GEO | MORPHIX

pid Stream Assessment Technique **Project Code:** PN16 107

Date:	May 16, 2017	**Stream/Reach:**	J15
Weather:	cloudy	**Location:**	New Sudbury
Field Staff:	AW, AY, SC	**Watershed/Subwatershed:**	Junction Creek

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11
Channel Scouring/ Sediment Deposition	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☐ 8

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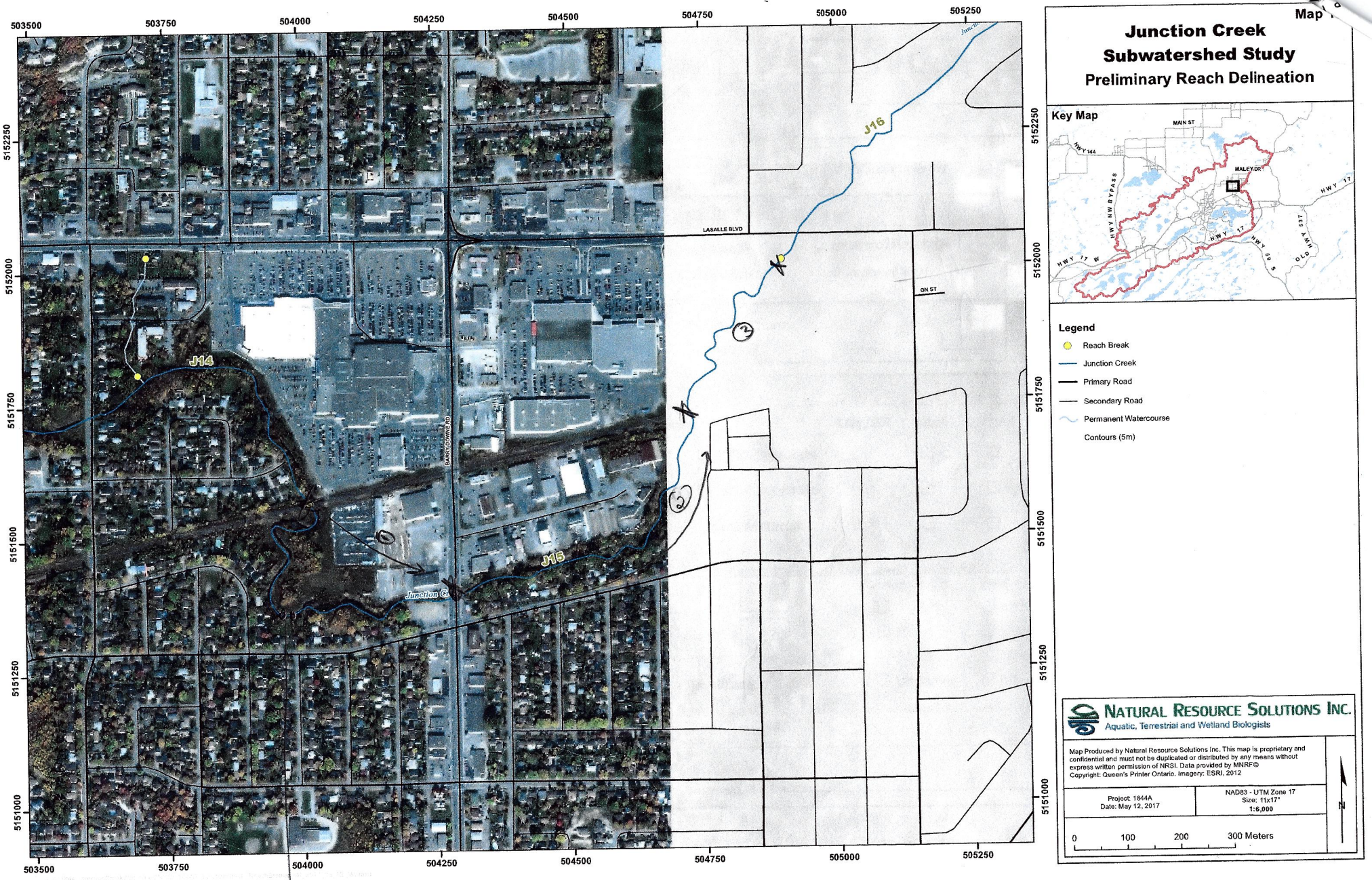
Date:	May 16, 2017	Reach:	JC15	Project Code:	PN16107

Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☒ 5 ☐ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☒ 3 ☐ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☒ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 19	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: _____ Checked by: CN

J15



fill & small stream
w/ iron colour & gas (pics) → little connected streams

Shopping carts: ~~HH~~

GEO MORPHIX Geomorphology Earth Science Observations

*area of deposition was 14.3m

Reach Characteristics

Project Code/Phase: PN16107

Date:	May 16, 2017	**Stream/Reach:**	J16
Weather:	Sunny	**Location:**	New Sudbury
Field staff:	AV, AW, SC	**Watershed/Subwatershed:**	Junction Creek
UTM (Upstream)		**UTM (Downstream)**	

Land Use (Table 1): 7,9 | **Valley Type** (Table 2): 1 | **Channel Type** (Table 3): 7 | **Channel Zone** (Table 4): 2 | **Flow Type** (Table 5): 1 | ☑ Groundwater | Evidence: iron staining

Riparian Vegetation

Dominant Type: (Table 6): 1, 2
Species: _____

Coverage:
- ☐ None
- ☒ Fragmented
- ☐ Continuous

Channel widths
- ☐ 1-4
- ☒ 4-10
- ☐ > 10

Age Class (yrs):
- ☐ Immature (<5)
- ☐ Established (5-30)
- ☒ Mature (>30)

Encroachment: (Table 7)

Aquatic/Instream Vegetation

Type (Table8): 6 | Coverage of Reach (%): 5

Woody Debris
- ☑ Present in Cutbank
- ☑ Present in Channel
- ☐ Not Present

Density of WD:
- ☐ Low
- ☐ Moderate
- ☑ High

WDJ/50m: 1

Water Quality

Odour (Table 16): 1

Turbidity (Table 17): 4, 5 (orange)

Channel Characteristics

Sinuosity (Type) (Table 9): 1
Sinuosity (Degree) (Table 10): 1
Gradient (Table 11): 1
Number of Channels (Table 12): 1
Entrenchment (Table 13): 2
Type of Bank Failure (Table 14): 1/2
Downs's Classification (Table 15): E

	Clay/Silt	Sand	Gravel	Cobble	Boulder	Parent	Rootlets
Riffle Substrate	☐	☐	☑	☐	☐	☐	☐
Pool Substrate	☑	☑	☑	☐	☐	☐	☐
Bank Material	☑	☐	☐	☐	☐	☐	☐

Bankfull Width (m)	5.6	7.5	4.05	**Wetted Width (m)**	4.2	6	3.07
Bankfull Depth (m)	1.18	0.3*	1	**Wetted Depth (m)**	0.55	0.7	0.4

Riffle/Pool Spacing (m): NA | **% Riffles:** <5 | **% Pools:** 60 | **Meander Amplitude:** Not able to measure

Pool Depth (m) @ BF: >1.2 | **Riffle Length (m):** N10 | **Undercuts (m):** 0.3 | **Comments:** 1 riffle

Velocity (m/s): 0.11 | 0.0 | 0.31 | **Wiffle ball / ADV / Estimated**

Bank Angle
- ☐ 0 – 30
- ☐ 30 – 60
- ☑ 60 – 90
- ☐ Undercut

Bank Erosion
- ☐ < 5%
- ☐ 5 – 30%
- ☑ 30 – 60%
- ☐ 60 – 100%

Notes:
lots of roots (little)
beaver dam + leaves area near dam (both sides of trail)
A lot of understory.
very still water due to WDJ, within it - possible mid-bar
large vegetated island between channels (maybe)
lots of overhanging trees, and canopy cover

*0.3 above water for 2nd bankfull depth

pretty much 0

2nd wetted depth taken beside the house/bank, beside a culvert & 2 pipes that connect to homes.

→ Bank angle is about 90°

→ couldn't tell if bank was undercut or eroded in some sections due to deep/dark water

a lot of exposed roots, undercutting

Completed by: _____ Checked by: _____

Note: on opposite side of the road, past the second creek, water gets more shallow → can now see point bars on meanders and more evidence of erosion.

more debris (woody) upstream as well

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Geomorphology Earth Science Observations

General Site Characteristics

Project Code: PN16107

Date:	May 16, 2017	**Stream/Reach:**	J16
Weather:	Sunny	**Location:**	
Field Staff:	AV/SC/AW	**Watershed/Subwatershed:**	Junction creek

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

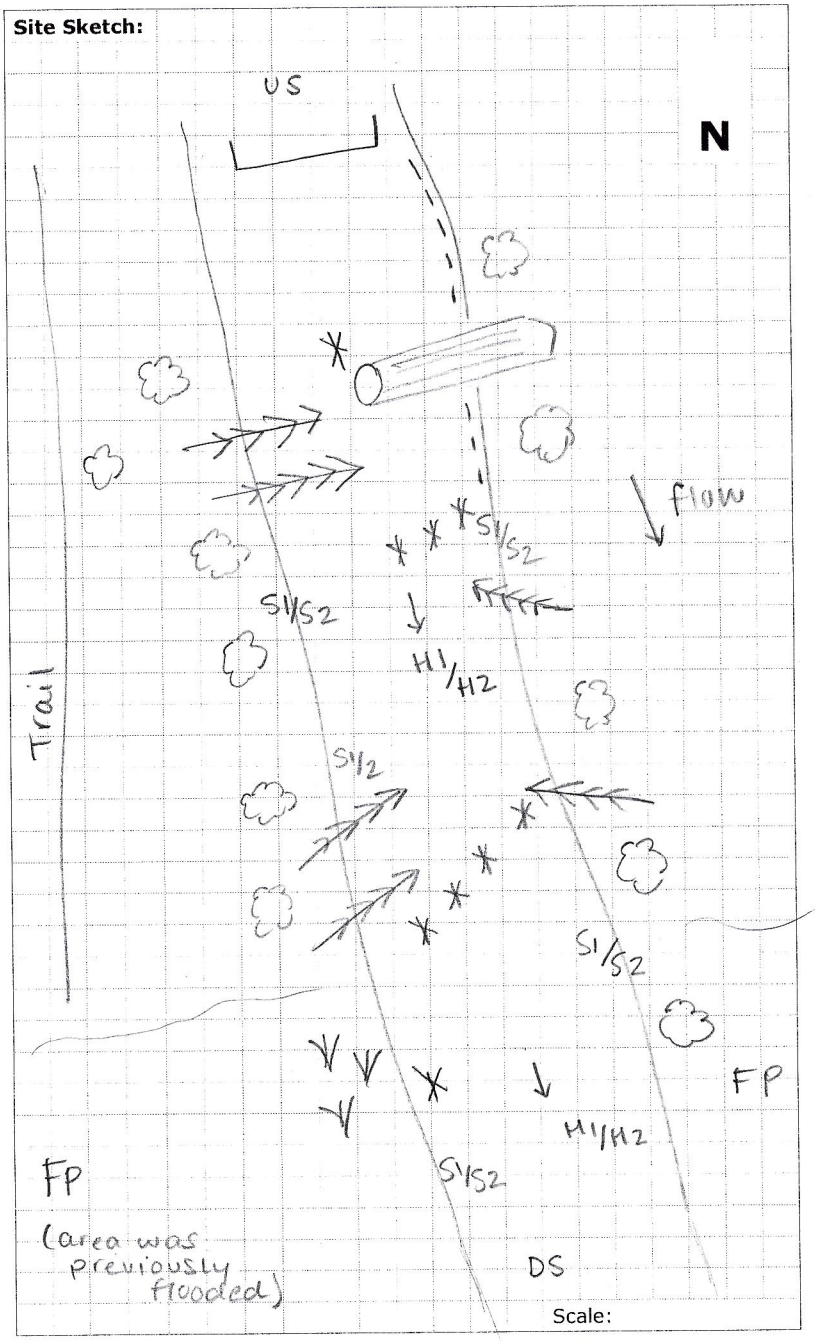
Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:



Additional Notes:

Completed by: AV Checked by: _____

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Rapid Geomorphic Assessment

Project Code: PN16107

Date:	May 16, 2017	**Stream/Reach:**	TJ16
Weather:	Sunny	**Location:**	New Sudbury
Field Staff:	AW, AW, SC	**Watershed/Subwatershed:**	JC

Process	No.	Geomorphic Indicator	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		✓	1/7
	2	Coarse materials in riffles embedded		✓	
	3	Siltation in pools		✓	
	4	Medial bars		✓	
	5	Accretion on point bars		✓	
	6	Poor longitudinal sorting of bed materials		✓	
	7	Deposition in the overbank zone	✓		
		Sum of indices =	1	6	0.14
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		✓	1/8
	2	Exposed sanitary / storm sewer / pipeline / etc.		✓	
	3	Elevated storm sewer outfall(s)	NA		
	4	Undermined gabion baskets / concrete aprons / etc.		✓	
	5	Scour pools downstream of culverts / storm sewer outlets		✓	
	6	Cut face on bar forms		✓	
	7	Head cutting due to knick point migration		✓	
	8	Terrace cut through older bar material		✓	
	9	Suspended armour layer visible in bank		✓	
	10	Channel worn into undisturbed overburden / bedrock	✓		
		Sum of indices =	1	8	0.13
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	✓		5/9
	2	Occurrence of large organic debris	✓		
	3	Exposed tree roots	✓		
	4	Basal scour on inside meander bends		✓	
	5	Basal scour on both sides of channel through riffle	✓		
	6	Outflanked gabion baskets / concrete walls / etc.		✓	
	7	Length of basal scour >50% through subject reach	✓		
	8	Exposed length of previously buried pipe / cable / etc.		✓	
	9	Fracture lines along top of bank		✓	
	10	Exposed building foundation	NA		
		Sum of indices =	5	4	0.56
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		✓	0/7
	2	Single thread channel to multiple channel		✓	
	3	Evolution of pool-riffle form to low bed relief form		✓	
	4	Cut-off channel(s)		✓	
	5	Formation of island(s)		✓	
	6	Thalweg alignment out of phase with meander form		✓	
	7	Bar forms poorly formed / reworked / removed		✓	
		Sum of indices =	0	7	0.0

Additional notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 = 0.21

Condition	In Regime	In Transition/Stress	In Adjustment
SI score =	☐ 0.00 - 0.20	☒ 0.21 - 0.40	☐ 0.41

Completed by: _____ Checked by: _____

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Rapid Stream Assessment Technique

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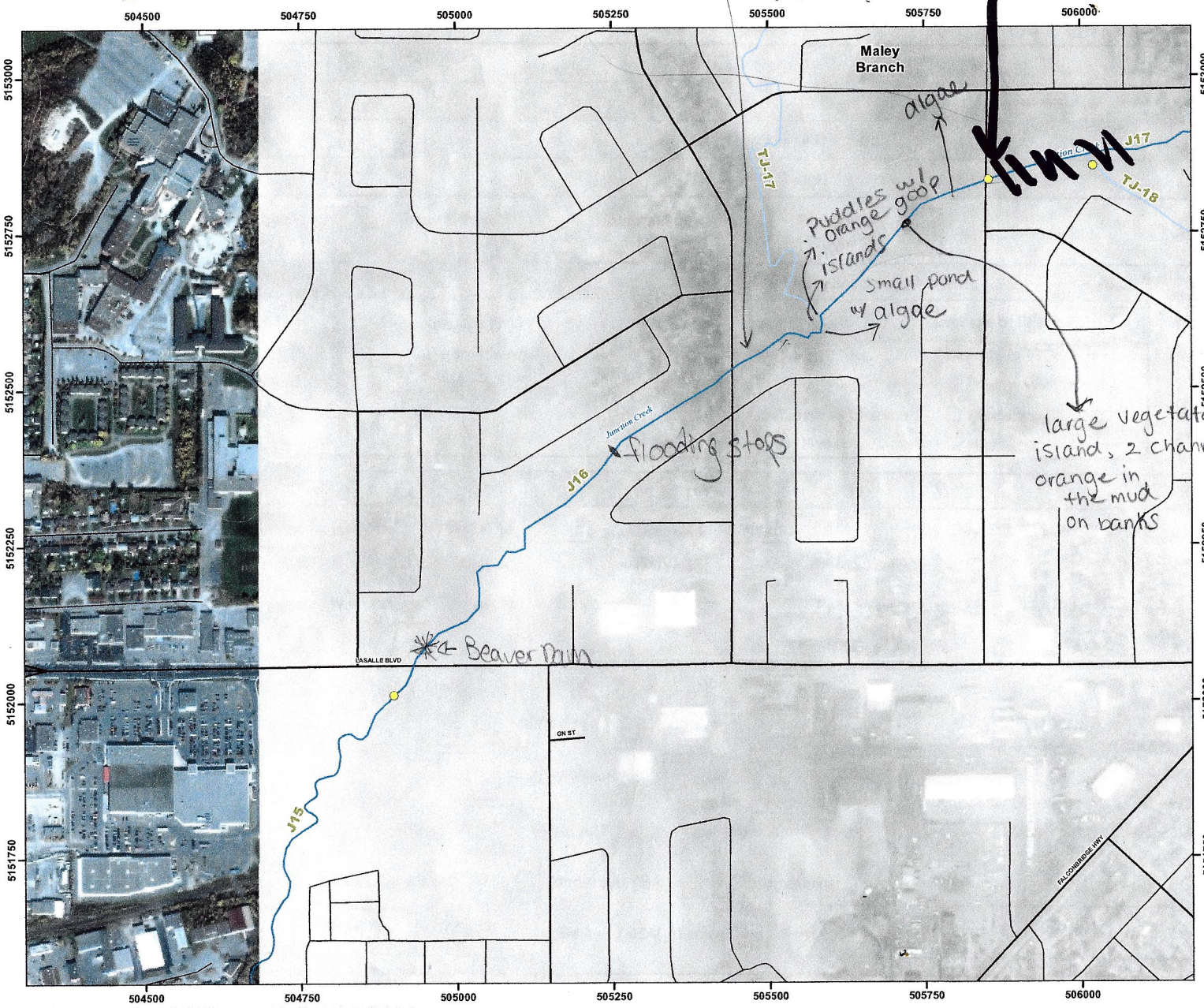
Point range	☐ 0 ☐ 1	☐ 2 ☐ 3	☐ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 23.5	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: _____ Checked by: _____

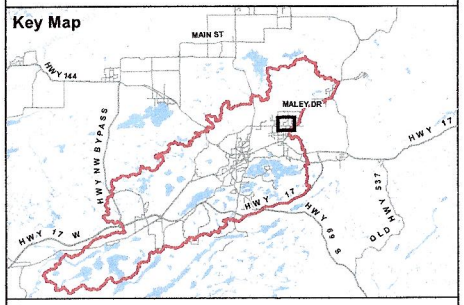


Map 14

Junction Creek Subwatershed Study

Preliminary Reach Delineation

Key Map



Legend

- Reach Break
- Junction Creek
- Primary Road
- Secondary Road
- Permanent Watercourse
- Contours (5m)

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Project: 1844A Date: May 12, 2017	NAD83 - UTM Zone 17 Size: 11x17" 1:6,000

0 100 200 300 Meters

N

GEO | MORPHIX
Geomorphology Earth Science Observations

Reach Characteristics

Project Code/Phase: PN16107

Date:	May 17, 2017	**Stream/Reach:**	TJ17
Weather:	25°C, hot, sunny	**Location:**	New Sudbury - Lansing
Field staff:	AW, AV, SC	**Watershed/Subwatershed:**	Junction Creek
UTM (Upstream)		**UTM (Downstream)**	

Land Use (Table 1): 1, 5, 7 | **Valley Type** (Table 2): 1 | **Channel Type** (Table 3): 8 | **Channel Zone** (Table 4): 2 | **Flow Type** (Table 5): 1 | ☒ Groundwater | Evidence: iron staining

Riparian Vegetation

Dominant Type: (Table 6): 3, 1
Species: _____

Coverage:
- ☐ None
- ☒ Fragmented
- ☐ Continuous

Channel widths
- ☐ 1-4
- ☒ 4-10
- ☐ > 10

Age Class (yrs):
- ☐ Immature (<5)
- ☐ Established (5-30)
- ☒ Mature (>30)

Encroachment: (Table 7): 2

Aquatic/Instream Vegetation

Type (Table8): ☒ | **Coverage of Reach (%):** ☒

Woody Debris
- ☒ Present in Cutbank
- ☒ Present in Channel
- ☐ Not Present

Density of WD:
- ☐ Low
- ☒ Moderate
- ☐ High

WDJ/50m: 0

Water Quality

Odour (Table 16): 1

Turbidity (Table 17): 2

Channel Characteristics

Sinuosity (Type) (Table 9): 2
Sinuosity (Degree) (Table 10): 2
Gradient (Table 11): 2
Number of Channels (Table 12): 1
Entrenchment (Table 13): 2
Type of Bank Failure (Table 14): 5 + 6
Downs's Classification (Table 15): E

	Clay/Silt	Sand	Gravel	Cobble	Boulder	Parent	Rootlets
~~Riffle Substrate~~ Pure?	☐	☐	☐	☐	☐	☐	☐
Pool Substrate	☒	☐	☐	☒	☒	☒	☐
Bank Material	☒	☐	☐	☐	☐	☒	☐

Bankfull Width (m)	9.3	5.0	7.3	**Wetted Width (m)**	6.9	4.0	3.7
Bankfull Depth (m)	1.2	1.45	1.2	**Wetted Depth (m)**	0.6	0.85	0.2

Riffle/~~Pool~~ Spacing (m): NA | **% Riffles:** 0 | **% Pools:** 100 | **~~Meander Amplitude~~:**
~~Pool Depth~~ (m): NA | **~~Riffle Length~~ (m):** | **Undercuts (m):** few + couldn't get to
Velocity (m/s): 0.22 | 0.57 | 1.09 | **Wiffle ball / ADV / Estimated**

Bank Angle
- ☐ 0 – 30
- ☐ 30 – 60
- ☒ 60 – 90
- ☐ Undercut

Bank Erosion
- ☐ < 5%
- ☐ 5 – 30%
- ☐ 30 – 60%
- ☒ 60 – 100%

b few, maybe 1cm total

Comments: Couldn't measure pool depth because too soft + deep

Notes: till deposits + grassy hor gang into creek really deep + orange, log jam, little bit of undercut, mostly erosion

Clay banks in parts + silt, cobble + boulders in thinner layer, small water fall + riffle, major debris chart, onto banks + huge blow (possible old dam), bright orange H2O from pipe, island that split side (erosion), till dep + Before culvert → more slumping + silt w/less boulders/cobble but embedded more. created because of partial jam (till, cobble + wood), huge trees cut by beavers →

Completed by: AW | Checked by: CH

Floodplain partially confined.

Bridge footings above creek → this area very eroded into clay banks

Slight odour by plastic culvert/storm sewer

not riffles & pools but good flow

undercutting near the hydro lines & slumping banks & water orange.

couple of big islands past ↗

about 50m upstream of Maley Dr. Water's very orange

very deep, overhanging vegetation & narrow near the end (Maley)

gravel & small rocks at Maley → some from eroded trail but most upstream

One slab failure + one rotational slip (pics)

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General Site Characteristics

Project Code: PN 16 107

Date:	May 17 2017	**Stream/Reach:**	TJ 17
Weather:	Sunny,	**Location:**	New Sudbury
Field Staff:	AW, SE, AV	**Watershed/Subwatershed:**	Junction Creek

Features

- Reach break
- Cross-section
- Flow direction
- Riffle
- Pool
- Medial bar
- Eroded bank
- Undercut bank
- Rip rap/stabilization/gabion
- Leaning tree
- Fence
- Culvert/outfall
- Swamp/wetland
- Grasses
- Tree
- Instream log/tree
- Woody debris
- Station location
- Vegetated island

Flow Type

H1	Standing water
H2	Scarcely perceptible flow
H3	Smooth surface flow
H4	Upwelling
H5	Rippled
H6	Unbroken standing wave
H7	Broken standing wave
H8	Chute
H9	Free fall

Substrate

S1	Silt	**S6**	Small boulder
S2	Sand	**S7**	Large boulder
S3	Gravel	**S8**	Bimodal
S4	Small cobble	**S9**	Bedrock/till
S5	Large cobble		

Other

BM	Benchmark	**EP**	Erosion pin
BS	Backsight	**RB**	Rebar
DS	Downstream	**US**	Upstream
WDJ	Woody debris jam	**TR**	Terrace
VWC	Valley wall contact	**FC**	Flood chute
BOS	Bottom of slope	**FP**	Flood plain
TOS	Top of slope	**KP**	Knick point

Site Sketch:

Additional Notes:

Silt/Till with lots of org. debris & woody

Completed by: AW Checked by: CH

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Rapid Geomorphic Assessment

Project Code: PN16107

Date:	May 17, 2017	**Stream/Reach:**	TJ17
Weather:	25°C	**Location:**	New Sudbury
Field Staff:	AW, AV, SC	**Watershed/Subwatershed:**	Junction Creek

Process	No.	Geomorphic Indicator Description	Present? Yes	Present? No	Factor Value
Evidence of Aggradation (AI)	1	Lobate bar		X	2/7
	2	Coarse materials in riffles embedded		X	
	3	Siltation in pools		X	
	4	Medial bars		X	
	5	Accretion on point bars		X	
	6	Poor longitudinal sorting of bed materials	X		
	7	Deposition in the overbank zone	X		
		Sum of indices =	2	5	0.29
Evidence of Degradation (DI)	1	Exposed bridge footing(s)		X	1/8
	2	Exposed sanitary / storm sewer / pipeline / etc.		X	
	3	Elevated storm sewer outfall(s)	NA		
	4	Undermined gabion baskets / concrete aprons / etc.	NA		
	5	Scour pools downstream of culverts / storm sewer outlets		X	
	6	Cut face on bar forms		X	
	7	Head cutting due to knick point migration		X	
	8	Terrace cut through older bar material		X	
	9	Suspended armour layer visible in bank		X	
	10	Channel worn into undisturbed overburden / bedrock	X		
		Sum of indices =	1	7	0.13
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc.	X		5/9
	2	Occurrence of large organic debris	X		
	3	Exposed tree roots	X		
	4	Basal scour on inside meander bends		X	
	5	Basal scour on both sides of channel through riffle		X	
	6	Outflanked gabion baskets / concrete walls / etc.	NA		
	7	Length of basal scour >50% through subject reach	X		
	8	Exposed length of previously buried pipe / cable / etc.		X	
	9	Fracture lines along top of bank	X		
	10	Exposed building foundation		X	
		Sum of indices =	5	4	0.56
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chute(s)		X	1/7
	2	Single thread channel to multiple channel		X	
	3	Evolution of pool-riffle form to low bed relief form		X	
	4	Cut-off channel(s)		X	
	5	Formation of island(s)		X	
	6	Thalweg alignment out of phase with meander form	X		
	7	Bar forms poorly formed / reworked / removed		X	
		Sum of indices =	1	6	0.14

Additional notes:

Stability Index (SI) = (AI+DI+WI+PI)/4 = 0.28

Condition	In Regime	In Transition/Stress	In Adjustment
SI score =	☐ 0.00 - 0.20	☒ 0.21 - 0.40	☐ 0.41

Completed by: _____ Checked by: CH

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Rapid Stream Assessment Technique

Project Code: PNJ6107

Date:	May 17, 2017	**Stream/Reach:**	TJ17
Weather:	25°C	**Location:**	New Sudbury
Field Staff:	AW, AV, SC	**Watershed/Subwatershed:**	Junction Creek

Evaluation Category	Poor	Fair	Good	Excellent
Channel Stability	• < 50% of bank network stable • Recent bank sloughing, slumping or failure frequently observed	• 50-70% of bank network stable • Recent signs of bank sloughing, slumping or failure fairly common	• 71-80% of bank network stable • Infrequent signs of bank sloughing, slumping or failure	• > 80% of bank network stable • No evidence of bank sloughing, slumping or failure
	• Stream bend areas highly unstable • Outer bank height 1.2 m above stream bank (2.1 m above stream bank for large mainstem areas) • Bank overhang > 0.8-1.0 m	• Stream bend areas unstable • Outer bank height 0.9-1.2 m above stream bank (1.5-2.1 m above stream bank for large mainstem areas) • Bank overhang 0.8-0.9m	• Stream bend areas stable • Outer bank height 0.6-0.9 m above stream bank (1.2-1.5 m above stream bank for large mainstem areas) • Bank overhang 0.6-0.8 m	• Stream bend areas very stable • Height < 0.6 m above stream (< 1.2 m above stream bank for large mainstem areas) • Bank overhang < 0.6 m
	• Young exposed tree roots abundant • > 6 recent large tree falls per stream mile	• Young exposed tree roots common • 4-5 recent large tree falls per stream mile	• Exposed tree roots predominantly old and large, smaller young roots scarce • 2-3 recent large tree falls per stream mile	• Exposed tree roots old, large and woody • Generally 0-1 recent large tree falls per stream mile
	• Bottom 1/3 of bank is highly erodible material • Plant/soil matrix severely compromised	• Bottom 1/3 of bank is generally highly erodible material • Plant/soil matrix compromised	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material	• Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material
	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally trapezoidally-shaped	• Channel cross-section is generally V- or U-shaped	• Channel cross-section is generally V- or U-shaped
Point range	☐ 0 ☐ 1 ☐ 2	☒ 3 ☐ 4 ☐ 5	☐ 6 ☐ 7 ☐ 8	☐ 9 ☐ 10 ☐ 11

Channel Scouring/ Sediment Deposition	• > 75% embedded (> 85% embedded for large mainstem areas)	• 50-75% embedded (60-85% embedded for large mainstem areas)	• 25-49% embedded (35-59% embedded for large mainstem areas)	• Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)
	• Few, if any, deep pools • Pool substrate composition >81% sand-silt	• Low to moderate number of deep pools • Pool substrate composition 60-80% sand-silt	• Moderate number of deep pools • Pool substrate composition 30-59% sand-silt	• High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) • Pool substrate composition <30% sand-silt
	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits common	• Streambed streak marks and/or "banana"-shaped sediment deposits uncommon	• Streambed streak marks and/or "banana"-shaped sediment deposits absent
	• Fresh, large sand deposits very common in channel • Moderate to heavy sand deposition along major portion of overbank area	• Fresh, large sand deposits common in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits uncommon in channel • Small localized areas of fresh sand deposits along top of low banks	• Fresh, large sand deposits rare or absent from channel • No evidence of fresh sediment deposition on overbank
	• Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand	• Point bars common, moderate to large and unstable with high amount of fresh sand	• Point bars small and stable, well-vegetated and/or armoured with little or no fresh sand	• Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☒ 5 ☐ 6	☐ 7 ☐ 8

Date:	May 17, 2017	Reach:	TJ17	Project Code:	PN16107

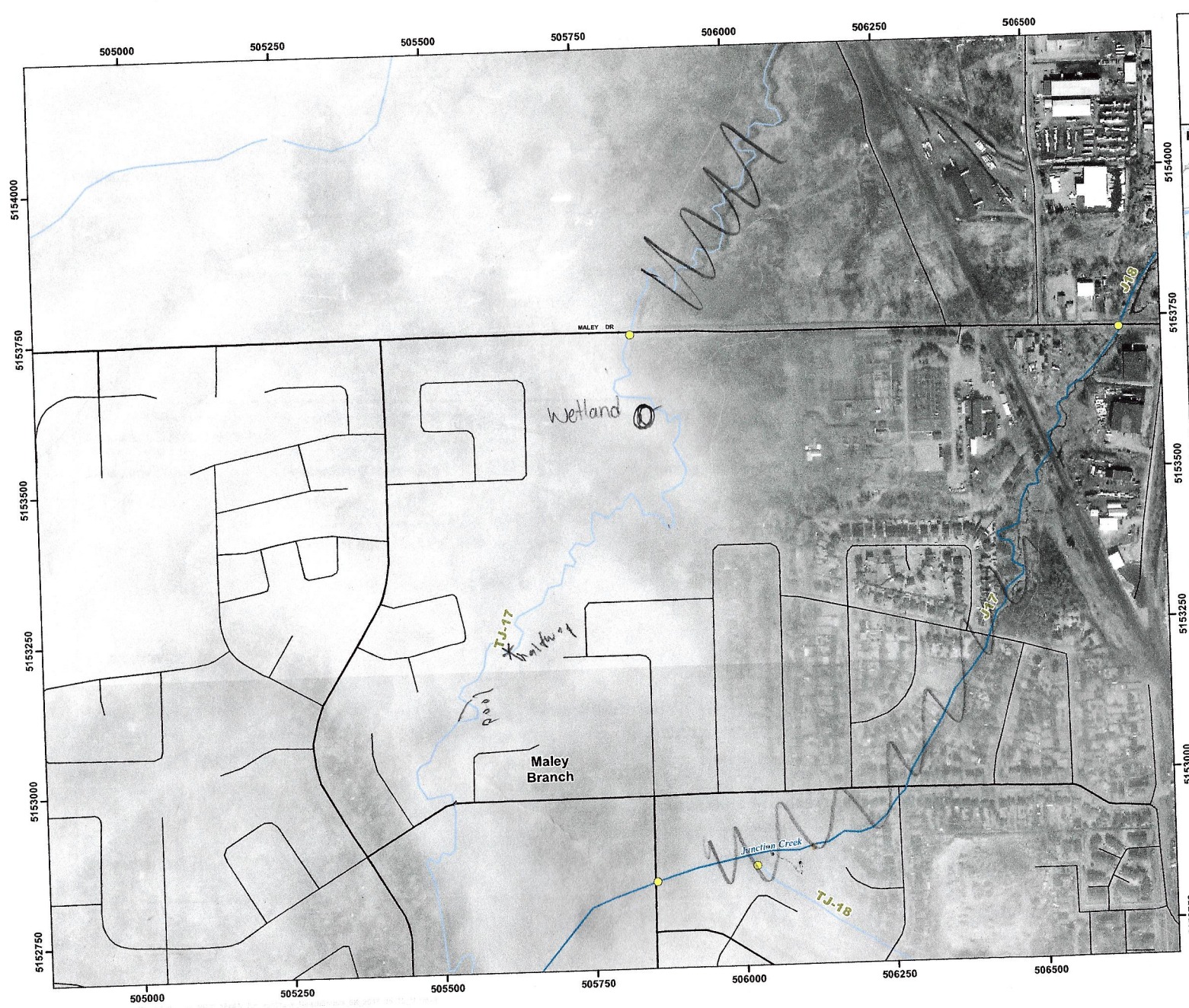
Evaluation Category	Poor	Fair	Good	Excellent
Physical Instream Habitat	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	• Wetted perimeter 40-60% of bottom channel width (45-65% for large mainstem areas)	• Wetted perimeter 61-85% of bottom channel width (66-90% for large mainstem areas)	• Wetted perimeter > 85% of bottom channel width (> 90% for large mainstem areas)
	• Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few riffles present, runs and pools dominant, velocity and depth diversity low)	• Few pools present, riffles and runs dominant. • Velocity and depth generally slow and shallow (for large mainstem areas, runs and pools dominant, velocity and depth diversity intermediate)	• Good mix between riffles, runs and pools • Relatively diverse velocity and depth of flow	• Riffles, runs and pool habitat present • Diverse velocity and depth of flow present (i.e., slow, fast, shallow and deep water)
	• Riffle substrate composition: predominantly gravel with high amount of sand • < 5% cobble	• Riffle substrate composition: predominantly small cobble, gravel and sand • 5-24% cobble	• Riffle substrate composition: good mix of gravel, cobble, and rubble material • 25-49% cobble	• Riffle substrate composition: cobble, gravel, rubble, boulder mix with little sand • > 50% cobble
	• Riffle depth < 10 cm for large mainstem areas	• Riffle depth 10-15 cm for large mainstem areas	• Riffle depth 15-20 cm for large mainstem areas	• Riffle depth > 20 cm for large mainstem areas
	• Large pools generally < 30 cm deep (< 61 cm for large mainstem areas) and devoid of overhead cover/structure	• Large pools generally 30-46 cm deep (61-91 cm for large mainstem areas) with little or no overhead cover/structure	• Large pools generally 46-61 cm deep (91-122 cm for large mainstem areas) with some overhead cover/structure	• Large pools generally > 61 cm deep (> 122 cm for large mainstem areas) with good overhead cover/structure
	• Extensive channel alteration and/or point bar formation/enlargement	• Moderate amount of channel alteration and/or moderate increase in point bar formation/enlargement	• Slight amount of channel alteration and/or slight increase in point bar formation/enlargement	• No channel alteration or significant point bar formation/enlargement
	• Riffle/Pool ratio 0.49:1 ; ≥1.51:1	• Riffle/Pool ratio 0.5-0.69:1 ; 1.31-1.5:1	• Riffle/Pool ratio 0.7-0.89:1 ; 1.11-1.3:1	• Riffle/Pool ratio 0.9-1.1:1
	• Summer afternoon water temperature > 27°C	• Summer afternoon water temperature 24-27°C	• Summer afternoon water temperature 20-24°C	• Summer afternoon water temperature < 20°C
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☒ 4	☐ 5 ☐ 6	☐ 7 ☐ 8
Water Quality	• Substrate fouling level: High (> 50%)	• Substrate fouling level: Moderate (21-50%)	• Substrate fouling level: Very light (11-20%)	• Substrate fouling level: Rock underside (0-10%)
	• Brown colour • TDS: > 150 mg/L	• Grey colour • TDS: 101-150 mg/L	• Slightly grey colour • TDS: 50-100 mg/L	• Clear flow • TDS: < 50 mg/L
	• Objects visible to depth < 0.15m below surface	• Objects visible to depth 0.15-0.5m below surface	• Objects visible to depth 0.5-1.0m below surface	• Objects visible to depth > 1.0m below surface
	• Moderate to strong organic odour	• Slight to moderate organic odour	• Slight organic odour	• No odour
Point range	☐ 0 ☐ 1 ☐ 2	☐ 3 ☐ 4	☒ 5 ☐ 6	☐ 7 ☐ 8
Riparian Habitat Conditions	• Narrow riparian area of mostly non-woody vegetation	• Riparian area predominantly wooded but with major localized gaps	• Forested buffer generally > 31 m wide along major portion of both banks	• Wide (> 60 m) mature forested buffer along both banks
	• Canopy coverage: <50% shading (30% for large mainstem areas)	• Canopy coverage: 50-60% shading (30-44% for large mainstem areas)	• Canopy coverage: 60-79% shading (45-59% for large mainstem areas)	• Canopy coverage: >80% shading (> 60% for large mainstem areas)
Point range	☐ 0 ☐ 1	☐ 2 ☐ 3	☒ 4 ☐ 5	☐ 6 ☐ 7

Total overall score (0–42) = 21	Poor (<13)	Fair (13-24)	Good (25-34)	Excellent (>35)

Completed by: AW Checked by: CH

Kelly Lake to

TJ-17

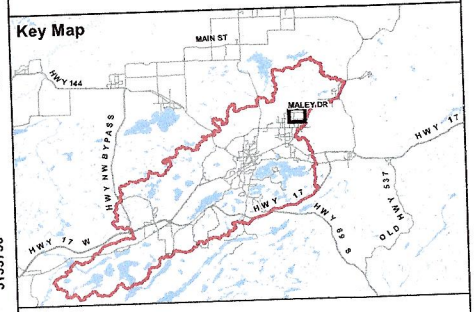


Map 15

Junction Creek Subwatershed Study

Preliminary Reach Delineation

Key Map



Legend

- Reach Break
- Junction Creek
- Primary Road
- Secondary Road
- Permanent Watercourse
- Contours (5m)

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NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Project: 1844A
Date: May 12, 2017

NAD83 - UTM Zone 17
Size: 11x17"
1:6,000

0 100 200 300 Meters

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Appendix F4
Detailed Summaries

Detailed Geomorphological Assessment Summary

Reach TJ-14-1

Project Number:	PN 16107	**Date:**	May 17, 2017
Client:	City of Greater Sudbury	**Length Surveyed (m):**	157.4
Location:	Lasalle Blvd.	**# of Cross-Sections:**	7

Reach Characteristics

Drainage Area:	Not measured	**Dominant Riparian Vegetation Type:**	Trees
Geology/Soils:	Bedrock	**Extent of Riparian Cover:**	Fragmented
Surrounding Land Use:	Commercial and residential	**Width of Riparian Cover:**	1-4 Channel widths
Valley Type:	Confined	**Age Class of Riparian Vegetation:**	Established
Dominant Instream Vegetation Type:	Attached algae	**Extent of Encroachment into Channel:**	Moderate
Portion of Reach with Vegetation:	60%	**Density of Woody Debris:**	Low

Hydrology

Measured Discharge (m^3/s):	Not Measured	**Calculated Bankfull Discharge (m^3/s):**	Not Calculated
Modelled 2-year Discharge (m^3/s):	Not modelled	**Calculated Bankfull Velocity (m/s):**	Not Calculated
Modelled 2-year Velocity (m/s):	Not modelled		

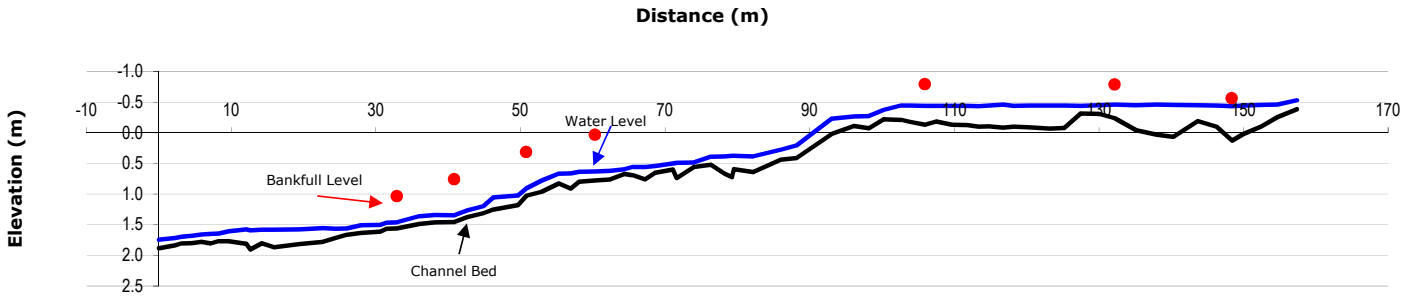
Profile Characteristics

Bankfull Gradient (%):	1.37
Channel Bed Gradient (%):	1.50
Riffle Gradient (%):	2.06
Riffle Length (m):	50.33
Riffle-Pool Spacing (m):	0.00

Planform Characteristics

Sinuosity:	1.21
Meander Belt Width (m):	Not measured
Radius of Curvature (m):	Not measured
Meander Amplitude (m):	Not measured
Meander wavelength (m):	Not measured

Longitudinal Profile



Bank Characteristics

	Minimum	Maximum	Average
Bank Height (m):	0.4	1.00	0.56
Bank Angle (deg):	20	90	50
Root Depth (m):	0.10	0.50	0.29
Root Density (%):	5	80	21
Bank Undercut (m):	None	None	N/A

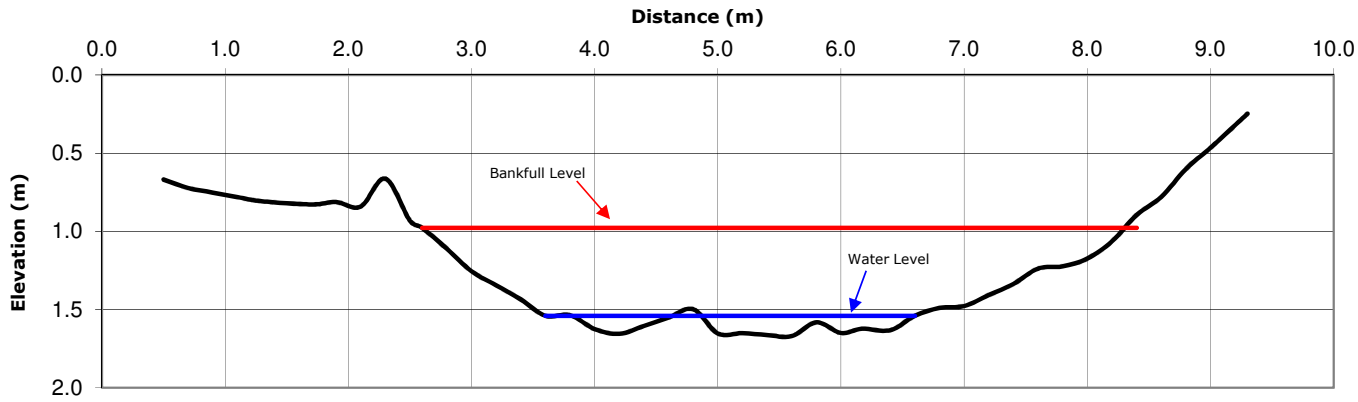
	Minimum	Maximum	Average
Torvane Value (kg/cm^2):		Not measured	
Penetrometer Value (kg/cm^3):		Not measured	
Bank Material (range):		Clay to large Boulder	

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	4.70	6.40	5.66
Average Bankfull Depth (m):	0.37	0.69	0.46
Bankfull Width/Depth (m/m):	7	16	13
Wetted Width (m):	2.70	4.45	3.51
Average Water Depth (m):	0.07	0.43	0.18
Wetted Width/Depth (m/m):	7	46	27
Entrenchment (m):	N/A	Not measured	N/A
Entrenchment Ratio (m/m):	N/A	Not measured	N/A
Maximum Water Depth (m):	0.13	0.56	0.28
Manning's *n* :		0.04	

Photograph at cross section 7 (looking downstream)

Representative Cross-Section 2



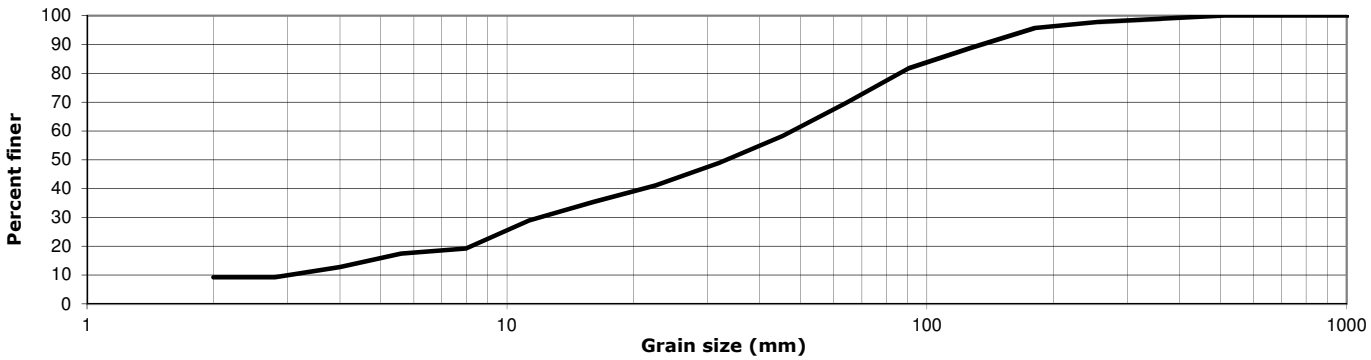
Substrate Characteristics

Particle Size (mm)

D_{10} :	2.8
D_{50} :	35.0
D_{84} :	128.0

Subpavement:	Bedrock
Particle shape:	Angular to sub-rounded
Embeddedness (%):	5% and 20%
Particle range (riffle):	Very Coarse Sand to Boulders
Particle Range (pool):	Granules to Cobbles

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):		**Tractive Force at Bankfull (N/m^2):**	51.40
for D_{50}:	1.01	**Tractive Force at 2-year flow (N/m^2):**	Not modelled
for D_{84}:	1.84	**Critical Shear Stress (D_{50}) (N/m^2):**	25.49
Unit Stream Power at Bankfull (W/m^2):	79.21		

General Field Observations

Channel Description

The reach meanders though a confined valley with a bedrock knob mid-survey. Average bankfull depth and width were 5.66 m and 0.46 m, respectively. Bank erosion was noted along the edge of the parking lot along the right bank. Bank material mainly ranged from silt to gravel with some riprap observed throughout. The downstream section of the survey was mainly a long riffle. Riffle material ranged from sand to large boulders. A long pool was observed upstream of the bedrock knob. Pool material consisted of sand, gravel, and small cobbles.

Cross Section 6 - Facing Downstream

Detailed Geomorphological Assessment Summary

Reach J15

Project Number:	PN 16107	**Date:**	May 18, 2017
Client:	Fielding Street, Sudbury	**Length Surveyed (m):**	61.1
Location:	New Sudbury	**# of Cross-Sections:**	4

Reach Characteristics

Drainage Area:	Not measured	**Dominant Riparian Vegetation Type:**	Shrubs and grasses
Geology/Soils:	Bedrock	**Extent of Riparian Cover:**	Fragmented
Surrounding Land Use:	Residential	**Width of Riparian Cover:**	4 - 10 Channel widths
Valley Type:	Partially confined	**Age Class of Riparian Vegetation:**	Mature (>30 years)
Dominant Instream Vegetation Type:	Rooted emergent	**Extent of Encroachment into Channel:**	None
Portion of Reach with Vegetation:	5%	**Density of Woody Debris:**	Low

Hydrology

Measured Discharge (m^3/s):	1.10	**Calculated Bankfull Discharge (m^3/s):**	3.80
Modelled 2-year Discharge (m^3/s):	Not modelled	**Calculated Bankfull Velocity (m/s):**	0.48
Modelled 2-year Velocity (m/s):	Not modelled		

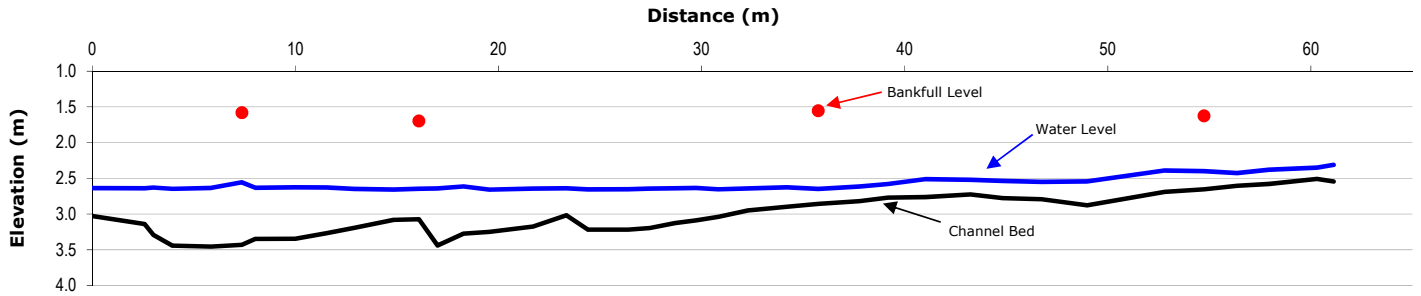
Profile Characteristics

Bankfull Gradient (%):	0.03
Channel Bed Gradient (%):	1.38
Riffle Gradient (%):	2.24
Riffle Length (m):	9.23
Riffle-Pool Spacing (m):	N/A

Planform Characteristics

Sinuosity:	1.20
Meander Belt Width (m):	Not measured
Radius of Curvature (m):	Not measured
Meander Amplitude (m):	Not measured
Meander wavelength (m):	Not measured

Longitudinal Profile



Bank Characteristics

	Minimum	Maximum	Average
Bank Height (m):	0.79	1.35	1.02
Bank Angle (deg):	20	90	52
Root Depth (m):	0.25	1.35	0.87
Root Density (%):	5	20	10
Bank Undercut (m):	0.05	0.2	0.13

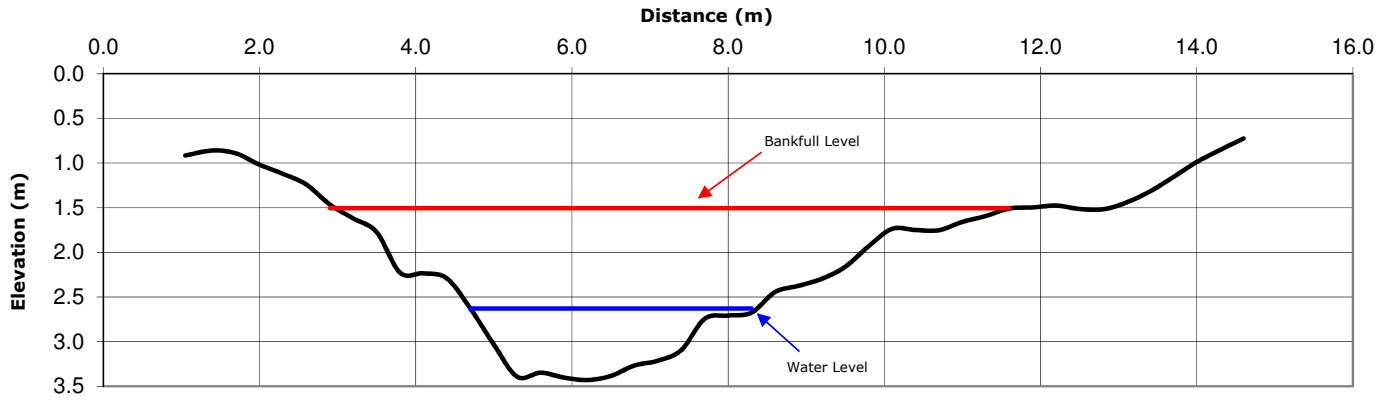
	Minimum	Maximum	Average
Torvane Value (kg/cm^2):		Not measured	
Penetrometer Value (kg/cm^3):		Not measured	
Bank Material (range):		Silt and sand (cobbles @ XS4)	

Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	7.45	8.70	8.13
Average Bankfull Depth (m):	0.81	1.13	0.97
Bankfull Width/Depth (m/m):	7	10	9
Wetted Width (m):	3.60	6.05	4.91
Average Water Depth (m):	0.23	0.55	0.36
Wetted Width/Depth (m/m):	6	27	17
Entrenchment (m):		Not measured	
Entrenchment Ratio (m/m):		Not measured	
Maximum Water Depth (m):	0.32	0.80	0.57
Manning's *n* :		0.035	

Photograph at cross section 2 (looking at the left bank)

Representative Cross-Section 2



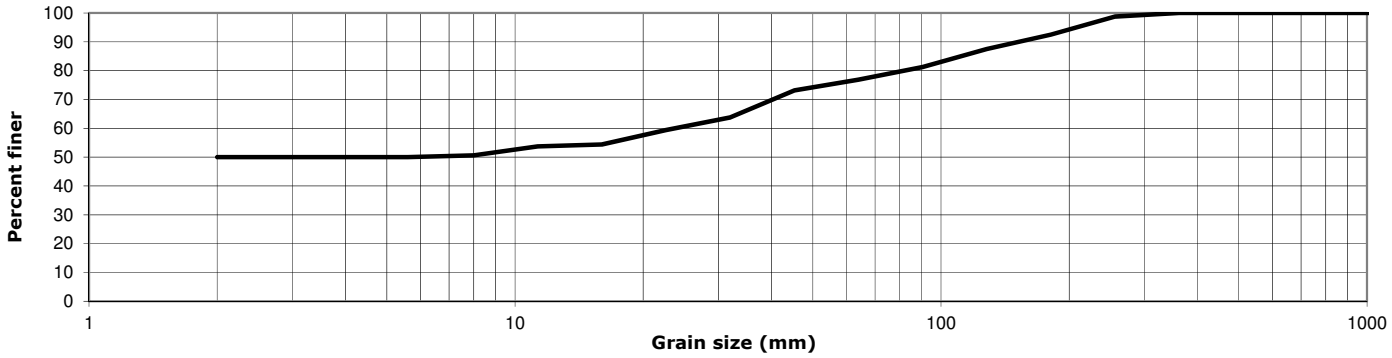
Substrate Characteristics

Particle Size (mm)

D_{10} :	0.0
D_{50} :	2.0
D_{84} :	110.0

Subpavement:	Sand and silt
Particle shape:	Sub-rounded to angular
Embeddedness (%):	10
Particle range (riffle):	Gravel to boulders
Particle Range (pool):	Sand

Cumulative Particle Size Distribution



Channel Thresholds

Flow Competency (m/s):		**Tractive Force at Bankfull (N/m^2):**	2.85
for D_{50}:	0.27	**Tractive Force at 2-year flow (N/m^2):**	Not modelled
for D_{84}:	1.72	**Critical Shear Stress (D_{50}) (N/m^2):**	1.46
Unit Stream Power at Bankfull (W/m^2):	1.38		

General Field Observations

Channel Description

This reach meanders through a residential and commercial area with a moderate gradient and sinuosity. This reach generally had more runs and pools with few riffles. The detailed assessment was completed where riffle features were available. Average bankfull width and depth were 7.8 m and 0.9 m, respectively. Bank erosion was evident and undercuts up to 0.20 m were measured. Slumping and leaning trees were also present. Bank material consisted of silt and sand. Riffle materials ranged from gravel to boulders. Pools consisted mainly of sand.

Cross Section 3 - Facing Downstream