04 September 2025 GRN File: 4665-G-24

The Town of Saugeen Shores
Via email to candace.hamm@saugeenshores.ca
Attention: Candace Hamm
cc. Matt Armstrong – Saugeen Valley Conservation Authority

Two-Zone Regulatory Flood Mapping Summary Memo - Southampton, Town of Saugeen Shores, ON – FINAL

Dear Ms. Hamm,

Greenland Consulting Engineers (Greenland) was retained to update the recently completed One-Zone regulatory flood mapping of Southampton in the Town of Saugeen Shores (Town) to Two-Zone flood mapping. The regulatory flood mapping was produced by Water's Edge Environmental Solutions (Water's Edge) for the Saugeen Valley Conservation Authority (SVCA) through funding received under the Flood Hazard Identification and Mapping Program (FHIMP) in 2023. All floodplain mapping data acquisition, modeling, and mapping requirements for the FHIMP were detailed in the Saugeen Shores Floodplain Mapping Final Report completed by Water's Edge (2024). Greenland served as the peer reviewer for the original FHIMP mapping project.

The Two-Zone mapping update was completed under the FHIMP program, which includes additional requirements to the 2023 funding program under which the original regulatory mapping was prepared. The additional requirements included a return period analysis of the regulatory event, and a climate change proxy scenario to be modelled and mapped, dependent on the statistical annual exceedance probability (AEP) of the regulatory flood event.

The purpose of the Two-Zone floodplain delineation is to delineate the floodway and flood fringe for the purpose of identifying areas within the floodplain which could be developed without any significant adverse effects to the floodplain hydraulics or posing a safety risk. The floodway is inner portion of the floodplain which is require for the safe passage of flow, or which represents a significant risk to life / property damage. No development (with exception of works required by nature to be within the floodway) is permitted within the floodway. The flood fringe is the outer portion of the floodplain, where development and site alteration may be permitted.

The floodway and flood fringe were delineated in accordance with the Ontario Ministry of Natural Resources River and Stream Systems Flood Hazard Limit Technical Guide (2002). The methodology to prepare the new Two-Zone flood map sheets for Southampton, as well as the new FHIMP requirements are detailed herein.

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Delineation of the Existing Floodway and Flood Fringe

Upon award of the project, Greenland reviewed the 2D hydraulic model developed by Water's Edge to determine if any updates to the model would be required. Based the review of the existing hydraulic model completed as part of the 2023 FHIMP project, no changes to the hydraulic model were required to update the existing regulatory flood mapping to show the Two-Zone floodplain (floodway and flood fringe).

Greenland reviewed the required depth, velocity and depth* velocity criteria for the study area to confirm compliance with regulatory requirements. These parameters are the safety criteria that are used delineate the floodway from the flood fringe. Areas that exceed any of the three (3) safety criteria thresholds are considered floodway in the Two-Zone mapping. Based on consultation with the Town and SVCA, the same criteria that was used for the other SVCA FHIMP projects completed in 2024, was applied for this project, including:

- Maximum allowable depth*velocity product of 0.4 m2/s;
- Maximum allowable velocity of 1.7 m/s; and,
- Maximum allowable depth of 0.8 m.

As part of the 2023 FHIMP project, three (3) hydraulic rasters were produced as part of the deliverables. These rasters are outputs of the hydraulic model, and include the flood depth, water velocity, and depth*velocity product for the Regional (Hurricane Hazel) storm event. In order to complete the delineation of the floodway and flood fringe, the rasters were converted into shapefile format.

The potential floodway and flood fringe were delineated in GIS for each of the three (3) criteria using the shapefiles developed. The delineation was based on the maximum safety threshold for each criterion. For example, the maximum depths from the 2D model results that equalled or exceeded 0.8m were considered the floodway criterion for that parameter. The most conservative result for each of the three (3) safety criteria was used to develop the preliminary floodway and flood fringe shapefiles for the study area.

Encroachment Analysis

The Two-Zone delineation must also have consideration of the impacts of development on the floodplain hydraulics, which is completed through an encroachment analysis. The encroachment analysis assesses the impact of development within the floodplain, through the assumption that portions of the flood fringe become ineffective flow areas (obstructions) to flow. It is an iterative analysis to assess what the maximum extent of encroachment is allowable without any significant negative impacts to the floodplain hydraulics. The area that cannot be encroached without significant impacts, is then considered within the regulations for the floodway.

Greenland undertook several scenarios to assess encroachment of the flood fringe with input from the Town and SVCA. The general process followed for the encroachment analysis was as follows:

- Determine the scenario to be modelled, in consultation with the Town and SVCA;
- Prepare the relevant shapefiles in ArcGIS of areas that can be encroached;

- Clip the terrain to the encroachment area shapefiles;
- Increase the elevation of the terrain above the existing water surface elevation under the regulatory scenario in ArcGIS to act as a proxy for filling during development;
- Mosaic the existing terrain with the raised terrain to create a final encroachment scenario terrain;
- Add the new terrain to the existing HEC-RAS model and run the Hazel storm event associated with the encroachment terrain (HEC-RAS version 6.3.1);
- Export the maximum Depth, Velocity, and Depth* Velocity product rasters;
- Compare the existing floodplain rasters to the encroachment scenario rasters;
- Discuss the results with the Town and SVCA to determine if the impacts to the floodplain are considered acceptable; and,
- As required, initiate the process again if there is a significant impact to the existing floodplain hydraulics.

Based on the above, the following encroachment scenario was determined to be the final approved scenario acceptable by the Town and SVCA:

1. No encroachment of the existing floodway;
2. There is no encroachment outside of the settlement boundary or of Town-owned land within the settlement boundary;
3. No encroachment is permitted with the valley hazard or shoreline hazard areas;
4. There is a setback of 8m from the top of bank of all watercourses where encroachment is not permitted, as per the Twon of Saugeen Shores Zoning By-Law; and,
5. A maximum of 70% encroachment of the remaining developable lot area is permitted.

The above items were applied in sequence to determine the encroachment area for the encroachment analysis. Shapefiles of the settlement boundary, parcel fabric, and Town-owned parcels to be removed from the encroachment area were provided by the Town; and a shapefile of the shoreline/ valley hazards were provided by the SVCA for the encroachment analysis. Greenland developed an 8m buffer shapefile of the watercourses to be applied for the encroachment scenario. Once the non-developable areas were removed for the parcel fabric for Southampton, a 70% buffer was applied to the remaining lot area. The final buffered parcels served as the area of the terrain that would be encroached as described above.

The new encroachment terrain was added to the existing HEC-RAS model (version 6.3.1) developed by Water's Edge and run for the Hurricane Hazel storm. The floodplain hydraulics rasters were then exported and analyzed in ArcGIS.

The average flood elevation increase under the encroachment scenario is 0.04m, when only considering the increases in flood elevation under this scenario. There are some areas where flood elevations would decrease. If considering all flood elevation changes, the average increase of flood elevation is 0.025m. In addition, it is critical that safe ingress/egress is maintained under the encroachment scenario. It was confirmed that no new areas within the right-of-way have a flood depth of 0.3m or greater under the encroachment scenario, as compared to the existing condition. As this encroachment scenario was considered acceptable by the Town and SVCA, the final Two-Zone flood maps were prepared for the regulatory event (Hurricane Hazel).

Flood Mapping

The final floodway and flood fringe were delineated in consultation with the Town and SVCA, and include the following:

- Floodway: the area of the floodplain that exceeds the hydraulic safety criteria under the existing condition or encroachment scenario, as well as the 8m setback from the watercourse top of banks.
- Flood Fringe: The remainder of the floodplain outside of the floodway, based on the existing floodplain limits.
- One-Zone Floodplain: Areas outside the settlement boundary remain under the One-Zone floodplain policy.

The 70% encroachment of lots will be a policy-related requirement by the Town that they will assume the responsibility of monitoring and enforcing as required. It is not included within the Two-Zone mapping.

The map sheets have been prepared for the Regulatory Event (Hurricane Hazel) and are attached in **Appendix A**. The floodplain modeling and mapping should be updated every 20 years, or more frequently if there is significant encroachment within the settlement area.

Climate Change Considerations

Climate change considerations are a requirement under the FHIMP funding program. Water's Edge modeled and mapped three (3) climate change scenarios, as well as a climate change proxy scenario as part of the 2023 mapping project. The scenarios include:

1. 25 year climate change- CMIP-6, mid-century, medium emission scenario (Goderich IDF Curves);
2. 100 year climate change- CMIP-6, mid-century, medium emission scenario (Goderich IDF Curves);
3. 100 year climate change- CMIP-6, mid-century, high emission scenario (Goderich IDF Curves); and,
4. 500 year- climate change proxy scenario.

Under the 2025 funding, the FHIMP requirements for climate change have been adjusted. As required through the FHIMP program guide, a climate change proxy scenario must be modelled, dependent on the annual exceedance probability (AEP) of the flood event standard. As it relates to this project, the flood event standard is the Hurricane Hazel storm. The following process determines the climate change proxy scenario that is required to be modelled, as per the FHIMP Program Guide (2022):

A) If the flood event standard exceeds the 100 year event, the return period for the magnitude of the flood event standard shall be estimated/computed.
B) Where the magnitude of the flood event standard is less than the 0.5% AEP but greater than the 100 year event, the 200 year and 350 year flood magnitudes must be estimated and mapped as a proxy for climate change.

C) Where the magnitude of the flood event standard is less than the 350 year event, but greater than the 200 year, the 250 year event must be estimated and mapped as a proxy for climate change.
D) If the flood event standard is greater than 350 year event, no additional mapping is required.

Greenland completed an analysis on the return period of the Hazel storm on a representative watercourse within the study area, specifically Creek 6 downstream of Fairy Lake, which represents the largest creek (and greatest flow) within the study area. Given that none of the watercourses in the study area are gauged, and there is no nearby 'representative hydrology' for gauged creeks that are a similar drainage area / land use, the analysis was completed based on the rainfall depth and modeled flow of the creek.

An equation for the relation between the rainfall depth and the return period storm from the modelled IDF curve was extended to the rainfall depth of the Hazel storm, with the same process followed for the flow values. The 24 hour rainfall depth was obtained from the final Saugeen Shores Floodplain Mapping Report completed by Water's Edge (2024). Based on the 24 hour rainfall depths, the IDF curves for the other rainfall durations for the study area were obtained using the IDF Curve Look Up Tool, which was used in the hydrologic modeling in the Water's Edge study. The return period of the Hurricane Hazel storm was then calculated for each rainfall duration, by extend the rainfall depth equation for the 2 year to 100 year storm events in the IDF Curve Look up Tool to the rainfall depth under the Hurricane Hazel event. The relationship between rainfall depth and return period for each storm event duration are shown below in **Figure 1.**

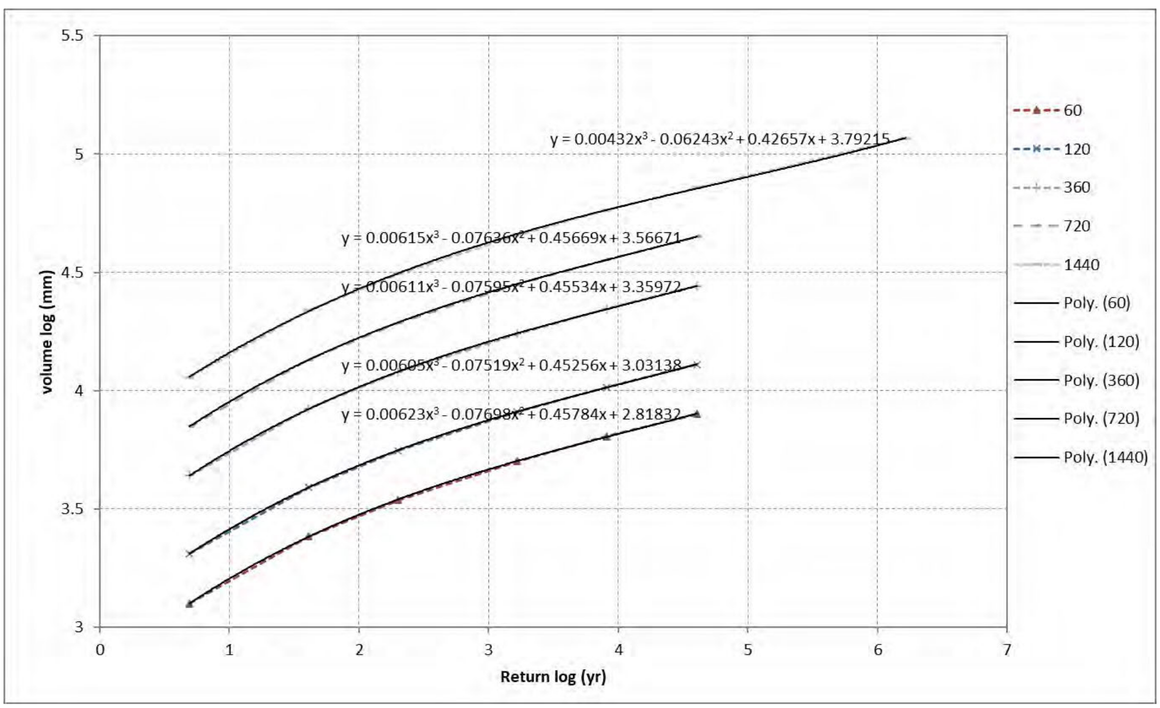


Figure 1 Relationship Between Return Period and Rainfall Depth, for 60min to 24 hour Storms

Hurricane Hazel is a 48 hour storm event; however, the storm can be modelled either as a 48 hour event, or using the last 12 hours of the storm with an increased antecedent moisture condition. Water's Edge modelled the last 12 hours of the storm event in the hydrologic model developed, therefore the return period based on the 12-hour storm duration was used for the return period calculation. The results of the return period calculation are shown in **Table 1**, below.

Table 1 Hurricane Hazel Return Period Based on Rainfall IDF

Duration	Rainfall (mm)	Return (yr)
1hr	52.58	150
2hr	90.27	800
6hr	151.78	1525
12hr	**210.30**	**2120**
24hr	210.30	2220

As shown in **Table 1**, the return period for the Hurricane Hazel event is 1 in 2,120 years based on the rainfall IDF curve. A second calculation was completed for the return period determination, based on the modeled flows of Creek 6. The equation for the relationship between modeled flows and the 2 year to 100 year storm events was extended to estimate the return period of the Hurricane Hazel storm. The relationship between the modeled flow and the return period for the 24 hour event (only modeled storm duration from Water's Edge) is shown below in **Figure 2.**

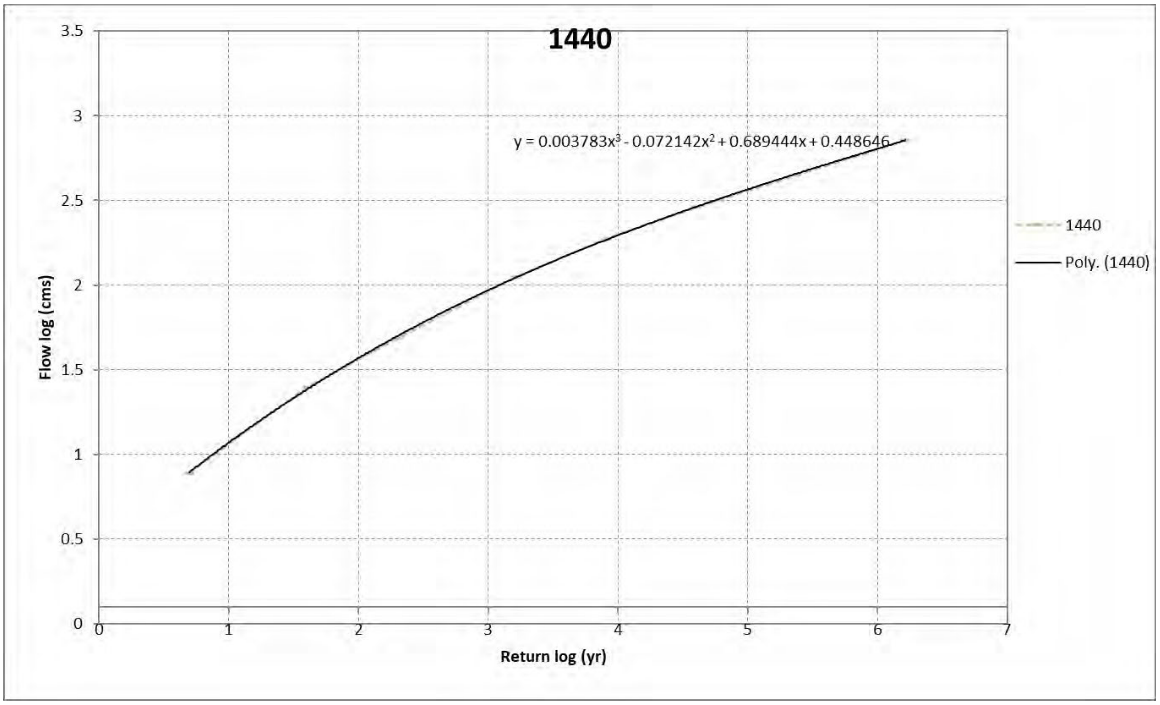


Figure 2 Relationship Between Return Period and Modeled Flow for the 24 Hour Storm

The results from the equation calculated in **Figure 2** are shown in **Table 2**, below.

Table 2 Hurricane Hazel Return Period Based on Modeled Flow

Duration	Flow (m^3/s)	Return (yr)
24hr	31.46	5440

Based on the flow within Creek 6 in it's most downstream reach, the return period of the Hurricane Hazel storm is 1 in 5,440 years.

Based on the return period analysis completed, the Hurricane Hazel event exceeds the 1 in 350 year event, therefore no additional climate change proxy mapping is required. This is supported in the Water's Edge reporting, where the flow modeled for each reach in the study area is greater under the Hurricane Hazel storm than the 1 in 500 year event.

Closure

Two-Zone regulatory flood mapping has been developed for the settlement area of Southampton in the Town of Saugeen Shores. The floodway and flood fringe were delineated in consultation with the Town and SVCA to ensure that all regulatory requirements were met to apply the Two-Zone policy approach within Southampton. Additional calculations on the Hurricane Hazel return period to ensure that all 2025 FHIMP program requirements were met, were also completed.

Respectively Submitted,

[redacted]

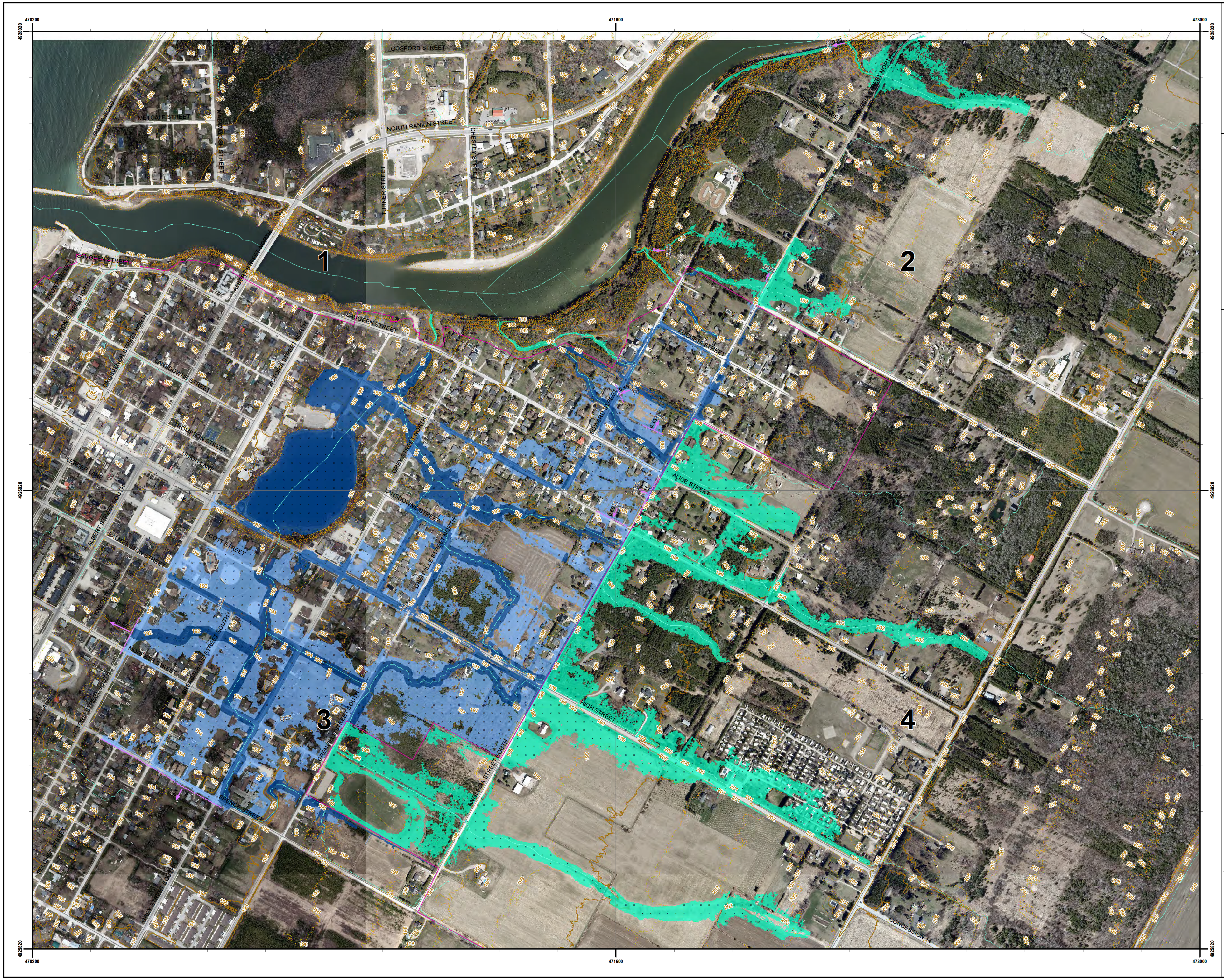
Kirsten McFarlane
Project Coordinator

Jim Hartman, P.Eng.
Senior Associate

George Yang, P.Eng.
Senior Modelling Specialist

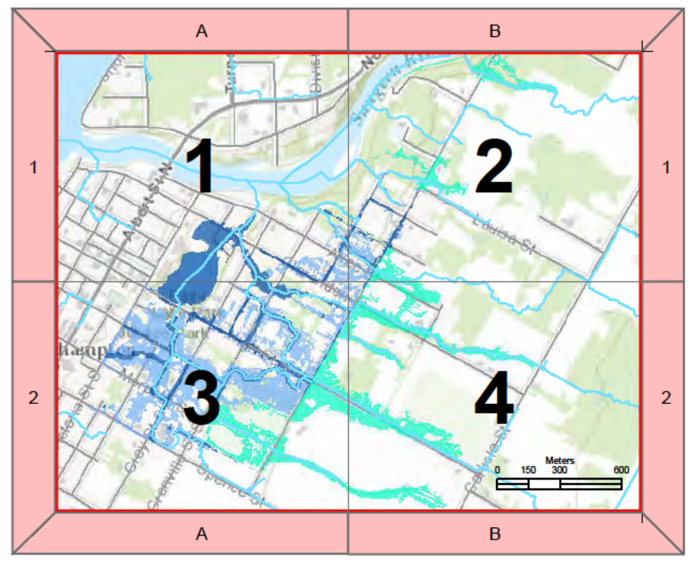
Attachments:
Appendix A- Two-Zone Flood Map Sheets

Appendix A – Two-Zone Flood Map Sheets



Southampton

Floodlines
(Existing Condition)



Legend

	Rivers		2-Zone
	Roads		Hurricane Hazel Floodway
	Contour 5m		Hurricane Hazel Flood Fringe
	Contour 1m		Hurricane Hazel Floodplain

2D Flood Elevation

181.00 — REGULATORY FLOOD ELEVATION
0.10 — REGULATORY FLOOD DEPTH

N W E S

Sheet: Index

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Meters 0 40 80 160 240 320 400

Saugeen Shores
Saugeen Conservation

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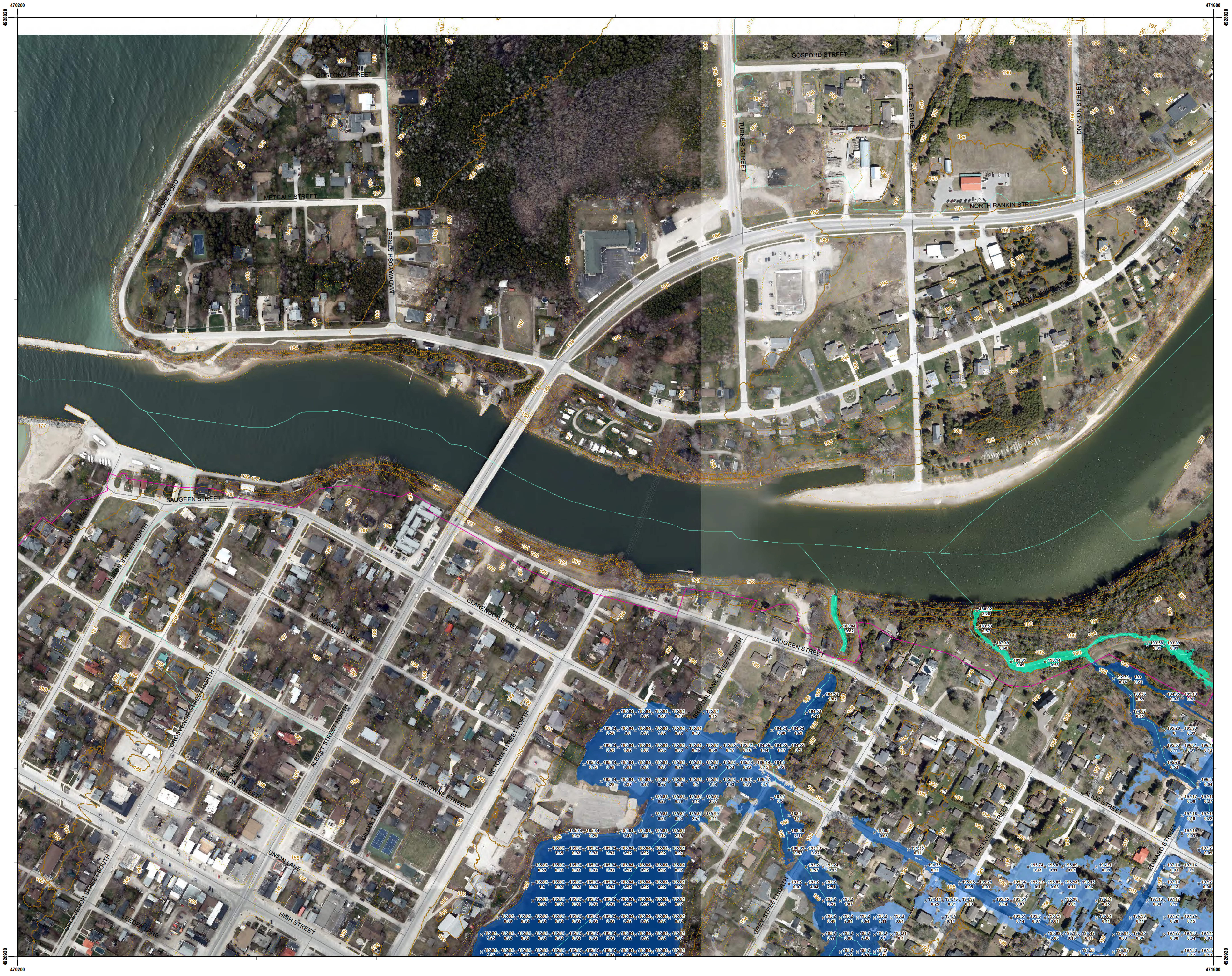
1 cm on the map represents 20 m on the ground

All measurements are in Metric.

Vertical Datum: Mean Sea Level (G.S.C.)
Horizontal Datum: North American Datum 1983 (NAD 83)
Projection: Universal Transverse Mercator
Zone: 17
Central Meridian: 81 West
Grid Spacing: 100 Meters

NOTES:
1. Floodlines were generated using a DEM derived from a LiDAR survey.
2. Where a discrepancy between the contours and the Floodlineis evident, the Floodline shall take precedence.
3. An additional topographic survey and professional expertise may be used to more precisely locate the Floodline on specific properties.



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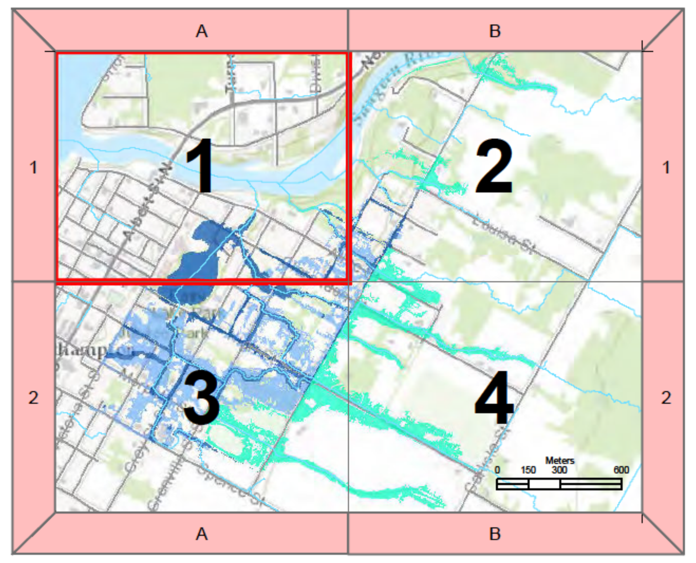

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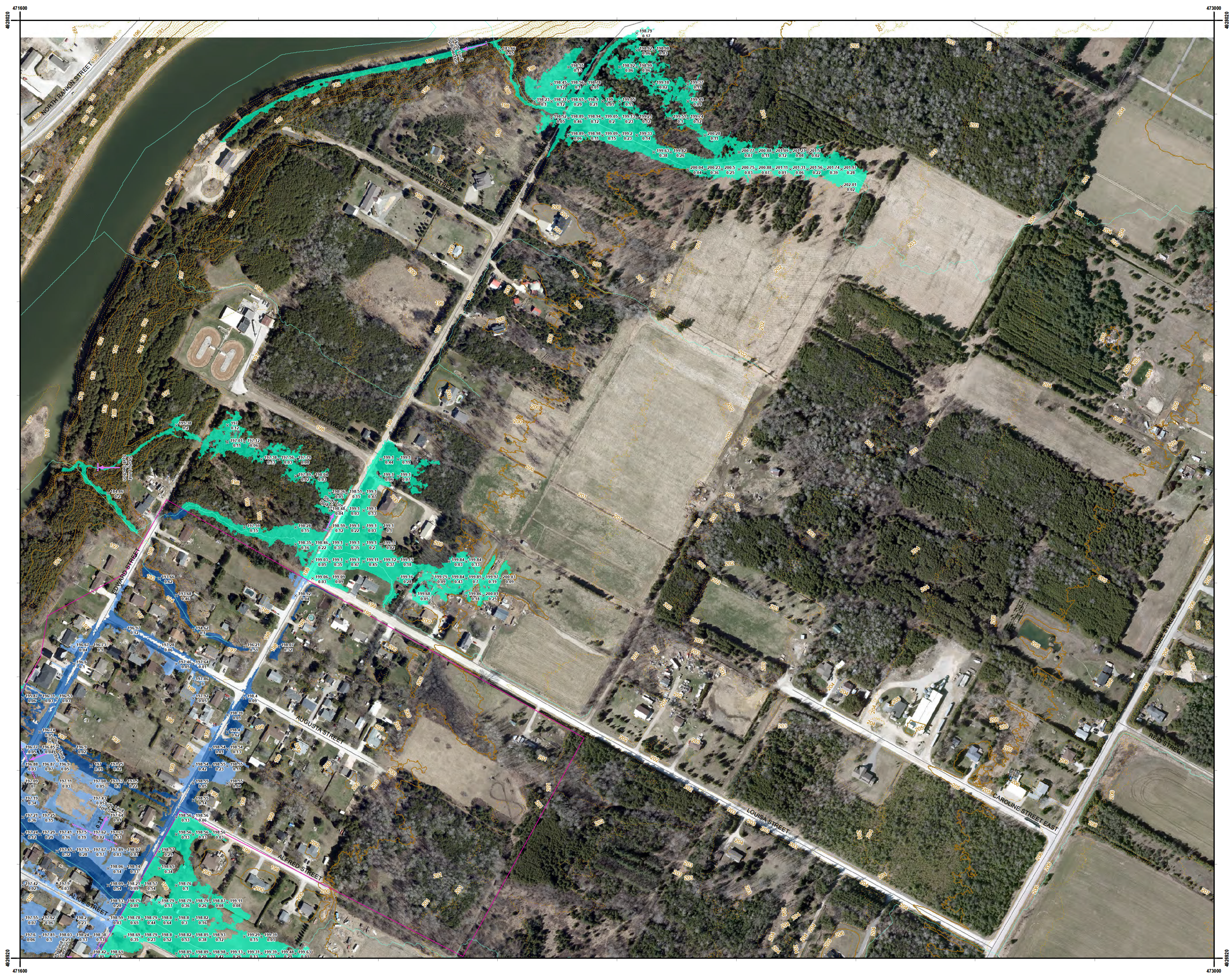

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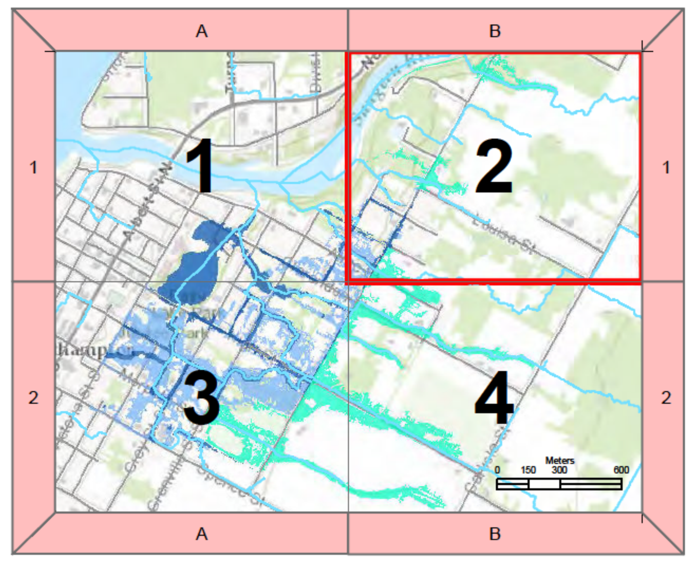

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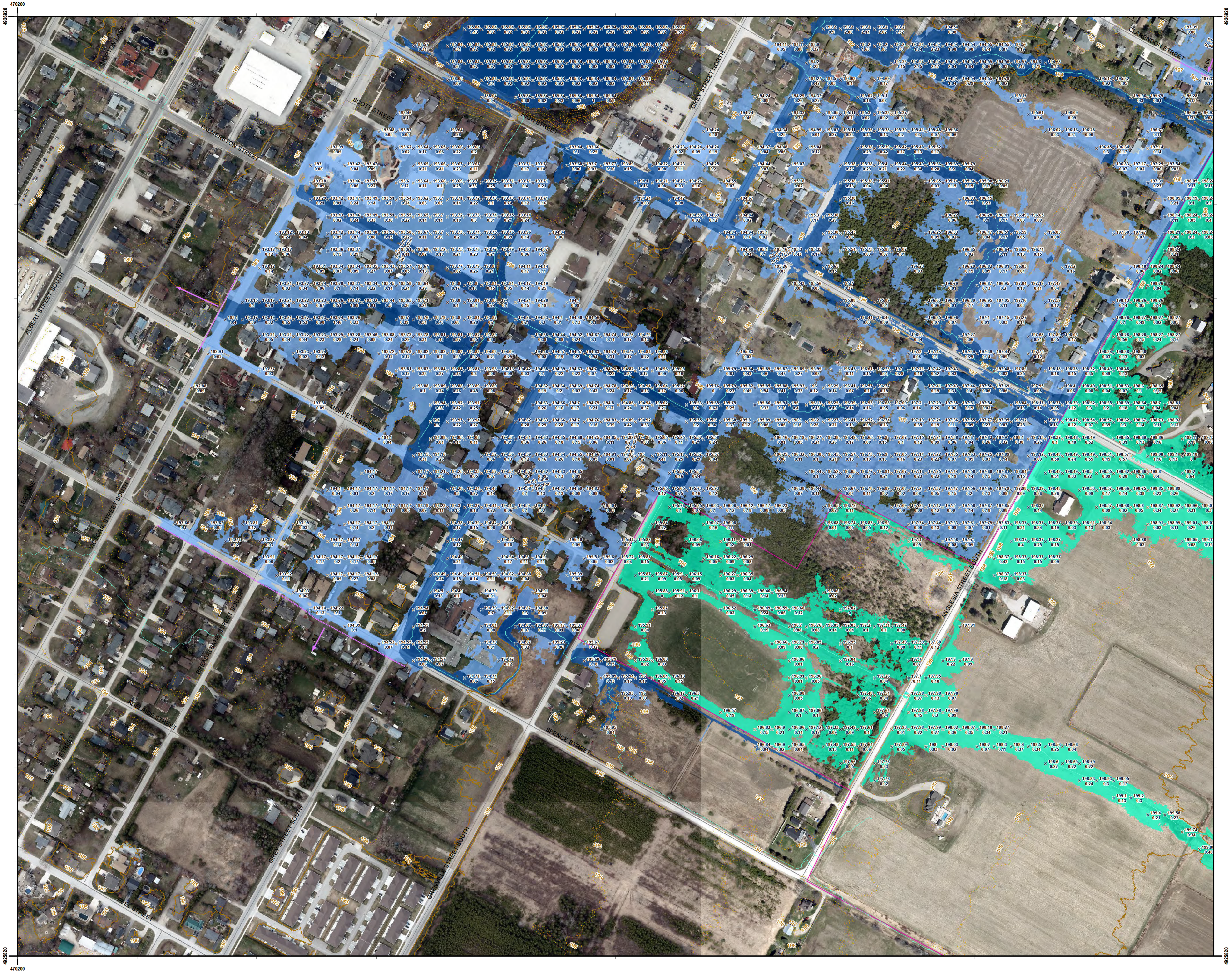

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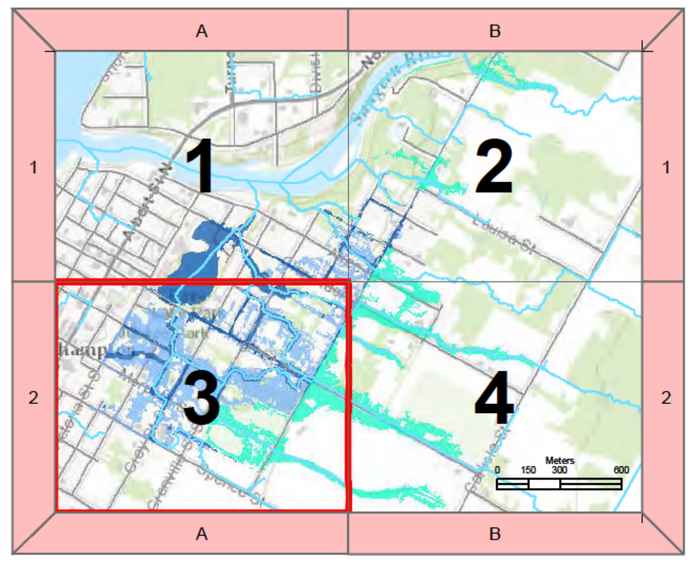

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LICENSED PROFESSIONAL ENGINEER J.D. HARTMAN 04 SEPT. 2025 PROVINCE OF ONTARIO

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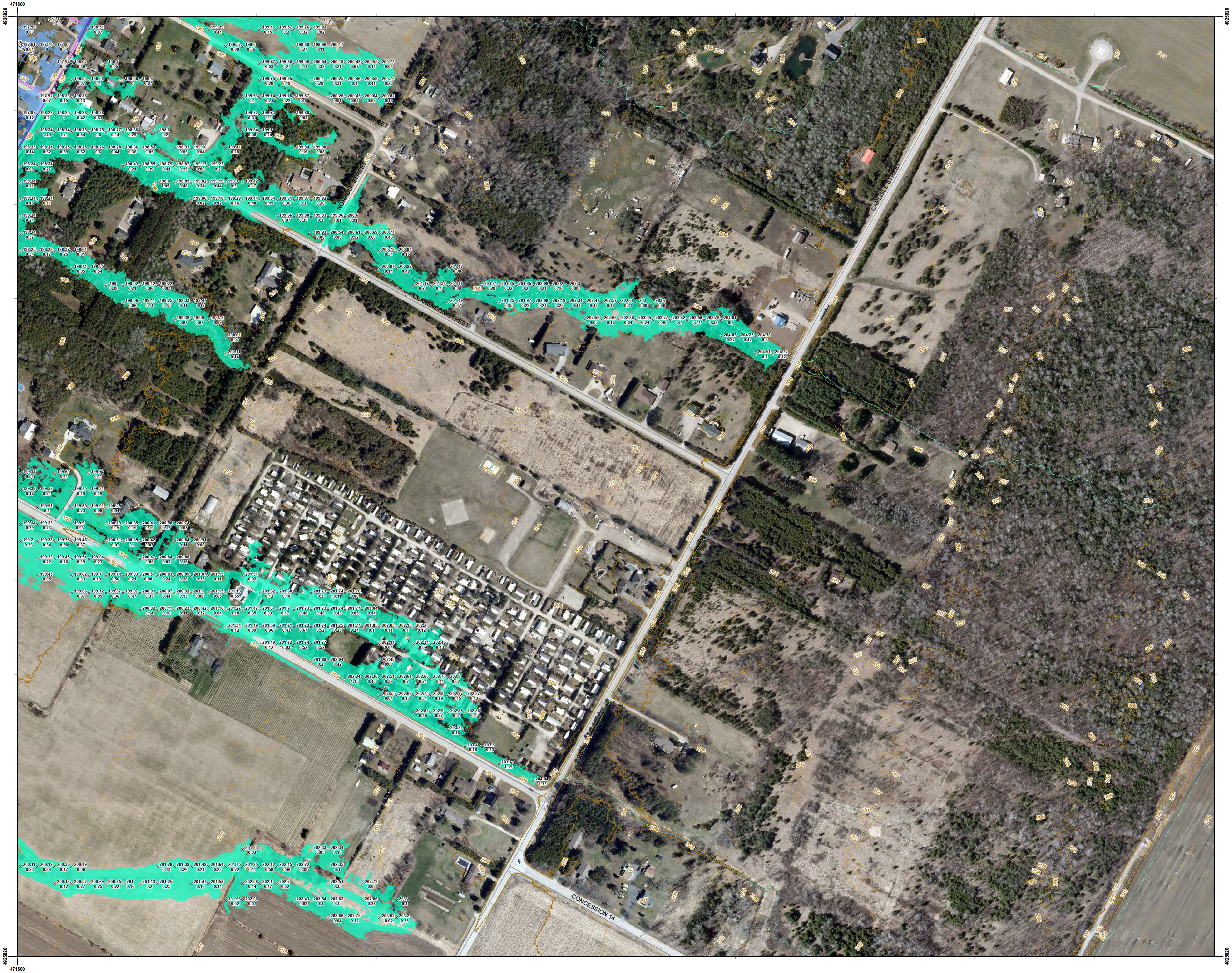

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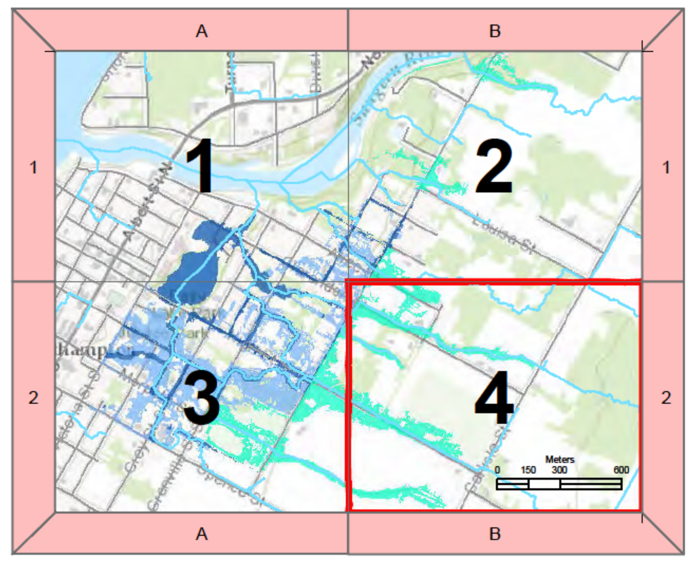

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- Rivers
- Roads
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- 2-Zone
- Hurricane Hazel Floodway
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Saugeen Shores

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Licensed Professional Engineer — Z. YANG — 100175525 — Sep. 04 2025 — Province of Ontario

Licensed Professional Engineer — J.D. HARTMAN — 04 SEPT. 2025 — Province of Ontario

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