

GUIDING SOLUTIONS IN THE NATURAL ENVIRONMENT

## Headwater Drainage Feature Assessment

4134 16<sup>th</sup> Avenue

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Date: Project:

October 2017 215200

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## 1. Introduction

A Headwater Drainage Feature Assessment was undertaken for features on the property located at 4134 16<sup>th</sup> Avenue (subject property), the York Downs Golf Course lands, in the City of Markham, Regional Municipality of York. The data for Headwater Drainage Features (HDF) were collected according to the *Ontario Stream Assessment Protocol Headwater Drainage Feature Module* (Stanfield *et al.* 2013), scoped for data relevance and adapted to a reach based approach. The features were classified according to the *Evaluation, Classification and Management of Headwater Drainage Features Guidelines* (Toronto and Region Conservation Area and Credit Valley Conservation 2014). Aerial photograph interpretation and discussions with golf course staff formed the basis for the HDF assessment. Several drains, outlets and tile drains are scattered throughout the golf course property and considerable effort was expended to establish their origins, layout and connections. **Figure 1** illustrates flow patterns, infrastructure, piped, tiled and surface drainage features within the subject property.

## 2. Headwater Drainage Feature Guidelines

The HDF guidelines use an integrated approach for the evaluation of key attributes of drainage features including flow and feature form (combined under the term hydrology), riparian vegetation, fish and fish habitat and terrestrial habitat. The evaluation divides headwater drainage features into segments, with breaks between segments occurring where key attributes change. Each segment is assigned a rating of its functional significance of "important", "valued", "contributing" or "limited". The functional significance of all attributes of each segment is then considered to determine the recommended management option for each segment. These evaluations can lead to one of six possible management recommendations – Protection, Conservation, Mitigation, Recharge Protection, Maintain or Replicate Terrestrial Linkage and No Management.

The management recommendations taken directly from the TRCA/CVC HDF Assessment protocol are summarized as follows:

**Protection** – Important Functions: e.g. swamps with amphibian breeding habitat; perennial headwater drainage features; seeps and springs; Species at Risk (SAR) habitat; permanent fish habitat with woody riparian cover:

- Protect and/or enhance the existing feature and its riparian zone corridor, and groundwater discharge or wetland in-situ;
- Maintain hydroperiod;
- Incorporate shallow groundwater and base flow protection techniques such as infiltration treatment;
- Use natural channel design techniques or wetland design to restore and enhance existing habitat features, if necessary; realignment not generally permitted; and,
- Design and locate the Stormwater Management (SWM) system (e.g. extended detention outfalls); to be designed and located to avoid impacts (i.e. sediment, temperature) to the feature.



**Conservation** – Valued Functions: e.g. seasonal fish habitat; with woody riparian cover; marshes with amphibian breeding habitat; or general amphibian habitat with woody riparian cover:

- Maintain, relocate, and/or enhance drainage feature and its riparian zone corridor;
- If catchment drainage has been previously removed or will be removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage), as feasible;
- Maintain or replace on-site flows using mitigation measures and/or wetland creation, if necessary;
- Maintain or replace external flows;
- Use natural channel design techniques to maintain or enhance overall productivity of the reach; and,
- Drainage feature must connect to downstream.

*Mitigation* – Contributing Functions: e.g. contributing fish habitat with meadow vegetation or limited cover.

- Replicate or enhance functions through enhanced lot level conveyance measures, such as well vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features connected to downstream;
- Replicate onsite flow and outlet flows at the top end of the system to maintain feature functions with vegetated swales, bioswales, etc. If catchment drainage has been previously removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage); and,
- Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or LID stormwater options (refer to Conservation Authority Water Management Guidelines for details).

Recharge Protection – Recharge Functions: e.g. features with no flow with sandy or gravelly soils.

- Maintain overall water balance by providing mitigation measures to infiltrate clean stormwater, unless the area qualifies as an Area of High Aquifer Vulnerability under the ORMCP or Significant Recharge Areas under the Source Water Protection Act. These areas will be subject to specific policies under their respective legislation; and,
- Terrestrial features may need to be assessed separately through an Environmental Impact Study to determine whether there are other terrestrial functions associated with them.

*Maintain or Replicate Terrestrial Linkage* – *Terrestrial Functions:* e.g. features with no flow with woody riparian vegetation and connects two other natural features identified for protection.

- Maintain the corridor between the other features through in-situ protection or if the other features require protection, replicate and enhance the corridor elsewhere; and,
- If the feature is wider than 20 m, it may need to be assessed separately through an Environmental Impact Study to determine whether there are other terrestrial functions associated with it.

**No Management Required** – Limited Functions: e.g. features with no or minimal flow; cropped land or no riparian vegetation; no fish or fish habitat; and no amphibian habitat.



 The feature that was identified during desktop pre-screening has been field verified to confirm that no feature and/or functions associated with headwater drainage features are present on the ground and/or there is no connection downstream. These features are generally characterized by lack of flow, evidence of cultivation, furrowing, presence of a seasonal crop, and lack of natural vegetation. No management recommendations required.

## 3. Results

Field investigations took place on July 19, August 3 and August 17, 2016 and April 13, July 28 and September 21, 2017. **Table 1** provides the results of the HDF Analysis, including management recommendations, for each of the features identified on the subject property. Each of these features are identified on **Figures 1a** through **1e**. Photographs of each of the features are provided in a photolog (**Appendix A**).

Drainage	Step 1		Step 2	Step 3	Step 4	Output from
Feature Segment	Hydrology	Modifiers	Riparian	Fish Habitat	Terrestrial Habitat	HDF Assessment
BR2-H1A-S1	Contributing		Important	Contributing	Valued	Conservation
BR3-H2-S1	Important		Important	Contributing	Contributing	Protection
BR3-H2-S2	Important		Important	Contributing	Contributing	Protection
BR3-H2-S3	Important		Important	Contributing	Contributing	Protection
BR3-H2-S4	Valued		Contributing	Contributing	Limited	Mitigation
BR3-H2-S5	Valued		Important	Contributing	Contributing	Conservation
BR3-H2-S6	Valued		Important	Contributing	Contributing	Conservation
BR3-H2-S7	Valued		Contributing	Contributing	Limited	Mitigation
BR3-H2-S8	Valued		Important	Contributing	Contributing	Conservation
BR3-H2-S9	Valued		Important	Contributing	Contributing	Conservation
BR3-H2-S10	Contributing		Important	Contributing	Contributing	Conservation
BR3-H2-S11	Valued*	Tile Drain	-	Contributing	-	Mitigation
BR3-H2A-S1	Important		Contributing	Contributing	Limited	Protection
BR3-H2A-S2	Important		Important	Contributing	Contributing	Protection
BR3-H2A-S3	Valued		Important	Contributing	Contributing	Conservation
BR3-H2A-S4	Valued		Contributing	Contributing	Limited	Mitigation
BR3-H2A-S5	Valued		Important	Contributing	Contributing	Conservation
BR3-H2A-S6	Important		Important	Contributing	Contributing	Protection
BR3-H2A-S7	Important		Important	Contributing	Contributing	Protection
BR3-H2A-S8	Important		Important	Contributing	Contributing	Protection
BR3-H2B-S1	Contributing		Important	Contributing	Contributing	Conservation
BR3-H2B-S2	Contributing		Contributing	Contributing	Limited	Mitigation
BR3-H2B-S3	Contributing		Valued	Contributing	Contributing	Mitigation
BR3-H2B-S4	Contributing		Valued	Contributing	Contributing	Mitigation
BR3-H2B-S5	Contributing		Valued	Contributing	Contributing	Mitigation

#### Table 1. HDFA Management Recommendations



Drainage	Step 1		Step 2	Step 3	Step 4	Output from
Feature Segment	Hydrology	Modifiers	Riparian	Fish Habitat	Terrestrial Habitat	HDF Assessment
BR3-H2B-S6	Contributing		Valued	Contributing	Contributing	Mitigation
BR3-H2B-S7	Contributing		Valued	Contributing	Contributing	Mitigation
BR3-H2B-S8	Contributing		Valued	Contributing	Contributing	Mitigation
BR3-H2Ba-S1	Contributing		Limited	Contributing	Contributing	Mitigation
BR3-H2Ba-S2	Contributing		Valued	Contributing	Contributing	Mitigation
BR3-H3-S1	Valued*		Important	Contributing	Valued	Conservation
BR3-H3-S2	Valued*		Important	Contributing	Valued	Conservation
BR3-H3-S3	Contributing		Important	Contributing	Valued	Conservation
BR3-H4-S1	Limited	Tile Drain Outlet	-	Contributing	-	No Management
BR3-H5-S1	Valued	Tile Drain Outlet	-	Contributing	-	No Management
BR3-H6-S1	Limited	Tile Drain Outlet	-	Contributing	-	No Management
BR3-H7-S1	Limited	Tile Drain Outlet	-	Contributing	-	No Management
BR4-H1-S1	Important	Pond Connection	-	Contributing	-	No Management
BR4-H1-S2 POND						
BR4-H1-S3	Important	Tile Drain Outlet	-	Contributing	-	No Management
BR5-H1-S1	Valued*	Pond Connection	-	Contributing	-	No Management
BR5-H1-S2			PON	ID		
BR5-H1-S3	Valued*	Tile Drain Outlet	-	Contributing		No Management
Drainage	Step 1		Step 2	Step 3	Step 4	Output from
Feature Segment	Hydrology	Modifiers	Riparian	Fish Habitat	Terrestrial Habitat	HDF Assessment
BR5-H1-S4			PON	ID		
BR5-H1A-S1	Valued	Tile Drain Outlet	-	Contributing	-	No Management
BR5-H1B-S1	Valued*	Tile Drain Outlet	-	Contributing	-	No Management
BR5-H2-S1	Valued*	Tile Drain Outlet	-	Contributing	-	No Management
BR5-H3-S1	Valued	Tile Drain Outlet	-	Contributing	-	No Management
BR5-H4-S1	Valued*	Tile Drain Outlet	-	Contributing	-	No Management
BR5-H5-S1	Valued*	Tile Drain Outlet	-	Contributing	-	No Management
BR5-H6-S1	Undetermined	Tile Drain Outlet	-	Contributing	-	No Management
BR5-H7-S1	Valued	Tile Drain Outlet	-	Contributing	-	No Management
BER3-H1-S1	Valued		Important	Contributing	Contributing	Conservation
BER3-H1-S2	Valued	Tile Drain	-	Contributing	-	No Management
BER3-H1A-S1	Limited	Tile Drain	-		-	No Management
BER3-H2-S1	Limited	Roadside Ditch	Valued	Contributing	Contributing	Mitigation

\* Features which were flowing during the September site visit, but were not identified as groundwater discharge have been assigned a hydrology of "valued" as per the TRCA & CVC Guidelines (2014)



- Watercourse
- Reach Break

BEACON

0 50 100

1:9,000

BURNSIDE

200

300

400

- Piped Feature
- Existing Storm Sewer
- Outlet
- - Auxiliary Water
- --- Tile Drain Flow Path Segment Break
- Pond Segment
- Surface Flow

JD Barnes: Aerial Photograph, 2015. MBTW: Subject Property, 2015. Beacon Environmental, 2017. All other data.

4134 16TH AVE FIGURE 1: Headwater Drainage Feature Analysis

UTM Zone 17 N, NAD 83





- Watercourse

Reach Break

- Subject Property Tile Drain Flow Path
  - Inlet
  - Outlet
  - Existing Storm Sewer Segment Break

Surface Flow

JD Barnes: Aerial Photograph, 2015; MBTW: Subject Property, 2015; Beacon Environmental: All other data 2017.

#### MASTER ENVIRONMENTAL SERVICING PLAN FOR 4134 16TH AVE

FIGURE 1a: Headwater Drainage Feature Assessment

UTM Zone 17 N, NAD 83





#### Legend

Reach Break

Piped Feature

- Surface Flow

- - Auxiliary Water
  - Tile Drain Flow Path
- Existing Storm Sewer Inlet
  - Outlet
- Burried/Stone Trench Segment Break

### MASTER ENVIRONMENTAL SERVICING PLAN FOR 4134 16TH AVE

FIGURE 1b: Headwater Drainage Feature Assessment

UTM Zone 17 N, NAD 83

JD Barnes: Aerial Photograph, 2015. MBTW: Subject Property, 2015. Beacon Environmental, 2017. All other data.





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- Subject Property Existing Storm Sewer
- Surface Flow
  - Burried/Stone Trench 
     Segment Break
- -- Auxiliary Water
- Inlet

Tile Drain Flow Path

Pond Segment

# MASTER ENVIRONMENTAL SERVICING PLAN FOR 4134 16TH AVE

FIGURE 1c: Headwater Drainage Feature Assessment

UTM Zone 17 N, NAD 83

JD Barnes: Aerial Photograph, 2015. MBTW: Subject Property, 2015. Beacon Environmental, 2017. All other data.





#### Legend

- Watercourse

Reach Break

-- Auxiliary Water

- Subject Property
  - Tile Drain Flow Path
  - Pond Segment
- Inlet Piped Feature
  - Outlet
  - Segment Break

## MASTER ENVIRONMENTAL SERVICING PLAN FOR 4134 16TH AVE

FIGURE 1d: Headwater Drainage Feature Assessment

UTM Zone 17 N, NAD 83

JD Barnes: Aerial Photograph, 2015. MBTW: Subject Property, 2015. Beacon Environmental, 2017. All other data.





#### MASTER ENVIRONMENTAL SERVICING PLAN FOR 4134 16TH AVE

FIGURE 1e: **Headwater Drainag**e Feature Assessment

UTM Zone 17 N, NAD 83

JD Barnes: Aerial Photograph, 2015. MBTW: Subject Property, 2015. Beacon Environmental, 2017. All other data.



## Appendix A

**HDFA** Photolog

#### **Bruce Creek**



Photo 1 BR2-H1-S1: Upstream view of feature from confluence with Bruce Creek. Sample Event 1 (April 18, 2017)

Photo 2 BR2-H1-S1: Downstream view of feature. Sample Event 2 (July 28, 2017)



Photo 3

BR2-H1-S1: Upstream view of feature near confluence with Bruce Creek. Note standing water from backwatering of Bruce Creek debris jam. Sample Event 3 (September 21, 2017)

Photo 4





Photo 5 BR2-H1-S2: Downstream view of feature. Note standing water. Sample Event 2 (July 28, 2017)

Photo 6 BR2-H1A-S1: Upstream view of feature. Note standing water. Sample Event 1 (April 18, 2017)



Photo 7

BR3-H2-S1: Downstream view of feature. Sample Event 1 (April 13, 2017)

Photo 8 BR3-H2-S1: Downstream view of feature. Sample Event 2 (July 28, 2017)



Photo 9 BR3-H2-S1: Downstream view of feature from reach break. Sample Event 3 (September 21, 2017)

Photo 10 BR3-H2-S2: Upstream view of feature. Sample Event 1 (April 13, 2017)



Photo 11

BR3-H2-S2: Upstream view of feature. Sample Event 2 (July 28, 2017)

Photo 12 BR3-H2-S2: Upstream view of feature. Sample Event 3 (September 21, 2017)



Photo 13 BR3-H2-S3: Downstream view of channelized feature type. Sample Event 1 (April 13, 2017)

Photo 14 BR3-H2-S3: Upstream view of channelized feature type. Sample Event 2 (July 28, 2017)



Photo 15

BR3-H2-S3: Downstream view of feature towards reach break; minimal flow. Sample Event 3 (September 21, 2017)

BR3-H2-S4: Downstream culvert outlet. Sample Event 1 (April 13, 2017)



Photo 17 BR3-H2-S4: Downstream culvert outlet. Sample Event 2 (July 28, 2017)

Photo 18 BR3-H2-S4: Downstream culvert outlet. Sample Event 3 (September 21, 2017)



Photo 19

BR3-H2-S5: Downstream view of the feature. Sample Event 1 (April 13, 2017)

Photo 20

BR3-H2-S5: Downstream view of the feature. Sample Event 2 (July 28, 2017)



Photo 21 BR3-H2-S5: Downstream view of the feature. Sample Event 3 (September 21, 2017)

Photo 22 BR3-H2-S6: Upstream view of feature. Sample Event 1 (April 13, 2017)



Photo 23

BR3-H2-S6: Downstream view of feature. Sample Event 2 (July 28, 2017)

BR3-H2-S6: Downstream view of feature. Sample Event 3 (September 21, 2017)



Photo 25 BR3-H2-S7: Upstream view of culvert outlet. Sample Event 1 (April 13, 2017)

Photo 26 BR3-H2-S7: Upstream view of culvert outlet. Sample Event 2 (July 28, 2017)



Photo 27

BR3-H2-S7: Upstream view of culvert outlet. Sample Event 3 (September 21, 2017) Photo 28

BR3-H2-S8: Downstream view of feature at downstream reach extent. Sample Event 1 (April 13, 2017)



Photo 29 BR3-H2-S8: Downstream view of feature at downstream reach extent. Sample Event 2 (July 28, 2017)

Photo 30 BR3-H2-S8: Downstream view of feature at downstream reach extent. Sample Event 3 (September 21, 2017)



Photo 31 BR3-H2-S9: Upstream view of feature. Sample Event 1 (April 13, 2017)

Photo 32 BR3-H2-S9: Upstream view of feature. Sample Event 2 (July 28, 2017)



Photo 33 BR3-H2-S9: Upstream view of the feature; standing water, iron staining. Sample Event 3 (September 21, 2017)

Photo 34 BR3-H2-S10: Upstream view of feature. Sample Event 1 (April 13, 2017)



Photo 35 BR3-H2-S10: Downstream view of feature. Sample Event 2 (July 28, 2017)

Photo 36 BR3-H2-S10: Downstream view of feature. Note dry conditions. Sample Event 3 (September 21, 2017)



Photo 37 BR3-H2-S11: Upstream view of pipe outlet. Sample Event 1 (April 13, 2017)

Photo 38 BR3-H2-S11: Upstream view of pipe outlet. Corrugated pipe is cracked/leaking Note iron staining. Sample Event 2 (July 28, 2017)



Photo 39 BR3-H2-S11: Upstream view of pipe outlet. Note dry conditions. Sample Event 1 (March 9, 2017)

Photo 40 BR3-H2A-S1: Downstream culvert extent. Sample Event 1 (April 13, 2017)



Photo 41 BR3-H2A-S1: Downstream culvert extent. Sample Event 2 (July 28, 2017)

Photo 42 BR3-H2A-S1: Downstream culvert extent. Sample Event 3 (September 21, 2017)



Photo 43 BR3-H2A-S2: Upstream view of feature from reach BR3-H2A-S2: Upstream view of feature from reach break. Sample Event 1 (April 13, 2017)

Photo 44 break. Sample Event 2 (July 28, 2017)



Photo 45 BR3-H2A-S2: Upstream view of feature. Sample Event 3 (September 21, 2017)

Photo 46 BR3-H2A-S3: Upstream view of feature. Sample Event 1 (April 13, 2017)



Photo 47 BR3-H2A-S3: Downstream view of feature. Sample Event 2 (July 28, 2017)

Photo 48 BR3-H2A-S3: Upstream view of feature. Sample Event 3 (September 21, 2017)



Photo 49 BR3-H2A-S4: Upstream view of tile outlet. Sample Event 1 (April 13, 2017)

Photo 50 BR3-H2A-S4: Upstream view of tile outlet. Sample Event 2 (July 28, 2017)



Photo 51 BR3-H2A-S4: Upstream view of tile outlet. Sample Event 3 (September 21, 2017)

Photo 52 BR3-H2A-S5: Downstream view of wetland feature. Sample Event 1 (April 13, 2017)



Photo 53 BR3-H2A-S5: Upstream view of wetland feature; standing water. Sample Event 2 (July 28, 2017)



Photo 54 BR3-H2A-S6: Downstream view of feature from upstream extent. Sample Event 1 (April 13, 2017)



Photo 55 BR3-H2A-S6: Downstream view of feature from upstream extent. Sample Event 2 (July 28, 2017)

Photo 56 BR3-H2A-S6: Downstream view of feature from upstream extent. Sample Event 3 (September 21, 2017)



Photo 57 BR3-H2A-S7: Upstream view of culvert at downstream extent. Sample Event 1 (April 13, 2017)

Photo 58 BR3-H2A-S7: Downstream view from culvert at downstream extent. Sample Event 2 (July 28, 2017)



Photo 59 BR3-H2A-S7: Downstream view of feature from upstream extent. Sample Event 3 (September 21, 2017)

Photo 60 BR3-H2A-S8: Upstream view of feature. Sample Event 1 (April 13, 2017)



Photo 61 BR3-H2A-S8: Upstream view of feature. Sample Event 2 (July 28, 2017)

Photo 62 BR3-H2A-S7: Upstream view of feature. Sample Event 3 (September 21, 2017)



Photo 63 BR3-H2B-S1: Upstream view of feature from downstream extent. Sample Event 1 (April 13, 2017)

Photo 64 BR3-H2B-S1: Downstream view of feature; substantial flow. Sample Event 2 (July 28, 2017)



Photo 65 BR3-H2B-S1: Upstream view of feature; interstitial BR3-H2B-S2: Upstream view of riprap near outlet. flow. Sample Event 3 (September 21, 2017)

Photo 66 Sample Event 2 (July 28, 2017)



Photo 67 BR3-H2B-S2: Downstream view downstream of outlet; dry conditions. Sample Event 3 (September 21, 2017)

Photo 68 BR3-H2B-S3: Downstream view of pond feature from SWM outfall. Sample Event 1 (April 13, 2017)



Photo 69 BR3-H2B-S4: Downstream view of feature from upstream extent. Sample Event 1 (April 13, 2017)

Photo 70 BR3-H2B-S4: Downstream view of feature from upstream extent; dry conditions. Sample Event 2 (July 28, 2017)



Photo 71 BR3-H2B-S5: Downstream view of feature; standing water conditions. Sample Event 1 (April 13, 2017)

Photo 72 BR3-H2B-S6: Downstream view of feature. Sample Event 1 (April 13, 2017)



Photo 73 BR3-H2B-S6: Downstream view of feature; dry conditions. Sample Event 2 (July 28, 2017)

Photo 74 BR3-H2B-S7: Downstream view of feature from upstream extent. Sample Event 1 (April 13, 2017)



Photo 75 BR3-H2B-S7: Downstream view of feature; standing water. Sample Event 2 (July 28, 2017)

Photo 76 BR3-H2B-S8: Upstream view of feature from culvert at downstream reach extent; standing water conditions. Sample Event 1 (April 13, 2017)



Photo 77 BR3-H2Ba-S1: Downstream view of feature from upstream extent; standing water conditions. Sample Event 1 (April 13, 2017)

Photo 78 BR3-H2Ba-S2: Downstream view of culvert at downstream feature extent. Sample Event 1 (April 13, 2017)



Photo 79 BR3-H2Ba-S2: Downstream view of culvert at downstream feature extent; standing water conditions. Sample Event 2 (July 28, 2017)

Photo 80 BR3-H3-S1: Downstream view of feature from culvert at upstream reach extent. Sample Event 1 (April 13, 2017)



Photo 81 BR3-H3-S1: Downstream view of feature. Sample Event 2 (July 28, 2017)

Photo 82 BR3-H3-S1: Downstream view of feature; dry conditions. Sample Event 3 (September 21, 2017)



Photo 83 BR3-H3-S2: Upstream view feature near downstream extent. Sample Event 1 (April 13, 2017)

Photo 84 BR3-H3-S2: Upstream view feature near downstream extent. Sample Event 2 (July 28, 2017)



Photo 85 BR3-H3-S2: Upstream view feature near downstream extent; standing water conditions. Sample Event 3 (September 21, 2017)

Photo 86 BR3-H3-S3: Upstream view of poorly defined feature. Sample Event 1 (April 13, 2017)



Photo 87 BR3-H3-S3: Downstream view of feature; standing water conditions. Sample Event 3 (September 21, 2017)

Photo 88 BR3-H4-S1: Downstream view of swale feature; dry conditions. Sample Event 1 (April 13, 2017)



Photo 89 BR3-H5-S1: View of tile outlet (arrow). Sample Event 1 (April 13, 2017)

Photo 90 BR3-H6-S1: View of tile outlet (arrow); dry conditions. Sample Event 1 (April 13, 2017)



Photo 91 BR3-H7-S1: View of tile outlet; dry conditions. Sample Event 1 (April 13, 2017)

Photo 92 BR4-H1-S1: View of pond outlet. Sample Event 1 (April 13, 2017)



Photo 93 BR3-H1-S1: View of pond outlet. Sample Event 2 (July 28, 2017)

Photo 94 BR4-H1-S1: View of pond outlet; standing water conditions. Sample Event 3 (September 21, 2017)



Photo 95 BR4-H1-S2: Upstream view of pond feature; standing water conditions. Sample Event 1 (April 13, 2017)

Photo 96 BR4-H1-S3: Upstream view of feature and tile outlet (arrow). Sample Event 1 (April 13, 2017)



Photo 97 BR4-H1-S3: View of tile outlet. Sample Event 2 (July 28, 2017)

Photo 98 BR4-H1-S3: View of tile outlet; minimal flow conditions. Sample Event 3 (September 21, 2017)



Photo 99 BR5-H1-S1: Upstream view of feature at confluence with Bruce Creek. Sample Event 1 (April 13, 2017)



Photo 100 BR5-H1-S1: Upstream view of feature at confluence with Bruce Creek. Sample Event 2 (July 28, 2017)



Photo 101 BR5-H5-S1: Upstream view of confluence with Bruce Creek; minimal flow conditions. Sample Event 3 (September 21, 2017)

Photo 102 BR5-H5-S2: Upstream view of pond feature; standing water conditions. Sample Event 1 (April 13, 2017)



Photo 103 BR5-H1-S3: Downstream view of pipe outlet to Pond D (arrow). Flow conditions could not be determined as the pipe was mostly submerged due to high pond water levels. Sample Event 1 (April 13, 2017)

Photo 104 BR5-H1-S3: Upstream view of pipe outlet; substantial flow conditions. Sample Event 2 (July 28, 2017)



Photo 105 BR5-H1-S3: Upstream view of pipe outlet; dry conditions. Sample Event 3 (September 21, 2017)

Photo 106 BR5-H1-S4: Upstream view of pond feature; standing water conditions. Sample Event 1 (April 13, 2017)



Photo 107 BR5-H1A-S1: View of tile outlet. Sample Event 1 (April 13, 2017)

Photo 108 BR5-H1A-S1: View of tile outlet; dry conditions. Sample Event 2 (July 28, 2017)





Photo 109 BR5-H1B-S1: View of broken concrete pipe outlet. BR5-H1B-S1: View of broken concrete pipe outlet. Sample Event 1 (April 13, 2017)

Photo 110 Sample Event 2 (July 28, 2017)



Photo 111 BR5-H1B-S1: View of broken concrete pipe outlet; minimal flow conditions. Sample Event 3 (September 21, 2017)

Photo 112 BR5-H2-S1: View of tile outlet at Bruce Creek. Sample Event 1 (April 13, 2017)



Photo 113 BR5-H2-S1: View of tile outlet at Bruce Creek. Sample Event 2 (July 28, 2017)

Photo 114 BR5-H2-S1: View of tile outlet at Bruce Creek; dry conditions. Sample Event 3 (September 21, 2017)



Photo 115 BR5-H3-S1: View of tile outlet on valley wall slope (arrow). Sample Event 1 (April 13, 2017)

Photo 116 BR5-H3-S1: View of tile outlet; dry conditions. Sample Event 2 (July 28, 2017)



Photo 117 BR5-H4-S1: View of tile outlet on valley wall slope (arrow). Sample Event 1 (April 13, 2017)

Photo 118 BR5-H4-S1: View of broken tile outlet. Sample Event 2 (July 28, 2017)



Photo 119 BR5-H4-S1: View of tile outlet on valley wall slope; BR5-H5-S1: View of tile outlet on valley wall slope Flowing at time of assessment. Sample Event 3 (September 21, 2017)

Photo 120 (arrow). Sample Event 1 (April 13, 2017)



Photo 121 BR5-H5-S1: View of tile outlet on valley wall slope. BR5-H5-S1: View of tile outlet on valley wall slope; Sample Event 2 (July 28, 2017)

Photo 122 dry conditions. Sample Event 3 (September 21, 2017)



Photo 123 BR5-H6-S1: View of pipe within Bruce Creek (note this is facing upstream. Flow conditions could not be determined. Sample Event 1 (April 13, 2017)



Photo 124 BR5-H7-S1: View of tile outlet within Bruce Creek (arrow). Sample Event 1 (April 13, 2017)





Photo 125 BR5-H7-S1: View of tile outlet within Bruce Creek. BR5-H7-S1: View of tile outlet within Bruce Creek; Sample Event 2 (July 28, 2017)

Photo 126 dry conditions. Sample Event 3 (September 21, 2017)

**Berczy Creek** 



Photo 127 BER3-H1-S1: Downstream view of feature. Sample Event 1 (April 13, 2017)

Photo 128 BER3-H1-S1: Downstream view of feature. Sample Event 2 (July 28, 2017)



Photo 129 BER3-H1-S1: Downstream view of feature; dry conditions. Sample Event 3 (September 21, 2017)

Photo 130 BER3-H1-S2: Downstream view of tile and culvert outlets (arrows). Sample Event 1 (April 13, 2017)



Photo 131 BER3-H1-S2: Upstream view of tile outlet. Sample Event 2 (July 28, 2017)

Photo 132 BER3-H1-S2: Upstream view of tile and culvert outlets (arrows); dry conditions. Sample Event 3 (September 21, 2017)



Photo 133 BER3-H1A-S1: Upstream view of feature; dry conditions. Sample Event 1 (April 13, 2017)

Photo 134 BER3-H2-S1: Downstream view of feature from upstream extent towards 16<sup>th</sup> Avenue; dry conditions. Sample Event 1 (April 13, 2017)