



View upstream through centre of the PPC (26-09-12)



View downstream through centre of the PPC (26-09-12)



View of left bank approach at centre of the PPC (26-09-12)



View of right bank approach at centre of the PPC (26-09-12)

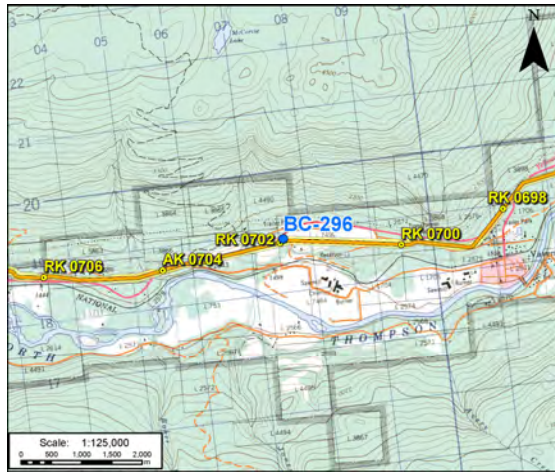
Channel Morphology

Pattern: Irregular
Confinement: Confined
Bank Shape LB: Vertical
RB: Vertical
Habitat Unit at PPC: Pool-Riffle
Habitat Unit through ZOI: Riffle-Pool
Gradient (%): 20
Main Stem: North Thompson River, FB,
1.1 km DS

	Mean (m)	Range (m)
Wetted Width:	1.37	0.56 - 3.00
Channel Width:	6.63	3.67 - 8.60
Bank Height:	0.72	0.30 - 1.17
Res. Pool Depth:	0.17	0.11 - 0.36

Water Quality/Quantity

Water Temperature (°C): 11.0
Conductivity (µS/cm): 629.0
pH: 8.13
D. Oxygen (mg/L): 10.30
Discharge (m³/s): 0.01
Flow Regime: Seasonal
Turbidity: Clear
Substrate % (PPC)
Organics: 0
Fines: 5
Sml Gravel: 10
Lrg Gravel: 10
Sml Cobble: 25
Lrg Cobble: 35
Boulder: 15
Bedrock: 0
Cover
Dominant: Boulders
Subdominant: Undercut Banks
Riparian
Type: Mixed
Maturity: Mature Forest
Crown Closure: 1-20%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - October 31

Least Risk Biological Window Proposed:

July 22 - October 31

Construction Timing:

Summer/Winter

Stream Classification BC:

S2

Navigability:

Potentially
Navigable

Reason for Decision:

Width > 5 m;
Slope > 4%

Barriers to Fish Movement:

Yes

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	7	10	1	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	M	M-H	L	L

Sampling Effort

Method	Time	Distance	Date
EF	341 s	200 m	26-09-12

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring if flowing⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Open-cut if dry or frozen to bottom

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge or other regulatory approved method

Historical Fish Presence:

No Previously Documented Fish Presence

Comments:

Peavine Creek has moderate potential for RB; channel dries up during late summer/fall but provides early spawning and seasonal rearing habitat for RB; abundant juvenile and YOY fish were captured and observed in residual pools within the ZOI; good cover is provided by boulders and undercut banks; a good mixture of gravel and small cobble provides suitable spawning substrate; wintering is limited by a lack of deep pools; migration is inhibited by gradient and dry sections during low flow; the channel is confined to a gully with steep approaches; complete crossing during the late summer/fall when flows are most manageable; large portions of the channel were de-watered at the time of the fall fisheries survey; dry channel conditions likely preclude habitat use for late summer/fall spawners.

		Trans Mountain Expansion Project				Peavine Creek				RK 701.94	
		Survey Date: September 26, 2012		Approved By: S. Johnston		TMEP site: BC-296				Sensitivity 	
		Drawn By: T. Jongbloets				UTM Zone: 11 307475 E 5719119 N NAD 83					
		Date Issued: February 26, 2013									



View upstream through centre of the PPC (19-07-13)



View downstream through centre of the PPC (19-07-13)



View of left bank approach at centre of the PPC (19-07-13)



View of right bank approach at centre of the PPC (19-07-13)

Channel Morphology

Pattern: Irregular
Confinement: Confined
Bank Shape LB: Vertical
RB: Vertical
Habitat Unit at PPC: Riffle-Pool
Habitat Unit through ZOI: Riffle-Pool
Gradient (%): 23
Main Stem: North Thompson River, FB, 355 m DS

	Mean (m)	Range (m)
Wetted Width:	1.68	1.30 - 2.00
Channel Width:	3.10	2.00 - 4.50
Bank Height:	0.62	0.30 - 1.50
Res. Pool Depth:	0.13	0.07 - 0.20

Water Quality/Quantity

Water Temperature (°C): 13.4
Conductivity (µS/cm): 452.7
pH: 8.40
D. Oxygen (mg/L): 9.70
Discharge (m³/s): 0.05
Flow Regime: Perennial
Turbidity: Clear

Substrate (PPC)

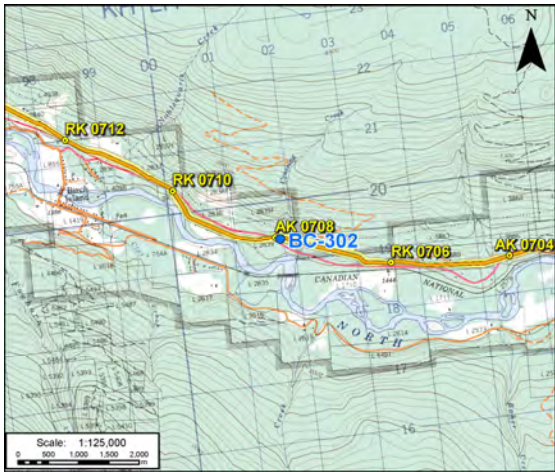
Organics: 0
Fines: 15
Sml Gravel: 15
Lrg Gravel: 10
Sml Cobble: 20
Lrg Cobble: 25
Boulder: 15
Bedrock: 0

Cover

Dominant: OHV
Subdominant: SWD

Riparian

Type: Mixed
Maturity: Mature Forest
Crown Closure: 41-70%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

August 7 - August 15

Least Risk Biological Window Proposed:

August 7 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S5/S3

Navigability:

Non-Navigable
Class 3

Reason for Decision:

Width 3 - 5 m;
Slope > 4%

Barriers to Fish Movement:

Yes

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
CO	-	5	-	-
CH	-	1	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	M	M	L	L
CH	M	M	L	L

Sampling Effort

Method	Time	Distance	Date
EF	201 s	100 m	26-09-12
MT	53 hrs	-	26-09-12
EF	121 s	100 m	19-07-13

Recommended Primary Pipeline Crossing Method:

Isolation with water quality monitoring if flowing⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Isolation with water quality monitoring during low flow⁽³⁾

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge

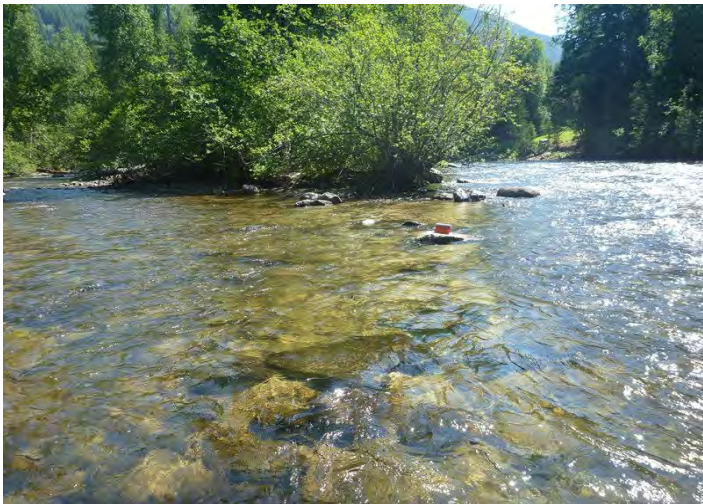
Historical Fish Presence:

CO

Comments:

Crossing Creek has low potential for fish within the PPC, which is attributed to steep gradient (23%) and numerous small falls within the ZOI; gradient upstream from the PPC is approximately 35%; juvenile CO and CH were captured between 400 m - 570 m downstream from the PPC (300 m downstream from Hwy 5); moderate rearing potential in the lower reaches of Crossing Creek is associated with cover provided by overhanging vegetation, woody debris and undercut banks; pockets of suitable gravel for spawning are present; shallow residual pool depths limit overwintering potential; a 1.3 m falls with a shallow plunge pool is located approximately 400 m downstream; no fish were captured near the PPC over 2 seasons of sampling; maintain downstream quality/quantity during construction.

		Trans Mountain Expansion Project				Crossing Creek				AK 707.91	
		Survey Date: September 25, 2012		Approved By: S. Johnston		TMEP site: BC-302				Sensitivity	
		Drawn By: C. Hartling				UTM Zone: 11 301702 E 5719600 N NAD 83					
Date Issued: August 9, 2013											



View upstream through centre of the PPC (09-07-13)



View downstream through centre of the PPC (09-07-13)



View of left bank approach at centre of the PPC (09-07-13)



View of right bank approach at centre of the PPC (09-07-13)

Channel Morphology

Pattern: Regular Meanders
Confinement: Occasionally Confined
Bank Shape LB: Vertical
RB: Vertical
Habitat Unit at PPC: Riffle-Run
Habitat Unit through ZOI: Riffle-Run
Gradient (%): 3
Main Stem: Raft River

	Mean (m)	Range (m)
Wetted Width:	36.32	28.60 - 45.00
Channel Width:	37.82	32.60 - 45.00
Bank Height:	0.62	0.25 - 1.20
Res. Pool Depth:	0.35	0.03 - 0.45

Water Quality/Quantity

Water Temperature (°C): 14.6
Conductivity (µS/cm): 43.7
pH: 7.05
D. Oxygen (mg/L): 10.97
Discharge (m³/s): -
Flow Regime: Perennial
Turbidity: Clear

Substrate (PPC)

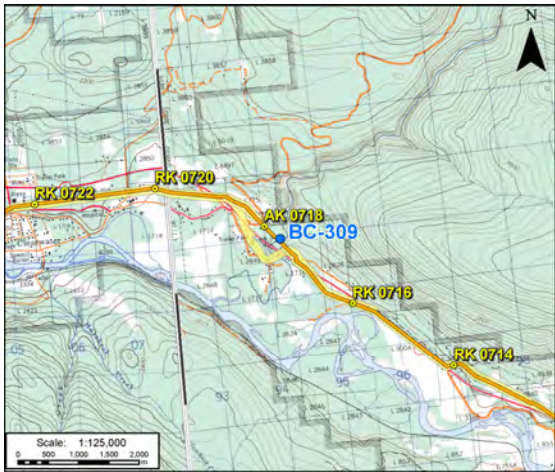
Organics: 0
Fines: 15
Sml Gravel: 10
Lrg Gravel: 10
Sml Cobble: 15
Lrg Cobble: 40
Boulder: 10
Bedrock: 0

Cover

Dominant: OHV
Subdominant: Boulders

Riparian

Type: Mixed
Maturity: Mature Forest
Crown Closure: 0%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - August 15

Least Risk Biological Window Proposed:

July 22 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S1B

Navigability:

Navigable

Reason for Decision:

Width > 5 m

Barriers to Fish Movement:

No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	-	1	-	-
CO	-	16	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	M	H	M	H
CO	M-H	H	M	H

Sampling Effort

Method	Time	Distance	Date
MT	116 hrs	-	09-07-13

Recommended Primary Pipeline Crossing Method:

Trenchless with water quality monitoring

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage during low flow⁽³⁾ or open-cut inside timing window⁽⁴⁾; water quality monitoring required

Historical Fish Presence:

CAS, CH, CO, CSU, BT, L, LNC, MW, RB, SK

Comments:

Large perennial channel with high potential for salmonids, including CO, CH, SK, BT and RB; CO and RB were captured within the ZOI; high rearing potential is attributed to numerous velocity breaks along banks and good cover provided by abundant OHV and instream boulders; unembedded coarse gravel/cobble material provide suitable habitat for spawning; high migration potential is associated with low gradient channel and a lack of barriers; moderate overwintering potential is attributed to perennial discharge but limited by a lack of deep pools throughout the ZOI.

Recommended Vehicle Crossing Method (Non-Frozen):

Access both banks

Recommended Vehicle Crossing Method (Dry/Frozen):

Access both banks

		Trans Mountain Expansion Project				Raft River				AK 717.67	
		Survey Date: July 9, 2013		Approved By: S. Johnston		TMEP site: BC-309				Sensitivity 	
		Drawn By: C. Hartling				UTM Zone: 11 294134 E 5725199 N NAD 83					
Date Issued: August 26, 2013											



View upstream through centre of the PPC (08-07-13)



View downstream through centre of the PPC (08-07-13)



View of left bank approach at centre of the PPC (08-07-13)



View of right bank approach at centre of the PPC (08-07-13)

Channel Morphology

Pattern: Irregular
Confinement: Unconfined
Bank Shape LB: Vertical
RB: Vertical
Habitat Unit at PPC: Riffle-Run
Habitat Unit through ZOI: Riffle-Pool
Gradient (%): 8
Main Stem: North Thompson River, FB,
1.3 km DS

	Mean (m)	Range (m)
Wetted Width:	1.28	0.60 - 2.20
Channel Width:	2.35	1.70 - 2.90
Bank Height:	0.29	0.08 - 0.50
Res. Pool Depth:	0.17	0.05 - 0.45

Water Quality/Quantity

Water Temperature (°C): 16.2
Conductivity (µS/cm): 106.6
pH: 7.26
D. Oxygen (mg/L): 10.31
Discharge (m³/s): 0.01
Flow Regime: Seasonal
Turbidity: Clear

Substrate (PPC)

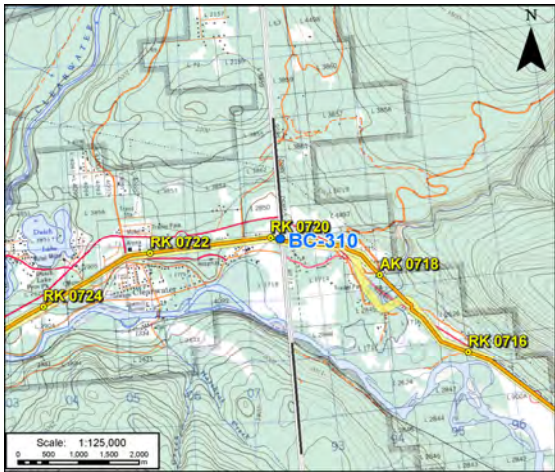
Organics: 0
Fines: 20
Sml Gravel: 15
Lrg Gravel: 40
Sml Cobble: 25
Lrg Cobble: 0
Boulder: 0
Bedrock: 0

Cover

Dominant: OHV
Subdominant: SWD

Riparian

Type: Mixed
Maturity: Mature Forest
Crown Closure: 21-40%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 15 - August 15

Least Risk Biological Window Proposed:

July 15 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S3

Navigability:

Non-Navigable
Class 2

Reason for Decision:

Width 1.2 - 3 m;
Slope > 4%

Barriers to Fish Movement:

Yes

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
CO	-	1	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	L	M	L	L

Sampling Effort

Method	Time	Distance	Date
EF	405 s	280 m	08-07-13

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring if flowing⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Open-cut if dry or frozen to bottom

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge or other regulatory approved crossing method

Historical Fish Presence:

No Previously Documented Fish Presence

Comments:

School Creek has low potential for salmonids at and adjacent to the PPC, attributed to a perched culvert at the Clearwater Village Road approximately 260 m downstream. Juvenile CO were captured and observed below perched culvert and the lower reaches of School Creek have moderate habitat value for rearing salmonids. Moderate rearing potential is attributed to abundant cover provided by OHV and woody debris; although low discharge and shallow depths likely reduce the overall habitat potential, including late-season spawning of CO and overwintering for juvenile fishes. School Creek was dry at the PPC in September 2012.

		Trans Mountain Expansion Project				School Creek				RK 719.84	
		Survey Date: July 8, 2013		Approved By: S. Johnston		TMEP site: BC-310				Sensitivity	
		Drawn By: A. Michaud				UTM Zone: 10 707453 E 5726234 N NAD 83					
Date Issued: July 30, 2013											



View upstream through centre of the PPC (29-11-12)



View downstream through centre of the PPC (29-11-12)



View of left bank approach at centre of the PPC (29-11-12)



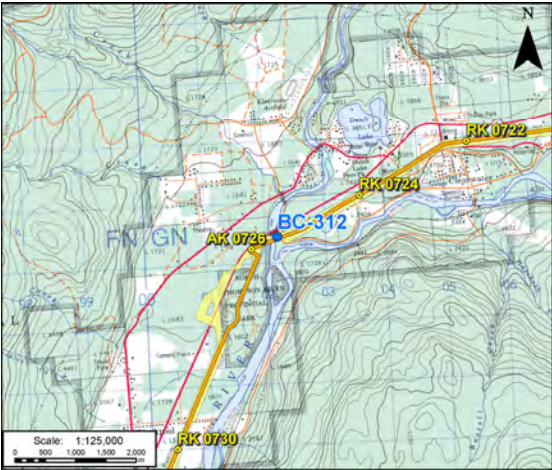
View of right bank approach at centre of the PPC (29-11-12)

Channel Morphology

Pattern:	Sinuous	
Confinement:	Confined	
Bank Shape	LB:	Sloping
	RB:	Sloping
Habitat Unit at PPC:	Run	
Habitat Unit through ZOI:	Run-Riffle	
Gradient (%):	2	
Main Stem:	North Thompson River, FB, 350 m DS	
	Mean (m)	Range (m)
Wetted Width:	91.57	77.00 - 96.50
Channel Width:	105.15	86.00 - 116.20
Bank Height:	1.71	0.90 - 2.30
Res. Pool Depth:	-	-

Water Quality/Quantity

Water Temperature (°C):	4.2	D. Oxygen (mg/L):	12.40
Conductivity (µS/cm):	46.4	Discharge (m³/s):	71.83
pH:	7.96	Flow Regime:	Perennial
		Turbidity:	Clear
Substrate % (PPC)			
Organics:	0	Cover	
Fines:	5	Dominant:	Boulders
Sml Gravel:	0	Subdominant:	Deep Pools
Lrg Gravel:	10	Riparian	
Sml Cobble:	20	Type:	Mixed
Lrg Cobble:	45	Maturity:	Mature Forest
Boulder:	20	Crown Closure:	0%
Bedrock:	0		



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

August 7 - August 15

Least Risk Biological Window Proposed:

August 7 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:	S1A
Navigability:	Navigable
Reason for Decision:	Width > 5 m
Barriers to Fish Movement:	No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
-	-	-	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
Salmonids	M	H	H	H

Sampling Effort	Time	Distance	Date
Method (none)	-	-	-

Recommended Primary Pipeline Crossing Method:

Trenchless with water quality monitoring

Recommended Contingency Pipeline Crossing Method:

Open-cut with water quality monitoring inside timing window⁽⁴⁾

Recommended Vehicle Crossing Method (Non-Frozen):

Access both banks

Recommended Vehicle Crossing Method (Dry/Frozen):

Access both banks

Historical Fish Presence:

CCG, CH, CO, BT, LNC, MW, RB, RSC, SK

Comments:

The Clearwater River is one of the largest tributaries to the North Thompson River and provides high value habitat for pacific salmon including SK, CH and CO; good rearing and holding habitat is attributed to slow velocity runs with good depth and instream cover provided by boulders; spawning in this section is limited by high percentages of boulder/cobble material and moderate substrate embeddedness; large channel morphology with sufficient depth and perennial flow offer high overwintering potential; the North Thompson River is also located 350 m downstream.

		Trans Mountain Expansion Project		Clearwater River				AK 725.53		
		Survey Date:	November 29, 2012	Approved By:	S. Johnston	TMEP site: BC-312				Sensitivity 
		Drawn By:	T. Jongbloets			UTM Zone: 10 702102 E 5724656 N NAD 83				
		Date Issued:	February 26, 2013							



View downslope through centre of the PPC (08-09-14)



View of NW approach at centre of the PPC (08-09-14)

Water Quality/Quantity

Type:	Shrub
Maturity:	Shrub
Crown Closure:	1-20%

Species	Fish Habitat Potential			
	Spawning	Rearing	Wintering	Migration
CO	1	1	1	1

Fish Habitat Potential

Sampling Effort			
Method	Time	Distance	Date
DN	-	20 m	08-09-14
VO	-	20 m	08-09-14



Isolation with fish salvage if water present

Open-cut if dry or frozen to bottom

No Previously Documented Fish Presence

Low-lying wetland area within a backwater swale that drains into the North Thompson River; potential flood area during peak runoff conditions; seasonal fish habitat value with potential connectivity to Mann Creek and North Thompson River during high flow periods; over 100 juvenile CO and 6 RSC were observed stranded in a small shallow (5 cm deep) isolated pool located approximately 115 m upslope from the PPC; no surface water was present at the PPC at the time of assessment; conduct precautionary fish salvage if water is present at the time of construction.

Barriers to Fish Movement: Yes

Ramp and culvert or other regulatory approved crossing method; Swamp Mats may be required

BC-314b



View upstream through centre of the PPC (13-09-12)



View downstream through centre of the PPC (13-09-12)



View of left bank approach at centre of the PPC (13-09-12)



View of right bank approach at centre of the PPC (13-09-12)

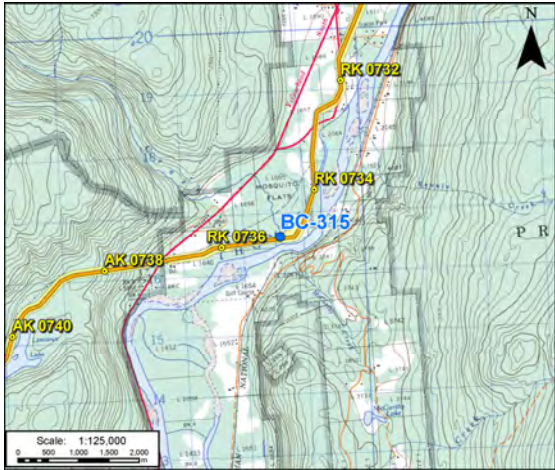
Channel Morphology

Pattern: Irregular Meandering
Confinement: Occasionally Confined
Bank Shape LB: Vertical
RB: Sloping
Habitat Unit at PPC: Run
Habitat Unit through ZOI: Run
Gradient (%): 1
Main Stem: North Thompson River, FB,
110 m DS

	Mean (m)	Range (m)
Wetted Width:	16.75	12.00 - 21.00
Channel Width:	19.50	17.00 - 24.00
Bank Height:	0.67	0.35 - 1.00
Res. Pool Depth:	-	-

Water Quality/Quantity

Water Temperature (°C): 11.9
Conductivity (µS/cm): 197.4
pH: 7.84
D. Oxygen (mg/L): 10.49
Discharge (m³/s): 0.09
Flow Regime: Perennial
Turbidity: Clear
Substrate % (PPC)
Organics: 0
Fines: 30
Sml Gravel: 20
Lrg Gravel: 20
Sml Cobble: 30
Lrg Cobble: 0
Boulder: 0
Bedrock: 0
Cover
Dominant: OHV
Subdominant: Undercut Banks
Riparian
Type: Mixed
Maturity: Mature Forest
Crown Closure: 1-20%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - August 20

Least Risk Biological Window Proposed:

July 22 - August 20

Construction Timing:

Summer/Winter

Stream Classification BC:

S2

Navigability:

Navigable

Reason for Decision:

Width > 5 m

Barriers to Fish Movement:

No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
CRH	-	5	1	-
C	-	-	-	3
RSC	-	4	8	-
RB	-	1	-	-
CO	-	21	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	L	H	M-H	H
BT	L	H	M-H	H
CH	L	H	M-H	H
RB	L	H	M-H	H
SK	L	H	M-H	H

Sampling Effort

Method	Time	Distance	Date
EF	231 s	45 m	13-09-12
EF	279 s	100 m	12-08-13
MT	72 hrs	-	12-08-13

Recommended Primary Pipeline Crossing Method:

Trenchless with water quality monitoring

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

Historical Fish Presence:

BT, CH, CO, CRH, EB, LSU, PK, RB, SK, WF

Comments:

Mann Creek is a large perennial channel with high habitat potential for salmonids; Mann Creek is a known spawning and rearing tributary for SK, CO and CH; the PPC is located approximately 100 m upstream from the North Thompson River and provides important migratory and staging habitat for adult spawners and juvenile fish; slow deep run habitat within the ZOI offers good rearing and wintering habitat but spawning is limited near the PPC by low water velocity and high percentages of fines; an off-channel area (or 'snye') is located upstream from the PPC.

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge

		Trans Mountain Expansion Project				Mann Creek				AK 735.09			
		Survey Date: September 13, 2012		Drawn By: T. Waites		Approved By: S. Johnston		TMEP site: BC-315		Sensitivity 			
		Date Issued: February 25, 2013						UTM Zone: 10 698509 E 5716833 N NAD 83					



View downslope through centre of the PPC (02-10-14)



View of N approach at centre of the PPC (02-10-14)

Water Quality/Quantity

Substrate (PPC)

Cover

Subdominant: OHV

Riparian

Type:	Mixed
Maturity:	Mature Forest
Canopy Closure:	1-20%



Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	L	M	L	M

Sampling Effort			
Method	Time	Distance	Date
-	-	-	-

Isolation with fish salvage if water present

Open-cut if dry or frozen to bottom

No Previously Documented Fish Presence

Vegetated backwater swale with potential seasonal connectivity to North Thompson River (the PPC is situated along active flood plain and North Thompson River is approximately 200 m downslope); drainage was dry at the time of assessment but may provide seasonal rearing habitat for juvenile salmonids or coarse fish during high flow periods; low potential for spawning and wintering is attributed to a lack of suitable substrate and seasonal discharge; conduct precautionary fish salvage if water is present at the time construction.

Barriers to Fish Movement: Yes

Ramp and Culvert or other regulatory approved crossing method; Swamp Mats may be required





View upslope through centre of the PPC (08-08-12)



View downslope through centre of the PPC (08-08-12)



View of NE approach at centre of the PPC (08-08-12)



View of SW approach at centre of the PPC (08-08-12)

Channel Morphology

Pattern: -
Confinement: Confined
Bank Shape LB: -
RB: -
Habitat Unit at PPC: Pool
Habitat Unit through ZOI: Pool
Gradient (%): 2
Main Stem: North Thompson River, FB,
760 m DS

	Mean (m)	Range (m)
Wetted Width:	-	-
Channel Width:	-	-
Bank Height:	-	-
Res. Pool Depth:	-	-

Water Quality/Quantity

Water Temperature (°C): 19.2
Conductivity (µS/cm): 508.0
pH: 7.30
D. Oxygen (mg/L): 2.71
Discharge (m³/s): -
Flow Regime: Seasonal
Turbidity: Lightly Turbid

Substrate % (PPC)

Organics: 90
Fines: 10
Sml Gravel: 0
Lrg Gravel: 0
Sml Cobble: 0
Lrg Cobble: 0
Boulder: 0
Bedrock: 0

Cover

Dominant: ISV
Subdominant: OHV
Riparian
Type: Deciduous
Maturity: Young Forest
Crown Closure: 21-40%

Fish Presence and Life History Stage

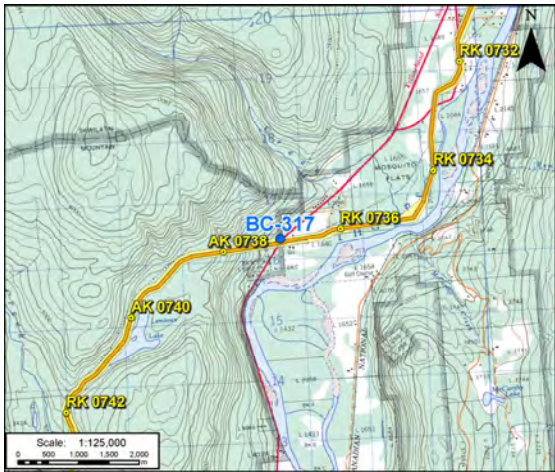
Species	YOY	Juv	Adult	Unknown
CO	-	23	-	-
CH	-	5	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	L	M	L	M
CH	L	M	L	M

Sampling Effort

Method	Time	Distance	Date
MT	124 hrs	-	22-07-06
MT	158 hrs	-	08-08-12
MT	106 hrs	-	13-08-13



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring if flowing

Recommended Contingency Pipeline Crossing Method:

Open-cut if dry or frozen to bottom

Historical Fish Presence:

CO, CH

Comments:

Wetland complex with periodic connectivity to the North Thompson River; ponded areas provide seasonal rearing habitat for juvenile salmonids; CH and CO were captured in 2006 and over 70 rearing CO were captured or observed within isolated pools in 2013; good cover provided by ISV and OHV; however high water temperatures, seasonal flow, and low DO limit overall potential for rearing and overwintering; beaver dams observed downstream from PPC may act as seasonal barriers to fish migration, although fish were observed upslope in 2006; potential for fall spawners within the PPC is nil, as substrate lacks gravels, and ponds become isolated with low DO and high temperature; culvert may be an appropriate vehicle crossing structure; low potential for sediment migration downstream given laminar flow conditions; site was dry in winter 2013.

Provincial Window of Least Risk:

July 15 - August 15

Least Risk Biological Window Proposed:

Open

Construction Timing:

Summer/Winter

Stream Classification BC:

NCD-W

Navigability:

-

Reason for Decision:

See Wetland
Evaluation Report
Vol. 5C

Barriers to Fish Movement:

Yes

Recommended Vehicle Crossing Method (Non-Frozen):

Existing or Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Existing or Clear-Span Bridge or other regulatory
approved crossing method

		Trans Mountain Expansion Project				Unnamed Drainage (Wetland)				AK 737.04	
		Survey Date: August 8, 2012		Drawn By: T. Waites		Approved By: S. Johnston		TMEP site: BC-317			
		Date Issued: February 25, 2013				UTM Zone: 10 696530 E 5716571 N NAD 83		Sensitivity 			



View upstream through centre of the PPC (06-09-12)



View downstream through centre of the PPC (06-09-12)



View of left bank approach at centre of the PPC (06-09-12)



View of right bank approach at centre of the PPC (06-09-12)

Channel Morphology

Pattern: Sinuous
Confinement: Occasionally Confined
Bank Shape LB: Undercut
RB: Sloping
Habitat Unit at PPC: Run
Habitat Unit through ZOI: Pool-Run
Gradient (%): 1
Main Stem: Lemieux Creek

	Mean (m)	Range (m)
Wetted Width:	6.66	5.40 - 7.50
Channel Width:	20.23	12.40 - 50.00
Bank Height:	0.39	0.16 - 0.74
Res. Pool Depth:	0.75	0.28 - 1.21

Water Quality/Quantity

Water Temperature (°C): 13.2
Conductivity (µS/cm): 212.7
pH: 7.98
D. Oxygen (mg/L): 9.79
Discharge (m³/s): 0.10
Flow Regime: Perennial
Turbidity: Clear

Substrate % (PPC)

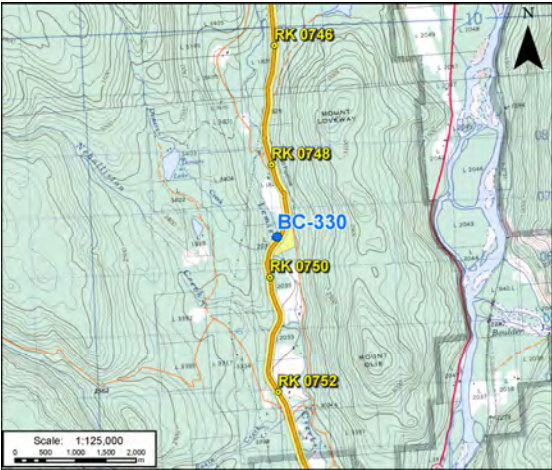
Organics: 0
Fines: 0
Sml Gravel: 5
Lrg Gravel: 5
Sml Cobble: 40
Lrg Cobble: 40
Boulder: 10
Bedrock: 0

Cover

Dominant: Deep Pools
Subdominant: Boulders

Riparian

Type: Mixed
Maturity: Mature Forest
Crown Closure: 0%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - August 15

Least Risk Biological Window Proposed:

July 22 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S1B

Navigability:

Navigable

Reason for Decision:

Width >5 m

Barriers to Fish Movement:

No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
SK	-	-	1	-
BT	-	-	1	-
CC	-	-	3	-
CO	-	49	-	-
CH	-	1	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
SK	M-H	M-H	M	H
BT	M-H	M-H	M	H
CH	M-H	M-H	M	H
CO	M-H	M-H	M	H

Sampling Effort

Method	Time	Distance	Date
VO	-	-	06-09-12
MT	144 hrs	-	23-07-06

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge

Historical Fish Presence:

CC, CH, CO, KO, MW, PK, RB, SK, LNC, NSC

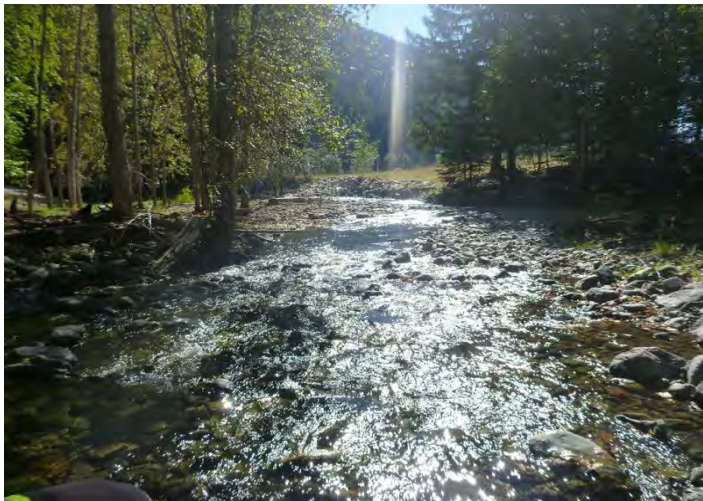
Comments:

Lemieux Creek is an important spawning and rearing stream for SK, CH and CO and provides moderate to high value habitat for salmonids; abundant juvenile CO and a few CH and CC were captured in 2006; adult SK and BT were observed in 2012; good shading and instream complexity with abundant cover are provided by deep pools, boulders, overhanging vegetation and woody debris; clean unembedded large gravel or small cobble substrate provide good spawning habitat throughout the ZOI; Lemieux Creek is lake-fed (Taweel Lake) and occasional deep pools over 1 m were observed; however, low discharge may reduce the overall potential for overwintering.

		Trans Mountain Expansion Project		Lemieux Creek				AK 749.31		
		Survey Date:	September 6, 2012	Approved By:	S. Johnston	TMEP site: BC-330				Sensitivity 
		Drawn By:	T. Waites							
		Date Issued:	February 25, 2013	UTM Zone: 10 692986 E 5706768 N NAD 83						



View upstream through centre of the PPC (06-09-12)



View downstream through centre of the PPC (06-09-12)



View of left bank approach at centre of the PPC (06-09-12)



View of right bank approach at centre of the PPC (06-09-12)

Channel Morphology

Pattern: Sinuous
Confinement: Occasionally Confined
Bank Shape LB: Sloping
RB: Sloping
Habitat Unit at PPC: Run-Riffle
Habitat Unit through ZOI: Riffle-Run
Gradient (%): 2
Main Stem: Lemieux Creek, FB, 430 m DS

	Mean (m)	Range (m)
Wetted Width:	4.35	2.63 - 6.03
Channel Width:	8.10	6.24 - 14.10
Bank Height:	0.49	0.22 - 0.86
Res. Pool Depth:	0.20	0.19 - 0.20

Water Quality/Quantity

Water Temperature (°C): 10.2
Conductivity (µS/cm): 210.0
pH: 8.49
D. Oxygen (mg/L): 11.15
Discharge (m³/s): 0.09
Flow Regime: Perennial
Turbidity: Clear

Substrate % (PPC)

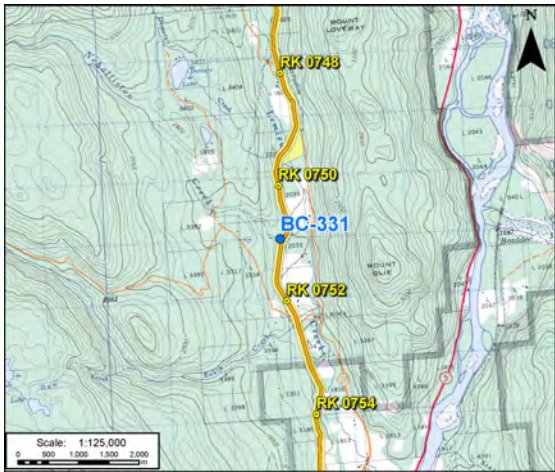
Organics: 0
Fines: 0
Sml Gravel: 10
Lrg Gravel: 10
Sml Cobble: 40
Lrg Cobble: 25
Boulder: 15
Bedrock: 0

Cover

Dominant: Boulders
Subdominant: SWD

Riparian

Type: Mixed
Maturity: Mature Forest
Crown Closure: 1-20%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - August 15

Least Risk Biological Window Proposed:

July 22 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S2

Navigability:

Potentially
Navigable

Reason for Decision:

Width > 5 m;
Potential Obstacles

Barriers to Fish Movement:

No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	-	5	-	-
CO	-	1	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	M	M-H	M	M-H
CO	M	M-H	M	M-H

Sampling Effort

Method	Time	Distance	Date
EF	60 s	100 m	06-09-12

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge

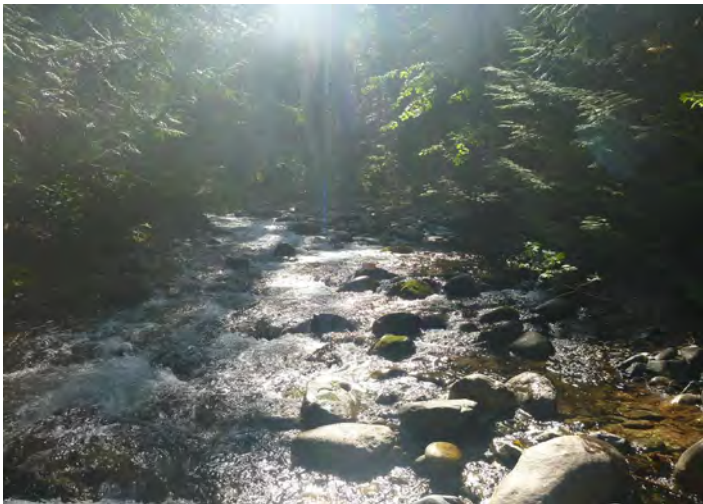
Historical Fish Presence:

RB

Comments:

Nehalliston Creek is a tributary to Lemieux Creek which provides suitable habitat for salmonids; juvenile CO and RB were captured within the ZOI in 2012; moderate to high rearing potential is attributed to channel complexity, shading, and good cover provided by boulders, woody debris and overhanging vegetation; no barriers to migration were observed; moderate spawning potential is attributed to unembedded coarse substrate material with suitable pockets of gravel and small cobble; moderate discharge and a lack of deep pools may limit the overall potential for overwintering.

		Trans Mountain Expansion Project				Nehalliston Creek				RK 750.95	
		Survey Date: September 6, 2012		Drawn By: T. Waites		Approved By: S. Johnston		TMEP site: BC-331		Sensitivity	
		Date Issued: February 25, 2012						UTM Zone: 10 692826 E 5705228 N NAD 83			



View upstream through centre of the PPC (08-08-12)



View downstream through centre of the PPC (08-08-12)



View of left bank approach at centre of the PPC (08-08-12)



View of right bank approach at centre of the PPC (08-08-12)

Channel Morphology

Pattern: Irregular
Confinement: Frequently Confined
Bank Shape LB: Vertical
RB: Vertical
Habitat Unit at PPC: Riffle
Habitat Unit through ZOI: Riffle-Run
Gradient (%): 3
Main Stem: Lemieux Creek, FB, 430 m DS

	Mean (m)	Range (m)
Wetted Width:	7.17	6.00 - 8.00
Channel Width:	10.50	9.00 - 13.00
Bank Height:	1.02	0.50 - 1.40
Res. Pool Depth:	-	-

Water Quality/Quantity

Water Temperature (°C): 15.4
Conductivity (µS/cm): 164.4
pH: 8.40
D. Oxygen (mg/L): 10.30
Discharge (m³/s): -
Flow Regime: Perennial
Turbidity: Clear

Substrate % (PPC)

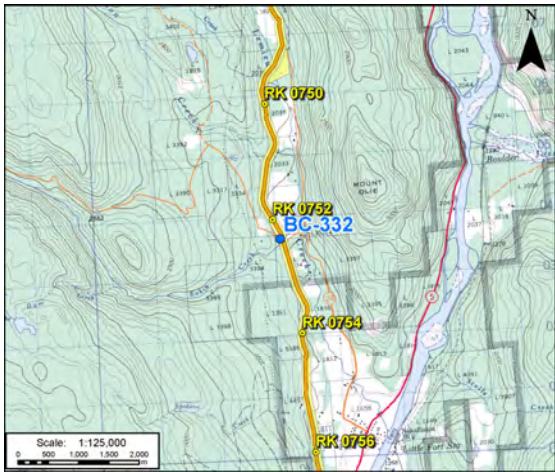
Organics: 0
Fines: 0
Sml Gravel: 0
Lrg Gravel: 0
Sml Cobble: 20
Lrg Cobble: 20
Boulder: 60
Bedrock: 0

Cover

Dominant: Deep Pools
Subdominant: Boulders

Riparian

Type: Mixed
Maturity: Mature Forest
Crown Closure: 1-20%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - August 15

Least Risk Biological Window Proposed:

July 22 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S2

Navigability:

Potentially
Navigable

Reason for Decision:

Width > 5 m;
Potential Obstacles

Barriers to Fish Movement:

No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	-	3	-	-
CO	-	1	-	-
CCG	-	-	1	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	M	M-H	M	H
CO	M	M-H	M	H

Sampling Effort Effort

Method	Time	Distance	Date
MT	12 hrs	-	08-08-12
MT	93 hrs	-	23-07-06
EF	342 s	150 m	23-07-06

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

Historical Fish Presence:

RB, CO, CCG

Comments:

Eakin Creek has moderate to high potential for salmonids; RB, CO and CCG were captured in 2006; the channel provides good complexity and shading with abundant velocity breaks; cover is provided by deep pools, boulders, undercut banks and woody debris; moderate spawning potential is attributed to pockets of gravel and small cobble throughout, but limited by a high percentage of large course substrate material; Eakin Creek has perennial flow with moderate wintering potential attributed to large channel size and catchment area; Eakin Creek is fed by a series of lakes upstream which includes Dum, Latremouille, Emar and Phinetta Lakes.

		Trans Mountain Expansion Project				Eakin Creek				RK 752.35			
		Survey Date: August 8, 2012		Drawn By: T. Waites		Approved By: S. Johnston		TMEP site: BC-332					
		Date Issued: February 25, 2012				UTM Zone: 10 692998 E 5703875 N NAD 83				Sensitivity			



View downstream through centre of the PPC (07-08-12)



View of right bank approach at centre of the PPC (07-08-12)

Water Quality/Quantity

Water Temperature (°C):	14.9	D. Oxygen (mg/L):	10.78
Conductivity (µS/cm):	336.3	Discharge (m³/s):	-
pH:	8.40	Flow Regime:	Perennial
		Turbidity:	Clear
<u>Substrate % (PPC)</u>			
Organics:	0	<u>Cover</u>	
Fines:	0	Dominant:	SWD
Sml Gravel:	5	Subdominant:	Boulders
Lrg Gravel:	10		
Sml Cobble:	25	<u>Riparian</u>	
Lrg Cobble:	40	Type:	Shrubs
Boulder:	20	Maturity:	Young Forest
Bedrock:	0	Crown Closure:	21-40%

<u>Substrate % (PPC)</u>	
Organics:	0
Fines:	0
Sml Gravel:	5
Lrg Gravel:	10
Sml Cobble:	25
Lrg Cobble:	40
Boulder:	20
Bedrock:	0

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	M	M-H	M	L

Recommended Primary Pipeline Crossing Method:
Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:
Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

RB

Montigny Creek is a small perennial channel with moderate habitat potential for RB; the North Thompson River is located within the ZOI; however, a perched culvert at Hwy 5 and Webb Road likely restricts upstream fish migration; resident RB have been captured in the channel over multiple years of sampling (2006, 2012); abundant cover is provided by woody debris, boulders, small pools and overhanging vegetation; spawning at the PPC is limited by high percentages of larger coarse substrate material, although there is a small proportion of small/large gravel; low discharge limits potential for overwintering; however resident RB are likely able to survive year-round in small residual pools.

BC-336



View upstream through centre of the PPC (02-08-12)



View downstream through centre of the PPC (02-08-12)



View of left bank approach at centre of the PPC (02-08-12)



View of right bank approach at centre of the PPC (02-08-12)

Channel Morphology

Pattern: Sinuous
Confinement: Frequently Confined
Bank Shape LB: Vertical
RB: Vertical
Habitat Unit at PPC: Riffle-Pool
Habitat Unit through ZOI: Riffle-Pool
Gradient (%): 12
Main Stem: North Thompson River, FB,
360 m DS

	Mean (m)	Range (m)
Wetted Width:	4.82	3.60 - 6.10
Channel Width:	7.43	6.10 - 8.40
Bank Height:	0.52	0.12 - 1.30
Res. Pool Depth:	0.20	0.04 - 0.35

Water Quality/Quantity

Water Temperature (°C): 13.6
Conductivity (µS/cm): 77.7
pH: 8.31
D. Oxygen (mg/L): 10.65
Discharge (m³/s): 0.21
Flow Regime: Perennial
Turbidity: Clear

Substrate % (PPC)

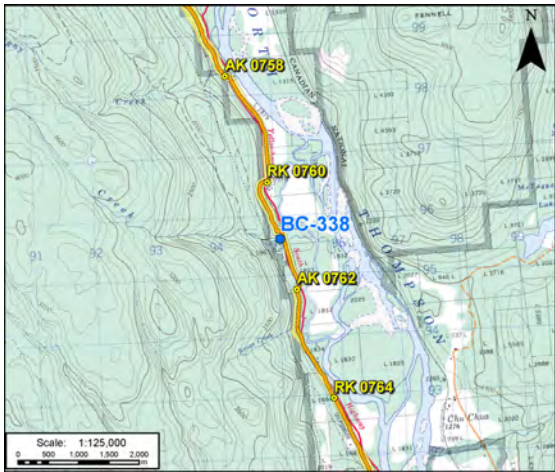
Organics: 0
Fines: 0
Sml Gravel: 0
Lrg Gravel: 0
Sml Cobble: 0
Lrg Cobble: 20
Boulder: 80
Bedrock: 0

Cover

Dominant: Boulders
Subdominant: Deep Pools

Riparian

Type: Deciduous
Maturity: Mature Forest
Crown Closure: 21-40%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - October 31

Least Risk Biological Window Proposed:

July 22 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S2

Navigability:

Potentially
Navigable

Reason for Decision:

Width > 5 m;
Slope > 4%

Barriers to Fish Movement:

Yes

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	-	2	5	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	L	M-H	M-H	M

Sampling Effort

Method	Time	Distance	Date
MT	70 hrs	-	02-08-12
EF	602 s	100 m	24-07-06

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:



Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

Historical Fish Presence:

RB

Comments:

Thuya Creek provides moderate habitat potential for RB; the channel drains from Thuya Lake and has potential to flow year-round; juvenile RB were captured in the channel over multiple years of sampling (2006, 2012); good cover is provided by boulders, pools and overhanging vegetation; low potential for spawning is attributed to a high percentage of large cobble and boulder substrate; moderate discharge and sufficient pool depths provide suitable overwintering habitat; a perched culvert under Hwy 5 likely restricts upstream fish migration from the North Thompson River; RB were captured upstream from the Hwy suggesting possible fish emigration from Thuya Lake.

		Trans Mountain Expansion Project		Thuya Creek				RK 761.09	
		Survey Date: August 2, 2012 Drawn By: T. Waites Date Issued: February 26, 2013	Approved By: I. Emerson	TMEP site: BC-338 UTM Zone: 10 694978 E 5695850 N NAD 83				Sensitivity 	



View downstream through centre of the PPC (22-11-12)



View of right bank approach at centre of the PPC (22-11-12)

Water Quality/Quantity

Crown Closure: 1-20%

Species	Fish Habitat Potential			
	Spawning	Rearing	Wintering	Migration
CO	M	L	L	M

Fish Habitat Potential

Sampling Effort			
Method	Time	Distance	Date
MT	37 hrs	-	02-08-12



Clear-Span Bridge or other regulatory approved crossing method

Small spring-fed tributary to North Thompson River. Juvenile CO were captured in an isolated pool approximately 50 m downstream from the existing TMPL ROW. Steep gradient (25-50%) at the PPC and upstream from the existing TMPL ROW limits fish migration potential; however, gradient reduces to 2% downstream from the existing TMPL ROW; overall habitat potential for rearing and overwintering is limited by the seasonal flow regime (dry sections observed in November 2012) and limited instream cover; spawning potential is poor near the existing TMPL ROW given high percentages of bedrock and boulder, although suitable gravel and cobble substrates are present downstream from Hwy 5; complete crossing during low flow conditions; conduct precautionary fish salvage

BC-342



View downstream through centre of the PPC (01-08-12)



View of right bank approach at centre of the PPC (01-08-12)

Water Quality/Quantity

Water Temperature (°C):	11.0	D. Oxygen (mg/L):	11.46
Conductivity (µS/cm):	65.4	Discharge (m³/s):	0.84
pH:	8.16	Flow Regime:	Perennial
		Turbidity:	Clear
<u>Substrate % (PPC)</u>			
Organics:	0	<u>Cover</u>	
Fines:	0	Dominant:	Boulders
Sml Gravel:	5	Subdominant:	Undercut Banks
Lrg Gravel:	5		
Sml Cobble:	15	<u>Riparian</u>	
Lrg Cobble:	15	Type:	Deciduous
Boulder:	60	Maturity:	Mature Forest
Bedrock:	0	Crown Closure:	41-70%

<u>Substrate % (PPC)</u>	
Organics:	0
Fines:	0
Sml Gravel:	5
Lrg Gravel:	5
Sml Cobble:	15
Lrg Cobble:	15
Boulder:	60
Bedrock:	0

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	M	M-H	M	M-H
RB	M	M-H	M	M-H

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Clear-Span Bridge

CO

Darlington Creek is a perennial watercourse with moderate to high potential for salmonids; juvenile CO and RB were captured within the ZOI; abundant velocity breaks are evident and suitable instream cover is provided by boulders, undercut banks, overhanging vegetation and woody debris; moderate spawning potential is attributed to a predominance of larger substrate material within the ZOI; Darlington Creek's large channel size and moderate discharge likely offers year-round flow and moderate potential for overwintering; Darlington Creek is subject to high flows in the spring/summer and armouring may be required.

BC-343



View upstream through centre of the PPC (31-07-12)



View downstream through centre of the PPC (31-07-12)



View of left bank approach at centre of the PPC (31-07-12)



View of right bank approach at centre of the PPC (31-07-12)

Channel Morphology

Pattern: Irregular
Confinement: Occasionally Confined
Bank Shape LB: Sloping
RB: Undercut
Habitat Unit at PPC: Run-Riffle
Habitat Unit through ZOI: Run-Riffle
Gradient (%): 2
Main Stem: North Thompson River, FB, 600 m DS

	Mean (m)	Range (m)
Wetted Width:	8.93	5.70 - 16.00
Channel Width:	10.13	7.30 - 14.80
Bank Height:	0.28	0.04 - 1.30
Res. Pool Depth:	0.58	0.37 - 0.79

Water Quality/Quantity

Water Temperature (°C): 16.6
Conductivity (µS/cm): 55.9
pH: 7.98
D. Oxygen (mg/L): 9.35
Discharge (m³/s): 1.70
Flow Regime: Seasonal
Turbidity: Clear

Substrate % (PPC)

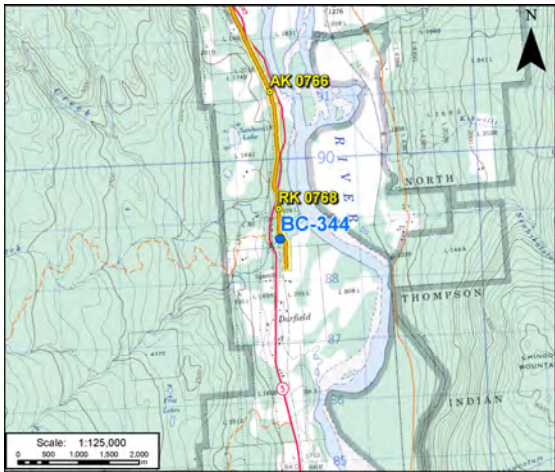
Organics: 0
Fines: 10
Sml Gravel: 10
Lrg Gravel: 15
Sml Cobble: 40
Lrg Cobble: 20
Boulder: 5
Bedrock: 0

Cover

Dominant: Undercut Banks
Subdominant: Deep Pools

Riparian

Type: Shrub
Maturity: Shrub
Crown Closure: 1-20%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - August 15

Least Risk Biological Window Proposed:

July 22 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S2

Navigability:

Potentially
Navigable

Reason for Decision:

Width > 5 m;
Potential Obstacles

Barriers to Fish Movement:

No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
CO	-	34	-	-
RB	-	1	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	M	M	M	M
RB	M	M	M	M

Sampling Effort

Method	Time	Distance	Date
MT	68 hrs	-	31-07-12

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring if flowing⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Open-cut if dry or frozen to bottom

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge or other regulatory approved crossing method

Historical Fish Presence:

CO, RB, LSU

Comments:

Lindquist Creek has moderate habitat potential for salmonids; juvenile CO and RB were captured within the ZOI; good instream complexity with abundant cover provided by undercut banks, pools, overhanging vegetation and woody debris; clean unembedded coarse substrate material was present for spawning; a large wintering pool (0.8 m deep) was observed approximately 200 m downstream, although sections of channel may be dry seasonally; Lindquist Creek is subject to high flows in the spring/summer and armouring may be required.



Trans Mountain Expansion Project

Survey Date: July 31, 2012
Drawn By: T. Waites
Date Issued: February 26, 2013

Approved By: S. Johnston

Lindquist Creek

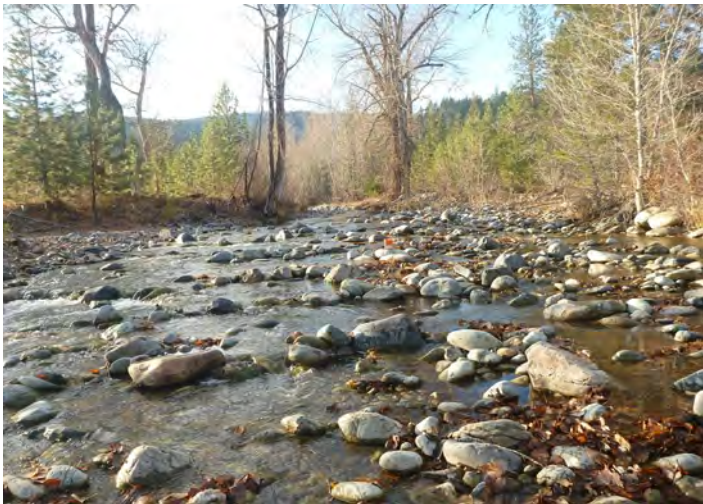
TMEP site: BC-344

UTM Zone: 10 696607 E 5688926 N NAD 83

RK 768.49

Sensitivity





View upstream through centre of the PPC (12-11-13)



View downstream through centre of the PPC (12-11-13)



View of left bank approach at centre of the PPC (12-11-13)



View of right bank approach at centre of the PPC (12-11-13)

Channel Morphology

Pattern: Sinuous
Confinement: Occasionally Confined
Bank Shape LB: Vertical
RB: Sloping
Habitat Unit at PPC: Riffle-Pool
Habitat Unit through ZOI: Riffle-Pool
Gradient (%): 6
Main Stem: North Thompson River (FB),
1.2 km DS

	Mean (m)	Range (m)
Wetted Width:	9.50	7.00 - 14.50
Channel Width:	15.85	12.00 - 25.00
Bank Height:	1.14	0.40 - 1.80
Res. Pool Depth:	0.12	0.05 - 0.20

Water Quality/Quantity

Water Temperature (°C): 3.4
Conductivity (µS/cm): 342.0
pH: 8.28
D. Oxygen (mg/L): 12.75
Discharge (m³/s): 0.32
Flow Regime: Perennial
Turbidity: Clear

Substrate (PPC)

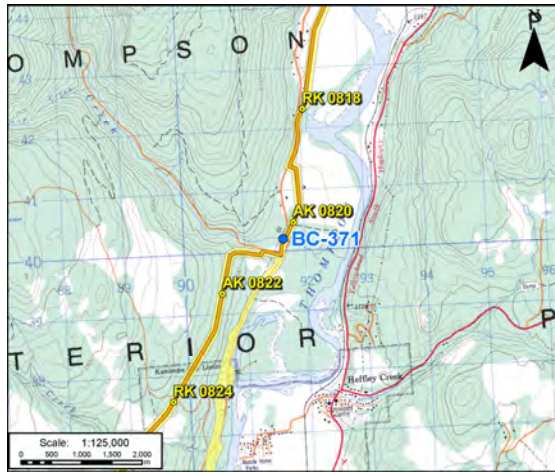
Organics: 5
Fines: 0
Sml Gravel: 5
Lrg Gravel: 15
Sml Cobble: 30
Lrg Cobble: 25
Boulder: 20
Bedrock: 0

Cover

Dominant: Boulders
Subdominant: Deep Pools

Riparian

Type: Mixed
Maturity: Young Forest
Crown Closure: 1-20%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - September 30

Least Risk Biological Window Proposed:

July 22 - September 30

Construction Timing:

Summer/Winter

Stream Classification BC:

S2

Navigability:

Potentially
Navigable

Reason for Decision:

Width >5 m;
Slope >4%

Barriers to Fish Movement:

No

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring
during low flow⁽³⁾

Historical Fish Presence:

BT, CO, RB

Comments:

Jamieson Creek has moderate to high habitat value for salmonids; one juvenile CO captured and numerous spawned-out adult CO observed within the ZOI. High channel complexity with abundant cover provided by frequent pools and instream boulders. Pockets of suitable spawning substrates throughout, although limited in some sections by high percentages of large cobble and boulder material. Perennial flow regime and sufficient depths contribute to moderate overwintering and high migration potential.

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
CO	-	1	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	M-H	H	M	H

Sampling Effort

Method	Time	Distance	Date
MT	12 hrs	-	12-11-13



Trans Mountain Expansion Project

Survey Date: November 12, 2013

Drawn By: T. Jongbloets

Date Issued: November 19, 2013

Approved By: I. Emerson

Jamieson Creek

TMEP site: BC-371

UTM Zone: 10 691547 E 5640420 N NAD 83

AK 820.32

Sensitivity





View downstream through centre of the PPC (30-07-13)



View of right bank approach at centre of the PPC (30-07-13)

Water Quality/Quantity

Crown Closure: 21-40%

Organics:	5
Fines:	40
Sml Gravel:	20
Lrg Gravel:	25
Sml Cobble:	10
Lrg Cobble:	0
Boulder:	0
Bedrock:	0

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	L	L	L	L

Sampling Effort			
Method	Time	Distance	Date
EF	386 s	300 m	30-07-13

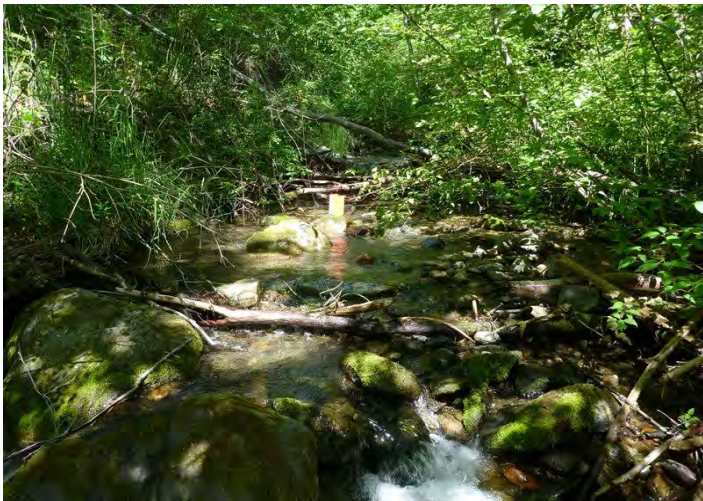


Open-cut if dry or frozen to bottom

Yes

This channel is fed by O'Connor Lake (stocked with RB) via a series of man-made ditches and natural gullies, which may allow fish to enter the channel from the lake. Rearing and overwintering potential are limited by a lack of depth, cover, and deep pools throughout the ZOI. The lack of suitable gravels and high percentage of fines reduces spawning potential. A private irrigation structure 250 m upstream from the PPC directs some of the water from the channel for agricultural use. Water flows as far as Westsyde Road where it is diverted to a pond and there is no further connectivity to the North Thompson River. The pond is aerated and can provide wintering habitat for fish, but a steep gradient 300 m downstream from the PPC prevents fish from moving back upstream. No fish were captured but two landowners have confirmed the presence of RB in the channel, both above and below the gradient barrier.

		Trans Mountain Expansion Project		Unnamed Channel				RK 824.58	
		Survey Date: July 30, 2013 Drawn By: A. Michaud Date Issued: August 16, 2013		Approved By: S. Johnston		TMEP site: BC-374 UTM Zone: 10 689237 E 5637357 N NAD 83			



View upstream through centre of the PPC (31-07-13)



View downstream through centre of the PPC (31-07-13)



View of left bank approach at centre of the PPC (31-07-13)



View of right bank approach at centre of the PPC (31-07-13)

Channel Morphology

Pattern: Irregular
Confinement: Occasionally Confined
Bank Shape LB: Vertical
RB: Undercut
Habitat Unit at PPC: Riffle-Pool
Habitat Unit through ZOI: Riffle-Pool
Gradient (%): 8
Main Stem: Lanes Creek

	Mean (m)	Range (m)
Wetted Width:	2.70	0.54 - 5.80
Channel Width:	6.30	4.50 - 12.20
Bank Height:	0.72	0.44 - 1.20
Res. Pool Depth:	0.17	0.12 - 0.22

Water Quality/Quantity

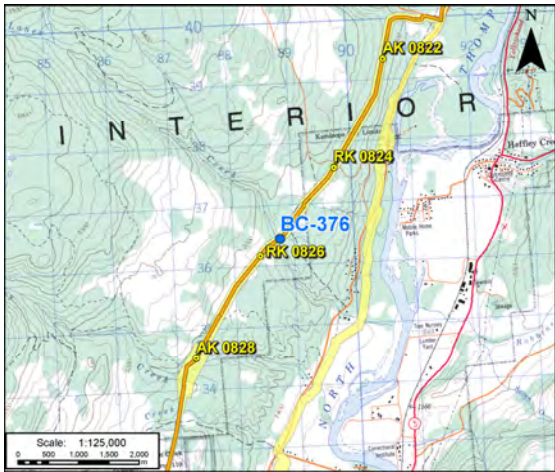
Water Temperature (°C): 14.3
Conductivity (µS/cm): 879.0
pH: 8.43
D. Oxygen (mg/L): 10.49
Discharge (m³/s): 0.10
Flow Regime: Perennial
Turbidity: Clear

Substrate (PPC)

Organics: 0
Fines: 5
Sml Gravel: 10
Lrg Gravel: 25
Sml Cobble: 25
Lrg Cobble: 20
Boulder: 15
Bedrock: 0

Cover

Dominant: SWD
Subdominant: OHV
Riparian
Type: Deciduous
Maturity: Mature Forest
Crown Closure: 41-70%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - September 30

Least Risk Biological Window Proposed:

July 22 - September 30

Construction Timing:

Summer/Winter

Stream Classification BC:

S2

Navigability:

Potentially
Navigable

Reason for Decision:

Width > 5 m;
Slope > 4%

Barriers to Fish Movement:

Yes

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	-	7	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	L	M-H	M	L

Sampling Effort

Method	Time	Distance	Date
MT	139 hrs	-	31-07-13

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

Historical Fish Presence:

RB

Comments:

Lanes Creek has moderate potential for RB; fish likely out-migrate from O'Connor Lake (~5 km upstream); upstream migration restricted by 12 m bedrock falls approximately 285 m downstream from the PPC; good rearing habitat is attributed to moderate channel complexity and abundant cover provided by SWD, OHV and boulders; lake-fed channel with moderate wintering potential, although wintering may be limited overall by discharge and a lack of pools > 0.5 m in depth; small pockets of gravel were present but spawning is limited by an abundance of cobble and boulder material.

		Trans Mountain Expansion Project				Lanes Creek				AK 825.49	
		Survey Date: July 31, 2013		Approved By: S. Johnston		TMEP site: BC-376				Sensitivity	
		Drawn By: A. Michaud				UTM Zone: 10 688681 E 5636660 N NAD 83					
Date Issued: August 16, 2013											



View upstream through centre of the PPC (13-08-13)



View downstream through centre of the PPC (13-08-13)



View of left bank approach at centre of the PPC (13-08-13)



View of right bank approach at centre of the PPC (13-08-13)

Channel Morphology

Pattern: Irregular
Confinement: Occasionally Confined
Bank Shape LB: Sloped
RB: Vertical
Habitat Unit at PPC: Riffle-Pool
Habitat Unit through ZOI: Riffle-Pool
Gradient (%): 8
Main Stem: North Thompson River, FB,
>2.5 km DS

	Mean (m)	Range (m)
Wetted Width:	1.51	1.36 - 2.09
Channel Width:	2.60	1.84 - 3.90
Bank Height:	0.47	0.13 - 1.15
Res. Pool Depth:	0.14	0.05 - 0.37

Water Quality/Quantity

Water Temperature (°C): 16.0
Conductivity (µS/cm): 937.0
pH: 8.80
D. Oxygen (mg/L): 8.59
Discharge (m³/s): 0.01
Flow Regime: Perennial
Turbidity: Clear

Substrate (PPC)

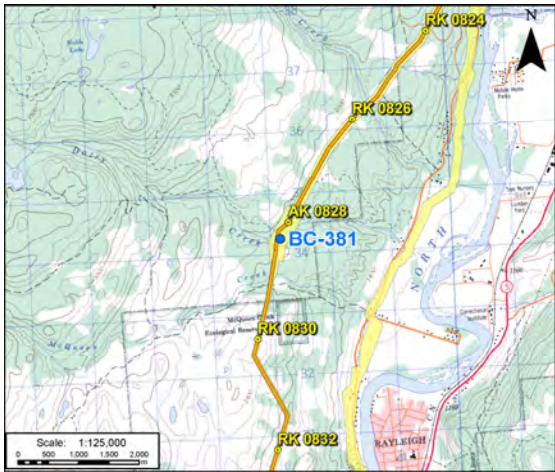
Organics: 0
Fines: 10
Sml Gravel: 20
Lrg Gravel: 15
Sml Cobble: 25
Lrg Cobble: 25
Boulder: 5
Bedrock: 0

Cover

Dominant: OHV
Subdominant: SWD

Riparian

Type: Grass/Deciduous
Maturity: Initial/Mature
Crown Closure: 70-90%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - September 30

Least Risk Biological Window Proposed:

July 22 - September 30

Construction Timing:

Summer/Winter

Stream Classification BC:

S3

Navigability:

Non-Navigable
Class 2

Reason for Decision:

Width 1.2 - 3 m;
Slope > 4%

Barriers to Fish Movement:

No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	-	4	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	M	M-H	L	M

Sampling Effort

Method	Time	Distance	Date
MT	88 hrs	-	14-08-13

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

Historical Fish Presence:

RB

Comments:

Small fish-bearing watercourse with moderate to high rearing habitat value for juvenile RB, attributed to good channel complexity and abundant cover (overhanging vegetation, woody debris and small pools); 4 juvenile RB were captured within ZOI; abundant small pools observed, but the overall overwintering potential is limited by channel size, depth and discharge; moderate spawning potential is attributed to pockets of gravel throughout, but limited by a high percentage of cobble substrate; the stream banks are composed of riprap where an existing fiber optic line crosses the channel.

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge

		Trans Mountain Expansion Project				Dairy Creek				AK 828.35			
		Survey Date: August 23, 2013		Approved By: S. Johnston		TMEP site: BC-381				Sensitivity 			
		Drawn By: A. Michaud		Date Issued: August 23, 2013		UTM Zone: 10 687063 E 5634473 N NAD 83							



View upstream through centre of the PPC (20-08-13)



View downstream through centre of the PPC (20-08-13)



View of left bank approach at centre of the PPC (20-08-13)



View of right bank approach at centre of the PPC (20-08-13)

Channel Morphology

Pattern: Sinuous
Confinement: Occasionally Confined
Bank Shape LB: Sloping
RB: Vertical
Habitat Unit at PPC: Run
Habitat Unit through ZOI: Run
Gradient (%): 0.5
Main Stem: Thompson River

	Mean (m)	Range (m)
Wetted Width:	407.00	286.00 - 537.00
Channel Width:	555.00	540.00 - 604.00
Bank Height:	2.29	1.00 - 2.50
Res. Pool Depth:	-	-

Water Quality/Quantity

Water Temperature (°C): 17.4
Conductivity (µS/cm): 115.0
pH: 7.54
D. Oxygen (mg/L): 9.29
Discharge (m³/s): 745.50
Flow Regime: Perennial
Turbidity: Moderate

Substrate (PPC)

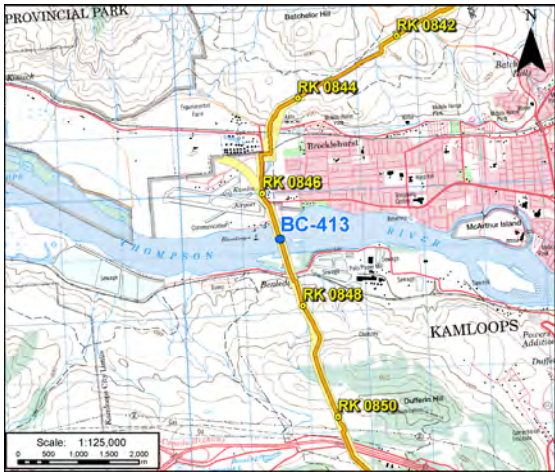
Organics: 0
Fines: 95
Sml Gravel: 5
Lrg Gravel: 0
Sml Cobble: 0
Lrg Cobble: 0
Boulder: 0
Bedrock: 0

Cover

Dominant: Deep Pools
Subdominant: Boulders

Riparian

Type: None/Shrub
Maturity: Initial/Shrub
Crown Closure: 0%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - August 15

Least Risk Biological Window Proposed:

July 22 - August 15

Construction Timing:

Summer/Winter

Stream Classification BC:

S1A

Navigability:

Navigable

Reason for Decision:

Width > 5 m

Barriers to Fish Movement:

No

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
-	-	-	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
CO	L	M	H	H
CH	L	M	H	H
BT	L	M	H	H
RB	L	M	H	H

Sampling Effort

Method	Time	Distance	Date
(none)	-	-	20-08-13

Recommended Primary Pipeline Crossing Method:

Trenchless with water quality monitoring

Recommended Vehicle Crossing Method (Non-Frozen):

Access both banks

Recommended Contingency Pipeline Crossing Method:

Open-cut with water quality monitoring inside timing window⁽⁴⁾

Recommended Vehicle Crossing Method (Dry/Frozen):

Access both banks

Historical Fish Presence:

BB, BT, CC, CH, CO, CSU, KO, L, LNC, LT, MW, NSC, PK, RB, RSC, SK, ST, SU and WSG

Comments:

The Thompson River supports indicator and anadromous salmon species (BT, RB, CO, CH, PK, SK); it provides high wintering habitat potential attributed to perennial flow, depth and low velocity; spawning habitat potential is low, limited by a lack of suitable spawning gravels; rearing habitat is moderate, attributed to channel depth, but limited by a lack of channel complexity and limited cover; the Thompson River is an essential migration corridor for spawning salmon.

		Trans Mountain Expansion Project				Thompson River				RK 846.82			
		Survey Date: August 20, 2013		Drawn By: A. Michaud		Approved By: S. Johnston		TMEP site: BC-413				Sensitivity	
		Date Issued: August 27, 2013						UTM Zone: 10 681618 E 5619240 N NAD 83					



Channel Morphology

Pattern: -
 Confinement: Unconfined
 Bank Shape LB: -
 RB: -
 Habitat Unit at PPC: Pool
 Habitat Unit through ZOI: Pool
 Gradient (%): 2
 Main Stem: Thompson River, FB, 250 m DS

	Mean (m)	Range (m)
Wetted Width:	-	-
Channel Width:	-	-
Bank Height:	-	-
Res. Pool Depth:	-	-

Water Quality/Quantity

Water Temperature (°C):	12.3	D. Oxygen (mg/L):	0.90
Conductivity (µS/cm):	130.4	Discharge (m³/s):	-
pH:	7.12	Flow Regime:	Seasonal
		Turbidity:	Moderate

Substrate (PPC)

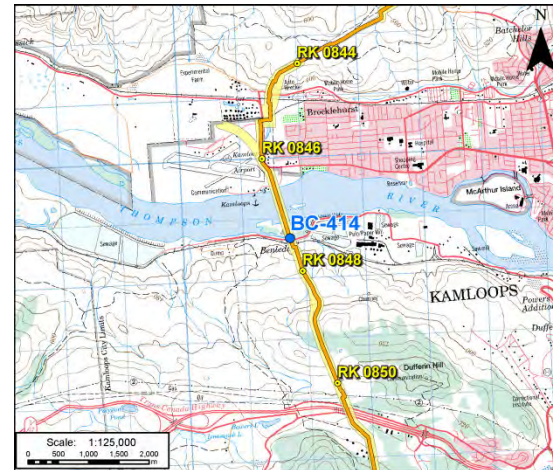
Organics:	100
Fines:	0
Sml Gravel:	0
Lrg Gravel:	0
Sml Cobble:	0
Lrg Cobble:	0
Boulder:	0
Bedrock:	0

Cover

Dominant: ISV
Subdominant: Deep Pools

Riparian

Type: Deciduous
Maturity: Pole Sapling
Crown Closure: 21-40%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

Open

Least Risk Biological Window Proposed:

Open

Construction Timing:

Summer/Winter

Stream Classification BC: NCD-W

Navigability: -

Reason for Decision: See Wetland Evaluation Report Vol. 5C

Barriers to Fish Movement: Yes

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
NSC	-	1	-	-
RSC	-	-	12	-
PCC	-	11	7	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
All	L	L	L	L

Sampling Effort

Method	Time	Distance	Date
EF	214 s	100 m	22-05-13
MT	20 hrs	-	22-05-13

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage if water present

Recommended Contingency Pipeline Crossing Method:

Open-cut if dry or frozen to bottom

Historical Fish Presence:

No Previously Documented Fish Presence

Comments:

Seasonal ponded area within North Thompson River floodplain; flooded at time of survey but likely dry for much of the year; area has direct connectivity to the river when flooded and NSC, RSC, and PCC were captured in minnow traps; low DO levels likely preclude use of this habitat by salmonids; rearing, overwintering and migration limited by lack of flow, seasonal dry periods, and poor water quality; spawning is limited by 100% organic substrate; winter construction recommended; fish salvage with potential beaver dam removal. Swamp Mats may be required.

		Trans Mountain Expansion Project		Unnamed Drainage (Wetland)			RK 847.40		
		Survey Date: May 22, 2013		Approved By: S. Johnston		TMEP site: BC-414			
		Drawn By: C. Hartling							
		Date Issued: June 13, 2013							
							Sensitivity		
									



View upstream through centre of the PPC (20-08-14)



View downstream through centre of the PPC (20-08-14)



View of left bank approach at centre of the PPC (20-08-14)



View of right bank approach at centre of the PPC (20-08-14)

Channel Morphology

Pattern: Sinuous
Confinement: Occasionally Confined
Bank Shape LB: Vertical
RB: Vertical
Habitat Unit at PPC: Run-Riffle
Habitat Unit through ZOI: Run
Gradient (%): 5
Main Stem: Jacko Lake, FB, 950 m DS

	Mean (m)	Range (m)
Wetted Width:	1.17	0.80 - 1.90
Channel Width:	1.67	0.80 - 2.30
Bank Height:	0.50	0.30 - 0.70
Res. Pool Depth:	0.05	0.01 - 0.10

Water Quality/Quantity

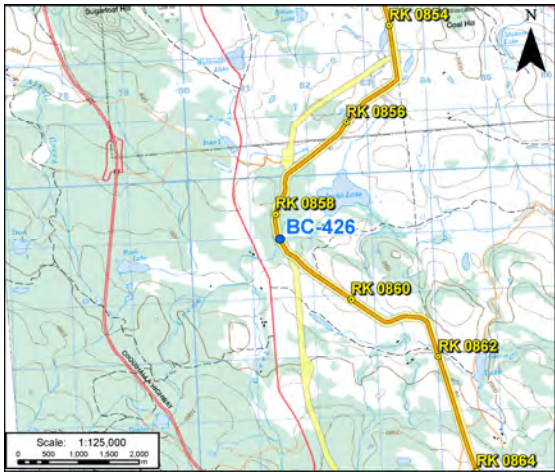
Water Temperature (°C): 13.5
Conductivity (µS/cm): 590.0
pH: 8.33
D. Oxygen (mg/L): 9.31
Discharge (m³/s): -
Flow Regime: Seasonal
Turbidity: Lightly Turbid

Substrate (PPC)

Organics: 25
Fines: 70
Sml Gravel: 5
Lrg Gravel: 0
Sml Cobble: 0
Lrg Cobble: 0
Boulder: 0
Bedrock: 0

Cover

Dominant: OHV
Subdominant: LWD
Riparian
Type: Deciduous
Maturity: Young Forest
Crown Closure: 1-20%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - October 31

Least Risk Biological Window Proposed:

July 22 - October 31

Construction Timing:

Summer/Winter

Stream Classification BC:

S3

Navigability:

Non-Navigable
Class 2

Reason for Decision:

Width 1.2 - 3 m;
Natural Barriers

Barriers to Fish Movement:

Yes

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	-	1	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	L	M	L	M

Sampling Effort

Method	Time	Distance	Date
EF	350 s	300 m	20-08-14
- (dry)	-	-	19-10-13
- (dry)	-	-	22-08-13

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring if flowing⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Open-cut if dry or frozen to bottom

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge or other regulatory approved crossing method

Historical Fish Presence:

RB (fish records are from Jacko Lake, located downstream from the LSA)

Comments:

Peterson Creek has low to moderate habitat potential for RB, attributed to a seasonal flow regime, low wintering potential, limited substrate for spawning (predominately fines) and multiple beaver dams in the LSA; one juvenile RB was captured approximately 100 m downstream from the PPC in 2014 (high flow year); watercourse was previously observed to be dry in 2013 (August and October); conduct fish salvage and manage for water quality/quantity if flowing during construction.

		Trans Mountain Expansion Project				Peterson Creek				RK 858.43	
		Survey Date: August 20, 2014		Approved By: I. Emerson		TMEP site: BC-426				Sensitivity 	
		Drawn By: H. Dussault		Date Issued: August 25, 2014		UTM Zone: 10 681479 E 5608990 N NAD 83					



View upslope through centre of the PPC (09-04-13)



View downslope through centre of the PPC (09-04-13)



View of N approach at centre of the PPC (09-04-13)



View of S approach at centre of the PPC (09-04-13)

Channel Morphology

Pattern: -
Confinement: Unconfined
Bank Shape LB: -
RB: -
Habitat Unit at PPC: Pool
Habitat Unit through ZOI: Pool
Gradient (%): 3
Main Stem: Hull Lake, FB, 2.1 km DS

	Mean (m)	Range (m)
Wetted Width:	-	-
Channel Width:	-	-
Bank Height:	-	-
Res. Pool Depth:	-	-

Water Quality/Quantity

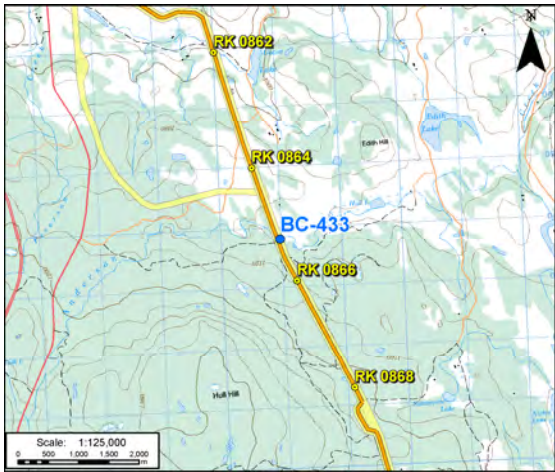
Water Temperature (°C): 1.9
Conductivity (µS/cm): 370.6
pH: 8.03
D. Oxygen (mg/L): 10.88
Discharge (m³/s): -
Flow Regime: Perennial
Turbidity: Moderate

Substrate % (PPC)

Organics: 25
Fines: 70
Sml Gravel: 5
Lrg Gravel: 0
Sml Cobble: 0
Lrg Cobble: 0
Boulder: 0
Bedrock: 0

Cover

Dominant: ISV
Subdominant: SWD
Riparian
Type: Coniferous
Maturity: Mature Forest
Crown Closure: 21-40%



Source: NRC, Centre for Topographical Information. 2013 (1:125,000)

Provincial Window of Least Risk:

July 22 - August 15

Least Risk Biological Window Proposed:

July 22 - October 31

Construction Timing:

Summer/Winter

Stream Classification BC:

NCD-W

Navigability:

-

Reason for Decision:

See Wetland
Evaluation Report
Vol. 5C

Barriers to Fish Movement:

Yes

Fish Presence and Life History Stage

Species	YOY	Juv	Adult	Unknown
RB	-	1	-	-

Fish Habitat Potential

Species	Spawning	Rearing	Wintering	Migration
RB	L	M-H	M	L

Sampling Effort

Method	Time	Distance	Date
MT	135 hrs	-	09-04-13

Recommended Primary Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring⁽¹⁾

Recommended Contingency Pipeline Crossing Method:

Isolation with fish salvage and water quality monitoring during low flow⁽³⁾

Historical Fish Presence:

RB

Comments:

At the PPC, Anderson Creek is a large beaver dam complex which provides moderate habitat value for RB; juvenile RB were captured within the ZOI; moderate pool depths and good instream cover provide suitable habitat for wintering and rearing; beaver dams may act as seasonal barriers to fish migration; little to no potential for spawning given predominance of organics and fines; seasonal flooding is evident near the existing TMPL ROW; beaver dam removal may be required at time of construction; Anderson Creek has a provincial timing window (lower reaches), although the least risk biological timing window proposed considers RB only at the PPC.

Recommended Vehicle Crossing Method (Non-Frozen):

Clear-Span Bridge

Recommended Vehicle Crossing Method (Dry/Frozen):

Clear-Span Bridge or other regulatory approved crossing method

		Trans Mountain Expansion Project				Anderson Creek				RK 865.25	
		Survey Date: April 9, 2013		Approved By: I. Emerson		TMEP site: BC-433				Sensitivity	
		Drawn By: H. Dussault				UTM Zone: 10 684973 E 5603816 N NAD 83					
Date Issued: April 16, 2013											