Appendix A Baseline Geomorphological Characterization Report

Fullarton Dam Rehabilitation Environmental Assessment, Baseline Geomorphological Characterization Report

Revision 2

January 28, 2025

Prepared for:

Upper Thames River Conservation Authority

Prepared by:

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Project Number: 160901056

Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
0	Final Report	Chase Konecny	2023-03-10	Andrew Doherty	2023-03-10	Heather Amirault	2023-03-10
1	Updated with minor text edits	Chase Konecny	2024-11-19	Andrew Doherty	2024-11-19	Heather Amirault	2024-11-19
2	Updated with minor text edits	Chase Konecny	2024-01-28	Andrew Doherty	2024-01-28	Heather Amirault	2024-01-28

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1.0 INTRODUCTION

Stantec Consulting Ltd was retained by the Upper Thames Region Conservation Authority (UTRCA) to conduct an Environmental Assessment (EA) for the Fullarton Dam and reservoir at the Fullarton Conservation Area (the Project) in the Municipality of West Perth, Ontario. The EA is being conducted to support long-term planning for the Fullarton Dam. As part of the initial phases of the EA, this report was prepared to establish a baseline characterization of geomorphological conditions for the unnamed watercourse that flows through the reservoir and dam and discharges into the North Thames River at the downstream end of the project site (Figure 1).

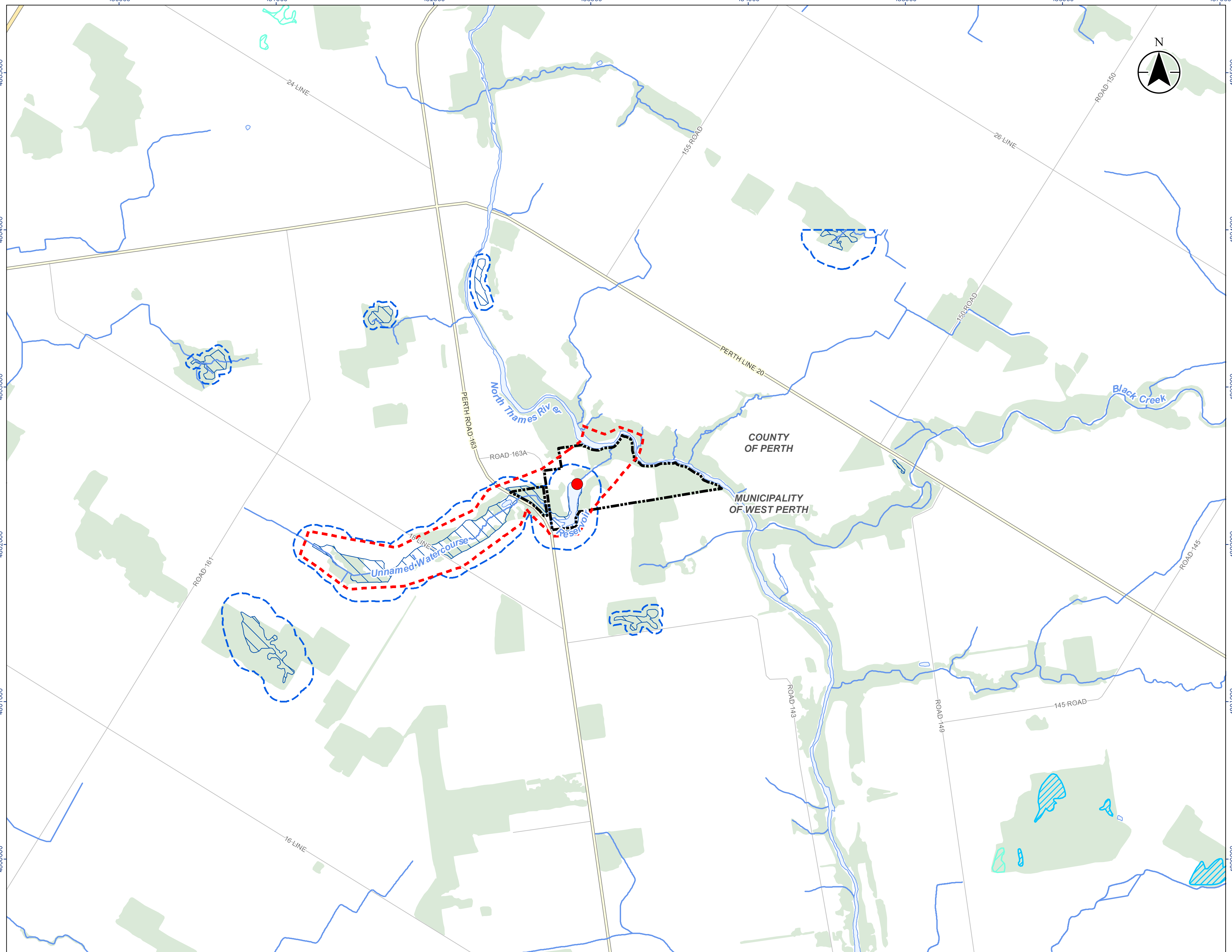
The baseline assessment was prepared based on a field assessment conducted by Stantec and available background site information, including hydrology, hydraulic data, and topographic information. Establishing baseline conditions will inform the development and evaluation of alternative solutions as part of the EA's anticipated next steps. These alternative solutions are expected to include options related to maintaining the dam or removing all or a portion of the dam combined with restoring the unnamed watercourse at the project site. Concurrently under separate covers, Stantec is also conducting a geotechnical review of the dam and baseline site assessments of hydrogeology, archaeology, natural heritage, and cultural heritage to provide key input to evaluating alternatives.

The EA will evaluate impacts and opportunities for the alternatives, including associated costs, habitat considerations for unnamed watercourse and the reservoir (e.g., snapping turtles), fish passage, and use of the conservation area by local residents. Under the Lakes and Rivers Improvement Act (2017), any contemplated dam reconstruction or modification requires an EA of the dam and surrounding areas.

1.1 BACKGROUND

Fullarton Conservation Area is a 34-hectare area used recreationally for hiking, fishing, canoeing, and picnicking. Trails are located throughout the Conservation Area, including around the reservoir and through the site's mixed deciduous and pine wood forested areas. Two baseball diamonds are located on the northwest portion of the Fullarton Conservation Area; they are part of the Fullarton Centennial Park, which opened on June 25, 1966.

The Fullarton Dam, an earth dam, was installed on the unnamed watercourse in the 1950s to create a recreational lake/reservoir. This reservoir has an area of approximately 2.5 hectares. The earth dam structure impounding is 110 m long, with a crest width of approximately 6 m and approximately 2.5 m of hydraulic head impounded at low flow conditions. Based on the project discussions, dam maintenance is the responsibility of the Municipality of West Perth.



Stantec

Legend

- Fullarton Dam
- Expressway / Highway
- Major Road
- Minor Road
- Regulated Watercourse (UTRCA)
- Waterbody
- Regulated Wetland (UTRCA)
- Wetland - Evaluated (Other)
- Wetland - Not evaluated per Ontario Wetland Evaluation System
- Regulated Area - Other (UTRCA)
- Wooded Area
- Fullarton Dam Property Boundary
- Geomorphological Characterization Study Area

0 0.5 1 km

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Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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Project Location
County of Perth

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Technical Review by CK on 2025-01-24

Client/Project
UPPER THAMES RIVER CONSERVATION AUTHORITY
FULLARTON DAM REHABILITATION

Figure No.
1

Title
Location of Study Area

The unnamed watercourse runs through the Fullarton Conservation Area and provides potential coldwater habitat (UTRCA, 2017). The dam blocks fish passage to upstream reaches of the unnamed watercourse. Email correspondence between the UTRCA and Dietrich Engineering (March 7, 2023) confirmed that alternative solutions identified within the project site will not be subject to the *Drainage Act*.

1.2 BASIS

The baseline characterization is based on a site assessment conducted by Stantec on January 11, 2023, project discussion with the UTRCA and Municipality of West Peth, and multiple background data sources available for the site. Table 1 summarizes the background data available and reviewed as part of this baseline assessment report. In addition, Appendix A presents photographs from the site assessment, and Appendix B provides key background documentation.

Table 1: Baseline Characterization Data Sources

Data Type	Source
Field Data	• Channel Survey by Stantec (2023) • Fluvial Geomorphological Field Assessment by Stantec (2023) • Detailed Site Survey by Konecny et al. (2018) • Fluvial Geomorphological Field Assessment by Konecny et. al. (Fall 2018)
Site Photographs	• Stantec Field Visit (2023) • UTRCA (2010, 2011, 2015, 2019, 2022)
Models	• Hydraulic HEC-RAS Model (Konecny et al. 2018) • Hydrologic HEC-HMS as part of the 2007 Dam Safety Assessment Report (DSA; Acres International, 2007)
UTRCA Data	• 2022 Watershed Report Card – Fullarton (UTRCA, 2022) • Report Card Watersheds Map (UTRCA, 2022)
Historical Imagery	• Aerial photography provided by the University of Toronto (2023) and the National Air Photo Library
Reports	• Environmental Conditions Report (UTRCA 2017) • Neil Drain & Fullarton Reservoir Rehabilitation – Phase I Final Report (Konecny et al., 2018) • Neil Drain & Fullarton Reservoir Rehabilitation – Phase II Final Report (Konecny et al., 2018) • Dam Safety Report (Acres International, 2007) • Neil Drain Report (Howes, 1967)

2.0 HYDROLOGY

The drainage area for the unnamed watercourse at the confluence of the North Thames River is approximately 4 km^2. The North Thames River is 350 m downstream of the Fullarton Dam. The land use within the unnamed watercourse drainage area is predominantly agricultural and undifferentiated rural land use (85%), with approximately 5% marsh/swamp along the channel corridor, 5% treed area, and community infrastructure and open water over the remaining area (Ontario Flow Assessment Tool, n.d.).

The Fullarton Corridor 2022 Watershed Report Card states that 50-70% of the local streamflow is baseflow from groundwater discharge. This groundwater discharge that characterizes the watershed supports coldwater aquatic habitat. The UTRCA has identified unnamed watercourse as providing potential coldwater habitat.

Environment Canada's Stratford WWTP weather station (ID 6148105) indicates that the area receives an average annual precipitation of 1070 mm based on data from 1981 to 2010.

2.1 DESIGN FLOW

A HEC-HMS hydrology model was developed as part of the dam safety analysis conducted for the Fullarton Dam (Acres, 2007). This model calculates design flows for the unnamed watercourse into the reservoir. These design flows will inform the development of alternative solutions, including, for example, conceptual channel and floodplain dimensions. Model inputs used local climate data (Woodstock, Stratford, and London Airport) and physical parameters for the drainage area, including stream length and average watershed slope using topographic and soil mapping obtained from the Department of Energy, Mines and Resources Canada and Ontario Ministry of Natural Resources and Forestry (MNRF).

Table 2 summarizes average design flows from the dam safety analysis for both spring and summer flow conditions. The flows consider an average of the flows ranging from 1-day to 8-day rain-on-snowmelt events in the spring, and 6-hour to 5-day rainfall events in the summer. The dam safety analysis considered additional snowmelt and rain scenarios and corresponding flow responses.

Table 2: HEC-HMS Model Average Flows (Acres International, 2007)

Return Period (years)	Spring (m^3/s)	Summer (m^3/s)
2	3.6	3.2
5	5.1	6.8
10	6.1	9.4
25	7.3	13.0
50	8.3	15.8
100	9.2	18.6
250	10	22.5
Hurricane Hazel	NA	32.5

Additionally, the dam safety analysis (Acres, 2007) used a reservoir storage routing technique to model the attenuation of watercourse flows through the reservoir. The modelling indicates that the maximum reduction between the reservoir inflow and outflow is 0.1 m^3/s for all modelled flow events up to the 250-year event. Based on this modelling, the dam provides negligible flow attenuation during high flows. Therefore, peak flows during high-flow events downstream of the reservoir would not be expected to change appreciably because of removal of the dam.

2.2 BANKFULL FLOW

The bankfull discharge of the unnamed watercourse at the project is between 1-2 m^3/s based on field observations by Stantec. The bankfull discharge typically occurs at a return period of approximately 1.5 years. Therefore, the bankfull discharge estimated based on site observations helps corroborate the 2-year flows (Table 2) developed as part of the background study.

2.3 BASEFLOW

Modelling as part of the dam safety review (Acres 2007) indicates a baseflow in the watercourse of 0.12 m^3/s and 0.01 m^3/s for the spring and fall, respectively. These baseflow calculations were calibrated against a local watershed. Considering the small drainage area of the watercourse, these results indicate suitable baseflows for open channel habitat during low-flow periods (i.e., continuous flow in the watercourse).

Removal of the dam and reservoir has the potential to impact groundwater recharge and baseflows in unnamed watercourse. The baseline hydrogeological assessment prepared concurrently with this geomorphology assessment will inform potential impacts and mitigation requirements related to low-flow conditions in unnamed watercourse.

3.0 HYDRAULICS

Background data of the project site includes hydraulic models on the unnamed watercourse and Fullarton Dam (Konecny et al. 2018; Acres 2007). This modelling, combined with detailed site survey data (Konecny et al. 2018), will inform and provide a basis for developing and evaluating conceptual alternative solutions for restoring the unnamed watercourse as part of options related to a full or partial removal of the Fullarton Dam. Key hydraulic conditions that will inform the development and evaluation of alternatives are discussed in the following sub-sections.

3.1 HYDRAULICS AT THE DAM

The typical hydraulic head across Fullerton Dam is approximately 2.5 m (i.e., the elevation difference between the reservoir and the unnamed watercourse downstream). Flow is conveyed through a rectangular concrete drop-inlet structure in the reservoir and discharges through an 800 mm diameter concrete outlet pipe into unnamed watercourse. An emergency spillway is positioned on the right side of the dam, discharging to a vegetated channel leading downstream to the unnamed watercourse.

Hydraulic modelling indicates that the dam overtops as frequently as a 3-year return period flow event (Konecny et al. 2018; Acres 2007). During a 250-year event, modelling (Konecny et al. 2018) indicates that water depths overtopping the dam crest are approximately 0.4 m. This control depth at the crest causes flooding to sections of the conservation area trails adjacent to the reservoir and contributes to flooding of Perth Road 163a, located immediately upstream of the reservoir. Elsewhere in the project area, the 250-year flood is contained in the channel valley.

3.2 HYDRAULIC EFFECTS OF THE THAMES RIVER

The North Thames River is approximately 350 m downstream of the Fullarton Dam. As part of the background study by Konecny et al. (2018), water levels in the North Thames River were identified to hydraulically control the watercourse up to the dam as frequently as a 2-year North Thames River flow event. Additionally, the hydraulic modelling estimated that a 5 to 10-year North Thames flow inundates the watercourse floodplain between the confluence and dam. A 250-year event inundation map completed by Konecny et al. (2018) is provided in Appendix B. These hydraulic conditions will be considered as part of unnamed watercourse alternatives.

3.3 RESERVOIR BACKWATER

Stantec's site assessment and channel survey indicate that the low-flow water surface elevation in the reservoir backwaters through the existing 1,200 mm corrugated steel pipe culvert beneath Perth Road 168a. Survey data shows that the bed elevation of the existing unnamed watercourse matches the reservoir's low-flow surface water level approximately 300 m upstream of the culvert crossing. It is anticipated that the culvert crossing will become the hydraulic control for channel flows upstream of Perth Road 163a after a full or partial removal of the dam. The background site topography, including Perth

Road 163a culvert crossing survey data, will inform consideration for impacts related to removing the backwater condition as part of alternative solutions.

4.0 GEOMORPHOLOGY

The site assessment by Stantec observed that the unnamed watercourse is stable in the study area. Aggradation was observed upstream of the reservoir, consistent with background reporting and the anticipated impacts of a dam (i.e., blocking downstream sediment transport). The unnamed watercourse is unconfined throughout the study area with a wide, well-connected floodplain. Riparian vegetation is well-established, which supports channel stability and coldwater aquatic habitat (i.e., shade). Channel banks were observed to consist of loam and silt, transitioning to higher sand/clay content closer to the confluence of the North Thames River. General observations indicate the presence of gravel and cobble substrate in areas where silt has not inundated perceived historical sediment

The unnamed watercourse historically descended from tablelands, down the North Thames River valley wall in a steeper reach (through the existing reservoir area), and onto the North Thames River floodplain. Under current conditions, the elevation drop between tablelands and the North Thames River is made through the Fullarton Dam, and terminates approximately 120 m downstream of the dam. Background channel profile data indicates a historical average channel slope of approximately 0.3% through the study area prior to dam installation. Average channel slope appears to have remained similar to historical conditions, with the exception of more localized changes immediately upstream of Perth Road 163a where the slope has decreased as a result of sedimentation.

4.1 HISTORICAL WATERCOURSE

Aerial photography of the site from 1954, before the construction of the Fullarton Dam, informs the geomorphological interpretation of the impacts of the dam on unnamed watercourse. Aerial photography after dam installation in 1959 and 1963 documents change in the unnamed watercourse. Historically, the unnamed watercourse is observed within a channel corridor with limited vegetation and relatively uniform width for its approximately 1,100 m length through the study area. Sinuosity upstream of Perth Road 163a was appreciably higher than the downstream reaches (pre- and post-dam) and existing site conditions at this upstream location. The reach of the unnamed watercourse now inundated by the reservoir was through notably barren land in 1954. The 1959 imagery showed that the unnamed watercourse was still a channel through the existing marsh area, with some sparse vegetation on the floodplains. By 1963, aerial photographs suggest that the unnamed watercourse upstream of the original pond began to transition into marsh.

4.2 SEDIMENTATION

The background study by Konecny et al. estimates sediment accumulation at the reservoir as a result of the dam. Additionally, background data provided by the UTRCA (2006 and 2016) assesses sediment depths in the reservoir. The background data estimated a 90 to 160 m3/year sediment loading rate. Additionally, UTRCA's Fullarton Dam and Conservation Area existing condition report (2017) estimates a natural channel bottom compared to the top of the sediment profile, corresponding to average sediment

depths of 0.3-0.4 m in the reservoir. The UTRCA's sediment and natural channel profile is presented in Figure 3 below.

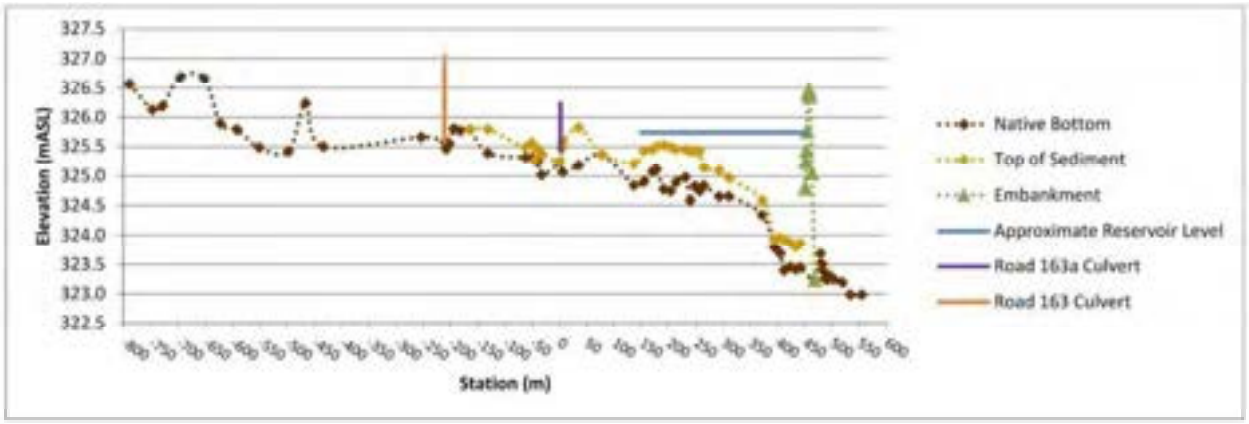


Figure 2: Watercourse Channel and Sediment Profile (UTRCA, 2017)

Figure 2 by UTRCA indicates that sedimentation extends upstream of the dam's reservoir through the Perth Road 163a culvert to nearly Perth Road 163, located approximately 670 m from the dam and corresponding to the identified extent of reservoir backwater discussed in section 3.3. Stantec observed the sedimentation between Perth Road 163 and Perth Road 163a and noted that sediment depths increased closer to Perth Road 163a, contributing to a reduction in channel slope upstream of the reservoir. Sedimentation from the effects of reservoir backwater has caused a morphological transition of the unnamed watercourse upstream of the reservoir, with sediment filling pools, inundating riffles and resulting in a plane-bed flow.

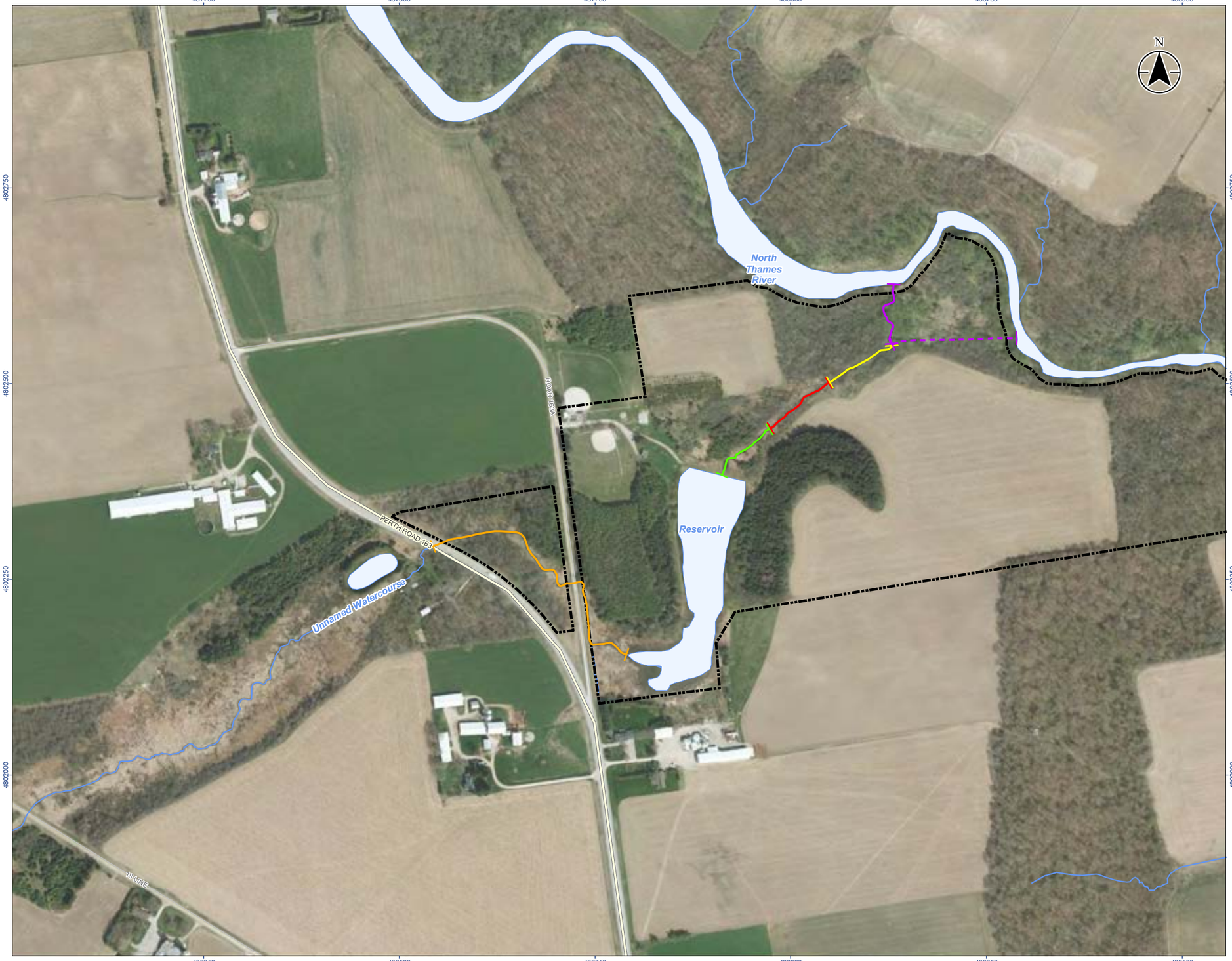
The background profile and sedimentation data will support the development of alternative conceptual solutions, including evaluating potential invert elevations of a restored channel and high-level requirements for earthworks and excavation during construction.

4.3 SEDIMENT CONTINUITY

The Fullarton Dam and reservoir disrupt sediment transport continuity in the unnamed watercourse. The sediment supply downstream of the dam is impacted due to particles settling out in the reservoir. Downstream of the dam, the point bar substrate was assessed to approximate the channel bed load particle size (i.e., fine gravel) by Konecny et al. (2018). The *Fullarton Existing Conditions Report* (UTRCA, 2017) notes that gravels and pebbles have been observed in the channel bed upstream of the area affected by backwater from the reservoir, confirming that there is an upstream bed load sediment supply consistent with the bed load particle size for unnamed watercourse below the dam identified by Konecny et al. (2018). Disrupting the supply of fine gravels and pebbles to the unnamed watercourse below the dam has potential impacts on aquatic habitats (e.g., spawning beds). The alternative solutions developed in the EA's next phases will evaluate the opportunity to restore sediment transport in unnamed watercourse and the potential benefits to aquatic habitats.

4.4 REACH DESCRIPTIONS

Stantec identified five reaches of unnamed watercourse (not including the reservoir) at the project site (Figure 3). The reaches are distinguished by differing morphology, channel dimensions, or channel slope. One of the reaches is upstream of the reservoir, and four are downstream (between the dam and the North Thames River). Table 3 and the site photographs in Appendix A summarize geomorphological characteristics.



Stantec

Legend

- Major Road
- Minor Road
- Regulated Watercourse (UTRCA)
- Waterbody
- Fullarton Dam Property Boundary

Reach

- Reach 1
- Reach 2
- Reach 3
- Reach 4
- Reach 5
- 1954 Channel Alignment

0 100 200 metres
1:5,000 (At original document size of 11x17)

Notes

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FULLARTON DAM REHABILITATION

Figure No.
3

Title
Stream Reaches

Table 3: Existing Watercourse Reach Characteristics

Reach	Channel Length (m)	Channel Slope (%)	Channel Substrate	Sinuosity	Bankfull Channel Width (m)	Morphology	Vegetation	Comments
1	120	0.25	Silt dominated with sparse gravel and cobble	Low	3-4	Plane-Bed following transition from riffle-pool	Shrub saplings upstream, herbaceous vegetation downstream with mixed deciduous floodplain	• Saturated floodplain soils in the downstream half of the reach suggest a high water table
2	120	0.6	Gravel and cobble dominated, with some boulders in the riffles and silty sand in the pools	Moderate	3-4	Riffle-Pool	Shrub-sapling and herbaceous vegetation with mixed coniferous and deciduous trees on the floodplain	• Steeper because of its location on the valley wall between tablelands and the North Thames River floodplain
3	70	0.34	Silt	Low	6-7	Plane-Bed	Shrub-sapling and herbaceous vegetation with sparse coniferous and deciduous trees	• Recently over-widened (no over-widening in 1954 historical imagery) • Potentially affected by backwater from historical beaver damming or floodplain contraction experienced at high flow stages
4	90	0.34	Gravel and cobble dominated with some boulders in riffles and siltation in pools	Moderate	3-4	Riffle-Pool	Shrub-sapling and herbaceous vegetation with deciduous trees	• Appears as a reference reach of the historical riffle-pool sequence on the North Thames River floodplain • Observed lack of bed load particles • Silt in pools is likely the result of high-flow backwater from downstream beaver dam
5	60	Steep bed, hydraulic slope dependent on North Thames WSE	Silt over cobble and gravel	Moderate	6-8	Plane-Bed	Shrub-sapling and herbaceous vegetation with deciduous trees	• Historical planform realignment decreased reach length and increased channel slope • Hydraulically controlled by a beaver dam • Historically hydraulic control from the North Thames River • Silt accumulation from beaver damming

5.0 CONCLUSION

Stantec conducted a geomorphologic baseline of the unnamed watercourse at the Fullarton Conservation Area in the Municipality of West Perth, Ontario. This baseline assessment was conducted as part of the initial phases of an EA to support long-term planning for Fullarton Dam. As part of the next steps, the EA is expected to develop and evaluate alternative options related to maintaining the dam or removing all or a portion of the dam combined with restoring the unnamed watercourse at the project site.

The baseline assessment is based on a site assessment conducted by Stantec and a review of background data and reporting available for the project site. Overall, the site assessment characterized the unnamed watercourse as stable and well-vegetated with a wide and well-connected floodplain. The unnamed watercourse is aggrading in some reaches, and the effects of the online dam installation have impacted watercourse morphology and sediment transport.

The Background data reviewed as part of the baseline assessment included hydrologic and hydraulic modelling results, background studies, and detailed site topographic data. These background data, combined with the site assessment, will provide a basis for developing and evaluating alternative solutions.

6.0 REFERENCES

Acres International. (August, 2007). *Dam safety assessment report for Fullarton Dam*.

Howe, J. (January 9, 1967). *Neil Drain Report.*

Konecny et al. (Hydrophilics). (November 26, 2018). *Neil drain and Fullarton reservoir rehabilitation – phase I final report.*

Konecny et. al. (Hydrophilics). (April 1, 2019). *Neil drain and Fullarton reservoir rehabilitation – Phase II final report* – Report prepared to fulfill the degree requirements of a Bachelor of Applied Science in Environmental Engineering at the University of Waterloo.

Upper Thames River Conservation Authority. (March, 2017). *Fullarton dam and conservation area – existing environmental conditions.* – Report prepared to fulfill the degree requirements of a Bachelor of Applied Science in Environmental Engineering at the University of Waterloo.

Upper Thames River Conservation Authority. (2022). *Maps of watershed information.* Upper Thames River Conservation Authority. https://thamesriver.on.ca/watershed-health/watershed-report-cards/watershed-maps/.

Upper Thames River Conservation Authority. (2022). *2022 Upper Thames River watershed report cards.* Upper Thames River Conservation Authority. https://thamesriver.on.ca/watershed-health/watershed-report-cards/.

APPENDIX A:
Photographic Inventory

Photo 1: Fullarton Dam and Reservoir.

Photo 2: Reservoir Drop Inlet Structure.

Photo 3: Reservoir outlet structure.

Photo 4: Looking downstream from the Fullarton Dam outlet at the unnamed watercourse.

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Photo 10: Reach 2 looking downstream at riffle-pool sequencing.

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Photo 13: Reach 3 silt accumulation and over-widened channel.

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Photo 17: Reach 5 looking downstream at downstream beaver dam.

Photo 18: Downstream of beaver dam where the unnamed watercourse outlets to the North Thames River.

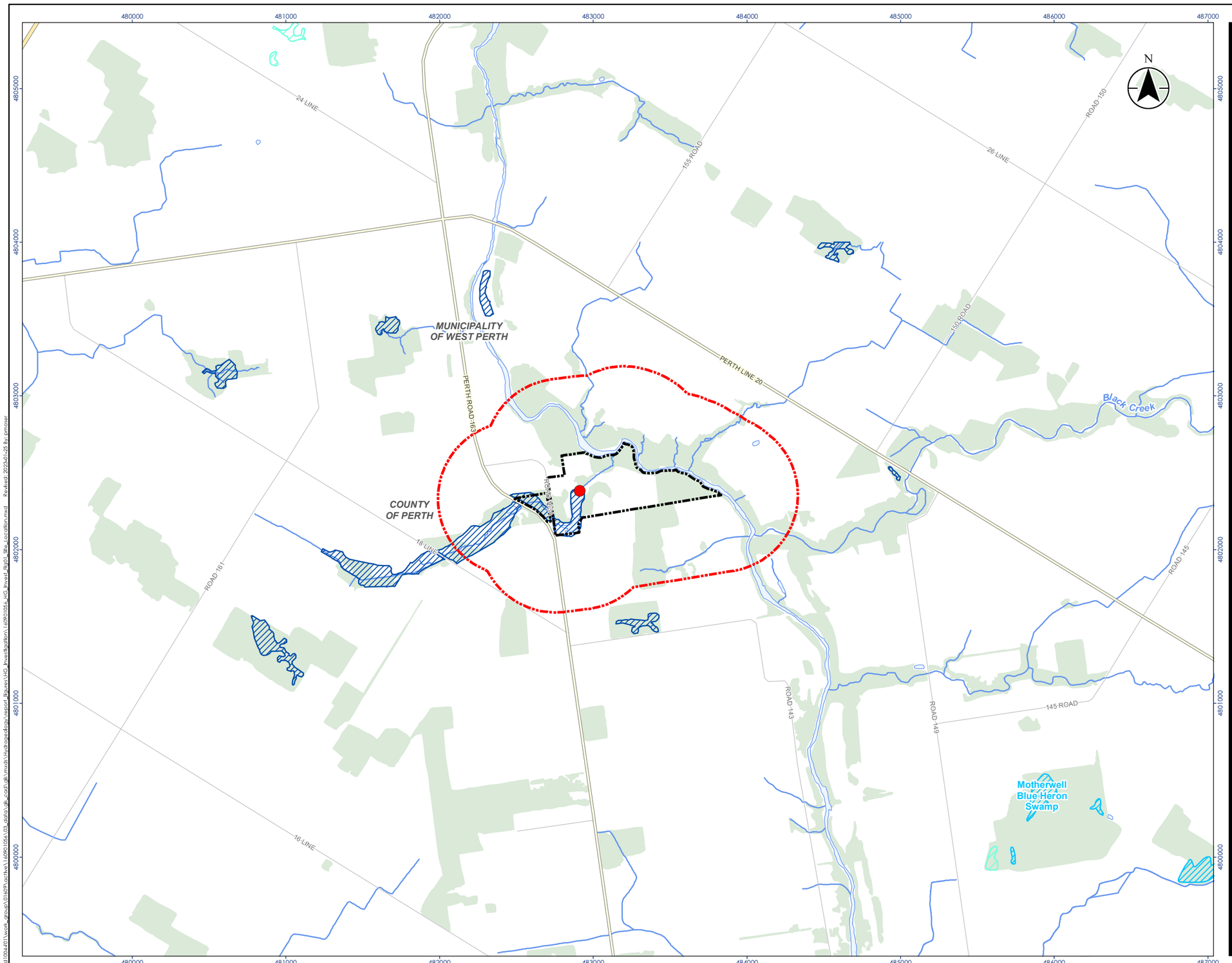
Photo 19: Confluence of the unnamed watercourse and the North Thames River.

Photo 20: Beaver dam obstructing pre-1954 watercourse Alignment.

Photo 21: Perth Road 163a culvert.

Photo 22: Reach 2 riffle cobbles.

Appendix A Figures



Stantec

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- Fullarton Dam Study Area (500m)

0 500 1,000 metres

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Notes

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Client/Project
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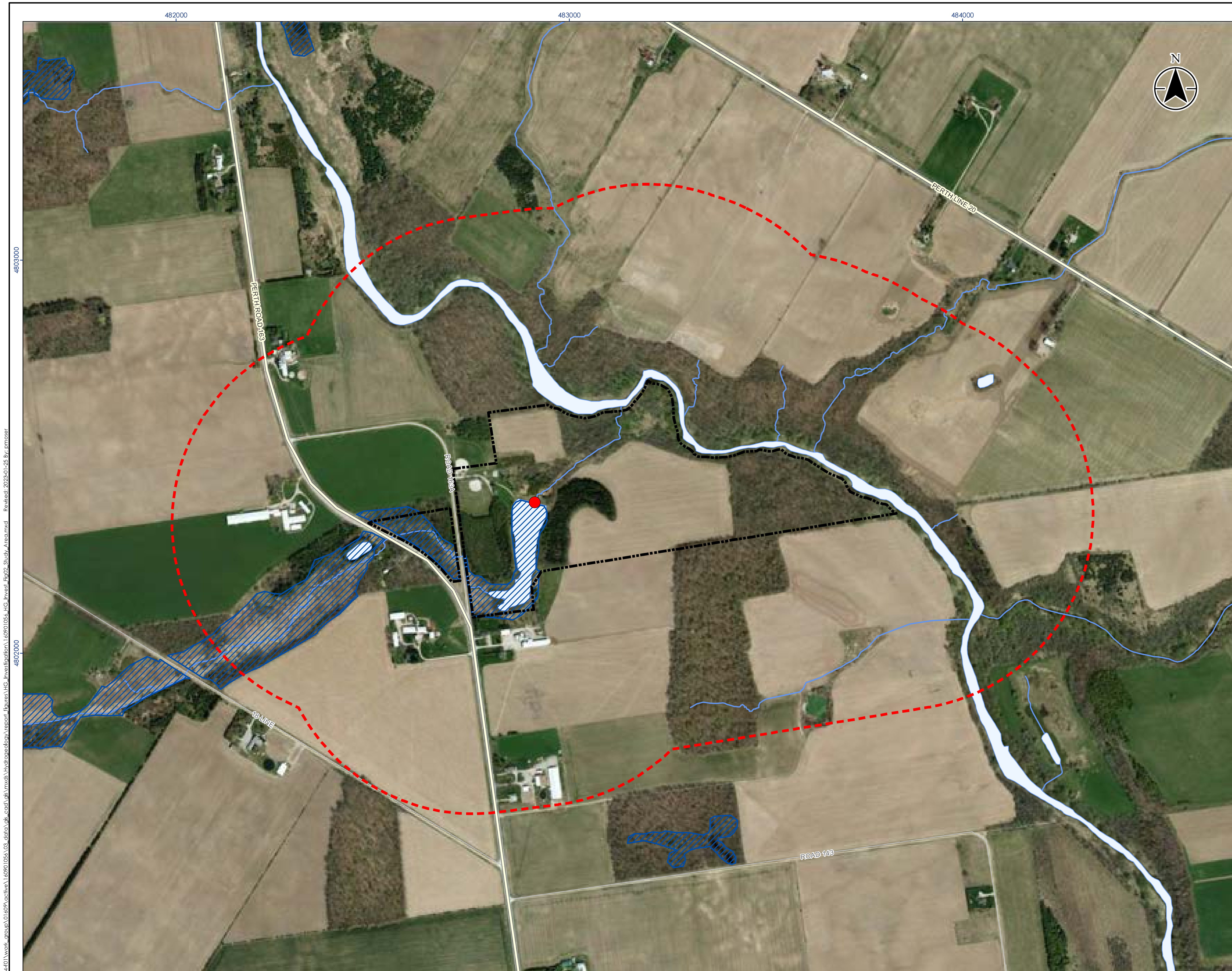
Figure No.
1

Title
Site Location



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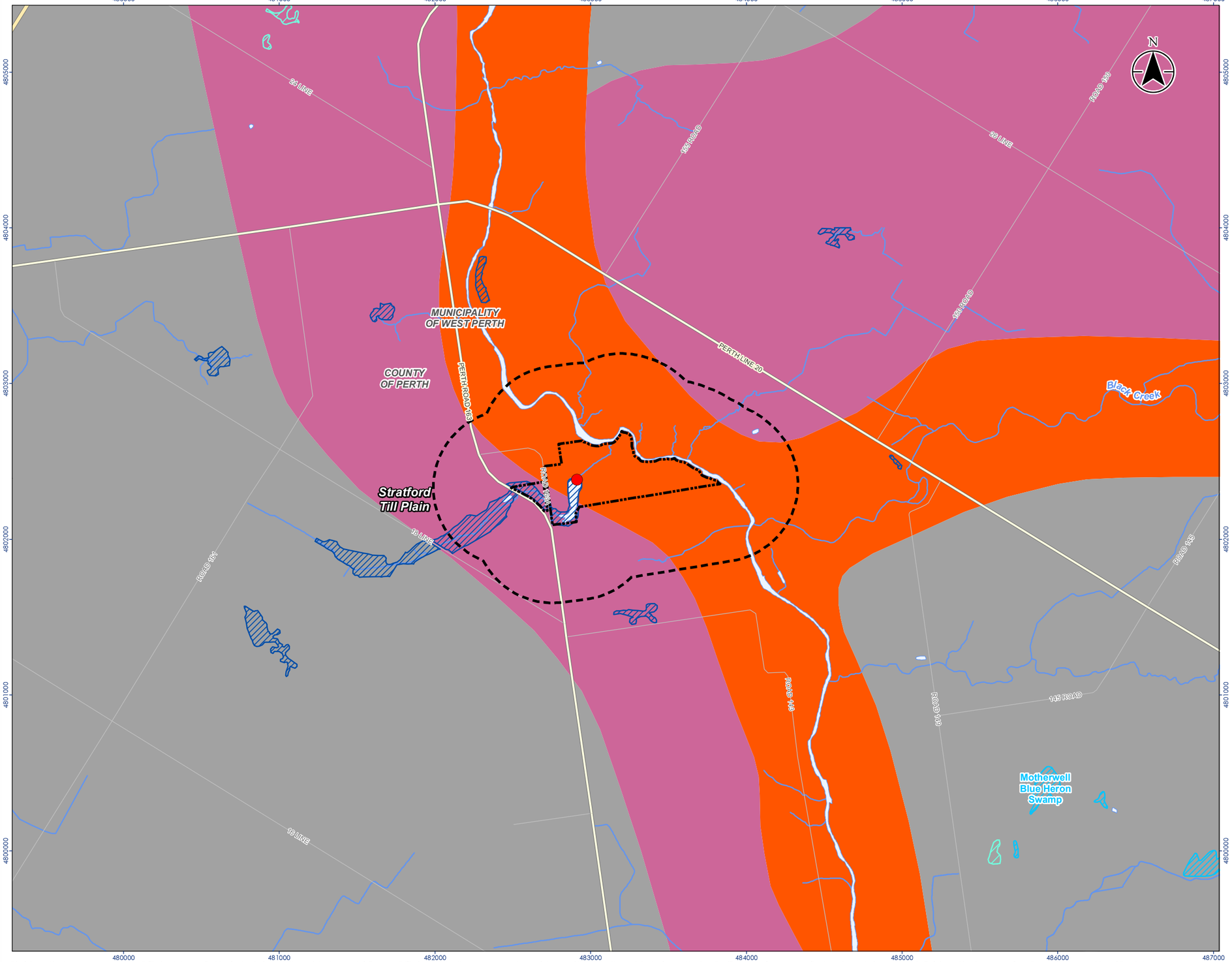
Client/Project
UPPER THAMES RIVER CONSERVATION AUTHORITY
FULLARTON DAM REHABILITATION

Figure No.
2

Title
Study Area



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- Regulated Wetland (UTRCA)
- Wetland - Evaluated (Other)
- Wetland - Not evaluated per Ontario Wetland Evaluation System
- Physiographic Region Boundary

Physiography

- 5: Till Plains (Undrumlinized)
- 3: Spillways
- 2: Till Moraines
- Fullarton Dam Property Boundary
- Fullarton Dam Study Area (500m)

0 500 1,000 metres

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Figure No.
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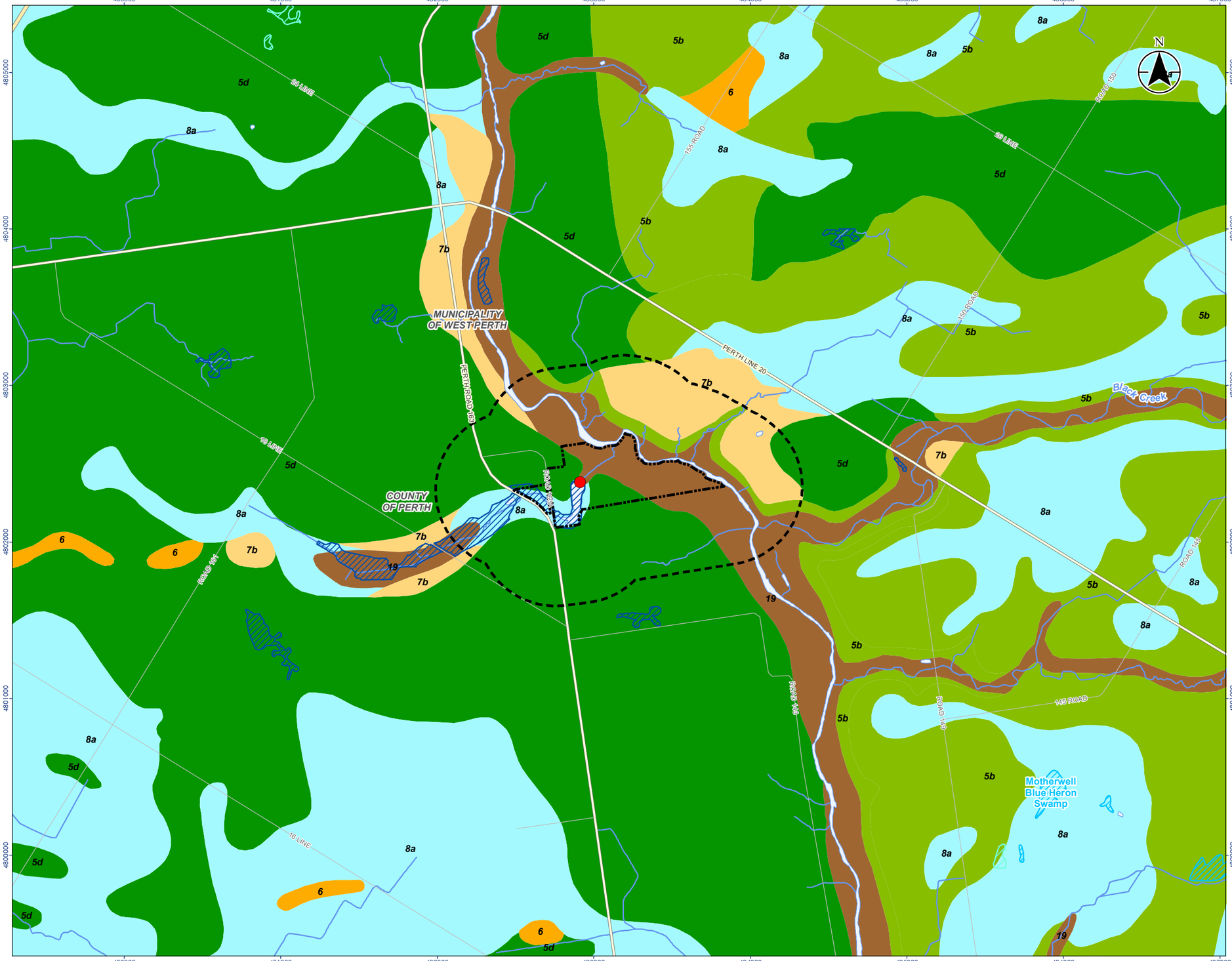
Title
Physiography



Stantec

Legend

- Fullarton Dam
- Expressway / Highway
- Major Road
- Minor Road
- Regulated Watercourse (UTRCA)
- Waterbody
- Regulated Wetland (UTRCA)
- Wetland - Evaluated (Other)
- Wetland - Not evaluated per Ontario Wetland Evaluation System

Surficial Geology

- 19: Modern alluvial deposits
- 8a: Fine-textured glaciolacustrine deposits (Massive-well laminated)
- 7b: Glaciofluvial deposits (Gravelly deposits)
- 6: Ice-contact stratified deposits
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 5d: Glaciolacustrine-derived silty to clayey till
- Fullarton Dam Property Boundary
- Fullarton Dam Study Area (500m)

0 500 1,000 metres

1:25,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.
3. Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV ISBN 978-1-4435-2483-4

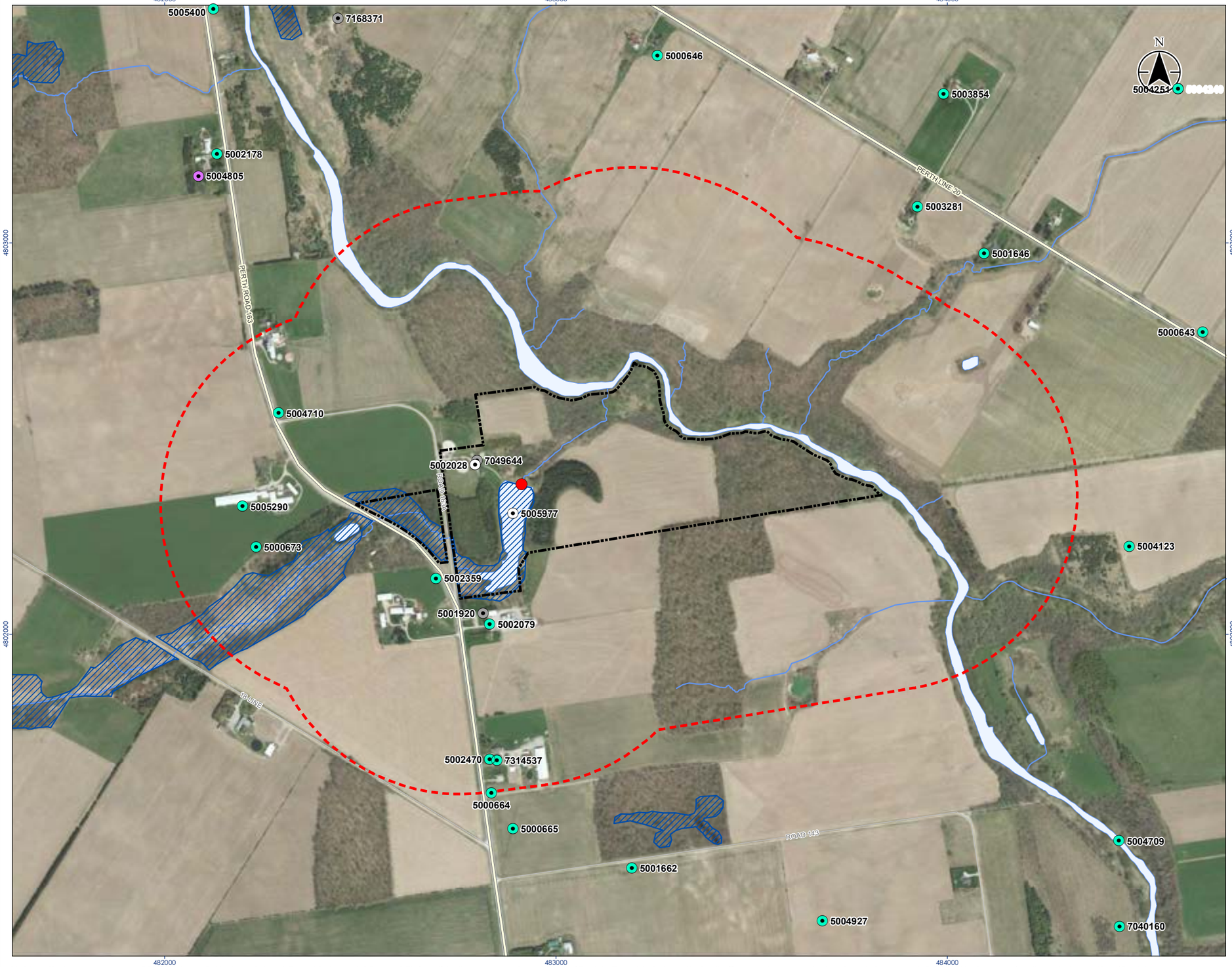
Project Location
County of Perth

160901056 REVA
Prepared by PRM on 2023-01-25
Technical Review by GW on 2023-01-25

Client/Project
UPPER THAMES RIVER CONSERVATION AUTHORITY
FULLARTON DAM REHABILITATION

Figure No.
4

Title
Surficial Geology



Stantec

Legend

- Fullarton Dam

Water Well Record (MECP)

- Observation Wells
- Test Hole
- Water Supply
- Abandoned / Other
- Major Road
- Minor Road
- Regulated Watercourse (UTRCA)
- Waterbody
- Regulated Wetland (UTRCA)
- Fullarton Dam Property Boundary
- Fullarton Dam Study Area (500m)

0 250 500 metres

1:10,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.
3. Orthoimagery © First Base Solutions, 2023. Imagery Date, 2010.
4. MECP water well record locations have been positioned based on published UTM coordinates and their locations should be considered approximate.

Project Location
County of Perth

160901056 REVA
Prepared by PRM on 2023-01-25
Technical Review by GW on 2023-01-25

Client/Project
UPPER THAMES RIVER CONSERVATION AUTHORITY
FULLARTON DAM REHABILITATION

Figure No.
5

Title
MECP Water Well Records

Stantec

Legend

- Fullarton Dam
- Expressway / Highway
- Major Road
- Minor Road
- Regulated Watercourse (UTRCA)
- Waterbody
- Regulated Wetland (UTRCA)
- Wetland - Evaluated (Other)
- Wetland - Not evaluated per Ontario Wetland Evaluation System
- Significant Groundwater Recharge
- Highly Vulnerable Aquifer
- Fullarton Dam Property Boundary
- Fullarton Dam Study Area (500m)

0 250 500 metres

1:25,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
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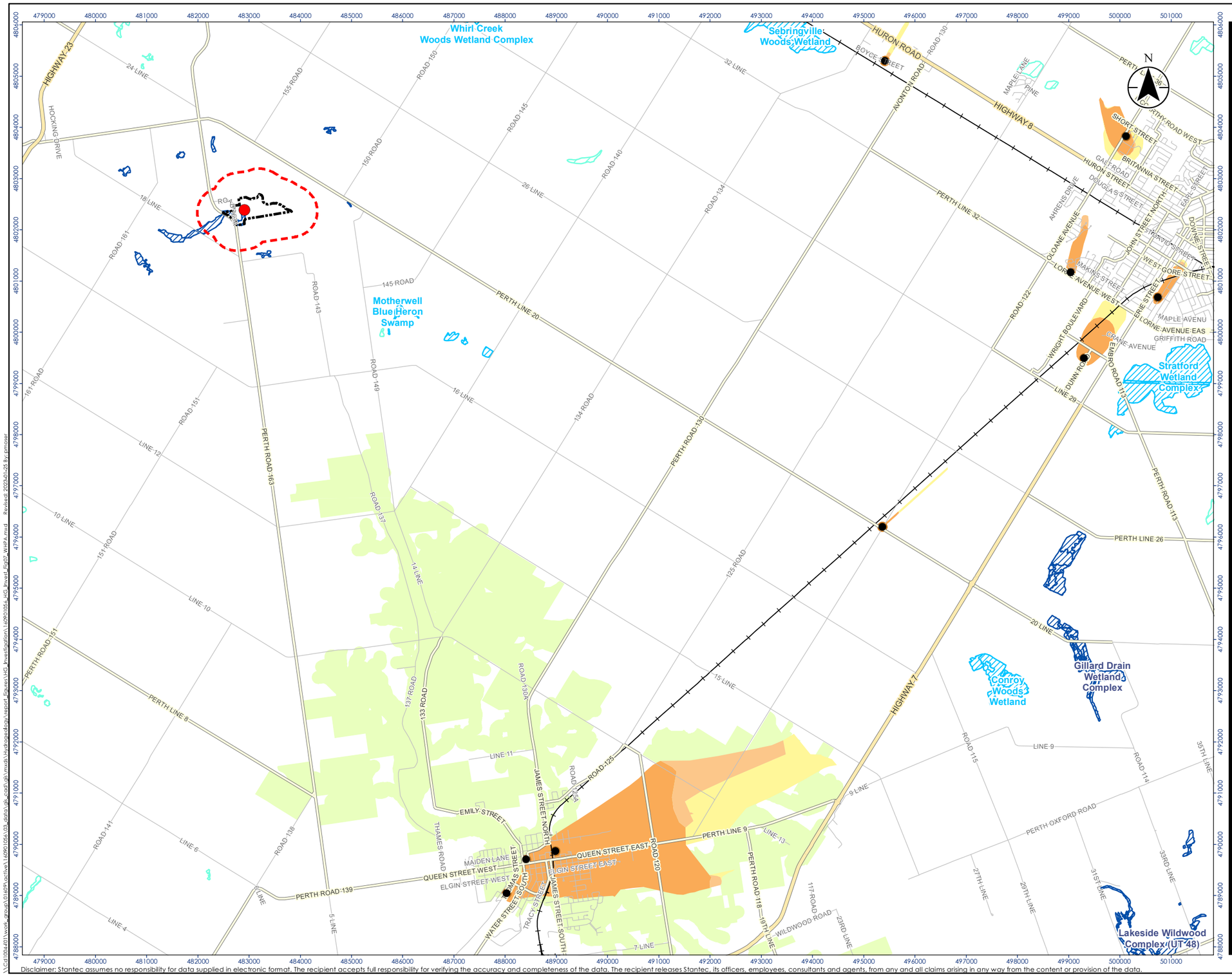
Client/Project
UPPER THAMES RIVER CONSERVATION AUTHORITY
FULLARTON DAM REHABILITATION

Figure No.
7

Title
UTRCA Source Water Protection Data



Stantec

Legend

- Fullarton Dam
- Production Well
- Expressway / Highway
- Major Road
- Minor Road
- Railway - Operational
- Regulated Wetland (UTRCA)
- Wetland - Evaluated (Provincial)
- Wetland - Evaluated (Other)
- Wetland - Not evaluated per Ontario Wetland Evaluation System
- Fullarton Dam Property Boundary
- Fullarton Dam Study Area (500m)

WHPA

- A
- B
- C
- D
- E

0 250 500
metres
1:75,000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2023.
3. Orthoimagery © First Base Solutions, 2023. Imagery Date, 2010.

Project Location
County of Perth

160901056 REVA
Prepared by PRM on 2023-01-25
Technical Review by GW on 2023-01-25

Client/Project
UPPER THAMES RIVER CONSERVATION AUTHORITY
FULLARTON DAM REHABILITATION

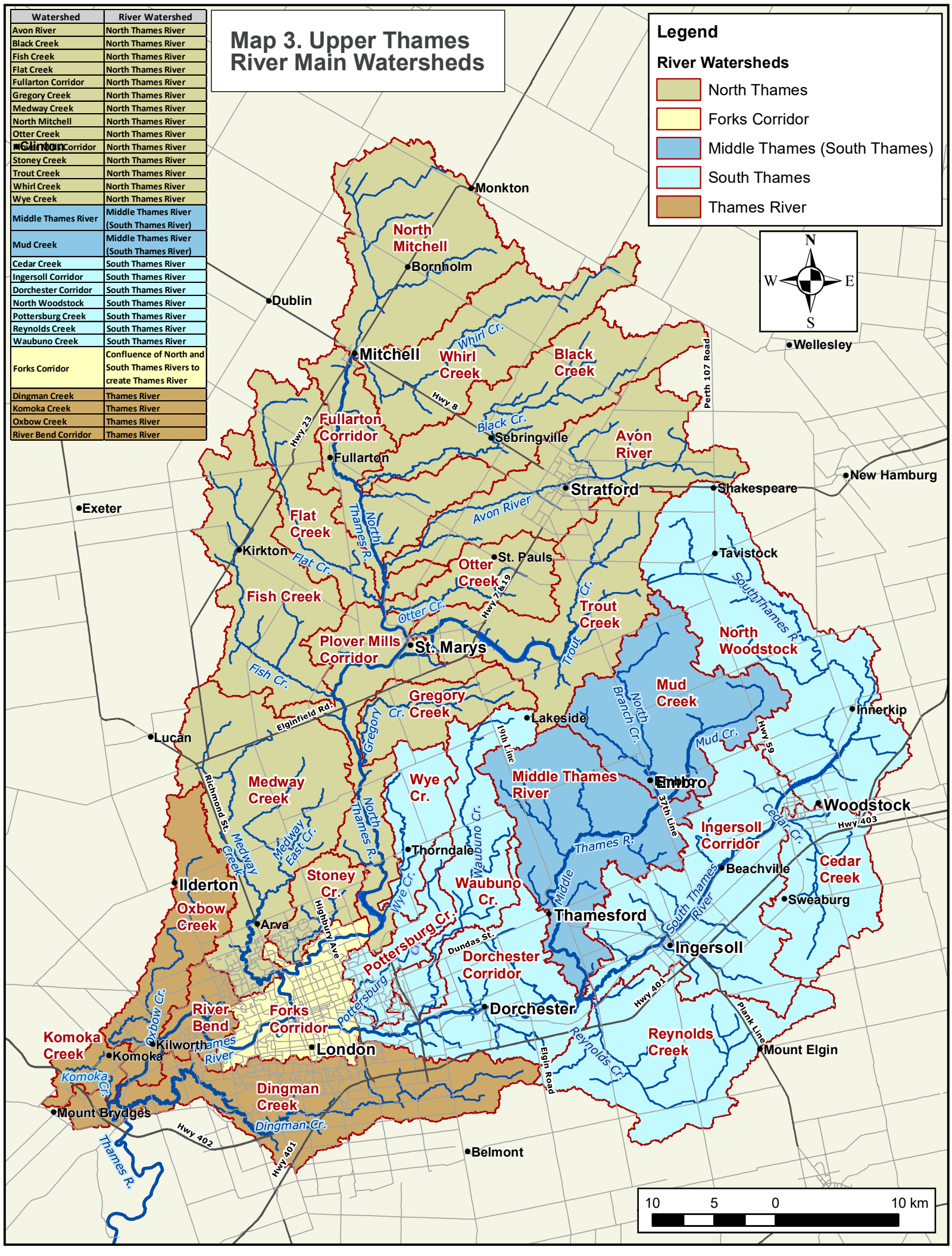
Figure No.
6

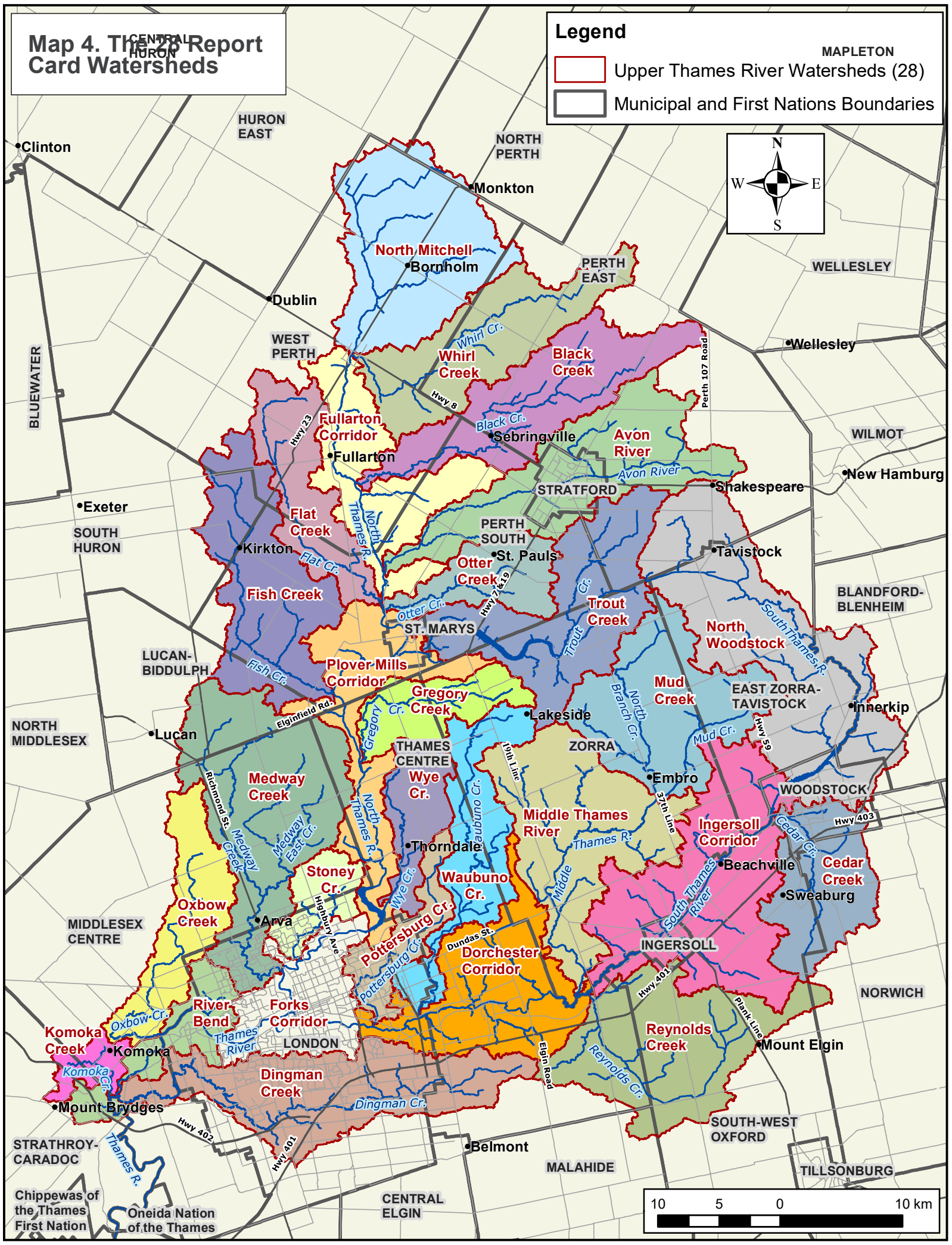
Title
WHPA

APPENDIX B:
Key Background Documentation

Figure 3. Floodplain Map Showing Regulatory 250 Year Flood Lines

Watershed	River Watershed
Avon River	North Thames River
Black Creek	North Thames River
Fish Creek	North Thames River
Flat Creek	North Thames River
Fullarton Corridor	North Thames River
Gregory Creek	North Thames River
Medway Creek	North Thames River
North Mitchell	North Thames River
Otter Creek	North Thames River
Plover Mills Corridor	North Thames River
Stoney Creek	North Thames River
Trout Creek	North Thames River
Whirl Creek	North Thames River
Wye Creek	North Thames River
Middle Thames River	Middle Thames River (South Thames River)
Mud Creek	Middle Thames River (South Thames River)
Cedar Creek	South Thames River
Ingersoll Corridor	South Thames River
Dorchester Corridor	South Thames River
North Woodstock	South Thames River
Pottersburg Creek	South Thames River
Reynolds Creek	South Thames River
Waubuno Creek	South Thames River
Forks Corridor	Confluence of North and South Thames Rivers to create Thames River
Dingman Creek	Thames River
Komoka Creek	Thames River
Oxbow Creek	Thames River
River Bend Corridor	Thames River



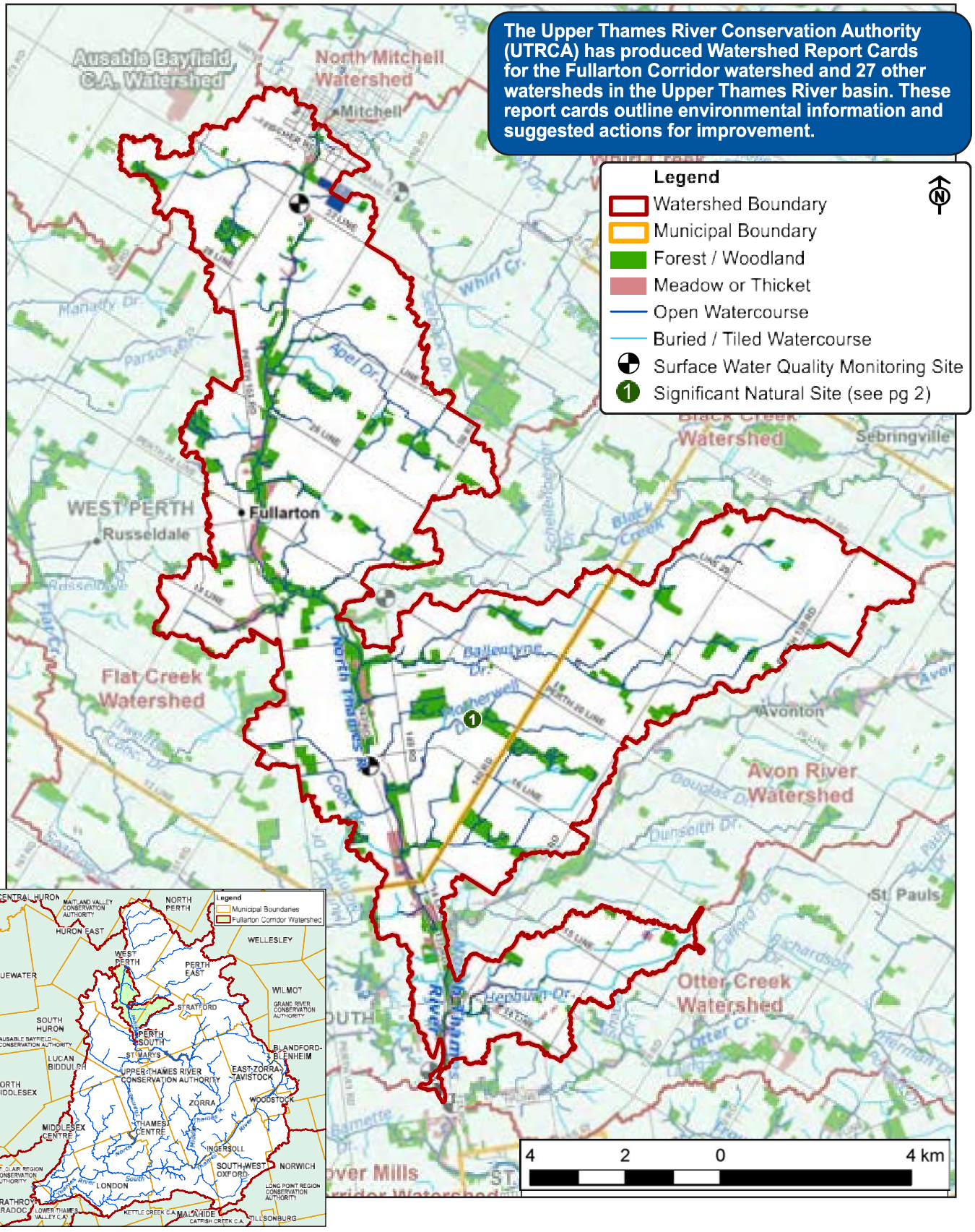

Map 4. The 28 Report Card Watersheds
Legend
Upper Thames River Watersheds (28)
Municipal and First Nations Boundaries
N
W
E
S
CENTRAL HURON
MAPLETON
HURON EAST
NORTH PERTH
Clinton
Monkton
North Mitchell
Bornholm
PERTH EAST
WELLESLEY
Dublin
WEST PERTH
Whirl Cr.
Whirl Creek
Black Creek
Wellesley
BLUEWATER
Hwy 8
Perth 107 Road
Fullarton Corridor
Hwy 23
Black Cr.
Sebringville
Avon River
WILMOT
Fullarton
Avon River
New Hamburg
STRATFORD
Shakespeare
Exeter
Flat Creek
North Thames R.
PERTH SOUTH
SOUTH HURON
Kirkton
Flat Cr.
St. Pauls
Tavistock
Otter Creek
Hwy 7&19
Fish Creek
Otter Cr.
Trout Creek
BLANDFORD-BLENHEIM
ST. MARYS
North Woodstock
South Thames R.
LUCAN-BIDDULPH
Plover Mills Corridor
Fish Cr.
Gregory Creek
Mud Creek
EAST ZORRA-TAVISTOCK
Innerkip
Elginfield Rd.
Gregory Cr.
Lakeside
North Branch Cr.
NORTH MIDDLESEX
Lucan
THAMES CENTRE
ZORRA
Mud Cr.
Hwy 59
Wye Cr.
19th Line
Embro
Medway Creek
Richmond St.
Medway East Cr.
North Thames R.
Waubuno Cr.
37th Line
WOODSTOCK
Middle Thames River
Ingersoll Corridor
Hwy 403
Thames R.
Cedar Cr.
Thorndale
Beachville
Cedar Creek
Stoney Cr.
Middle
South Thames River
Sweaburg
Oxbow Creek
Wye Cr.
Waubuno Cr.
Highbury Ave
MIDDLESEX CENTRE
Arva
Pottersburg Cr.
Dundas St.
Dorchester Corridor
INGERSOLL
Hwy 401
NORWICH
River Bend
Forks Corridor
Oxbow Cr.
Komoka Creek
Thames River
LONDON
Reynolds Creek
Plank Line
Komoka
Komoka Cr.
Elgin Road
Mount Elgin
Dingman Creek
Dingman Cr.
Mount Brydges
Hwy 402
SOUTH-WEST OXFORD
STRATHROY-CARADOC
Hwy 401
Belmont
MALAHIDE
TILLSONBURG
Thames R.
Chippewas of the Thames First Nation
Oneida Nation of the Thames
CENTRAL ELGIN
10 5 0 10 km

Surface Water Quality
C - Improved

Forest Conditions
D - Slight Improvement

2022 Watershed Report Card

Fullarton



2022 Watershed Report Card

Watershed Features

Feature	Description
Municipalities	West Perth (64%, 76 km^2), Perth South (36%, 42 km^2). Total area: 11,777 ha (118 km^2), 3% of the Upper Thames River watershed. 815 km^2 lies upstream.
Significant Natural Sites	Wetlands: (1) Motherwell Blue Heron Swamp. (See numbered site on map). Earth Science Areas of Natural and Scientific Interest: Fullarton Moraine, North Thames Valley.
Land Cover	82% agriculture, 12% natural vegetation, 1% open space, 4% urban, < 1% aggregates, 1% water. 2% of the watershed is in impervious cover (e.g., hard surfaces such as roofs and roads).
Population	1,723 in 2021; a 16% increase since 2016, partly due to watershed boundary corrections.
Soil Type	50% silty loam, 39% clay loam, 8% bottomland, 2% loam, 1% not mapped/urban
Physiography	71% undrumlinized till plain, 17% spillway, 12% till moraine
Soil Erosion/ Delivery	13% highly erodible (lands that could potentially contribute > 7 tonnes/ha/yr of soil to a watercourse). The average for the Upper Thames River watershed is 9%.
Tiling and Drainage	72% of the watershed has agricultural field tile (21% random + 51% systematic), 4% urban drainage, 24% no tiling. There has been very little change over the last five years.
Watercourse Characteristics	Total length: 189 km of watercourses Watercourse type: 40% natural, 42% channelized, 18% buried/closed Temperature: 21% cool/coldwater, 79% warmwater/unconfirmed Main channel slope: 0.26% slope (low/flat) for North Thames, 0.35% slope (moderate) for McEwan and 20th Con. Dr.; range is 0.09-1.26% in Upper Thames River watersheds
Dams and Barriers	9 barriers to fish passage have been recorded including the Fullarton Conservation Area Dam and other smaller perched culverts, beaver dams, etc.
Spills	2001-2005: 1; 2006-2010: 3; 2011-2015: 1; 2016-2020: 1 Recent reported spill involved an industrial chemical.
Sewage Treatment	The Mitchell Wastewater Treatment Plant services the Town of Mitchell and discharges treated effluent to the North Thames River just downstream of Mitchell. All other homes and businesses in the watershed are serviced by private septic systems.
% Vegetation Cover and Types	Vegetation cover: 1,425 ha or 12.1% of the Fullarton Corridor watershed Composition: 69% deciduous forest, 3% mixed forest, 9% plantation/coniferous forest, 15% meadow, 4% thicket
Wetland Cover	3.3% (388 ha) of the watershed is in wetland cover. Environment Canada (2013) recommends at least 6% wetland cover. No wetland cover was lost between 2010 and 2015.
Woodlot or Patch Size	See table below
Fish and Mussels	Fish Species: 48 species including 3 with only historic records Gamefish: Smallmouth and Largemouth Bass, and Northern Pike Mussel Species: 13 species
Species-at-Risk	Birds: 10 species including Barn Swallow and Wood Thrush Fish: 3 species including Black Redhorse and Silver Shiner Insect: Monarch Mussels: Rainbow and Wavy-rayed Lampmussel Reptiles: Snapping Turtle and Midland Painted Turtle Plants: Kentucky Coffee-tree

Size Category	Number of Woodlots	Average Size (ha)	Total Woodland Area (ha)	% of Woodland Area	Largest Woodlot (ha)
Small (< 10 ha)	121	3	351	30	157
Medium (10-30 ha)	16	19	299	26	
Large (> 30 ha)	9	57	510	44	

For more information on watershed features and how they compare to the other 27 subwatersheds, see the tables in the full report: 2022 Upper Thames River Watershed Report Cards at www.thamesriver.on.ca.

Grade: C Improved

2022 Watershed Report Card

Surface Water Quality

Fullarton Corridor has improved since the last report card and scores an overall grade of C. The surface water quality of the watershed is monitored at the downstream end on the North Thames River at Perth Line 12 (see map). The UTRCA has a water quality target of a B grade for Fullarton Corridor by 2037.

Phosphorus levels have improved since 2015 and are much lower than the Upper Thames River average. Bacteria (*E.coli*) levels are low and better than the Upper Thames River average. Recent chloride levels (mainly from road salt) are low, and below the aquatic life guideline. Recent nitrate levels are mostly above the aquatic guideline. General improvements in water quality are seen at this site compared to an upstream monitoring site at Line 32, south of Mitchell. A healthy, natural river channel running through this area is helping to improve water quality.

Steam health or water quality, as indicated by benthic score from the North Thames site near Science Hill, continued to show slight improvement.

Indicators	Fullarton Corridor					Upper Thames 2016-2020	Provincial Guideline	Indicator Description
	1996-2000	2001-2005	2006-2010	2011-2015	2016-2020			
Phosphorus (mg/l) *	No data	No data	0.060 C	0.135 D	**0.053 C Improved**	0.110 D	0.030 B Aquatic Life	Phosphorus is found in products such as fertilizer, detergents, and waste, and contributes to excess algae and low oxygen in streams and lakes.
Bacteria (CFU *E. coli*/ 100 ml) **	No data	No data	84 B	157 C	**128 C Steady**	211 C	200 C Recreation	*E. coli* is a fecal coliform bacteria found in human and animal (livestock/ wildlife/pets) waste. *E. coli* is a strong indicator of the potential to have other disease-causing organisms in the water.
Benthic Score (FBI)	5.79 D	5.82 D	5.62 C	5.38 C	**5.34 C Steady**	5.99 D	< 5.00 B Target Only	Benthic organisms (aquatic invertebrates that live in stream sediments) are good indicators of water quality and stream health. The Family Biotic Index (FBI) scores each taxa according to its pollution tolerance.

*75th percentile, UTRCA data. **Geometric mean, Health Unit data. Province-wide grading system used (see page 8).
In 2019, the Provincial Recreational Guideline for *E. coli* changed from 100 Colony Forming Units *E.coli* / 100 ml to 200 CFU *E.coli* / 100 ml.

Found in the Fullarton Corridor watershed, the Mottled Sculpin is a common inhabitant of spring-fed streams. It has a large mouth and can eat prey items almost as large as itself. It has been driven out of many of its habitats by the invasive Round Goby.

Extreme flooding in February 2018 in St. Marys, Ontario.

Climate Change

Climate change continues to be a critical issue. Locally, storms and floods are becoming more intense and frequent, which affects water quality by increasing runoff and erosion. Flooding and increased temperatures also stress native plant and animal species. Many local municipalities and industries are enacting Climate Action Plans that focus on reducing greenhouse gases and developing adaptation strategies, including nature-based solutions. Increasing natural cover (trees, wetlands, and forests) and green cover (agricultural cover crops) will absorb carbon and improve resiliency to climate change impacts.

Grade: D
Slight Improvement

2022 Watershed Report Card

Forest Conditions

Forest conditions in the Fullarton Corridor watershed have improved slightly since the last watershed report cards in 2017, and score an overall grade of D. It should be noted that some of the change is due to improved mapping methods and boundary corrections.

The percent forest cover (9.8%) has increased slightly from 9.4% five years ago primarily due to improved mapping and succession (see table). The Environment Canada (EC) guideline for southern Ontario is a minimum of 30% forest cover. Meadows and thickets add another 2.3% cover for a total of 12.1% natural vegetation cover.

The percent forest interior (0.7%) is very low, indicating most woodlots are too small and narrow to support area sensitive species such as Scarlet Tanager and Ovenbird. The EC guideline is 10% forest interior.

The percent riparian zone forested (37.4%) has increased from 28.3% in 2016, primarily due to mapping improvements. Levels are still below the EC guideline of 50%. Additional riparian areas are in permanent meadows and thickets (12.4%) for a total of 49.8% riparian zone vegetated. The North Thames River is well-vegetated in this area, unlike the tributary watercourses and drains.

Indicators	Fullarton Corridor 2022*	Upper Thames Average 2022*	EC Guideline **	Indicator Description
% Forest Cover	**9.8 D**	11.3 D	30.0 B	Percent forest cover is the percentage of the watershed that is forested or wooded. Forest cover includes upland and wetland forest types.
% Forest Interior	**0.7 F**	1.5 F	10.0 B	Percent forest interior is the percentage of the watershed that is forest interior. Forest interior is the protected core area 100 m inside a woodlot that some bird species require to nest successfully. The outer 100 m is considered "edge" habitat and prone to high predation, wind damage and alien species invasion.
% Riparian Zone Forested	**37.4 C**	35.7 C	50.0 B	Percent riparian zone forested is a measure of the amount of forest cover within a 30 m riparian/buffer zone adjacent to all open watercourses. Riparian habitats support high numbers of wildlife species and provide an array of ecological functions including water quality protection.

* 2022 report card data is based on 2015 colour air photography. ** EC Guideline - Environment Canada guideline based on "How much habitat is enough?" 2013. Grades based on Conservation Ontario (2022).

Losses and Gains

Forest Area Removed

Years	ha
2000-2006	3
2006-2010	<1
2010-2015	3

Approximately 3 ha of forest were cleared and converted to other uses (e.g., urban, agriculture, aggregates) between the 2010 and 2015 air photography. An additional 3-4 ha of forest were cleared in the previous 10 years.

Forest Area Gained

Years	ha
2010-2015	62

New data shows that approximately 62 ha of forest were gained between 2010 and 2015 due to forest succession and improved mapping. Several 20- to 30-year-old tree planting sites and some thickets matured to the point where they could be classified as mature woodland in 2015. This data demonstrates the value of continued tree planting and conservation efforts.

Red-bellied Woodpeckers nest locally in tree cavities often at the edge of woodlands. Photo: Sharon Nethercott

Groundwater

Municipal Water Supply

The Town of Mitchell has 4 municipal wells which draw groundwater from a deep bedrock aquifer, and supply water to 4870 people. Municipal well water is tested and treated.

Private Wells

Approximately 270 private wells are on record in this watershed, the majority drawing from bedrock aquifers. Properly constructed deep wells have a lower risk of contamination from the surface when compared to shallow wells. The highest risk to any well is from contaminants and activities closest to the well. The safety, testing, and treatment of a private well are the responsibility of the well owner.

Groundwater Monitoring

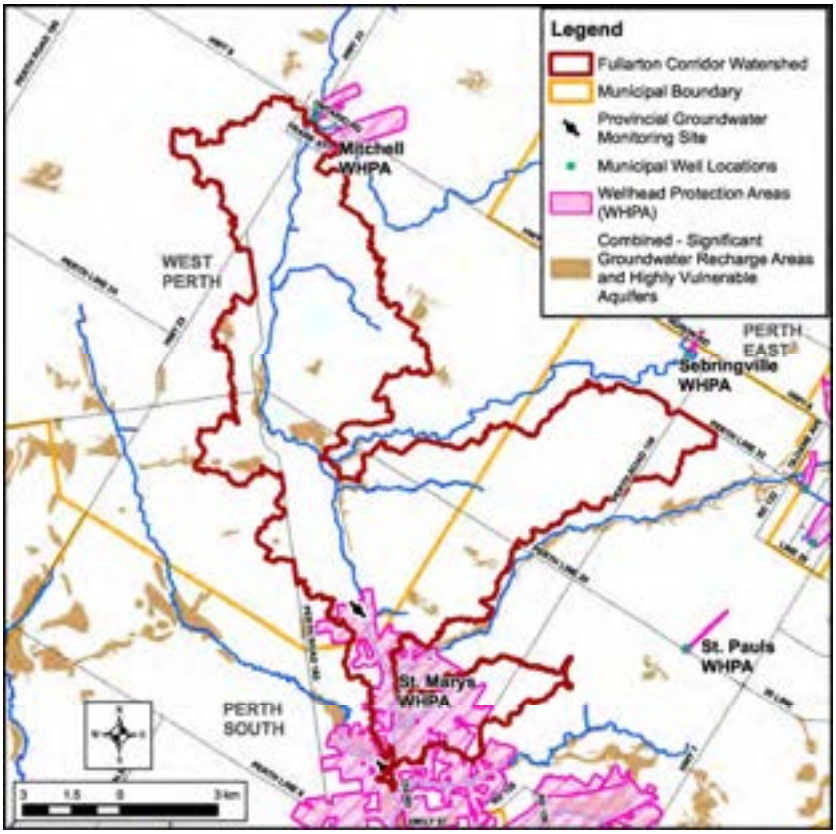
The Provincial Groundwater Monitoring Network has shown groundwater levels generally decline from May to October and increase (recharge) from late fall to early spring, with the largest increase in March (up to 1.5 m change). Recent data shows the recharge period is shifting later to November to May, with a trend of warmer and drier weather from October to November and cooler temperatures in May. The rate of decline in groundwater levels is directly related to maximum air temperatures. Summer rainfall does not typically affect groundwater levels as evaporation and plant uptake greatly exceeds rainfall, and most rainfall is utilized by plants during summer.

Did you know?

- About 50-70% of total local streamflow is baseflow from groundwater discharging into streams.
- Vegetation relies more on groundwater as it is more stable than rainfall. Most remaining wetlands are groundwater dependent.

Drinking Water Source Protection

Local source protection plans have been completed to protect sources of municipal drinking water. The Thames-Sydenham and Region Source Protection Plan (2015) has policies to address risks to municipal water systems. Visit www.sourcewaterprotection.on.ca for information on groundwater resources, Source Protection Plan policies, and a Water Supply System Summary for Mitchell.



On The Map

Significant Groundwater Recharge Areas: Areas where a relatively large volume of water makes its way from the ground's surface down to the aquifer.

Highly Vulnerable Aquifers: Areas where there is a relatively fast pathway from the ground's surface down to an aquifer, generally making the aquifer more vulnerable to contamination.

Wellhead Protection Areas: Areas surrounding the wellhead, through which contaminants are reasonably likely to move toward or reach the well.

Protecting these areas is very important for the protection of local groundwater as a source of drinking water.

Local Actions for Improvement

Individuals, groups, businesses, municipalities, and agencies all have a role in improving the health of the watershed through these suggested actions. For more information on agencies that can help, contact the UTRCA (see page 8).

A number of the local actions listed below are also identified in the following reports:

- The Thames River (Deshkan Ziibi) Shared Waters Approach to Water Quality and Quantity (Thames River Clearwater Revival, 2019),
- Perth Natural Heritage Systems Study (Perth County, 2018 and 2019),
- Upper Thames River Source Protection Area Approved Assessment Report (Thames-Sydenham Source Protection Region, 2015), and
- Recovery Strategy for the Thames River Aquatic Ecosystem (Thames River Recovery Team, 2005).

Local Actions to Improve Surface Water and Groundwater

- Protect and establish buffers (native trees, grasses) along watercourses to cool streams, provide food for aquatic species, stabilize banks, and trap and absorb nutrients and other pollutants.
- Assess the purpose of eight dams/barriers in Fullarton Corridor to determine if any should be removed or modified to improve river health and fish passage. At least two watercourses, Hepburn Drain and Neil Drain, have coldwater habitat that may be suitable for Brook Trout introduction if the barriers are removed or mitigated.
- Use drain maintenance methods that protect aquatic habitat (e.g., low flow channels, spot or bottom cleanouts).
- Repair or replace faulty septic systems and ensure proper maintenance of the system.
- Continue to implement agricultural Best Management Practices (BMPs):
  - Establish cover crops to protect soil from erosion, prevent nutrient loss, and build soil health.
  - Reduce nutrient loss from cropland (4R Stewardship Approach: right source, right rate, right time, right place).
  - Use best practices in manure storage and spreading, pesticide and fertilizer storage and application, fuel storage, and restricting livestock access to watercourses.
  - Complete and follow Environmental Farm Plans and Nutrient Management Plans (www.omafra.gov.on.ca).
  - Utilize grants for stewardship work from the UTRCA Clean Water Program (www.cleanwaterprogram.ca).
- In Mitchell, continue the following actions:
  - For new development, implement urban stormwater planning using Low Impact Development (LID), stormwater BMP, subwatershed studies, catchment area planning, and erosion control.
  - Incorporate LID into the planning process and promote the implementation of LID techniques, including in Master Plans, Secondary Plans, and any subwatershed studies.
  - Consider using a water balance and landscape approach for inbuilt and new development to manage stormwater runoff.
  - Maintain base flow to natural heritage features through water balance.
  - For existing development, implement pollution prevention and control planning for all aspects of stormwater runoff including combined storm-sewer overflows.
  - Continue to upgrade sewer systems where risk of contamination is greatest (e.g., extend sanitary sewers to urban properties on septic systems).
  - Minimize use of fertilizers, adhere to Ontario's Cosmetic Pesticide Ban, and utilize the municipal hazardous waste disposal program.

Blocks of trees are planted using a machine planter in a prepared field.

Local Actions to Improve Drinking Water

- Decommission abandoned wells according to Ministry of Environment, Conservation, and Parks standards.
- Homeowners with wells should understand the condition of their well and risks to their water supply (see www.wellaware.ca).
- Sample private wells each spring and fall (available through the Health Unit).
- Keep contaminants (e.g., fuel, pesticides, manure, waste) away from your well area. Consider septic system inspections (see www.omafra.gov.on.ca)
- To protect municipal drinking water sources, implement Source Protection Plan policies.

Local Actions to Improve Forest and Vegetation Cover

- Connect the existing riverside woodlands and meadows with additional plantings to create a continuous wildlife corridor along the North Thames and its tributaries.
- For tree planting and naturalization projects, create a more natural and diverse habitat by using a variety of native plant species that are better adapted to the local climate, pests, etc. The UTRCA provides tree planting assistance and advice, and grants may be available (see contact information on page 8).
- Municipalities can conserve woodlands, wetlands, and other natural areas by strengthening tree conservation by-laws and enforcement, Official Plan designations, and providing landowner incentives and education.
- Connect isolated woodlots by planting shelterbelts, windbreaks, and buffers along fields and watercourses, which will also protect against soil erosion and improve water quality. Thin older, denser windbreaks.
- Increase forest interior by making woodlots larger and wider by planting native trees and shrubs along the edges or allowing the edges to naturalize on their own.
- Landowners wishing to selectively log their woodlots should use Good Forestry Practices (i.e., Basal Area Guidelines, not Diameter Limit Harvesting) and hire a Certified Tree Marker to mark the woodlot and oversee harvesting.
- Woodlot owners can improve the quality of their woodlots by identifying and removing invasive alien species such as buckthorn (see www.ontarioinvasiveplants.ca and www.thamesriver.on.ca). Keep out livestock and unauthorized motorized vehicles to protect habitat quality.

Great Lakes Connection

The Fullarton Corridor is in the Thames River watershed, which is part of the Lake Erie watershed. Water from the Fullarton Corridor (North Thames River) takes 4-10 days to flow through London and Chatham, and then into Lake St. Clair. About two weeks later, it reaches Lake Erie via the Detroit River.

Shared Waters Approach

In 2012, partners in the Thames River watershed formed the Thames River Clear Water Revival to work together on the protection of water, with the shared goal of a healthy and vital Thames River which would also benefit Lake St. Clair and Lake Erie. This partnership brings together Indigenous peoples, three levels of government, two local conservation authorities, and the local community. A state of the environment report with a focus on actions needed for water quantity and quality was completed in 2019: The Thames River (Deshkan Ziibi) Shared Waters Approach to Water Quality and Quantity. Implementation by all partners is underway. The Shared Waters Approach contains significant input from four of the eight distinct First Nations whose traditional territory includes the Thames River watershed and highlights the positive participation and sharing of traditional ecological knowledge within this approach.

2022 Watershed Report Card

Highlights of Progress Since 2017

The Fullarton Corridor watershed is benefiting from many conservation efforts that continue to be implemented by individuals, groups, businesses, agencies, and municipalities on private and public lands. Examples of activities since 2017 include:

- Perth South held its first Tree Power in 2021, a partnership between UTRCA and the municipality. A total of 300 trees were available and residents of Perth South were able to order their choice of five native hardwood species. The goal is to increase local tree and leaf cover.
- Many municipalities in the Upper Thames watershed are taking action on climate change. For Perth County municipalities, there is a shared Climate Change Coordinator. There is a commitment to reducing emissions and taking action on climate change by the Federation of Canadian Municipalities under the Partners for Climate Protection Program, a network of more than 350 Canadian municipal governments.
- Perth County contracted the UTRCA to complete the Perth County Natural Heritage Systems Study (Perth County, 2018 and 2019) to identify existing important natural heritage features on the landscape.
- Over 5,035 trees were planted at 16 properties from 2016 to 2020 under the UTRCA's Private Land Reforestation Program. Trees were planted into windbreaks, along watercourses, and in block plantings to enlarge existing woodlots or create new woodlots.
- Under the UTRCA's Communities for Nature Program, 100 trees were planted by 30 students at the Mitchell Wetlands.
- Watershed landowners completed 10 Clean Water Program projects from 2016 to 2020 including fragile land retirement and erosion control measures. The CWP was initiated in 2001 as a partnership between local municipalities to fund environmental projects (www.cleanwaterprogram.ca). From 2001 to 2020, 82 projects were completed.
- Local volunteers continue to improve this stretch of the North Thames River through the annual Thames River Cleanup that started in 2000. Each spring, volunteers remove garbage and litter from the river and its banks.

Perth South Tree Power 2021

Ontario-Wide Report Cards

Conservation Authorities produce report cards for their watersheds every five years to track changes, using a standardized grading system (www.conservationontario.ca). Grades vary across the province, reflecting the range of physical characteristics and human activities. The complete set of UTRCA report cards and supporting information are available in a report titled 2022 Upper Thames River Watershed Report Cards (thamesriver.on.ca).

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UPPER THAMES RIVER CONSERVATION AUTHORITY

Thames Canadian Heritage River

Appendix B Baseline Hydrogeological Characterization Report

Baseline Hydrogeological Characterization Report, Fullarton Dam Rehabilitation

March 20, 2023

Updated November 26, 2024

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Limitations and Sign-off

The conclusions in the Report titled Baseline Hydrogeological Characterization Report, Fullarton Dam Rehabilitation are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

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1 Introduction

Stantec Consulting Ltd. (Stantec) was retained by the Upper Thames River Conservation Authority (UTRCA) to complete baseline characterization reports in support of an Environmental Assessment (EA) for the rehabilitation of the Fullarton Dam at the Fullarton Conservation Area (Site), located at 2999 Perth Road 163A in Perth County, Municipality of West Perth, Lot 15, Concession Mitchell Road East Side (Figure 1).

Fullarton Conservation Area (CA) is a 34-hectare area used for recreation such as hiking, fishing, canoeing in the pond, and picnicking. There are two trails in Fullarton CA that allow for day trips through the wetland and around the pond, or through a mixed deciduous and pine wood forest. The existing Fullarton Dam, an earth dam, was built along an unnamed watercourse in the 1950s to create a recreational lake. The outcome of a 2007 dam safety assessment indicates that the current condition of the earth dam requires rehabilitation to meet appropriate safety and stability standards.

2 Site Setting

2.1 Physiography and Surficial Geology

The Site (Figure 2) is located within the till moraines (specifically, the Milverton and Mitchell moraines) of the physiographic region defined as the Stratford Till Plain. The Stratford Till Plain is a relatively uniform silty clay throughout the region (Chapman and Putnam, 1984). Spillways associated with the North Thames River are also dominant at the Site (Figure 3).

Surficial geology mapping by the Ontario Geological Survey (OGS, 2010) is presented on Figure 4. The Site is mapped within an area of fine-textured glaciolacustrine deposits of silt and clay (Figure 4, unit 8a). The Fullarton Dam property boundary extends into modern alluvial deposits associated with the North Thames River (Figure 4, unit 19) and glaciolacustrine-derived silty to clayey till (Figure 4, unit 5d).

Bedrock near the Site is described by Armstrong and Dodge (2007) as the Oxford Formation. The Oxford Formation predominantly consists of dolostone, shale and/or sandstone.

The topography is characterized by generally low relief, with the steepest slopes near the North Thames River. The topography near the Site varies between 325 to 335 m above mean sea level (AMSL).

2.2 Local Groundwater Supply

A review of aerial imagery shows the Site resides in a rural to agricultural area. A review of the Ministry of Environment, Conservation, and Parks (MECP) Water Well Records (WWRs; MECP, 2023) indicated that there are 11 WWRs located within 500 m of the Site (Figure 5), with no private water supply wells being located downgradient between the dam and the North Thames River. Seven of the eleven WWRs are identified as being private water supply wells. The nearest private water supply well is located approximately 335 m to the southwest of the Site and is constructed in bedrock. The only mapped overburden water supply well within 500 m of the Site is located approximately 710 m to the west of the dam.

According to the WWRs, overburden ranges from 25 to 41 m in thickness and predominately consists of clay with shallow deposits of gravel and stones. Four of the seven water supply wells are screened in overburden and only one well record (Well 5002028) provides water level information. For Well 5002028, which is located 145 m west of the Site, the static water level is reported as being 1.8 m below ground surface (BGS).

2.3 Surface and Groundwater Quality

Surface water and groundwater quality data near the Site is limited. The Upper Thames River Conservation Authority (UTRCA) provides report cards for the watershed every five years. The two most recent report cards were analyzed, the most recent of which was created in 2022 covering the years from 2016 to 2020 (UTRCA 2022[1]) followed by the 2017 report card which covers the years between 2011 and 2015 (UTRCA 2017a[2]). Based on these report cards, there are two surface water quality monitoring stations located within the watershed, one station located approximately 8.0 km north of the Site with the other station located approximately 6.0 km south of the Site near the intersection of Line 16 and 137 Road. These stations are part of the Provincial Water Quality Monitoring Network and are sampled monthly between April and November of each year. The report cards indicate the following:

- Surface water phosphorus concentrations in the Fullarton Corridor have decreased since 2015 but still exceed the Provincial Water Quality Objective (PWQO) for the excessive growth of plants in rivers and streams (0.03 mg/L). Phosphorus concentrations during the 2017 reporting were 0.135 mg/L (75th percentile) whereas concentrations during the 2022 reporting period decreased to 0.053 mg/L (75th percentile).
- *E. coli* concentrations in surface water in the Fullarton watershed have decreased from a geometric mean of 157 CFU/ 100 mL in the 2017 reporting period to 128 CFU/ 100 mL in the 2022 reporting period. The Provincial Recreational Guideline for *E. coli* was updated in 2019 from 100 CFU/100 mL to 200 CFU/100 mL. As such, the *E.coli* concentration presented in the 2022 report card is below the Provincial Recreational Guideline.
- The 2022 report card indicates that chloride concentrations in surface water is below the aquatic life guideline and that nitrate concentrations in surface water is mostly above the aquatic life guideline. The range in surface water concentrations observed is not provided in the document, nor is the provincial guideline against which the concentrations are compared.
- The UTRCA summarized surface water sampling completed in the reach of the unnamed watercourse where the Fullarton Dam is built as part of their Existing Conditions Report (UTRCA 2017b[3]). The watercourse was sampled three times in June and September of 2015 at three locations: upstream of Fullarton Pond, in Fullarton Pond upstream of the dam, and downstream of the dam. Results from this surface water quality sampling were as follows:
- *E.coli* concentrations were variable, ranging from approximately 10 CFU/100 mL to over 1000 CFU/100 mL. With the exception of the late fall at the pond and downstream locations, *E. coli* concentrations exceeded the PWQO for recreational waters of 100 CFU/ 100 mL.
- Nitrate concentrations were variable, ranging from approximately 1 mg/L to 11 mg/L. Concentrations were above the Canadian Environmental Quality Guideline (CEQG) for the protection of aquatic life (2.93 mg/L) during all sampling events at the upstream sampling location, during the early June sampling event at the pond, and during both June sampling events

[1] UTRCA 2022. 2022 Watershed Report Card, Fullarton. Prepared by the Upper Thames River Conservation Authority.
[2] UTRCA 2017a. 2017 Watershed Report Card, Fullarton. Prepared by the Upper Thames River Conservation Authority.
[3] UTRCA 2017. Fullarton Dam and Conservation Area, Existing Environmental Conditions. Prepared in draft, March 2017.

at the downstream location. When compared to the Ontario Drinking Water Quality Guidelines (ODWQS), nitrate concentrations exceed the chemical standard of 10 mg/L at the three sample locations during the first sampling round in June 2015.

- Chloride concentrations at all sampling locations were below 30 mg/L, noting that the corresponding ODWQS Aesthetic Objective for chloride is 250 mg/L.

The nearest Provincial Groundwater Monitoring Network site operated by the UTRCA is Well 54, which is a bedrock well located approximately 6.0 km downstream of the Site. The quality of groundwater at Well 54 is deemed excellent (Nicks 2017[4]).

2.4 Municipal Water Supply and Source Water Protection

The closest Well Head Protection Area (WHPA) (WHPA-E) is located approximately 4.75 km south of the Site and is associated with the St. Mary's WHPA, which has production wells located approximately 12.5 km south of the Site (Figure 6). There is also a WHPA associated with the Mitchell municipal water supply system located approximately 9.5 km north of the Site. There are no surface water Intake Protection Zones (IPZs) nearby. As the Site is not located within a WHPA or an IPZ, under the *Clean Water Act* (2006) list of prescribed drinking water threats, there are no activities that would result in a significant chemical and/or pathogen threat to the surface water supply if present during dam rehabilitation (MECP, 2018[5]).

A review of the MECP Source Protection Information Atlas (2022) indicates the Site is not located within either a Significant Groundwater Recharge Area (SGRA) or a Highly Vulnerable Aquifer (HVA) (Figure 7). Therefore, under the *Clean Water Act* (2006) list of prescribed drinking water threats, there are no activities that would pose a significant chemical and/or pathogen threat to the surface water supply as part of the potential dam rehabilitation works (MECP, 2018[4]).

[4] Nicks, L. 2017. Appendix B, Hydrogeology Assessment of Fullarton Conservation Area. Prepared January 17, 2017.
[5] Ministry of the Environment, Conservation and Parks (MECP). 2018. Table of Drinking Water Threats, Clean Water Act 2006. Originally Published November 20, 2008, Re-published following amendments. Effective July 1, 2018.

3 Gap Analysis

3.1 Changes in Groundwater Quality

The current surface water quality of the Fullarton Dam reservoir is unknown, as the last known sampling was conducted in 2015. At the location of the dam, Stantec anticipates that after dam removal, the overall hydraulic head will be decreased due to the loss of the ponded area and, subsequently, may reduce the rate of groundwater recharge in this area (i.e., due to reduction in vertical hydraulic gradients). As such, the infiltration of surface water stored within the reservoir potentially containing chemical parameters exceeding the ODWQS may also be reduced.

The release of surface water downstream, the quality of which exceeds the ODWQS for *E.coli* and nitrate based on sampling completed in 2015, during dam removal may have the opportunity to impact downstream shallow groundwater supply wells, if present. A review of the MECP WWR database indicates that there are no shallow supply wells downstream of the dam and that most the supply wells near the dam are screened in bedrock; however, Stantec recommends the completion of a door-to-door survey of residential and commercial properties within 1.0 km downstream of the dam to confirm the presence or absence of supply wells. A preliminary review of aerial imagery indicates that there may be four to six properties within this area. A water sample may be taken prior to the dam removal and on an as-needed basis after removal. If only bedrock wells are present, the impact of the release of the reservoir water during dam removal is not expected to impact these supply wells, especially considering the subsurface consists of thick clay-based till unit and fine-grained material that is likely characterized by low permeability (e.g., aquitard) that provides a natural protective barrier between the ground surface and deeper bedrock aquifer.

3.2 Changes to Groundwater-Surface Water Interactions

Baseflow contributions to the reservoir and connected unnamed watercourse near the Site is not known; however, it is reasonable to assume that contributions to these features from groundwater is likely similar to other groundwater-surface water relationships in other areas of the watershed (i.e., 50-70% of flows in local watercourses attributed to groundwater discharge; UTRCA 2017b[2]). Assuming the width and depth of the watercourse following its rehabilitation does not change notably from its current state, Stantec does not anticipate that groundwater discharge to the unnamed watercourse will be detrimentally altered following dam removal. However, to confirm this assertion, a field investigation to observe and track the location of potential groundwater seeps could be conducted prior to removing the dam. These seeps could be tracked during and after dam removal to understand changes, should they occur.

Groundwater quantity and flow may also be affected by changes in infiltration of precipitation due to dam removal. Infiltration could decrease depending on the construction of riparian habitat adjacent to the watercourse associated with the Fullarton Dam or could be enhanced due to an increase in permeable surfaces resulting from the removal of the dam and loss of the reservoir. These changes are unknown due to a lack of knowledge of local groundwater flow direction. The installation of monitoring wells in the overburden surrounding the dam may assist in supporting a better understanding of groundwater quantity and local flow dynamics in the shallow groundwater system.