

January 20, 2022

Project Number: 2089-21

Sunset Lakes Developments  
1705 Old Prescott Road  
Greely, ON  
K4P 1M6

**Attention: Dan Anderson**

**Subject: Catchment Divide Analysis & LiDAR Data Review**

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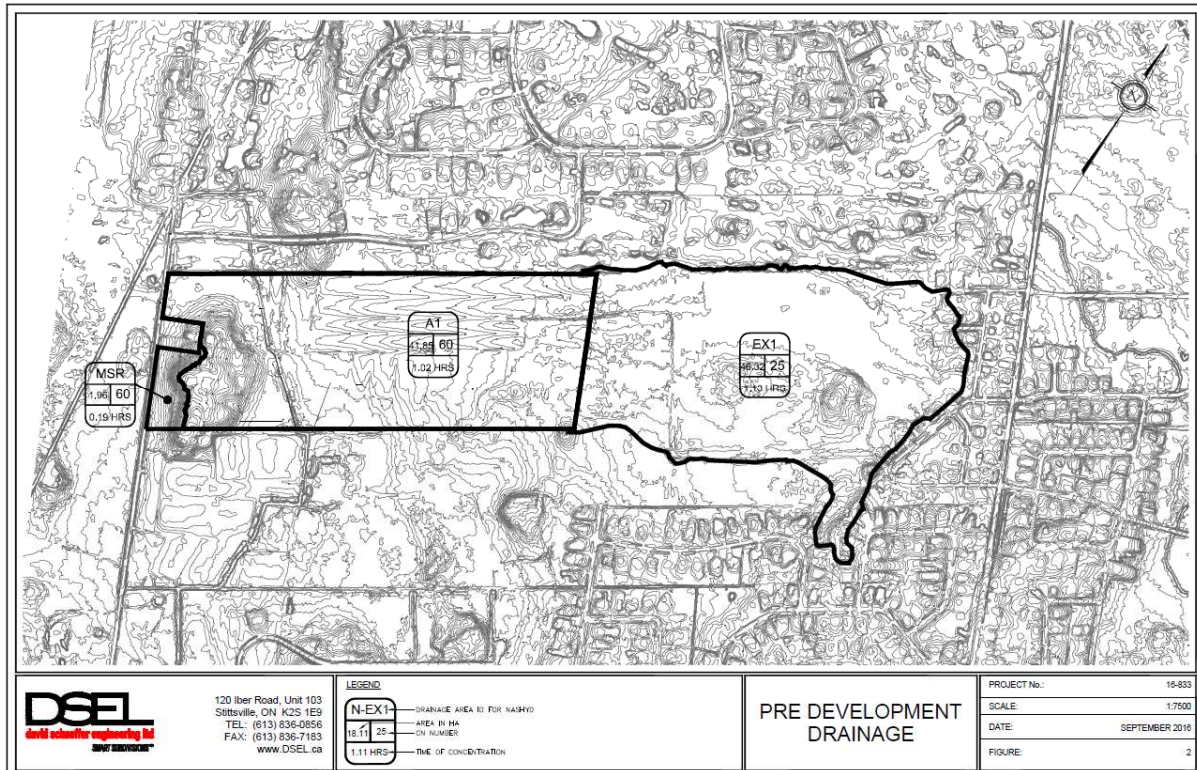
## Introduction

This memorandum has been prepared to support the delineation of an accurate catchment area divide for the subject area; located in and about 6544 Jack Pine Crescent in Greely, ON. This work is intended to utilize accurate site-specific elevation information in order to determine the localized sub-catchments on-site and indicate the general direction of flow across the subject property.

## Background Information

An application for development by way of subdivision is under review for the subject site. Municipal staff have noted the discrepancy between the watershed delineation as proposed in the stormwater management plan and, the existing documentation of surface water direction contained in the Grey's, Dancy and Osgoode Gardens Municipal Drains (MD) Engineer Reports. Specifically, the subdivision stormwater proposal directs all surface flows to the western edge of the site where they would outlet to a recently constructed drainage channel within a city-owned corridor, associated with the Emerald Links Phase III subdivision. This drainage corridor, and the upstream contributing area are described and approved through the registered plan of subdivision and associated ECA approval. These approvals are based on sizing the drainage corridor to accommodate the flows from the existing external catchment area that encompasses the subject site, and thus maintaining the existing watershed boundary between Grey's Creek and the Osgoode Garden MD. The approved Stormwater Management Report and Pond Design Brief for Emerald Links Phase III (DSEL, 2016-REV 4) states in section 1.1 "Existing conditions: External drainage area exists to the east of the property. The existing surface topography was prepared based on a combination of LIDAR data from the City of Ottawa in addition to site visits. It is anticipated that **46.32 ha** of external area is tributary to the site. See **Figure 1** below for existing drainage areas directed to Manotick Station Road, Grey's Creek Municipal Drain, and from the external area to the east.

Figure 1: Figure 2 from DSEL Emerald Links Ph.3 Report



The report goes on to say in section 3.2.2.2 “Post-development analysis was completed for the limits of development and external undeveloped area modeled in the pre-development analysis.” Further, that “A ditch system is proposed at the east edge of the property to convey flow from the external area around the site, bypassing the stormwater facility, eventually discharging to the GCMD”.

The external area is depicted in Figure 2 of the report, shown above. The undeveloped area is EX1, accounting for most of the subject site. An ECA (#1727-AR5UP6) was issued by MECPC for Emerald Links Phase III which includes “rear yard ditches: rear yard ditches to be constructed along the rear of Lot 11 to Lot 18, receiving run-off from the rear of Lots 11 to 18, designed to accommodate up to and including the 100-year return storm runoff from an internal catchment area of approximately 5.04 ha and an external area of 46.32 ha, discharging to Grey's Creek Municipal Drain.”

The existing Engineers Reports for Grey's Creek MD (1990) and Osgoode Gardens Cedar Acres MD (2001) indicate a catchment area dividing the subject property approximately down the middle, with flows splitting to the east and west. However, on-site observations and survey points from both the landowners, the consulting engineer and Ontario Land Surveyor do not conform with these records. Water on site was observed to only flow to the west. As such, J.F. Sabourin and Associates Inc. was retained to investigate and establish the watershed divide for the subject site.

It is noted that based on historic air photos of the site, the property has remained substantially undisturbed since 1976. The presence of dense and mature vegetation on site indicates that it is unlikely that the property was regraded, or elevations significantly changed since this time.

An initial watershed divide review to clarify the RVCA and SNCA watershed jurisdiction was prepared and provided by JFSA in December 2021, although it relied on older topographic data (LiDAR from 2015). This updated report is based on recently available LiDAR from Natural Resources Canada, which was acquired by the City of Ottawa in 2020. The findings of that initial investigation are not changed by this memo. The subdivision boundary has been refined based on this latest topographic data and additional site observations and survey points.

## Procedure

A cursory check of watercourses in the area was completed on the Ottawa geoportal and South Nation Conservation Authority mapping tool and identified the following watercourses as potential outlets:

- Grey's Creek Municipal Drain: tributary to Middle Castor River
- Osgoode Gardens Municipal Drain: tributary to North Castor River

The relationship between the subject site and these two municipal drains is displayed in **Figure 2**.

Using the City of Ottawa's latest available LiDAR mapping (1m DEM, 2020), the drainage area to each receiver (municipal drain) was determined by the application of watershed delineation tools using GIS software. The GIS software uses a raster-based approach to calculating drainage areas, where each cell is assigned an elevation and the subsequent flow paths are calculated by finding the lowest elevation cell adjacent to the original cell. The drainage areas derived by this process were then verified manually and refined using contour mapping.

The GIS analysis was augmented by the collection of on-site survey points along road crowns and culvert inverts and obverts on Jack Pine Crescent and White Oak Drive by ARK Engineering. This survey identified a high point at the intersection of Jack Pine Crescent and White Oak Drive that would impede normal flow from the site to the east, to Stagecoach Road.

## Results

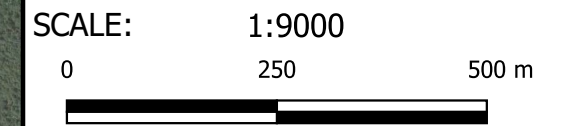
The results of the analysis are visually displayed in **Figure 3**. Three sub-watersheds were identified which drain towards the west, ultimately out letting to Greys Creek Municipal Drain. No portion of the subject site has flows draining to the Osgoode Gardens Municipal Drain, despite the boundaries indicated by the Municipal Drain Engineers Reports. We note that the area where this correction occurs is through the middle of the site where grades are quite flat. Additional scrutiny on site and in the data supports the findings of this report, however it is understandable how the older MD Engineer Reports would struggle to refine this divide in the area.





**Legend**

- - - Site Boundary
- Watercourses



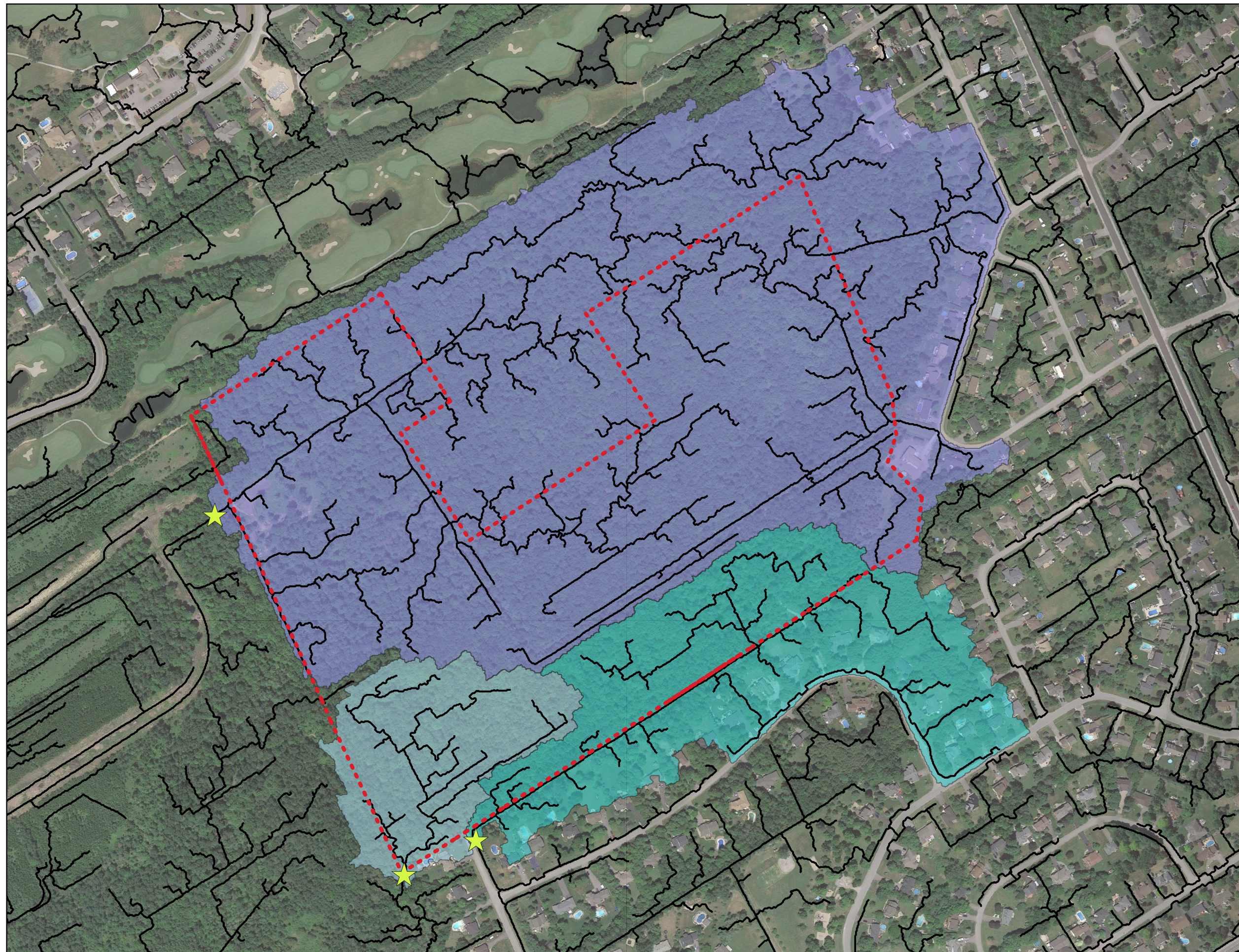
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Figure 2: Location of Significant Municipal Drains

|         |            |
|---------|------------|
| PROJECT | 2089-21    |
| DRAWN   | TE         |
| DATE    | 11-01-2022 |

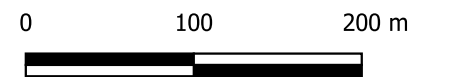




**Legend**

- - - Site Boundary
- Low Points
- ★ Outlet Points
- Greys Creek North
- Greys Creek Mid
- Greys Creek South

SCALE: 1:4500



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Figure 3: Drainage Delineation - 2020  
 LiDAR

|         |            |
|---------|------------|
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| DRAWN   | TE         |
| DATE    | 11-01-2022 |



## LiDAR Data Review

The catchment analysis was based on the 2020 LiDAR data. LiDAR data directly affects the accuracy of the simulated drainage catchments, it is paramount to have confidence in the elevation data used. Therefore, JFSA completed an analysis to ensure that the LiDAR data applied in this topographic analysis is dependable.

JFSA acquired LiDAR data flown in 2020 from Natural Resources Canada (NRC) on December 8<sup>th</sup>, 2021. Two (2) tiles were obtained, with each tile providing 10 km x 10 km of coverage at a resolution of 1 m. **Figure 4** outlines the extent and location of the LiDAR data obtained. JD Barnes Limited completed a topographical boundary survey of the subject lands in March 2021. The majority of points collected by JD Barnes were boundary markers and therefore did not establish the true ground elevation. However, the survey did establish geodetic benchmarks for on-site work.

Using the JD Barnes survey markers as benchmarks, ARK engineering completed a survey of proposed road centerlines, at actual ground surface elevations, in March of 2021. The area surveyed overlapped with elevation data from one (1) of the LiDAR tiles. JFSA undertook a comparison between the spot elevations obtained from the ARK Engineering survey and the elevations obtained from the 2020 LiDAR at the same locations. Attachment A contains the elevation differences for all points in the analysis, with a visual representation of the results provided in **Figure 5**.

JFSA completed a statistical analysis of the difference between the two data sets. Error! Reference source not found. is a summary of this analysis and **Error! Reference source not found.** is the difference distribution, indicating the percentage of points that fall within given accuracy ranges.

**Table 1: Statistical Analysis of LiDAR to Survey Elevation difference**

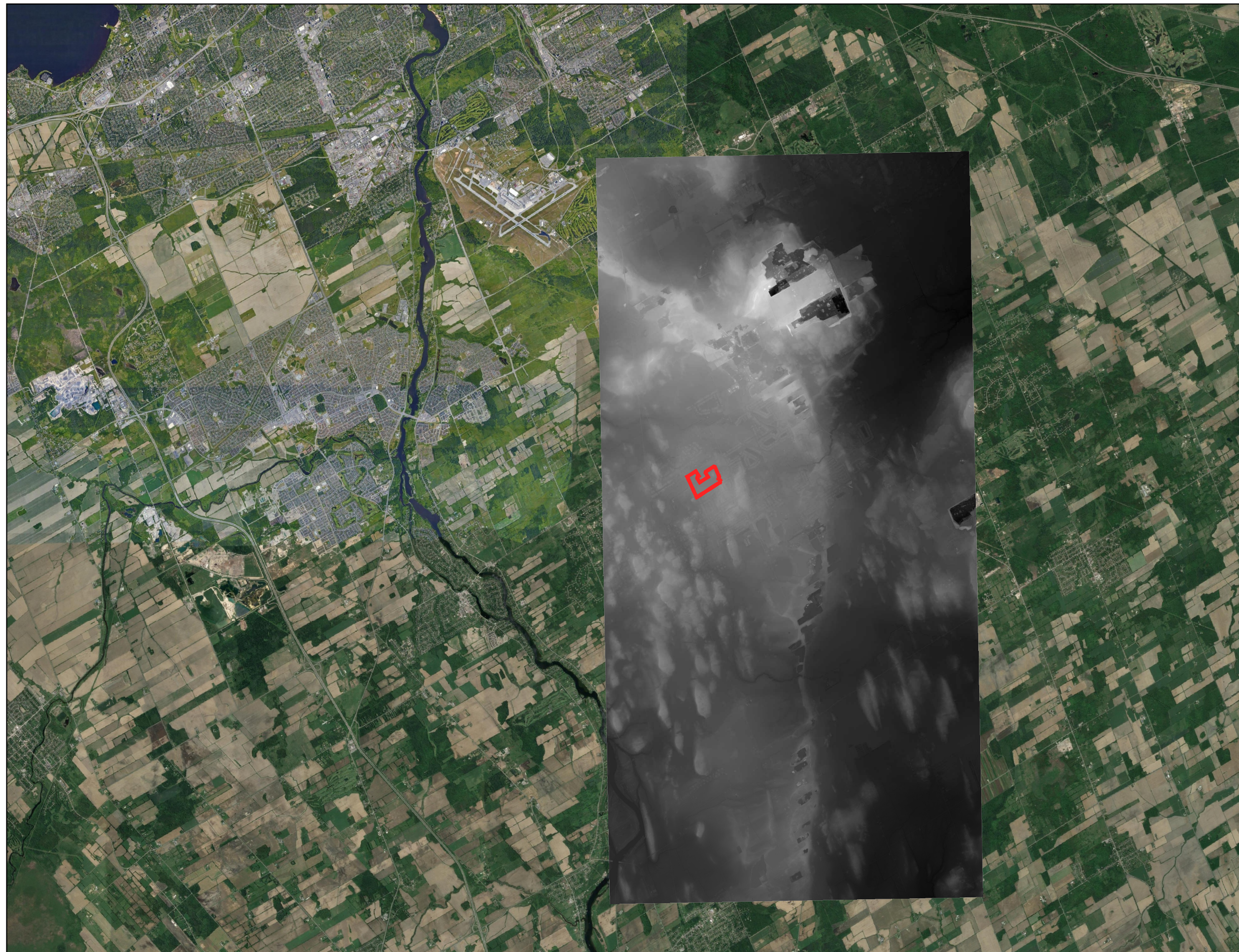
| Statistical Analysis          | (m)   |
|-------------------------------|-------|
| Average Difference            | -0.34 |
| Max + Difference              | 0.70  |
| Max - Difference              | -0.84 |
| 1 Standard deviation (68%)    | 0.25  |
| 2 Standard deviations (95%)   | 0.49  |
| 3 Standard deviations (99.7%) | 0.74  |

\*Note: negative values indicate that the LiDAR elevations are lower than the field survey and vice versa.

**Table 2: Elevation Difference Distribution Summary**

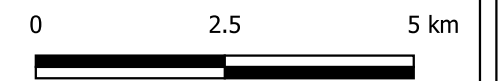
| Elevation Difference | % Of Total Points |
|----------------------|-------------------|
| ± 5 cm               | 5.6%              |
| ± 10 cm              | 9.3%              |
| ± 25 cm              | 24.1%             |
| ± 50 cm              | 81.5%             |
| ± 75 cm              | 94.4%             |
| ±100 cm              | 100%              |






— Site Boundary

SCALE: 1:100000



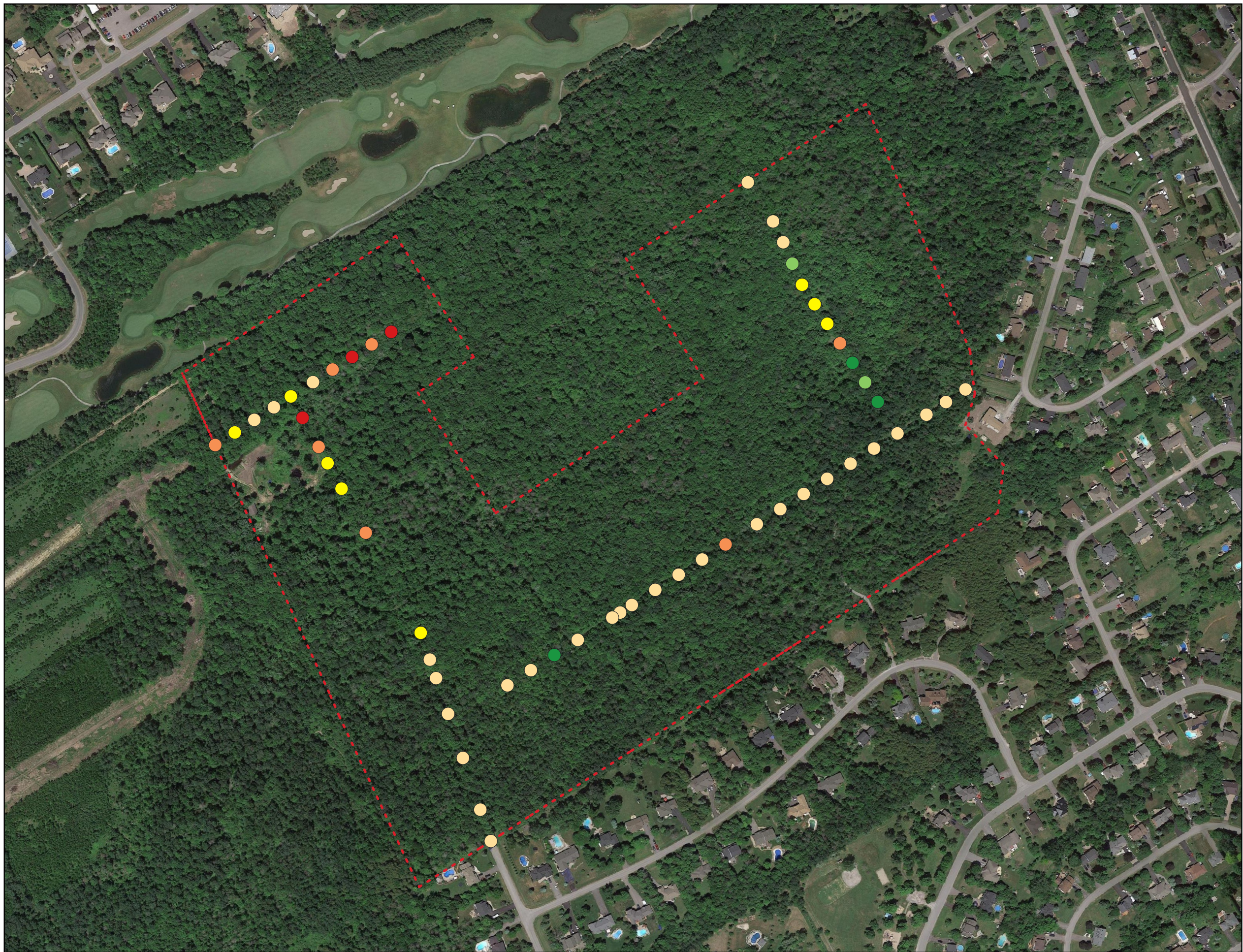

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Figure 4: LiDAR Tiles

|         |            |
|---------|------------|
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| DATE    | 10-12-2021 |

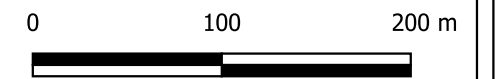




**Legend**

- ± 5 cm
- ± 10 cm
- ± 25 cm
- ± 50 cm
- ± 75 cm
- ± 100 cm
- - - Site Boundary

SCALE: 1:4000



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Figure 5: Elevation Difference LiDAR & Survey

|         |            |
|---------|------------|
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| DRAWN   | TE         |
| DATE    | 21-12-2021 |



This analysis found that the average difference between the LiDAR and Survey was -34cm with 81.5% of all applicable points within  $\pm 50$ cm of the LiDAR value. Upon closer investigation of the data, the variation between the survey and LiDAR elevations was determined to be the result of systematic error rather than random error. The most likely cause of this discrepancy is due to differences in the vertical datum used between the survey data and the LiDAR data.

The 2020 LiDAR released by NRC was the first LiDAR dataset to use the new Canadian Geodetic Vertical Datum of 2013 (CGVD2013), which is now the new standard for heights across Canada. This vertical datum is based on changes to the height reference system from CGVD28 to CGVD2013. NRC released a guide to the *Heights Reference System Modernization (2020)* which provides guidance on how to approach systematic differences of the new vertical datum:

- Pg 11 states that: “the difference between benchmarks on previous GNSS models and the new CGVD2013 model varies from a minimum of -0.678 metres to a maximum of 0.349 metres, with an average of -0.157 metres”.
- Pg 6 states: “those who transfer heights with precision of less than 2 cm over small regions (e.g. municipal infrastructure). For these users, the difference between CGVD28 and CGVD2013 should be considered, but generally applying a constant offset will suffice”.

The height difference we found (-0.34 metres), lies within the range specified by NRC. Based upon the guidance document we have determined it is appropriate to use a constant offset to adjust the LiDAR upwards by 0.34 metres. Undertaking this adjustment found that 42.6% of all points were within  $\pm 10$ cm and 75.9% of all applicable points were within  $\pm 25$  cm of the adjusted LiDAR values. Given the level of vegetation present at this location, JFSA believes that this is a reasonable and acceptable degree of variation between the two data sets. **Table 3** is the difference distribution of the adjusted values, indicating the percentage of points that fall within given accuracy ranges. A visual representation of the adjusted elevation points is provided in **Figure 6**.

Table 3: Adjusted Elevation Difference Distribution Summary

| Elevation Difference | % Of Total Points |
|----------------------|-------------------|
| $\pm 5$ cm           | 20.4%             |
| $\pm 10$ cm          | 42.6%             |
| $\pm 25$ cm          | 75.9%             |
| $\pm 50$ cm          | 96.3%             |
| $\pm 75$ cm          | 98.1%             |
| $\pm 100$ cm         | 98.1%             |

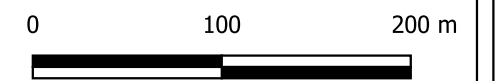




**Legend**

- ± 5 cm
- ± 10 cm
- ± 25 cm
- ± 50 cm
- ± 75 cm
- ± 100 cm
- - - Site Boundary

SCALE: 1:4000



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Figure 6: Adjusted Elevation Difference  
 LiDAR & Survey

|         |            |
|---------|------------|
| PROJECT | 2089-21    |
| DRAWN   | TE         |
| DATE    | 22-12-2021 |



## Summary

The results of the catchment area analysis indicate that the entire site drains to the west to Greys Creek Municipal Drain. This finding is based on current site-specific survey and LiDAR topographic data. The drainage divide recorded in municipal drainage documents should be revised to reflect this refined catchment area information.

This watershed divide was based in a large part upon the 2020 LiDAR data obtained from Natural Resources Canada on December 8<sup>th</sup>, 2021. JFSA verified and reviewed the LiDAR data using survey points collected on-site by ARK Engineering. Although a systematic difference in elevation was found, it was determined to be appropriate to adjust the LiDAR elevations by applying a constant offset of 34 cm due to a discrepancy between vertical datums in the two datasets. Based on the adjusted LiDAR elevations, JFSA is confident that the LiDAR data obtained reflects the surveyed ground surface, and that the drainage area divide provided in this analysis is reflective of real-world conditions.

### J.F Sabourin and Associates Inc.



Tim Eisner, M.Pl., LEED Green Associate  
Planner, JFSA

Reviewed By:



Jonathon Burnett, B.Eng., P.Eng.  
Water Resources Engineer



### Tables

- Table 1: Statistical Analysis of LiDAR to Survey Elevation difference
- Table 2: Elevation Difference Distribution Summary
- Table 3: Adjusted Elevation Difference Distribution Summary

### Figures

- Figure 1: Figure 2 from DSEL Emerald Links Ph.3 Report
- Figure 2: Location of Significant Municipal Drains
- Figure 3: Drainage Delineation- 2020 LiDAR
- Figure 4: LiDAR Tiles
- Figure 5: Elevation Difference LiDAR & Survey
- Figure 6: Adjusted Elevation Difference LiDAR & Survey

### Attachments

- Attachment A: Point Evaluation Comparison

## Documents Referenced

Natural Resources Canada (2020) *Height Reference System Modernization*. Published by the Government of Canada.

[https://www.nrcan.gc.ca/sites/nrcan/files/files/pdf/Height\\_reference\\_system\\_modernization\\_\(EN\).pdf](https://www.nrcan.gc.ca/sites/nrcan/files/files/pdf/Height_reference_system_modernization_(EN).pdf)



# Attachment A

## Point Evaluation Comparison



Attachment A: Point Evaluation Comparison

| [1]<br>Point ID | [2]<br>X<br>(MTM 9) | [3]<br>Y<br>(MTM 9) | [4]<br>2020-LiDAR<br>Elevation<br>(m) | [5]<br>Survey<br>Elevation<br>(m) | [6]<br>(4-5)<br>Elevation<br>Difference<br>(m) |
|-----------------|---------------------|---------------------|---------------------------------------|-----------------------------------|--|
| 1               | 375020.9264         | 5013172.14          | 101.69                                | 102.50                            | -0.81  |
| 2               | 374999.9012         | 5013158.615         | 101.77                                | 102.45                            | -0.68  |
| 3               | 374978.8753         | 5013145.09          | 101.72                                | 102.50                            | -0.78  |
| 4               | 374957.8501         | 5013131.565         | 101.82                                | 102.43                            | -0.61  |
| 5               | 374936.8242         | 5013118.04          | 101.85                                | 102.15                            | -0.30  |
| 6               | 374913.0109         | 5013102.722         | 102.05                                | 102.20                            | -0.15  |
| 7               | 374894.7732         | 5013090.99          | 101.96                                | 102.43                            | -0.47  |
| 8               | 374873.7479         | 5013077.465         | 102.48                                | 102.88                            | -0.40  |
| 9               | 374852.7221         | 5013063.94          | 102.41                                | 102.58                            | -0.17  |
| 10              | 374831.6968         | 5013050.414         | 102.18                                | 102.80                            | -0.62  |
| 11              | 374925.6495         | 5013079.708         | 101.56                                | 102.40                            | -0.84  |
| 12              | 374942.8442         | 5013048.397         | 101.93                                | 102.56                            | -0.63  |
| 13              | 374952.4714         | 5013030.867         | 102.17                                | 102.36                            | -0.19  |
| 14              | 374967.5127         | 5013003.478         | 102.03                                | 102.24                            | -0.21  |
| 15              | 374993.5088         | 5012956.141         | 101.94                                | 102.49                            | -0.55  |
| 16              | 375052.601          | 5012848.538         | 102.47                                | 102.70                            | -0.23  |
| 17              | 375062.4353         | 5012819.712         | 102.57                                | 102.86                            | -0.29  |
| 18              | 375069.1237         | 5012799.809         | 102.55                                | 102.83                            | -0.28  |
| 19              | 375082.0336         | 5012761.396         | 102.55                                | 102.85                            | -0.30  |
| 20              | 375097.9581         | 5012714.004         | 102.11                                | 102.38                            | -0.27  |
| 21              | 375127.9911         | 5012624.633         | 101.76                                | 102.08                            | -0.32  |
| 22              | 375116.6566         | 5012658.362         | 101.66                                | 101.95                            | -0.29  |
| 23              | 375171.0331         | 5012808.348         | 102.70                                | 102.97                            | -0.27  |
| 24              | 375145.8341         | 5012792.068         | 102.59                                | 102.96                            | -0.37  |
| 25              | 375196.236          | 5012824.621         | 102.97                                | 103.00                            | -0.03  |
| 26              | 375221.4344         | 5012840.901         | 102.66                                | 102.97                            | -0.31  |
| 27              | 375413.9467         | 5012965.272         | 102.23                                | 102.66                            | -0.43  |
| 28              | 375380.3477         | 5012943.568         | 102.14                                | 102.66                            | -0.52  |
| 29              | 375355.1487         | 5012927.288         | 102.15                                | 102.60                            | -0.45  |
| 30              | 375304.7507         | 5012894.73          | 102.29                                | 102.75                            | -0.46  |
| 31              | 375279.5511         | 5012878.452         | 102.39                                | 102.72                            | -0.33  |
| 32              | 375266.9519         | 5012870.312         | 102.38                                | 102.78                            | -0.40  |
| 33              | 375258.5519         | 5012864.886         | 102.38                                | 102.82                            | -0.44  |
| 34              | 375329.9497         | 5012911.009         | 102.20                                | 102.64                            | -0.44  |
| 35              | 375539.9423         | 5013046.667         | 102.13                                | 102.58                            | -0.45  |
| 36              | 375514.7433         | 5013030.388         | 102.23                                | 102.66                            | -0.43  |
| 37              | 375489.5443         | 5013014.109         | 102.31                                | 102.77                            | -0.46  |
| 38              | 375464.3447         | 5012997.831         | 102.38                                | 102.78                            | -0.40  |



Attachment A: Point Evaluation Comparison

| [1]<br>Point ID | [2]<br>X<br>(MTM 9) | [3]<br>Y<br>(MTM 9) | [4]<br>2020-LiDAR<br>Elevation<br>(m) | [5]<br>Survey<br>Elevation<br>(m) | [6]<br>(4-5)<br>Elevation<br>Difference<br>(m) |
|-----------------|---------------------|---------------------|---------------------------------------|-----------------------------------|--|
| 39              | 375439.149          | 5012981.547         | 102.34                                | 102.72                            | -0.38  |
| 40              | 375638.302          | 5013110.211         | 102.38                                | 102.74                            | -0.36  |
| 41              | 375617.3028         | 5013096.645         | 102.22                                | 102.69                            | -0.47  |
| 42              | 375596.3035         | 5013083.079         | 102.25                                | 102.60                            | -0.35  |
| 43              | 375565.1413         | 5013062.946         | 102.22                                | 102.64                            | -0.42  |
| 44              | 375516.8309         | 5013138.812         | 103.71                                | 103.73                            | -0.02  |
| 45              | 375489.6822         | 5013180.8           | 105.27                                | 105.50                            | -0.23  |
| 46              | 375503.2565         | 5013159.806         | 104.86                                | 104.16                            | 0.70   |
| 47              | 375543.9794         | 5013096.825         | 102.58                                | 102.56                            | 0.02   |
| 48              | 375530.4052         | 5013117.819         | 103.15                                | 103.08                            | 0.07   |
| 49              | 375462.5336         | 5013222.787         | 103.52                                | 103.68                            | -0.16  |
| 50              | 375476.1079         | 5013201.794         | 104.55                                | 104.66                            | -0.11  |
| 51              | 375452.0997         | 5013245.445         | 103.00                                | 102.91                            | 0.09   |
| 52              | 375442.3508         | 5013268.466         | 102.09                                | 102.38                            | -0.29  |
| 53              | 375431.3973         | 5013290.848         | 101.93                                | 102.30                            | -0.37  |
| 54              | 375404.264          | 5013332.845         | 101.92                                | 102.25                            | -0.33  |