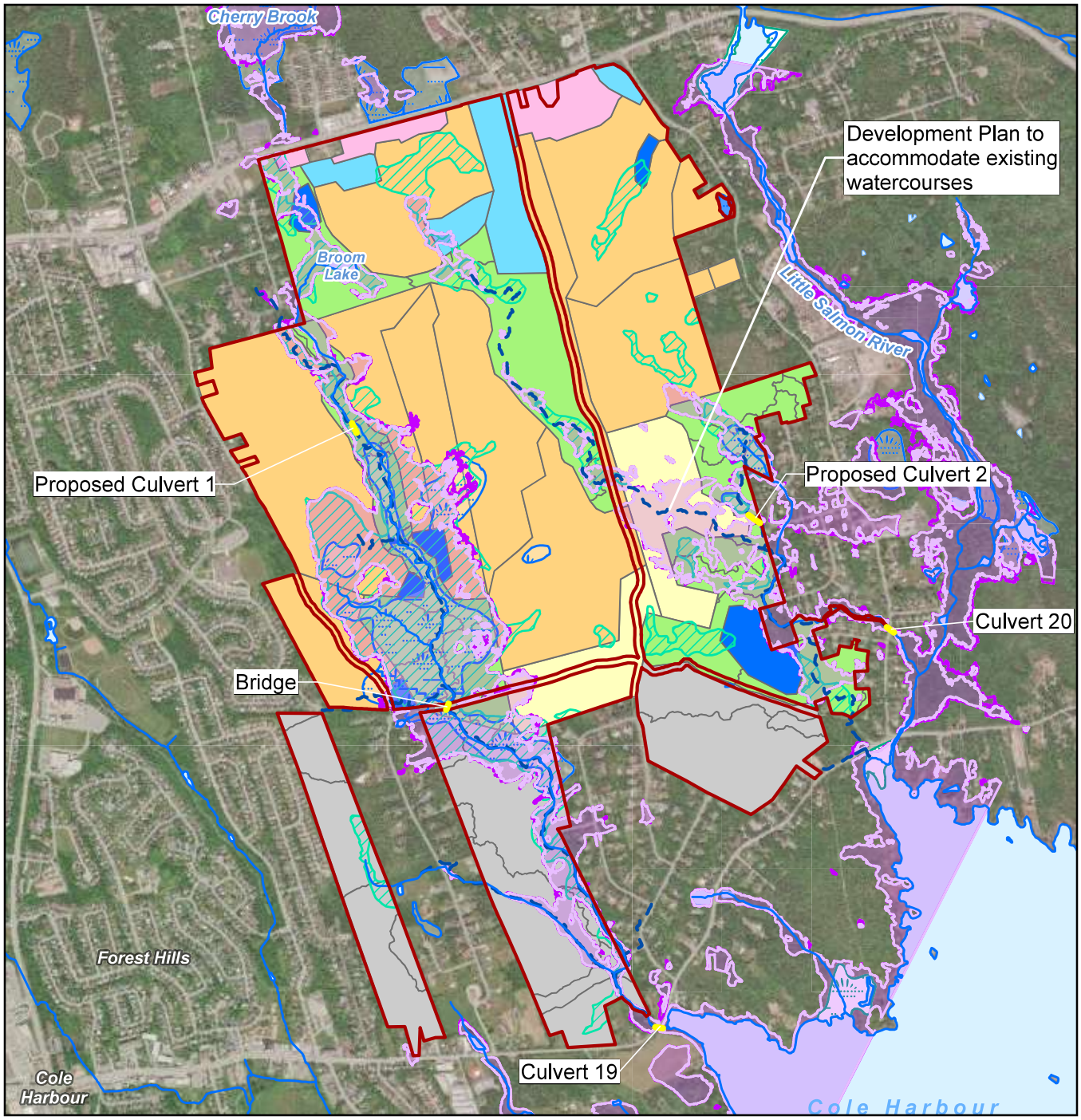
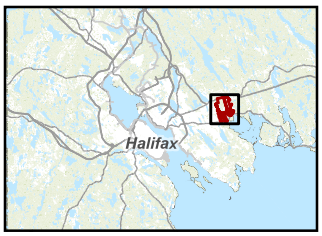




Notes
1. Coordinate System: NAD 1983 CSRS UTM Zone 20N
2. Data Sources: Stantec, Government of Nova Scotia, Department of Service Nova Scotia and Internal Services; Government of Nova Scotia, Department of Environment and Climate Change.
3. Background: ESRI; Government of Nova Scotia, Department of Service Nova Scotia and Internal Services.

Legend
- Study Area
- Culvert
- 20yr Flood Extent (Draft, HRM 2023)
- 100yr Flood Extent (Draft, HRM 2023)

Land Use
- Institutional
- Low Residential
- High Residential
- Mixed Use / Commercial
- Green Space
- Pond
- Future Vacant Parcel

Wetlands and Waterways
- Waterway
- Waterway (Stantec, LiDAR-delineated)
- Waterbody
- Designated Wetland of Special Significance
- Wetland
- Wetlands (Stantec, 2023)

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(At original document size of 8.5x11)
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Stantec

Project Location
Halifax Regional Municipality, Nova Scotia

Prepared by HB on 2024-02-13
Revised by AC on 2024-10-24

Client/Project 160410459
Halifax Regional Municipality
Future Serviced Communities
Westphal Stormwater Management Plan

Figure No.
9.1

Title
Conceptual Development and Culvert Locations

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Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

9.5 Stormwater Management Strategy

Urbanization inevitably leads to changes in the landscape and as such, in order to successfully implement development plans that result in balanced and environmentally sustainable development, it is key to devise an effective management strategy. This section provides a general description of stormwater management measures which, when combined, form a comprehensive approach to stormwater management in order to meet established SWM criteria and protect the surrounding natural environment.

Following discussions with HRM and HW, it was agreed that quantity control measures would be implemented to limit post-development peak flows to pre-development levels up to the 100-year storm. It is therefore recommended that quantity control measures in the form of end-of-pipe stormwater management (SWM) dry ponds be implemented at key locations within the proposed development area to mitigate post development peak flows to pre-development levels.

The current SWM pond locations are conceptual (i.e., not an approved plan) and subject to change based on results of more detailed analysis as the development plan progresses. The SWM ponds should be located outside of the floodplain based on existing topography and proposed grading to restrict post development peak flows to existing conditions levels. Urbanization typically alters the water balance, leading to increased runoff and decreased infiltration, primarily due to increased impervious surfaces associated with urban development. In addition, urbanization usually results in increased sediment and phosphorus loading in receiving watercourses. Retaining native and existing ground cover should be prioritized where possible to preserve ecosystem service function, reduce volume of runoff discharged into watercourses, promote infiltration, and provide an opportunity for evapotranspiration. Where retaining native cover is not possible, it is recommended that a treatment train approach consisting of lot level best management practices (BMPs), such as directing residential roof runoff to vegetated surfaces, introducing vegetated swales, and low impact development (LID) measures such as infiltration trenches, bioswales, etc., be investigated at the detailed design stage to provide quality control of runoff prior to discharging into the receiving watercourses and to promote infiltration.

Please refer to **Section 6** for mitigation recommendations to reduce phosphorus (P) loading, *E. coli* loading and sediment loading from the WSA and achieve contaminant loads of existing conditions.

To reduce annual Total P load to the watershed, future development scenarios must consider implementing a combination of measures such as a street maintenance program to remove sediment-associated P from roadways and catch basins, along with the implementation of Low Impact Development (LID) measures to reduce loading.

The implementation of LID measures within the future developments would also aid in the removal of fecal coliform through sedimentation.

Erosion and sedimentation control measures are recommended during construction of all future developments to mitigate sediment loadings into the receiving water bodies.

Table 9.2, taken from the Credit Valley Conservation Low Impact Development Stormwater Management Planning and Design Guide (CVC, 2010, Table 3.4.1), provides a comparison of site constraints for a variety of structural LID SWM practices.

Table 9.2 Comparison of Site Constraints for a Range of Structural LID SWM Practices

LID Stormwater Management Practice	Depth to high water table or bedrock[1] (m)	Typical Ratio of Impervious Drainage Area to Treatment Facility Area	Native Soil Infiltration Rate (mm/hr)[3]	Head[4] (m)	Space[5] %	Slope[6] %	Pollution Hot Spots[7]	Setbacks[8]
Rain barrel	N/A	[5 to 50 m^2][2]	N/A	1	0	N/A	Yes	None
Cistern	1	[50 to 3000 m^2][2]	N/A	1 to 2	0 to 1	N/A	Yes	U, T
Green roof	N/A	1:1	N/A	0	0	0	Yes	None
Roof downspout disconnection	N/A	[5 to 100 m^2][2]	Amend if < 15 mm/hr[9]	0.5	5 to 20	1 to 5	Yes	B
Soakaway, infiltration trench or chamber	1	5:1 to 20:1	Not a constraint	1 to 2	0 to 1	< 15%	No	B, U, T, W
Bioretention	1	5:1 to 15:1	Underdrain required if < 15 mm/hr	1 to 2	5 to 10	0 to 2	No	B, U, W
Biofilter (filtration only Bioretention design)	N/A	5:1	N/A	1 to 2	2 to 5	0 to 2	Yes	B, T
Vegetated filter strip	1	5:1	Amend if < 15 mm/hr[9]	0 to 1	15 to 20	1 to 5	No	None
Permeable pavement	1	1:1 to 1.2:1	Underdrain required if < 15 mm/hr	0.5 to 1	0	1 to 5	No	U, W
Enhanced grass swale	1	5:1 to 10:1	N/A	1 to 3	5 to 15	0.5 to 6	No	B, U
Dry swale	1	5:1 to 15:1	Underdrain required if < 15 mm/hr	1 to 3	5 to 10	0.5 to 6	No	B, U, W
Perforated pipe system	1	5:1 to 10:1	Not a constraint	1 to 3	0	< 15%	No	B, U, T, W

Notes:
1. Minimum depth between the base of the facility and the elevation of the seasonally high water table or top of bedrock.
2. Values for rain barrels, cisterns and roof downspout disconnection represent typical ranges for impervious drainage area treated.
3. Infiltration rate estimates based on measurements of hydraulic conductivity under field saturated conditions at the proposed location and depth of the practice.
4. Vertical distance between the inlet and outlet of the LID practice.
5. Percent of open pervious land on the site that is required for the LID practice.
6. Slope at the LID practice location.
7. Suitable in pollution hot spots or runoff source areas where land uses or activities have the potential to generate highly contaminated runoff (*e.g.*, vehicle fueling, servicing or demolition areas, outdoor storage or handling areas for hazardous materials and some heavy industry sites).
8. Setback codes: B = Building foundation; U = Underground utilities; T = Trees; W = drinking water wellhead protection areas.
9. Native soils should be tilled and amended with compost to improve infiltration rate, moisture retention capacity and fertility.

For the Westphal Study Area, which is underlain by sandy to clay loam soils and the Taylors Head and Beaverbank Formations, several LIDs are worth considering:

- Bioretention Cells and Rain Gardens are designed to imitate natural water cycles and are effective in removing various contaminants from runoff, while also reducing its volume and intensity;
- Permeable Pavements allow stormwater to seep through into a stone reservoir for temporary storage or infiltration;
- Vegetated Filter Strips and Swales are designed to process and reduce runoff from nearby impervious surfaces; and,
- Tree Plantings and Native Plantings can help absorb stormwater, decrease runoff, and enhance water quality.

However, the specific selection, design, and location of these LIDs should be further investigated during the detailed design stage. The assessment should take into account factors such as the infiltration capability of the native soils, the depth to bedrock, the depth to groundwater table, and local regulations. It should also be noted that LID measures that impact the overall drainage plan should be located within the right of way owned by the Municipality, since practices located at the lot level could be modified by property owners impacting the performance of the overall storm drainage plan.

10 Hydrologic and Hydraulic Modelling

The following sections provide a comprehensive overview of the conceptual stormwater management plan for the Westphal Study Area developer-proposed concept plan, including outlining measures required to restrict post-development peak flows to pre-development values, identifying flood risk areas, and summarizing the limitations associated with the modelling process.

This section provides a high-level estimate of the storage volume required to reduce post-development peak flows to pre-development conditions. While the proposed development concept plan serves as the basis for these calculations, it is understood that the final location and size of the SWM ponds may change based on recommendations from the various assessments that make up this project. These calculations are provided to aid in evaluating the feasibility of mitigating post-development impacts in the study area and do not represent firm conceptual designs.

10.1 Floodplain Identification

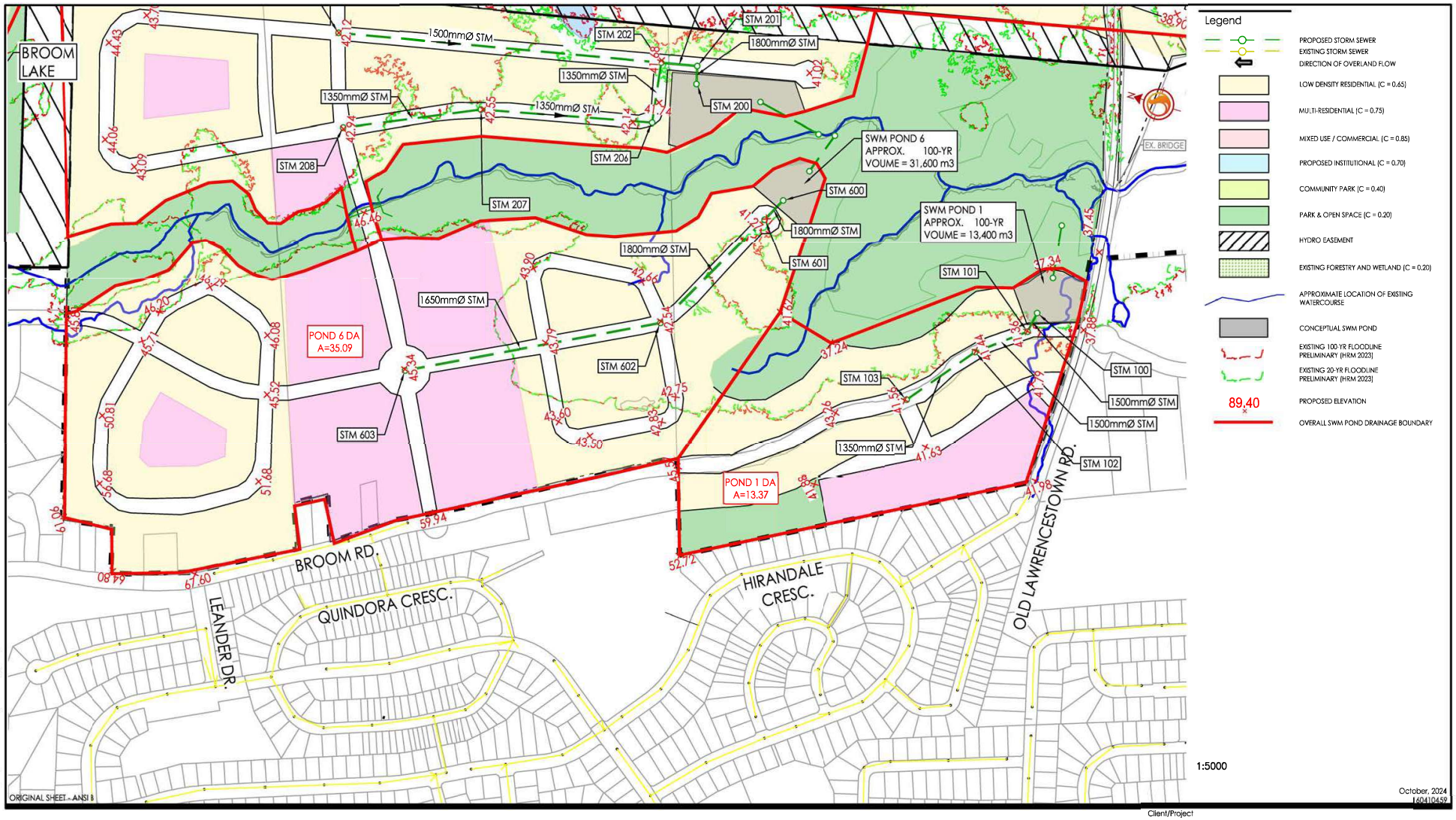
Based on the preliminary flood lines obtained from HRM, part of the proposed development lies within the floodplain. A portion of subcatchments C103A, C208A, C203A, C321A, C320A, C311A, C307A, C603A, C103A, C405C, C405D, C401A, and UNC-4 is within the preliminary flood limits. In order to minimize the risk of flooding and ensure the proposed roads are safe for traffic during emergency conditions, it is recommended that the proposed roads within these areas be raised above the 100-year flood line. Similarly, it is recommended that future development be restricted within the 100-year floodplain in consistency with municipal by-laws and the Nova Scotia Statement of Provincial Interest regarding flood risk areas.

10.2 Stormwater Management Dry Ponds

The location and sizing of dry ponds presented in this study provide an estimate of storage volumes required to mitigate post development peak flows, based on the information available at the time. However, these locations encroach the estimated flood extents and will require revision to avoid flooding risks and backwater effects in the ponds and associated stormwater infrastructure.

As presented on **Drawing SD-1** in **Appendix B**, the proposed development area would be serviced through storm sewers that would be sized to convey the 5-year runoff under free flow conditions to the proposed end of pipe SWM dry ponds for quantity control prior to discharging into the receiving watercourses. During major storm events, higher than the 5-year storm, peak overflows would be routed overland to the proposed SWM dry ponds.

A total of seven (7) SWM dry ponds have been proposed for stormwater management based on existing drainage patterns and the conceptual development plan to mitigate post development peak flows to pre-development levels for all storms from the 2-year up to the 100-year storm event. The final number, location, and size of the SWM dry ponds is to be confirmed based on best engineering principles and detailed floodplain mapping for the area, including flow monitoring and model calibration. The conceptual location and overall drainage area of the SWM ponds are shown in **Figure 10.1**, **Figure 10.2**, **Figure** 10.3, **Figure 10.4** and **Figure 10.5**.



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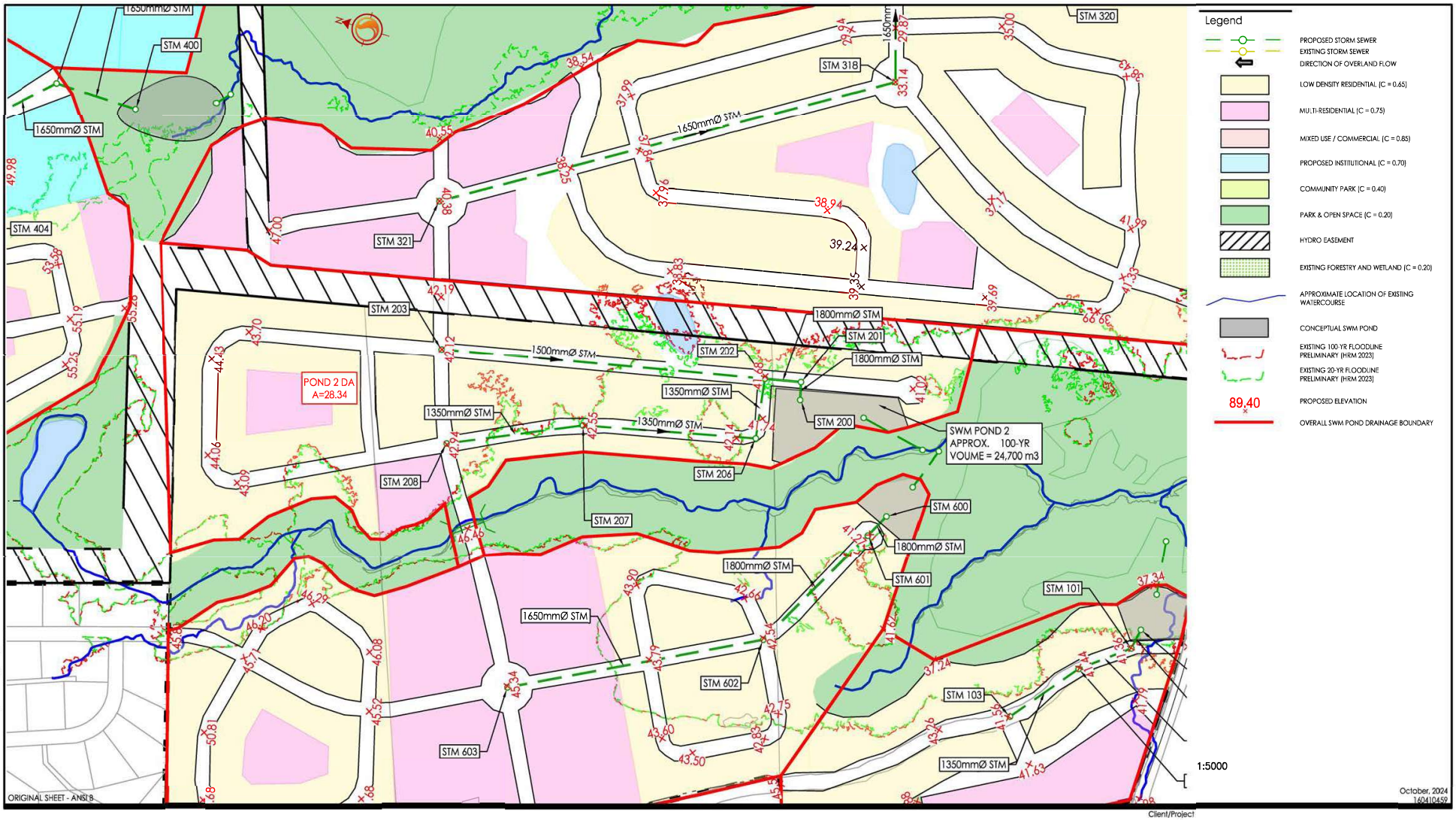
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STORM WATER MANAGEMENT

Figure No.
10.1

Title
OVERALL DRAINAGE AREA
TO SWM POND 1 & 6



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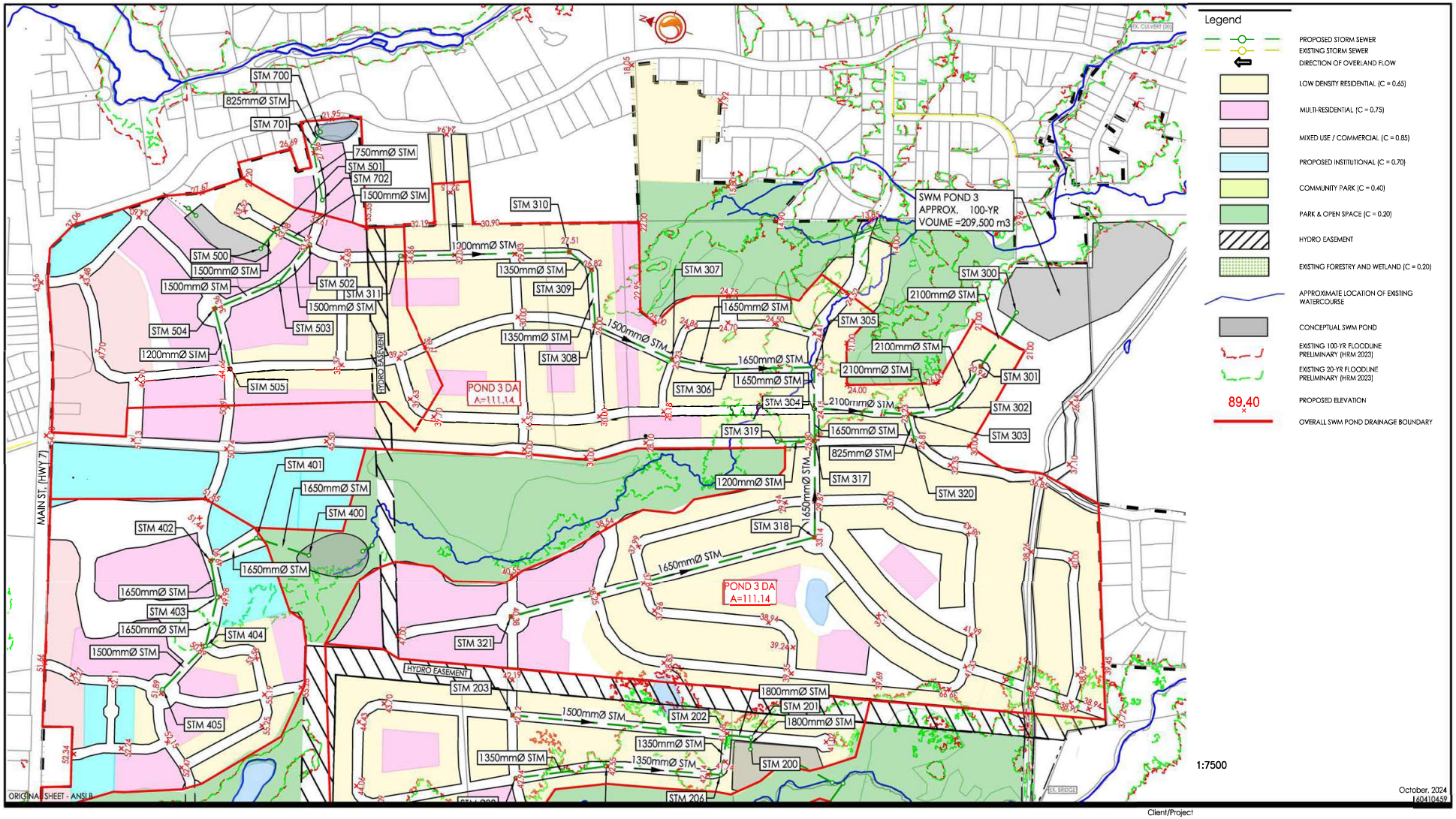
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Figure No.
10.2

Title
OVERALL DRAINAGE AREA
TO SWM POND 2



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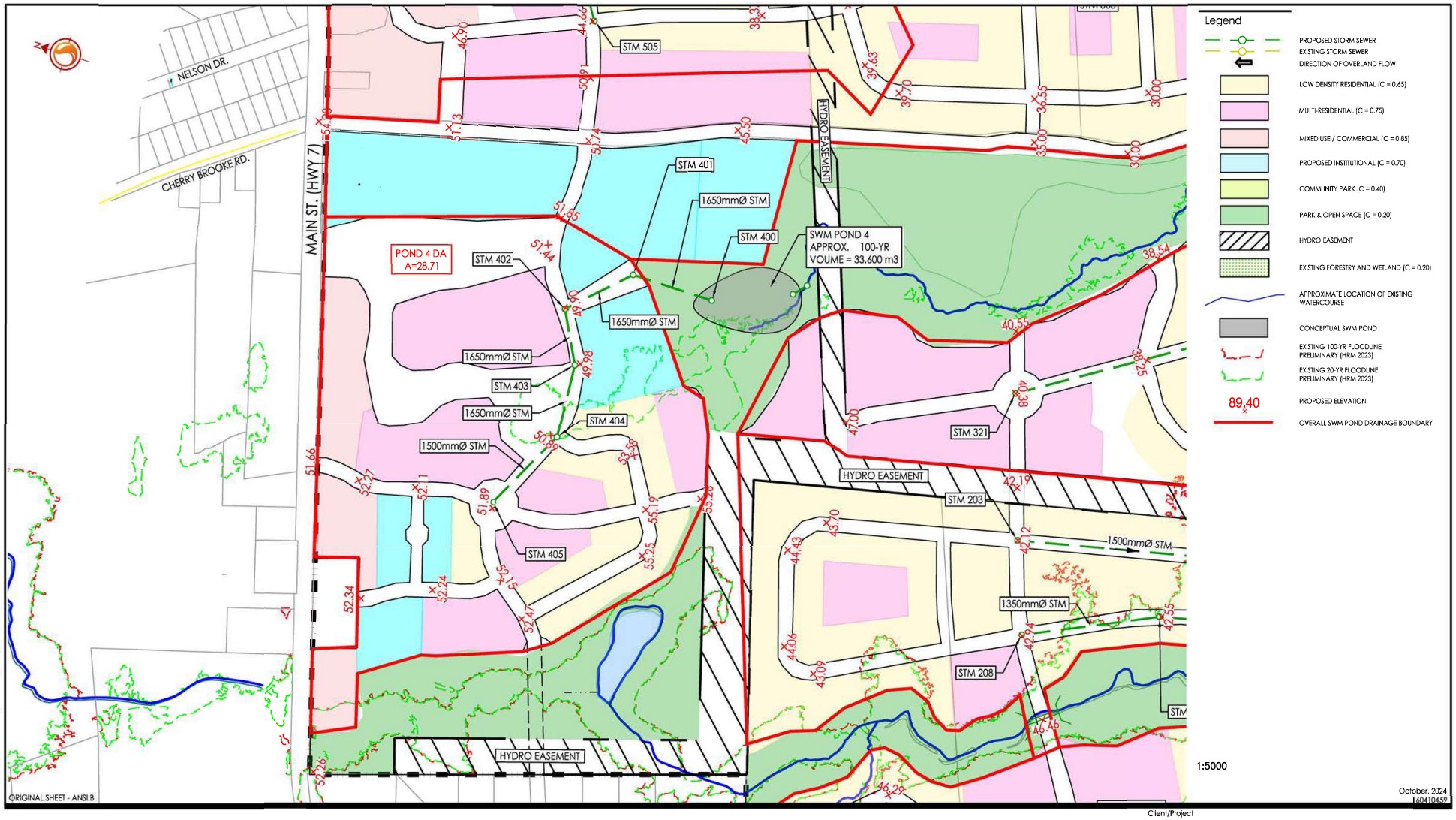
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Figure No.
10.3

Title
OVERALL DRAINAGE
AREA TO SWM POND 3



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ORIGINAL SHEET - ANSI B

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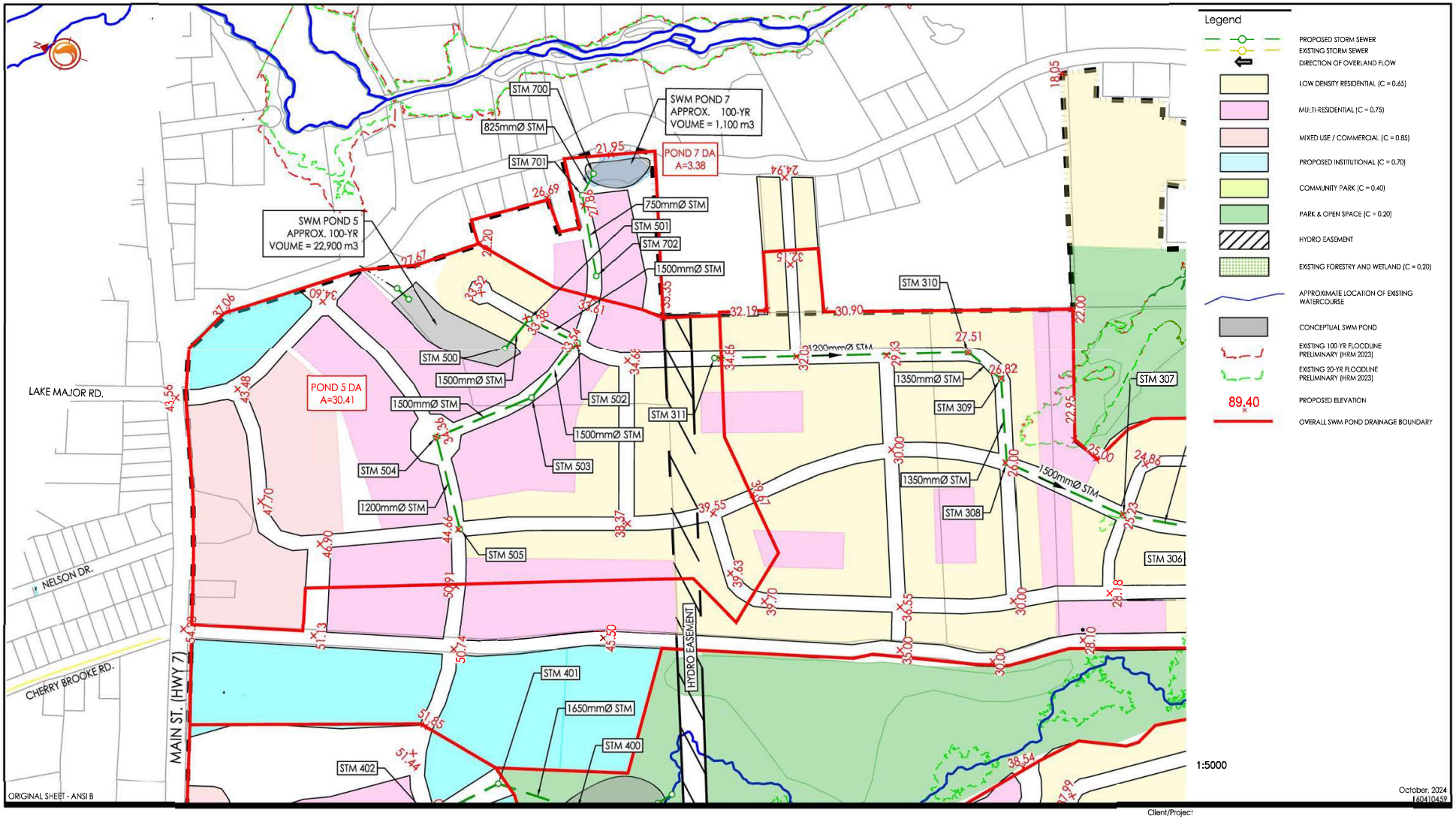
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Figure No.
10.4

Title
OVERALL DRAINAGE
AREA TO SWM POND 4



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Figure No.
10-5

Title
OVERALL DRAINAGE AREA
TO SWM POND 5 & 7

The drainage areas and approximate 100-year volume requirements for the proposed SWM dry ponds are summarized in **Table 10.1**Table 10.1**.**

Table 10.1 Proposed Pond 100-yr Volume

Pond ID	Drainage Area (ha)	100-yr Volume (m^3)
Pond 1	13.5	13,400
Pond 2	27.9	24,700
Pond 3	116.5	209,500
Pond 4	29.6	33,600
Pond 5	30.7	22,900
Pond 6	34.4	31,600
Pond 7	3.5	1,100

The future conditions PCSWMM model includes fixed water levels as boundary conditions at Cole Harbour and Little Salmon River during the 100-year storm. This model is used to assess the hydraulic performance of the proposed SWM Ponds, and as such the effects of backwater from the receiving watercourses on the SWM Ponds are reflected in the results.

The drainage area for Pond 3 is substantial, which results in significant volume requirements to restrict post-development peak flows to pre-development levels up to the 100-year design storm event. During future stages of design/planning, it is recommended to explore the feasibility of incorporating an additional SWM pond upstream of SWM Pond 3 discharging into the tributary, thus reducing the drainage area to SWM Pond 3 and the resulting volume requirements.

In general, it is recommended that the proposed development plans for the WSA be revised to avoid residential, commercial, and institutional land uses within the 100-year floodplain and to ensure that appropriately sized blocks are allocated for the SWM Ponds outside of the confirmed 100-year floodplain. In the further stages of planning and development of the site, the development plan should be revised to relocate residential development and SWM ponds that are currently close to or within the potential flood line. By pulling back the development, and potentially adding density to the remaining, the population/development yield of the site could remain similar, and it could reduce the potential risks associated with flooding. The Land Suitability Report outlines that areas within 30 m of a watercourse have low suitability for development, so setback areas from watercourses have to be studied on a site-specific basis during subsequent area planning to determine suitability.

The conceptual stormwater management plan shown on **Drawing SD-1** in **Appendix B** includes trunk storm sewers at SWM pond inlets. These trunk sewers have been conceptually sized to convey the 5-year storm at a maximum of 80% pipe capacity under free flow conditions and pipe sizes vary from 750 mm to 2100 mm in diameter. However, pipe sizes and SWM pond locations will be confirmed at the detailed design stage, pending a revision of the site conceptual plan and land use distribution to reduce

future risks of flooding and environmental degradation. **Table 10.2** shows preliminary trunk storm sewer characteristics.

Table 10.2 Storm Sewer Characteristics

U/S MH ID	D/S MH ID	U/S Invert Elevation (m)	D/S Invert Elevation (m)	Diameter (mm)
101	Pond_1	37.61	37.57	1500
102	101	37.79	37.67	1500
103	102	38.28	37.94	1350
201	Pond_2	37.46	37.40	1800
202	201	37.64	37.52	1800
203	202	39.04	37.94	1500
206	202	38.30	38.09	1350
207	206	38.95	38.36	1350
208	207	39.45	38.98	1350
301	Pond_3	15.02	12.88	2100
302	301	16.22	15.02	2100
303	302	17.31	16.28	2100
320	303	20.49	18.59	825
304	303	19.22	17.31	2100
305	304	20.13	19.67	1650
306	305	21.16	20.19	1650
307	306	21.79	21.16	1650
308	307	22.63	21.94	1500
309	308	23.58	22.78	1350
310	309	24.02	23.61	1350
311	310	31.48	24.20	1200
317	304	22.00	19.67	1650
318	317	28.97	22.00	1650
319	317	23.10	22.45	1200
321	318	37.04	29.03	1650
401	Pond_4	44.88	41.50	1650
402	401	45.95	44.91	1650
403	402	46.36	46.01	1650
404	403	46.85	46.39	1650
405	404	47.99	47.00	1500
501	Pond_5	27.74	27.22	1500
502	501	28.53	27.80	1500



U/S MH ID	D/S MH ID	U/S Invert Elevation (m)	D/S Invert Elevation (m)	Diameter (mm)
503	502	29.58	28.59	1500
504	503	31.01	29.61	1500
505	504	38.37	31.31	1200
601	Pond_6	37.50	37.38	1800
602	601	38.32	37.52	1800
603	602	41.66	38.47	1650
701	Pond_7	23.01	22.91	825
702	701	24.19	23.08	750

10.3 Quantity Control Results

As shown on **Drawing EXSD-1** and **SD-1** in **Appendix C**, flow points have been established along the existing watercourses at proposed crossings, watercourse intersections and at SWM pond outlet locations to compare pre-development and post-development peak flows. The stage-storage-discharge relationship of the proposed SWM ponds was iterated in PCSWMM in order to restrict post-development peak flows to pre-development levels for the 2, 5, 10, 25, 50 and 100-year design storms. **Table 10.3**Error! Reference source not found. presents the post- to pre-development peak flow comparison at the different flow points along the watercourses for the 2-year, 5-year, and 100-year design storm events. Refer to **Appendix C** for a table showing peak flow results for all storm events.

Table 10.3 Post to Pre-Development Peak Flow Comparison

Flow Point ID	2-year, 24hr Chicago Peak Flow (m^3/s)		5-year, 24hr Chicago Peak Flow (m^3/s)		100-year, 24hr Chicago Peak Flow (m^3/s)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
FP1	0.269	0.117	0.446	0.142	1.505	1.322
FP2	1.396	1.337	2.295	1.972	7.550	6.526
FP3	2.895	2.848	4.272	4.064	11.501	9.568
FP4	4.023	3.739	5.946	5.447	15.566	13.743
FP5	1.166	1.081	2.081	1.458	8.044	7.718
FP6	0.669	0.640	0.990	0.945	2.513	2.352
FP7	0.454	0.200	0.811	0.288	3.235	1.923
FP8	2.396	2.198	3.672	3.132	11.533	9.684
FP9	2.357	1.539	3.374	2.048	8.936	4.568
FP10	0.513	0.354	0.816	0.537	2.634	1.427
FP11	0.639	0.632	0.929	0.792	2.404	1.878
FP12	0.997	0.558	1.778	0.838	6.971	3.326
FP13	3.708	3.354	5.397	4.854	12.187	10.767

It is expected that post development peak flows will be further reduced during smaller rainfall events (i.e., 2-year) once best management practices and LIDs are integrated at the detailed design stage.

Final sizing and location of the SWM ponds should be confirmed at the detailed design stage, pending flow monitoring, model calibration and detailed floodplain mapping for the area to ensure that post development peak flows along the watercourses are balanced within 10% (+ or -) of pre-development levels.

10.4 Modelling Limitations

The following are some of the limitations associated with the current modelling approach:

- Boundary Conditions: The hydrologic/hydraulic PCSWMM models for the Westphal Study Area used a fixed water elevation at all watercourse outfalls as a boundary condition for the 100-year design storm event. This fixed 100-year water elevation was estimated from the preliminary floodlines obtained from HRM from their on-going Regional Flood Risk Mapping project. The hydrologic/hydraulic model should be refined at later stages of design once the floodline elevations are confirmed.
- Calibration: Flow monitoring data for the Westphal watershed is not available at this time and as such, the hydrologic/hydraulic PCSWMM model has not been calibrated. Hydrologic and hydraulic parameters used in this modeling exercise have been selected as discussed in this report based on available information. However, these parameters have not been calibrated to reflect the actual runoff response from the watershed, which includes significant external rural and urban catchments with watercourses and natural depressions and wetlands. Without calibration, the model's predictions are based solely on theoretical calculations and assumptions, which may not accurately reflect real-world conditions. The model was not designed to assess site-specific flooding risks. This report primarily relies on floodlines provided by HRM, which were generated using a high-level regional model that may underestimate flooding along smaller streams. A detailed floodline delineation is necessary to accurately evaluate flooding risks along the watercourses crossing the site.
- The model was not designed to assess site-specific flooding risks. This report primarily relies on floodlines provided by HRM, which were generated using a high-level regional model that may underestimate flooding along smaller streams. A detailed floodline delineation is necessary to accurately evaluate flooding risks along the watercourses crossing the site

11 Floodplain & Sustainable Development

Planning and development decisions should be guided by best practices in both floodplain management and sustainable development. This process should integrate the principles of resilience to climate change and commitment to environmental conservation at each step of planning.

To guide the HRM in planning, development, and refinement of sustainable future development plans for the WSA, it is recommended to develop a high level map outlining opportunities to protect and improve the natural environment and associated limitations and constraints. It is important to note that most development constraints which include meander belt widths, existing wetlands and woodlots, and regulatory flood plains, greatly impact the environment and hence should not be altered. However other constraints such as modification to drainage may be permitted if carried out as part of an integrated planning approach such as a subwatershed study. Should there be a need to alter/affect development constraints, detailed investigation must be performed to evaluate the impact on natural features and downstream properties and infrastructure, and to establish corresponding measures to eliminate/compensate for the adverse impacts. Development constraint mapping for the WSA has been provided in the Land Suitability Assessment (Stantec, 2024), as well as in this report. However, these studies do not quantify the impacts on stormwater/flooding resulting from any alterations that may be proposed as part of the development concept plans.

Wetlands effectively aid in reducing the negative impacts of frequent heavy rainfall events by collecting runoff in their naturally low-lying areas, allowing it to be slowly released into receiving watercourses, infiltrated into the soil to recharge groundwater systems, or absorbed by wetland vegetation. As a result, wetlands represent an important constraint for any development in Nova Scotia. Conservation of wetlands in the province is guided by the Nova Scotia Wetland Conservation Policy and supported by regulation under the provincial Environment Act and Activities Designation Regulations. The goals of the policy are to have no loss of Wetlands of Special Significance (WSS) and to prevent net loss in area and function for other wetlands.

As stated in the statement of provincial interest regarding flood risk areas, within the *Floodway*, development must be restricted to uses such as roads, open space uses, utility and service corridors, parking lots and temporary uses, and the placement of off-site fill must be prohibited. Within the *Floodway Fringe,* flood proofed development may be permitted except for residential institutions where flooding could pose a significant threat to the safety of residents if evacuation became necessary, and in any use associated with the warehousing or the production of hazardous materials. Additionally, the placement of off-site fill within the *Floodway Fringe* must be limited to that required for flood proofing or flood risk management.

Development contrary to the Statement of Provincial Interest regarding Flood Risk Areas may be permitted provided a hydrotechnical study, carried out by a qualified person, shows that the proposed development will not contribute to upstream or downstream flooding or result in a change to flood water flow patterns.

Based on the above, it is recommended that no active development be permitted within the limits of the 100-year regulatory floodplain. Some reduced risk uses may be considered in agreement with HRM by-laws and the Nova Scotia Statement of Provincial Interest regarding Flood Risk Areas. This is subject to design considerations that effectively mitigate and/or minimize the impact of such development on the floodplain and protect the riparian corridor functions. It is further recommended that future development phasing start in higher areas outside of the identified preliminary floodplain and that detailed floodplain mapping be completed to confirm floodplain extents and development setbacks.

Moreover, any proposed development should adhere to the constraints identified in the Land Suitability Assessment constraint mapping for the WSA (Stantec, 2024). This includes areas of significant wildlife habitat, wetlands, steep slopes, and other environmentally sensitive areas. In areas where development is proposed within or in proximity to the identified floodplain, suitable mitigation measures should be implemented.

In addition, the promotion of green space creation or naturally forested park areas greatly reduce volume of runoff and pollutant loading discharged into receiving watercourses and as such, it is recommended that green space be promoted within future development plans.

12 Stormwater Management Conclusions and Recommendations

The following lists the key points concluded from the stormwater analysis:

- The stormwater management plan for the Westphal Study Area includes storm sewers sized for the 5-year storm at 80% full flow pipe capacity, overland flow routing to end-of-pipe SWM facilities and seven (7) SWM dry ponds designed to restrict post-development peak flows to existing watercourses to pre-development values for up to and including the 100-year storm. However, the analysis has identified important limitations and vulnerabilities in the layout provided by the developer. Although this layout was used to assess the feasibility of controlling post-development peak flows, it requires critical consideration of key elements. The proposed development layout and associated stormwater management requires a thorough revision based on further analysis of the land use distribution and the siting of SWM ponds, as well as detailed hydraulic modeling, to confidently mitigate risks of flooding and reduce risks of degradation to the natural assets within the study area. High density land uses can potentially reduce the footprint of development and help to maintain development and stormwater management infrastructure away from flooding risk areas.
- Due to the resulting volumetric requirements of the conceptual SWM Pond 3, it is recommended to explore the feasibility of incorporating an additional SWM pond upstream at the detailed design stage in order to reduce the overall drainage area to the SWM ponds and the resulting volume requirements.
- Quality control for the WSA is to be provided through best management practices, along with the use of LID measures to provide filtration and promote infiltration within public areas.
- Two proposed watercourse crossings have been identified within the development area based on the street layout shown in the development concept plan which is subject to change. The proposed culverts were conceptually sized to meet the Hw/D ≤ 1 criterion for the 100-year design storm event. This criterion is used to size culverts to convey the peak flow and velocity of runoff during extreme weather events, thereby reducing the risk of flooding and infrastructure damage.
- Current development plans infringe on the preliminary 100-year floodline (drainage areas C103A, C208A, C203A, C321A, C320A, C311A, C307A, C603A, C103A, C405C, C405D, C401A, and UNC-4).
- Part of the planned development area (drainage areas C319A, C307A and UNC-4, as well as C103A) overlap portions of the existing watercourses.

Based on the discussion provided in this report, the following is a summary of recommendations:

- The conceptual development plan be revised to accommodate existing watercourses and wetlands, unless otherwise specified in future environmental assessments.

- Flow monitoring in the watercourses and subsequent model calibration be completed to confirm regulatory floodplain limits, and proposed pond sizes and locations.
- No active development be permitted within the limits of the 100-year regulatory floodplain. Some reduced risk uses may be considered in agreement with HRM by-laws and the Nova Scotia Statement of Provincial Interest regarding Flood Risk Areas. This is subject to design considerations that effectively mitigate and/or minimize the impact of such development on the floodplain and protect the riparian corridor functions.
- A detailed geotechnical investigation is recommended to be completed at the detailed design stage. Geotechnical recommendations should be provided for the proposed Stormwater Management (SWM) ponds, grade-raise restrictions, and the feasibility of Low Impact Developments (LIDs) in the area.
- The feasibility of implementing an additional SWM Pond upstream of SWM Pond 3 be investigated during future design stages to reduce the current development area tributary to SWM Pond 3.
- A revision of land use distribution to increase high-density uses, reduce development footprint and allow the location of the proposed ponds is advised to inform the design of an effective and sustainable stormwater management plan.
- The development concept plan be revisited to ensure SWM Ponds are located outside of the 100-year floodplain and/or delineated wetlands, to maximize the use of natural areas considering the recommendations of the LSA, to consider high-density land uses that reduce sprawl to achieve this purpose, and to inform the revision of the proposed development layout and stormwater management plan to reduce risk of flooding and degradation to natural assets in the study area. The current layout includes SWM ponds located in or close to areas under risks of flooding.
- Future development phasing start in higher areas outside of the identified preliminary floodplain and detailed floodplain mapping be completed to confirm floodplain extents and development setbacks as future developments move closer to the identified preliminary floodplain.
- In future stages of planning and development of the site, the development plan should be revised to relocate residential development and SWM ponds that are currently close to or within the potential floodplain. By pulling back the development, and potentially adding density to the remaining area, the population/development yield of the site could remain similar, and it could reduce the potential risks associated with flooding. The Land Suitability Report outlines that areas within 30 m of a watercourse have low suitability for development. Minimum setbacks to the watercourses in excess of the 30 m identified in the Land Suitability Report must be studied on a site-specific basis during subsequent area planning.
- Retaining native and existing ground cover be prioritized where possible to preserve ecosystem service function, reduce volume of runoff discharged into watercourses, promote infiltration, and provide an opportunity for evapotranspiration.

- Implementing structural LID measures within public property to reduce contaminant loads for the development area to achieve contaminant loads of existing conditions.
- Implementing erosion and sedimentation control measures to mitigate effects from development during construction, as well as implementing construction sequencing to minimize the quantity of soil exposed at any given time to prevent erosion.

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APPENDICES

Appendix A Water Quality Results

Table A-1 : Westphal Study Area Water Quality Results

Bureau Veritas ID		VPD953	VWV207	WDN011	WKL341	WRG656	XAK366	XIU285	XPK296
Sampling Date		2023/04/20 09:20	2023/05/23 15:07	2023/06/19 11:49	2023/07/18 09:00	2023/08/14 08:40	2023/09/19 08:00	2023/10/20 08:40	2023/11/15 10:20
COC Number		N/A	N/A	938243-03-01	943103-01-01	948313-01-01	954357-01-01	C#958826-01-01	C#963441-01-01
	UNITS	**SW-27**	**SW-27**	**SW-27**	**SW-27**	**SW-27**	**SW-27**	**SW-27**	**SW-27**
Microbiological									
Escherichia coli	CFU/100mL	6	<10	320	170	>2500	1000	<100	<100
Total Coliforms	CFU/100mL	>250	970	>2500	1100	>2500	>2500	1500	1300
Inorganics									
Dissolved Chloride (Cl-)	mg/L	53	45	23	34	14	19	27	28
Colour	TCU	35	28	130	47	170	85	46	28
Total Suspended Solids	mg/L	4	13	1.8	2.8	4.2	250	2	6.8
Turbidity	NTU	2.8	40	4.9	1.8	6.9	5.5	1.7	3.5
Total Phosphorous	mg/L		0.09	0.025	0.022	0.039	0.03	<0.020	<0.020

Bureau Veritas ID		VPD952	VWV206	WDN010	WKL340	WRG655	XAK365	XIU284	XPK295
Sampling Date		2023/04/20 10:03	2023/05/23 15:28	2023/06/19 11:23	2023/07/18 09:10	2023/08/14 08:20	2023/09/19 08:20	2023/10/20 09:10	2023/11/15 10:45
COC Number		N/A	N/A	938243-03-01	943103-01-01	948313-01-01	954357-01-01	C#958826-01-01	C#963441-01-01
	UNITS	**SW-26**	**SW-26**	**SW-26**	**SW-26**	**SW-26**	**SW-26**	**SW-26**	**SW-26**
Microbiological									
Escherichia coli	CFU/100mL	9	10	830	390	>2500	>2500	<100	400
Total Coliforms	CFU/100mL	>250	370	1700	1200	>2500	>2500	1300	1400
Inorganics									
Dissolved Chloride (Cl-)	mg/L	120	110	75	94	35	27	82	90
Colour	TCU	12	8.8	30	11	54	52	12	7.9
Total Suspended Solids	mg/L	1.4	<1.0	1.2	1.6	4.6	21	1.2	<2.0
Turbidity	NTU	0.59	0.2	2.7	0.76	9.4	8.3	0.88	0.98
Total Phosphorous	mg/L		0.028	0.034	0.021	0.049	0.066	<0.020	<0.020

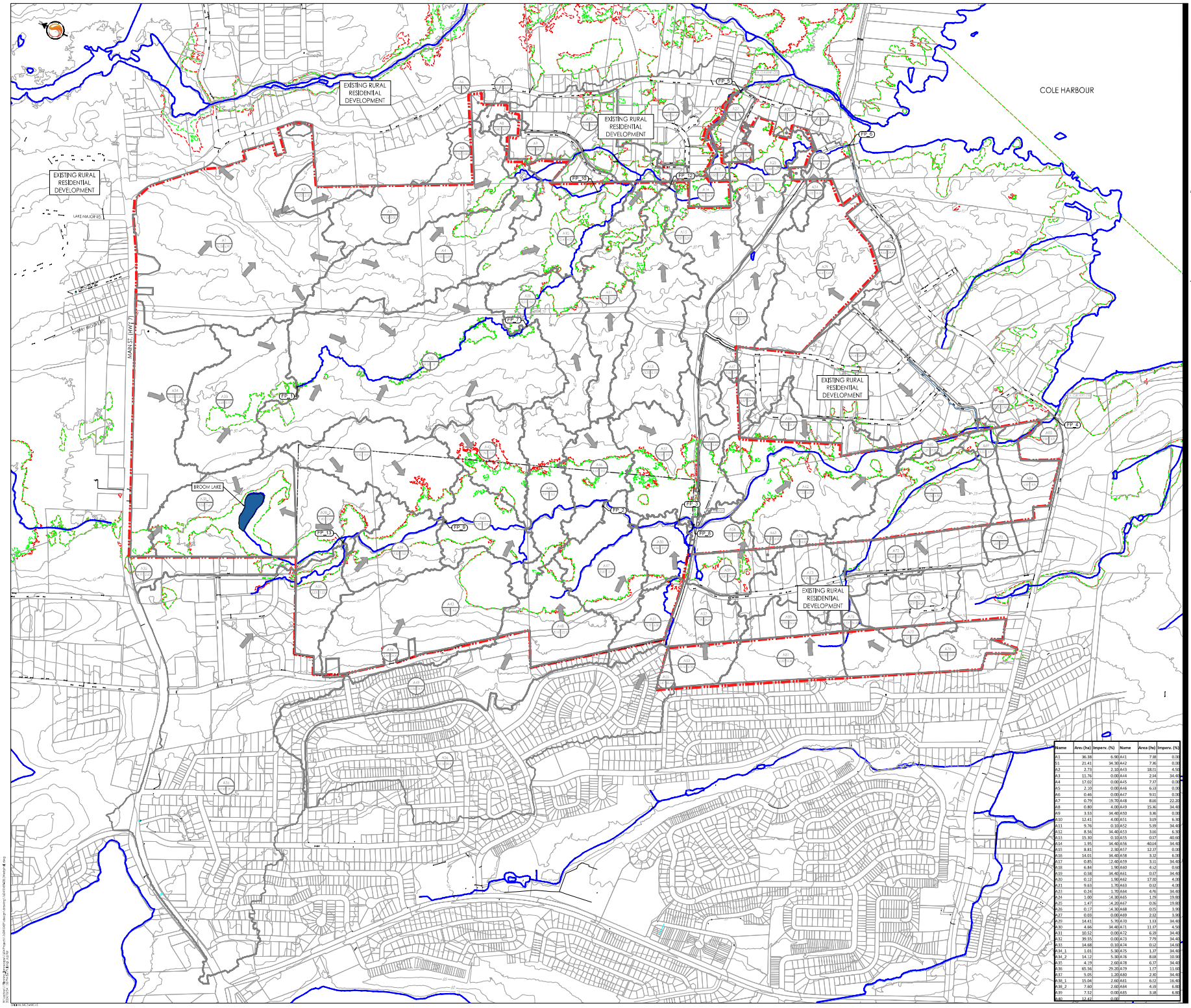
Table A-1 (continued): Westphal Study Area Water Quality Results

Bureau Veritas ID		VPD954	VWV208	WDN012	WKL342	WRG657	XAK367	XIU286	XPK297
Sampling Date		2023/04/20 09:45	2023/05/23 14:46	2023/06/19 12:20	2023/07/18 08:30	2023/08/14 08:50	2023/09/19 07:30	2023/10/20 08:50	2023/11/15 10:30
COC Number		N/A	N/A	938243-03-01	943103-01-01	948313-01-01	954357-01-01	C#958826-01-01	C#963441-01-01
	UNITS	**SW-29**	**SW-29**	**SW-29**	**SW-29**	**SW-29**	**SW-29**	**SW-29**	**SW-29**
Microbiological									
Escherichia coli	CFU/100mL	10	<10	290	20	370	600	<100	<100
Total Coliforms	CFU/100mL	>250	280	1300	760	960	1500	600	200
Inorganics									
Dissolved Chloride (Cl-)	mg/L	70	53	25	35	23	21	30	34
Colour	TCU	61	55	160	190	230	180	80	84
Total Suspended Solids	mg/L	<1.0	<1.0	2	<1.0	2.8	2.0 (1)	1.2	<2.0
Turbidity	NTU	0.65	1.0	3	1.7	2.1	2	1	0.89
Total Phosphorous	mg/L		<0.020	0.017	0.021	0.022	0.029	<0.020	<0.020

Bureau Veritas ID		VPD955	VWV210	WDN013	WKL343	WRG658	XAK368	XIU287	XPK298
Sampling Date		2023/04/20 09:03	2023/05/23 14:57	2023/06/19 12:03	2023/07/18 08:45	2023/08/14 09:00	2023/09/19 07:50	2023/10/20 08:55	2023/11/15 10:35
COC Number		N/A	N/A	938243-03-01	943103-01-01	948313-01-01	954357-01-01	C#958826-01-01	C#963441-01-01
	UNITS	**SW-30**	**SW-30**	**SW-30**	**SW-30**	**SW-30**	**SW-30**	**SW-30**	**SW-30**
Microbiological									
Escherichia coli	CFU/100mL	16	<10	220	20	>2500	920	<100	<100
Total Coliforms	CFU/100mL	>250	510	>2500	990	>2500	>2500	400	600
Inorganics									
Dissolved Chloride (Cl-)	mg/L	67	51	25	34	19	21	29	33
Colour	TCU	53	49	150	160	190	160	68	73
Total Suspended Solids	mg/L	<1.0	<1.0	2.4	<1.0	2.6	9	1	<2.0
Turbidity	NTU	0.85	0.28	2.9	1.1	3.5	3.7	1.2	0.83
Total Phosphorous	mg/L		<0.020	0.018	0.018	0.029	0.032	<0.020	0.022

Parameter	Site	20-Apr-23	23-May-23	6-Jun-23	18-Jul-23	18-Aug-23	19-Sep-23	19-Oct-23	16-Nov-23
pH	SW-26	7.21	6.82	6.82	7.30	6.98	7.29	7.31	7.46
Temp		7.2	12.2	12.82	18.12	17.71	18.28	16.55	0.9
Conductivity (uS/cm)		512.97	391.2	-	-	-			442.5
Specific Conductivity (mS/cm)		-	0.517	0.397	0.57	0.258	0.192	0.119	
DO (%)		86.13	93.53	-	-	-			
DO (mg/L)		10.34	10.11	5.6	7.1	11.61	9.99	10.68	7.46
pH	SW-27	7.11	6.72	6.53	7	6.21	7.12	6.83	6.83
Temp		6.87	13.87	12.11	18.72	17.06	17.87	14.26	-0.2
Conductivity (uS/cm)		249.80	225.03	-	-	-			
Specific Conductivity (mS/cm)		-	0.286	0.166	0.284	0.122	0.167	0.238	208.4
DO (%)		60.8	75.17	-	-	-			
DO (mg/L)		7.3	8.01	5.99	4.68	8.11	6.03	7.93	9.11
pH	SW-29	7.44	7.00	6.72	7.14	6.73	8.1	7.42	7.34
Temp		8	15.8	13.08	20.22	17.87	18.18	16.49	0.1
Conductivity (uS/cm)		280.27	217.13	-	-	-			
Specific Conductivity (mS/cm)		-	0.264	0.143	0.21	0.146	0.13	0.155	171.8
DO (%)		99.43	97.50	-	-	-			
DO (mg/L)		11.74	9.87	6.53	6.2	11.45	9.88	10.88	14.22
pH	SW-30	7.39	7.16	6.69	7.43	6.84	7.72	7.56	7.42
Temp		7.70	16.17	13.24	19.95	17.51	18.04	16.63	0.1
Conductivity (uS/cm)		269.93	211.87	-	-	-			171.3
Specific Conductivity (mS/cm)		-	0.255	0.145	0.217	0.126	0.129	0.131	
DO (%)		97.00	101.17	-	-	-			
DO (mg/L)		11.56	9.78	6.54	6.12	12.08	11.48	12.15	14.62

Appendix B Storm Drainage Drawings



Name	Area (ha)	Imperv. (%)	Name	Area (ha)	Imperv. (%)
A1	36.38	6.90	A41	7.88	0.00
A2	21.41	34.30	A42	7.96	0.00
A3	2.73	2.10	A43	18.21	4.50
A4	11.76	0.00	A44	2.54	34.40
A5	17.02	0.00	A45	7.27	0.00
A6	2.10	0.00	A46	6.33	0.00
A7	0.46	0.00	A47	9.51	0.00
A8	0.79	19.70	A48	8.16	22.20
A9	0.80	4.00	A49	15.36	34.40
A10	3.53	34.40	A50	3.36	0.00
A11	12.41	4.00	A51	3.19	6.30
A12	9.76	0.10	A52	5.35	34.40
A13	8.56	34.40	A53	3.16	6.30
A14	15.30	0.10	A55	0.17	40.60
A15	1.95	34.40	A56	40.14	34.40
A16	8.81	2.30	A57	12.27	0.00
A17	14.01	34.40	A58	3.32	6.00
A18	0.85	12.40	A59	3.11	34.40
A19	6.84	1.90	A60	4.12	0.60
A20	0.58	34.40	A61	0.17	34.40
A21	0.12	1.90	A62	17.10	4.00
A23	9.63	1.70	A63	0.12	4.00
A24	0.24	1.70	A64	4.76	34.40
A25	1.00	34.30	A65	1.29	19.80
A26	1.47	34.20	A67	0.36	19.80
A27	0.17	34.30	A68	0.15	3.90
A29	0.60	0.00	A69	2.32	3.90
A30	14.41	5.70	A70	1.13	34.40
A31	4.66	34.40	A71	11.17	4.50
A32	10.52	0.00	A72	6.39	34.40
A33	39.55	0.00	A73	7.79	34.40
A34	14.68	0.10	A74	0.12	34.40
A34_1	1.01	5.30	A75	1.37	34.40
A34_2	14.12	5.30	A76	8.18	10.90
A35	4.19	2.60	A78	0.37	34.40
A36	65.56	29.20	A79	1.17	11.60
A37	5.05	1.20	A80	2.30	34.40
A38_1	15.04	2.60	A81	0.12	16.40
A38_2	7.60	2.60	A84	4.19	6.80
A39	7.52	0.00	A85	3.18	6.80
A80	12.42	0.00			

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Legend

EXISTING AREA ID
EXISTING IMPERVIOUSNESS
EXISTING STORM DRAINAGE AREA
EXISTING STORM SEWER REQUIREMENT
EXISTING STORM SEWER
STUDY AREA
EXISTING MAJOR OVERLAND FLOW ROUTE
EXISTING 100-YR FLOODLINE PROPERTY (Mike 2020)
EXISTING 25-YR FLOODLINE PROPERTY (Mike 2020)
FP_20 FLOW POINT ID
APPROXIMATE LOCATION OF EXISTING WATERCOURSE

Notes
1. CONTOUR INTERVAL 0.50m



KEYPLAN
NTS

No.	Revision	By	Dsn'd	Dwn	Chk'd	Dgn	Appd	Date (YY.MM.DD)
1	ISSUED FOR REVIEW	JP	DCT	JP	DCT	DCT		2020.06.16

File Name: 160410459-08 (Mike 1D).dwg

Permit-Seal

Client/Project
HRM
WESTPHAL STUDY AREA
FUTURE SERVICED COMMUNITIES
WATER AND WASTEWATER ANALYSIS
HALIFAX, NS

Title
EXISTING STORM
DRAINAGE AREA PLAN

Project No.
160410459

Scale
1:4000
0 40 120 200m

Drawing No.
EXSD-1

Sheet
5 of 5

Revision
1