Jock River, Barrhaven Conservancy

Erosion Hazard Assessment and Erosion Threshold Analysis

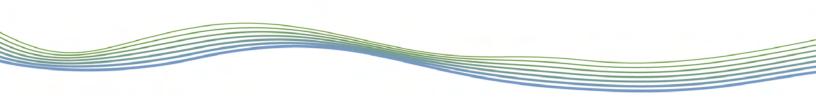


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> GEO MORPHIX Geomorphology Earth Science

Observations



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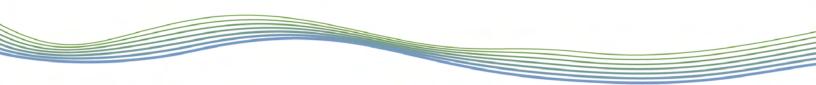
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1 Introduction

This report provides support in addressing meander belt width requirements for the Jock River and its tributaries and erosion threshold analyses for the Fraser Clark, Foster Ditch, and O'Keefe municipal drains. The property of the assessed reaches is located between Highway 416 to the west, Greenbank Road to the east, Strandherd Drive to the north, and Jock River to the South.

To delineate the hazard land associated with Jock River and the three (3) municipal drains and to determine the erosion thresholds analysis in support of the proposed stormwater management, the following activities were completed:

- Background review of existing documents related to the study area, including topography, physiography, and geology mapping;
- Review of the meander belt widths associated with the subwatershed study and subsequent analysis on the adjacent tributaries;
- Updated and confirm reach delineation for all three drains;
- Review of historical and recent aerial photographs;
- Completion of rapid geomorphic assessments of the three drains to document channel condition;
- Delineation of the hazard area adjacent to the Jock River and 3 drains based on the results of the updated belt width assessment where warranted;
- Complete a detailed geomorphic assessment of each municipal drain to determine a critical discharge or confirm existing erosion thresholds; and
- Modelling of erosion indices based on post- to pre-development synthetic storage or continuous modelling.

2 Background Review

A review of the meander belt widths and erosion threshold analyses from previous studies were completed for the Jock River and the three adjacent municipal drains. The following studies were reviewed:

- CH2M Hill Canada Limited. 2013. O'Keefe Drain Environmental and Stormwater Management Plan. Prepared for the City of Ottawa;
- CH2M Hill Canada Limited. 2013. Foster Stormwater Management Facility Environmental Study Report. Prepared for the City of Ottawa;
- Parish Aquatic Services, A Division of Matrix Solutions. 2016. Clarke Drain Erosion Threshold Assessment. Prepared for Minto Communities Inc.; and
- Stantec Consulting Ltd. 2007. Jock River Reach One Subwatershed Study Final Report: Volume 1 of 2. Prepared for the City of Ottawa.

3 Historical Assessment

Historical aerial photographs were reviewed to determine changes to the channel and surrounding land use/cover. This information, in part, provides an understanding of the historical factors that have contributed to current channel morphodynamics. The 1976 and 1991 aerials were provided by the City of Ottawa and the 2016 was provided by Google Earth Pro. A summary of the historical changes to the three drains are provided in **Table 1**. Historical aerial photographs are provided in **Appendix A**.

Watercourse	/atercourse 1976 1991		2014
Fraser Clark Drain	Agricultural fields surround associated reaches with little to no riparian buffer. Land use within the study site remains consistent to 2014. Reaches FCD2 and FCD3 consist of wetland features. Reach FCD3-3 was not present on the aerial photograph. Reaches FCD3-1, FCD3- 2, and FCD5 consist of swale features.	Residential development extends to McKenna Drive and Borrisokane Road. A localized residential property present adjacent to Reach FCD4. Tree growth within the narrow riparian areas. Reach FCD5 was ditched and straightened. No changes to the form of the remainder of the reaches since 1976. Two elongated storm water ponds are constructed, extending east from McKenna Drive parallel to Reach FD1-1.	Residential development extends to Strandherd Drive. Residential and commercial properties present along Strandherd Drive. Riparian buffers increase in width and an increase in tree cover. No changes to the form of the reaches since 1991. A storm water pond was constructed between Strandherd Drive and Reach FCD4. Reach FCD4-1 was built to convey flows from the pond to FCD4.
Foster Ditch	Agricultural fields surround associated reaches with no riparian buffer. Land use within the study site remains consistent to 2014. Reaches FD1, FD2, FD3 are narrow features. Reach FD3 was ditched, Reaches FD1 and FD2 were unmodified.	Residential properties extend to the east side of Borrisokane Road. Riparian buffers are narrow and fragmented. Reaches FD1, FD2, FD3, and upstream of Reach FD3 have been noticeably widened. A stormwater pond and Reach FCD1-1 was constructed adjacent to Reach FD1. A flow structure was present at the pond inlet and an access road crosses Reach FD1.	Riparian buffers widen slightly and some tree establishment was noted. Residential areas extend west to Strandherd Drive and north towards Fallowfield Road. Stormwater pond along reach FD1 was reshaped, given a new outlet flowing into Jock River. The flow structure and access road are removed Upstream of the study site stormwater ponds were constructed. Reaches FD4 and FD5 were created as inlet and outlet reaches to the ponds. Further upstream, reaches FD6 to FD14 were re-aligned for development purposes.

Watercourse	1976	1991	2014
O'Keefe Drain	Agricultural fields surround associated reaches. Land use within the study site remains consistent to 2014. A narrow, established riparian buffer zone was only present along Reach OKD1. All other reaches possess little to no riparian area. All reaches were previously straightened and ditched	No notable changes to land use, riparian coverage, and channel formation since 1976.	Riparian tree growth noted upstream of the study site. No changes to riparian coverage and channel formation to reaches OKD1 and OKD2. Commercial development extends east of Strandherd Drive. Reaches OKD3 to OKD8 were re-aligned. Stormwater ponds were constructed along reaches OKD3, and OKD5.
Jock River	Agricultural fields surround associated reaches. Narrow riparian zones along both banks of all reaches. Reach JR-4 more sinuous than reach JR-3. No other morphology apparent in aerial.	No notable changes to land use, riparian coverage, and channel formation since 1976.	No notable changes to riparian coverage and channel formation since 1991. Residential development just south of reach JR-3. Highway 416 was built intersection reach JR-4.

4 Existing Conditions

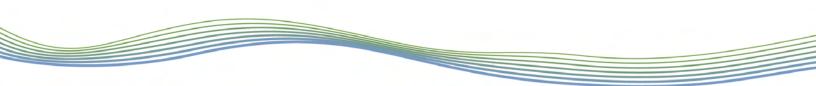
4.1 Watershed Characteristics

Channel morphology and planform are largely governed by the flow regime and the availability and type of sediments (i.e., surficial geology) within the stream corridor. Physiography, riparian vegetation and land use also physically influence the channel. These factors provide insight into existing conditions and perception to the future potential changes as they relate to a proposed activity.

Physiographically, the project site is located within an area dominated by glaciofluvial deposits comprised of alluvial deposits and topset facies. Within the project site, surficial deposits also include modern alluvium ranging from clay to gravel with organic deposits as well as glaciolacustrine sediments composed of massive to laminated silt and clay with minor sand and gravel (OGS, 2010).

4.2 Confirmation of Reach Delineation

Reaches are homogeneous segments of channel used in geomorphological investigations. They are studied semi-independently as each is expected to function in a manner that is at least slightly different from adjoining reaches. This allows for a meaningful characterization of a watercourse as the aggregate of reaches, or an understanding of a particular reach, for example, as it relates to a proposed activity.



Reaches are delineated based on changes in the following:

- Channel planform;
- Channel gradient;
- Physiography;
- Land cover (land use or vegetation);
- Flow, due to tributary inputs;
- Soil type and surficial geology; and
- Certain types of anthropogenic channel modifications.

This follows scientifically defensible methodology proposed by Montgomery and Buffington (1997), Richards et al. (1997), Brierley and Fryirs (2005), and the Toronto and Region Conservation Authority (2004).

Thirteen reaches were delineated within the study area in a desktop exercise using available data and background reports. These reaches were then field verified. Seven reaches of Fraser Clark Drain (FCD), two reaches of O'Keefe Drain (OKD), and four reaches of Foster Ditch (FD) were defined in the subject lands. The reaches for the Jock River remain the same from the Subwatershed Study (Stantec, 2007). A reach map is provided in **Appendix B**. Reach mapping extends north of the study site.

4.3 Channel Characteristics

Reach observations and channel measurements were collected in June 2017. These field investigations were used to gain insight into the conditions and general characteristics of each reach in the subject property. A photographic record is included in **Appendix C** and documents the conditions from all observed reaches. Field notes and observations are provided in **Appendix D**.

Rapid geomorphological assessments were completed and included the following reach-by-reach observations:

- Characterization of stream form, process, and evolution using the Rapid Geomorphological Assessment (RGA) (MOE, 2003, VANR, 2007);
- Assessment of the ecological function of the watercourse using the Rapid Stream Assessment Technique (RSAT) (Galli, 1996);
- Stream classification following a modified Downs (1995) and a modified Brierley and Fryirs (2005) River Styles Classification approach;
- Reach-scale habitat sketch maps based on Newson and Newson (2000) outlining channel substrate, flow behaviour, geomorphological units, and riparian vegetation on the day;
- Instream estimates of bankfull channel dimensions; and
- Bed and bank material composition and structure.

4.4 Rapid Geomorphological Assessments

Channel stability and susceptibility to erosion were objectively assessed through the application of the Ontario Ministry of the Environment's (2003) Rapid Geomorphic Assessment (RGA). The RGA evaluates degradation, aggradation, widening, and planimetric form adjustment at the reach scale. The end result of the RGA is to produce a score, or stability index, which evaluates the degree to which a stream has departed from its equilibrium condition. A stream with a score of less than 0.20 is in regime, indicating minimal changes to its shape or processes over time. A score of 0.21 to 0.40 indicates that a stream is in transition or stress and is experiencing major change to process and form outside the natural range of variability. A score of greater than 0.41

indicates that a stream is in extreme adjustment, exhibiting a new stream type, or in the process of adjusting to a new equilibrium (MOE, 2003; VANR, 2007).

The Rapid Stream Assessment Technique (RSAT) was also employed to provide a broader view of the system and consider the ecological functioning of the watercourses (Galli, 1996). Observations were made of channel stability, channel scouring or sediment deposition, instream and riparian habitats, and water quality. The RSAT score ranks the channel as maintaining a poor (<13), fair (13-24), good (25-34), or excellent (35-42) degree of stream health.

Reaches were also classified according to a modified Downs (1995) Channel Evolution Model and the River Styles Framework (Brierley and Fryirs, 2005). The Down's Model describes successional stages of a channel as a result of a perturbation, namely hydromodification. Understanding the current stage of the system is beneficial as this allows one to predict how the channel will continue to evolve, or respond to an alteration to the system. The River Styles Framework (Brierley and Fryirs, 2005) provides a geomorphological approach to examining river character, behaviour, condition, and recovery potential.

Field observations are provided in **Table 2** and **Table 3** below.

4.4.1 Fraser Clark Drain

Reach FCD2 exists as an unconfined wetland between agricultural fields. The reach flows south east with low gradient and entrenchment to the Jock River. Riparian vegetation was comprised of trees and grasses. In the upstream portion of the reach, riparian cover was continuous and tree dominated. The downstream was grass dominated and entirely encroached with reeds. Average feature width and depth were 9.3, and 0.4 m, respectively. Bed and bank material were soft and comprised of clay, silt, and sand. There was no development of geomorphic units. Approximately 0.30 to 0.40 m deep of loose bed material and organics were present on the bed at the time of assessment.

Reach FCD3 exists as an unconfined wetland. Riparian vegetation was fragmented containing scattered trees and dominated by grasses. Approximately 75% of upstream is heavily encroached with reeds, containing no notable flow. Bed and bank materials consisted of clay, silt, and sand. Average feature width and depth were 12.3 m, and 0.2 m, respectively. There was no riffle-pool development throughout the reach.

Reach FCD3-1 is an unconfined swale feature surrounded by active agricultural fields. The riparian zone was fragmented and consisted of grasses with scattered trees and shrubs. The swale was heavily encroached with grasses and reeds. The reach had no defined channel banks and no riffle-pool features. Bed material consisted of clay, silt, and sand.

Reach FCD3-2 starts approximately 25 m east of Borrisokane Road and flows intermittently over a low gradient. There was no surface water present at the time of assessment. The riparian area was grass dominated, with reeds fully encroaching the bed. The reach had no defined channel banks and no riffle-pool features. Bed material consisted of clay, silt, and sand.

Reach FCD3-3 was not present at the time of assessment.

Reach FCD5 exists as an unconfined swale feature with a low gradient. The reach begins on the western side of Borrisokane Road, and concludes at a culvert at Borrisokane Road. No surface water was present at the time of assessment. The bank angles were low with no evidence of erosion. Riparian vegetation consisted of mainly grasses with scattered trees. Bed and bank material consisted of clay, silt, sand. The reach was absent of geomorphic development.

4.4.2 Foster Ditch

Reach FD1 consists as a sinuous, unconfined channel that perennially flows into Jock River. The reach flows over a low gradient surrounded by agricultural fields. Riparian coverage was dominated by grass, with trees present at the upstream and downstream breaks. The banks were highly entrenched and undercutting was present in the downstream portion of the reach. Bank angles were high and extent of bank erosion included 30-60% of the reach. Bankfull width and depth were 4.7 m and 0.7 m, respectively. No riffle-pool features were present. Grasses encroached minimally into the channel and a low density of woody debris was present. The bed and banks of the channel were both comprised of clay and silt, with sand and scattered rip rap present in the heavily modified areas. Bed materials were soft and were 0.05 to 0.20 m deep.

Reach FD2 consisted of a low gradient, perennial channel surrounded by agricultural fields. The reach exhibits a sinuous planform and was slightly entrenched. The riparian area was narrow and consisted of trees, shrubs, and grasses. Reeds were extensively encroaching the channel at the downstream reach break. A moderate density of woody debris was present. High bank angles at 60-90 degrees and undercutting up to 0.10 m was present. Average bankfull width and depth were 7.6 m and 0.6 m, respectively. No riffle-pool features were present. The bed and banks were composed of clay and silt.

Reach FD3 is straight, ditched, and unconfined channel with a low gradient. The reach was surrounded by a narrow riparian buffer dominated by grasses with scattered trees. Reeds were moderately encroaching the channel. The banks had high angles of 60-90 degrees and were highly entrenched. A large woody debris jam at the downstream portion of the reach was causing substantial backwatering. Undercutting was present upstream and downstream of a large woody debris jam. Average bankfull width and depth were 6.9 m and 0.5 m, respectively. The reach was absent of riffle-pool features. Bed and bank material consisted of clay, silt, and sand. Approximately 0.3 to 0.4 m deep of fines were present on the bed upstream of the woody debris jam.

4.4.3 O'Keefe Drain

Reach OKD1 is a previously straightened and ditched channel flowing between agricultural fields. The reach had a low gradient and was unconfined. Riparian vegetation was continuous and dominated by trees and grasses. The channel was highly entrenched, with high bank angles between 60-90 degrees. Fluvial entrainment and exposed tree roots were commonly observed, with an extent of 60-100% of the reach exhibiting erosion. Encroachment was minimal. Woody debris was high in density with two woody debris jams per 50 m. Average bankfull width and depth were 4.6 and 0.7 m, respectively. The reach had no riffle-pool features. Substrate of the bed and bank ranged between clay, silt, sand, and organics. At the time of assessment, approximately 0.2 – 0.3 m of loose bed material was present on the bed.

Reach OKD2 was previously straightened and ditched. Riparian vegetation was narrow and consisted of grasses. Reed encroachment was moderate. The banks were highly entrenched with high angles of 60-90 degrees. Erosion was present in 30-60% of the reach. Two erosion scars were observed along the right bank. Average bankfull width and depth were 4.4 m and 0.7 m, respectively. Riffle-pool features were not observed. Bed and bank material included clay and silt. A low density of woody debris was present in the channel.

General reach characteristics are summarized below in **Table 2**, and results from the rapid assessments are summarized in **Table 3**.

	Average Bankfull	Average Bankfull	Subst	trate	Valley	Riparian		
Reach	Width (m)	Depth (m)	Riffle	Pool	Туре	Vegetation	Notes	
FCD2	N/A: wetland feature		No riffle-pool development: clay, silt, organics		Unconfined	Trees and grasses, fragmented	Wetland feature. Heavy reed encroachment. Soft bed materials.	
FCD3	N/A: wetla	nd feature	No riffl develop clay, silt,	oment:	Unconfined	Trees and grasses, fragmented	Wetland feature. Heavy reed encroachment. No flow.	
FCD3-1	N/A: swa	le feature	No riffl develop clay, silt,	oment:	Unconfined	Trees and grasses, fragmented	Swale feature. Channel dry at time of assessment. Heavy reed encroachment.	
FCD3-2	N/A: swale feature		No riffle-pool development: clay, silt, organics		Unconfined	Trees and grasses, fragmented	Swale feature. Channel dry at time of assessment. Heavy reed encroachment.	
FCD3-3			N/A:	no feature	at the time of	assessment		
FCD5	N/A: swale feature		No riffl develop clay, sil	oment:	Unconfined	Trees and grasses, fragmented	Swale feature. Channel dry at time of assessment. Heavy reed encroachment.	
FD1	4.3	0.4	No riffle pool development: clay, silt		Unconfined	Trees and grasses, fragmented	Sinuous and entrenched. Undercutting. Soft bed materials.	
FD2	7.6*	0.4	No riffle pool development: clay, silt		Unconfined	Trees shrubs and grasses, continuous	Sinuous and slightly entrenched. Undercutting. Heavy reed encroachment.	
FD3	6.9*	0.4	No riffle pool development: clay, silt, sand		Unconfined	Trees and grasses, fragmented	Straightened and ditch feature. Backwatering due to a large woody debris jam.	
OKD1	4.6	1.0	No riffle pool development: clay, silt, sand, organics		Unconfined	Trees shrubs and grasses, fragmented	Straightened and ditch feature. Highly entrenched. Soft bed materials.	
OKD2	4.4	0.7	No riffl develop clay,	oment:	Unconfined	Trees and grasses, fragmented	Straightened and ditch feature. Highly entrenched. Erosion scars observed.	

Table 2. General reach characteristics

*feature width

	RGA (MOE, 2003)			RSAT (Galli, 1996)			Down's	River Styles
Reach	Score	Condition	Dominant Systematic Adjustment	Score	Condition	Limiting Features	Channel Evolution Model (1995)	Framework (Brierley and Fryirs, 2005)
FCD2	0	In Regime	N/A	31	Good	Riparian Habitat	S – stable	Straight, suspended load
FCD3	0	In Regime	N/A	29.5	Good	Riparian Habitat	S – stable	Straight, suspended load
FCD3-1	0	In Regime	N/A	N/A	N/A	N/A	S – stable	Meandering, suspended load
FCD3-2	0	In Regime	N/A	N/A	N/A	N/A	S – stable	Meandering, suspended load
FCD3-3			N/A, Channel	non-exis	tent at time o	of assessmen	t.	
FCD5	0	In Regime	N/A	N/A	N/A	N/A	S – stable	Straight, suspended load
FD1	0.09	In Regime	Evidence of Aggradation	30.5	Good	Riparian Habitat	S – stable	Meandering, suspended load
FD2	0.12	In Regime	Evidence of Widening	31	Good	Riparian Habitat	S – stable	Meandering, suspended load
FD3	0.11	In Regime	Evidence of Widening	30	Good	Riparian Habitat	S – stable	Straight, suspended load
OKD1	0.12	In Regime	Evidence of Widening	30	Good	Channel Stability	e - enlarging	Straight, suspended load
OKD2	0	In Regime	N/A	29	Good	Riparian Habitat	C – Compound	Straight, suspended load

Table 3. Rapid assessment results

4.4.4 Jock River

Reach JR-2 is just downstream and east of the study site. Site reconnaissance was completed at the Borrisokane Road crossing at the reach break between JR-3 and JR-4. Photographs are provided in **Appendix C**. Both reaches are unconfined with narrow riparian buffer zones. Bank erosion was not observed in the vicinity of the crossing. This was consistent with Stantec's observations.

4.5 Detailed Geomorphological Assessments

A detailed geomorphological assessment was completed for each drain: OKD1, FD1, and FCD2 in June 2017. As these reaches are downstream of the proposed SWM facility, Wet Ponds, and Oil and Grit Separator. The extent of the detailed assessments areas are provided in **Appendix F**. As such, defining an erosion threshold is necessary to mitigate negative post-development impacts.

The detailed assessment includes the following:

- Longitudinal profile of the channel;
- Eight detailed cross-sectional surveys of the watercourse;
- Detailed instream measurements at each cross-section location including bankfull channel geometry, riparian conditions, bank material, bank height/angle, and bank root density;
- Bed material sampling at each cross-section following a modified Wolman's (1954) Pebble Count Technique or substrate sample; and
- Velocity, discharge and observations of active/inactive sediment transport at select representative cross-sections.

Bankfull characteristics, based on the results of the detailed assessments for each drain are presented in **Table 5** in **Section 6.1**. A summary of the detailed assessment results for Reach OKD1, FCD1, and FCD2 are provided in **Appendix G**.

5 Meander Belt Width Assessment

Most watercourses in southern Ontario have a natural tendency to develop and maintain a meandering planform, provided there are no spatial constraints. A meander belt width assessment estimates the lateral extent that a meandering channel has historically occupied and will likely occupy in the future. This assessment is therefore useful for determining the potential limit of development for proposed activities in the vicinity of a stream.

When defining the meander belt width for a creek system, the Ministry of Natural Resources and Forestry (MNRF) treats unconfined and confined systems differently. Unconfined systems are those with poorly defined valleys or slopes well-outside where the channel could realistically migrate. Confined systems are those where the watercourse in contained within a defined valley, where valley wall contact is possible.

In unconfined systems, the meander belt width can be graphically defined using orthorectified aerial imagery by determining the channel centreline and the channel's central tendency (i.e. meander belt axis). In cases where the channel has been previously modified or the location cannot be determined in the imagery – due to tree cover or poor photograph resolution, for example – a modelling approach is employed. More specifically, empirical models by Williams (1986). These models are scientifically-defensible and have been verified in past projects as suitable for use in southern Ontario. This modelling approach also serves as a preliminary, or planning level, meander belt width assessment.

All watercourses within the study site are within unconfined valley systems. Since the drainage features have been heavily modified, the meander belt width cannot be determined using orthorectified aerial imagery. Therefore, the modelling approach was used for all the drainage feature within the study site.

Meander belt widths were calculated using empirical models, as these reaches showed signs of previous modification. The results are outlined in **Table 4** and a map is provided in **Appendix H**.

Meander belt widths were proposed using a modified Williams (1986) model, based on field measurements of channel geometries. The modified model also accounts for the average bankfull width of a given reach and an additional 20% factor of safety. These empirical relations are outlined below:

 $B_w = 4.3 W_b^{1.12} + W_b$

[Eq. 1]

where B_w is meander belt width (m) and W_b is bankfull channel width (m).

Table 4. Meander belt width estimates

			GEO Morphix Ltd.		
Reach	[#] CH2MHILL (2013)	**Stantec (2007)	*Williams – Width (1986) (m)	Proposed Meander Belt Width (m)	
FCD2			N/A: wetland feature	; no erosion hazard	
FCD3			N/A: wetland feature; no erosion hazard		
FCD3-1	No previous mean	ider belt widths	N/A: wetland feature; no erosion hazard		
FCD3-2	given for the Fras	ser Clark Drain	N/A: wetland feature; no erosion hazard		
FCD3-3			N/A: wetland feature; no erosion hazard		
FCD5			N/A: wetland feature	; no erosion hazard	
FD1	18.9		32	32	
FD2	18.9	32.7	32^	32	
FD3	Not determined		32^	32	
OKD1	45.6	20.0	34	34	
OKD2	45.6	28.8	32	32	

*includes a 20% factor of safety

#O'Keefe and Foster Drain Report

##No reach specified, average given

^Using the bankfull width from reach FD1

The Fraser Clark Drain, reaches FCD2 and FCD3, consisted of a wetland feature with no channel centreline. Therefore, there is no erosion hazard associated with these features. The same applies to the swale features for reaches FCD3-1, FCD3-2, and FCD5.

Since the Foster Ditch was previously ditched, the bankfull dimensions are comprised. The detailed assessment completed at reach FD1 has more accurate bankfull dimension measurements. Therefore, the meander belt with calculation for reach FD1 are used for reaches FD2 and FD3.

The Jock River meander belt widths within the Subwatershed Study (Stantec, 2007) were reviewed to assess suitability. The meander belt widths provided by the Subwatershed Study for reaches JR-3 and JR-4 are 218 and 231 m, respectively (Stantec, 2007). These meander belt widths include a 10% buffer. We are generally in agreement with the scale of the meander belt widths. The central tendency of the watercourse generally follows the overall trend of the channel passing through riffles or runs. Although there may be an opportunity for minor adjustments to the central

tendencies for reaches JR-3 and JR-4. This does not fundamentally adjust the meander belt width from the location illustrated in the subwatershed study.

We have a minor refinement for the downstream reach, JR-2. The geologic feature at Half Moon bay is not technically a meander. Half Moon bay was formed by reworking the underlying glaciomarine deposits (OGS, 2010). Therefore, the meander belt width for reach JR-2 is 130 m plus a 10% buffer plus a 7 m setback. The proposed meander belt width for reach JR-2 is 150 m. This is smaller than that proposed in the subwatershed study.

6 Erosion Analysis

6.1 Erosion threshold Analysis

Erosion threshold analyses were completed for reaches OKD1, FD1, and FCD2 to determine the flow conditions under which channel bed and bank materials can potentially be entrained and transported. Erosion thresholds are established to provide targets for the proposed SWM facility, Wet Ponds, and Oil and Grit Separator discharges to ensure that post-development erosion rates into the receiving watercourses do not exceed natural pre-development rates.

The erosion threshold analysis provides a depth, velocity, or discharge at which sediments of a particular size may potentially be entrained. The results of the detailed geomorphic assessments were used to inform the erosion threshold analysis. Detailed geomorphic assessment locations were completed downstream of the proposed SWM facility, Wet Ponds, and Oil and Grit Separators. We note that even under the most typical conditions, due to natural variability of channel morphology and sediment characteristics within the reach, the computed flow characteristics would only provide first approximations of erosion thresholds.

Erosion thresholds are determined using different methods that are dependent on channel and sediment characteristics. For example, erosion thresholds for non-cohesive sediments may be estimated using either a shear stress or a velocity approach. An erosion threshold, in the form of a critical discharge, is then calculated based on the bed and bank materials and local channel geometry. Theoretically, above this discharge, entrainment and transport of sediment can occur.

Threshold targets are determined using different methods that are dependent on channel and sediment characteristics. An erosion threshold was quantified based on the bed and bank materials and local channel geometry in the form of a critical discharge. Theoretically, above this discharge, entrainment and transport of sediment can occur. The velocity, U (m/s) is iteratively calculated at various depths, until the average velocity in the cross section slightly exceeds the critical velocity of the bed material. The velocity is determined using a Manning's approach, where the Manning's n value is visually estimated, a method proposed by Cowan (1956). This is mathematically represented as

$$U = \frac{1}{n} d^{2/3} S^{1/2}$$

[Eq. 2]

where, d is depth of water (m), S is channel slope, and n is the Manning's roughness. The discharge is then calculated using the area of a typical cross section at that depth. Results of the erosion threshold analysis are provided below in **Table 5**.

Channel parameter	O'Keefe Drain Reach OKD1	Foster Ditch Reach FD1	Fraser Clark Drain Reach FCD2
Measured			
Average bankfull channel width (m)	4.59	4.69	9.33
Average bankfull channel depth (m)	0.98	0.70	0.39
Bankfull channel gradient (%)	0.05	0.17	0.0001
D ₅₀ (m)	0.000002	0.000002	0.000002
Average bankfull velocity (m/s)	0.51	0.52	0.05
Bankfull discharge (m ³ /s)	1.69	1.21	0.10
Bankfull shear stress (N/m ²)	3.53	8.33	1.46
Calculated for Bed Materials			
Critical velocity (m/s)	0.53*	0.53*	0.15
Critical discharge (m ³ /s)	0.80	0.68	0.33
Apparent shear stress (N/m ²)	3.80	11.60	2.5
Conditions at Time of Assessment			
Water depth (m)	0.14	0.21	0.23
Average velocity (m/s)	0.26	0.20	0.05
Average discharge (m ³ /s)	0.08	0.13	0.04
Sediment Transport Observations	No transport	No transport	No transport
Critical Discharges from Previous Re	eports		
Critical discharge (m ³ /s)	1.86 [#] (Stantec, 2007) 0.08 ^{##} (CH2MHILL, 2013)	0.79 [#] (Stantec, 2007) 0.82 (CH2MHILL, 2013)	1.70 (PARISH, 2013)

Table 5. Erosion thresholds for each drain

* Based on Fischenich (2001) for sandy loam

[#] Not given for a specific reach

calculated for reach OKD2

Since both bed and bank material are similar in all three reaches and bank erosion thresholds are a proportion of thresholds for bed material, erosion thresholds for bank materials would be higher. Therefore, using the thresholds for bed materials would keep the bank erosion thresholds values conservative.

The critical discharge of the bed and bank materials for the O'Keefe Drain at reach OKD1 is 0.80 m³/s. The critical discharge of the bed and bank materials for the Foster Ditch at reach FD1 is 0.68 m³/s. The critical discharge of the bed and bank materials for the Fraser Clark Drain at reach FCD2 is 0.33 m³/s.

7 Summary and Conclusions

The purpose of this report was to provide support in addressing meander belt width requirements and erosion threshold analyses for the Frazer Clark drain, the Foster Ditch, and the O'Keefe Drain. To delineate the limit of development, the meander belt width was calculated for the 2 reaches of the O'Keefe Drain and the 3 reaches of the Foster Ditch. The Frazer Clark Drain does not have a centre line of channel as the drain consisted of a wetland feature and therefore does not require and meander belt width. The meander belt widths for the O'Keefe Drain are 34 m for reach OKD1 and 32 m for reach OKD2. The meander belt widths for the reaches within the Foster Ditch are 32 m. The meander belt widths for the Jock River reaches JR-2, JR-3, and JR-4 are 150 m, 218 m, and 231 m, respectively.

The erosion threshold analyses provide targets for the proposed SWM facility, Wet Ponds, and Oil and Grit Separator discharge to ensure that post-development erosion rates into the receiving drains do not exceed the natural pre-development rates. The critical discharge of the bed and bank materials for reach OKD1, FD1, and FCD2 are 0.80 m³/s, 0.68 m³/s, and 0.33 m³/s respectively.

We trust this report meets your requirements. Should you have any questions please contact the undersigned.

Respectfully submitted,

Paul Villard Ph.D., P.Geo., CAN-CISEC Director, Principal Geomorphologist

Cara Hutton

Cara Hutton, M.Sc. Senior Environmental Technician

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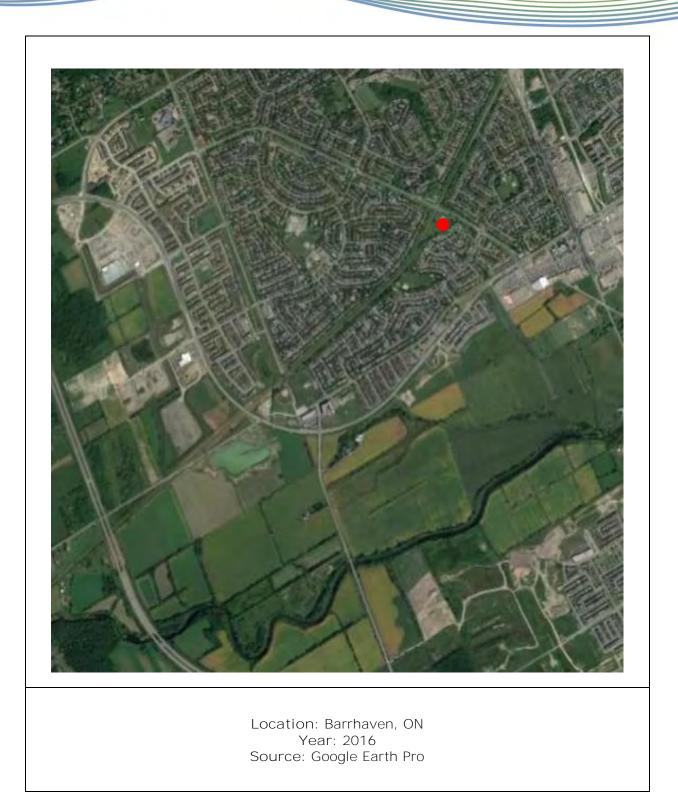
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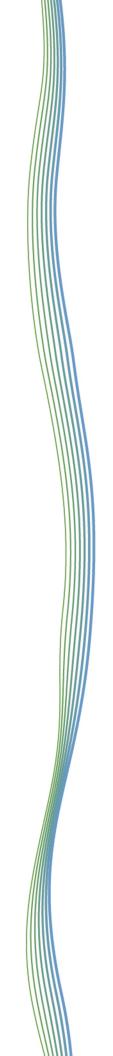


Appendix A Historical Aerial Photographs









Appendix B Reach Delineation

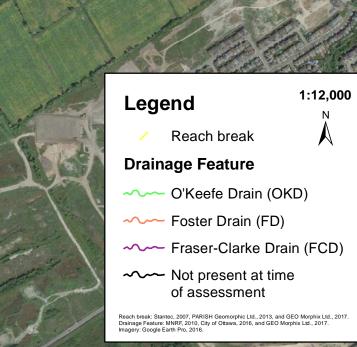




Reach Delineation

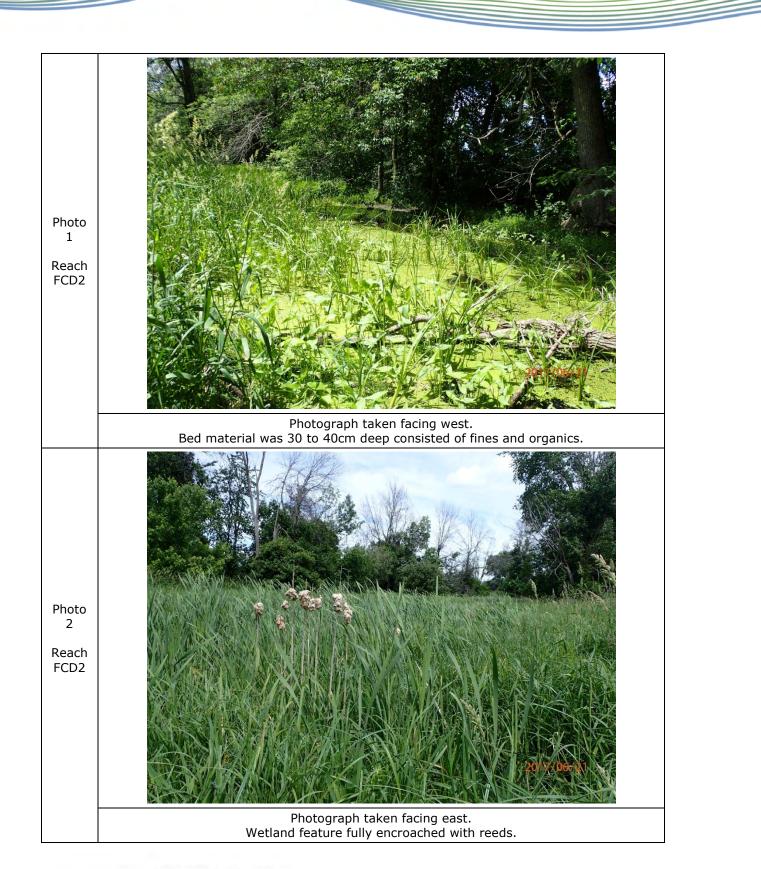
Jock River, O'Keefe Drain, Foster Drain, and Fraser-Clarke Drain

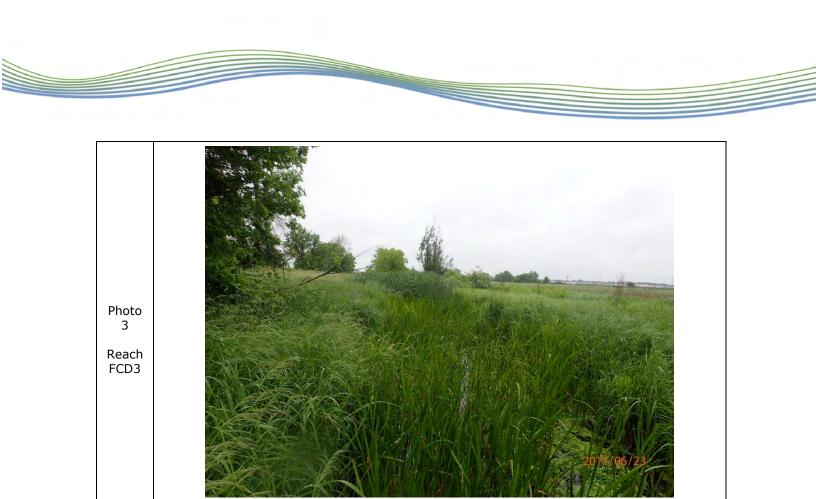
Barrhaven, Ottawa





Appendix C Photographic Record

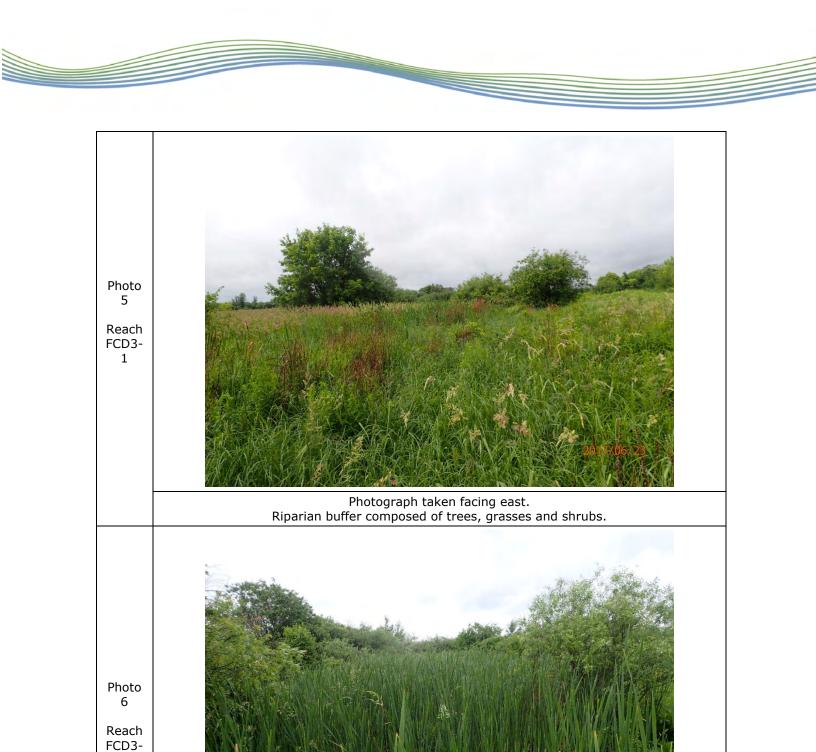




Photograph taken facing east. Heavily encroaching reeds in the wetland feature was observed.

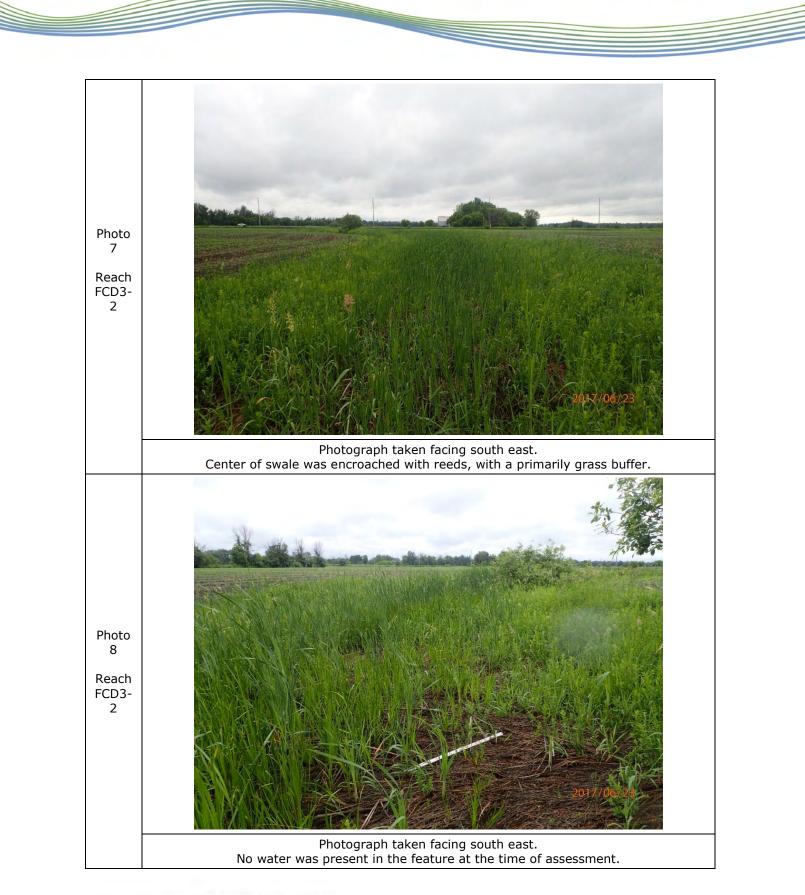


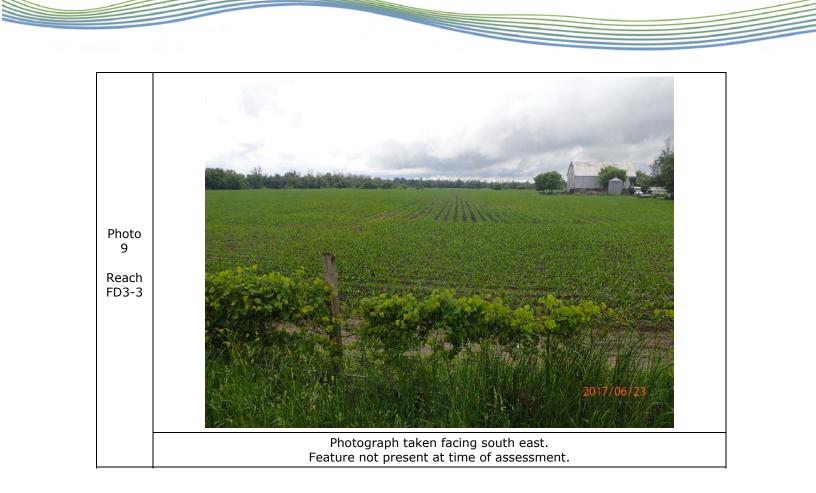
Photograph taken facing east. Fragmented riparian buffer was dominated by grass.

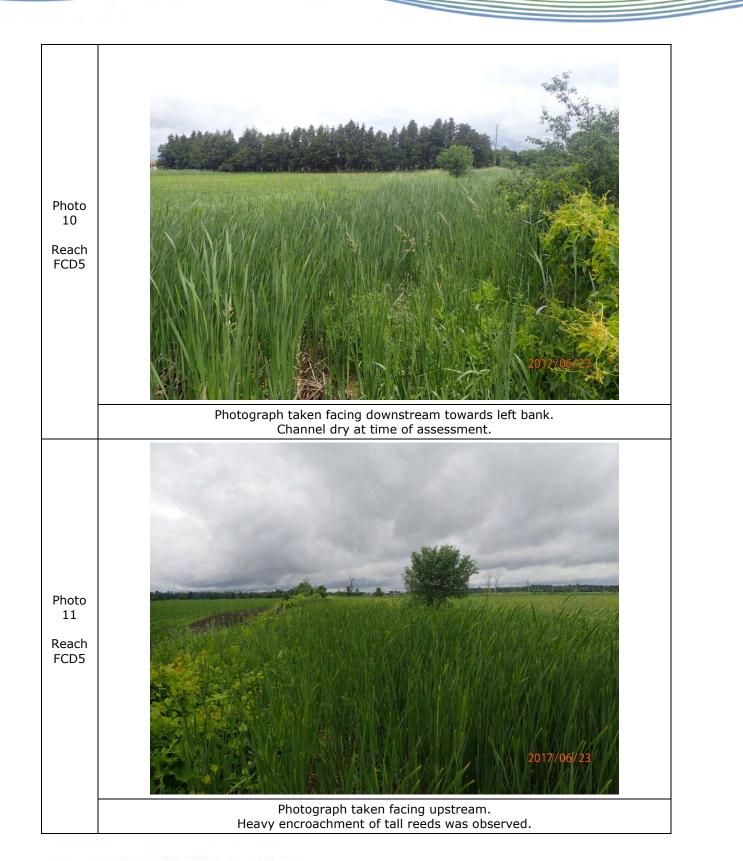


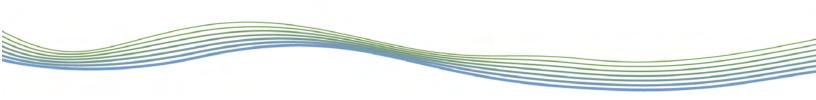
Photograph taken in the middle of the feature, facing east. Swale was primarily composed of reeds and was dry at the time of assessment.

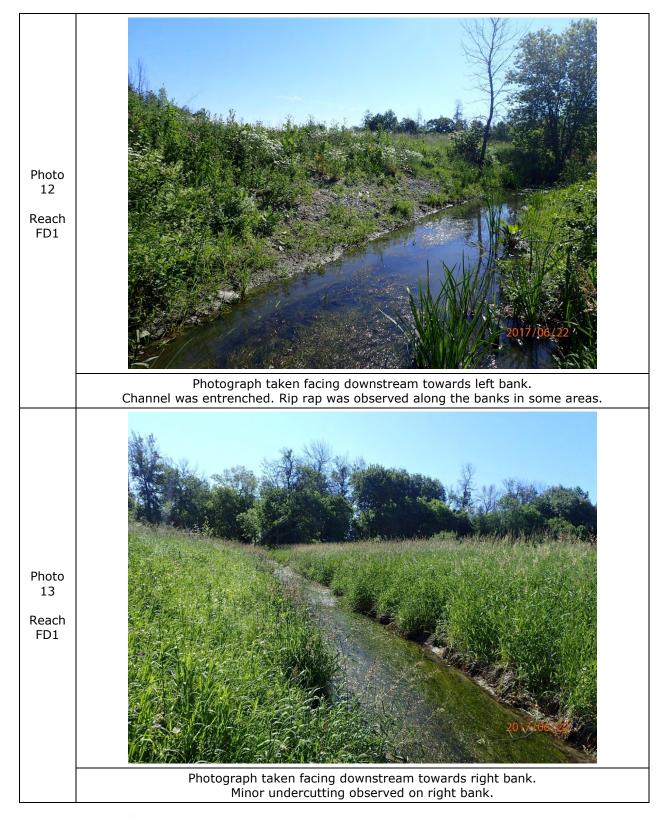
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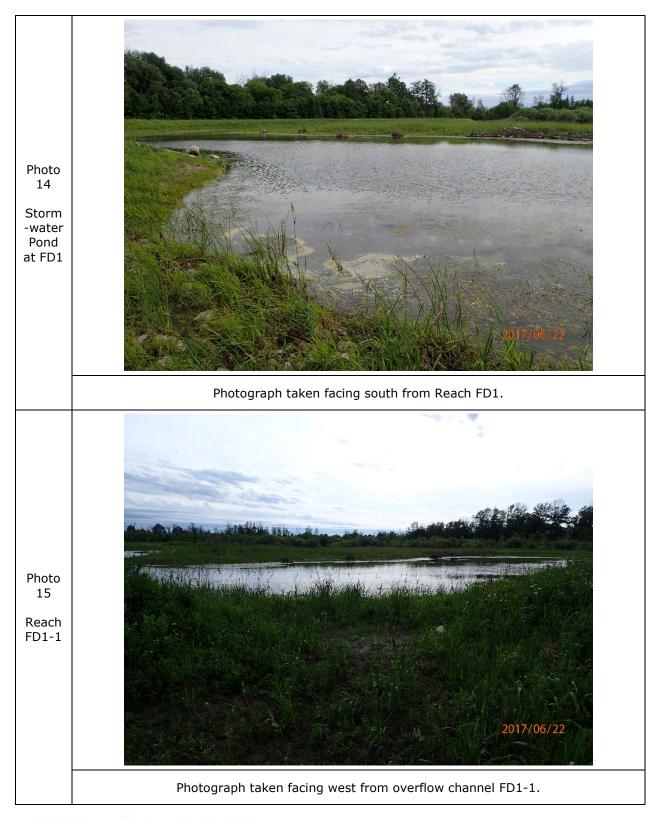


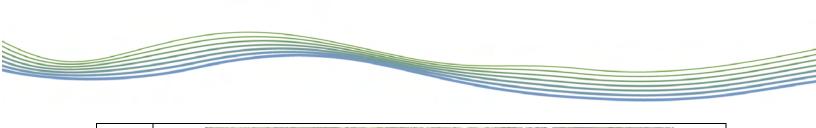


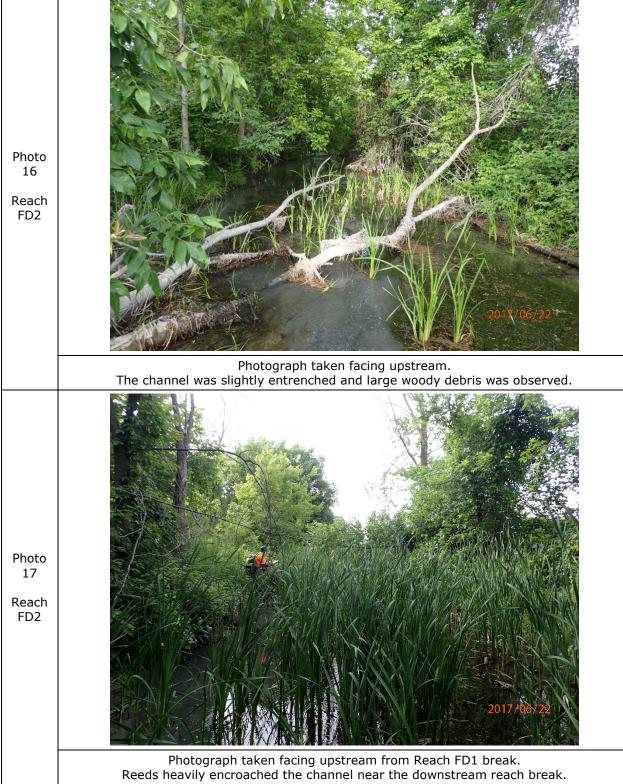


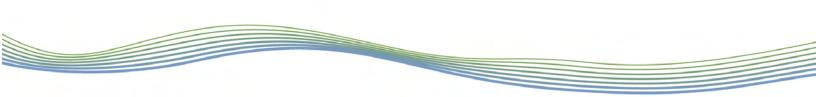


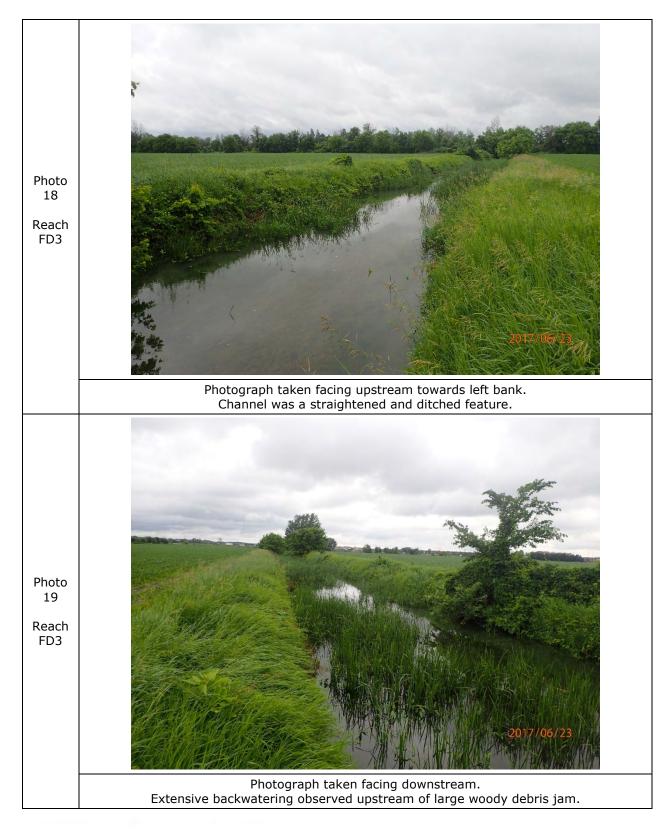


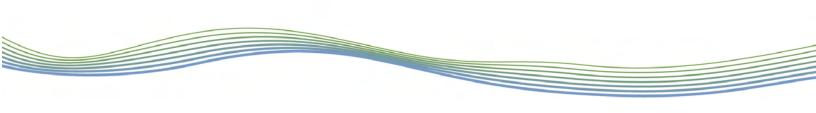


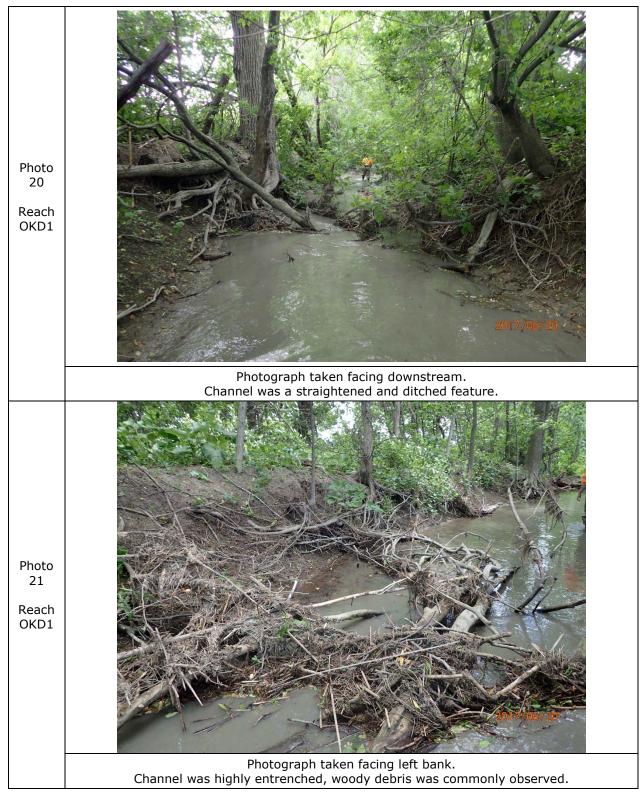


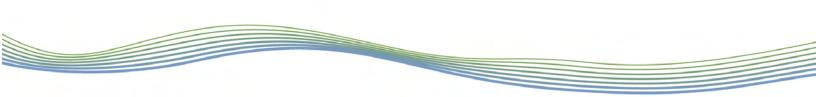


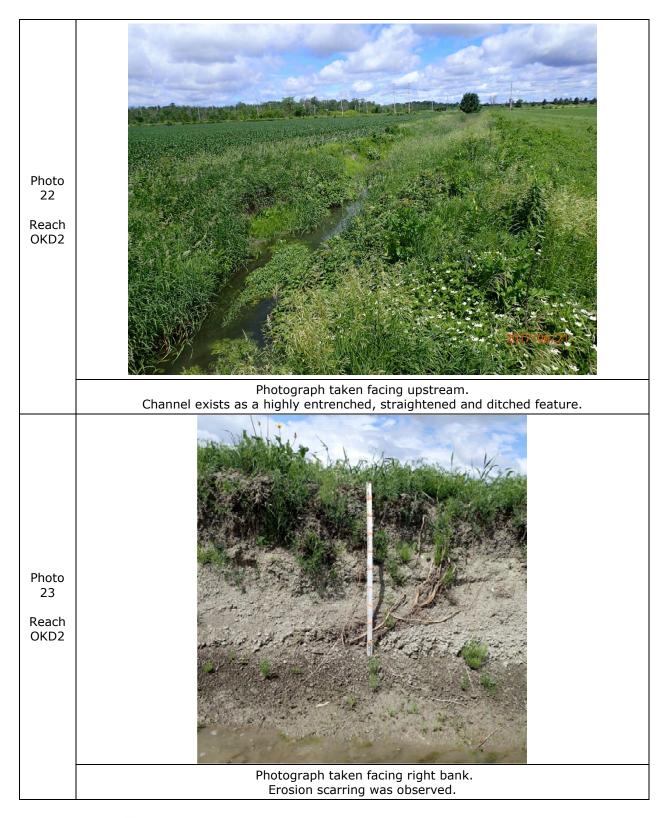














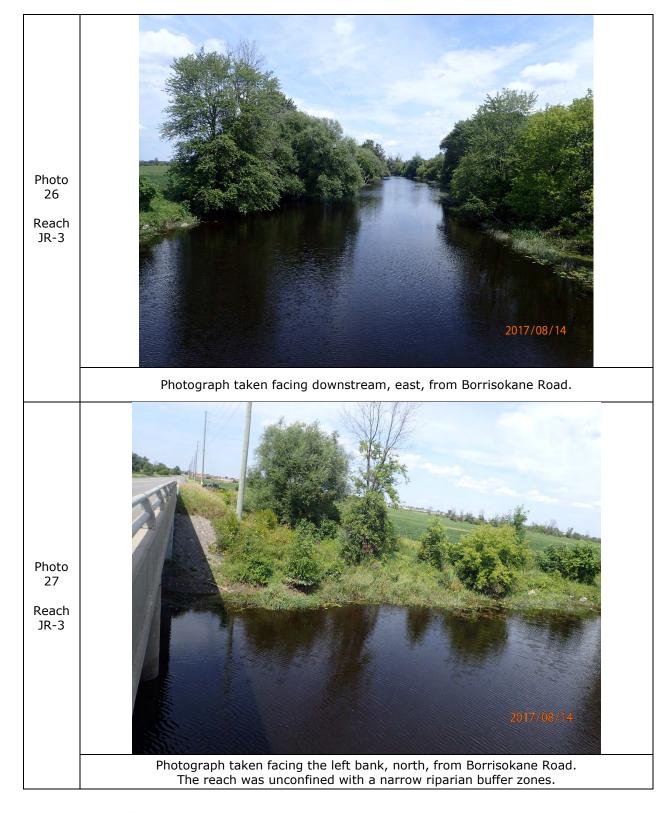
Photograph taken facing upstream, west, from Borrisokane Road.

Photograph taken facing right bank, south, from Borrisokane Road. The reach was unconfined.

Photo 25

Reach JR-4 2017/08/14







Appendix D Field Observations

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T 416.920.0926

Ottawa Office PO Box 336 Woodlawn PO Dunrobin, Ontario, Canada K0A 1T0

T 613.979.7303

Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD2
Field Staff:	LG BM2	Watercourse:	Foster Drain
Weather:	Rain 18C	Watershed:	Jock River

Location



lat=45.260226245331054, long=-75.75114652679375, alt=94.27012027340467, accuracy=48.0

General Characteristics				
Land Use:	Agricultural			
Valley Type:	Unconfined			
Channel Type:	11 - Straight suspended load			
Flow Type:	Perennial			
Groundwater:	No			
Notes:				

Riparian Vegetation

Dominant Vegetation Type:

Trees, Grasses

Dominant Species: Riparian Coverage: Width of Riparian Zone: Riparian Age Class: Extent of Encroachment into channel:

Trees, Grasses Grass dominant in downstream portion, trees dominant upstream portion Fragmented 1 - 4 Channel Widths Established (5-30 years) Moderate

Notes: Fully encroached in downstream portion of reach.

Aquatic/Instream Vegetation

Type of Instream Vegetation:Rooted EmergentCoverage of Reach (%):70Presence of Woody Debris:Present in ChanneDensity of Woody Debris:LowNumber of WDJs per 50 m:0

):	70
is:	Present in Channel
is:	Low
m	0

Notes:

Channel CharacteristicsType of Sinuosity:SinuousDegree of Sinuosity:Straight (1 - 1.05)Gradient:LowNumber of Channels:SingleEntrenchment:Low (>2.2)Bank Failures (Brierley and
Fryirs, 2005):NoneDowns Model of ChannelS - stable

Evolution (1995):	S - Stable
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt, Organics
Bank Material:	Clay, Silt, Sand
Bank Angle:	0 - 30
Extent of Bank Erosion:	< 5%

Notes:

Channel Measurements

Additional Measurements	
ls riffle-pool development absent?	yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A

Notes:

		Water Quality
Odour:	None	
Turbidity:	Clear	
Notes:		

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		June 21 2017	Stream/Reach: FCD2
		Sunny 25°	Location: Ottawa - Barrhaven
Field Staff: LG BM2			Watershed/Subwatershed:
Feature	es		Site Sketch:
	Reach break		
xx	Cross-section		
	Flow direction		
\sim	Riffle		
\bigcirc	Pool		
CEECED	Medial bar		MP
HIBHHH	Eroded bank		
	Undercut bank		
XXXXXX	Rip rap/stabilization	/gabion	N N N
**	Leaning tree		V · · V
XXX	Fence		
	Culvert/outfall		
\bigcirc	Swamp/wetland		AA.
WWW	Grasses		G V V tsi V
O	Tree		
	Instream log/tree		
* * *	Woody debris		
只	Station location		An. XSU
V	Vegetated island		
Flow T	уре		XII MIN VIII
H1	Standing water		There is a compared of the com
H2	Scarcely perceptible	e flow	
нз	Smooth surface flow	N	
Н4	Upwelling		6 5 7 8 35
H5	Rippled		W.C.S. A. JI
H6	Unbroken standing	wave	Auga ().
H7	Broken standing wa	ive	M Job 189
H8	Chute		NV YW W
H9	Free fall		(/ AF A
Substra	ate		1,36
S1	Silt	S6 Small boulder	North 6/ C / I
S2	Sand	S7 Large boulder	
S 3	Gravel	S8 Bimodal	E D Z L V V
S 4	Small cobble	S9 Bedrock/till	4. 1.452
S 5	Large cobble		We VE V
Other			
вм	Benchmark	EP Erosion pin	
BS	Backsight	RB Rebar	A REAL ASIA
DS	Downstream	US Upstream	
WDJ	Woody debris jam	TR Terrace	
vwc	Valley wall contact	FC Flood chute	Scale:
BOS	Bottom of slope	FP Flood plain	Additional Notes:
TOS	Top of slope	KP Knick point	~ 40 cm of sediment lorganics build up before bed

Date:	-7.	200 72/17	Strea	Project C	FCD2			
Veather:	5	750	Local	the second s	ottawa	- 12-	ccl.	e la
ield Staff:	100	ny 25 RM2		rshed/Subwaters		120	Thow	
ielu Stall;		5 1011	wate	isneu/Subwaters				
Process		T	Geomorphi	c Indicator			esent?	Factor
	No.	Description				Yes	No	Value
	1	Lobate bar	· · · · · · · · · · · · · · · · · · ·				X	_
	2	Coarse materials in	riffles embed	ded			NIA	_
Evidence of	3	Siltation in pools		· · · ·			NIA	014
Aggradation (AI)	4	Medial bars					X	- ' '
(A1)	5	Accretion on point b	and the second				NIA	_
	6	Poor longitudinal so	and the second	naterials			X	_
	7	Deposition in the ov	erbank zone				\times	
					Sum of indices =	0	4	0
	1	Exposed bridge foot	ng(s)					1
	2	Exposed sanitary / s	torm sewer /	pipeline / etc.				11/
	3	Elevated storm sewe	er outfall(s)					NIA
	4	Undermined gabion	baskets / cor	ncrete aprons / etc.				
Evidence of	5	Scour pools downstr	eam of culve	rts / storm sewer o	utlets			
egradation (DI)	6	Cut face on bar form						_
(2-7)	7	Head cutting due to	knick point n	nigration			×	013
	8	Terrace cut through	and the second sec	The second s			NIA	
	9	Suspended armour	ayer visible i	n bank			×	
	10	Channel worn into u	undisturbed overburden / bedrock X					
					Sum of indices =	0	3	0
	1	Fallen / leaning tree	s / fence nos	ts / etc.		×	1	
	2	Occurrence of large			· · · · · · · · · · · · · · · · · · ·	X		-
	3	Exposed tree roots	organic debi			~	×	-
	4	Basal scour on inside meander bends					×	- 217
Evidence of	5	Basal scour on both					NIA	- '
Widening (WI)	6	Outflanked gabion b	and a desire of a second s				NIA	-
(**1)	7	Length of basal scou					×	-
	8	Exposed length of p					×.	-
	9	Fracture lines along					x	-
	10	Exposed building for					NIA	-
••••••••••••••••••••••••••••••••••••••					Sum of indices =	2	5	0.28
	1		````					
	1	Formation of chute(×.	-
Evidence of	2	Single thread chann					Χ.	-
Planimetric	3	Evolution of pool-riff	le form to lo	w bed relief form			NIA	-
Form Adjustment	4	Cut-off channel(s)					Χ.	015
(PI)	5	Formation of island(X	-
	6		g alignment out of phase with meander form					
	7	Bar forms poorly for	med / reworl	ked / removed		65	×	
				1	Sum of indices =	0	5	$\underline{10}$
dditional note	es:	-		Stability I	ndex (SI) = (AI+D	I+WI+	PI)/4 =	= 0.07
dditional note	es:		Condition	Stability I In Regime	ndex (SI) = (AI+D	1		= 0.07 ustment

Checked by:

2

GEO MORPHIX

Rapid Stream Assessment Achnique

Date:	Jure 21/17	hnique Project Code: 1707) Stream/Reach: FCD2-				
Weather:	sunny 25°	Location:	Ottawa-	Back		
Field Staff:	LG BM2	Watershed/Subwate		Barrhaven		
Evaluation Category	Poor	Fair	Good	Excellent		
	 < 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 		
Channel	 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		
Stability NO CON	 Young exposed tree roots abundant > 6 recent large tree falls per stream mile 	Young exposed tree roots common predominantly old and		 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 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	00102	030405	6 6 7 8	X 9 🗆 10 🗆 11		
NIAT	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) 		
	 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 		
Channel Scouring/ Sediment Deposition	 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 add/or "banana"-shaped sediment deposits absent 		
	 deposits very common in channel Moderate to heavy sand deposition along major portion of overbank area 	 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 		
NIA	 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, Point bars few, si well-vegetated and/or armoured with little or po			
Point range	00102	0304	0506	□ 7 ¥ 8		

Date:		Reach:	Project Code	
Evaluation Category	Poor	Fair	Good	Excellent
	• 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)	and runs dominant	 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)
Physical Instream Habitat	 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
MAL	 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
AIN	• 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	00102	□ 3 □ 4	□ 5 □ 6 (0708
	 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%)
Water Quality	• 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	00102	□ 3 □ 4	□5 ⊠.6	0708
Riparian Habitat -	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
Conditions	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	001)	0405	□ 6 □ 7
otal overall sc	ore (0-42) = 3	Poor (<13) Fa	ir (13-24) Good (25-3	4) Excellent (>35)

GEO Morphix Ltd.

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Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD3
Field Staff:	LG BM2	Watercourse:	Frazer Clark Drain
Weather:	Rain 18C	Watershed:	Jock River

Location



lat=45.25976031175945, long=-75.75790180828797, alt=1.5463331083301004, accuracy=12.0

General Characteristics			
Land Use:	Agricultural, Residential		
Valley Type:	Unconfined		
Channel Type:	11 - Straight suspended load		
Flow Type:	Perennial		
Groundwater:	No		
Notes:			

Riparian Vegetation

Dominant Vegetation Type: Grass

Trees, Grasses

Dominant Species: Riparian Coverage: Width of Riparian Zone: Riparian Age Class: Extent of Encroachment into channel:

Fragmented 1 - 4 Channel Widths

Established (5-30 years)

Heavy

Notes:

Aquatic/Instream Vegetation

Type of Instream Vegetat Coverage of Reach (Presence of Woody Del Density of Woody Del Number of WDJs per 50

tion:	Rooted Emergent
(%):	100
bris:	Present in Channel
bris:	Low
0 m:	0

Notes:

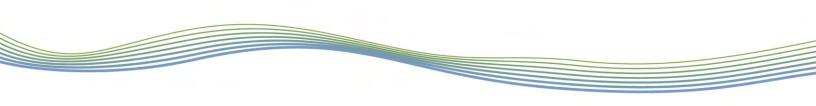
Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Low (>2.2)
Bank Failures (Brierley and Fryirs, 2005):	None
Downs Model of Channel Evolution (1995):	S - stable
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt, Organics
Bank Material:	Clay, Silt, Sand
Bank Angle:	0 - 30
Extent of Bank Erosion:	< 5%

Notes:

Channel Me	asurements
Cross Section #1:	
Bankfull Width (m): 11.5	Wetted Width (m): 4
Bankfull Depth (m): N/A	Wetted Depth (m): 0.12
Velocity (m/s): 0.02	Measurement Type: Wiffle ball
Cross Section #2: Run	
Bankfull Width (m): 12	Wetted Width (m): 3.5
Bankfull Depth (m): N/A	Wetted Depth (m): 0.11
Velocity (m/s): N/A	Measurement Type: N/A
Cross Section #3:	
Bankfull Width (m): 13.5	Wetted Width (m): _4
Bankfull Depth (m): N/A	Wetted Depth (m): 0.15
Velocity (m/s): N/A	Measurement N/A Type:
Additional Measurements	
Is riffle-pool development absent? yes	
Riffle-pool Spacing (m): N/A	
% Riffles: N/A	
% Pools: N/A	
Meander Amplitude (m):	
Pool Depth (m): N/A	
Riffle Length (m): N/A	
Undercuts (m): N/A	
· · ·	

Notes: Height of left bank: 0.60. No notable velocity at cross section 1.



Water	Qua	ПŢУ

Odour: None

Turbidity: Slightly Turbid

Notes:

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				GEO MORPHIX
Gene	eral Site Cha	rad	teristics	Project Code: 17071
Date:		J	one 23/17	Stream/Reach: FCD3
Weath	ner:		any. 20°	Location: Ottawa - Barrhaven
Field S	Staff:	L	6 BM2	Watershed/Subwatershed:
Featur	es			Site Sketch:
	Reach break			VI NI Poccess
*×	Cross-section			acces
	Flow direction			
\sim	Riffle			$(\mathcal{N}, \mathcal{N})$
\bigcirc	Pool			NI VI E
CEED .	Medial bar			
HHHHHH	Eroded bank			
*****	Undercut bank			
XXXXXX	Rip rap/stabilization	/gabi	on	
	Leaning tree			fall reeds
XXX	Fence			VIV (C) dense
	Culvert/outfall			
	Swamp/wetland			(V) chaurel
WWW C	Grasses		1	$\square \square $
0	Tree			
***	Instream log/tree Woody debris			
· ~ *	Station location			
(V)	Vegetated island			aussut and a
Flow T				grossut Ind VIV
H1	Standing water			channel O, AN A,1
H2	Scarcely perceptible	flow		edae (1)
нз	Smooth surface flow			
Н4	Upwelling			
Н5	Rippled			~ Im () () ()
H6	Unbroken standing	wave		grass Smith
H7	Broken standing wa	ve		Q Q Q
H8	Chute			
Н9	Free fall			Chill Wilshort m
Substr				ON CO derse r
S1	Silt	S6	Small boulder	B V 1/ chance
S2	Sand	S7	Large boulder	(L) (L' Crar
S3 S4	Gravel Small cobble	58 60	Bimodal Bodrock/till	$F_{\mathcal{F}} = F_{\mathcal{F}} $
54 S5	Large cobble	S9	Bedrock/till	
Other	carge counte			
BM	Benchmark	EP	Erosion pin	FILL AND
BS	Backsight	RB	Rebar	
DS	Downstream	US	Upstream	$e \vee \vee \vee \vee \vee \vee$
WDJ	Woody debris jam	TR	Terrace	Confluence
vwc	Valley wall contact	FC	Flood chute	Scale:
BOS	Bottom of slope	FP	Flood plain	Additional Notes:
TOS	Top of slope	КР	Knick point	
	-F			

anid Geor	orn	hic Assessment		Project Coc			MOR	
apid Geon ate:		ri 23/17		/Reach:	FCO3			
leather:	ra	ing 20°	Locatio	on:	Ottawa-	Barr	haven	
eld Staff:	1	G BM2	Waters	shed/Subwatershe	d:			
			Geomorphic	Indicator		Pre	sent?	Factor
Process	No.	Description				Yes	No	Value
	1	Lobate bar					X	
	2	Coarse materials in	riffles embedde	ed			NIA	
vidence of	3	Siltation in pools					MA	<i>C</i> (1)
Aggradation	4	Medial bars		X	OIH			
(AI)	5	Accretion on point b	ars				NIA	Ì
	6	Poor longitudinal so		aterials			×	
	7	Deposition in the ov					×	0
		L	(a		Sum of indices =	0	Ч	0
	1	Exposed bridge foot	ing(s)		1			
		Exposed bridge lood Exposed sanitary / s	A Martin Contractor of the second	nineline / etc				1 12
	2	Elevated storm sew			AIM		1	
	3	Undermined gabion		rete anrons / etc			-	
Evidence of	4				ets V			~ ~
Degradation	5	Scour pools downstream of culverts / storm sewer outlets						013
(DI)	6	and the second se		×				
	7	Head cutting due to		NIA				
	8	Terrace cut through		×				
	9	Suspended armour					Ŷ	-
	10	Channel worn into	undisturbed ov	erburden / bedrock	Sum of indices =	0	3	0
	1						X	
	1	Fallen / leaning tree				Y		
	2	Occurrence of large	e organic debris	5		1		4
	3	Exposed tree roots					×	-
	4	Basal scour on insid	and the second				AIN	- ·
Evidence of Widening	5	Basal scour on both			•			11/2
(WI)	6	Outflanked gabion	And the second se				NIA	
	7	Length of basal sco					NIR	-
	8			ed pipe / cable / etc.				-
	9	Fracture lines along					X	-
	10	Exposed building for	oundation		Cum of indicos -	1	6	6.14
					Sum of indices =	1		10.11
	1	Formation of chute	(s)				X	
	2	Single thread chan	nel to multiple	channel			X	_
Evidence of Planimetric	3	Evolution of pool-r					NIA	CIT
Form	4	Cut-off channel(s)					X.	015
Adjustment	5	Formation of island	d(s)		and the first of the second		X	-ask
(PI)	6		and the second se	with meander form				- ask
	7	Bar forms poorly fe					×	
					Sum of indices =	0	5	0
Additional not	es:			Stability In	dex (SI) = (AI+I	DI+WI	+PI)/4 =	6.035
			Condition	In Regime	In Transition/St	ress	In Adju	istment
			SI score =	⊠ 0.00 - 0.20	0.21 - 0.4	0		0.41
			JI SCOLE -	- 0100 0120				

Completed by: Checked by:

Rapid Stream Assessment Technique

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Project Code: 17071
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Date:	Jone 23/17	Stream/Reach:		FCD3		
Neather:	rainy 20°	Location:			barrheven	
Field Staff:	LG BM2	Watershed/Subwate	rshed:	100000		
Evaluation Category	Poor	Fair		Good	Excellent	
	 < 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 	stable • Infreque	of bank network ent signs of bank g, slumping or	 > 80% of bank network stable No evidence of bank sloughing, slumping or failure 	
Channel	 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 	Outer bandle of the second secon	bend areas stable ank height 0.6-0.9 e stream bank (1.2- bove stream bank e mainstem areas) erhang 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 	
Stability Morosyd	 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 Z-3		tree roots nantly old and naller young roots ent large tree falls am 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 generall	1/3 of bank is y highly resistant il 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	00102	030405	D 6	0708 (9 0 10 0 11	
	 > 75% embedded (> 85% embedded for large mainstem areas) 	 50-75% embedded (60- 85% embedded for large mainstem areas) 	59% em	embedded (35- bedded for large m areas)	 Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas) 	
NIT	 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 	pools Pool sub 	e number of deep strate composition sand-silt	 High number of deep poo (> 61 cm deep) (> 122 cm deep for large mainstem areas) Pool substrate compositio <30% sand-silt 	
Channel Scouring/ Sediment Deposition	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	and/or "	ed streak marks banana"-shaped t deposits oon	 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 	uncomm • Small lo	rrge sand deposits ion in channel calized areas of nd deposits along w banks	 Fresh, large sand deposits rare or absent from channel No evidence of fresh sediment deposition on overbank 	
NIA	 Point bars present at most stream bends, moderate to large and unstable with high amount of fresh sand 	nd unstable with high amount of fresh sand fresh sand fresh sand be well-vegetated and/or and/or and/or armound with little or no and/or armound or no fresh sand fresh sand be well-vegetated and/or armound or no fresh sand be well-vegetated and/or armound be armound be well-vegetated and/or armound be armou			 Point bars few, small and stable, well-vegetated and/or armoured with littl or no fresh sand 	
Point range	0 0 1 0 2	□ 3 □ 4		5 🗆 6	□ 7 x 8	

Date:		Reach:	Project Code:	
Evaluation Category	Poor	Fair	Good	Excellent
	 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)
Physical Instream Habitat	 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
NIT	 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
NIA		 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	x 5 🗆 6	□ 7 □ 8
	 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%)
Water Quality	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 0 1 0 2	. □ 3 □ 4	□ 5 x 6	0708
Riparian Habitat	 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
Conditions	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	001	⊠ 2 ⊡ 3	0405	□ 6 □ 7
otal overall so	core (0-42) = 29.5	Poor (<13) Fa	air (13-24) Good (25-3	34) Excellent (>35)

Completed by: $\angle G_7$ Checked by: _

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Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD3-1
Field Staff:	LG BM2	Watercourse:	Frazer Clark Drain
Weather:	Rain 18C	Watershed:	Jock River

Location



lat=45.25719582508419, long=-75.76280598993611, alt=49.93364386812506, accuracy=12.0

General Characteristics					
Land Use:	Agricultural, Residential				
Valley Type:	Unconfined				
Channel Type:	12 - Sinuous suspended load				
Flow Type:	Intermittent				
Groundwater:	No				
Notes:	No flow . Channel fully encroached by reeds and grasses. Only small puddles of water found .				

Riparian Vegetation

Dominant Vegetation Type:	-
Dominant Species:	F
Riparian Coverage:	
Width of Riparian Zone:	
Riparian Age Class:	
Extent of Encroachment into channel:	ł
Notes	(

Trees, Grasses
Reeds and grasses
Fragmented
1 - 4 Channel Widths
Established (5-30 years)
Heavy
Grasses and reeds fully encroach channel . Scattered
trees present trees denser at the upstream confluences

otes: trees present, trees denser at the upstream confluence with FCD3-1 AND FCD4-1

Aquatic/Instream Vegetation

Type of Instream Vegetation Coverage of Reach (%) Presence of Woody Debris Density of Woody Debris Number of WDJs per 50 m

Rooted Emergent
100
Not Present
None
0

Notes:

There may have been debris present , grasses to thick to see anything on the ground

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Low (>2.2)
Bank Failures (Brierley and Fryirs, 2005):	None
Downs Model of Channel Evolution (1995):	S - stable
Riffle Substrate:	N/A
Pool Substrate:	Clay, silt
Bank Material:	Clay,Silt,Sand
Bank Angle:	0 - 30
Extent of Bank Erosion:	< 5%

Notes:

Channel Measurements			
Cross Section #1:			
Bankfull Width (m):	12	Wetted Width (m):	N/A
Bankfull Depth (m):	N/A	Wetted Depth (m):	N/A
Velocity (m/s):	N/A	Measurement Type:	N/A
Cross Section #2:			
Bankfull Width (m):	8	Wetted Width (m):	N/A
Bankfull Depth (m):	N/A	Wetted Depth (m):	N/A
Velocity (m/s):	N/A	Measurement Type:	N/A
Additional Measurement	ts		
ls riffle-poo development absent?			
Riffle-pool Spacing (m)	: N/A		
% Riffles	: N/A		
% Pools	: N/A		
Meander Amplitude (m)	NI/A		
Pool Depth (m)	: N/A		
Riffle Length (m):	: N/A		
Undercuts (m)	: N/A		
Notes	:		

valer Quant	/ater Qualit	uality
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Odour:	N/A
Turbidity:	N/A

I/A Notes: No flow

			GEO MORPHI General Serves Descriptions
Gen	eral Site Cha	racteristics	Project Code: 17071
Date:		Jure 23/1	7 Stream/Reach: FCO3-1
Weath	ner:	rainy 70°	· Location: Ottawa-Barrhavel
Field :	Staff:	LG BMZ	Watershed/Subwatershed:
Featur	res		Site Sketch: Star FCD3-2+
	Reach break		CANNO.
×	Cross-section		
	Flow direction		
-	Riffle		N
	Pool Modial have		ET CAR 21
	Medial bar Eroded bank		M M
	Eroded bank Undercut bank		V18. B1
XXXXX	Rip rap/stabilization	abion	
	Leaning tree	gabion	
(XX			
	Culvert/outfall		
\bigcirc	Swamp/wetland		El (C) C) - Channel Fully
¥¥¥	Grasses		Channel lolly encroached
G	Tree		ED (V Co with reeds
	Instream log/tree		DIVINI COMMICCO
* * *	Woody debris		B C - no Flow
못	Station location		or water
	Vegetated island		N'ASSI' VILLIN
Flow T			
H1	Standing water		
H2	Scarcely perceptible Smooth surface flow		dense
H3 H4		/	(() grases
H5	Upwelling Rippled		
H6	Unbroken standing	wave	CAN (C3)
H7	Broken standing wa		
H8	Chute		
Н9	Free fall		
Substr	ate		
S1	Silt	S6 Small boulder	
S2	Sand	S7 Large boulder	
S 3	Gravel	S8 Bimodal	
S 4	Small cobble	S9 Bedrock/till	(ΛE_3)
S5	Large cobble		
Other	Developed		
BM	Benchmark	EP Erosion pin	
s s	Backsight Downstream	RB Rebar US Upstream	
NDJ	Downstream Woody debris jam	US Upstream TR Terrace	Beginning of
/WC	Valley wall contact	FC Flood chute	05 access
BOS	Bottom of slope	FP Flood plain	Additional Notes:
	a second of slope	· · · · · · · · · · · · · · · · · · ·	Additional Notes.

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		hic Assessment		Project C	oue. 1701			
Date:	Ju	ve 23/17	Strea	m/Reach:	FCD3	-1		
Weather:	(oudy 20°	Locat	tion:	ottawa	- B	arrhav	eh
ield Staff:	L	G BM2	Wate	rshed/Subwaters	ned:			
			Geomorphi	c Indicator		Pre	sent?	Factor
Process	No.	Description	·····			Yes	No	Value
	1	Lobate bar					X	
	2	Coarse materials in	riffles embed	ded			NIA	
Evidence of 3 Siltation in pools							NIA	
ggradation	4	Medial bars					X	014
(AI)	5	Accretion on point b	ars				NIA	. ,
	6	Poor longitudinal so		naterials			X	
	7	Deposition in the ov	A POINT AND A POINT APPROXIMATION APPROXIMATIONATIONA APPROXIMATIONATIONA APPROXIMATIONA				X	
900.00.00.00.00.00.00.00.00.00.00.00.00.	,		0.0011K 2011C		Sum of indices =	0	LI	0
	1	Exposed bridge foot	ing(s)		A		Γ	
	2	Exposed sanitary / s		nineline / etc	NIAT			
	3	Elevated storm sewe	and the second	pipeline / etc.	NIA			
	3 4	Undermined gabion		crete annone / etc				
Evidence of	5	and the second			tlata			
egradation	6	Scour pools downstr		rts / storm sewer ou	ueus v			012
(DI)	7	Cut face on bar forms V 0/3						
		Head cutting due to knick point migration X Terrace cut through older bar material NI R						
	8	Cusanandad amasun laura visikla in bank						
	9	the second se					X	
*****	10	Channel worn into u	naisturbed o	verburden / bedrock	Sum of indices =	0	X 3	0
		E-llas / lassing has			Sum of malecs -	<u> </u>	T	
	1	Fallen / leaning trees / fence posts / etc. ×						
	2	Construction of the second data description of the second data data and the second data data data data data data data da	Occurrence of large organic debris X					
- 43	3	Exposed tree roots					·X ·	
vidence of	4	Basal scour on inside					X	
Widening	5	Basal scour on both					NIA	0/7
(WI)	6	Outflanked gabion b		and a second sec			NIA	
	7	Length of basal scou	and the second se	and the second se			Κ.	
	8	A second second design of the second s	Exposed length of previously buried pipe / cable / etc.					
	9	Fracture lines along					X	
	10	Exposed building foundation N/A Sum of indices = 0 7 0						
						0	<u> </u>	0
	1	Formation of chute(X	
Evidence of	2	Single thread chann					X	
Planimetric	3	Evolution of pool-riff	le form to lo	w bed relief form			NIA	
Form Adjustment	4	Cut-off channel(s)					×	0
(PI)	5	Formation of island(×	U/4
	6	Thalweg alignment of	white the second s				NI.A	
	7	Bar forms poorly for	med / reworl	ked / removed		6	NIA	-
					Sum of indices =	6	4	Õ
dditional note	s:			Stability In	dex (SI) = (AI+D	I+WI+	PI)/4 =	0
no flow			Condition	In Regime	In Transition/Str	ress	In Adjus	stment
neary	4	1 or Cass	SI score =	⊠ 0.00 - 0.20	0.21 - 0.40		. 0	

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Completed by: _____ Checked by: _____

Rapid Stream Assessment Technique

Project Code: 17071

Date:	June 23/17	Stream/Reach:	FcD3-1		
Weather:	cloudy 20° Location:		Ottawe -B	arrhoven	
Field Staff:	LG BM2	Watershed/Subwate			
Evaluation Category	Poor	Fair	Good	Excellent	
	 < 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 	
Channel	 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 	
Stability No roots	 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	
Marine Marine	 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	030405	□ 6 □ 7 □ 8	0 9 🛛 10 🗆 11	
	 > 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) 	
NIA	 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 	
Channel Scouring/ Sediment Deposition	 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 iocalized 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 	
MIR	 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:	June 23/17	Reach: FCD3	Project Code:	17071
Evaluation Category	Poor	Fair	Good	Excellent
- posated III inspall pockets pockets	• 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)
1-1010	 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)
Physical Instream	 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
Habitat	 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
NA	 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
NIA	• 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	00102	页 3 🛙 4	□ 5 □ 6	0708
NVA [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
Water Quality	 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
L	 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	 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
Conditions	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 s	core (0-42) = 3()	Poor (<13) F	air (13-24) Good (25-	34) Excellent (>35)

Completed by:

Checked by:

3

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Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD3-2
Field Staff:	LG BM2	Watercourse:	Frazer Clark Drain
Weather:	Rain 18C	Watershed:	Jock River

Location



lat=45.25550095657881, long=-75.76600135181351, alt=66.9408353150523, accuracy=24.0

General Characteristics

Land Use:	Agricultural, Residential
Valley Type:	Unconfined
Channel Type:	12 - Meandering suspended load
Flow Type:	Intermittent
Groundwater:	No

Notes:

Riparian Vegetation

Dominant Vegetation Type: Dominant Species: Riparian Coverage: Width of Riparian Zone: Riparian Age Class: Extent of Encroachment into channel:

: Grass : Fragmented

Grass, Trees

1 - 4 Channel Widths

Established (5-30 years)

nel: Heavy

Notes:

Aquatic/Instream Vegetation

Type of Instream Vegetation: Coverage of Reach (%): Presence of Woody Debris: Density of Woody Debris: Number of WDJs per 50 m:

ר:	Reeds
):	90%
5:	None
5:	N/A
า:	N/A

Notes:

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Low sinuosity
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Slightly
Bank Failures (Brierley and Fryirs, 2005):	N/A
Downs Model of Channel Evolution (1995):	S - stable
Riffle Substrate:	N/A
Pool Substrate:	Silt, organics
Bank Material:	Clay, Silt,
Bank Angle:	0 - 30
Extent of Bank Erosion:	<5%

Notes:

	Channel Mea	asurements	
Cross Section #1:			
Bankfull Width (m):	5.3	Wetted Width (m):	N/A
Bankfull Depth (m):	N/A	Wetted Depth (m):	N/A
Velocity (m/s):	N/A	Measurement Type:	N/A
Cross Section #2:			
Bankfull Width (m):	4	Wetted Width (m):	N/A
Bankfull Depth (m):	N/A	Wetted Depth (m):	N/A
Velocity (m/s):	N/A	Measurement Type:	N/A
Cross Section #3:			
Bankfull Width (m):	2.9	Wetted Width (m):	N/A
Bankfull Depth (m):	N/A	Wetted Depth (m):	N/A
Velocity (m/s):	N/A	Measurement Type:	N/A
Additional Measuremen	nts		
Is riffle-po development absen			
Riffle-pool Spacing (m): <u>N/A</u>		
% Riffle	s: N/A		
% Pool	s: N/A		
Meander Amplitud (m	N/A		
Pool Depth (m): N/A		
Riffle Length (m): N/A		
Undercuts (m): N/A		

Notes:

Water	Quality
vvator	Zaanty

Odour: N/A

Turbidity:	N/A	-
Turbidity: Notes:		-

GEO MORPHIX Project Code: 17071 **General Site Characteristics** Jore 23/17 FC302 Date: Stream/Reach: rainy 20° Ottawa-Barrhaven Weather: Location: BM Field Staff: G Watershed/Subwatershed: Features Site Sketch: Tapers off -20-30m before Borrizo Kane = Reach break Cross-section Flow direction 11 Riffle Ν Pool COM D Medial bar HHHHHH Eroded bank ----- Undercut bank Rip rap/stabilization/gabion Fully Culvert/outfall encroache \bigcirc Swamp/wetland with Grasses **AAA** G Tree reeds Instream log/tree ★ ★ ★ Woody debris 只 Station location V Vegetated island Flow Type H1 Standing water H2 Scarcely perceptible flow нз Smooth surface flow Upwelling H4 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 **S**3 Gravel **S8** Bimodal Buffer Hinner than FCD3-1 **S**4 Small cobble S9 Bedrock/till **S**5 Large cobble 1 Other вм Benchmark ĒΡ Erosion pin BS Backsight RB Rebar DS Downstream US Upstream WDJ Woody debris jam TR Terrace vwc Valley wall contact FC Flood chute Scale: BOS Bottom of slope FP Flood plain Additional Notes: TOS Top of slope KΡ Knick point

Date:	T	phic Assessmen		Project (Cana	0			
Weather:	10	OVE ZITT	12000	am/Reach:	FCU3	-4			
	10	nny 20°	Loca	ation:	Ottawa	-13a1	rhave	1	
Field Staff:		LG BM2	Wat	ershed/Subwaters	shed:				
Process			Geomorph	nic Indicator		Pre	esent?	Factor	
	No.	Description				Yes	No	Value	
	1	Lobate bar					X		
	2	Coarse materials in	riffles embe	dded .			NIA	-	
Evidence of	3	Siltation in pools				1	NIA	014	
Aggradation (AI)	4	Medial bars					X	-011	
(AI)	5	Accretion on point I					NA	VO:12	
	6	Poor longitudinal so					X	- Phor	
	7	Deposition in the or	verbank zone				X		
					Sum of indices =	0	4	0	
	1	Exposed bridge foo					NIA	1	
	2	Exposed sanitary /		/ pipeline / etc.			NIA	1	
	3	Elevated storm sew					NIA	-	
Evidence of	4	Undermined gabion					NIA	1014	
Degradation	5			erts / storm sewer ou	utlets		X		
(DI)	6	Cut face on bar form	ns		· · · · · · · · · · · · · · · · · · ·		NIA	no hars	
	7	Head cutting due to	knick point r	nigration			X	-	
	8	Terrace cut through					MA	ve hais	
	9	Suspended armour	layer visible	rer visible in bank					
	10	Channel worn into u	Indisturbed o	verburden / bedrock			X	-	
					Sum of indices =	6	LI	G	
	1	Fallen / leaning tree	es / fence pos	sts / etc.			X		
	2	Occurrence of large							
	3	Exposed tree roots							
	4	Basal scour on insid	asal scour on inside meander bends						
vidence of Widening	5	Basal scour on both	sides of char	nnel through riffle			NIA	NO FIT	
(WI)	6	Outflanked gabion b	oaskets / con	crete walls / etc.			MIR	Not press	
	7	Length of basal score	ur >50% thro	ough subject reach			X		
	8	Exposed length of p	reviously bur	ied pipe / cable / etc	2.		X	1017	
	9	Fracture lines along	top of bank				×	1	
	10	Exposed building for	undation				AlGI	1	
					Sum of indices =	6)	6	
	1	Formation of chute(s)				X		
Fuller 6	2	Single thread chann		channel			Ŷ.	-	
Evidence of Planimetric	3						×.	-	
Form	4	Cut-off channel(s)	olution of pool-riffle form to low bed relief form						
Adjustment	5	Formation of island(
(PI)	6		ent out of phase with meander form						
	7		formed / reworked / removed						
		Peen/ 101	, , , , , , , , , , , , , , , , , , , ,	, removed	Sum of indices =	()	6	0	
dditional note	5:			Stability In	ndex (SI) = (AI+D	I+WI+			
10 flow			Condition	In Regime	In Transition/St		In Adju		
	sa	ncroached	SI score =						
our i gia		vid valied	Si score =	図 0.00 - 0.20	0.21 - 0.40		0	.41	

Completed by: _

_____ Checked by: ____

Rapid Stream Assessment Technique

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Project Code: 1707
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Date:	Two 23/17	Stream/Reach:		oject Code:		
Weather: rainy 20°		Location:		FLUD Z		
Field Staff:	LG BM2 Watershed/Subwate		rshed:	Ottawa - Barrhaven		
Evaluation Category	Poor	Fair		Good	Excellent	
	 < 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 	stable • Infrequer	of bank network nt signs of bank g, slumping or	 > 80% of bank network stable No evidence of bank sloughing, slumping or failure 	
Channel	 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 	 Outer bar m above 1.5 m above for large 	end areas stable nk height 0.6-0.9 stream bank (1.2- ove stream bank mainstem areas) rhang 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 	
Stability no roots keen in banks	 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 	predomin large, sm scarce	antly old and aller young roots t large tree falls	 Exposed tree roots old, large and woody Generally 0-1 recent large tree falls per stream mile 	
5 k high veg	 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 	generally	/3 of bank is highly resistant 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	030405	□ 6	0 🔊 0 8	□ 9 □ 10 □ 11	
NIA	 > 75% embedded (> 85% embedded for large mainstem areas) 	 50-75% embedded (60- 85% embedded for large mainstem areas) 	• 25-49% e 59% emb mainstem	embedded (35- edded for large 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 	
Channel Scouring/ Sediment Deposition	 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 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 	uncommoSmall loca	ge sand deposits n in channel Ilized areas of d deposits along 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 	well-veget	small and stable, tated and/or with little or no l	 Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand 	
Point range	00102	□ 3 □ 4		5 🗆 6	□ 7 ⊠ 8	

Date:		Reach:	Project Code:	
Evaluation Category	Poor	Fair	Good	Excellent
	• 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)
Physical Instream Habitat	 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
AIA	 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°CSummer afternoon water temperature 24-27°CSummer temperature		 Summer afternoon water temperature 20-24°C 	 Summer afternoon water temperature < 20°C
Point range	00102	□3 ⊠ 4	□ 5 □ 6	□ 7 □ 8
	 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%)
Water Quality	 Brown colour TDS: > 150 mg/L 	Grey colourTDS: 101-150 mg/L	 Slightly grey colour TDS: 50-100 mg/L 	Clear flow TDS: < 50 mg/L
water Quanty	 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	00102	□ 3 □ 4	□ 5 □ 6	□ 7 ⊠ 8
Narrow riparian area of mostly non-woody vegetation Habitat		 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
Conditions	Canopy coverage: <50% shading (30% for large mainstem areas)	 Canopy coverage: 50- 60% shading (30-44% for large mainstem areas) 	ng (30-44% 60-79% shading (45-59% >80% shading	
Point range	₫ 0 🗆 1	□ 2 □ 3	□ 4 □ 5	□ 6 □ 7
Total overall s	core (0-42) = 27	Poor (<13) Fa	air (13-24) Good (25-3	34) Excellent (>35)

Completed by: <u>LG</u> Checked by:

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Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FCD5
Field Staff:	LG BM2	Watercourse:	Frazer Clark Drain
Weather:	Cloudy 20 degrees	Watershed:	Jock River

Location



General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	11 - Straight suspended load
Flow Type:	Intermittent

Groundwater: No

Notes: No water present.

Riparian Vegetation

Grasses, Trees

Dominant Vegetation Type: Dominant Species: Riparian Coverage: Fragmented Width of Riparian Zone: Riparian Age Class: Extent of Encroachment into channel:

Grass 1 - 4Widths Established

Hea∨y

Notes:

Aquatic/Instream Vegetation

Type of Instream Vegetation: Coverage of Reach (%): Presence of Woody Debris: Density of Woody Debris: Number of WDJs per 50 m:

Reeds			
100%			
Not present	-		
None			
0			

Notes:

Channel Characteristics

Type of Sinuosity:	N/A
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Slightly Entrenched
Bank Failures (Brierley and Fryirs, 2005):	N/A
Downs Model of Channel Evolution (1995):	S - stable
Riffle Substrate:	N/A
Pool Substrate:	N/A
Bank Material:	Clay, Silt, Sand
Bank Angle:	0 - 30
Extent of Bank Erosion:	<5%

Notes:

Channel Measurements

Additional Measurements	
ls riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A

	Water Quality
Odour:	N/A
Turbidity:	N/A
Notes:	

				GEO MORPHIX Isramephology Erbisance Observations
Gene	eral Site Cha		Project Code:	
Date:		June 23/11	Stream/Reach:	FCD5
Weath	er:	cloudy 20°	Location:	Ottawa - Barrhaver
Field S	Staff:	Jure 23/17 Cloudy 20° LG BM2	Watershed/Subwatershed:	
Feature	es		Site Sketch: Borrisok	ane
	Reach break			
	Cross-section			K K
~~	Flow direction			N
\bigcirc	Riffle			
	Pool Madial bar			
	Medial bar Eroded bank			
	Eroded bank Undercut bank		\$	
XXXXXX	Rip rap/stabilization	/gabion		
	Leaning tree	gabion		
x				
1 1	Culvert/outfall			
	Swamp/wetland			
¥¥¥	Grasses			
G	Tree			
	Instream log/tree		B B B B B B B B B B B B B B B B B B B	
***	Woody debris			
묫	Station location			
V	Vegetated island			
Flow T	уре			
H1	Standing water			
H2	Scarcely perceptible	flow		-Fully
HЗ	Smooth surface flow	V		encroache
H4	Upwelling			V V i w reeds
H5	Rippled			
H6	Unbroken standing	wave		
H7	Broken standing wa	ve		Y Y
H8	Chute		4	
Н9	Free fall		(3)	the inter I flor
Substr				ro water Ifla
S1	Silt	S6 Small boulder		I in channel
S2	Sand	S7 Large boulder		
S 3	Gravel	S8 Bimodal		
S4	Small cobble	S9 Bedrock/till	2 inter	Y Y
S5	Large cobble		FD3 Water	FOS
Other BM	Benchmark	EP Erosion pin	- Channel	
BM BS	Benchmark Backsight	EP Erosion pin RB Rebar		
BS DS	Downstream	US Upstream		Flow
WDJ	Woody debris jam	TR Terrace		FO3
VWC	Valley wall contact			Scale:
BOS	Bottom of slope	FP Flood plain	Additional Notes:	
TOS	Top of slope	KP Knick point		

1								
0	М	0	R	Ρ	н	I	х	

Date:	To	nº 73/17	Strea	m/Reach:	FCDS					
Veather:	C	audu 70°	Loca	tion:	Other	0-12	barrha	uch		
ield Staff:	L	G BMZ	Wate	rshed/Subwatersh	ed:	1.		/		
Process			Geomorphi	c Indicator		Pre	sent?	Factor		
FIOCESS	No.	Description				Yes	No	Value		
	1	Lobate bar					NIA			
	2	Coarse materials in	riffles embed	ded			NIA	1		
Evidence of	.3	Siltation in pools					×	1		
Aggradation	4	Medial bars					×	1		
(AI)	5	Accretion on point b	ars				NIA	0/4		
	6	Poor longitudinal so		naterials			X	1 ' '		
	7	Deposition in the ov	erbank zone				×	1		
				· · ·	Sum of indices =	0	4	G		
	1	Exposed bridge foot	ng(s)		r					
	2	Exposed sanitary / s		pipeline / etc.				1		
	3	Elevated storm sewe			NIA			1		
	4	Undermined gabion		ncrete aprons / etc.						
Evidence of	5			rts / storm sewer out	lets			013		
Degradation (DI)	6	Cut face on bar form								
(01)	7	Head cutting due to	knick point r	nigration			×			
	8	Terrace cut through								
	9	Suspended armour I					NIA	1		
	10	Channel worn into u	ndisturbed o	verburden / bedrock			X	1		
					Sum of indices =	0	3	0		
	1	Fallen / leaning tree	s / fence pos	ts / etc.			X			
	2	Occurrence of large	organic debr	is			×	1		
	3	Exposed tree roots					X	1		
	4	Basal scour on insid	e meander b	ends	Г	-		1		
Evidence of	5	Basal scour on both	sides of char	nnel through riffle	NIA			1		
Widening (WI)	6	Outflanked gabion b	askets / con	crete walls / etc.				1		
	7	Length of basal scou	r >50% thro	ugh subject reach				1		
	8	Exposed length of p	eviously bur	ied pipe / cable / etc.	1			0/4		
	9	Fracture lines along	top of bank				×])		
	10	Exposed building for	Indation				NA			
					Sum of indices =	σ	Ч	0		
	1	Formation of chute(5)				X			
Evidence (2	Single thread chann		channel			X	1		
Evidence of Planimetric	3	Evolution of pool-rif					NIA	1		
Form	4	Cut-off channel(s)								
Adjustment	5	Formation of island(s)								
(PI)	6	Thalweg alignment of		with meander form			NIA	1 1		
	7	Bar forms poorly for					NIA			
					Sum of indices =	\circ	1-1	6		
Additional note	es:			Stability In	dex (SI) = (AI+D	I+WI+	PI)/4 =	0		
	the first of the local division of the									
- no wo	ter		Condition	In Regime	In Transition/St	ress	In Adju	stment		

Completed by: _____ Checked by: _____

Rapid Stream Assessment Technique

Project Code: 17071

Date:	June 23/17	Stream/Reach:		FCDS		
Weather: cloudy 20* Location:			Ottawa-	Barrhaven		
Field Staff:	LG BM2	Watershed/Subwater	Watershed/Subwatershed:			
Evaluation Category	Poor	Fair		Good	Excellent	
0	 < 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 	stable • Infreque	of bank network ent signs of bank ig, slumping or	 > 80% of bank network stable No evidence of bank sloughing, slumping or failure 	
Channel	 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 	 Outer bain above 1.5 m all for large 	bend areas stable ank height 0.6-0.9 e stream bank (1.2- bove stream bank e mainstem areas) rerhang 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 	
Stability	 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 	generall	1/3 of bank is ly highly resistant il matrix or material	 Bottom 1/3 of bank is generally highly resistant plant/soil matrix or material 	
		 Channel cross-section is generally trapezoidally- shaped 		l cross-section is ly V- or U-shaped	 Channel cross-section is generally V- or U-shaped 	
Point range	0 0 1 0 2	<u> </u>	□ 6	□ 7 □ 8	¤ 9 🗆 10 🗆 11	
ſ	 > 75% embedded (> 85% embedded for large mainstem areas) 	 50-75% embedded (60- 85% embedded for large mainstem areas) 	59% en	embedded (35- nbedded for large m areas)	 Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas) 	
Pool substrate composition >81% sand- composition >81% sand- composition >81% sand- composition >81% sand- composition sand-		 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 poo (> 61 cm deep) (> 122 cm deep for large mainstem areas) Pool substrate composition <30% sand-silt 	
Channel Scouring/ Sediment Deposition	Streambed streak marks and/or "banana"-shaped sediment deposits common	Streambed streak marks and/or "banana"-shaped sediment deposits common	and/or '	bed streak marks `banana″-shaped nt deposits non	Streambed streak marks and/or "banana"-shaped sediment deposits absent	
NIA	Fresh, large sand deposits very common in channel Mederate to beauty cond Common in channel Channel		 Fresh, large sand deposits uncommon in channel Small localized areas of fresh sand deposits along top of low banks 		 Fresh, large sand deposit rare or absent from channel No evidence of fresh sediment-deposition on overbank 	
, L	 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 litt or no fresh sand 	
Point range	□ 0 □ 1 □ 2	□ 3 □ 4	C	5 🗆 6	□ 7 ⊠ 8	

ate:	June 23/17	Reach: FCD5	Project Code:	17071
Evaluation Category	Poor	Fair	Good	Excellent
	• Wetted perimeter < 40% of bottom channel width (< 45% for large mainstem areas)	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)
Physical Instream	 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
Habitat	 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 0 1 0 2	⊠ 3 □ 4	□ 5 □ 6	□ 7 □ 8
	• 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%)
NIN	Brown colour TDS: > 150 mg/L	Grey colour TDS: 101-150 mg/L	Slightly grey colourTDS: 50-100 mg/L	 Clear flow TDS: < 50 mg/L
Water Quality	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
L	Moderate to strong organic odour	 Slight to moderate organic odour 	 Slight organic odour 	No odour
Point range	0 0 1 0 2	□ 3 □ 4	0506	□ 7 ¤ 8
Riparian	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
Habitat Conditions	• 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 (45-5 for large mainstem areas) 		Canopy coverage: >80% shading (> 60% fo large mainstem areas)
Point range		□ 2 □ 3	0405	□ 6 □ 7
Total overall	score (0-42) = 28.5	Poor (<13)	Fair (13-24) Good (25	Excellent (>35)

Completed by: _____

___ Checked by: __

GEO Morphix Ltd.

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T 416.920.0926

Ottawa Office PO Box 336 Woodlawn PO Dunrobin, Ontario, Canada K0A 1T0

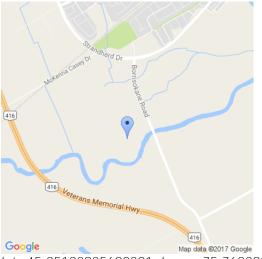
T 613.979.7303

Project Number: PN17071

Reach Characteristics

Date:	2017-06-22	Reach:	FD1
Field Staff:	LG BM2	Watercourse:	Foster Drain
Weather:	Sunny 25 degrees	Watershed:	Jock River

Location



lat=45.25182925690391, long=-75.768392678713, alt=61.008241515689946, accuracy=12.0

General Characteristics

Land Use: Agricultural Valley Type: Unconfined Channel Type:

12 - Sinuous suspended load

Flow Type: Perennial

No

Groundwater:

Riparian Vegetation

Dominant Vegetation Type: Dominant Species: Riparian Coverage: Width of Riparian Zone: Riparian Age Class: Extent of Encroachment into channel:

Grasses Fragmented

Minimal

Trees, Grasses

1 - 4 Channel Widths Established (5-30 years)

Notes:

Aquatic/Instream Vegetation

Type of Instream Vegetation: Coverage of Reach (%): Presence of Woody Debris: Present in Channel Density of Woody Debris: Number of WDJs per 50 m: 0

80 Low

Rooted Submergent

Notes: Rooted emergent and submergent veg.

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight
Gradient:	Low
Number of Channels:	Single
Entrenchment:	High (<1.4)
Bank Failures (Brierley and Fryirs, 2005):	Undercutting (Hydraulic Action)
Downs Model of Channel Evolution (1995):	S - Stable - no observable morphological change
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt
Bank Material:	Clay, Silt
Bank Angle:	60 - 90
Extent of Bank Erosion:	30 - 60%

Notes: Riffle pool sequence absent .

Channel Measurements

Additional Measurements	
ls riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	0.20,

Notes: 50-75% erosion extent along reach .

Water Quality

Odour:	None
Turbidity:	Clear
Notes:	Slightly turbid to opaque, appears clear because of bed sediment being close to surface

	GEO MORPHIX
General Site Characteristics	Project Code: 17071
Date: Jure 22/17	Stream/Reach:
Weather: Cloudy 20°	Location:
Field Staff: I.G. BM2	Watershed/Subwatershed:
Features	Site Sketch:
Reach break	at le v
Cross-section	NA JONNON AT ()
Flow direction	OU AN CL LO
Riffle	Not P N
Pool	MARKEDZ MARSI
Medial bar	
####### Eroded bank	
Undercut bank	the second se
Rip rap/stabilization/gabion	Pov.
->>>> Leaning tree	
Culvert/outfall	
Swamp/wetland	
₩₩₩ Grasses	(3) V × × × × ×
C Tree	Y Y Y
Instream log/tree	
K 🛪 🗶 Woody debris	AE SOLO
只 Station location	XI MIC
Vegetated island	
Flow Type	
H1 Standing water	NA C3
H2 Scarcely perceptible flow	
H3 Smooth surface flow	
H4 Upwelling	NV Nb
H5 Rippled	V
H6 Unbroken standing wave	
H7 Broken standing wave	V XS8
H8 Chute	- Under Cutting
H9 Free fall	a contraction of grasses
Substrate	- aense grass V/ 1/ + U
S1 Silt S6 Small boulder	DEFECT
S2 Sand S7 Large boulder	Continuous X. X.
S3 Gravel S8 Bimodal	
S4 Small cobble S9 Bedrock/till	-rooted
S5 Large cobble	Superger COVY XV
Other	Controus of the the
BM Benchmark EP Erosion pin	(Y, Y, V/) W
BS Backsight RB Rebar	A A MCD
DS Downstream US Upstream	V VIVer
WDJ Woody debris jam TR Terrace	Sola Jock R.
VWC Valley wall contact FC Flood chute	Stale.
BOS Bottom of slope FP Flood plain	Additional Notes:
TOS Top of slope KP Knick point	

Date:	5	re 22/11	Strea	am/Reach:	ode: 170)				
Weather:		oudy 20-	Loca	tion:	Ner	earlot	tawa			
Field Staff:	1	BM2 6	Wate	ershed/Subwaters	100000000	0 101	(
		11 -9		concer, outputters,						
Process			Geomorph	ic Indicator			Present?	Factor		
	No.	Description				Ye		Value		
	1	Lobate bar			-		×			
	2	Coarse materials in	riffles embed	lded			NIA	·		
Evidence of	3							- 1		
Aggradation (AI)	4	Medial bars					X	- 6		
()	5	Accretion on point			ч.		×	2		
	6	Poor longitudinal so	the second se	naterials		×				
and the second	7	Deposition in the o	verbank zone				×			
		T			Sum of indi	ces =				
	1	Exposed bridge foo	ting(s)		N	IA				
	2	Exposed sanitary /	storm sewer ,	/ pipeline / etc.		-				
	3	Elevated storm sew	ver outfall(s)							
Evidence of	4		and the second se	ncrete aprons / etc.						
Evidence of Degradation	5	Scour pools downst	V							
(DI)	6	Cut face on bar forms					\times			
	7	Head cutting due to					×			
	8	Terrace cut through	n older bar ma	aterial			\times			
	9	Suspended armour				IA	10.0000000			
	10	Channel worn into	undisturbed o	verburden / bedrock						
					Sum of indi	ces =				
	1	Fallen / leaning tree	es / fence pos	sts / etc.			\mathbf{X}			
	2	Occurrence of large organic debris								
	3	Exposed tree roots			N	IA		no tree		
	4	Basal scour on insid	de meander b	ends			X			
Evidence of Widening	5	Basal scour on both	n sides of char	nnel through riffle				NIA		
(WI)	6	Outflanked gabion	baskets / con	crete walls / etc.				NIN		
	7	Length of basal sco	ur >50% thro	ough subject reach			\times			
	8			ied pipe / cable / etc			X	_		
	9	Fracture lines along					X			
	10	Exposed building for	undation					MA		
					Sum of indi	ces =				
	1	Formation of chute	(s)							
Evidence of	2	Single thread chan	nel to multiple	e channel	er an and a fear and an		1			
Planimetric	3	Evolution of pool-riffle form to low bed relief form					×	-		
Form	4	Cut-off channel(s)					×	-		
Adjustment (PI)	5	Formation of island(s)					X	-		
((-1)	6	Thalweg alignment	alweg alignment out of phase with meander form					topent		
	7	Bar forms poorly fo	rmed / rewor	ked / removed			×			
					Sum of indi	ces =				
Additional note	s:			Stability Ir	ndex (SI) = (AI+DI+W	I+PI)/4 =	=		
			Condition	In Regime	In Transitio			ustment		
			SI score =	0.00 - 0.20	0.21	- 0.40	П	0.41		
						0.10	L			

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Ra

Date:	Jone 22/17	Stream/Reach:	San San	oject Code:			
Weather:	Cloudy 200	Location:			n-H		
Field Staff:	BM2 G	Watershed/Subwatershed:		Tang			
Evaluation Category	Poor	Fair	Good		Excellent		
	 < 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 	stableInfreque	of bank network nt signs of bank g, slumping or	 > 80% of bank network stable No evidence of bank sloughing, slumping or l failure 		
Channel	 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 very		
Stability NA Trees	 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 	predomir large, sm scarce	tree roots hantly old and haller young roots ht large tree falls m mile	 Exposed tree roots old, large and woody Generally 0-1 recent larg tree falls per stream mile 		
 Bottom 1/3 of bank is highly érodible 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 10 material		
	Channel cross-section is generally trapezoidally- shaped	 Channel cross-section is generally trapezoidally- shaped 	Channel-cross-section is generally V- or U-shaped S		Channel cross-section is generally V- or U-shaped		
Point range	00102	□ 3 □ 4 □ 5	□ 6	0708	₫ 9 □ 10 □ 11		
NIA	 > 75% embedded (> 85% embedded for large mainstem areas) 	 50-75% embedded (60- 85% embedded for large mainstem areas) 	• 25-49% e 59% emb mainstem	embedded (35- edded for large areas)	 Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas) 		
NIA	Pool substrate composition >81% sand- silt	sand- • Pool substrate composition 60-80% sand-silt • of deep pools • Pool substrate compositio 30-59% sand-silt		trate composition	 High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) Pool substrate composition <30% sand-silt 		
Channel Scouring/ Sediment Deposition	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		
	 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 	leposits common in thannel Small localized areas of resh sand deposits along		 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 	well-veget	small and stable, ated and/or with little or no	 Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand 		
Point range	0 0 1 0 2	□ 3 □ 4		5 🗆 6	□ 7 ⊠ 8		

n OS

Date:		Reach:	Project Code:			
Evaluation Category	Poor	Fair	Good	Excellent		
	• 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) X		
	 Dominated by one habitat type (usually runs) and by one velocity and depth condition (slow and shallow) (for large mainstem areas, few niffles 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) 		
NK Physical Instream Habitat MA	 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 > 6 cm deep (> 122 cm for 		
	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		
ny	 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 v		
Point range	00102	3 4	□ 5 □ 6 (
	 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%)		
Water Quality	• 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		
	< 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	00102	□ 3 □ 4	□5 卤 6	0708		
Riparian Habitat	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	0405	□ 6 □ 7		
otal overall so	ore (0-42) = 30.5	Poor (<13) Fa	ir (13-24) Good (25-3	4) Excellent (>35)		

Completed by: _____ Checked by: ____

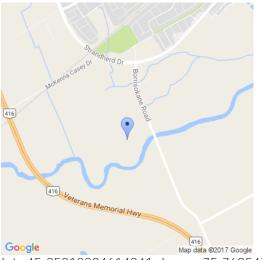


Project Number: PN17071

Reach Characteristics

Date:	2017-06-22	Reach:	FD2
Field Staff:	LG BM2	Watercourse:	Foster Drain
Weather:	Cloudy 20 degrees	Watershed:	Jock River

Location



lat=45.25212204614041, long=-75.7685473728085, alt=69.52584001778119, accuracy=16.0

General Characteristics

Land Use:	Agricultural
Valley Type:	Unconfined
Channel Type:	12 - Sinuous, suspended load
Flow Type:	Perennial

No

Groundwater:

Riparian Vegetation

Trees, Shrubs, Grasses

Dominant Vegetation Type: Dominant Species: Riparian Coverage: Width of Riparian Zone: Riparian Age Class: Extent of Encroachment into channel:

Grass Continuous

1 - 4 Channel Widths

Established (5-30 years)

innel: Minimal

Notes:

Aquatic/Instream Vegetation

Type of Instream Vegetation: Coverage of Reach (%): Presence of Woody Debris: Density of Woody Debris: Number of WDJs per 50 m:

Rooted Emergent	
55	
Present in Cutbank, Present in Channel	
Moderate	
2	

Notes: Extensive reed encroachment in channel, rooted submergent plants, algae

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Low sinuosity (1.06-1.30)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	Slightly
Bank Failures (Brierley and Fryirs, 2005):	Undercutting (hydraulic action)
Downs Model of Channel Evolution (1995):	S - Stable – no observable morphological change
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt
Bank Material:	Clay, Silt
Bank Angle:	60 - 90
Extent of Bank Erosion:	0 - 30%

Notes:

Ball
Ball

Additional Measurements	
Is riffle-pool development absent?	yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	0.10

Notes: Cross Section 1 near culvert at upstream break. Cross Section 2 downstream at bend near woody debris.

	Water Quality
Odour:	None
Turbidity:	Clear
Notes:	Slightly organic smell

General Site	Characteristics	Project Code: (707)					
Date:	June 22/1	Stream/Reach:					
Weather:	claudy 20°	Location: Neplan Ottawa					
Field Staff:	BMZ 118	Watershed/Subwatershed:					
Features		Site Sketch:					
 Leaning tree Fence Culvert/outf Swamp/wet Swamp/wet Tree Instream loca Station loca Vegetated is Flow Type Standing wat 	n on k ilization/gabion all land g/tree is tion sland	N C C C C C C C C C C C C C C C C C C C					
 H3 Smooth sur H4 Upwelling H5 Rippled H6 Unbroken star H7 Broken star H8 Chute H9 Free fall 	anding wave	Jon Official					
Substrate S1 Silt S2 Sand S3 Gravel S4 Small cobbl S5 Large cobbl Other		die Children Children Children Die					
BM Benchmark BS Backsight DS Downstrear WDJ Woody debi VWC Valley wall BOS Bottom of s TOS Top of slope	is jam TR Terrace contact FC Flood chute lope FP Flood plain	Additional Notes:					
căr.		pric 379 sturt last piz 403 completed by: 102 Checked by:					

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	-	• • • • • • • • •		1 - A - A - A - A - A - A - A - A - A -	· · ·		,		
						GEO	мо	RPHIX	
	norpl	nic Assessment			ode: 17071				1
Date:	10	ref 111	Strea	m/Reach:	ED2				
Weather:	CL	oudy 20	Locat	tion:	Ottawa	-B.	arthau	en	
Field Staff:	LG	BMZ	Wate	rshed/Subwaters	hed:	1			
			Geomorphi	c Indicator	A 02 598730	Dro	sent?]
Process	No.	Description	deomorphi			Yes	No	Factor Value	F
	1	Lobate bar				165	X	vulue	-r1
	2	Coarse materials in	riffles embed	ded			NIA	21	000
Evidence of	3	Siltation in pools	Times embed	ueu	1		NIA	alu	abse
Aggradation	4	Medial bars					INN	019	- lear
(AI)	5	Accretion on point b	ars				NIK	-	abi
	6	Poor longitudinal so		naterials			K		
	7	Deposition in the ov					X		
	L				Sum of indices =	\bigcirc	4	0	
		Eveneed hadden of				\sim			1
	1	Exposed bridge foot		· · · · ·				in	
	2	Exposed sanitary /		pipeline / etc.				IA	
0.00	3	Elevated storm sewer outfall(s) Undermined gabion baskets / concrete aprons / etc.							~
Evidence of	4			L	-				
Degradation	6	Scour pools downstream of culverts / storm sewer outlets							
(DI)	7							019	
	8	lead cutting due to knick point migration errace cut through older bar material					X N/A		
	9	the second s	bended armour layer visible in bank						
	10		undisturbed overburden / bedrock						
	10	channel worth into t		verburden / bedrock	Sum of indices =	0	4		
87) 							1		J
	1	Fallen / leaning tree				X			
	2	Occurrence of large organic debris							
	3	Exposed tree roots				X		11/7	
Evidence of	4	Basal scour on insid					X	4/7	
Widening	5		h sides of channel through riffle N 1/2 baskets / concrete walls / etc.						> de
(IW)	7	Length of basal sco					NIA		0.00
	8	Exposed length of p					<u>\</u> .		r th
	9	Fracture lines along		ied hihe / capie / et		*	X	1	pipe we the it we
	10	Exposed building fo					NIA	-	plau
	1 10	Exposed building 10			Sum of indices =	4	3	0.57	place like
						7_		10.51]
	1	Formation of chute							
Evidence of	2	Single thread chann	the second se				X		
Planimetric	3	Evolution of pool-rif	tle form to lo	w bed relief form			NIK	0 11	
Form Adjustment	4	Cut-off channel(s)					X	014	
(PI)	5	Formation of island(s)					X	Jank	
	6	Thalweg alignment out of phase with meander form Bar forms poorly formed / reworked / removed					6.14	-u	
	7	bar forms poorly fo	rmed / rework	ked / removed	Curra of to di	~	NA		
					Sum of indices =	0]
Additional note	s:			-	ndex (SI) = (AI+D		PI)/4 =	6.14	
			Condition	In Regime	In Transition/Str	ess	In Adjus	stment	
			SI score =	₫ 0.00 - 0.20	0.21 - 0.40		0	41	

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Completed by: _____ Checked by: _____

Rapid Stream Assessment Technique

Project Code: 17071

Date:	Jure 23/17	Stream/Reach:	ED2-			
Weather:	Cloudy 20°	Location: Ottava		Whanch		
Field Staff:	LG BM2	Watershed/Subwate		4		
Evaluation Category	Poor	Fair	Good	Excellent		
	 < 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 		
Channel	 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 		
Stability	 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 Stream mile Young exposed tree roots common 4-5 recent large tree falls per stream mile Z-3 recent large tree falls 		predominantly old and large, smaller young roots scarce	 Exposed tree roots old, large and woody Generally 0-1 recent larg 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 resistan 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	030405	□6□7乘8	9 10 11		
NIA	 > 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) 		
NIB	 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 pool (> 61 cm deep) (> 122 cm deep for large mainstem areas) Pool substrate composition <30% sand=silt 		
Channel Scouring/ Sediment Deposition	 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		
Seposition	 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 		
NIR	 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 littl or no fresh sand 		
Point range	00102	□ 3 □ 4	□ 5 □ 6	口7渔8		

Date:	June 23/17	Reach: FD2	Project Code:	17071	
Evaluation Category	Poor	Fair	Good	Excellent	
	• 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) 	
Physical Instream	 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 	
Habitat	 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 	
NIP	 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	
MIA	 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	00102	□ 3 □ 4	口5 威6	0708	
	 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 	
Water Quality	• 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 0 1 0 2	□ 3 □ 4	□ 5 ¤ (6	0708	
Riparian Habitat	 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 	
Conditions	 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	001	口 2 婑 3	□ 4 □ 5	□ 6 □ 7	
Total overall s	core (0-42) = 3 \	Poor (<13) F	air (13-24) Good (25-	34) Excellent (>35)	

Completed by: _____ Checked by: ____

GEO Morphix Ltd.

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Ottawa Office PO Box 336 Woodlawn PO Dunrobin, Ontario, Canada K0A 1T0

T 613.979.7303

Project Number: PN17071

Reach Characteristics

Date:	2017-06-23	Reach:	FD3
Field Staff:	LG BM2	Watercourse:	Foster Drain
Weather:	Cloudy 20 degrees	Watershed:	Jock River

Location



lat=45.25255737724697, long=-75.76969411847692, alt=60.14974220112034, accuracy=6.0

General Characteristics

Land Use: Agricultural Valley Type: Channel Type:

Unconfined 11 - Straight suspended load

Flow Type: Perennial no

Groundwater:

Riparian Vegetation

Trees, Grasses

Dominant Vegetation Type: Dominant Species: Riparian Coverage: Width of Riparian Zone: Riparian Age Class: Extent of Encroachment into channel:

: Grass : Fragmented

1 - 4 Channel Widths

Established (5-30 years)

innel: Minimal

Notes:

Aquatic/Instream Vegetation

Type of Instream Vegetation: Coverage of Reach (%): Presence of Woody Debris: Density of Woody Debris: Number of WDJs per 50 m

:	Rooted Submergent
:	75
:	Present in Channel
:	Low
:	0.25
:	1 large WDJ causing extensive back watering Rooted submergent dominant, emergent also moderately

Notes: Rooted present

Channel Characteristics

Type of Sinuosity:	N/A
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	High (<1.4)
Bank Failures (Brierley and Fryirs, 2005):	Undercutting (Hydraulic Action)
Downs Model of Channel Evolution (1995):	S - Stable - no observable morphological change
Riffle Substrate:	N/A
Pool Substrate:	N/A
Bank Material:	Clay, Silt, Sand
Bank Angle:	60 - 90, Undercut
Extent of Bank Erosion:	30 - 60%

Notes:

Channel Measurements								
Cross Section #1: Run								
Bankfull Width (m):	8.2	Wetted Width (m):	5.4					
Bankfull Depth (m):	N/A	Wetted Depth (m):	0.31					
Velocity (m/s):	0.22	Measurement Type:	Wiffle Ball					
Cross Section #2:								
Bankfull Width (m):	5.5	Wetted Width (m):	4.3					
Bankfull Depth (m):	N/A	Wetted Depth (m):	0.48					
Velocity (m/s):	0.15	Measurement Type:	Wiffle Ball					

Additional Measurements	
ls riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	0.08, most likely higher in some areas

Notes: Upstream of culvert bank height ~1.4

	Water Quality
Odour:	None
Turbidity:	Opaque
Notes:	Turbid/ opaque

			the end of the	
				GEO MORPHIX
				Generalenderge Earth Stankar Observations
Gene	eral Site Cha	racteristics	Project Code:	17071
Date:		June 23/17	Stream/Reach:	FD3
Weath	er:	cloudy 20°	Location:	Ottawa-Barrhave
Field S	taff:	LG BM2	Watershed/Subwatershed:	
	Reach break Cross-section Flow direction Riffle Pool Medial bar Eroded bank Undercut bank Rip rap/stabilization Leaning tree Fence Culvert/outfall Swamp/wetland Grasses Tree Instream log/tree Woody debris Station location Vegetated island Vegetated island Veget	y/gabion e flow v wave		Colvert T N N N N N N N N N N N N N N N N N N N
S5 Other BM BS DS WDJ VWC	Large cobble Benchmark Backsight Downstream Woody debris jam Valley wall contact			Y Co Y Co Scale:
BOS TOS	Bottom of slope Top of slope	FP Flood plain KP Knick point	Additional Notes:	
	. op of slope	in this point		

Completed by: _____ Checked by: ____

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				à e is			1		
						GEO	мо	RPHIX	
Rapid Geo	morp	hic Assessment	:	Project C	ode: 17071		2		
Date:	J	ne 23/17	Stre	am/Reach:	FO3				
Weather:	CI	audu 20°	Loca	tion:	Othew	1 - Be	archav	eh	
Field Chaffe		C P MZ				150	111 44	UI .	
Field Staff:		6 511	wate	ershed/Subwaters	hed:				
Process			Geomorph	ic Indicator		Pre	esent?	Factor	
	No.	Description				Yes	No	Value	
	1	Lobate bar					X		-r -1
	2	Coarse materials in	riffles embed	dded			NIA		
Evidence of	3	Siltation in pools					NIA		-1
Aggradation	4	Medial bars					×	014	
(AI)	5	Accretion on point b					NM		
	6	Poor longitudinal so		and the second sec		-	X		
	7	Deposition in the ov	erbank zone			-	×		
					Sum of indices =	0	4	10	
	1	Exposed bridge foot	ing(s)				1		
	2	Exposed sanitary / s	storm sewer	/ pipeline / etc.				NIA	
	3	Elevated storm sewer outfall(s)						N.	
	4	Undermined gabion baskets / concrete aprons / etc.					5	1	
Evidence of Degradation	5	Scour pools downstream of culverts / storm sewer outlets					\prec	1	
(DI)	6	Cut face on bar forms					Alla	1	
	7	Head cutting due to knick point migration					X	0/4	
	8	Terrace cut through older bar material					NIA		
	9	Suspended armour layer visible in bank					×		
	10	Channel worn into u	indisturbed o	verburden / bedrock			×		
					Sum of indices =	O	4	6	
	1	Fallen / leaning tree	s / fence pos	sts / etc.		X	T		
	2	Occurrence of large		and the second sec		X			
	3	Exposed tree roots							
	4	Basal scour on inside meander bends					X	1	
Evidence of	5	Basal scour on both sides of channel through riffle					NIA	1	
Widening (WI)	6		on baskets / concrete walls / etc.				NA	2)
	7	Length of basal scou	ur >50% thro	r >50% through subject reach				317	
	8	Exposed length of p	reviously bur	ried pipe / cable / etc			X]	
	9	Fracture lines along	top of bank				×]	
	10	Exposed building for			NA				
					Sum of indices =	3	Ц	6.42	
	1	Formation of chute(s)	·			×		
	2	Single thread chann		e channel			×		
Evidence of	3	Evolution of pool-riff		and the second se	******		NIA	-	
Planimetric Form	4	Cut-off channel(s)						-	
Adjustment	5	Formation of island(s)					X	015	
(PI)	6	Thalweg alignment	and the state of t	with meander form			NIA	100	
	7	Bar forms poorly for	the second s	A start of a start of the start			X	1	
	L			inter y removed	Sum of indices =	0	5	0	
Additional note	s:			Stability Tr	ndex (SI) = (AI+D				
		· · · · · · · · · · · · · · · · · · ·	Condition	In Regime	In Transition/St		In Adju	10 11	
				⊠ 0.00 - 0.20					
			SI score =	La 0.00-0.20	0.21 - 0.4			.41	

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Completed by: _____ Checked by: _____

Rapid Stream Assessment Technique

Project Code: (707)

Rapid Strea	am Assessment Te	chnique	Pr	Project Code: (1011			
Date:	Jone 23/17	Stream/Reach:		FD3			
Weather:	Cloudy 20°	Location:		Ottawa - Barrheven			
Field Staff:	LG BM2	Watershed/Subwater	shed:				
Evaluation Category	Poor	Fair	r Good		Excellent		
	 < 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 	stable • Infreque	o of bank network ent signs of bank ng, slumping or	 > 80% of bank network stable No evidence of bank sloughing, slumping or failure 		
Channel	 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 	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 		
Stability Exposed Loginning	 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 Exposed tree root large and wood Generally 0-1 r		 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 	tible generally highly resistant gene plant/soil matrix or material plant mate		 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	030405		5 0 7 0 8 (9 0 10 0 11		
	 > 75% embedded (> 85% embedded for large mainstem areas) 	50-75% embedded (60- 85% embedded for large mainstem areas)	59% er	6 embedded (35- nbedded for large em areas)	Riffle embeddedness < 25% sand-silt (< 35% embedded for large mainstem areas)		
NIA	 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 	pools Pool su 	te number of deep bstrate composition 6 sand-silt	 High number of deep pools (> 61 cm deep) (> 122 cm deep for large mainstem areas) Pool substrate composition <30% sand-silt 		
Channel Scouring/ Sediment	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	and/or "banana"-shaped and/or "ban sediment deposits sediment de uncommon		 Streambed streak marks and/or "banana"-shaped sediment deposits absent 		
Deposition 6	 Fresh, large sand deposits very common in channel Moderate to heavy sand deposition along major portion of overbank area 	n deposits common in un channel • Small localized areas of fresh sand deposits along to		 Fresh, large sand deposits uncommon in channel Small localized areas of fresh sand deposits along top of low banks Fresh, large sand rare or absent channel No evidence of sediment depo overbank 			
NAA	 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 b well-ve armou fresh s 	 Point bars few, small and stable, well-vegetated and/or armoured with little or no fresh sand 			
Point range	0 0 1 0 2	□ 3 □ 4		□ 5 □ 6	□71×8		

Date:	June 23/17	Reach: FD3	Project Code:	17071	
Evaluation Category	Poor	Fair	Good	Excellent	
-	• 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) 	
Physical Instream	 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 	
Habitat	 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 	
NIA	 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	
NA	 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	
	 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%)	
Water Quality	 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 	
Water Quality	 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	口 5 図 6	0708	
Riparian Habitat	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 	
Conditions	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 0 1 (□ 4 □ 5	□ 6 □ 7	
Total overall s	core (0-42) = 30	Poor (<13) F	air (13-24) Good (25-	•34) Excellent (>35)	

Completed by: <u>LG</u>

Checked by:

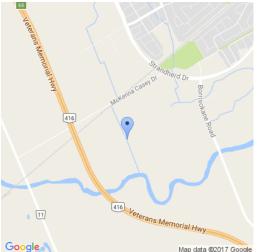
GEO Morphix Ltd.Head Office
2800 High Point Drive, Suite 100A
Milton, Ontario, Canada L9T 6P4Ottawa Office
PO Box 336 Woodlawn PO
Dunrobin, Ontario, Canada K0A 1T0T 416.920.0926T 613.979.7303

Project Number: PN17071

Reach Characteristics

Date:	2017-06-20	Reach:	OK D1
Field Staff:	BM2, LG	Watercourse:	O'Keefe Drain
Weather:	Sunny and cloudy 25 degrees	Watershed:	Jock River

Location



 Google
 Map data @2017 Google

 Iat=45.25370261269744, long=-75.777420503692, alt=59.06083766710607, accuracy=4.0

General CharacteristicsLand Use:AgriculturalValley Type:UnconfinedChannel Type:11 - Straight suspended loadFlow Type:PerennialGroundwater:No

Riparian Vegetation

Dominant Vegetation Type: Dominant Species: Extent of Encroachment into channel:

Trees, Shrubs, Grasses Trees, shrubs, some grasses

Riparian Coverage: Width of Riparian Zone: Riparian Age Class:

Continuous 1 - 4 Channel Widths

Established (5-30 years)

Minimal

Notes:

Aquatic/Instream Vegetation

Type of Instream Vegetation: Coverage of Reach (%): Presence of Woody Debris: Density of Woody Debris: Number of WDJs per 50 m: 2

5 Present in Channel High

Rooted Emergent

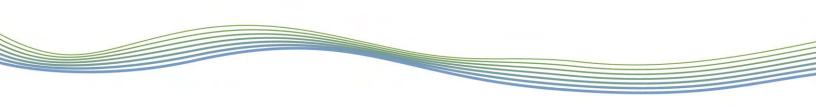
Notes:

Channel Characteristics

Type of Sinuosity:	Sinuous
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	High (<1.4)
Bank Failures (Brierley and Fryirs, 2005):	Fluvial Entrainment (Hydraulic Action), Undercutting
Downs Model of Channel Evolution (1995):	e - intiation of continuous erosion
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt, Sand, Organics
Bank Material:	Clay, Silt
Bank Angle:	60 - 90, Undercut
Extent of Bank Erosion:	60 - 100%

Notes: Extensive undercutting and exposed roots.

	Channel Mea	asurements	
Cross Section #1: Run			
Bankfull Width (m):	N/A	Wetted Width (m):	2.5
Bankfull Depth (m):	1.4	Wetted Depth (m):	0.14
Velocity (m/s):	0.2	Measurement Type:	Wiffle ball
Cross Section #2: Run			
Bankfull Width (m):	N/A	Wetted Width (m):	2.4
Bankfull Depth (m):	1.6	Wetted Depth (m):	0.19
Velocity (m/s):	0.14	Measurement Type:	Wiffle ball
Cross Section #3: Run			
Bankfull Width (m):	N/A	Wetted Width (m):	1.5
Bankfull Depth (m):	2	Wetted Depth (m): (0.12
Velocity (m/s):	0.2	Measurement Type:	Wiffle ball
Additional Measuremen	nts		
Is riffle-po	ol		
development absen			
Riffle-pool Spacing (m): N/A		
% Riffle	s: N/A		
% Pool	s: N/A		
Meander Amplitud (m	NI/Δ		
Pool Depth (m): N/A		
Riffle Length (m): N/A		
Undercuts (m): 0.30, 0.80, 0.40,		



Water	Oual	litv
	20.0.	,

Odour: None

Turbidity: Turbid

GEO

MORPHIX

Date:	Jon 20/	Stream/Reach:
Weather:	Sunny 25°	Location: Ottawa-Barrhaven
Field Staff:	LG BMZ	Watershed/Subwatershed:
Features		Site Sketch:
Reach breat		2 Files
Cross-section	n	Aug Q
Flow directi	n	-Bank erosion CV (Et Vines
Riffle		CONTRACTS () + 1 + 2
Pool		-substrate Contrate
Medial bar		continuous (SAR & S
Eroded ban	¢	
Undercut ba	nk	
	ilization/gabion	
->>>> Leaning tree		(en wat
** Fence		20142
L Culvert/out	all	(), ()
Swamp/wet	land	A HAK CO
₩₩₩ Grasses		C & XK V
C Tree		TE He 3
Instream lo		
××∗ Woody deb	is	**
只 Station loca	tion	() Jes
Vegetated i	sland	
Flow Type		
H1 Standing wa	iter	Cuives)
H2 Scarcely pe	rceptible flow	
H3 Smooth sur	face flow	
H4 Upwelling		() + + + L
H5 Rippled		
H6 Unbroken s	anding wave	
H7 Broken star	ding wave	White Fr
H8 Chute		RV/14/U
H9 Free fall	2 5	
Substrate	2	
S1 Silt	S6 Small boulder	CZ M
S2 Sand	S7 Large boulder	
S3 Gravel	S8 Bimodal	(FN K
S4 Small cobbi		
S5 Large cobbl	e	XX KB
Other		(PAR A
BM Benchmark	EP Erosion pin	Dent P-Siece across
BS Backsight	RB Rebar	(21 6) varis
DS Downstream		
WDJ Woody deb	is jam TR Terrace	could find the
VWC Valley wall	contact FC Flood chute	Scale:
BOS Bottom of s	lope FP Flood plain	Additional Notes:
TOS Top of slope	KP Knick point	

pictures 12-100 reach

Date:	Jon 20/17	Stream/Reach:	OKD1	-
Weather:	SUMMY 25°	Location:	Ottawa	-Barrhoven
Field Staff:	LG BM2	Watershed/Subwater	Contraction of States and	
Evaluation Category	Poor	Fair	Good	Excellent
	 < 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 netw stable Infrequent signs of ba sloughing, slumping of failure 	stable • No evidence of bank
Channel	 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 st Outer bank height 0.6 m above stream bank 1.5 m above stream to for large mainstem ar Bank overhang 0.6-0. 	5-0.9 stable (1.2- • Height < 0.6 m above sank stream (< 1.2 m above eas) stream bank for large
Stability	 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 i scarce 2-3 recent large tree per stream mile 	• 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 resist plant/soil matrix or m	tant generally highly resistant
	 Channel cross-section is generally trapezoidally- shaped 	 Channel cross-section is generally trapezoidally- shaped 	Channel cross-section generally V- or U-sha	
Point range	□ 0 □ 1 □ 2	□ 3 □ 4 □ 5 (06070	8
NIA	 > 75% embedded (> 85% embedded for large mainstem areas) 	 50-75% embedded (60- 85% embedded for large mainstem areas) 	 25-49% embedded (3 59% embedded for la mainstem areas) 	
NIX	 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 opools Pool substrate compo 30-59% sand-silt 	(> 61 cm deep)
Channel Scouring/ Sediment Deposition	Streambed streak marks and/or "banana"-shaped sediment deposits common	 Streambed streak marks and/or "banana"-shaped sediment deposits common 	 Streambed streak ma and/or "banana"-shap sediment deposits uncommon 	
Depusidun	 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 dep uncommon in channe Small localized areas fresh sand deposits a top of low banks 	of channel
NNR	 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 a well-vegetated and/o armoured with little o fresh sand 	r stable, well-vegetated
Point range		0304	0506	D7 🛛 8

)ate:	June 20/17	Reach: OKD	Project Code:	17071
Evaluation Category	Poor	Fair	Good	Excellent
	 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)
Physical Instream	 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
Habitat	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
NIR	 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
NIA	• 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 0 1 0 2	□ 3 □ 4	□ 5 ⊠ 6	□ 7 □ 8
	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 flowTDS: < 50 mg/L
Water Quality	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

Completed by: _____ Checked by: _

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Project Code: 17071 **Rapid Geomorphic Assessment** 20117 OKD Date: Stream/Reach: 250 Stawa - Barrhaven Weather: Location: **Field Staff:** MZ Watershed/Subwatershed: Geomorphic Indicator Present? Factor Process absent Value No. Description Yes No 1 Lobate bar X 2 Coarse materials in riffles embedded NIA -infrastruce absent 014 3 Siltation in pools NA Evidence of Aggradation 4 Medial bars X (AI) 5 Accretion on point bars NIA 6 Poor longitudinal sorting of bed materials × 7 Deposition in the overbank zone χ. Sum of indices = 4 \cap 1 Exposed bridge footing(s) 2 Exposed sanitary / storm sewer / pipeline / etc. 3 Elevated storm sewer outfall(s) NIA 4 Undermined gabion baskets / concrete aprons / etc. Evidence of 5 Scour pools downstream of culverts / storm sewer outlets Degradation 013 6 Cut face on bar forms (DI) 7 Head cutting due to knick point migration X 8 NIA Terrace cut through older bar material 9 Suspended armour layer visible in bank × 10 Channel worn into undisturbed overburden / bedrock X Sum of indices = 0 \bigcirc 3 1 Fallen / leaning trees / fence posts / etc. × Occurrence of large organic debris 2 × 3 Exposed tree roots X NA Straight channel 4 Basal scour on inside meander bends Evidence of 5 Basal scour on both sides of channel through riffle NIA Widening 316 6 Outflanked gabion baskets / concrete walls / etc. NIA (WI) 7 Length of basal scour >50% through subject reach × 8 Exposed length of previously buried pipe / cable / etc. × Fracture lines along top of bank 9 х 10 Exposed building foundation NM 3 6.5 Sum of indices = 1 Formation of chute(s) \prec 2 Single thread channel to multiple channel X Evidence of 6/4 3 Evolution of pool-riffle form to low bed relief form NIA Planimetric Form 4 Cut-off channel(s) × Adjustment 5 Formation of island(s) × (PI) NIA 6 Thalweg alignment out of phase with meander form 7 Bar forms poorly formed / reworked / removed NIA 4 Sum of indices = 0 Additional notes: Stability Index (SI) = (AI+DI+WI+PI)/4 = 0.125 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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Head Office 2800 High Point Drive, Suite 100A Milton, Ontario, Canada L9T 6P4

T 416.920.0926

Ottawa Office PO Box 336 Woodlawn PO Dunrobin, Ontario, Canada K0A 1T0

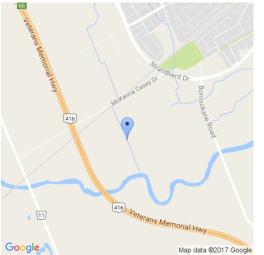
T 613.979.7303

Project Number: PN17071

Reach Characteristics

Date:	2017-06-21	Reach:	OKD2
Field Staff:	LG BM2	Watercourse:	O'Keefe Drain
Weather:	Sun and cloud 18C	Watershed:	Jock River

Location



lat=45.253683882781495, long=-75.77752606140785, alt=57.03539215789929, accuracy=6.0

General Characteristics		
Land Use:	Agricultural	
Valley Type:	Unconfined	
Channel Type:	11 - Straight suspended load	
Flow Type:	Perennial	
Groundwater:	No	
Notes:		

Riparian Vegetation

Dominant Vegetation Type: Dominant Species: Riparian Coverage: Width of Riparian Zone: Riparian Age Class: Extent of Encroachment into channel:

Grass Fragmented

Grasses, trees

1 - 4 Channel Widths

Established (5-30 years)

Moderate

Notes: A few trees scattered along banks.

Aquatic/Instream Vegetation

Type of Instream Vegetation Coverage of Reach (%) Presence of Woody Debris Density of Woody Debris Number of WDJs per 50 m

ion:	Rooted Emergent
%):	100
ris:	Not Present
ris:	None
) m:	0

Notes: Top half of reach heavily encroached with reeds.

Channel Characteristics

Type of Sinuosity:	N/A
Degree of Sinuosity:	Straight (1 - 1.05)
Gradient:	Low
Number of Channels:	Single
Entrenchment:	High (<1.4)
Bank Failures (Brierley and Fryirs, 2005):	Fall/Sloughing (Mass Failure)
Downs Model of Channel Evolution (1995):	C – Compound – aggradation of channel bed with erosion of channel banks
Riffle Substrate:	N/A
Pool Substrate:	Clay, Silt
	oldy, one
Bank Material:	Clay, Silt

Two erosion scars, potentially from sloughing brought on by undercutting photos 191-192

Notes:

Significant erosion on the sides of the upstream culvert photos 183-185

Channel Measurements

Additional Measurements	
Is riffle-pool development absent?	Yes
Riffle-pool Spacing (m):	N/A
% Riffles:	N/A
% Pools:	N/A
Meander Amplitude (m):	N/A
Pool Depth (m):	N/A
Riffle Length (m):	N/A
Undercuts (m):	N/A

Notes:

	Water Quality
Odour:	None
Turbidity:	Opaque
Notes:	

Date:		Tracteristics	Project Code: (707) Stream/Reach: 0V-102
Weath		JOVE 21	UFUZ
the second		Cloudy 20	UTiawa Darhaven
Field S	Staff:	LG BM	Watershed/Subwatershed:
Featur	es		Site Sketch:
	Reach break		Site Sketch:
~ ~	Cross-section		
	Flow direction		
	Riffle		N N
\bigcirc	Pool		Y Y Y
	Medial bar		N C Y
UNDIMHII	Eroded bank		
	Undercut bank		N K W V
XXXXXX	Rip rap/stabilization,	/gabion	My & X
	Leaning tree		
XX	rence		Charles and the second se
	Culvert/outfall		che De A
	Swamp/wetland		100 ² V 22 V V
WWW C	Grasses		
0	Tree		Y NIN Y
	Instream log/tree		
*** 只	Woody debris Station location		
X V			
Flow T	Vegetated island		Y V -
H1	Standing water		Y YY - continuous
H2	Scarcely perceptible	flow	A CONTROL
H3	Smooth surface flow		y grass buffer
H4	Upwelling		
Н5	Rippled		TN KNY
H6	Unbroken standing v	wave	
H7	Broken standing way		Y Y shrobs
Н8	Chute		the pret of the sector of the
Н9	Free fall		Y Y Y Weeds J Flow
Substr	ate		
S1	Silt	S6 Small boulder	
S2	Sand	S7 Large boulder	
S 3	Gravel	S8 Bimodal	WV/
S 4	Small cobble	S9 Bedrock/till	E OLdun
S 5	Large cobble		4 FIC VI DIVE
Other			dige to N
вм	Benchmark	EP Erosion pin	
BS	Backsight	RB Rebar	
DS	Downstream	US Upstream	Bold Con Diedge of .
WDJ	Woody debris jam	TR Terrace	and the the state
vwc	Valley wall contact	FC Flood chute	Scale:
BOS	Bottom of slope	FP Flood plain	Additional Notes:
	Top of slope	KP Knick point	Photos #142 - 187

-: ^·

Completed by: _____ Checked by: _____

colvert colvert reeds tasses 0165,00 X51-US 500x Treeds -stram width centinuous N XSZ -DS X J flow in STI

Rapid Stream Assessment Technique

5

stable

Date:

Weather:

Field Staff:

Evaluation

Category

Stream/Reach: Barr with Location: Suppu 2 B Watershed/Subwatershed: -> erosid Good Excellent Poor Fair 1als • 71-80% of bank network • < 50% of bank network</p> • 50-70% of bank network > 80% of bank network stable stable stable 2 Infrequent signs of bank sloughing, slumping or No evidence of bank sloughing, slumping or · Recent bank sloughing, Recent signs of bank slumping or failure sloughing, slumping or frequently observed failure fairly common failure failure

	nequently observed	ranure rainly common	Tallule	Tallule
NIA Stroggett Channel	 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
Stability No roots feely	 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
\bigvee	 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	00102	030405	060708 (0 9 0 10 0 11
NIA	 > 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)
J	 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
Channel Scouring/ Sediment Deposition	 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
Seposition	 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
NIA	 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
			0506	

Project Code:

Date:		Reach:	Project Code:				
Evaluation Category	Poor	Fair	Good	Excellent			
	• 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) 			
Physical Instream	 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 			
Habitat	 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 			
NIK	 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	cm deep (> 122 cm for			
	 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 				
NIA	 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℃ 8			
Point range	00102	□ 3 □ 4	0506 (0708			
	 Substrate fouling level: High (> 50%) 	Substrate fouling level: Moderate (21-50%)	Substrate fooling level: Very light (11-20%)	Substrate fouling level: Rock underside (0-10%)			
Watan Quality	 Brown colour TDS: > 150 mg/L 	• Grey colour • TDS: 101-150 mg/L	 Slightly grey colour TDS: 50-100 mg/L 	Clear flowTDS: < 50 mg/L			
Water Quality	 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			
2	 Moderate to strong organic odour 	Slight to moderate organic odour		• No odour			
Point range	00102	□ 3 □ 4	5 6	□ 7 □ 8			
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 bot banks			
Habitat Conditions	• 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)				
Point range	□ () □ 1	□ 2 □ 3	0405	□ 6 □ 7			
Total overall s	core (0-42) = 29.5	Poor (<13) F	air (13-24) Good (25-	34) Excellent (>35)			

						GEO	мо	RPHIX		
Rapid Geor	norp	hic Assessment		Project Comm/Reach:	ode: 101					
Weather:	00	001.200	Locat		Ottawa	- 12	barrha	Ph		
Field Staff:	50	MAY CS		rshed/Subwaters		<u>^ </u>	n'i vu	101		
		3/ 12/1								
Process		D	Geomorphi	c Indicator			sent?	Factor Value		
	No.	Description				Yes	No	value		
	1	Lobate bar					X	4		
	2	Coarse materials in	riffles embed	ded			NIA	4		
Evidence of	3	Siltation in pools					NIA	4		
Aggradation (AI)	4	Medial bars				-	X	4		
(/)	5	Accretion on point b					NIA	4		
	6	Poor longitudinal sor		naterials			X	4		
	7	Deposition in the ov	erbank zone				X			
					Sum of indices =			1		
·	1	Exposed bridge foot	ing(s)			IN	A			
	2	Exposed sanitary / s	torm sewer /	pipeline / etc.]		
	3	Elevated storm sewe	er outfall(s)					1		
	4	Undermined gabion	baskets / cor	ncrete aprons / etc.		L.		1		
vidence of	5	Scour pools downstr	eam of culve	V		1 .				
egradation (DI)	6	Cut face on bar form	าร			NIA		1		
()	7	Head cutting due to	knick point r	nigration			X			
	8	Terrace cut through	older bar ma		NA	1				
	9	Suspended armour I	uspended armour layer visible in bank							
	10	Channel worn into u	ndisturbed o	rer visible in bank X						
				1	Sum of indices =					
	1	Fallen / leaning tree	s / fence pos	ts / etc.			X	1		
	2	Occurrence of large		×	1					
	3	Exposed tree roots		$\frac{1}{\chi}$	-					
	4	Basal scour on inside		X	1					
vidence of	5	Basal scour on both		NA	1 /					
Widening	6	Outflanked gabion b				NIA				
(WI)	7	Length of basal scou					X			
	8	Exposed length of p				×				
	9	Fracture lines along	the second se	p.p.,,,		~	×	1		
	10	Exposed building for			NIA					
	L	, , , , , , , , , , , , , , , , , , , ,			Sum of indices =		N/	1		
	1	Earmation of chuto(-)				X	1		
	1	Formation of chute(shaanal				-		
vidence of	2	Single thread chann					×	-		
lanimetric	3	Evolution of pool-riff	ie form to lo	w bed relief form			NIA	4		
Form djustment	4	Cut-off channel(s)	•				X	-		
(PI)	5	Formation of island(ith man in f			~	-osk		
	6	Thalweg alignment of	and the first of the second				01.03			
- 45	7	Bar forms poorly for	med / rewor	kea / removed	Cum of indiana		NIA			
					Sum of indices =					
dditional note	s:			Stability Ir	dex (SI) = (AI+D	I+WI+	PI)/4 =	1		
			Condition	In Regime	In Transition/St	ress	In Adju	stment		
			SI score =	0.00 - 0.20	0.21 - 0.40			0.41		

• • • • • • • • • •

,

Completed by: _____ Checked by: ____

3



Appendix E RGA and RSAT Results





RGA Results

O'Keefe Drain, Foster Drain, and Fraser-Clarke Drain

Barrhaven, Ottawa

- ----- O'Keefe Drain (OKD)
- ----- Foster Drain (FD)
- ----- Fraser-Clarke Drain (FCD)

1:12,000

N

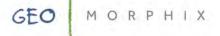
Not present at time of assessment

RGA Condition

✓ In Regime

Reach break: Stantec, 2007, PARISH Geomorphic Ltd., 2013, and GEO Morphix Ltd., 2017. Drainage Feature: MNRF, 2010, City of Ottawa, 2016, and GEO Morphix Ltd., 2017. RGA Condition: GEO Morphix Ltd., 2017. Imagery: Google Earth Pro, 2016.





RSAT Results

O'Keefe Drain, Foster Drain, and Fraser-Clarke Drain

Barrhaven, Ottawa

Legend	1:12,000
 Reach break 	Å
Drainage Feature	
·── O'Keefe Drain (C	NKD)
Foster Drain (FD)
Fraser-Clarke Dr	ain (FCD)
Not present at tin of assessment	ne
RSAT Condition	
Good	
~~~ N/A	
Reach break: Stantec, 2007, PARISH Geomorphic Ltd., 2013, an Drainage Feature: MNRF, 2010, City of Ottawa, 2016, and GEO RSAT Condition: GEO Morphix Ltd., 2017. Imagery: Google Ear	Morphix Ltd., 2017.

1:12,000



# **Appendix F Detailed Assessments Locations**





# **Detailed Assessments**

O'Keefe Drain, Foster Drain, and Fraser-Clarke Drain

Barrhaven, Ottawa

# Legend

### 1:12,000

Reach break



### Drainage Feature

- ----- O'Keefe Drain (OKD)
- ----- Foster Drain (FD)
- ----- Fraser-Clarke Drain (FCD)
- Not present at time of assessment

### **Detailed Assessment**

GEO Morphix Ltd. (2017)

Reach break: Stantec, 2007, PARISH Geomorphic Ltd., 2013, and GEO Morphix Ltd., 2017. Drainage Feature: MNRF, 2010, City of Ottawa, 2016, and GEO Morphix Ltd., 2017. Detailed Assessment: GEO Morphix Ltd., 2017. Imagery: Google Earth Pro, 2016.



# Appendix G Detailed Assessment Summaries

# GEO

M O R P H I X Geomorphology Earth Science

## Detailed Geomorphological Assessment Summary

Reach FCD2

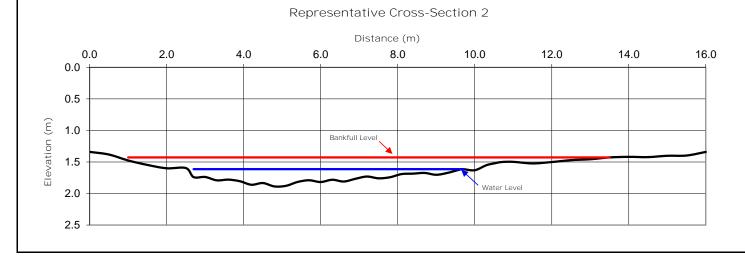
<u> </u>	DNIA TOT :		KCC				2/0047		
Project Number:	PN17071			Date:		June 20	0/ 2017		
Client:		naeffer Engineer	ing Ltd.	Length Surv		99.4			
ocation:	Barrhave	n, Ottawa		# of Cross-	Sections:	7			
Reach Characteris	tics								
)rainage Area:		Not measured		Dominant Riparia	n Vegetation Ty	vpe: Sh	rubs and grasses		
Geology/Soils:		Clay Plains		Extent of Riparian	n Cover:	Fra	agmented		
Surrounding Land Use	∋:	Agricultural, Resid	ential	Width of Ripariar	Cover:	1 -	4 Channel width	S	
/alley Type:		Unconfined		Age Class of Ripa	rian Vegetation	: Es	tablished (5-30 y	ears)	
ominant Instream V	egetation Typ	e: Rooted eme	rgent	Extent of Encroad	hment into Cha	nnel: Mo	oderate		
Portion of Reach with	Vegetation:	70%		Density of Woody	Debris:	Lo	W		
lydrology									
leasured Discharge (	$(m^3/s)$ :	0.0	)4	Calculated Bankfu	III Discharge (m	$1^{3}/s$ ):	0.42	2	
lodelled 2-year Disch		Not mo		Calculated Bankfu			0.19		
lodelled 2-year Veloc		Not mo				5).			
Profile Characteris	stics			Planform ()	naracteristics				
Bankfull Gradient		0.1	7	Sinuosity:			1.79		
Channel Bed Gradi	. ,	0.12		Meander Belt Width (m):			Not measured		
Riffle Gradient (%	. ,	N/A: no riffles		Radius of Curvature (m):			Not measured		
Riffle Length (m):	).	N/A: no riffles		Meander Amplitude (m):			Not measured		
Riffle-Pool Spacing (m):		N/A: no riffle-pool spacing		Meander wavelength (m):			Not measured		
	-				g()-				
ongitudinal Profil	le								
	-	40		nce (m)			05	10	
1.0 +	5	10	15	20	25 .	30	35	40	
€ ^{1.2}	Water Leve	1			Bankfull Le	evel			
L 1.4		·			•		•		
1.4									
				$\sim$			$\sim$		
ш 2.0 <u>-</u>							-		
2.2			Channel Bed						
Bank Characteristi	CS								
	Minimum	Maximum	Average			Minimum	Maximum	Averag	
ank Height (m):	0.3	0.60	0.46						
ank Angle (deg):	15	25	19	Torvane Value (kg/cm ² ):			Not measured		
oot Depth (m):	0.10	0.10	0.10	Penetrometer Va		Not measured			
Root Density (%):	50	100	90	Bank Material (ra	nge):		Sandy Loam		
Bank Undercut (m):		N/A: no undercu	ts						

#### Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	5.10	12.50	9.33
Average Bankfull Depth (m):	0.19	0.26	0.23
Bankfull Width/Depth (m/m):	21	50	40
Wetted Width (m):	1.80	10.40	5.54
Average Water Depth (m):	0.02	0.22	0.13
Wetted Width/Depth (m/m):	19	86	54
Entrenchment (m):		Not measured	
Entrenchment Ratio (m/m):		Not measured	
Maximum Water Depth (m):	0.01	0.28	0.22
Manning's <i>n</i> :		0.080	



Photograph at cross section 2 (facing upstream)



ubstrate Cha	aracterist	ics												
Particle Size	(mm)			Si	ubpave	ment:			Clay					
D ₁₀ :	<	2.0		Pa	article s	shape:			N/A: fir	ne sedim	nent			
D ₅₀ :	<	2.0		Er	nbedde	dness	(%):		N/A: fir	ne sedim	nent			
D ₈₄ :	<	2.0		Pa	article r	ange (	riffle):	:	N/A: rif	fle-pool	seque	ence	abser	nt
					article f				N/A: rif					
100 90 80 70 40 40 30 40 40 30														
<u> </u>													++	
^L 20														1
0														
1			10	Grains	size (mr	n)	10	00					10	000

Channel Thresholds	
--------------------	--

Flow Competency (m/s):
for D ₅₀ :
for D ₈₄ :
Unit Stream Power at Bankfull (W/m ² ):

Tractive Force at Bankfull  $(N/m^2)$ : Tractive Force at 2-year flow  $(N/m^2)$ : Critical Shear Stress  $(D_{50})$   $(N/m^2)$ : 3.76 Not modelled 1.46

#### General Field Observations

Channel Description

0.27

0.27

0.72

This channel runs between agricultural fields before flowing into Jock River. The channel is straight, slightly entrenched, and has a low gradient. Riffle-pool sequences are absent within this reach, only run features are present. Bank erosion was not present. Woody debris is present in the channel at a low density. Average bankfull width and depth are 9.23 m and 0.23 m, respectively. Bank material consists of sandy loam, bed material consists of fine sediment and organics. Depth of fine sediment on the bed at the time of assessment was approximately 0.30 - 0.40 m.





### GEO

### **Detailed Geomorphological Assessment Summary**

Reach FD1

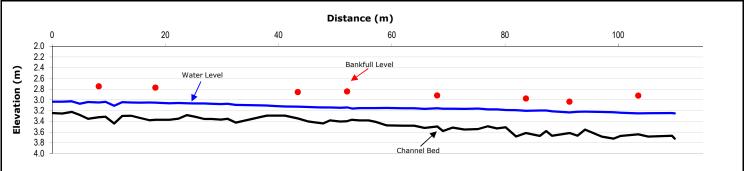
<b>Project Number:</b>	PN 17071	Date:	June 22/ 2017
Client:	David Schaeffer Engineering Ltd.	Length Surveyed (m):	110.0
Location:	Barrhaven, Ottawa	# of Cross-Sections:	8

Reach Characteristics							
Drainage Area: Not r		measured	Dominant Riparian Vegetation Type:	Grasses			
Geology/Soils:	Clay	/ Plains	Extent of Riparian Cover:	Fragmented			
Surrounding Land Use:	Agr	icultural	Width of Riparian Cover:	1 - 4 Channel widths			
Valley Type:	Unc	onfined	Age Class of Riparian Vegetation:	Established (5-30 years)			
Dominant Instream Vegetation	Type:	Rooted submergent	Extent of Encroachment into Channel:	Minimal			
Portion of Reach with Vegetation	on:	80%	Density of Woody Debris:	Low			

Hydrology							
Measured Discharge (m ³ /s):	0.13	Calculated Bankfull Discharge (m ³ /s):	0.77				
Modelled 2-year Discharge (m ³ /s):	Not modelled	Calculated Bankfull Velocity (m/s):	0.45				
Modelled 2-year Velocity (m/s):	Not modelled						

Profile Characteristics		Planform Characteristics	
Bankfull Gradient (%):	0.17	Sinuosity:	1.22
Channel Bed Gradient (%):	0.40	Meander Belt Width (m):	Not measured
Riffle Gradient (%):	N/A: no riffles	Radius of Curvature (m):	Not measured
Riffle Length (m):	N/A: no riffles	Meander Amplitude (m):	Not measured
Riffle-Pool Spacing (m):	N/A: no riffle-pool spacing	Meander wavelength (m):	Not measured

### Longitudinal Profile



### Bank Characteristics

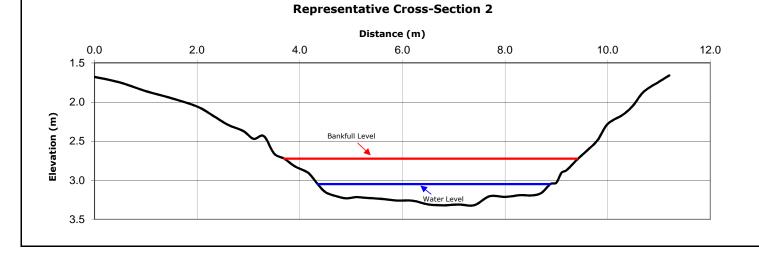
	Minimum	Maximum	Average		Minimum	Maximum	Average
Bank Height (m):	1.3	1.75	1.48				
Bank Angle (deg):	45	70	53	Torvane Value (kg/cm ² ):		Not measured	
Root Depth (m):	0.10	0.10	0.10	Penetrometer Value (kg/cm ³ ):		Not measured	
Root Density (%):	40	90	84	Bank Material (range):	Clay, Silt, Sand, some Rip-Rap prese		Rap present
Bank Undercut (m):	0.05	0.30	0.13				

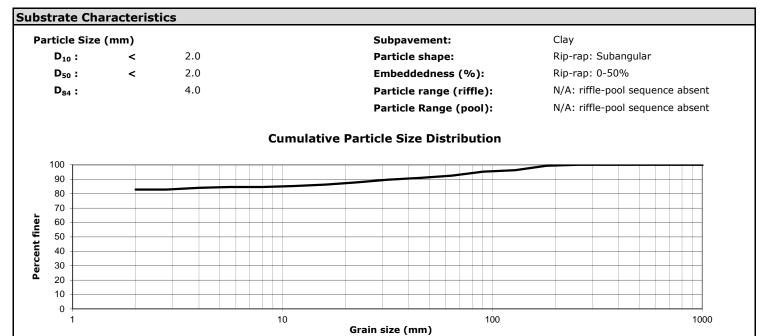
### **Cross-Sectional Characteristics**

	Minimum	Maximum	Average
Bankfull Width (m):	3.30	5.70	4.29
Average Bankfull Depth (m):	0.34	0.48	0.40
Bankfull Width/Depth (m/m):	9	14	11
Wetted Width (m):	2.17	4.95	3.34
Average Water Depth (m):	0.15	0.27	0.21
Wetted Width/Depth (m/m):	11	24	16
Entrenchment (m):		Not measured	
Entrenchment Ratio (m/m):		Not measured	
Maximum Water Depth (m):	0.22	0.41	0.31
Manning's <i>n</i> :		0.050	
-			



Photograph at cross section 6 (looking at the right bank)





### Channel Thresholds

Flow Competency (m/s):	
for D ₅₀ :	0.27
for D ₈₄ :	0.37
Unit Stream Power at Bankfull (W/m ² ):	3.01

Tractive Force at Bankfull (N/m²): Tractive Force at 2-year flow (N/m²): Critical Shear Stress (D₅₀) (N/m²): 6.70 Not modelled 1.46

#### **General Field Observations**

#### **Channel Description**

This channel runs between agricultural fields before flowing into Jock River. The channel is sinuous with a low gradient, and highly entrenched. Riffle-pool sequences are absent within this reach, only run features are present. Undercutting is present in the downstream portion of the reach. A low density of woody debris is present in the channel. Average bankfull width and depth are 4.69 m and 0.50 m, respectively. Bank material consists of clay, silt and sand, with rip-rap between cross sections 2 and 5. Bed material consists of clay, and sporatic rip-rap. Depth of fine sediment on the bed at time of assessment was approximately 0.05 - 0.20 m.

#### **Cross Section 4 - Facing Downstream**



GEO MORPHIX Geomorphology Earth Science

### Detailed Geomorphological Assessment Summary

			Rea	ch OKD1				
Project Number:	PN 17071			Date:		June	e 20, 2017	
Client:	David Scha	effer Engineering	g Ltd.	Length Sur	rveyed (m):	82.0	)	
_ocation:	Barrhaven,	Ottawa		# of Cross	-Sections:	8		
Reach Characteris	+100							
		at magazina d		Densis est Disesi		. T	Trace and Crasses	
Drainage Area:		ot measured		Dominant Ripari	-	n Type:	Trees and Grasses	
Geology/Soils:		lay Plains		Extent of Riparia			Continuous	la o
Surrounding Land Use		gricultural		Width of Riparia			1 - 4 Channel widt Established (5-30	
/alley Type:		nconfined		Age Class of Rip	0			rears)
Dominant Instream V			nt	Extent of Encroa		Channel:	Minimal	
Portion of Reach with	Vegetation:	5%		Density of Wood	ly Debris:		High	
Hydrology								
leasured Discharge (	(m³/s):	0.08		Calculated Bank	full Discharge	e (m³/s):	1.6	59
Modelled 2-year Disch	narge (m³/s):	Not model	led	Calculated Bank	full Velocity (	m/s):	0.5	51
Modelled 2-year Veloo	city (m/s):	Not model	led					
Profile Characteris	stics			Planform (	Characterist	ics		
Bankfull Gradient	(%):	0.05		Sinuosity			1.00	
Channel Bed Gradi		0.10		3	Belt Width (m	ו):	Not meas	sured
Riffle Gradient (%	):	N/A: no rif	fles	Radius of	Curvature (m	ר):	Not meas	sured
Riffle Length (m):		N/A: no rif	fles	Meander .	Amplitude (m	n):	Not meas	sured
Riffle-Pool Spacing	g (m):	N/A: no riffle-poo	l spacing	Meander wavelength (m):		m):	Not meas	sured
ongitudinal Profil	е							
			Distan	. ,				
0	10	20 30		40	50	60	70	80
0.6	•	•	Bar	kfull Level	•		•	
Ε 0.8						•		
8.0 U U U U U U U U U U U U U U U U U U U	w	ater Level						
Tey 1.2								
1.6	$ \vee$				$\sim$			
1.8				Channel Bed				
Bank Characteristi	CS							
	Minimum	Maximum	Average			Minimu	um Maximum	Avera
Bank Height (m):	1.4	1.70	1.59					
Bank Angle (deg):	50	80	67	Torvane Value (	kg/cm²):		Not measured	
-								

0.20

5

1.00

25

N/A: no undercuts

0.53

13

Penetrometer Value (kg/cm³):

Bank Material (range):

Root Depth (m):

Root Density (%):

Bank Undercut (m):

Not measured

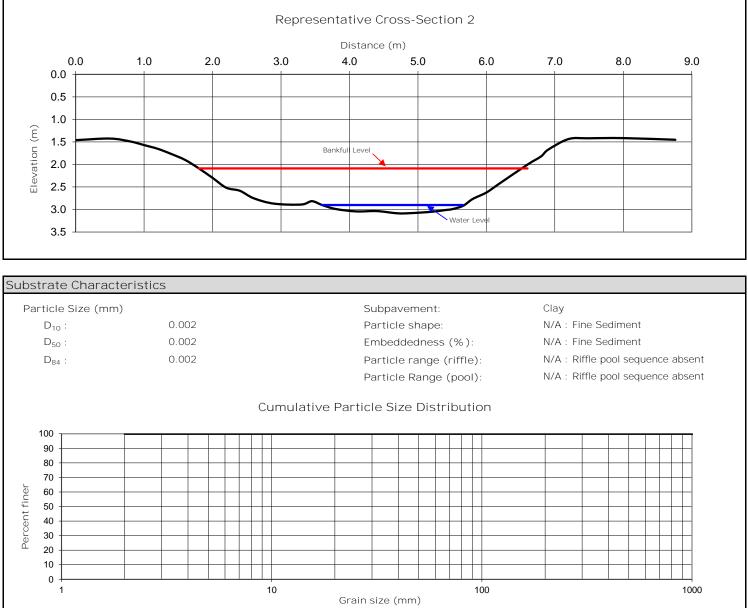
Clay, Silt

#### Cross-Sectional Characteristics

	Minimum	Maximum	Average
Bankfull Width (m):	4.30	4.83	4.59
Average Bankfull Depth (m):	0.62	0.81	0.72
Bankfull Width/Depth (m/m):	5	8	6
Wetted Width (m):	1.95	2.61	2.29
Average Water Depth (m):	0.13	0.16	0.14
Wetted Width/Depth (m/m):	14	20	16
Entrenchment (m):		Not measured	
Entrenchment Ratio (m/m):		Not measured	
Maximum Water Depth (m):	0.17	0.24	0.19
Manning's <i>n</i> :		0.035	



Photograph at cross section 6 (looking at the right bank)



Channel Thresholds							
Flow Competency (m/s):		Tractive Force at Bankfull (N/m ² ):	3.53				
for D ₅₀ :	0.01	Tractive Force at 2-year flow (N/m ² ):	Not modelled				
for D ₈₄ :	0.01	Critical Shear Stress (D ₅₀ ) (N/m ² ):	0.00				
Unit Stream Power at Bankfull (W/m ² ):	1.81						

#### General Field Observations

Channel Description

This channel runs between agricultural fields before flowing into Jock River. The channel is straight and highly entrenched, with a low gradient. This reach did not contain riffle-pool sequences, only run features were present. Average bankfull width and depth are 4.6 m and 0.7 m, respectively. Bank erosion was evident. Woody debris was commonly observed in the channel. Both bed and bank material consisted of a sandy loam. Depth of fines on the bed were approximately 0.2 - 0.3 m at time of assessment.







# Appendix H Meander Belt Widths



