Kanata West

Headwaters Report

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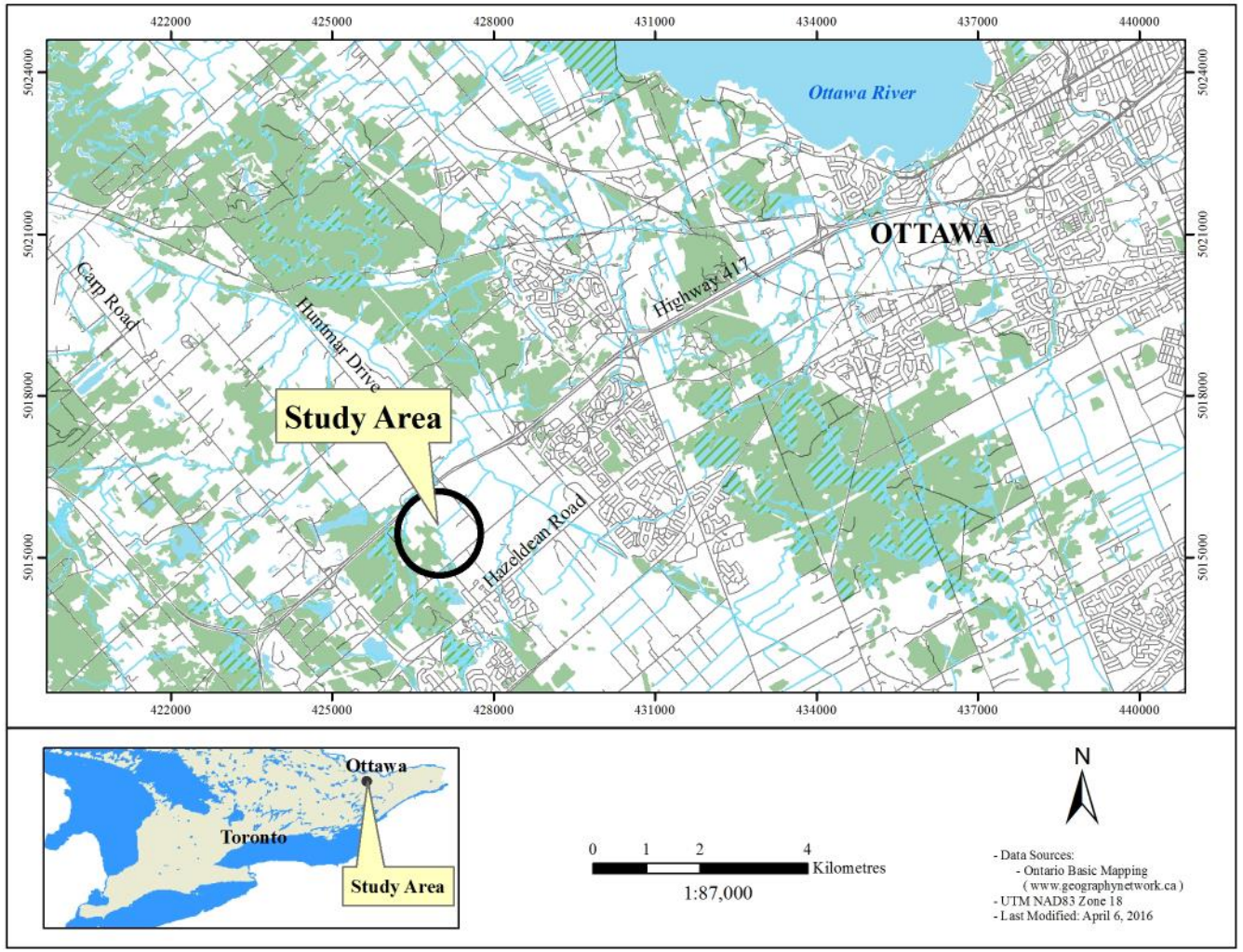
1.0 INTRODUCTION

The following report has been prepared by Bowfin Environmental Consulting (Bowfin) on behalf of the proponent and Muncaster Environmental Planning Inc. It is understood that future development is being planned for lands situated within the Urban Area of the City of Ottawa in parts of Lot 1 and 2 Concession 1 in the Township of Huntley (Figure 1). The lands in question include approximately 55 hectares situated west of Huntmar Drive and south of Highway 417 and Palladium Drive in Ottawa, Ontario (Figure 2). The existing land use is forested with cropped land. Portions of the forest have been recently removed. The adjacent lands include residential and commercial development to the east and south, natural habitat to the west and south and highway 417 to the north.

This report provides a summary of the findings along with an evaluation of the headwaters as per the *Evaluation, Classification and Management of Headwater Drainage Features Guidelines* created by Credit Valley Conservation and Toronto Region Conservation (July 2013, updated January 2014).

Figure 1 Location of Study Area



2.0 METHODOLOGY

The field work, including habitat assessment, fish community sampling, amphibian surveys and headwater assessments, was completed from April 2016 to August 2016.

2.1 Review of Background Information

The review of background information was conducted in order to identify potential environmental concerns and to augment the data collected during the site visit. Background information regarding fish species was obtained with a request for information to Mississippi Valley Conservation Authority and a search of the Natural Heritage Information Centre (NHIC) databases.

2.2 Habitat Description

The fish habitat features within the study area was described based on the MTO *Environmental Guide for Fish and Fish Habitat October 2006* and the *Ontario Stream Assessment Protocol*. Information on the channel morphology was collected (channel width, wetted width, bankfull and wetted depths, cover type and abundance, and substrate type). The location of specific features mentioned in the text is shown on Figure 2.

2.3 Fish Community Sampling

Fish community sampling was performed to document the use of the site by fish during the spring. The community was sampled utilizing electrofishing.

2.4 Headwater Drainage Features

The headwater drainage features within the study area were assessed based on the *Evaluation, Classification and Management of Headwater Drainage Features: Interim Guidelines* (here after referred to as the Guidelines) (prepared by Credit Valley Conservation Authority and Toronto and Region Conservation, revised July 2013 and finalized January 2014). The Guideline is divided into three parts. Part 1 is the Evaluation and discusses various suggested study designs/methods. Part 2 determines the appropriate Classification following the outcome of Part 1. Finally, Part 3 outlines the Management Recommendations. An Evaluation, Classification and Management Table is provided at the end of this report (Appendix A).

2.5 Amphibian Surveys

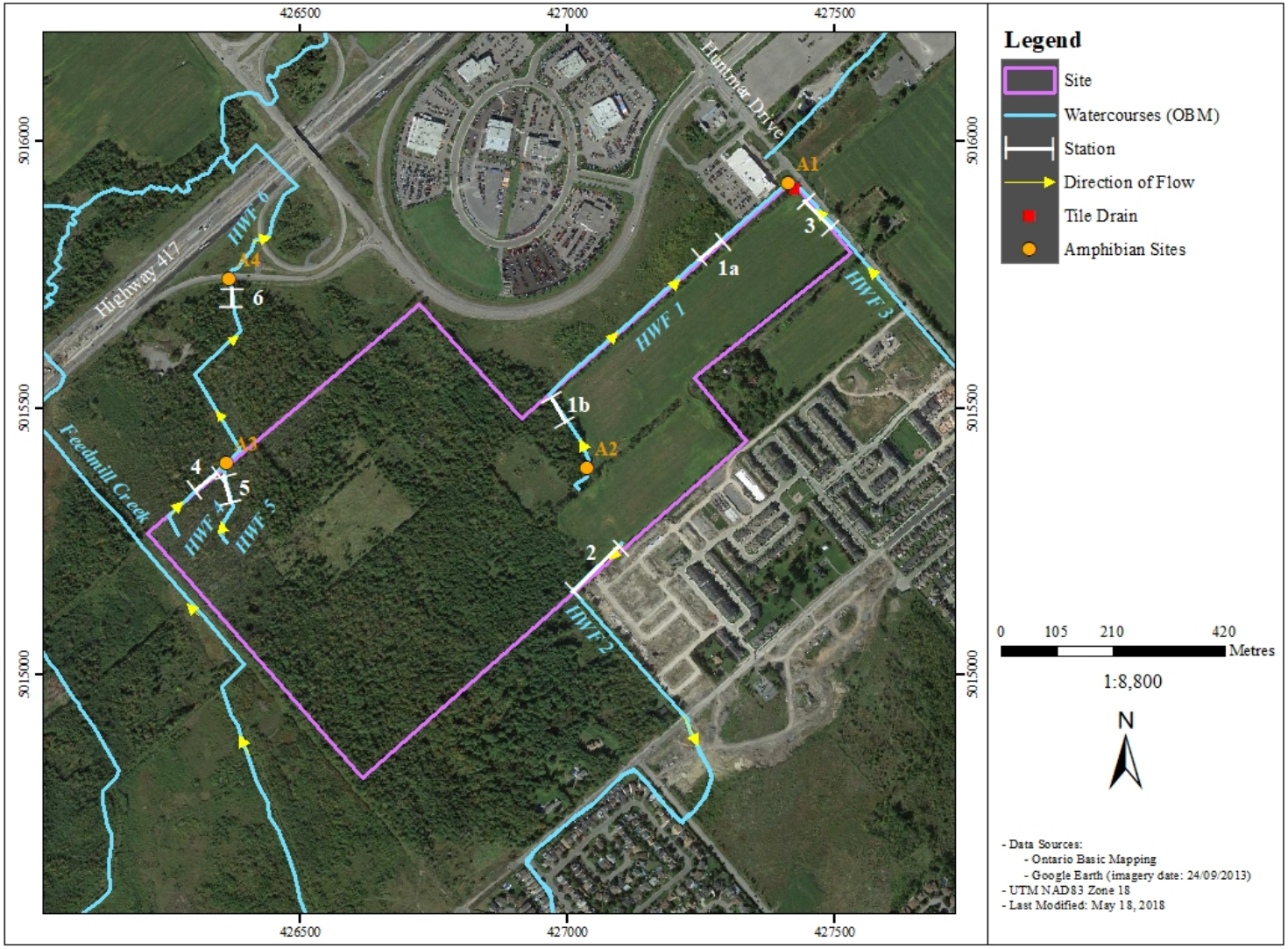
Nighttime amphibian calling surveys were completed as per the *Environment Canada Marsh Monitoring Program* (MMP) guide. The protocol is summarized below:

- The surveys were completed 3 times during the spring and early summer (once during each of the three survey period in order to collect data on all species)
- Observations began 30 minutes after sunset and end before midnight;
- Each station was surveyed for 3 minutes during which time the species and the calling code were recorded for each of the following distances: 0-50m, 50-100m, and >100m. Additional notes were taken on whether the amphibians were in the feature being assessed. The calling codes were recorded as one of:
    - Code 1: Calls not simultaneous, number of individuals can be accurately counted
    - Code 2: Some calls simultaneous, number of individuals can be reliably estimated
    - Code 3: Full chorus, calls continuous and overlapping, number of individuals cannot be reliably estimated
- Surveys were only conducted if the wind strength was Code 0, 1, 2 or 3 on the Beaufort Wind Scale.
- Amphibian survey stations were separated by at least 500 m.

All surveys include the recording of the following information:

- Date
- Name of observer(s) conducting field work
- Time (start and end time, duration)
- Weather conditions (temperature, % cloud cover, wind)
- GPS location
- Species presence and abundance information

Figure 2 Location of Headwater Features and Survey Stations



3.0 RESULTS

3.1 Site Investigations

3.1.1 Summary of Visits and Sampling Site Locations

Several visits were completed between April 2016 and August 2016. Fish community sampling was completed during the spring (May 4, 2016). Amphibian surveys were completed during the spring (April 21 and May 19, 2016) and summer (June 16, 2016). Additional visits in 2018 were undertaken to assess the flow conditions of Feature 1. Environmental conditions for each visit are described in Table 1 below.

Table 1 Summary of Dates, Times of Site Investigations

Date	Time (h)	Staff	Air Temperature (Min-Max) °C	Weather	Purpose
April 15, 2016	0930-1300	S. St.Pierre C. Fontaine	5.0-15.0 (-2.1-14.6)	Clear skies, light breeze changing to clear skies, light air	- Headwater Assessment
April 21, 2016	2000-2200	S. St.Pierre C. Fontaine	18.0-21.0 (-0.6-22.8)	Overcast, periods of light rain, light to gentle breeze	- Amphibian Survey
May 2, 2016	1100-1315	B. Pierson C. Fontaine	9.0-11.0 (2.4-9.3)	Overcast, light to gentle breeze	- Headwater Assessment
May 4, 2016	0815-1000	M. Lavictoire S. St.Pierre	10.0 (3.3-15.1)	95% cloud cover, light breeze changing to 95% cloud cover, light to gentle breeze	- Fish Sampling
May 19, 2016	2315-0000	S. St.Pierre C. Fontaine	10.0 (7.8-20.1)	Clear skies, light air	- Amphibian Survey
June 16, 2016	2115-2230	S. St.Pierre C. Fontaine	20.0-24.0 (11.9-28.8)	Clear skies, light air	- Amphibian Survey
August 11, 2016	0845-1045	S. St.Pierre C. Fontaine	25.0-28.0 (19.0-34.4)	10% cloud cover, light air changing to clear skies, light air	- Headwater Assessment
April 13, 2018	1100-1200	M. Lavictoire	6 (1.2-9.1)	100% cloud cover, light breeze	- Headwater verification of flow at Station 1
April 19, 2018	1000-1100	C. Fontaine	-1 (-0.7-3.3)	100% cloud cover, gentle breeze	

M. Lavictoire – Michelle (Nunas) Lavictoire – M. Sc. Natural Resources
S. St. Pierre – Shaun St. Pierre – B. Sc. Biology and Fisheries and Wildlife Technologist
B. Pierson—Brittney Pierson—Honours BSc. Biology and Environmental Science
C. Fontaine - Cody Fontaine - Fisheries and Wildlife Technologist

*Min-Max Temp Taken From: Environment Canada. National Climate Data and Information Archive. Ottawa International Airport. [November 9, 2016]

3.1.2 Habitat and Fish Community Descriptions

The following sections provide information on the aquatic habitat and fish communities collected in 2016. A total of six headwater features (HWF) are described herein. Each of the headwater features were walked in their entirety and one to two stations were was established in a representative area(s).

Comparison of Selected Channel Parameters

A summary of the water temperatures and other parameters collected at the stations during 2016 is provided in Table 2. In order to put the water levels witnessed in 2016 into context, a review of the snow melt, flood and drought status during the field season is provided. The snow pack of winter 2015-2016 melted prior to ice off resulting in low peak flows in 2016. This was followed by a heavy snow storm at the start of April and cold air temperatures through to mid-April. Thin layers of ice were present on slow flowing channels in the mornings until after April 15th. Mississippi Valley Conservation Authority issued a water safety statement during the spring (March 11). The water level conditions returned to normal by March 18, 2016. A flood watch was issued on April 18th and continued until May 17th. Air temperatures returned to nearer normal but there was little rainfall in May. The amount of rainfall in the seven days prior to each field visit is provided in Table 3.

Table 2 Features and Sampling Parameters

Station No.	Date	Time (h)	Air Temp (°C)	Water Temp (°C)	pH	TDS (ppm)	Conductivity (µs)	Ave. Depth (cm)	Ave. Wetted Width (m)	Ave. Channel Width (m)
Headwater Feature 1										
1a	April 15, 2016	0950	5.0			**				2.47
	May 2, 2016	1110	9.0			**				
	August 11, 2016	0912	27.0			**				
Headwater Feature 1										
1b	April 15, 2016	0958	6.0	7.0	8.23	268	378	4.8	1.47	2.53
	May 2, 2016	1126	10	7.8	8.35	277	383	2.8	0.57	
	August 11, 2016	0940	27.0			**				
Headwater Feature 2										
2	April 15, 2016	1015	11.0			**				2.29
	May 2, 2016	1120	10.0			**				
	August 11, 2016	0925	27.0			**				
Headwater Feature 3										
3	April 15, 2016	1036	10.0	7.1	7.65	450	611	15.9	1.67	2.21
	May 2, 2016	1101	9.0	10.0	7.75	483	694	8.3	0.97	
	August 11, 2016	0903	26.0			**				
Headwater Feature 4										
4	April 15, 2016	1131	12.0	16.2	7.66	723	1020	2.1	1.63	3.22
	May 2, 2016	1205	11.0	10.7	7.38	827	1200	2.0	1.80	
	August 11, 2016	1026	28.0			**				
Headwater Feature 5										
5	April 15, 2016	1136	13.0	17.0	8.14	548	776	3.4	1.57	3.37
	May 2, 2016	1205	11.0			*		2.9	1.8	
	August 11, 2016	1021	28.0			**				

Station No.	Date	Time (h)	Air Temp (°C)	Water Temp (°C)	pH	TDS (ppm)	Conductivity (µs)	Ave. Depth (cm)	Ave. Wetted Width (m)	Ave. Channel Width (m)
Headwater Feature 6										
6	April 15, 2016	1156	15.0	10.3	8.07	364	549	3.3	1.40	2.36
	May 2, 2016	1230	11.0			**				
	August 11, 2016	0852	25.0			**				

*too shallow

**dry

Headwater Feature 1

Headwater feature 1 flows southeast to northwest for 233 m then the flow changes to southwest to northeast for the remaining 584 m within the eastern portion of the study area. The surrounding habitat consisted of cropped fields and meadow on the downstream end. Upstream, the one bank was forested. There was a single row of trees along much of the agricultural area but this was removed by the property owner to the north during the summer. The total length of this watercourse is estimated at 807 m. The channel was dug and had a straight pattern. Two stations were established; one within the agricultural fields (1a) and one in the forested area (1b).

Station 1a

Station 1a started at approximately 160 m from Huntmar Drive and was 61 m in length. The average channel width was 2.5 m and the headwater feature was dry during all three hydrology visits in 2016. The site was checked for flow conditions in April 2018, at that time it was found that there was standing water and wood chips throughout the channel. The water was also standing at the mouth of the feature.

The substrate consisted of fines. Small woody debris was in the channel (Photo 1). No signs of erosion were noted.

Upon arrival at the station during the August 11th visit, the station was being cleared with machinery by the property owner to the north and no vegetation remained. The clearing included the removal of the treed windrow.

This feature could not be sampled due to a lack of water.

Photo 1 Station 1a looking upstream from the downstream end (April 15, 2016)

Photo 2 Station 1a looking upstream (April 13, 2018)

Station 1b

Station 1b started at approximately 160 m from the Palladium Drive off ramp and was 54 m in length. The feature type was channelized as it had been historically dug at one time.

The average channel width was 2.5 m and the station was dry. The average wetted widths during the three visits were: 1.47 m, 0.57 m and 0 m, respectively. The average water depths during these same visits were: 4.8 cm, 2.8 cm and 0 cm.

The substrate consisted of fines. The in-water cover consisted of aquatic vegetation which included: reed canary grass. Some small woody debris was noted within the station. No signs of erosion were noted.

The top of the banks were vegetated with herbaceous vegetation and woody species. The most common species were: wild parsnip, Canada goldenrod, reed canary grass, common buckthorn, Manitoba maple, wild-red raspberry, white cedar, trembling aspen and white birch. Riparian vegetation consisted of forest and cropped lands

This feature could not be sampled due to insufficient water.

Photo 3 Station 1b looking downstream from upstream end (April 15, 2016)

Photo 4 Station 1b looking downstream from upstream end (August 11, 2016)

Headwater Feature 2

Headwater feature 2 flows northeast to southwest within the southern portion of the study area. The channel began along the edge of an agricultural field and residential area and continued south where the surrounding lands was forested on one side and residential on the other. The total length of this watercourse is estimated at 1.6 km. The feature type was channelized as it had been historically dug at one time.

Station 2

Station 2 was located approximately 310 m north from Maple Grove Road and was 120 m in length. This station was situated on the upstream end of the feature. The average channel width was 2.3 m and the headwater feature was dry during all three visits.

The substrate consisted of fines. The channel contained terrestrial vegetation: ragweed, thistle, white clover common buckthorn, white cedar and American elm. No signs of erosion were noted.

The top of the banks were vegetated with herbaceous vegetation and woody species. The most common species were: ragweed, thistle, white clover common buckthorn, white cedar and American elm.

This feature could not be sampled due to lack of water.

Photo 5 Station 2 looking upstream from the downstream end (April 15, 2016)

Photo 6 Station 2 looking upstream from the downstream end (May 2, 2016)

Headwater Feature 3

Headwater feature 3 flows southeast to northwest within the furthest eastern portion of the study area. The feature consisted of a roadside ditch with a paved roadway (Huntmar) along the east bank and cropped fields on the west. The channel was dug with a straight pattern.

Station 3

Station 3 was located approximately 279 m south of Palladium Drive and was 75 m in length. The average channel width was 2.2 m and the headwater feature was dry. The average wetted widths during the three visits were: 1.67 m, 0.97 m and 0 m, respectively. The average water depths during these same visits were: 15.9 cm, 8.3 cm and 0 cm.

The substrate consisted of fines. In-water cover was provided by aquatic vegetation. These species included: purple loosestrife, reed canary grass and great water dock.

The top of the banks were fully vegetated with herbaceous vegetation and woody species. The most common species were: reed canary grass, Canada goldenrod and wild parsnip.

During the May 4, 2016 visit, the station was shocked for 326 seconds over an area of approximately 106 m^2. The sampling continued approximately 10 m beyond the end of the station because the channel had been cleaned out and the slightly deeper water void of vegetation improved sampling and observing fish. The average wetted width and water depth obtained were 1.25 m and 11.5 cm (range 3-33 cm), respectively. Only 3 central mudminnows were captured (size 64-71 mm) and 1 brook stickleback observed.

No sampling was completed during the summer of 2016 due to lack of water.

Photo 7 Station 3 looking upstream from the downstream end (May 2, 2016)

Photo 8 Station 3 looking upstream from the downstream end (August 15, 2016)

Headwater Feature 4

Two small headwater channels that flowed into headwater feature 6 (described further below) were found within the study area. Headwater feature 4 was the north branch and flowed southwest to northeast into HWF 6. The surrounding habitat consisted of a cutblock consisting primarily of meadow with areas of scrubland and forest on the north side. The total length of this watercourse is estimated at 180 m. The channel had a straight pattern. The feature type was channelized as it had been recently dug.

Station 4

Station 4 was 51 m in length. The average channel width was 3.2 m and the headwater feature was dry. The average wetted widths during the three visits were: 1.63 m, 1.80 m and 0 m, respectively. The average water depths during these same visits were: 2.1 cm, 2 cm and 0 cm.

The substrate consisted of fines. In-water cover was provided by aquatic vegetation. These species included: reed canary grass, purple loosestrife and water smartweed. No signs of erosion were noted.

The top of the banks were vegetated with herbaceous vegetation and woody species. The most common species were: reed canary grass, spotted joe-pye weed, spotted jewelweed and American elm.

No sampling was completed during the summer of 2016 due insufficient water.

Photo 9 Station 4 looking downstream from upstream end (April 15, 2016)

Photo 10 Station 4 looking downstream from upstream end (August 15, 2016)

Headwater Feature 5

Headwater feature 5 was the south branch of the two headwater channels flowing into HWF 6. The surrounding habitat consisted of a cutblock consisting primarily of meadow with areas of forest on the east side. The total length of this watercourse is estimated at

160 m. The channel had a straight pattern. The feature type was channelized as it had been recently dug.

Station 5

Station 5 was approximately 56 m in length. The average channel width was 3.4 m. The average wetted widths during the three visits were: 1.57 m, 1.8 m and 0 m, respectively. The average water depths during these same visits were: 3.4 cm, 2.9 cm and 0 cm.

The substrate consisted of fines. In-water cover was provided by aquatic vegetation. These species included: reed canary grass, purple loosestrife and water smartweed. No signs of erosion were noted.

The top of the banks were vegetated with herbaceous vegetation and woody species. These species included: reed canary grass, spotted joe-pye weed, spotted jewelweed and American elm.

No sampling was completed during the summer of 2016 due to insufficient water.

Photo 11 Station 5 looking upstream from downstream end (April 15, 2016)

Photo 12 Station 5 looking upstream from downstream end (August 11, 2016)

Headwater Feature 6

Headwater feature 6 receives water from both HWF 4 and 5 continuing north outside of the study area. This tributary was located within a forest. This feature received flow from HWFs 4 and 5. The total length of this watercourse is estimated at 889 m. The channel had a straight pattern. The feature type was channelized as it had been historically dug at one time.

Station 6

Station 6 started at approximately 16 m south of the Palladium Drive off ramp and was 34 m in length. The average channel width was 2.4 m. The average wetted widths during the three visits were: 1.4 m, 0 m and 0 m, respectively. The average water depths during these same visits were: 3.3 cm, 0 cm and 0 cm.

The substrate consisted of fines. No in-water cover was observed during the early spring when water was present. Later in the season the channel was vegetated with species such as: spotted joe-pye weed, false wood nettle and sensitive fern. No signs of erosion were noted.

The top of the banks were partially vegetated with herbaceous vegetation and woody species. The most common species were: sensitive fern, Virginia creeper, riverbank grape, common buckthorn, tartarian honeysuckle, balsam poplar, green ash and trembling aspen.

No sampling was completed during the summer of 2016 due to insufficient water.

Photo 13 Station 6 looking upstream from downstream end (April 15, 2016)

Photo 14 Station 6 looking upstream from the downstream end (August 11, 2016)

4.0 HEADWATER DRAINAGE FEATURES ASSESSMENT

4.1 Classification

4.1.1 Step 1: Hydrology Classification

In Step 1 the flow is classified based on the amounts recorded during the three visits. These are summarized in Table 4 (as per OSAP S4.M10).

The amount of rainfall recorded in the seven days preceding each station visit is summarized in Table 3 to provide context to the water depths in Table 4.

Table 3 Summary of Rainfall for the 7 Days Preceding the Flow Surveys

Dates	Total Rainfall (mm)
April 8 to 15, 2016	11.8
April 25 to May 2, 2016	6.8
August 4 to August 11, 2016	0.0
April 6 to 12, 2018	12.2
April 12 to 18, 2018	48.2

Total Rainfall taken from: Environment Canada. 2014. National Climate Data and Information Archive – Ottawa INTL. On-line (http://climate.weatheroffice.gc.ca) accessed May 11, 2018.

Summary of 2016 Results

During the spring freshet visit on April 15th, 2016 three HWFs, (HWFs 1 (station 1b), 5 and 6 all contained substantial surface water flow. HWF 3 contained minimal surface water flow, HWF 4 contained standing water and HWF 1a and 2 were dry.

By the second visit on May 2nd, 2016 only one HWF still showed substantial surface water flow (HWFs 1b). HWFs 3, 4 and 5 contained standing water. HWF 6 was mostly dry but had some areas of standing water and HWFs 1a and 2 were dry.

All were dry by the summer visit (note that there was little rainfall in the general area this summer and an attempt to compensate for the drought was made by waiting for a rainfall event, but none occurred).

The lack of water in Feature 2 was not surprising, since the portion of the feature within the study area was the very upstream end. However, the discrepancy between Stations 1a and 1b warranted further investigations. This was completed in 2018.

Summary of Flow Conditions on HWF 1 in 2016 and 2018

In 2016, the entire length of HWF 1 was walked and just downstream of Station 1b, there was no longer any water present on the surface. There were some shrubs in the channel and along both banks which may have absorbed the water or the flow may have infiltrated the substrate.

Robinson (2004) identified the west and central portions of the site as moderate recharge areas due to sand and Paleozoic bedrock while the clay soils in the east portion (which includes Stations 1a and b) were considered to have a low recharge. Geotechnical experts consulted agreed with this analysis indicating that based on the soils info on site and soils mapping info in the area, the soils in this area would consist of a clayey silt (low infiltration) over a sandy glacial till (moderate to high infiltration). They concluded that there was low infiltration potential but that it was possible that the water was finding the higher infiltration soils and infiltrating into the ground (pers. comm Paterson Group).

In 2018, the stations were revisited in mid-April. As in 2016, Station 1b contained substantial flow in 2018. The channel between the two stations was heavily vegetated with reed canary grass (change in conditions following tree removal in 2016) and within the reed canary grass the flow was recorded as minimal (grass was pulled out to facilitate evaluating the flow). In Station 1b and further downstream, the flow was measured as standing water despite the regular rainfall during the 7 days prior to the visit (48.2 mm). Where standing water was present, the channel was full of wood chips from the previous tree clearing by the adjacent landowner.

The results from 2018 suggest that the difference in flow conditions is a result of the channel's characteristics (vegetation and wood chips) and not because of recharging. The hydrological assessment of Station 1a was raised to Contributing based on the 2018 data.

General Comments

Where the option was Valued or Contributing, those features with substantial and/or minimal flow during the first two visits were classified as Valued and those with standing or no surface water by the second visit were ranked as Contributing.

Note that feature 1 did not match the classification system provided in the guidelines. It was channelized (dug) but dry during the spring visits. Given that it was dry and did not have any signs of groundwater seepage or wetland functions it has been labelled as Limited.

Table 4 Hydrology classification features using data from OSAP S4.M10.

Feature	Reach	Definitions of Flow Influence	Flow Conditions	Feature Code Type	Hydrology Classification
HWF 1	a	Spring Freshet or rainfall events Late April-May	Standing Water (spring 2018) (2)	Channelized or Constrained (2) A shallow trough-like depression conveying water only in the early spring when there was snowmelt. Flow not sufficiently sustained	Contributing
		July-August	No surface water (summer 2016) (1)		
	b	Spring Freshet or rainfall events Late April-May	Surface flow substantial (5)	Channelized or Constrained (2) Channel banks are visible and there is evidence that the stream has been historically been dredged/straightened.	Valued
		July-August	No surface water (1)		
HWF 2		Late April-May	No surface water (1)	Channelized or Constrained (2) Channel banks are visible and there is evidence that the stream has been historically dredged/straightened.	Limited*
		July-August			

Feature	Reach	Definitions of Flow Influence	Flow Conditions	Feature Code Type	Hydrology Classification
HWF 3		Spring Freshet or rainfall events	Minimal flow (4)	Roadside Ditch (8) This watercourse conveys roadside and other impervious cover drainage that has been directed to run parallel with a roadway.	Contributing
		Late April-May	Standing Water (2)		
		July-August	No surface water (1)		
HWF 4		Spring Freshet or rainfall events	Standing water (2)	Channelized or Constrained (2) Channel banks are visible and there is evidence that the stream has been recently dredged/straightened.	Contributing
		Late April-May			
		July-August	No surface water (1)		
HWF 5		Spring Freshet or rainfall events	Surface flow substantial (5)	Channelized or Constrained (2) Channel banks are visible and there is evidence that the stream has been recently dredged/straightened.	Contributing
		Late April-May	Standing water (2)		
		July-August	No surface water (1)		

Feature	Reach	Definitions of Flow Influence	Flow Conditions	Feature Code Type	Hydrology Classification
HWF 6		Spring Freshet or rainfall events	Surface flow substantial (5)	Channelized or Constrained (2) Channel banks are visible and there is evidence that the stream has been historically dredged/straightened.	Contributing
		Late April-May	Standing water (2)		
		July-August	No surface water (1)		

* Note that the guidelines do not include an option of a channelized feature with no flow or standing water during the spring visits. This feature has been labelled as Limited as it does not meet the Valued or Contributing definition

4.1.2 Step 2: Riparian Classification

In Step 2 the riparian habitat is classified based on the width and type of vegetation on the banks. These are summarized in Table 5.

Table 5 Riparian Classification

HWF/ Tributary	Reach	OSAP S4.M10 Code	Riparian Classification	Comments
HWF 1	a	- South Side 3 (Cropped Land) - North Side 4 (Meadow)	Valued	The southern bank is a cropped land. The northern bank is meadow.
HWF 1	b	- East Side 3 (Cropped Land) 5 (Scrubland) - West Side 6 (Forest)	Important	The riparian habitat within 0-1.5m along the eastern bank is scrubland, however, past the 1.5m is cropped land. The western bank is forested.
HWF 2		- South Side 1 (None) - North Side 6 (Forest) 3 (Cropped Land)	Important	The southern bank is residential. The northern bank contains areas of forest as well as cropped land.
HWF 3		- East Side 1 (None) - West Side 3 (Cropped Land) 4 (Meadow)	Limited	The eastern bank is a paved road. The riparian habitat within 0-1.5m along the western bank is meadow, however, past the 1.5m is cropped land.
HWF 4		- South Side 4 (Meadow) - North Side 4 (Meadow)	Important	The riparian habitat along the southern bank is meadow. The

HWF/ Tributary	Reach	OSAP S4.M10 Code	Riparian Classification	Comments
		5 (Scrubland) 6 (Forest)		riparian habitat within 0-1.5m along the northern bank is meadow, however, past the 1.5m is scrubland and forested areas.
HWF 5		- East Side 6 (Forest) 4 (Meadow) - West Side (Meadow)	Important	The riparian habitat within 0-1.5m along the eastern bank is meadow, however, past the 1.5m is forest. The western bank is meadow.
HWF 6		6 (Forest)	Important	In the study area the feature is surrounded by forest.

4.1.3 Step 3: Fish and Fish Habitat Classification

The fish habitat is classified based on fish observations during the spring and summer. Features that provide habitat for species at risk or critical (spawning) habitat would be considered the most significant.

Of the six features only contained sufficient water during any season to provide potential fish habitat (HWFs 3).

HWF 3 has all been listed as Valued for the following reasons:

- No critical habitat or species at risk or species of conservation is present in the headwater feature.
- During the spring sampling, the number and diversity of fish was poor (two central mudminnows were captured, one brook stickleback observed).

The remaining five features (HWFs 1-2 and 4-6) were listed as Contributing as this is the only option available in the protocol for channels that do not provide direct fish habitat. These HWFs act more to transport allochthonous materials through the feature to downstream habitat and do not directly provide habitat for fish.

4.1.4 Step 4: Terrestrial Habitat Classification

This step is more of a classification of amphibian habitat than of the terrestrial habitat. According to the guidelines, only those features associated with wetland habitats can be considered Important or Valued. Features classed as Contributing are those that may or do provide a linkage between habitat for wildlife movement and Limited is given to those that do not meet any of the above criteria.

None of the features linked to habitats and as such did not provide corridor functions.

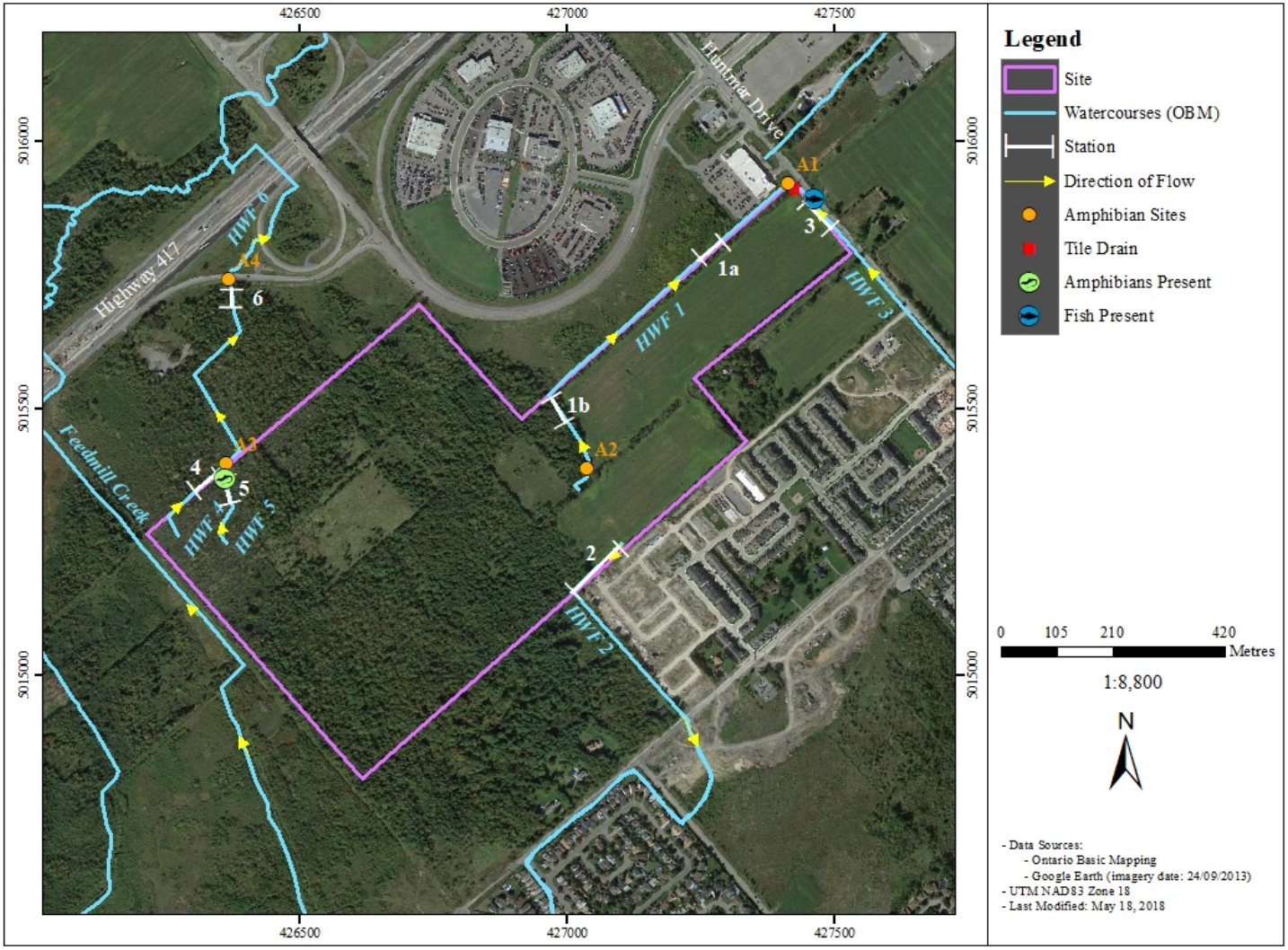
The MMP amphibian monitoring protocol was followed with the extra step of identifying whether or not amphibians were calling from the specific feature or not (Table 6). Details are provided in Appendix A.

Table 6 Terrestrial Classification

HWF/ Tributary	OSAP S4.M10 Code	Marsh Monitoring Protocol Calling Code	Comments	Classification
HWF 1A and HWF 3	HWF 1- South Side 3 (Cropped Land) - North Side 4 (Meadow) HWF 4- East Side 1 (None) - West Side 3 (Cropped Land) 4 (Meadow)	0	No calls within the feature.	Limited
HWF 1B	- East Side 3 (Cropped Land) 5 (Scrubland) - West Side 6 (Forest)	0	No calls within feature.	Limited
HWF 2	- South Side 1 (None)	0	No calls within feature.	Limited

HWF/ Tributary	OSAP S4.M10 Code	Marsh Monitoring Protocol Calling Code	Comments	Classification
	- North Side 6 (Forest) 3 (Cropped Land)			
HWF 4 and HWF 5	HWF 6- South Side 4 (Meadow) - North Side 4 (Meadow) HWF 7- East Side 6 (Forest) 4 (Meadow) - West Side (Meadow)	1	Few frogs calling during first visit only	Limited
HWF 6	6 (Forest)	0	None	Limited

Figure 3 Fish and Amphibian Results



4.2 Part 3 – Management Recommendations

The management recommendations are grouped into six categories: protection, conservation, mitigation, maintain recharge, maintain/ replicate terrestrial linkage, and no management required.

The presence of Important riparian habitat at five sites and the Valued fish habitat at one feature results in all but HWF 1b and 2 being classified as Conservation. HWF 1a ranked Contributing leading to Mitigation and HWF 2 ranked Limited for the hydrology leading to the No Management Required.

5.0 SUMMARY

Six headwater features were present within the urban study area. The features were visited multiple times during 2016 including three flow classification visits, and additional flow visits were completed during spring 2018 on HWF 1. All features had been channelized except HWF 3 which was the roadside ditch to Huntmar Road. Headwater feature 2 was dry during all three flow visits. The remaining channels contained standing water (HWF 4), surface flow minimal (HWF 3) or surface flow substantial (HWFs 5 & 6). A few forage fish (2 central mudminnows and 1 brook stickleback) were encountered at HWF 3. Amphibians were heard calling from two features during the first visits only (HWFs 4 and 5).

At this time the recommended management is Conservation for all but the lower portion of the HWF 1 (1a) which is Mitigation and HWF 2 which is assessed as No Management Required.

The management implications of Conversation signify that the following options are available (as described in the guideline):

1. The channel may be maintained, relocated or enhanced. It is noted that should the channel be relocated then it is to be done using natural channel design.
2. The groundwater or wetland contribution is to be maintained or replicated. If the catchment drainage will be removed as part of the development then the function should be restored through enhancement of lot level control (i.e. restore original catchment using clean roof drainage), as feasible
3. Maintain or replace on-site flows using mitigation measures and/or wetland creation, if necessary.
4. Maintain or replace external flows
5. Drainage feature must connect to downstream

The management implications of Mitigation signify that the following options are available (as described in the guideline):

1. Replicate or enhance functions through enhanced lot level conveyance measures to mimic online wet vegetation pockets, or to replicate through constructed wetland features connected to the downstream.
2. Replicate on-site flow and outlet flows at the top end of system to maintain feature functions.
3. Replicate functions by lot level conveyance measures connected to the natural heritage system, as feasible and/or Low Impact Development stormwater options.

6.0 References

MTO (2006). *Environmental Guide for Fish and Fish Habitat, Section* 5: Sensitivity of Fish and Fish Habitat. Ministry of Transportation Ontario.

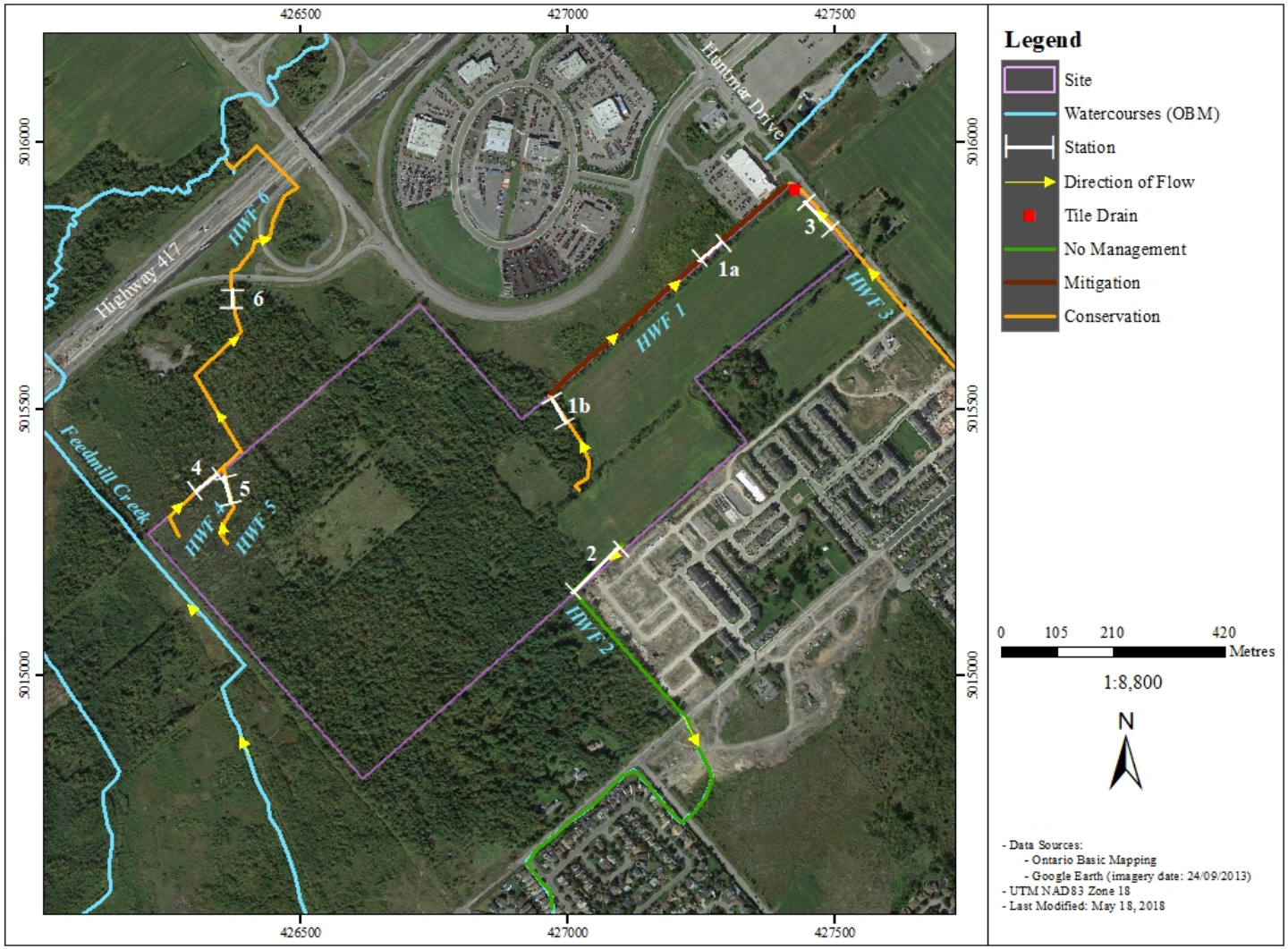
Robinson Consultants (2004). Carp River Watershed/ Subwatershed Study Volume I - Main Report. Prepared for the City of Ottawa. 248pp.

TRCA and CVC (2014). Evaluation, Classification and Management of Headwater Drainage Features Guideline. Toronto and Region Conservation Authority and Credit Valley Conservation, TRCA Approval July 2013 (Finalized January 2014). 27pp.

Table 7 Evaluation, Classification and Management Summary

Drainage Feature Segment	Hydrology Classification	Fish and Fish Habitat Classification	Riparian Classification	Terrestrial Habitat Classification	Management Recommendation
HWF 1a	Contributing	Contributing	Valued	Limited	Mitigation
HWF 1b	Valued	Contributing	Important	Limited	Conservation
HWF 2	Limited	Contributing	Important	Limited	No Management Required
HWF 3	Contributing	Valued	Limited	Limited	Conservation
HWF 4	Contributing	Contributing	Important	Limited	Conservation
HWF 5	Contributing	Contributing	Important	Limited	Conservation
HWF 6	Contributing	Contributing	Important	Limited	Conservation

Figure 4 Management Recommendations



Appendix A - Summary of Channel Form

Watercourse	Average Bank Height (cm)	Bank Width (m)	Channel Stability	Morphology	Channel Slope	Bank Material	Substrate Material	Discharge points, seeps, tile drain outlet, etc.	Width and Depth of Associated Storage
HWF 1a	25	2.5	No signs of erosion	Dry	1°	Fines	Fines	No evidence	No wetlands are located along this channel
HWF 1b	27	2.5	No signs of erosion	Dry	1°	Fines	Fines	No evidence	No wetlands are located along this channel.
HWF 2	25	2.3	No signs of erosion	Dry	0.5°	Fines	Fines	No evidence	No wetlands are located along this channel.
HWF 3	30	2.3	No signs of erosion	Dry	2°	Fines	Fines	Tile Drain Outlet	No wetlands are located along this channel.
HWF 4	20	3.1	No signs of erosion	Dry	1°	Fines	Fines	No evidence	No wetlands are located along this channel
HWF 5	19	3.4	No signs of erosion	Dry	0.5°	Fines	Fines	No evidence	No wetlands are located along this channel
HWF 6	22	2.4	No signs of erosion	Dry	2°	Fines	Fines	No evidence	No wetlands are located along this channel

Appendix B - Amphibian Survey Results

HWF	Site	Visit 1 (Species, #) April 21, 2016			Visit 2 (Species, #) May 19, 2016			Visit 3 (Species, #) June 16, 2016		
		Distance from Site								
		50m	50-100m	>100m	50m	50-100m	>100m	50m	50-100m	>100m
HWF 1a and HWF 3	**A1**	none	none	none	none	none	none	none	none	none
HWF 1b	**A2**	none	none	none	none	none	none	none	none	none
HWF 4 and HWF 5	**A3**	none	Wood Frog (2)	none	none	none	none	none	none	none
HWF 6	**A4**	none	none	none	none	none	none	none	none	none

Green - In Feature