_0180_01_Peachland_profile_11x17L40.mxd

Appendix B

Peachland and Greata Creek Longitudinal and Topographical Profiles



Peachland Creek Profile

Legend

Water

- Lake
- TRIM Stream
- Profile
- Profile Start

Roads

- Public
- Loose
- Rough

- Field Assessment Photo

Projection: BC Albers
Datum: NAD83

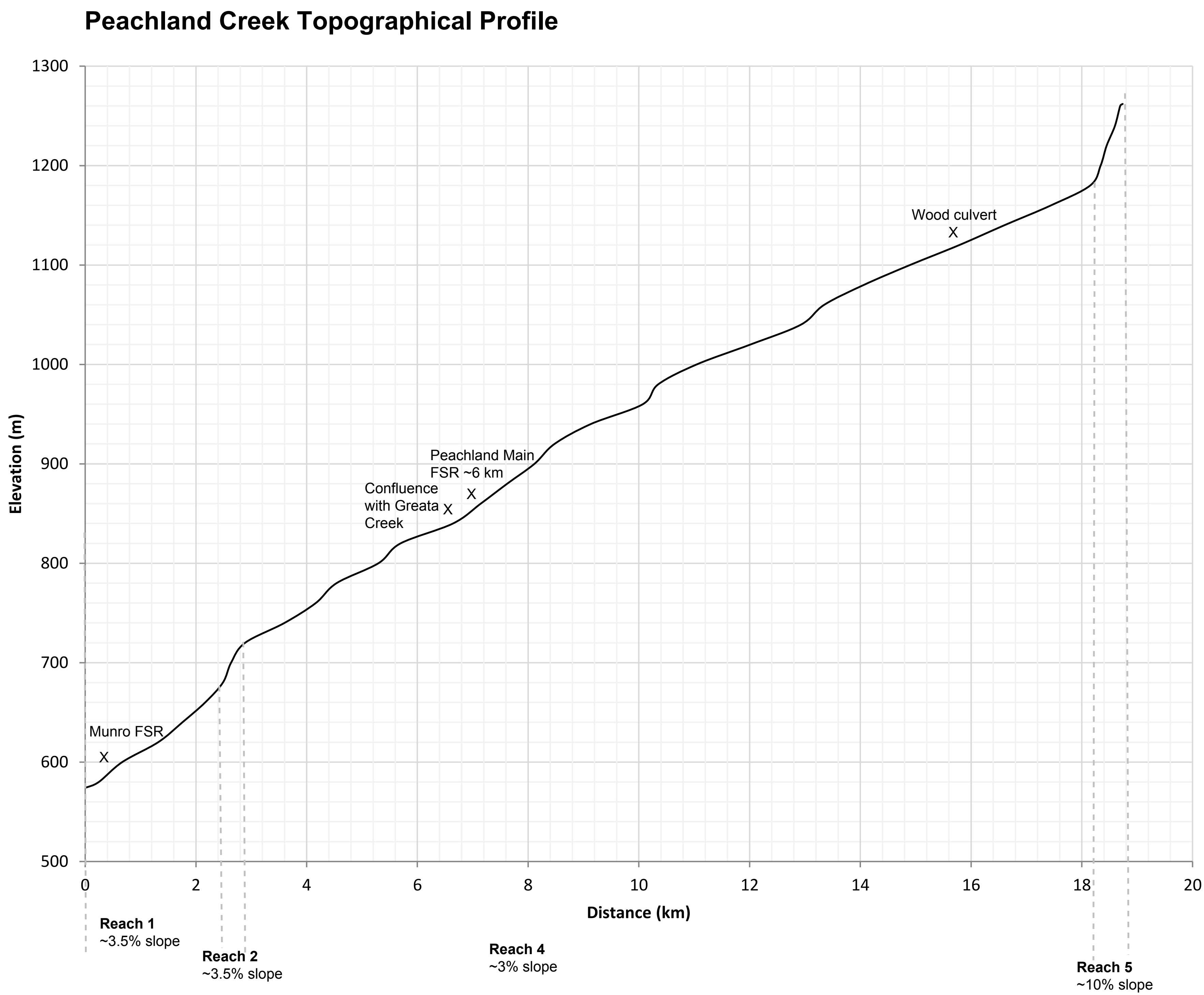
1:40,000

0 255 510 1,020 1,530 2,040
metre

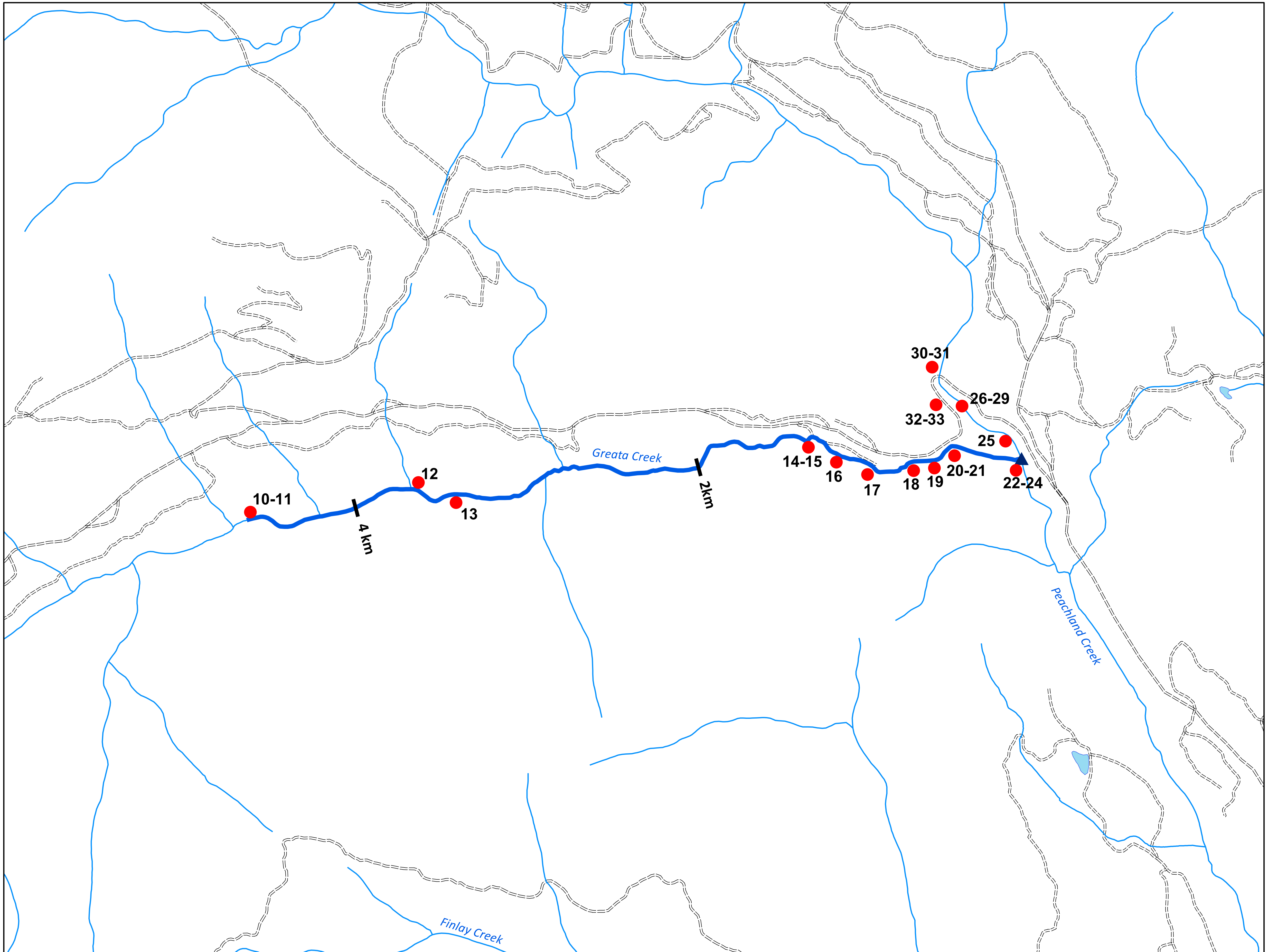
Map produced for:
Urban Systems Ltd.
304-1353 Ellis Street, Kelowna, BC V1Y 1Z9

Map Produced by:
FPS Drafting & Geomatics Ltd.
2784 Paris Street, Penticton, BC, V2A 8G2

Source
Land and Resource Data Warehouse
National Resources Canada



Peachland Creek Topographical Profile
1300
1200
1100
1000
900
800
700
600
500
Elevation (m)
0
2
4
6
8
10
12
14
16
18
20
Distance (km)
Munro FSR
X
Confluence
with Greata
Creek
X
Peachland Main
FSR ~6 km
X
Wood culvert
X
Reach 1
~3.5% slope
Reach 2
~3.5% slope
Reach 4
~3% slope
Reach 5
~10% slope



PEACHLAND ON THE LAKE

Greata Creek Profile

Legend

Water
- Lake
- TRIM Stream
- Profile
- Profile Start

Roads
- Public
- Loose
- Rough

- Field Assessment Photo

N W E S

Projection: BC Albers
Datum: NAD83

1:20,000

0 125 250 500 750 1,000
metre

URBAN systems

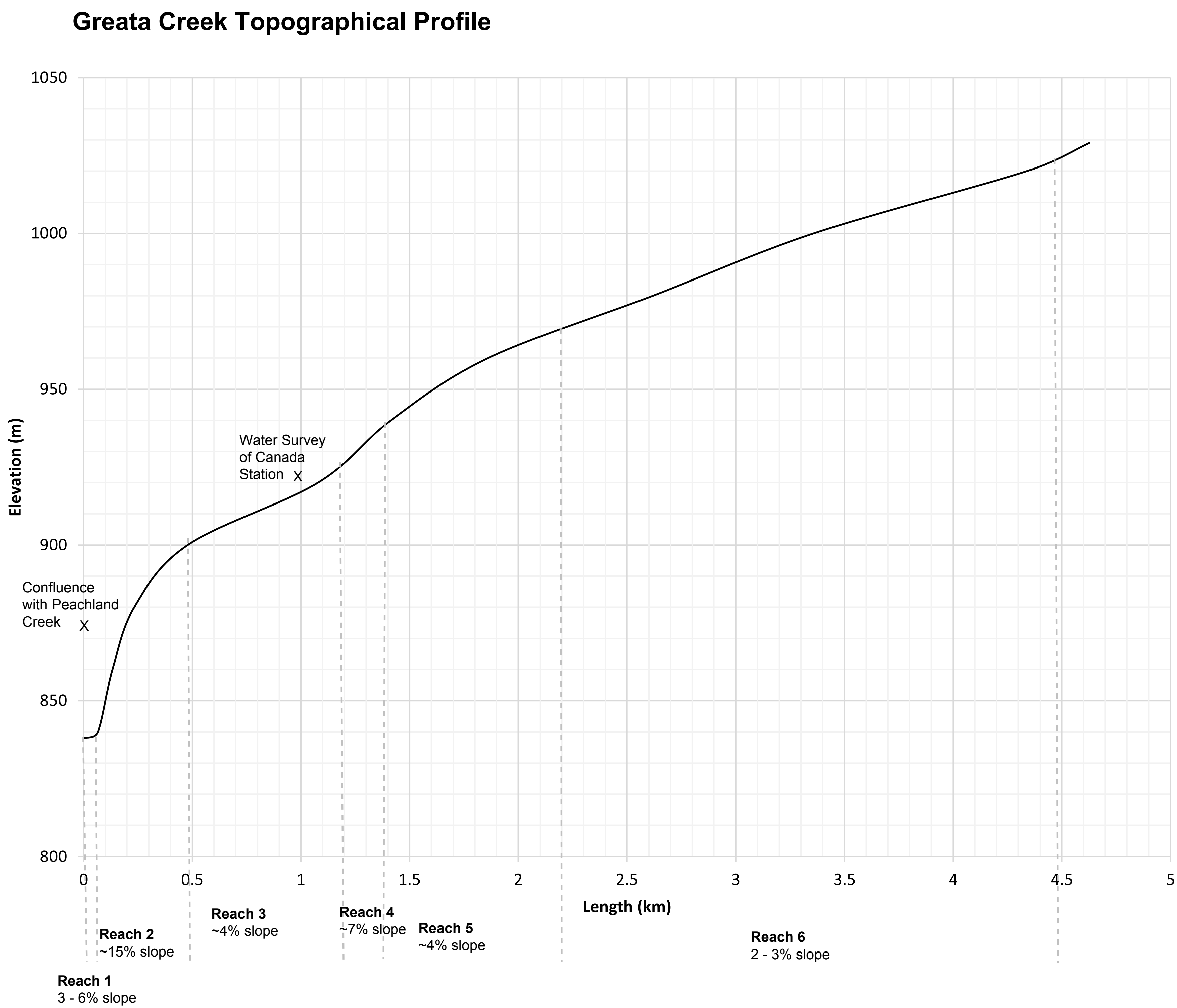
Map produced for:
Urban Systems Ltd.
304-1353 Ellis Street, Kelowna, BC V1Y 1Z9

FPS Drafting & Geomatics Ltd.

Map Produced by:
FPS Drafting & Geomatics Ltd.
2784 Paris Street, Penticton, BC, V2A 8G2

Source
Land and Resource Data Warehouse
National Resources Canada

0655_0180_01_Greata_profile_11x17L20.mxd


Greata Creek Topographical Profile
Elevation (m)
1050
1000
950
900
850
800
Length (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Water Survey
of Canada
Station X
Confluence
with Peachland
Creek X
Reach 1
3 - 6% slope
Reach 2
~15% slope
Reach 3
~4% slope
Reach 4
~7% slope
Reach 5
~4% slope
Reach 6
2 - 3% slope

Appendix C

Field Assessment Photos

Field Assessment - Peachland and Greata Creek

Field Work Notes and Pictures* – August 13, 14 and 15, 2014

August 13, 2014

Photo #1 **Location**: 49.83174N 119.96312W Below Peachland Creek Spillway **Notes**: Channel is stable with properly functioning deciduous riparian zone. Moss covered boulders. 12% channel slope. Step-pool boulder channel classification.	
Photo #2 **Location**: 49.83104N 119.96036W Peachland Creek **Notes**: Reach break. Channel is stable with properly functioning mature conifer riparian zone. Moss covered boulder/cobbles. 6% channel slope. Cascade-pool boulder/cobble channel classification. Partially confined valley.	

Photo #3 **Location**: 49.83078N 119.95726W Peachland Creek **Notes**: Exposed root wad, large woody debris (LWD). Excellent fish habitat. Downstream of tributary entering north of channel (left bank looking downstream). Bar deposited at mouth of tributary.	

* Photos correspond to locations on maps in Appendix B and D

Photo #4 **Location**: 49.83156N 119.95095W Peachland Creek **Notes**: Reach Break. Channel is stable with properly functioning mature conifers riparian zone. No disturbance. Moss covered banks. 3% channel slope. Ripple-pool cobble channel classification. LWD, excellent fish habitat.	
Photo #5 **Location**: 49.83293N 119.949128W Peachland Creek **Notes**: Reach break. Channel is stable, confined, with properly functioning mature conifer riparian zone. Moss covered boulder/cobbles. 5% channel slope. Natural undercutting, no disturbance. Cascade-pool boulder/cobble channel classification. LWD present.	

Photo #6 **Location**: 49.83371N 119.931684W Peachland Creek **Notes**: Reach break. Upstream of meadow created by beaver dam downstream ~20m. U-shaped valley. 1% slope. Ripple-pool gravel stable channel.	

Photo #7 **Location**: 49.83371N 119.9307W Peachland Creek **Notes**: Wood culvert, overgrown road crossing. No current erosion **Risk**: Low	
Photo #8 **Location**: 49.82884N 119.9070W Peachland Creek **Notes**: Reach break. U-shaped valley. Properly functioning mature conifer/deciduous riparian zone. 2% channel slope. Ripple-pool gravel – partially aggregated channel classification. Sand aggradation likely natural. No evidence of sediment sources or disturbance indicators.	
Photo #9 **Location**: 49.8237N 119.8977W Peachland Creek **Notes**: Reach break. Channel stable with properly functioning mature conifer/deciduous riparian zone and meadow. 5% slope. Cascade-pool cobble. Large wood debris.	

Photo # 10 **Location**: 49.79442N 119.899W Greata Creek **Notes**: Channel is moderately stable with properly functioning deciduous/coniferous riparian zone. Moss covered boulders. 2-3% channel slope. Ripple-pool cobble channel classification. Cattle trampling along bank; defined trails. **Risk**: Moderate	
Photo #11 **Location**: 49.79453N 119.8987W Greata Creek **Notes**: Bank slumping **Risk**: Moderate	
Photo #12 **Location**: 49.79477N 119.88614W Greata Creek **Notes**: Cattle disturbance, ~5% trampling. Properly functioning mature conifer/deciduous riparian zone and meadow. 2-3% slope. Ripple-pool cobble with aggregated gravel bars. Large wood debris. **Risk**: Moderate	

Photo # 13 **Location**: 49.79444N 119.88178W Greata Creek **Notes**: Stable channel with properly functioning mature conifer/deciduous riparian zone. 4% slope. Cascade-pool cobble with aggregated sand and gravel bars. Large wood debris.	
Photo #14 **Location**: 49.796013N 119.85635W Greata Creek **Notes**: ATV/Cattle crossing. Channel is stable with mature deciduous riparian zone. Cascade-pool cobble channel classification. Disturbed banks for ~8m along channel. **Risk**: Moderate	
Photo #15 **Location**: 49.796013N 119.85635W Greata Creek **Notes**: Same as photo 14	

Photo #16 **Location**: 49.79515N 119.855072W Greata Creek **Notes**: Water Survey of Canada Hydrometric station (08NM173). Concrete weir, find sediment and pebbles on channel bed.	
Photo #17 **Location**: 49.79488N 119.853181W Greata Creek **Notes**: Approx. 50m below Headwaters Rd. Channel is stable with mature deciduous riparian zone. Cascade-pool boulder channel classification. Moss covered boulders.	
Photo #18 **Location**: 49.794393N 119.84925W Greata Creek **Notes**: Old failure (3m x 5m x 0.5m), ~ 20m downslope of Headwaters Rd. Evenly vegetated with low surface erosion currently. Sediment bar in creek ~ 15 years old. **Risk**: Low	

Photo # 19 **Location**: 49.79488 119.84817W Greata Creek **Notes**: Mid-channel bar, possible bank failure on south side of creek. 3m x 6m x 0.5m	
Photo #20 **Location**: 49.79478N 119.84696W Greata Creek **Notes**: Slope instability on south side, directly connected to Greata Creek. Active over past 5 years. Downstream ~50m of this location the side slopes equal 100%. Some raveling with exposed head scarps. **Risk**: High Low to moderate sediment input; high risk of occurrence.	
Photo #21 **Location**: 49.79502N 119.8467W Greata Creek **Notes**: Step-pool boulder, degrading channel classification. 10-15% slope. V-shaped valley 70-90% slope. Small failures, no major sediment sources.	

Photo #22 **Location**: 49.79364N 119.841081W Confluence of Greata and Peachland Creek. **Notes**: Looking upstream Greata Creek. Channel is incised but stable with mature deciduous and coniferous riparian zone. 6% channel slope. ~50m upstream of confluence channel is moderately degraded. LWD. No sediment wedge at confluence.	
Photo #23 **Location**: 49.79364N 119.841081W Confluence of Greata Creek and Peachland Creek. **Notes**: Looking upstream Peachland Creek. Channel is stable with mature deciduous and coniferous riparian zone. 8% channel slope. Step-pool boulder. Moss covered logs and boulders.	
Photo #24 **Location**: 49.79364N 119.841081W Confluence of Greata Creek and Peachland Creek **Notes**: Looking downstream Peachland Creek. Same as upstream channel characteristics.	

Photo #25 **Location**: 49.79521N 119.841878W Peachland Creek **Notes**: Channel is stable with mature deciduous and dogwood riparian zone. 3% slope. Ripple-pool cobble, partially aggregated with gravel.	
Photo #26 **Location**: 49.79364N 119.841081W Peachland Creek **Notes**: Active beaver dam. Pond measures 50m x 30m x 1m. **Risk**: High	
Photo #27 **Location**: 49.79645N 119.844512W Peachland Creek Upstream of beaver dam; west side of creek **Notes**: Small sediment wedge likely from upper road. 3m x 4m x 0.5m	

Photo #28 **Location**: 49.79733N 119.84515W Peachland Creek **Notes**: Large bank failure, likely natural. 50m x 10m x 0.5-1.0m. Fine silt. Vegetated gravel bar downstream. Chronic sediment exposed to rainfall. Head scarp has likely increased due to continued erosion. **Risk**: Moderate	
Photo #29 **Location**: 49.79733N 119.84515W Peachland Creek **Notes**: Same as Photo 28. **Risk**: Moderate	
Photo #30 **Location**: 49.79862N 119.846603W Peachland Creek and Headwaters Rd - downstream. **Notes**: Three culverts (1700mm) downstream of Peachland Main FSR.	

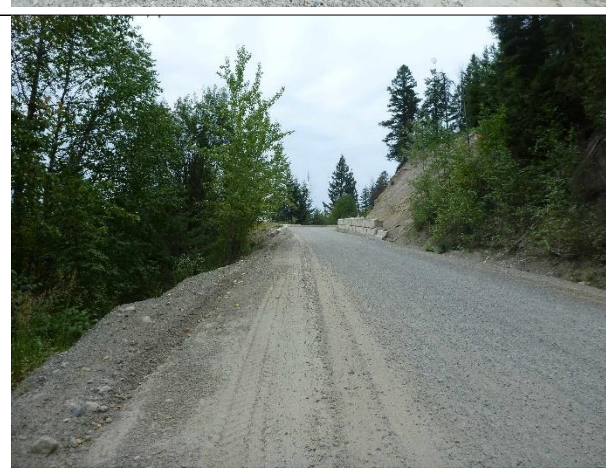
Photo #31 **Location**: 49.79862N 119.846603W Peachland Creek and Peachland Main FSR - upstream. **Notes**: Two culverts (1700mm) upstream of Peachland Main FSR. Third culvert buried on upstream side of Peachland Main FSR. Visible culverts are clear of obstructions. **Risk**: Moderate	
Photo #32 **Location**: 49.797694N 119.846847W Peachland Main FSR **Notes**: Erosion from outside edge of road. Sediment is connected to the creek below. Due to runoff down road. Fine sediment. **Risk**: High	
Photo #33 **Location**: 49.797694N 119.846847W Peachland Main FSR **Notes**: Looking south from photo 32.	

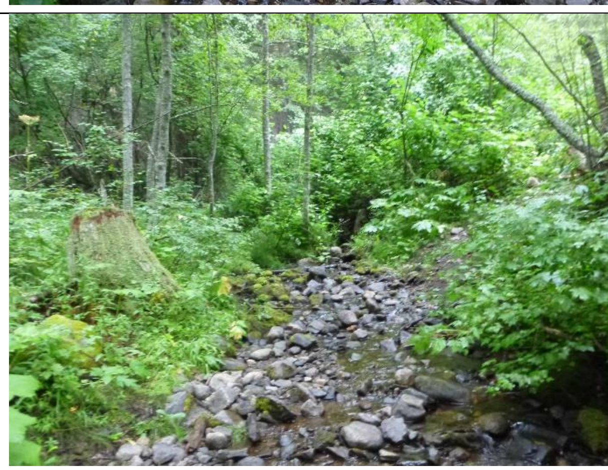
Photo #34 **Location**: 49.81339N 119.860688W Peachland Creek with small tributary entering from north east side. **Notes**: Channel is stable, confined, with properly functioning mature conifer riparian zone. Moss covered boulder. 6% channel slope. Cascade-pool boulder channel classification. LWD present.	
Photo #35 **Location**: 49.81339N 119.860688W Peachland Creek and small tributary to the north east. **Notes**: Quad and motorized vehicle crossing creek. Trail runs ~8m along tributary. **Risk**: Low	
Photo #36 **Location**: 49.81339N 119.860688W Peachland Creek and small tributary to the north east. **Notes**: Looking upstream of tributary.	

Photo #37 **Location**: 49.797898N 119. 846976W Peachland Main FSR south west of switchback. **Notes**: Concrete berm on outside edge of road causes runoff to concentrate and results in erosion off the upslope side road. Carries fines to creek along both sides of road. **Risk**: High	
Photo #38 **Location**: 49.797898N 119. 846976W Peachland Main FSR south west of switchback. Ditch line on downslope side of road (west side). **Notes**: Ditch is periodically cleaned ~2-3 years. **Risk**: High	
Photo #39 **Location**: 49.797898N 119. 846976W Peachland Main FSR south west of switchback. **Notes**: Culvert shown in Photo 38 is buried below this lockblock structure. **Risk**: High	

Photo #40 **Location**: 49.79844N 199.8473984W Peachland Main FSR north west edge of switchback (downslope side of road). **Notes**: Runoff from downslope side of road (outer edge) directly connected to creek. Incised ~30cm. Collects sediment as shown in Photos 37-39. **Risk**: High	
Photo #41 **Location**: 49.79873N 119.846692W Peachland Creek, upstream of Peachland Main FSR crossing at switchback. **Notes**: Deposition along creek connected directly to runoff from road. Fine clay sediment deposited 2m x 5m x 0.2m along creek. **Risk**: High (includes location at photos 37-40). High during extreme rainfall events	
Photo #42 **Location**: 49.7991N 119.8466W Upstream of Peachland Main FSR crossing. **Notes**: 1.5m high bank erosion. Channel appears to have been diverted – see photo 43. **Risk**: Moderate	

Photo #43 **Location**: 49.7991N 119.8466W Peachland Creek **Notes**: Berm used to divert channel as shown in Photo 42. Likely a historic placer mine.	
Photo #44 **Location**: 49.78864N 119.83713W Creek side (west-side) of Brenda Mines Rd. **Notes**: Slope failure from road < 0.5m incised. Resulted in a shallow failure that is connected to the creek. No significant surface road runoff possible. **Risk**: Low	
Photo #45 **Location**: 49.75233N 119.80853W Munro FSR bridge at Peachland Creek Upstream of ~330m DOP drinking water intake. **Notes**: Channel is stable, confined, with properly functioning mature conifer riparian zone. Moss covered boulder. 5% channel slope. Cascade-pool boulder/cobble channel classification. LWD present. Quads have been crossing the creek. **Risk**: High	

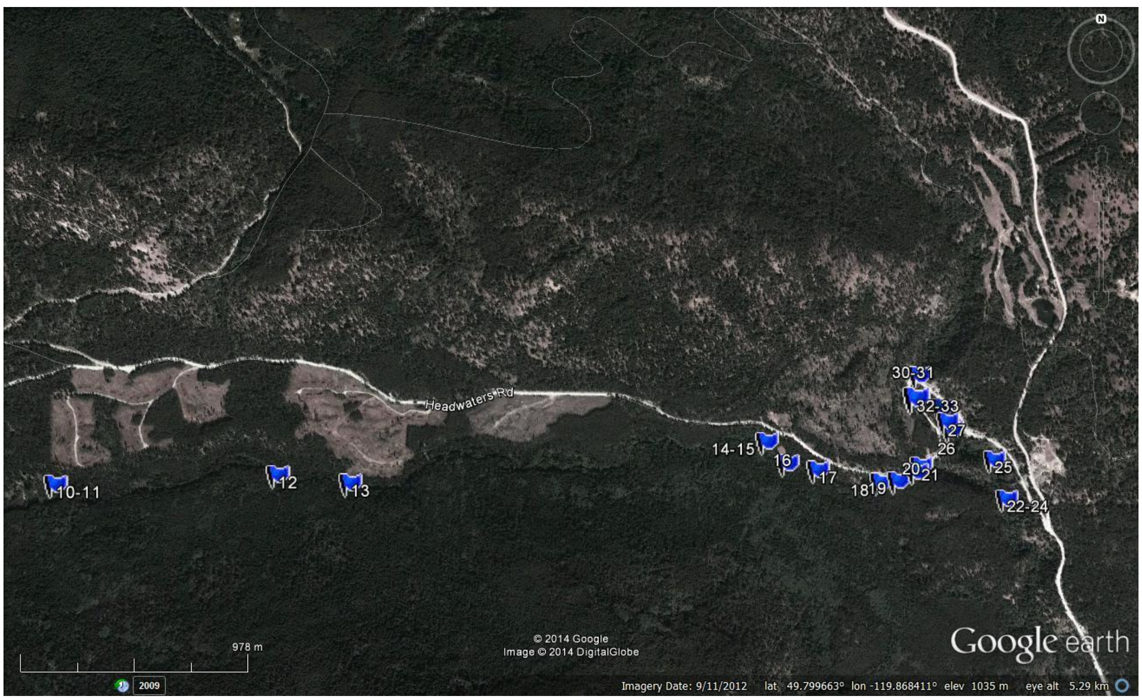
Photo #46 **Location**: 49.75233N 119.80853W Munro FSR on west side of bridge over Peachland Creek. **Notes**: Road climbs ~10-15% grade. Rill on road surface 0.3m x 0.2m deep. Cross ditches have been in which resulted in rill ditch that connects to creek on inside of road. East side of bridge Munro FSR ~5% grade. **Risk**: High	
Photo #47 **Location**: 49.75233N 119.80853W Munro FSR on west side of bridge over Peachland Creek. **Notes**: Close of up rill erosion as shown in Photo 46. Bridge also is a contributor of sediment – suggest surfacing road with gravel and drainage management on road. **Risk**: High	
Photo #48 **Location**: 49.75303N 119.81393W Top of Munro FSR switchback. **Notes**: Newly excavated hill slope, exposed, to widen corner. Runoff is connected to creek. **Risk**: High	

Photo #49 **Location**: 49.7541N 119.80437W DOP drinking water intake **Notes**: Concrete weir with stop logs to divert water to intake.	
Photo #50 **Location**: 49.7541N 119.80437W DOP drinking water intake (Point of Interest)	
Photo #51 **Location**: 49.7541N 119.80437W DOP drinking water intake **Notes**: Reservoirs	

Appendix D

Photo Location Maps

August 13, 2014 Field Assessment Photo Locations. Corresponds with Appendix B Peachland Creek Profile Map.



August 14, 2014 Field Assessment Photo Locations. Corresponds with Appendix B Greata Creek Profile Map.

August 14, 2014 Field Assessment Photo Locations. Corresponds with Appendix B Greata Creek Profile Map.

August 15, 2014 Field Assessment Photo Locations. Corresponds with Appendix B Peachland Creek Profile Map.

August 15, 2014 Field Assessment Photo Locations. Corresponds with Appendix B Peachland Creek Profile Map.

August 15, 2014 Field Assessment Photo Locations. Corresponds with Appendix B Peachland Creek Profile Map.