

Appendix A. Hydrologic Modelling Memorandum

Phase 2 Component 2 – Modelling Memorandum (Draft)

Date:	October 9, 2025	165 King St West
Project Name:	Dundee North Secondary Plan	Suite 201
Project No.:	CE805800	Kitchener, ON N2G 1A7
		Canada
		T +1.519.579.3500
		www.jacobs.com
Client:	City of Kitchener	
Prepared by:	Jacobs (Laura Hutchings, Christian Martin) and Aqua Insight (Patty Meyer, Gaelen Merrit)	
Reviewed by:	Tom Mahood, Ashraf Zaghal Jillian Schmitter, Patty Meyer	
Approved by:	Jillian Schmitter	

Statement of Limitations

This Memorandum has been prepared exclusively for internal use by the City of Kitchener (City). Any information provided by the City and third party's and relied upon is presumed to be accurate for the purposes of this report preparation. Where baseline conditions change, additional information becomes available portions of the studies conclusions may warrant re-evaluation. This Report contains observations and professional opinions reflecting Jacobs' best judgment using information understood to be factual and correct. Jacobs will not accept responsibility for conditions arising from information or facts that were concealed or not fully disclosed to Jacobs.

This Memorandum was not prepared in anticipation of any legal proceedings, nor is this Memorandum intended for use or reliance in any way in any legal proceedings related to the project, or otherwise. No liability is accepted for any use or reliance on the information provided herein by third parties. Jacobs accepts no responsibility for damages, if any, suffered by any party as a result of decisions made or actions based on this Report. No other warranty, expressed or implied, is made.

This Memorandum is to be read in full. No excerpts shall be taken to be representative of the findings. Jacobs takes no responsibility for misrepresentation or misuse of portions of this Memorandum.

Background and Purpose

This technical memorandum (TM) documents the hydrologic and hydrogeologic modelling completed as part of Phase 2, Component 2 of the Scoped Subwatershed Study for the Dundee North Secondary Plan Area in the City of Kitchener.

This phase of the study evaluates the potential impacts of two preliminary land use scenarios, developed by the City of Kitchener, on surface water and groundwater systems. This memo outlines the methodology used to update the existing conditions models and presents key findings related to peak flows, water balance and groundwater conditions under future, uncontrolled land use scenarios.

Modelling uncontrolled conditions, without stormwater management (SWM) measures in place, provides a baseline understanding of how urbanization alone alters the natural hydrologic response. This approach isolates the effects of urban land use change on runoff, recharge and flow regime, allowing for a clearer identification of areas where management may be required. The results of uncontrolled modelling provide a basis for developing SWM strategies and establishing performance targets that will guide future controlled (i.e., with SWM measures implemented) modelling and planning.

1. Hydrology

1.1 Summary of Phase 1 Characterization

The Dundee Secondary Plan Study Area includes the headwaters of Blair Creek and Cedar Creek, both currently characterized by rural, low-intensity land uses with limited and often seasonal drainage features. Phase 1 characterization was completed using the GAWSER hydrologic model, which was based on existing-condition models for both subwatersheds.

Continuous simulation modelling using long-term climate data was applied to establish baseline water balance conditions, including runoff, evapotranspiration and groundwater recharge. Results confirmed that under existing conditions, most precipitation either infiltrates or is lost through evapotranspiration, with relatively low runoff typical of rural headwater systems.

Full details of the Phase 1 characterization are provided in Technical Memorandum 1: *Subwatershed Goals, Objectives, Targets and Draft Land Uses*.

1.2 Future Conditions Modelling Approach

The Component 2 modelling builds directly on the existing conditions GAWSER model developed under Component 1. For this phase, the existing conditions model was updated to represent future uncontrolled land use scenarios while maintaining model routing and subcatchment boundaries to ensure a like-for-like comparison of outputs, so that observed changes in hydrologic response are attributable solely to the land use scenarios rather than changes in the model geometry or structure.

Key updates included:

- Removal of hummocky topography and natural depression storage areas within anticipated development areas.
- Updated impervious values based on land use assumptions (Table 1-1).
- No stormwater management (SWM) controls assumed.
- Climate data inputs remained consistent with the Component 1 model.
- Base Time Factors (FTB) updated per GAWSER guidance for urbanized areas, as described in Tables 2-3 and 2-4.
- All other parameters (soil properties, rating curves, routing) were retained from the Component 1 validated model.

1.2.1 Future Land Use Scenarios

An area-weighted imperviousness approach was used to represent future conditions (land use scenarios). Each land use type was assigned a representative impervious percentage (Table 1-1) and a composite subcatchment imperviousness was calculated based on the proportion of land uses within each subcatchment.

Only the relevant portion of subcatchments partially within the Dundee Secondary Plan boundary were updated while the balance retained existing conditions. Increases in impervious cover were offset by corresponding reduction in pervious Hydrologic Response Units (HRUs), while the relative proportions of pervious HRUs remained unchanged.

The imperviousness assumptions for each land use category are summarized in Table 1-1. These coverage assumptions were based on the Upper Cedar Creek Scoped Subwatershed Study (Matrix Solutions Inc, 2019).

Table 1-1: Impervious Coverage Percentage by Land Use

Land Use Category	Impervious Coverage (%)
Low Density Residential	50
High Density Residential	78
Natural Heritage	0
Urban Centre	85
Cultural Heritage Resources	50
Nodes (Mixed Use)	83

Scenario A and Scenario B reflect different land use scenarios for the Dundee Secondary Plan Area, but total imperviousness is broadly similar. Tables 1-2 through 1-4 summarize subcatchments areas, imperviousness, and HRU distributions under existing and future scenarios.

Table 1-2: Subcatchment Characteristics for Existing Conditions

ID	Area (km ²)	HRU 1 (imperviousness)	HRU 2	Hydrologic Response Unit (HRU) Distributions							
				HRU 3	HRU 4	HRU 5	HRU 6	HRU 7	HRU 8	HRU 9	FTB
101	0.69	0.4	9.6	0	49	0	0	0	0	41	5
101-1 Forest	0.06	0	0	0	0	0	0	24.5	75.5	0	5
101-2 Silt	0.16	0	100	0	0	0	0	0	0	0	5
102	0.24	0.2	10	0	6.6	5	21.4	13.7	43.1	0	5
103	0.15	0.4	11	0	24	14	50.6	0	0	0	5
104	0.29	0.1	11	0	31	14	43.9	0	0	0	5
105	0.25	0.1	10	0	30	16	43.9	0	0	0	5
105-1 Forest	0.03	0	0	0	0	0	0	24.5	75.5	0	5
105-2 Silt	0.05	0	100	0	0	0	0	0	0	0	5
106	0.39	0.1	10	0	30	0	0	0	0	59.9	5
107	0.07	1.8	0	0	68.2	7.5	22.5	0	0	0	5
111	0.47	1.8	10	0	29	15	40.2	1	3	0	5
301	1.17	3.6	10.4	0	53.4	6.7	16.5	7.7	1.7	0	5
302	0.51	5.8	10	0	29	15	40.2	0	0	0	5
303	0.87	2.3	0	1.1	42.2	28.9	25.5	0	0	0	5

Table 1-3: Subcatchment Characteristics for Future Land Use Scenario A

ID	Area (km ²)	HRU 1 (imperviousness)	HRU 2	Hydrologic Response Unit (HRU) Distributions							
				HRU 3	HRU 4	HRU 5	HRU 6	HRU 7	HRU 8	HRU 9	FTB ¹
101	0.69	49	5	0	25	0	0	0	0	21	1.2
101-1 Forest	0.06	0	0	0	0	0	0	24.5	75.5	0	5
101-2 Silt	0.16	17.7	82.3	0	0	0	0	0	0	0	5
102	0.24	10	9	0	6	5	19	12	39	0	5
103	0.15	37	7	0	15	9	32	0	0	0	1.2

ID	Area (km ²)	HRU 1 (imperviousness)	Hydrologic Response Unit (HRU) Distributions								
			HRU 2	HRU 3	HRU 4	HRU 5	HRU 6	HRU 7	HRU 8	HRU 9	FTB ¹
104	0.29	65	4	0	11	5	15	0	0	0	1.2
105	0.25	50	5	0	15	8	22	0	0	0	1.2
105-1 Forest	0.03	0	0	0	0	0	0	75.4	24.6	0	5
105-2 Silt	0.05	30	70	0	0	0	0	0	0	0	5
106	0.39	56	4	0	13	0	0	0	0	27	1.2
107	0.07	7	0	0	64	7	22	0	0	0	5
111	0.47	48	5	0	16	8	20	1	2	0	1.2
301	1.17	52	5	0	27	3	8	4	1	0	1.2
302	0.51	55	5	0	14	7	19	0	0	0	1.2
303	0.87	9	0	1	39	27	23	0	0	0	5

¹FTB is the overland flow base time factor. For subcatchments with an imperviousness greater than 30%, FTB was updated to 1.2 per GAWSER guidance for urban catchments

Table 1-4: Subcatchment Characteristics for Future Land Use Scenario B

ID	Area (km ²)	HRU 1 (imperviousness)	Hydrologic Response Unit (HRU) Distribution								
			HRU 2	HRU 3	HRU 4	HRU 5	HRU 6	HRU 7	HRU 8	HRU 9	FTB ¹
101	0.69	49	5	0	25	0	0	0	0	21	1.2
101-1 Forest	0.06	0	0	0	0	0	0	24.5	75.5	0	5
101-2 Silt	0.16	17.7	82.3	0	0	0	0	0	0	0	5
102	0.24	10	9	0	6	5	19	12	39	0	5
103	0.15	37	7	0	15	9	32	0	0	0	1.2
104	0.29	62	4	0	12	5	17	0	0	0	1.2
105	0.25	44	6	0	17	9	24	0	0	0	1.2
105-1 Forest	0.03	0	0	0	0	0	0	75.4	24.6	0	5

ID	Area (km ²)	Hydrologic Response Unit (HRU) Distribution									
		HRU 1 (imperviousness)	HRU 2	HRU 3	HRU 4	HRU 5	HRU 6	HRU 7	HRU 8	HRU 9	FTB ¹
105-2 Silt	0.05	30	70	0	0	0	0	0	0	0	5
106	0.39	66	3	0	10	6	15	0	0	0	1.2
107	0.07	7	0	0	64	7	22	0	0	0	5
111	0.47	49	5	0	15	8	20	1	2	0	1.2
301	1.17	50	5	0	28	3	9	4	1	0	1.2
302	0.51	58	4	0	13	7	18	0	0	0	1.2
303	0.87	9	0	1	39	27	24	0	0	0	5

¹FTB is the overland flow base time factor. For subcatchments with an imperviousness greater than 30%, FTB was updated to 1.2 per GAWSER guidance for urban catchments

1.2.2 Single Event Modelling - Peak Flow Analysis

The GAWSER model was updated, as described earlier in Section 1.2, to represent the proposed land use scenarios and executed to generate peak flows for the 2- to 100-year return period design storm events and the Regional Storm. Consistent with the approach applied in Component 1, the 4-hour Chicago distribution has been applied. Peak flows were generated at key locations within and downstream of the Study Area, in the absence of stormwater management controls.

The simulated peak flows for future uncontrolled land use are summarized in Tables 1-5 and 1-6, and the percentage difference compared to existing conditions at key outlets is presented in Tables 1-7 and 1-8.

Table 1-5. Simulated Flow Rates for Storm Events (Scenario A)

	Flow Rate (m ³ /s)						
	2-year	5-year	10-year	25-year	50-year	100-year	Regional
Blair Creek							
Reidel Drive	3.44	5.47	6.83	8.50	9.78	11.19	17.04
New Dundee Road	0.86	1.29	1.63	2.99	5.87	8.27	30.50
Roseville Swamp Gauge 2	0.34	0.85	1.21	1.68	2.04	2.41	8.43
Cedar Creek							
Subcatchment 301	2.17	3.45	4.33	5.43	6.25	7.08	10.78
Subcatchment 302	1.57	2.48	3.08	3.84	4.40	4.96	5.39
Subcatchment 303	0.29	0.64	0.88	1.20	1.43	1.67	4.74

Tale 1-6. Simulated Flow Rates for Storm Events (Scenario B)

	Flow Rate (m ³ /s)						
	2-year	5-year	10-year	25-year	50-year	100-year	Regional
Blair Creek							
Reidel Drive	3.54	5.61	7.01	8.71	10.02	11.43	17.12
New Dundee Road	0.87	1.31	1.65	3.25	6.09	8.53	30.57
Roseville Swamp Gauge 2	0.34	0.85	1.21	1.68	2.04	2.41	8.43
Cedar Creek							
Subcatchment 301	2.11	3.39	4.27	5.37	6.20	7.03	10.76
Subcatchment 302	1.62	2.52	3.12	3.88	4.44	5.01	5.39
Subcatchment 303	0.29	0.64	0.88	1.20	1.43	1.67	4.74

Table 1-7. Percent Change in Return Period Peak Flows Under Future Uncontrolled Land Use Conditions (Scenario A) Compared to Existing Land Use Conditions

Blair Creek	Flow Rate (m³/s)						Regional
	2-year	5-year	10-year	25-year	50-year	100-year	
Reidel Drive	18596%	4891%	3093%	2289%	1874%	1593%	314%
New Dundee Road	750%	316%	252%	343%	573%	659%	99%
Roseville Swamp Gauge 2	95%	25%	17%	12%	10%	9%	1%
Cedar Creek							
Subcatchment 301	1096%	714%	625%	564%	533%	512%	168%
Subcatchment 302	1365%	947%	842%	765%	726%	698%	174%
Subcatchment 303	139%	112%	107%	103%	100%	99%	63%

Table 1-8. Percent Change in Return Period Peak Flows Under Future Uncontrolled Land Use Conditions (Scenario B) Compared to Existing Land Use Conditions

Flow Rate (m³/s)							
	2-year	5-year	10-year	25-year	50-year	100-year	Regional
Blair Creek							
Reidel Drive	19139%	5019%	3177%	2348%	1923%	1629%	316%
New Dundee Road	760%	322%	256%	382%	598%	682%	99%
Roseville Swamp Gauge 2	17%	17%	17%	18%	18%	19%	1%
Cedar Creek							
Subcatchment 301	1067%	701%	616%	557%	528%	507%	168%
Subcatchment 302	1406%	966%	855%	775%	735%	705%	174%
Subcatchment 303	138%	112%	107%	102%	100%	99%	63%

The results above indicate that, in the absence of stormwater management, future development within the Dundee Secondary Plan area will significantly increase peak flows within the Blair Creek headwaters (at Reidel Drive and New Dundee Road), with the greatest proportional increases occurring for smaller, more frequent storm events (2-year and 5-year). This reflects the conversion of largely rural, pervious lands to urbanized land uses.

Within the Cedar Creek subcatchments, peak flows are much lower overall, with more moderate increases due to the more limited extent of new urbanization.

1.2.3 Long-Term Continuous Model – Water Balance

A 53-year continuous time-series (1966 to 2019, Preston climate station) was applied to the hydrologic model to assess long-term water balance impacts. Results are reported at both the subcatchment scale and aggregated at two key outlets: the Secondary Plan Area (Reidel Drive) and the broader Blair Creek subwatershed (at Highway 401).

The results of the long-term water balance simulations are summarized in Table 1-9 for existing conditions. Tables 1-10 and 1-11 present the results for Land Use Scenarios A and B, respectively, while Tables 1-12 and 1-13 summarize the relative percentage change from existing conditions.

Table 1-9. Existing Conditions Water Balance Summary

ID	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Recharge (mm)
101 – Sand	844	374	124	347
101 – Forest	844	274	34	536
101 – Silt	844	357	345	143
102	844	392	60	392
103	844	400	104	340
104	844	391	117	336
105 – Sand	844	388	127	329
105 – Forest	844	402	18	425
105 – Silt	844	357	345	143
106	844	204	394	246
107	844	438	126	281
108	844	441	63	341
109	844	449	11	385
110	844	435	55	354
111	844	439	72	333
Cedar Creek Subcatchments				
301	844	376	176	292
302	844	369	167	308
303	844	376	141	328

Table 1-10. Water Balance Summary (Scenario A)

ID	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Recharge (mm)
101 – Sand	844	246	422	177
101 – Forest	844	388	6	450
101 – Silt	844	313	414	117
102	844	358	134	352
103	844	285	351	209
104	844	207	525	113
105 – Sand	844	248	432	164
105 – Forest	844	402	18	425
105 – Silt	844	283	463	99
106	844	225	448	171
107	844	369	187	289
108	844	384	103	357
109	844	392	41	411
110	844	380	115	350
111	844	254	418	172
Cedar Creek Subcatchments				
301	844	243	456	145
302	844	234	464	146
303	844	357	182	305

Table 1-11. Water Balance Summary (Scenario B)

ID	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Recharge (mm)
101 – Sand	844	246	422	177
101 – Forest	844	388	6	450
101 – Silt	844	313	414	117
102	844	358	134	352
103	844	285	351	209
104	844	216	506	123
105 – Sand	844	264	397	183
105 – Forest	844	402	18	425
105 – Silt	844	283	463	99
106	844	199	513	132
107	844	369	187	289
108	844	384	103	357
109	844	392	41	411

ID	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Recharge (mm)
110	844	380	115	350
111	844	251	424	169
Cedar Creek Subcatchments				
301	844	249	444	151
302	844	226	481	137
303	844	358	181	305

Table 1-12. Water Balance Future vs Existing (Scenario A) in the Study Area

ID	Imperviousness %		Runoff (mm)			Recharge (mm)		
	Existing	Future	Existing	Future	% Change	Existing	Future	% Change
101 – Sand	0.4	49	124	422	241%	347	177	-49%
101 – Forest	0	0	34	6	-82%	536	450	-16%
101 – Silt	0	17.7	345	414	20%	143	117	-18%
102	0.2	10	60	134	123%	392	352	-10%
103	0.4	37	104	351	236%	340	209	-39%
104	0.1	65	117	525	349%	336	113	-67%
105 – Sand	0.1	50	127	432	240%	329	164	-50%
105 – Forest	0	0	18	18	1%	425	425	0%
105 – Silt	0	30	345	463	34%	143	99	-31%
106	0.1	56	394	448	14%	246	170	-31%
107	1.8	7	126	187	49%	281	289	3%
108	1.8	1.8	63	103	65%	341	357	5%
109	1.8	1.8	11	41	286%	385	411	7%
110	1.8	1.8	55	115	109%	354	350	-1%
111	1.8	48	72	418	483%	333	172	-48%
Cedar Creek Subcatchments								
301	3.6	52	176	456.1	159%	292	144.9	-50%
302	5.8	55	167	464.3	177%	308	145.5	-53%
303	2	9	141	182.5	30%	328	304.4	-7%

Table 1-13. Water Balance Future vs Existing (Scenario B) in the Study Area

ID	Imperviousness %		Runoff (mm)			Recharge (mm)		
	Existing	Future	Existing	Future	% Change	Existing	Future	% Change
101 – Sand	0.4	49	124	422	241%	347	177	-49%

ID	Imperviousness %		Runoff (mm)			Recharge (mm)		
	Existing	Future	Existing	Future	% Change	Existing	Future	% Change
101 – Forest	0	0	34	6	-82%	536	450	-16%
101 – Silt	0	17.7	345	414	20%	143	117	-18%
102	0.2	10	60	134	123%	392	352	-10%
103	0.4	37	104	351	236%	340	209	-39%
104	0.1	62	117	506	333%	336	123	-63%
105 – Sand	0.1	44	127	397	213%	329	182	-45%
105 – Forest	0	0	18	18	1%	425	425	0%
105 – Silt	0	30	345	463	34%	143	99	-31%
106	0.1	66	394	513	30%	246	132	-46%
107	1.8	7	126	187	49%	281	289	3%
108	1.8	1.8	63	103	65%	341	357	5%
109	1.8	1.8	11	41	286%	385	411	7%
110	1.8	1.8	55	115	109%	354	350	-1%
111	1.8	49	72	424	489%	333	169	-49%
Cedar Creek Subcatchments								
301	3.6	50	176	443.8	152%	292	151	-48%
302	5.8	58	167	480.5	187%	308	137	-55%
303	2	9	141	181.2	29%	328	305	-7%

At the subcatchment scale, the results indicate that development produces substantial shifts in the water balance where imperviousness is highest. Runoff increases by up to 489%, in some subcatchments while recharge declines by up to 63% in some subcatchments. Evapotranspiration also decreases, though to a lesser extent.

Increases are most pronounced in upstream subcatchments such as 101, 102, 103 and 104, where annual runoff is projected to more than double compared to existing conditions. Differences between Scenarios A and B are minimal, indicating that overall runoff generation is similar under both future land use layouts.

To provide a broader context, the subcatchment-level findings were aggregated to both the Secondary Plan Area outlet at Reidel Drive and the broader subwatershed outlet at Highway 401. This allows comparison between localized impacts within the Secondary Plan Area and broader subwatershed-scale effects. The summary of this analysis is presented in Tables 1-14 and 1-15.

Table 1-14. Water Balance Summary (mm/year) – Scenario A

Location	Surface Runoff	Groundwater Recharge	Evapotranspiration
Existing Land Use Conditions			
Secondary Plan Area (Reidel Dr)	100.0	356.3	387.9
Subwatershed (at Hwy. 401)	83.1	317.3	443.8

Future Uncontrolled Land Use Conditions			
Secondary Plan Area (Reidel Dr)	385.6	193.0	265.6
Subwatershed (at Hwy. 401)	183.0	302.5	358.7
Difference (Scenario A)			
Secondary Plan Area (Reidel Dr)	285.6	-163.3	-122.3
Subwatershed (at Hwy. 401)	99.9	-14.8	-85.1

Table 1-15. Water Balance Summary (mm/year) – Scenario B

Location	Surface Runoff	Groundwater Recharge	Evapotranspiration
Existing Land Use Conditions			
Secondary Plan Area (Reidel Dr)	100.0	356.3	387.9
Subwatershed (at Hwy. 401)	83.1	317.3	443.8
Future Uncontrolled Land Use Conditions			
Secondary Plan Area (Reidel Dr)	385.6	193.0	265.6
Subwatershed (at Hwy. 401)	184.2	301.8	358.2
Difference (Scenario B)			
Secondary Plan Area (Reidel Dr)	285.6	-163.3	-122.3b
Subwatershed (at Hwy. 401)	101.1	-15.5	-85.6

At Reidel Drive, both Scenarios A and B show large changes in the water balance compared to existing conditions. Surface runoff increases by nearly 286 mm/year, while recharge decreases by 163mm/year and evapotranspiration decreases by 122 mm/year. These changes reflect the extensive imperviousness within the Secondary Plan Area, which limits infiltration and increases direct runoff to the watercourse

At the Highway 401 outlet, the same general pattern is observed, but the effects are much smaller in magnitude due to the scale of the Blair Creek subwatershed. Runoff increases by around 100 mm/year, while recharge decreases by around 15 mm/year, and evapotranspiration decreases by around 85 mm/year. These results indicate the local-scale impacts of development are moderated downstream.

Overall, these findings suggest that while development with the Secondary Plan Area would substantially alter the local water balance (without SWM controls in place), downstream effects at the broader subwatershed scale are expected to be more moderate.

1.3 Interpretation and Discussion

The modelling results highlight that future development without stormwater management controls would lead to a substantial shift in the local water balance.

At the subcatchment scale, increases in impervious cover cause a pronounced shift in the water balance, with surface runoff increasing and groundwater recharge decreasing. The most notable impacts occur in the northern and central Blair Creek subcatchments where urbanization is most pronounced. While evapotranspiration also declines slightly, the dominant effect is the redistribution of precipitation from infiltration and storage toward runoff.

The peak flow analyses reinforce this trend. Peak flows at Reidel Drive under future conditions increase by more than an order of magnitude for smaller return-period events, reflecting the conversion of pervious headwater areas to impervious surfaces. The relative increase in flow diminishes with increasing storm magnitude, indicating that the flow regime becomes much flashier, with even frequent rainfall events generating substantial peaks. This shift indicates a reduced capacity for infiltration and storage, with more runoff response to rainfall and higher peaks generated even during the smaller, more frequent storm events. Downstream of the Study Area, at New Dundee Road and the Roseville Swamp gauge, the effects of channel attenuation remain evident, with peak flow increases less pronounced than upstream.

When assessed at the Dundee Secondary Plan outlet at Reidel Drive, the overall change in water balance shows a marked increase in runoff and reduction in recharge. At the subwatershed outlet at Highway 401, the same trends are apparent but muted. This indicates that the most critical impacts are localized in the headwater subcatchments, while downstream responses are moderated by attenuation. These impacts are driven by both the increase in impervious surfaces and the removal of natural storage features and hummocky topography within the Secondary Plan area that currently promote infiltration and attenuate runoff.

Comparison of the two land use scenarios shows that the overall magnitude and direction of impacts are similar, but Scenario A results in slightly lower peak flows at Reidel Drive. In Cedar Creek, where the extent of development is smaller, differences between the two scenarios are negligible, though Scenario B maintains slightly higher recharge. Overall, Scenario A is marginally preferred for Blair Creek due to reduced peak flow impacts, while Scenario B offers some advantage for Cedar Creek by better sustaining recharge.

These findings reinforce the importance of stormwater management measures at the Secondary Plan scale to mitigate local increases in peak flows, sustain groundwater recharge and preserve baseflow contributions to Blair Creek and Cedar Creek.

2. Hydrogeology

2.1 Summary of Phase 1 Characterization

The phase 1 hydrogeologic characterization analyzed both local and regional well water levels, lithologic records, transient drive point piezometer data and the existing Waterloo Moraine FEFLOW model to form an overall conceptualization of groundwater flow within the study area:

- The upland areas on the Waterloo Moraine (i.e. west of Reidel Drive near Fisher Hallman Rd.) act as strong groundwater recharge areas and straddle a groundwater flow divide for at least three subwatersheds: Strasburg Creek north of the study area, Blair Creek from the central portion, Roseville Swamp from the southern portion, and Cedar Creek from a small southwestern portion of the study area.
- Most of the (saturated) groundwater flow in the study area is toward Blair Creek. However, changes in groundwater recharge rate due to development within the study area affect Blair Creek and other subwatersheds as the change in local groundwater levels affects groundwater flow directions to the other nearby subwatersheds such as Strasburg Creek, Upper Blair Creek, Roseville Swamp, and Cedar Creek.
- Groundwater recharge rates that exceed 300 mm/year are predicted in the upland areas of the study area where there are strong downward gradients, sandy surficial soils, and hummocky topography. Groundwater recharge migrates downward into the Upper and Middle Moraine Sands aquifers. Where

present, the Middle Maryhill Till creates a local perched system above the primary water table, which is located in the Middle Waterloo Moraine Sands unit.

- Strong downward vertical gradients drive approximately 35% of this recharge below the Middle Waterloo Moraine Sands, through the Lower Maryhill Till and Catfish Creek Till Aquitards into the Pre-Catfish Creek Aquifer. Once in this aquifer, groundwater flow is interpreted to travel northwestward towards the Region of Waterloo's water supply wells (Wells K34 and K36) in the Strasburg Well Field.
- The Upper Blair Creek headwater areas immediately west Reidel Drive receive limited seasonal groundwater discharge, particularly during times of moisture deficit, including drought periods. This limited groundwater discharge provides groundwater support to the riparian wetland complexes along the headwaters of Upper Blair Creek, but not enough to support perennial flow in Upper Blair Creek west of Reidel Drive.
- East of Reidel Drive, Blair Creek begins flowing perennially via consistent groundwater discharge, primarily from the Middle Waterloo Moraine Sands. Upper Blair Creek continues to gain more groundwater discharge as water flows downstream to Blair Creek Drive.

2.2 Groundwater Modelling Objectives and Approach

As GAWSER is a distributed hydrologic model with limited representation of the subsurface, application of the Region of Waterloo's Moraine Model, a FEFLOW groundwater flow model, was used to answer questions regarding the impact of future proposed development on the groundwater flow system. Unlike the distributed catchment and HRU-based GAWSER, the FEFLOW model is a fully discretized physical representation of the subsurface, and its domain encompasses the entire Region of Waterloo. It is therefore able to make holistic predictions regarding how changes in groundwater recharge may impact the groundwater flow system within and beyond the Blair Creek Watershed. As the Study Area lies on the eastern slope of the Waterloo Moraine, it straddles the headwaters of several watersheds. Changing the recharge in one subwatershed can impact the groundwater levels, flow patterns, and groundwater discharge in others. Consequently, this regional scale groundwater flow model was used to predict changes within this study.

The primary objective of the groundwater modelling was to determine the potential impacts of changes in groundwater recharge due to the proposed development on the local water table and groundwater discharge to surface water features such as Blair Creek, Strasburg Creek, Roseville Swamp, and Cedar Creek.

The overall approach to the groundwater modelling effort was as follows:

- update the existing groundwater flow model (Moraine Model) using recently collected data within and around the study area and evaluate the change in the model calibration because of these updates
- update the groundwater flow model with new GAWSER-simulated recharge representing future land use development under land use scenarios A and B (Discussed in Section 4.1 of the main report)
- apply the calibrated groundwater flow model to evaluate changes in shallow water level elevations, groundwater discharge to surface features, and compare to existing conditions.

The following sections provide additional details on the model updates and application.

2.2.1 Groundwater Flow Model Updates

The Region of Waterloo's Moraine Model (version 2) was updated during the Upper Cedar Creek Scoped Subwatershed Study (Matrix 2017) and the Strasburg Hydrogeology Study (Matrix, 2018) and this groundwater flow model was used as a starting point for the groundwater flow modelling applied in this study. At the beginning of this project (2021), the Region's Moraine Model (v2) was the most up to date model that was fully documented and available for use in this project.

The groundwater flow model was updated locally using the following data sources;

- 1) New water level data collected by developers, which included well and drive point piezometer data from the Grambian Lands, Activa Lands, Ormston Lands, and the Upper Blair State of Watershed Study.
- 2) Data from the Region of Waterloo's WRAS system: including manual and transducer data for all wells within 1 kilometre of the study area.
- 3) Steady state calibration datasets used in previous modelling studies: the Region's Moraine Model applied in the Tier Three Water Budget and Risk Assessment (Matrix 2012), the Strasburg Hydrogeology Study (Matrix 2018), and the Cedar Creek Subwatershed Study (Matrix 2017).

These datasets were merged, and any duplicate data was removed. The data was analyzed and used to identify where updates to the groundwater flow model were required, with an emphasis on aligning the model's geologic layer structure and parameterization with the lithology observed at the Grambian, Activa, and Ormstrom Lands Wells. These updates are discussed in detail in the Dundee Secondary Plan TM 1 (Jacobs, 2025).

2.2.2 Groundwater Recharge

One of the key objectives of the GAWSER modelling (Section 1.2) was to produce estimate of groundwater recharge for application in the Moraine Model. GAWSER does not represent the three-dimensional saturated groundwater flow system, so GAWSER's predicted change in groundwater recharge on a catchment scale was used as an input into the groundwater flow model (Moraine Model) to predict how changes in groundwater recharge may change the hydrogeological flow system.

The average recharge distribution obtained from the GAWSER "Existing Conditions" scenario was applied in the updated groundwater flow model on a subcatchment scale within the Study Area. There was little overall change in the recharge volume within the Study Area relative to the Moraine Model (v2) obtained at the onset of the project. Specifically, the mean annual groundwater recharge rate applied in the model provided at the onset of the study was 297 mm/year, and the mean annual recharge value in the updated and revised calibrated model was 305 mm/year.

2.2.3 Groundwater Model Calibration Data

A model calibration dataset was assembled to evaluate the groundwater flow model's ability to simulate observed steady-state water levels and groundwater discharge (baseflows) within and around the Study Area. A total of 142 water level targets were assembled and used for groundwater flow model calibration. The aim of the model calibration was to maintain or improve the existing model's calibration from a statistical perspective, and maintain model inputs and boundary conditions that align with our Conceptual Model of the area. Tables 2-1 and 2-2 present calibration statistics and fit to baseflow targets before and after groundwater model updates. These tables illustrate the model calibration in the Study Area was

maintained or improved, with large improvements in the match between simulated and observed baseflows in Blair Creek.

Table 2-1. Model Calibration Statistics to Observed Water Level Data

Statistic	Original Groundwater Model	Updated Groundwater Model
Mean Residual (m)	0.51	0.71
Mean Absolute Residual (m)	2.55	2.50
Root Mean Squared Error (m)	3.36	3.32
Normalized Root Mean Squared Error (%)	7	7

Table 2-2. Baseflow Calibration Statistics to Observed

Baseflow Location	Observed Range (L/s)	Original Groundwater Model (L/s)	Updated Groundwater Model (L/s)
Blair Creek at Dickie Settlement Road	146.4 to 219.6	99.9	140.3
Blair Creek at New Dundee Road	8.5 to 9.5	36.5	7.4
Cedar Creek at Cedar Road	53.6 to 80.4	207.5	205.7
Strasburg Creek at K34/K36	72.0 to 81.0	39.8	47.2

2.3 Groundwater Flow Application; Future Scenarios Results

One key output of the GAWSER model is spatially distributed groundwater recharge rates under various land use scenarios. Two future development scenarios (Scenario A and B; see Section 1.2.1) were evaluated in GAWSER and the resulting output (subcatchment scale groundwater recharge rates) were then used as input into the groundwater flow model for each scenario (Figure 2). The recharge distribution applied in the groundwater flow model under the two scenarios model are summarized in Table 2-3.

Table 2-3. Changes in Groundwater Recharge across the Study Area by Scenario

Parameter	Existing Conditions	Scenario A	Scenario B
Mean Recharge Rate (mm/year)	305	243	243
Change in Recharge (mm/year)		-62	-62
Volumetric Recharge Rate (L/s)	127	101	101
Volumetric Change in Recharge (L/s)		-26	-26

Both future development scenarios are predicted to reduce groundwater recharge rates across the Study Area by approximately 20%. The two GAWSER scenarios simulate a decrease in groundwater recharge in the development areas, as expected, and nominal increase in recharge (less than 50 mm/year) in the downstream areas, interpreted to be due to stream leakage in small areas in the downstream portion of Blair Creek.

Recharge rates from Scenario A and Scenario B were input to the FEFLOW model and run to steady state. For each scenario, the mean hydraulic head on model layer 2 (i.e., the upper water table) over each subcatchment was calculated and compared to the simulated water levels in the same model layer in the Existing conditions scenario. Results are illustrated on Figure 4, and the largest head decline is simulated to occur in the upland areas west of Reidel Drive, where groundwater recharge is reduced the most.

Absolute simulated groundwater discharge values are illustrated in Table 2-4. Simulated changes in groundwater discharge relative to existing are illustrated in Table 2-5. An additional monitoring point was added to quantify the simulated change in groundwater discharge to Roseville Swamp.

Table 2-4. Simulated Groundwater Discharge Values

Baseflow Location	Existing Conditions (L/s)	Scenario A (L/s)	Scenario B (L/s)
Blair Creek at Dickie Settlement Rd	140.25	140.05	140.12
Blair Creek at New Dundee Rd	7.44	6.87	6.89
Cedar Creek at Cedar Rd	205.71	198.96	199.06
Strasburg Creek	47.17	43.21	43.90
Roseville Swamp	40.55	39.66	39.68

Table 2-5. Simulated Reduction in Groundwater Discharge under Land Use Scenario A and B

Baseflow Location	Change In Discharge Existing to Scenario A (L/s)	Change In Discharge Existing to Scenario A (%)	Change In Discharge Existing to Scenario B (L/s)	Change In Discharge Existing to Scenario B (%)
Blair Creek at Dickie Settlement Rd	0.21	0.15	0.13	0.09
Blair Creek at New Dundee Rd	0.56	7.63	0.55	7.39
Cedar Creek at Cedar Rd	6.75	3.28	6.65	3.24
Strasburg Creek	3.96	8.40	3.27	6.94
Roseville Swamp	0.89	2.19	0.86	2.13

2.4 Interpretation and Discussion

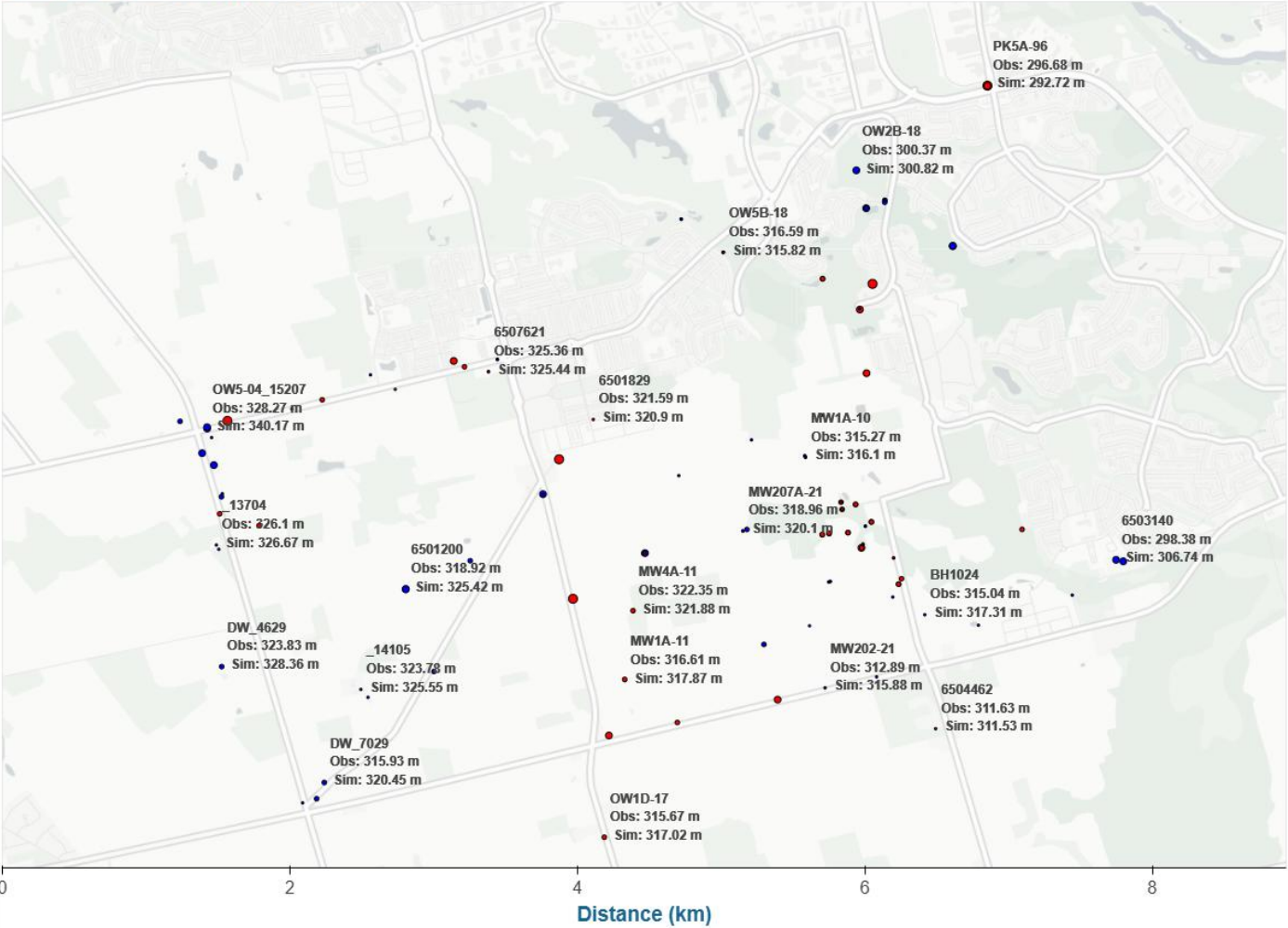
The two tested scenarios provide alternative land use layouts for proposed development. However, on the subcatchment scale, the average change in imperviousness, which is the most important parameter affecting groundwater recharge, is similar between the two scenarios. This is because the Study Area is dominated by sand-rich soils and overburden, except for a small subcatchment in the northern portion of the Study Area where silt till is present. The uniform nature of the upper soils minimizes the spatial variability of groundwater recharge in the headwater area as one change in imperviousness in one sandy area is similar to a comparable change the imperviousness in another sandy area. On the subcatchment scale, this leads to similar recharge reductions and commensurately similar changes in groundwater levels and baseflow values between the two scenarios.

Overall, both scenarios are simulated to reduce local water levels up to 3.5 m, particularly in the westernmost headwater areas: this is both due to this area having the highest recharge reduction and the underlying water table, being at or near a topographic high, relies on local/direct recharge to maintain its

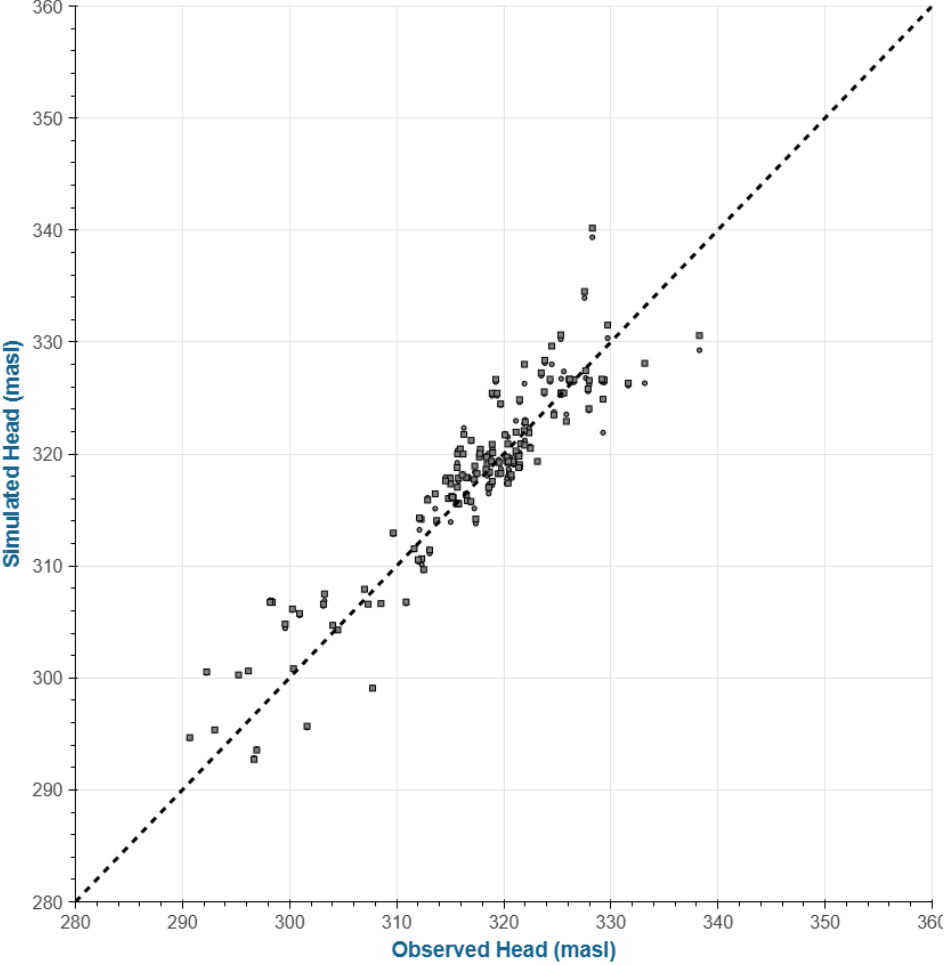
water levels. Due to the GAWSER-simulated minor recharge increase in the most downstream subcatchments, a head increase up to 30 cm is simulated.

As the greatest recharge reductions occur at or on the groundwater flow divide, the reduction in recharge results in a measurable, but relatively minor decrease in groundwater discharge at Blair Creek and its surrounding watersheds (Cedar Creek, Strasburg Creek, and Roseville Swamp). From an absolute volume perspective, baseflow at Cedar Creek is most reduced, with a decrease of 6.8 L/s. This decrease is primarily due to relatively large recharge reductions in the Cedar Creek subcatchments (1031 and 1034), as well as general erosion of the head support in its headwaters, which border Blair Creek's. However, this volumetric reduction amounts to only a 3.3% decrease in baseflow relative to its existing flow (at Cedar Rd). Strasburg Creek is similarly affected under both scenarios (losing approximately 4 L/s, or 8% of existing groundwater discharge), as the north-northwest portion of the study area, while within the Blair Creek watershed, also provides head support for the Strasburg Creek headwaters. Roseville swamp's groundwater discharge is affected somewhat less, losing less than 1 L/s of simulated groundwater discharge or approximately 2% of its existing discharge volume. Blair Creek itself is the least affected, with a predicted change of only 0.2 L/s, or 0.2% of its existing groundwater discharge. This may be because Blair Creek sources a larger portion of its groundwater discharge from local, downstream sources east of Reidel Drive, where slight increases in groundwater recharge were simulated by GAWSER and helped moderate the changes, or it may be because the groundwater discharge is sourced from deeper groundwater sources such as the Pre-Catfish Creek aquifer.

Plan View Calibration Residuals



Calibration Scatterplot



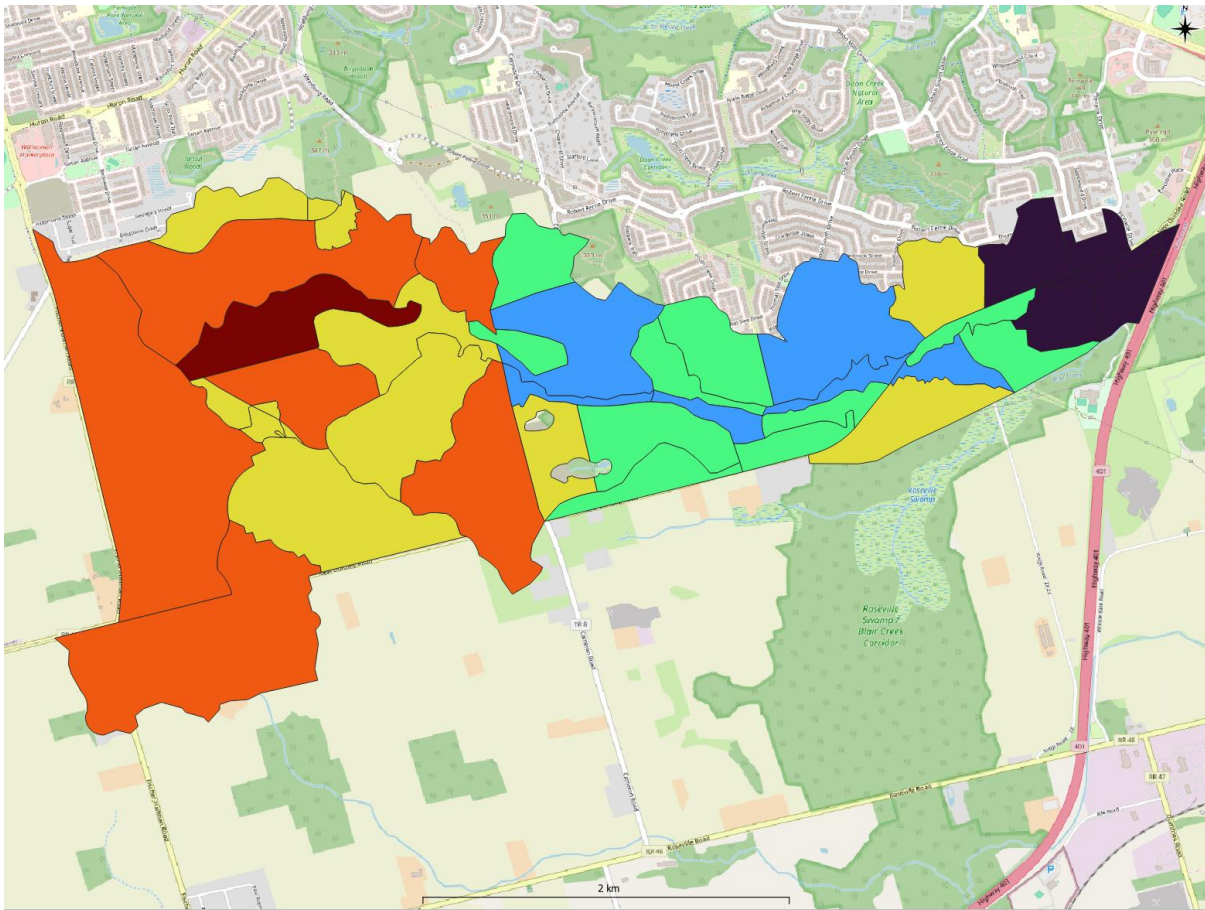
Plan View Residual (Obs – Sim)

- <-5 m
- -5 to -3 m
- -3 to -1 m
- -1 to 0 m
- 0 to 1 m
- 1 to 3 m
- 3 to 5 m
- >5 m

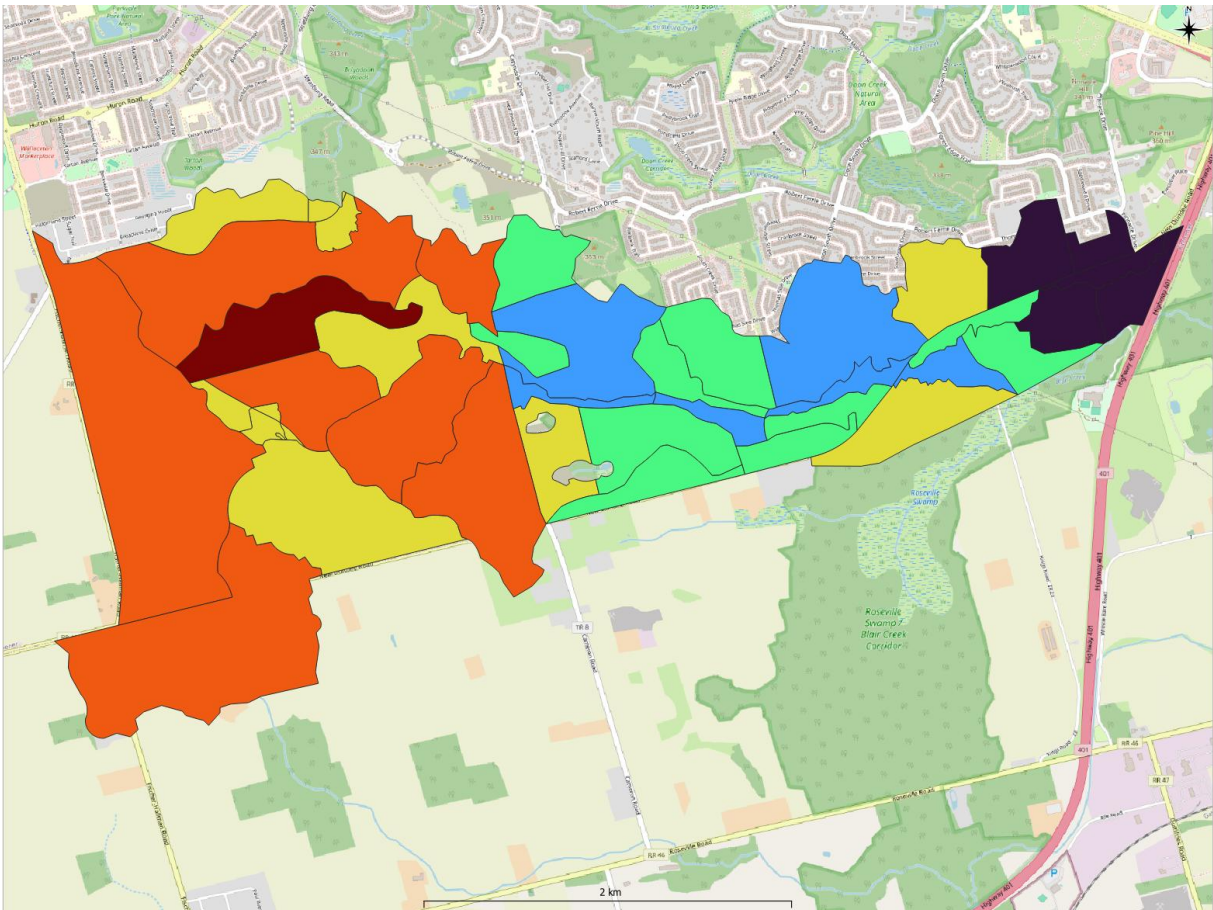
Scatterplot

- Base Model
- Updated Model

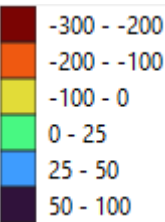
SCENARIO A



SCENARIO B



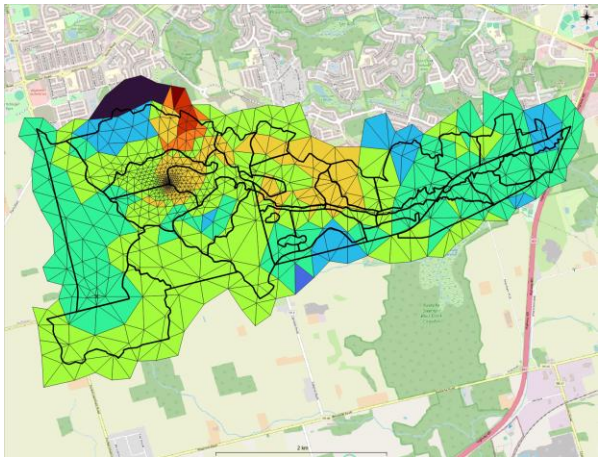
Change in Recharge From Existing (mm/a)



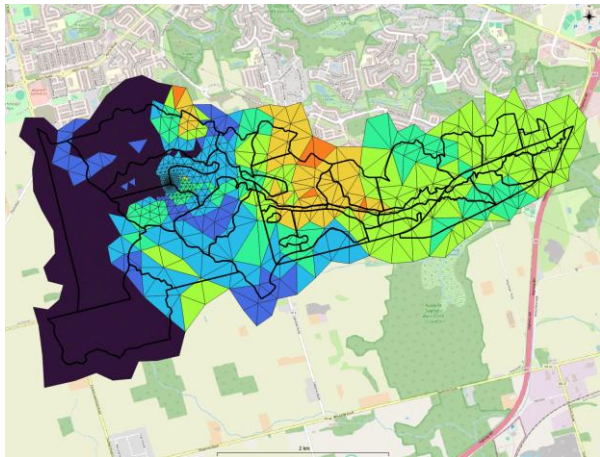
Phase 2 Component 2 – Modelling Memo: Groundwater Model

GAWSER Simulated Change in Recharge

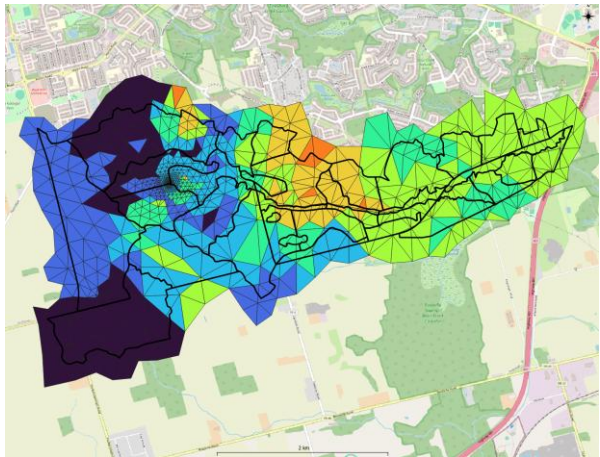
EXISTING



SCENARIO A



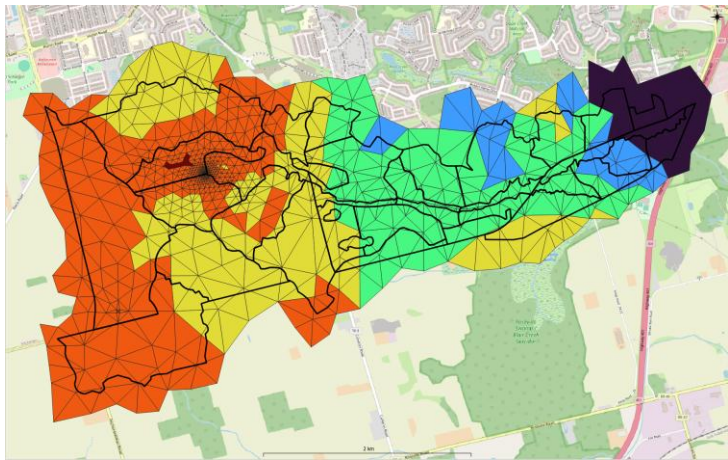
SCENARIO B



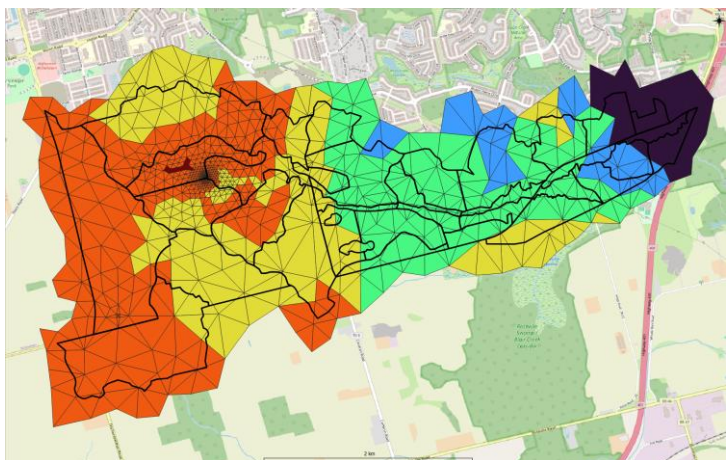
Recharge Rate (mm/a)



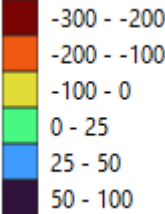
SCENARIO A



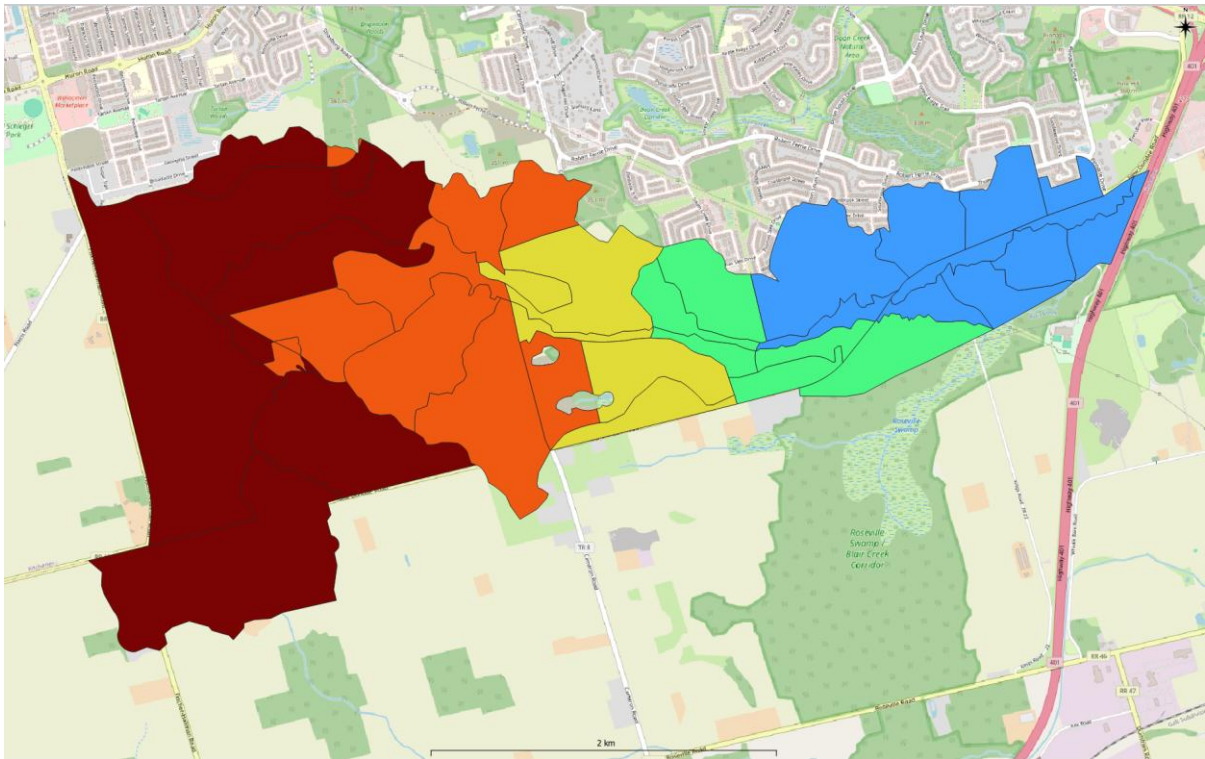
SCENARIO B



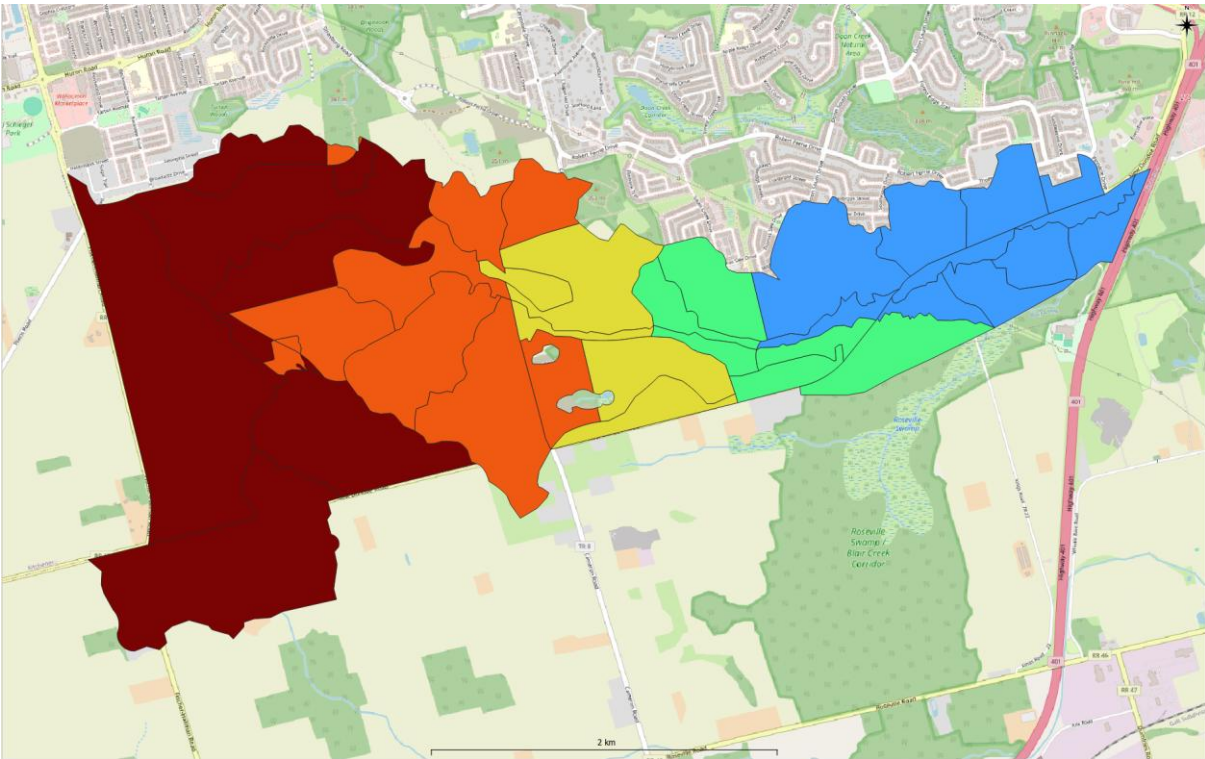
Change in Recharge
From Existing
(mm/a)



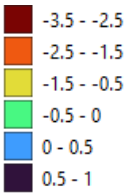
SCENARIO A



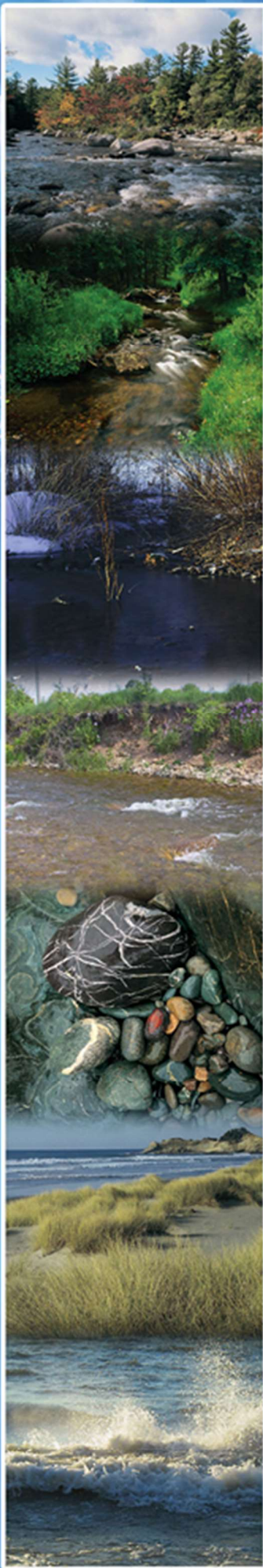
SCENARIO B



Simulated Change in Head (m)



Appendix B. Fluvial Geomorphology



**Blair Creek (Dundee North)
Stream Morphology
Monitoring Program**

2021 Report

**Prepared for:
Jacobs
&
City of Kitchener**

April 18, 2022

April 18, 2022
WE 21042

Mr. Tom Mahood, P.Eng.
Jacobs
72 Victoria Street South, Suite 300
Kitchener, ON
N2G 4Y9

Dear Mr. Mahood:

**RE: Blair Creek (Dundee North) Stream Morphology Monitoring Program
2021 Monitoring Report**

Water's Edge is pleased to submit the 2021 Stream Morphology Monitoring Report to support development in the Blair Creek Subwatershed within the City of Kitchener.

1 METHODOLOGY:

Our methodology generally follows the recommended monitoring framework set out by the Blair Creek State of the Watershed Report as seen in **Table 1** and completed for the Grand River Conservation Authority for the lower reaches of Blair Creek by Water's Edge from 2016 to 2021.

Conditions were assessed in the Fall 2021 at four cross sections that were established during an initial site inspection with Study Team staff (**Figure 1**, attached). During the inspection, field crews followed a similar methodology and made observations through the creek reach in order to provide future insights and comparisons into creek responses. Staff installed erosion pins and monumented four cross sections. Sediment samples were collected and assessed to determine particle distribution. Photographs were taken of each cross section.

Data was collected in Fall 2021 (November 25 and December 14, 2021). Future monitoring should maintain seasonal consistency throughout the monitoring campaign to ensure that the conditions are assessed under similar seasonal stressors.

The following sections provide further detail on the methodology.

1.1 Cross-Sectional Surveys

- Four (4) cross-sections have been marked for continued monitoring (**Figure 1**, attached) with rebar acting as georeferenced control points at either end. The lowest of these two bars will be used as the "bankfull" elevation for cross-section area and depth calculations to ensure consistency between data collection as bankfull markers can change depending on the season and recent conditions. Provided that the same "bankfull" marker is used, the channel depth and cross-sectional area can be directly compared from year to year.
- Surveys were performed using a high-accuracy GPS and total station. Where the total station was used, control points were first shot with the GPS to tie in with the geodetic survey.
- Cross-sections were surveyed from rebar to rebar, using a measuring tape to guide the survey rod (prism). The tape can be used as a visual guide for the surveyor and to frame photographs. Future surveys should be calibrated to the Fall 2021 survey (red line in plots).
- Points were not surveyed at regular intervals. Instead, inflection points were captured along the cross-section, increasing survey resolution for more complex areas of the channel.

- In locations where there were loose sediment deposits, the survey rod was held at the top of the deposit.
- Excel is utilized for displaying trends and create cross-section plots displaying the 2021 cross-sections. Surveyed cross-section locations can be seen in **Figure 1**, cross-section plots can be found in **Appendix B** and a cross-section summary can be seen in **Table 5**.

1.2 Site Photographs

- Site photographs are taken during each site inspection, providing a continuous photographic record of how the channel adjusts over time.
- Photographs are taken looking upstream, downstream, to the right bank (relative to downstream) and to the left bank (relative to downstream).
- Site photography can be seen in **Appendix A**.

1.3 Erosion Pins

- Erosion pins (EPs) were set depending on the stream geometry at the cross-section. For straight channels, they were set at the cross-section banks. If conditions did not allow for a pin to be placed at the cross-section, such as very shallow banks or woody debris set into the bank, the pin was placed immediately up or downstream depending on the bank conditions. For cross-sections placed at or near a meander bend, an erosion pin was set on the outside of that bend.
- EPs were initially set at 10 centimetres.
- EPs are measured using a metre stick from the bank to the end of the pin. In places with loose sediment around the pin, it was measured from where the bank begins to provide resistance to the metre stick. Note that inconsistencies with this resistance point, particularly between the spring and the fall observations can provide an over- or under-estimation of the bank migration rate, and large changes are confirmed with field observations, the cross-section survey, and aerial photography.
- A summary of the erosion pin data can be seen in **Table 4**.

1.4 Sediment Samples

- Bulk sediment samples were collected during the Fall 2021 field work and analyzed using a wet sieve analysis.
- Samples were collected using a shovel in an area that provided a good representation of the surrounding bed material. In places with unconsolidated, or mucky, deposits only native bed material was sampled.
- A summary of the sediment sample data can be seen in **Table 5**.

1.5 Geomorphic Assessments

- Rapid Geomorphic Assessment (RGA) and Rapid Stream Assessment Technique (RSAT) evaluations were performed in Fall 2021. Continued implementation of this analysis on an annual basis may assist in identifying when changes occurred on an annual basis rather than over a longer period. When executed annually and consistently by experienced staff, the results from these assessments will show how the stream is adjusting to changes in the watershed.
- Since cross-sections at the same site will generally exhibit similar characteristics, they were assessed as a group and individual features were presented for the cross-section assessments.
- RGA and RSAT results can be seen in **Tables 2** and **3** respectively, with the full assessment available in **Appendix C**.

1.6 Flow Assessment

- A critical discharge can be determined for the site based on an erosion threshold value determined from site data.

- Using flow data provided by the GRCA (monitoring station at Reidel Road near XS-D), an initial erosion threshold assessment can be determined at this site.
- Future monitoring should develop the threshold and determine the excess time that the erosion threshold was exceeded based on annual flow volumes.

1.7 Analysis

- Cross-section data (area, mean depth, and maximum depth) has been determined and can be used for comparison in future years. An average annual rate can also be calculated (percent adjustment based on the complete length of record).

1.8 Discussion

- Observations of Blair Creek were made during the 2020 site inspection, and these were compared against the photo and field note record that has been completed over the last 5 years.

2 RESULTS

Based on the methodology discussed above, the following data were collected:

- Cross-Section Photographs – see **Appendix A**
- Rapid Stream Assessment Technique – see **Table 2** for summary and **Appendix C** for details
- Rapid Geomorphic Assessment – see **Table 3** for summary and **Appendix C** for details.
- Erosion Pin Data – see **Table 4**
- Cross-Section Data and Plots – see **Table 5** and **Appendix B** respectively
- Sediment Data – see **Table 5**

3 SUMMARY AND CONCLUSIONS

3.1 Summary

As development expands throughout southern Kitchener within the watershed of Blair Creek, the GRCA has been leading environmental monitoring efforts within Blair Creek to assess baseline conditions and the effectiveness of SWM practices. The State of the Watershed Report was prepared to review the status of Blair Creek and assess the existing data and methods to provide recommendations for a refined program moving forward. For the geomorphic monitoring component, recommendations were made to expand the spatial distribution and the level of detail for some parameters, while discontinuing less effective or less critical methods of data collection. The recommended list of parameters for measurement and indicator targets for assessing the effectiveness of SWM are summarized in **Table 1**. Similar to the program implemented for the downstream reaches of Blair Creek by the GRCA, Water's Edge has initiated a similar program for the upper reaches of Blair Creek within the Dundee area.

The following summarizes the key features of the geomorphic monitoring as per the terms of reference agreed upon between Water's Edge, Jacobs, and the City of Kitchener:

- Four (4) new cross-sections (**Figure 1**, attached) were established to evaluate future conditions in the creek. Each cross-section was assessed using the same methodology as site conditions allowed;
- A geodetic survey was completed using a high accuracy GPS and Total Station to provide a plot for each monitored cross section in the Spring and Fall of each year. Control points were added using stable rebar placed perpendicular into the floodplain and set back from the top of bank on either side of the channel. The lowest top of these acts as the "bankfull" elevation marker for analysis to ensure consistency in the cross-section assessment. Results of the survey can be seen in **Table 5** and **Appendix B**;

- Erosion pins (rebar) were installed and marked at the cross sections, in addition to upstream and downstream as appropriate. They were measured from the tip until the bank provided resistance. Results can be seen in **Table 4**;
- Sediment samples were obtained at each site in 2021 in order to establish a baseline condition and allow for future observations of trends in sediment size. Samples were wet-sieved, and the results can be seen in **Table 5**;
- A photographic record of each cross-section was completed with views upstream, downstream, left bank and right bank (relative to downstream). Photos can be seen in **Appendix A**;
- RGA and RSAT assessments were completed at each site. Assessments are summarized in **Tables 3 and 4**; and,
- It is the intent that future monitoring will allow for comparisons between the initial data collection in 2021 and future years to identify where thresholds have been exceeded over time.

3.2 Conclusions

Water's Edge has completed the baseline monitoring for the Blair Creek (Dundee) Study Area and this summary will allow for effective monitoring in the future.

3.3 Future Considerations

We recommend that bi-annual monitoring be initiated to allow for comparisons to the baseline data established in this study.

We further recommend that surveys and photographs be completed bi-annually but that sediment sampling occur annually during the Fall inspection.

We trust this report meets the requirements laid out in the Terms of Reference to the satisfaction of the Jacobs and the City of Kitchener.

Should you have any questions please do not hesitate to contact the undersigned.

Respectfully submitted,



Ed Gazendam, Ph.D., P. Eng.,
President, Sr. Geomorphologist
Water's Edge Environmental Solutions Team Ltd.

Attachments:

Figure 1:	Cross-Section Locations
Table 1:	Blair Ck SOW Monitoring Summary
Table 2:	RSAT Summary
Table 3:	RGA Summary
Table 4:	Erosion Pin Summary
Table 5:	Cross Section and Sediment Summary
Appendix A:	Site Photography
Appendix B:	Cross-Section Plots
Appendix C:	RGA and RSAT Data Sheets

References:

Aquafor Beech Limited, 2009. State of the Watershed Report (SOW), Upper Blair Creek. Prepared for the Corporation of the City of Kitchener.

CH2M Gore & Storrie Limited, 1997. Blair-Bechtel-Bauman Creeks Subwatershed Plan. Prepared for the Grand River Conservation Authority.

Parish Geomorphic Limited, 2009. Blair Creek Erosion Thresholds Review and Update. Prepared for Stantec Consulting Limited.

Parish Aquatic Services, 2014. Blair Creek Geomorphic Monitoring Study, Monitoring Results – 2014. Prepared for Grand River Conservation Authority.

Stantec Consulting Limited, 2009. Upper Blair Creek (Kitchener) Functional Drainage Study Final Report, Volume 1. Prepared for City of Kitchener.

Water's Edge, 2017. Blair Creek Stream Morphology Monitoring Program – 2016 Monitoring Report.

Water's Edge, 2018. Blair Creek Stream Morphology Monitoring Program – 2017 Monitoring Report.

Water's Edge, 2019. Blair Creek Stream Morphology Monitoring Program – 2018 Monitoring Report.

Water's Edge, 2020. Blair Creek Stream Morphology Monitoring Program – 2019 Monitoring Report.



Figure 1: Location of Monitored Cross Sections

Table 1: Summary of proposed stream morphology monitoring parameters and indicator targets
(Adapted from SOW Report - Table 4.4.1)

Monitoring Parameter	Existing Conditions	Indicator Monitoring Target
Stream flow volume and hours of erosion discharge	<u>XS-4 (Dickie Settlement gauge)</u> 2-Year Discharge: 2.84 m³/s Bankfull Discharge: 2.62 m³/s (Parish, 2009) Critical Discharge: 0.4 m³/s <u>Average Annual Exceedances over 5-year Periods</u> Volume of Exceedance: 2 x 10 ⁶ m³ Time of Exceedance: 700 hours	Maintain annual flow volume and hours of exceedance above critical discharge within 15% of existing conditions assessed over 5-year periods
Bankfull cross-sectional area (m²)	Reaches 3-4 (XS 1-3): 3.0 ± 0.2 m² Reach 2 (XS 4-6): 2.4 ± 0.3 m² Main Tributary Reach (XS7-9): 0.8 ± 0.1 m² Roseville Tributary Reach (XS10-12): 2.7 ± 0.3 m²	Maintain bankfull cross-sectional area (m²) within 30% of existing conditions
Average bankfull channel depth (m)	Reaches 3-4 (XS 1-3): 0.50 ± 0.05 m Reach 2 (XS 4-6): 0.40 ± 0.05 m Main Tributary Reach (XS7-9): 0.35 ± 0.05 m Roseville Tributary Reach (XS10-12): 0.55 ± 0.05 m	Maintain bankfull depth (m) within 30% of existing conditions
Bank migration rates (cm/yr)	At locations where bank migration is expected (e.g. EP 4,5,10,12,19) Migration Rates are 5-10 cm/yr (or 1-2% of bankfull width per year)	Normal migration rates ≈ 10% bankfull width over 5 years at locations where bankfull migration is expected
Substrate particle size, D ₅₀ and D ₉₀ (mm)	<u>Gravel Bed</u> Reaches 3-4 (XS 2&3): Reach 2 (XS 4&6): <u>Sand Bed*</u> Tributary Reaches (XS 7-12)	Maintain D ₅₀ and D ₉₀ particle sizes within plus or minus one order of magnitude compared to existing conditions, assess at 5-year intervals

*"Assessment of target threshold exceedances requires interpretation of site conditions and monitoring trends by a qualified geomorphologist. Further data and interpretation are required to refine the existing grain size values for sand bed channels" (ABL, 2016 pg. 253).

Table 2 - Summary of 2021 RSAT results

RSAT Parameter / Maximum Score																
Location	Channel Stability /11		Scour and Deposition /8		In-stream Habitat /8		Water Quality /8		Riparian Conditions /7		Biological Indicators /8		Total Score /50		Conditions	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
XS A	3.0		2.0		1.0		4.0		6.0		2.0		18.0		Poor	
XS B	5.0		4.0		2.0		5.0		6.0		2.0		24.0		Fair	
XS C	5.0		4.0		2.0		5.0		6.0		2.0		24.0		Fair	
XS D	3.0		3.0		1.0		4.0		6.0		2.0		19.0		Poor	

Table 3 - Summary of 2021 RGA results

	RGA Form of Adjustments								Results			
Location	Aggradation		Degradation		Widening		Planform Adjustment		Stability Index		Condition	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
XS A	0.57		0.00		0.20		0.86		0.41		In Adjustment	
XS B	0.57		0.10		0.40		0.29		0.34		Transitional	
XS C	0.57		0.10		0.40		0.43		0.38		Transitional	
XS D	0.57		0.00		0.30		0.57		0.36		Transitional	

Table 4: Erosion Pin Measurements

Cross Section	Erosion Pin (EP)	Exposure (cm)												F2021-F20XX		F2021-F20YY		Difference of A.E.R. (cm/yr)
		Fall 2021	Spring 2022	Fall 2022	Spring 2023	Fall 2023	Spring 2024	Fall 2024	Spring 2025	Fall 2025	Spring 2026	Fall 2026	Erosion (cm)	A.E.R.* (cm/yr)	Erosion (cm)	A.E.R.* (cm/yr)		
XS A	Left	10											-	-	-	-	-	
	Right	10											-	-	-	-	-	
XS B	Left	10											-	-	-	-	-	
	Right	10											-	-	-	-	-	
XS C	Left	10											-	-	-	-	-	
	Right	10											-	-	-	-	-	
XS D	Left	10											-	-	-	-	-	
	Right	10											-	-	-	-	-	

Table 5: Summary of Cross Section and Substrate Data calculated with a bankfull delineation from the top of the lowest of the two georeferencing pins. Each year shows the average between the Spring and Fall observations. X-21 % Adj. is the % adjustment between Year X and 2021. The total adjustment is based on the the adjustment from the oldest data to the 2021 data.

Parameter	Cross Section															
	A								B							
	2021	2022	2023	2024	2025	2026	X-21 % Adj	Y-21 % Adj	2021	2022	2023	2024	2025	2026	X-21 % Adj	Y-21 % Adj
Area (m ²)	0.66						#DIV/0!	#DIV/0!	0.59						#DIV/0!	#DIV/0!
Mean Depth (m)	0.12						#DIV/0!	#DIV/0!	0.12						#DIV/0!	#DIV/0!
Max. Depth (m)	0.27						#DIV/0!	#DIV/0!	0.35						#DIV/0!	#DIV/0!
D ₁₆ (mm)	0.09						#DIV/0!	#DIV/0!	0.10						#DIV/0!	#DIV/0!
D ₅₀ (mm)	0.27						#DIV/0!	#DIV/0!	0.38						#DIV/0!	#DIV/0!
D ₈₄ (mm)	3.21						#DIV/0!	#DIV/0!	6.51						#DIV/0!	#DIV/0!

Parameter	Cross Section															
	C								D							
	2021	2022	2023	2024	2025	2026	X-21 % Adj	Y-21 % Adj	2021	2022	2023	2024	2025	2026	X-21 % Adj	Y-21 % Adj
Area (m ²)	1.76						#DIV/0!	#DIV/0!	1.31						#DIV/0!	#DIV/0!
Mean Depth (m)	0.20						#DIV/0!	#DIV/0!	0.19						#DIV/0!	#DIV/0!
Max. Depth (m)	0.53						#DIV/0!	#DIV/0!	0.30						#DIV/0!	#DIV/0!
D ₁₆ (mm)	0.11						#DIV/0!	#DIV/0!	0.09						#DIV/0!	#DIV/0!
D ₅₀ (mm)	0.55						#DIV/0!	#DIV/0!	0.43						#DIV/0!	#DIV/0!
D ₈₄ (mm)	1.84						#DIV/0!	#DIV/0!	5.69						#DIV/0!	#DIV/0!



Fluvial Geomorphology

Natural Channel Design

Stream Restoration

Monitoring

Erosion Assessment

Sediment Transport

APPENDIX A:

Site Photography

Visit our Website at www.watersedge-est.ca



PHOTOGRAPH NO.: 1
FROM: XS A
LOOKING: Downstream
DATE: November 25, 2021



PHOTOGRAPH NO.: 2
FROM: XS A
LOOKING: Downstream towards left bank
DATE: November 25, 2021



PHOTOGRAPH NO.: 3
FROM: XS A
LOOKING: Downstream towards right bank
DATE: November 25, 2021



PHOTOGRAPH NO.: 4
FROM: XS A
LOOKING: Upstream
DATE: November 25, 2021



PHOTOGRAPH NO.: 5
FROM: XS B
LOOKING: Downstream
DATE: November 25, 2021



PHOTOGRAPH NO.: 6
FROM: XS B
LOOKING: Downstream towards left bank
DATE: November 30, 2020



PHOTOGRAPH NO.: 7
FROM: XS B
LOOKING: Downstream towards right bank
DATE: November 25, 2021



PHOTOGRAPH NO.: 8
FROM: XS B
LOOKING: Upstream
DATE: November 25, 2021



PHOTOGRAPH NO.: 9
FROM: XS C
LOOKING: Downstream
DATE: November 25, 2021



PHOTOGRAPH NO.: 10
FROM: XS C
LOOKING: Downstream towards left bank
DATE: November 25, 2021



PHOTOGRAPH NO.: 11
FROM: XS C
LOOKING: Downstream towards right bank
DATE: November 25, 2021



PHOTOGRAPH NO.: 12
FROM: XS C
LOOKING: Upstream
DATE: November 25, 2021



PHOTOGRAPH NO.: 13
FROM: XS D
LOOKING: Downstream
DATE: November 24, 2021



PHOTOGRAPH NO.: 14
FROM: XS D
LOOKING: Downstream towards left bank
DATE: November 24, 2021



PHOTOGRAPH NO.: 15
FROM: XS D
LOOKING: Downstream towards right bank
DATE: November 24, 2021



PHOTOGRAPH NO.: 16
FROM: XS D
LOOKING: Upstream
DATE: November 24, 2021



Fluvial Geomorphology

Natural Channel Design

Stream Restoration

Monitoring

Erosion Assessment

Sediment Transport

APPENDIX B:

Cross-Section Plots

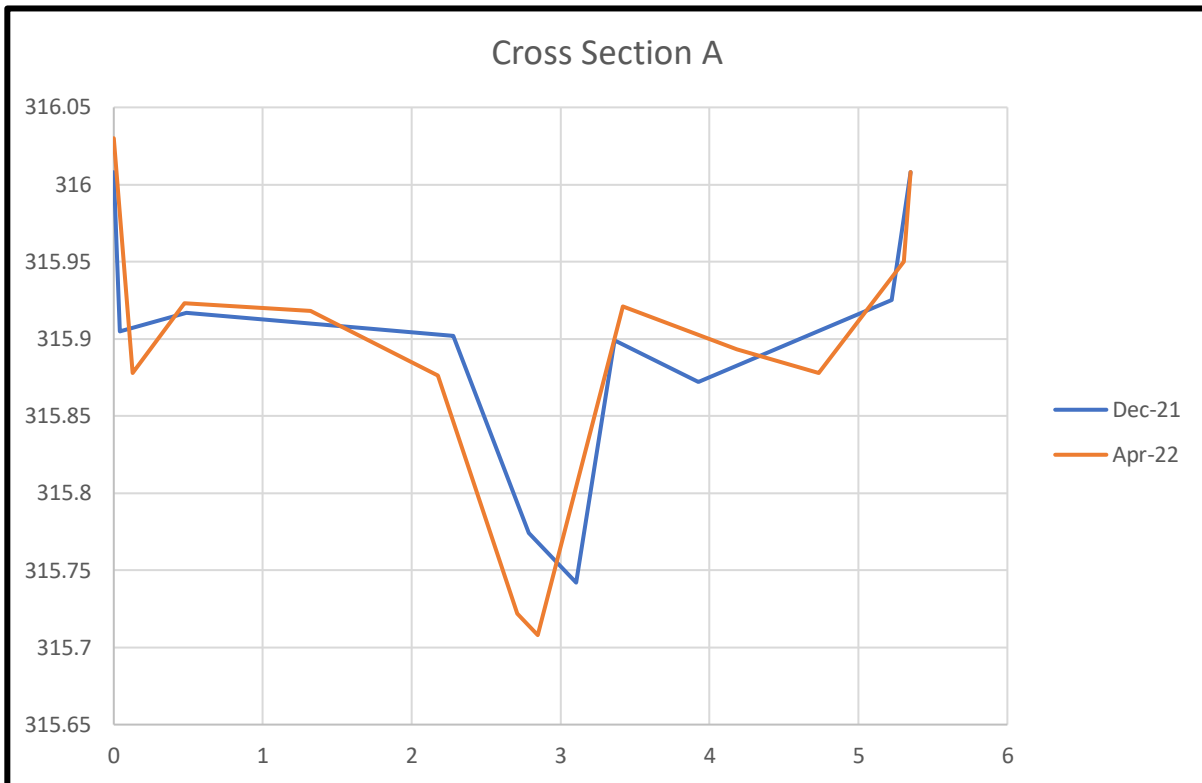


Figure 1: Cross Section A

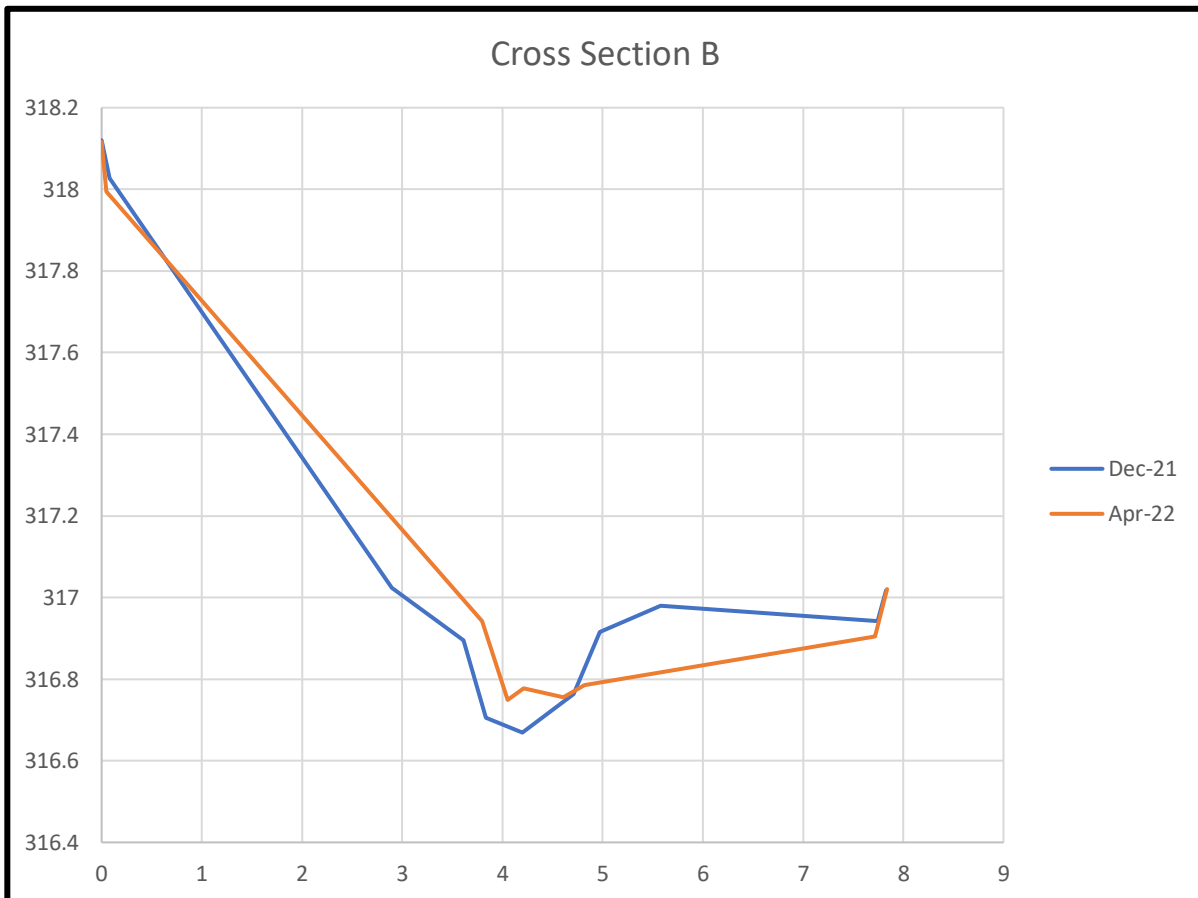


Figure 2: Cross Section B

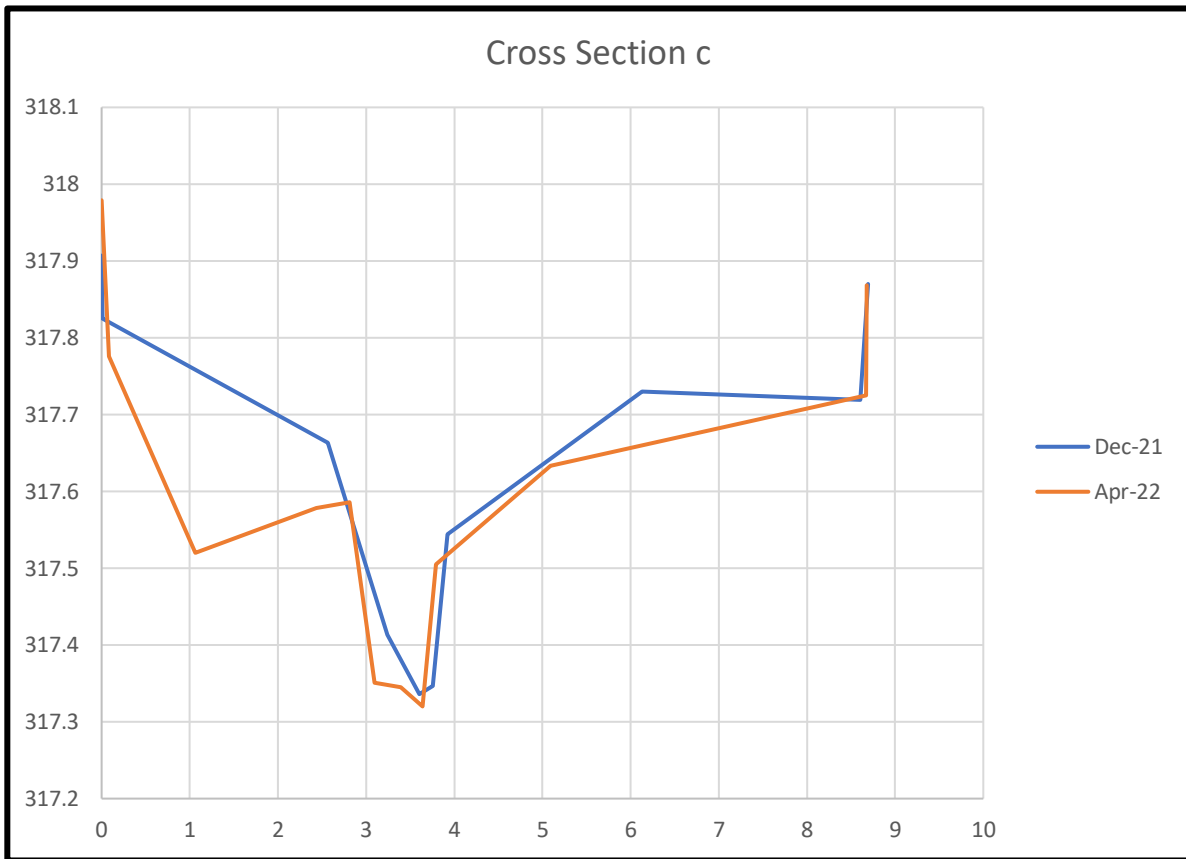


Figure 3: Cross Section C

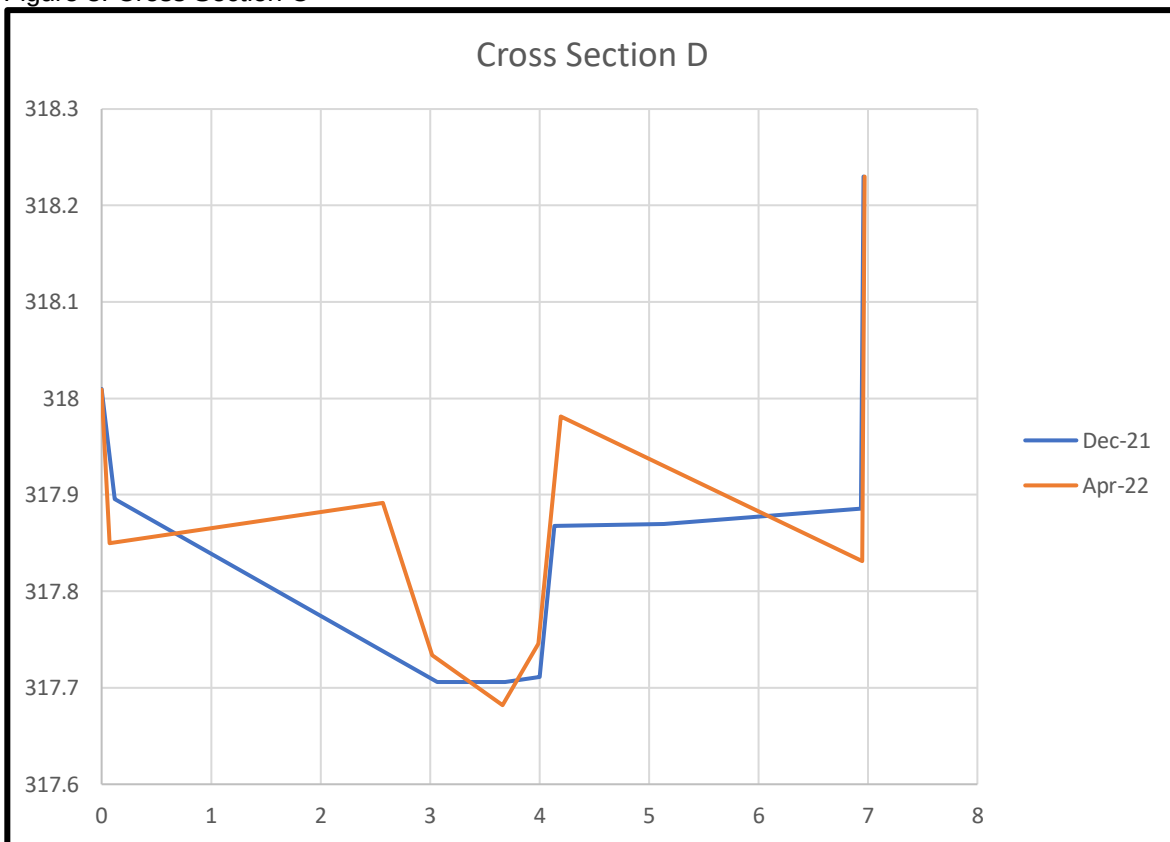


Figure 4: Cross Section D



Fluvial Geomorphology

Natural Channel Design

Stream Restoration

Monitoring

Erosion Assessment

Sediment Transport

APPENDIX C:

RGA and RSAT Field Data Sheets

RAPID GEOMORPHIC ASSESSMENT (RGA)



Creek Name: Blair Creek (Dundee)
Assessor: MR and EG
Date: Nov 25 & Dec 14, 2021

Form / Process	Geomorphic Indicator											
	No	Description	A	B	C	D						
Evidence of Aggradation (AI)	1	Lobate bar										
	2	Coarse material in riffles embedded										
	3	Siltation in pools	1	1	1	1						
	4	Medial bars										
	5	Accretion on point bars	1	1	1	1						
	6	Poor longitudinal sorting of bed materials	1	1	1	1						
	7	Deposition in the overbank zone	1	1	1	1						
		Sum of Indices	0.57	0.57	0.57	0.57	0.00	0.00	0.00	0.00	0.00	0.00
Evidence of Degradation (DI)	1	Exposed bridge footing(s)										
	2	Exposed sanitary/storm sewer/pipeline/etc.										
	3	Elevated storm sewer outfall(s)										
	4	Undermined gabion baskets/concrete aprons/etc.										
	5	Scour pools d/s of culverts/storm sewer outlets										
	6	Cut face on bar forms		1	1							
	7	Head cutting due to knick point migration										
	8	Terrace cut through older bar material										
	9	Suspended armour layer visible in bank										
	10	Channel worn into undisturbed overburden/bedrock										
	Sum of Indices	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Evidence of Widening (WI)	1	Fallen/leaning trees/fence posts/etc.		1	1	1						
	2	Occurrence of large organic debris	1	1	1	1						
	3	Exposed tree roots	1	1	1	1						
	4	Basal scour on inside meander bends		1	1							
	5	Basal scour on both sides of channel through riffle										
	6	Gabion baskets/concrete walls/etc. out flanked										
	7	Length of basal scour >50% through subject reach										
	8	Exposed length of previously buried pipe/cable/etc.										
	9	Fracture lines along top of bank										
	10	Exposed building foundation										
	Sum of Indices	0.20	0.40	0.40	0.30	0.00	0.00	0.00	0.00	0.00	0.00	
Evidence of Planimetric Form Adjustment (PI)	1	Formation of cut (s)	1									
	2	Single thread channel to multiple channel	1									
	3	Evolution of pool-riffle form to low bed relief form			1	1						
	4	Cutoff channel(s)	1			1						
	5	Formation of island(s)	1									
	6	Thalweg alignment out of phase meander form	1	1	1	1						
	7	Bar forms poorly formed/reworked/removed	1	1	1	1						
		Sum of Indices	0.86	0.29	0.43	0.57	0.00	0.00	0.00	0.00	0.00	0.00
Stability Index (SI) = (AI + DI+ WI+ PI) /m			0.41	0.34	0.38	0.36	0.00	0.00	0.00	0.00	0.00	0.00
Classification:			In Adjustment	Transitional	Transitional	Transitional	In Regime	In Regime	In Regime	In Regime	In Regime	In Regime

Classification	Stability Index	Interpretation
In Regime	SI ≤ 0.20	The channel morphology is within a range of variance for rivers of similar hydrographic characteristics and evidence of instability is isolated or associated with normal river meander processes.
Transitional/Stressed	0.21 ≤ SI ≤ 0.40	Channel morphology is within a range of variance for rivers of similar hydrographic characteristics, but the evidence of instability is frequent.
In Adjustment	0.40 ≤ SI	Channel morphology is not within the range of variance and evidence of instability is wide spread.

RAPID STREAM ASSESSMENT TECHNIQUE (RSAT) Evaluation

Creek Name: Blair Creek (Dundee)
Assessor: MR & EG

Date: Nov 25 and Dec 14, 2021



Evaluation Category	Relative Significance	Criteria	Section #												
			A	B	C	D									
1 Channel Stability	Indicative of hydrologic/flow regime alteration and general condition of physical aquatic habitat. Provides insight into past, present and possible future changes in channel morphometry	Bank Stability													
		Stream Bend Stability Outer bank													
		height/bank overhang													
		Exposed roots and falls													
		Bottom 1/3 of Bank													
		Cross-Section													
		Subtotal (0 to 11):	3.0	5.0	5.0	3.0									
2 Channel Scour and Sediment Deposition	Relates to level of uncontrolled stormwater runoff, sediment load and transport and degradation of instream habitat.	Riffle Embeddedness													
		# of deep pools / substrate													
		Streak marks/sediment deposits absent													
		large sand deposits/fresh													
		Point bar/vege/sand													
		Subtotal (0 to 8):	2.0	4.0	4.0	3.0									
3 Physical In-stream Habitat	Relates to the ability of a stream to meet basic physical requirements necessary for the support of a well-balanced aquatic community (eg: depth of flow, water velocity, water temperature, substrate type and quality, etc).	Wetted Perimeter													
		Diversity of structure, velocity and depth of flow													
		Riffle substrate													
		Riffle depth													
		Large Pool Depth													
		Channel Process													
		Riffle-Pool Ratio													
		Stream Temp. on a Summer Afternoon													
		Subtotal (0 to 8):	1.0	2.0	2.0	1.0									
		4 Water Quality	Indicative of watershed perturbations / general level of human activity, point and non-point source loads, and aquatic habitat conditions.	Substrate Fouling (on rock underside)											
Total Dissolved Solids (TDS)															
Clearness of Water															
Odour															
Subtotal (0 to 8):	4.0			5.0	5.0	4.0									
5 Riparian Habitat Conditions	Provides insight into change(s) in stream energetics, temperature regime, and both aquatic and terrestrial habitat conditions	Width of Riparian Buffer													
		Canopy coverage (Shading)													
		Subtotal (0 to 7):	6.0	6.0	6.0	6.0									
6 Biological Indicators	Best overall indication of stream health and level of watershed perturbation	Diversity of macro-invert community													
		Number of Individuals													
		Subtotal (0 to 8):	2.0	2.0	2.0	2.0									
		TOTAL SCORE (out of 50):	18.0	24.0	24.0	19.0									
		Verbal Score:	Poor	Fair	Fair	Poor									
Score		Verbal Ranking													
41 - 50		Excellent													
31 - 40		Good													
21 - 30		Fair													
11 - 20		Poor													
0 - 10		Degraded													

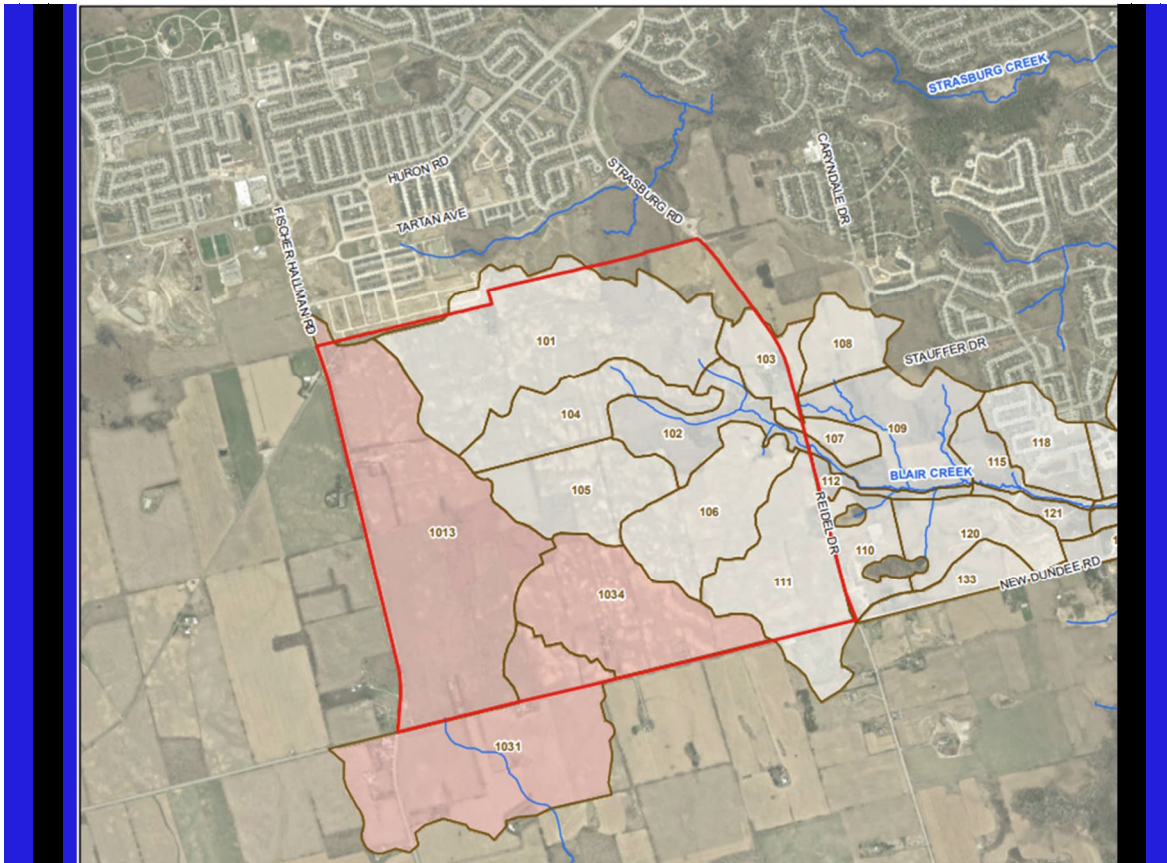
Appendix C. Stormwater Management Plan

Dundee Stormwater Management Plan Report (draft)

Document no: 0
Revision: 0

City of Kitchener
0

Dundee Secondary Plan
October 10, 2025





Dundee Stormwater Management Plan Report (draft)

Client name: City of Kitchener

Project name: Dundee Secondary Plan

Client reference: 0

Project no: CE805800

Document no:

Project manager: Tom Mahood

Revision: 0

Prepared by: various

Date: October 10, 2025

File name: Dundee_ScopedSubwatershedStudy
Report_R0

Document status:

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	10 October 2025	Draft Dundee SWM Plan	Ashraf Zaghal	Ashraf Zaghal	Jillian Schmitter Tom Mahood	J. Schmitter

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
0	October 10, 2025	October 10, 2025	City of Kitchener	Draft report

CH2M HILL Canada Limited

165 King Street West
Suite 201
Kitchener, ON N2G 1A7
Canada

T +1.519.579.3500
www.jacobs.com

© Copyright 2025 CH2M HILL Canada Limited. All rights reserved. The content and information contained in this document are the property of the Jacobs group of companies ("Jacobs Group"). Publication, distribution, or reproduction of this document in whole or in part without the written permission of Jacobs Group constitutes an infringement of copyright. Jacobs, the Jacobs logo, and all other Jacobs Group trademarks are the property of Jacobs Group.

NOTICE: This document has been prepared exclusively for the use and benefit of Jacobs Group client. Jacobs Group accepts no liability or responsibility for any use or reliance upon this document by any third party.

Statement of Limitations

This Memorandum has been prepared exclusively for internal use by the City of Kitchener (City). Any information provided by the City and third party's and relied upon is presumed to be accurate for the purposes of this report preparation. Where baseline conditions change, additional information becomes available portions of the studies conclusions may warrant re-evaluation. This Report contains observations and professional opinions reflecting Jacobs' best judgment using information understood to be factual and correct. Jacobs will not accept responsibility for conditions arising from information or facts that were concealed or not fully disclosed to Jacobs.

This Memorandum was not prepared in anticipation of any legal proceedings, nor is this Memorandum intended for use or reliance in any way in any legal proceedings related to the project, or otherwise. No liability is accepted for any use or reliance on the information provided herein by third parties. Jacobs accepts no responsibility for damages, if any, suffered by any party as a result of decisions made or actions based on this Report. No other warranty, expressed or implied, is made.

This Memorandum is to be read in full. No excerpts shall be taken to be representative of the findings. Jacobs takes no responsibility for misrepresentation or misuse of portions of this Memorandum.

Contents

Acronyms and abbreviations	1-5
1. Introduction	1-6
1.1 Document Purpose and Objectives.....	1-6
1.2 Study Area.....	1-6
1.2.1 Blair Creek Subwatershed.....	1-6
1.2.2 Cedar Creek Subwatershed	1-6
1.3 Background Review	1-6
1.3.1 Upper Blair Creek Functional Drainage Study (UBCFDS).....	1-1
1.3.2 State of the Watershed (Upper Blair Creek SOW)	1-1
1.3.3 Upper Cedar Creek Scoped Subwatershed Study	1-1
1.4 SWM Criteria and Guidelines	1-2
1.4.1 Upper Blair Creek Subwatershed Criteria	1-2
1.4.2 Cedar Creek Subwatershed Criteria	1-2
1.5 Study Approach	1-3
2. Existing Conditions.....	2-4
2.1 General Conditions.....	2-4
2.1.1 Land Use and Physiography	2-4
2.1.2 Natural Heritage.....	2-4
2.2 Hydrogeology.....	2-4
2.2.1 Hydraulic Conductivity.....	2-5
2.2.2 Local Depth to Water Table	2-5
2.3 Hydrology.....	2-5
2.3.1 Drainage Features.....	2-5
2.3.2 Hydrologic Modeling.....	2-5
2.3.3 Hydrologic Metrics	2-6
2.4 Geomorphology and Erosion Thresholds.....	2-7
2.5 Existing Infrastructure	2-7
3. Future Conditions	3-8
3.1 Land Use Scenarios	3-8
3.2 Transportation.....	3-8
3.3 Impact on Peak Flows.....	3-9
3.3.1 Blair Creek Subwatershed.....	3-9
3.3.2 Cedar Creek Subwatershed	3-9

3.4	Impact on Water Balance	3-10
3.4.1	Blair Creek Subwatershed	3-10
3.4.2	Cedar Creek Subwatershed	3-10
3.5	Evaluation of Land Use Scenarios.....	3-10
3.5.1	Catchment Hydrology Considerations.....	3-10
3.5.2	Land Use Considerations.....	3-10
4.	Identification and Evaluation of SWM Alternatives.....	4-11
4.1	Review of Alternative SWM Measures and Technologies.....	4-11
4.1.1	City-wide Considerations	4-11
4.1.2	Upper Blair Considerations	4-12
4.1.3	Upper Cedar Considerations.....	4-12
4.1.4	Development Applications.....	4-12
4.2	Preliminary SWM Strategy.....	4-14
4.2.1	Short List of Alternative SWM Measures and Technologies	4-14
4.2.2	Nature-Based Solutions for SWM	4-15
4.2.3	Land Use Considerations.....	4-16
4.2.4	Hierarchical Water-Balance Considerations.....	4-17
5.	Recommendations and Next Steps	5-19
6.	References	6-20

Acronyms and abbreviations

Acronym	Description
DSP	Dundee Secondary Plan
SKPA	Southwest Kitchener Policy
City	City of Kitchener
the Region	Region of Waterloo
BBB Study	Blair, Bechtel, and Bauman Creeks Subwatershed Plan
UBCFDS	Functional Drainage Study
SOW	State of the Watershed
CEM	Cumulative Effects Monitoring
GRCA	Grand River Conservation Authority
AMA	adaptive management approach
ICLs	impervious cover limits
MNR	Ministry of Natural Resources and Forestry
MECP	Ministry of Environment, Conservation, and Parks
SWM	stormwater management
UBC SOW	Upper Blair Creek State of the Watershed
TSS	total suspended solids
UCCSSWS	Upper Cedar Creek Scoped Subwatershed Study
ANSI	Areas of Natural and Scientific Interest
NHS	Natural Heritage System
PPS	Provincial Planning Statement
Region	Regional Municipality of Waterloo
GAWSER	Guelph All-Weather Storm Event Runoff

1. Introduction

1.1 Document Purpose and Objectives

The purpose of this Stormwater Management (SWM) Plan report is to document the existing drainage conditions within the Study Area, analyze the impacts of future land use scenarios in the context of the Dundee Secondary Plan (DSP), and provide management strategies and recommendations.

It is important to note that this report should be read in conjunction with the Hydrologic Modeling Memorandum (Scoped Subwatershed Study Report Appendix A) and its respective results, especially those covering existing conditions and future-uncontrolled conditions. The modeling of a future-controlled scenario has not been a part of the Modeling Memo. Therefore, the SWM strategy proposed in this report is presented as a high-level and conceptual input to the Scoped Subwatershed Study.

1.2 Study Area

The Study Area for the Dundee Secondary Plan (Study Area), including catchment delineation, is shown in Figure C-1. Located within the City of Kitchener (City), the Study Area is approximately 460 hectares in size (approximately 56 percent for Dundee North and 44 percent for the Southwest Kitchener Policy Area east of Fischer Hallman Road within the urban area boundary). It is bound by the limits of the Huron South Plan of Subdivision to the north, New Dundee Road to the south, Fischer Hallman Road to the west, and Reidel Road to the east.

1.2.1 Blair Creek Subwatershed

The portion of the Study Area within Blair Creek is approximately 242.37 ha and consists mainly of three tributaries in the headwaters of the Upper Blair Creek. Blair Creek is a groundwater fed coldwater perennial watercourse that flows through south Kitchener, the City of Cambridge, and the Township of North Dumfries before discharging to the Grand River.

1.2.2 Cedar Creek Subwatershed

A 195.3-hectare portion of the Study Area is a tributary to the Cedar Creek subwatershed. Cedar Creek is a perennial coldwater stream draining approximately 7,463 hectares within Kitchener and the Township of North Dumfries (Matrix Solutions et al, 2019). Cedar Creek headwaters are located on the Waterloo Moraine. Cedar Creek supports a coldwater brook trout fishery and drains primarily agricultural lands, remnant natural woodlands, and low-lying wetlands (Matrix Solutions et al, 2019).

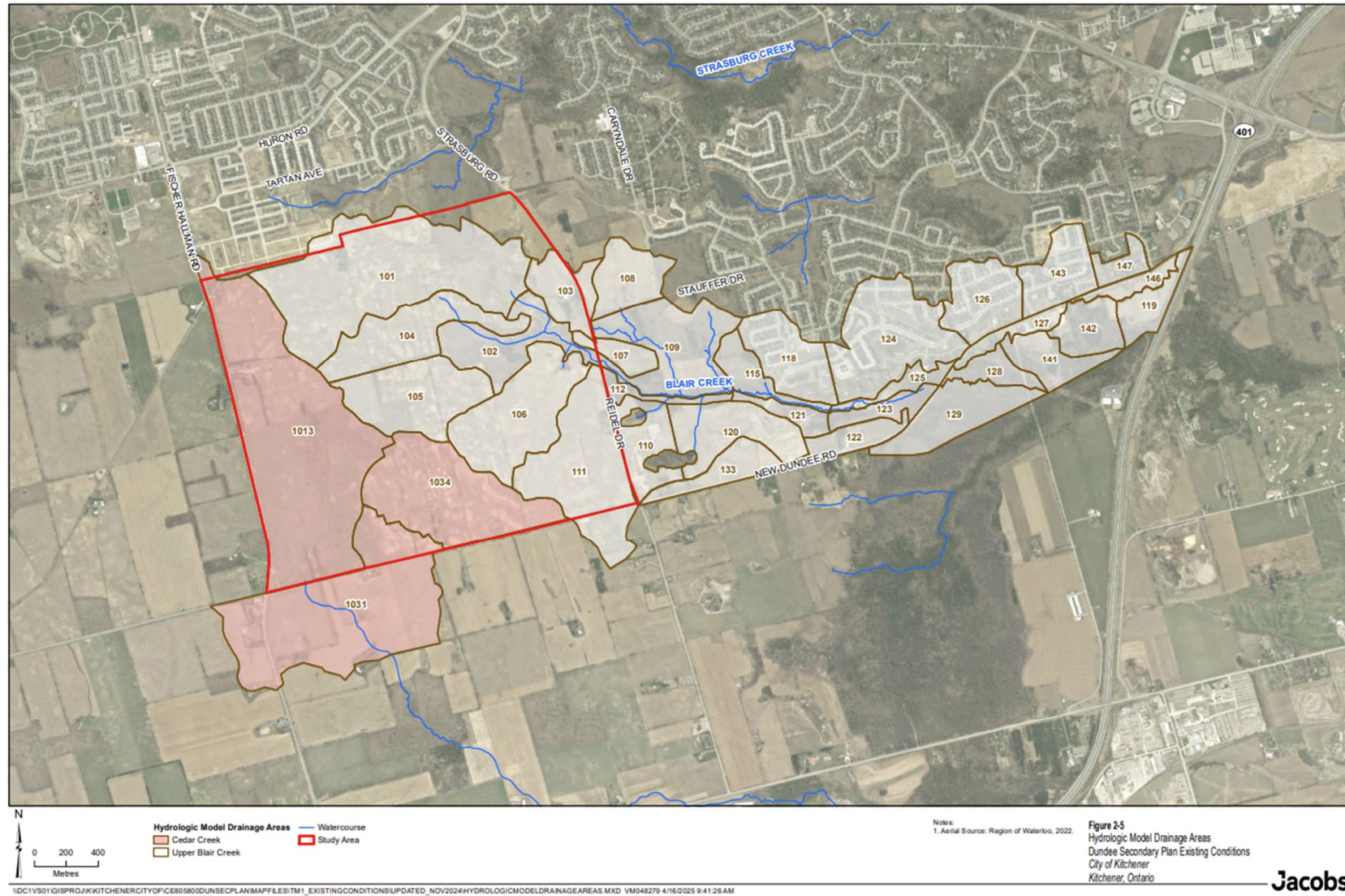
1.3 Background Review

Several studies of the Blair Creek subwatershed and Cedar Creek subwatershed have been completed. These studies include:

- Upper Blair Creek (Kitchener) Functional Drainage Study (UBCFDS) (Stantec Consulting Ltd, 2009),
- State of the Watershed (SOW) Studies, 2016 - 2020
- Upper Cedar Creek Scoped Subwatershed Study (Matrix, 2019)

The focus of this background review is drainage and stormwater management. For detailed description concerning other reports and disciplines, the reader is referred to the Scoped Subwatershed Study.

Figure C-2: Dundee Secondary Plan Study Area and Subwatersheds



1.3.1 Upper Blair Creek Functional Drainage Study (UBCFDS)

The Upper Blair Creek UBCFDS was commissioned to determine if development could be accommodated in the Upper Blair Creek Subwatershed while mitigating impacts and achieving the protections, preservation, and enhancement recommendations outlined in the original BBB Study (1997). The UBCFDS was intended to provide the Region, City, and GRCA with a technical basis for development planning within the Upper Blair Creek Subwatershed and implement a water balance approach to managing activity in the subwatershed which would limit changes to the hydrologic cycle.

The UBCFDS determined that using SWM practices on smaller sub-catchments within the watershed could allow development to proceed more flexibly. It investigated the existing geotechnical and hydrogeological conditions of the Blair Creek Subwatershed and reviewed and evaluated the SWM technologies that could promote water balance and mimic natural processes. A SWM Implementation Plan was developed based on the evaluation results. The SWM Implementation plan emphasized an Adaptive Management Approach (AMA), which serves to provide guidance on appropriately revising management approaches, monitoring protocols, and targets over time as conditions change. The UBCFDS's recommended approach includes revising targets and monitoring protocols based on the results from extensive and ongoing monitoring within the subwatershed (Stantec Consulting Ltd, 2009).

1.3.2 State of the Watershed (Upper Blair Creek SOW)

The purpose of the SOW reports is to consolidate and interpret the monitoring data collected by the City, landowners (developers), Region, and GRCA with respect to the subwatershed targets and objectives put forward in the UBCFDS. At the time of this study, three SOW Reports have been completed. These include:

- Upper Blair Creek State of the Watershed (2016 SOW) (Aquafor Beech Ltd., 2016),
- Cumulative Effects Monitoring – Blair Creek Case Study (CEA) (Grand River Conservation Authority, 2018), and
- Upper Blair Creek State of the Watershed (2020 SOW) (Jacobs Engineering Group, 2020)

Relevant findings of each report are incorporated in this report according to considerations that include but not limited to target setting, indicators, and location.

1.3.3 Upper Cedar Creek Scoped Subwatershed Study

The purpose of the Upper Cedar Creek Subwatershed Study was to inform the land use planning process within the subwatershed. Cedar Creek drains approximately 7,463 ha of primarily agricultural lands, remnant woodlands, and low-lying wetlands south and west of the cities of Kitchener and Cambridge (Matrix Solutions et al, 2019). The headwaters are located on the Waterloo Moraine, which supplies the Region with approximately 80 percent of its drinking water (Matrix Solutions et al, 2019).

This Subwatershed Study developed future land use concepts for the purposes of assessing potential impacts of development within the subwatershed (Matrix Solutions et al, 2019). It proposed a stormwater management plan that included infiltration and erosion control, water quality and chloride management, and unitary storage requirements, including the Regional Storm.

1.4 SWM Criteria and Guidelines

1.4.1 Upper Blair Creek Subwatershed Criteria

The 2009 UBCFDS established a stormwater management plan for the Upper Blair Creek Subwatershed. The plan is based on achieving the following goals (Stantec Consulting Ltd, 2009):

- **Infiltration** – maintain or increase existing infiltration volume.
- **Water Quality** – adhere to MECP guidelines or Enhanced Water Quality Standards.
- **Erosion (flow duration)** – maintain existing erosion hours by meeting flow targets and implementing stormwater management recommendations.
- **Peak Flow / Flooding** – maintain existing in-stream flow rates by meeting flow targets.

The UBCFDS identified stormwater management criteria for the subcatchments (101, 103, 104, 105, 106, and 111) within the Dundee Study Area, these are (Stantec Consulting Ltd, 2009):

- Lot-level infiltration systems are designed to accept 25 mm of runoff from roof, facilities to be over-sized by 15 percent to account for efficiency reduction over time.
- Conveyance (e.g. within parkettes) and end-of-pipe (e.g. stormwater management basin) infiltration as required to achieve a reasonable stormwater management facility drawdown time when combined with allowable surface discharge.
- 50 percent redundancy in infiltration capacity design.
- Infiltration galleries should be able to be taken 'off-line' during periods of high chloride loading.
- An "enhanced" (formerly level 1) level of water quality treatment is required – design accordance with MECP Design Guidelines.
- Storage/detention facilities designed in accordance with MECP/City guidelines capable of achieving the required peak flow reductions.

1.4.2 Cedar Creek Subwatershed Criteria

The following criteria apply to potential development within the Cedar Creek subwatershed:

- Control post-development flows to pre-development levels at the outlets to provide flood protection for downstream properties
- Reduce surface runoff volume to maintain pre-development water budget and mitigate erosion impacts
- Provide stormwater quality control to an Enhanced standard of treatment per current provincial criteria
- Manage chloride loadings to runoff, particularly from snowpack during spring freshet
- Infiltrate clean groundwater to maintain the groundwater supply to municipal wellfields, the Roseville Swamp, and the Upper Cedar Creek West Tributary

1.5 Study Approach

The Dundee Stormwater Management Plan will be completed as an integrated environmental assessment and is subject to both the Planning and Environmental Assessment Acts. It will complement and support the Dundee Secondary Plan and provide SWM background and guidelines for subwatershed planning.

This study will include the following:

- **Review of Existing Conditions:** This step will investigate the Existing Conditions for the Study Area. This memorandum documents the existing conditions needed to complete this step.
- **Review and Confirm SWM Criteria and Targets**
- **Evaluate Impact of Preferred Land Use**
- **Identify a short list of SWM measures**
- **Develop SWM Strategy**
- **Develop recommendations and identify next steps**

2. Existing Conditions

2.1 General Conditions

2.1.1 Land Use and Physiography

Lands in the Study Area are primarily designated as Prime Agriculture, Rural and Natural Heritage Conservation areas (City of Kitchener Official Plan, 2014). The Study Area is located within the Waterloo Moraine Complex, comprised of primarily sand till deposited by glaciers. The physiography of the region is generally hilly. Ground surface elevations are highest northwest of the Site and tend to decrease towards the Grand River to the east. Localized areas of lower elevation are associated with surface water features such as the Blair Creek and its tributaries or the Roseville Swamp.

2.1.2 Natural Heritage

The Study Area includes environmental features within the Region's Greenlands Network which contain defined Core Environmental Features such as Provincially Significant Wetlands and Environmentally Sensitive Policy Area (Regional Municipality of Waterloo, 2015).

To the east of the Study Area, Blair Creek flows through the provincially significant Roseville Swamp Cedar Creek Wetland Complex and the Blair Creek Wetland. The Blair Creek headwaters drain into soils of medium permeability resulting in little baseflow and measurable runoff during wet periods as well as significant infiltration. Roseville swamp is the discharge for many local and regional overburden aquifer inputs. It is a poorly drained flat area with a high storage volume which attenuates runoff resulting in bog and swamp deposits. Roseville swamp is most often saturated from groundwater and tributary discharge; therefore, precipitation contributes significantly to runoff. Blair Creek flows perennially from its confluence at Roseville swamp through the Blair Creek wetlands to the Grand River. Blair Creek wetlands have high permeability soils resulting in little runoff except for in impervious areas. Blair Creek supports a brook trout population. The fishery is highly dependent on groundwater recharge and discharge characteristics and is sensitive to changes in flow and water temperature.

The Cedar Creek catchments contain portions of the Greenlands Network (Map E1, Matrix, 2019). Core Environmental Features are located in the north and found in the form of deciduous woodlands and small swamp communities. The majority of headwater drainage features are found in agricultural fields that are actively cultivated and lack defined bed and banks.

2.2 Hydrogeology

The Study Area is located on the eastern flank of the Waterloo Moraine and is part of the Waterloo Hills physiographic region (Chapman & Putnam, 1984). Groundwater flows from the core of the Waterloo Moraine in the west, towards the Grand River in the east. The Waterloo Moraine is a significant groundwater recharge area, due to the rapid infiltration of precipitation on coarse-grained sands and gravels, and because the topographic surface is hummocky in many places, leading to a reduction in groundwater runoff. Groundwater recharge is greatest in the spring and fall when plant transpiration is low, and precipitation exceeds shallow moisture storage. Groundwater infiltrating to the water table on the Waterloo Moraine, flows downwards through the upper aquifers to the underlying deeper aquifers and then flows laterally towards the Grand River, and other nearby discharge features including Roseville Swamp, Blair Creek, and Cedar Creek.

2.2.1 Hydraulic Conductivity

Hydraulic conductivity tests have been completed across the Study Area and the interpreted hydraulic conductivity values range from 1.0×10^{-8} to 1.2×10^{-3} m/s. These values correspond to a range of values cited in literature for clay and silt to sand and gravel, respectively.

2.2.2 Local Depth to Water Table

Groundwater elevations on the Study Area are influenced by localized topographic features, surface water bodies, and discontinuous shallow aquitards create perched groundwater conditions in some areas. Hydrogeologic investigations of the Study Area (2021) found that shallow groundwater was encountered at depths ranging from 0.4 to 9.8 m below ground surface corresponding to groundwater elevations of 315.3 to 333.2 metres above sea level (m asl), with perched conditions interpreted in some areas on top of the discontinuous Upper and/or Middle Maryhill Till.

2.3 Hydrology

2.3.1 Drainage Features

The drainage features in the Study Area are located within the headwaters of two subwatersheds: the Blair Creek (to the northeast) and the Cedar Creek (to the southwest).

The portion of the Study Area within Blair Creek is approximately 242.37 ha and consists mainly of three tributaries in the headwaters of the Upper Blair Creek. The tributary creeks normally have minimal baseflow but can convey higher flows during storm events. The tributaries converge near Reidel Drive and flow southeast out of the Study Area. The creek continues to be fed by tributaries along its course. After it passes south of Dodge Drive it enters a marshland and is fed by headwaters from the Roseville Swamp. Ultimately, Blair Creek discharges to the Grand River.

The southwestern portion of the Study Area consists mainly of SKPA lands, which lie within the northwest headwaters of the Upper Cedar Creek subwatershed. This area (approximately 206.39 ha) is located north of New Dundee Road, and generally between Trussler Road and Reidel Drive. The drainage system in this area extends through agricultural fields, with largely poorly defined or undefined drainage features (swales and low areas that traverse agricultural fields), with infrequent overland flow conveyance. These areas of the Cedar Creek do, however, play a role in seasonal conveyance (extreme rainfall and snowmelt events). Cedar Creek becomes a more of a permanently flowing watercourse after it passes south of New Dundee Road, the southern boundary of the Study Area. It continues to flow southeast to the 401, and then south towards the town of Ayr where it discharges into the Nith River.

2.3.2 Hydrologic Modeling

Hydrologic modeling of the Study Area was undertaken using the Guelph All-Weather Storm Event Runoff (GAWSER) modeling program. An existing hydrologic model representing the existing conditions of the area was provided to Jacobs from the City as a starting point for modelling. For the Cedar Creek portion of the Study Area, current conditions were taken from an existing model developed for the Upper Cedar Creek Scoped Subwatershed Study (UCCSSWS) (Matrix Solutions et al, 2019), which also used the GAWSER methodology. The results of

2.3.3 Hydrologic Metrics

2.3.3.1 Peak Flows

Both the Blair Creek and Cedar Creek models were set to simulate Chicago-distribution precipitation events over four-hour duration corresponding to 25 mm, 2-, 5-, 10-, 25-, 50- and 100- year storms, as well as a 48-hour regional storm event (Hurricane Hazel). The results are presented below in Table 2-1 (Blair Creek) and Table 2-2 (Cedar Creek).

Table 2-11. Simulated Flow Rates for Storm Events (Blair Creek Model)

	Flow Rate (m ³ /s)						Regional
	2-year Storm	5-year Storm	10-year Storm	25-year Storm	50-year Storm	100-year Storm	
Reidel Drive	0.24	0.41	0.52	0.65	0.76	0.86	4.12
New Dundee Road	0.72	1.86	3.76	6.50	9.18	12.31	15.33
Roseville Swamp Gauge 2	0.06	0.19	0.42	0.81	1.17	1.55	8.37

Table 2-2 Simulated Flow Rates for Storm Events (Cedar Creek Model)

	Flow Rate (m ³ /s)						Regional
	2-year Storm	5-year Storm	10-year Storm	25-year Storm	50-year Storm	100-year Storm	
101: NW Branch d/s New Dundee Rd	0.31	0.77	1.15	1.61	1.97	2.43	4.02

2.3.3.2 Water Balance

One of the main purposes of running the GAWSER model was to calculate the contribution of precipitation to groundwater recharge. The GAWSER model was run under Continuous Mode to simulate the hydrological water balance for each defined area over a long-term period, from 1960 to 2019. The total water balance of each drainage area of the model can be represented as the following equation:

$$\text{Precipitation} = \text{Recharge} + \text{Evapotranspiration} + \text{Run-off}$$

Where precipitation represents the combined rainfall and snowfall, recharge represents the contribution to groundwater, evapotranspiration represents the amount of water that is evaporated or taken up by vegetation, and run-off is the overland flow (including through creeks and streams).

The continuous simulation indicates that the majority of rainfall would be infiltrated into the ground rather than become overland flow or direct runoff to receiving watercourses.

- Blair Creek subwatershed: 11% surface runoff, 89% evapotranspiration (53%) and infiltration (36%)
- Cedar Creek subwatershed: 5% surface runoff, 95% evapotranspiration and infiltration

These results are consistent with the characterization of the existing land use for the area, which is primarily rural, and hydrologic conditions within the two subwatersheds whereby soils exhibit low runoff and high infiltration potential. The results of the water balance analysis for the entire study area are provided in the Modeling Memo.

2.4 Geomorphology and Erosion Thresholds

Within a stream system, stability refers to a balance between erosion and sedimentation that enhances aquatic habitat and ecosystems within the subwatershed. The 2020 UBC SOW found that indicators of change for monitoring impacts on the fluvial geomorphology within the Blair Creek Subwatershed were found to be within thresholds as defined in the 2016 SOW (Aquafor Beech Limited 2016). Exceedances of thresholds have occurred; however, they are in areas which have other known impacts causing geomorphological changes, primarily due to beaver activity.

Other water quality and quantity indicators may be impacted by the observed beaver activity in the Study Area. The stream morphology monitoring concurs with the water quantity finding with respect to an observed significant increase in hours during which flows exceed the critical flow erosive threshold. At this time this exceedance of thresholds (increase of hours of erosive flows) has not resulted in observable impacts on stream morphology, however, this may change over the next monitoring period.

2.5 Existing Infrastructure

Development has proceeded within the Blair Creek Subwatershed, downstream of the Study Area. The stormwater management facilities that currently exist and are operating within the subwatershed are summarized in Table 2-3. No SWM facilities currently exist within the Cedar Creek Subwatershed.

Table 2-3. Upper Stormwater Management Facility Storage Volumes and MECP Requirements

SWM Facility	Type	Protection Level	Impervious Level (%)	MECP Required Storage Volume (m ³ /ha) ^[a]	Design Storage Volume (m ³ /ha)
Dodge Drive	Dry Pond	Basic (60% TSS Removal)	49.7	134.1	134
Hallman Groh South	Hybrid Wet Pond/ Wetland	Enhanced (80% TSS Removal)	56.4	152.3	152.5
Ormston	Hybrid Wet Pond/ Wetland	Enhanced (80% TSS Removal)	55	150	147.5
Stauffer Woods SWMF1	Wetland	Enhanced (80% TSS Removal)	57.5	107.5	107.5
Stauffer Woods SWMF 2	Wetland	Enhanced (80% TSS Removal)	63.5	113.5	113.5
Stauffer Woods SWMF 3	Hybrid Wet Pond/ Wetland	Enhanced (80% TSS Removal)	54.6	149.2	149

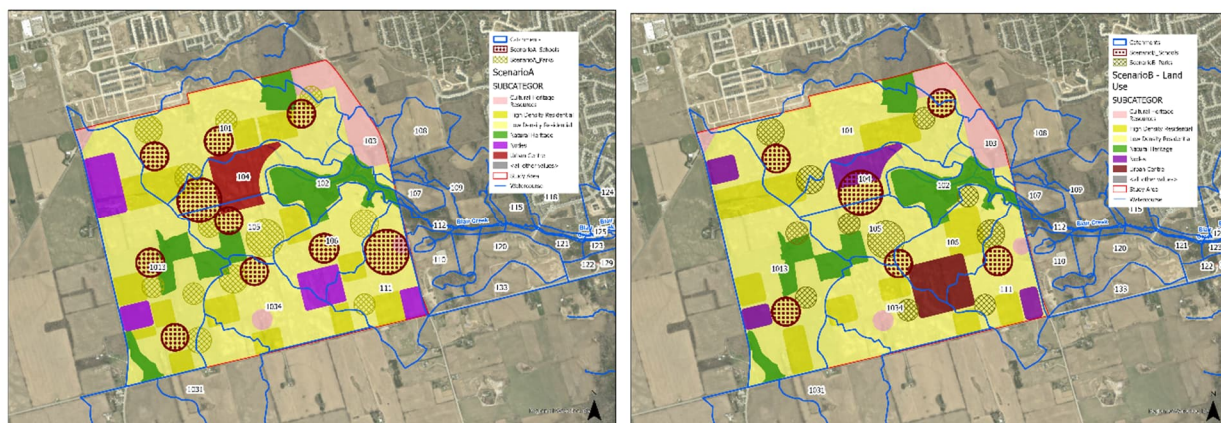
^[a] Interpolated based on Table 3.2 in MECP guidelines

3. Future Conditions

3.1 Land Use Scenarios

There are two land use scenarios for the future development of the Study Area: Scenario A and Scenario B. Total imperviousness in Scenario A is 44% compared to 46% in Scenario B. Significant impervious coverage is represented by Dundee Urban Centre, Nodes, Schools, and Residential areas (low and high density). Parks cover 37.3 hectares in Scenario A compared to 32.70 hectares in Scenario B.

Figure 3-1 Visualization of land use scenario A (Left) and Scenario B (Right)

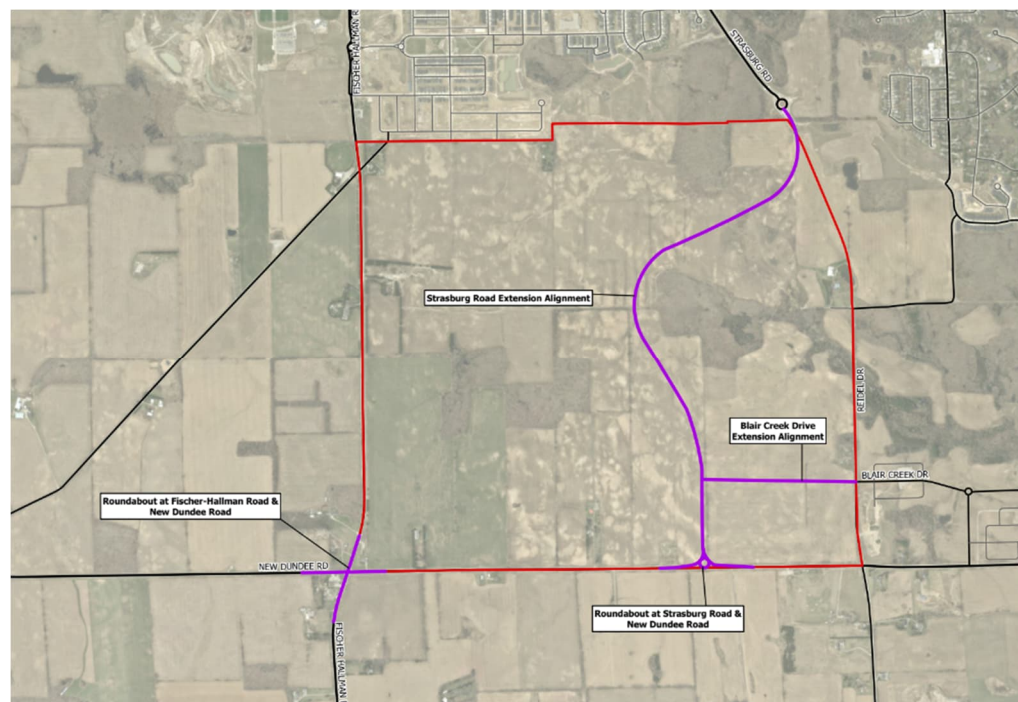


3.2 Transportation

Both land use scenarios include Strasburg Road and Blair Creek Drive extensions, identified through previously completed municipal class EAs (MTE Consultants Inc., 2024). These roads will form the primary transportation network within the Study Area. Blair Creek Drive currently runs west of Thomas Slee Drive, with a planned westward extension connection to Reidel Drive and intersecting with future Strasburg Road. According to the preferred alternative identified in the Blair Creek Extension EA, the proposed road will feature a 26.0 m right-of-way. The design includes two travel lanes and a dedicated parking lane, with sidewalks and bike lanes provided on both sides. The vehicle lanes and bike lanes will be separated by a 4.0 m wide boulevard to enhance pedestrian safety (MTE Consultants Inc., 2024).

Strasburg Road currently ends at Rockcliffe Drive, with a planned southward extension to New Dundee Road which will travel through the Study Area and will connect to New Dundee Road. According to the preferred alternative identified in the Strasburg Road Extension EA from 2013, the proposed road will feature a 30 m right-of-way and a posted speed of 60 km/h. The design includes four travel lanes and a multi-use path (MUP) on both sides. The vehicle lanes and MUPs will be separated by a 7.5 m boulevard to enhance pedestrian safety (SNC-Lavalin Inc., 2013).

Figure 3-2 Visualization of proposed roads, including Strasburg Road and Blair Creek Drive Extensions



3.3 Impact on Peak Flows

As noted in the Hydrologic Modeling Memorandum, in the absence of stormwater management, future development within the Dundee North Secondary Plan area will significantly increase peak flows ranging from the 2-year return period to the regional storm.

3.3.1 Blair Creek Subwatershed

At Reidel Drive and New Dundee Road, peak flows are predicted to be higher under Scenario B compared to Scenario A, except for the regional storm event, for which the increase in magnitude is almost the same.

At Roseville Swamp Gauge 2, Scenario A produces higher magnitudes than Scenario B for the most frequent storm events (2-year and 5-year storm events) and lower values for the less frequent storms, including the 25-year, 50-year and the 100-year storm events. The regional storm event maintains almost the same value under the two scenarios.

3.3.2 Cedar Creek Subwatershed

Compared to the Blair Creek subwatershed, the Cedar Creek subwatershed does not have the same degree of impact. More specifically, the increase of peak flow values under Scenarios A and B has similar pattern and almost the same magnitudes for return periods, ranging from the 2-year storm to the regional storm. Where no watercourse is present to receive stormwater discharge, particularly in portions of the study in the Cedar Creek Subwatershed, flooding and erosion along the overland flow path is possible.

3.4 Impact on Water Balance

The modelling results highlight that future development without stormwater management controls would lead to a substantial shift in water balance within the two subwatersheds.

3.4.1 Blair Creek Subwatershed

At Reidel Drive, where all flows from the contributing catchments converge, both Scenarios A and B show large changes in water balance compared to existing conditions. Surface runoff increases by nearly 286 mm/year, while recharge decreases by 163mm/year and evapotranspiration decreases by 122 mm/year. These changes reflect the extensive imperviousness within the Secondary Plan Area, which limits infiltration and increases direct runoff to the watercourse.

3.4.2 Cedar Creek Subwatershed

The decrease in recharge under future conditions is significant for two catchments (approximately 50%) and minor for one catchment (approximately 7%). Average recharge is very similar under Scenario A compared to Scenario B, 198.3 mm compared to 197.7 mm, respectively.

3.5 Evaluation of Land Use Scenarios

3.5.1 Catchment Hydrology Considerations

Overall, Scenario A is marginally preferred due to lower total imperviousness (44% compared to 46%). Moreover, peak flows are predicted to be generally lower under Scenario A compared to Scenario B.

3.5.2 Land Use Considerations

Scenario A contains larger area coverage of schools (46.58 ha compared to 27.15 ha for Scenario B) and more parks (37.34 ha compared to 32.70 ha for Scenario B). This difference in spatial coverage is important to consider as it promotes more pervious areas and indirectly connected impervious areas when considering stormwater management measures for infiltration and retention purposes. In addition, more schools and open space could help provide more green corridors and Natural Heritage linkages across the Study Area as will be discussed in the next chapter.

Scenario A is carried forward as the preferred land use for SWM strategies within the Study Area.

4. Identification and Evaluation of SWM Alternatives

The findings from the hydrological modeling and related analysis and metrics reinforce the importance of stormwater management measures at the Secondary Plan scale to mitigate local increases in peak flows, sustain groundwater recharge and preserve baseflow contributions to Blair Creek and Cedar Creek. Without such measures, the local hydrologic regime will shift toward more frequent and higher magnitude runoff events, increasing flood and erosion risks and degrading existing water quality and thermal regime.

4.1 Review of Alternative SWM Measures and Technologies

The review of potential SWM measures and technologies for implementation within the Study Area has included exploring guidelines and strategies considered in previous technical studies and planning documents. Among these are the Upper Blair Creek Functional Drainage Study (UBCFDS), the Upper Cedar Creek Scoped Subwatershed Study (UCCSSWS) and the City of Kitchener Integrated SWM Master Plan. Key Development Applications were also reviewed to cross-reference their proposed SWM strategies with previous technical and planning direction.

The overarching purpose of this review was to investigate conventional and innovative measures that could address the criteria stipulated in Section 1.4. The focus has been to strategize the most feasible and science-based measures that could mimic the pre-development hydrologic cycle to the extent possible and duplicate the high-infiltration/low-runoff hydrologic characteristics of the Study Area.

4.1.1 City-wide Considerations

The City of Kitchener Integrated SWM Plan and its Implementation Plan (2016) emphasized the need to continue to achieve infiltration targets to maintain the existing water balance per current approved and future subwatershed plans across the City. The SWM MP proposed a short list of SWM measures, including:

- Pollution Prevention, Municipal Management and Operation Practices, including:
 - o Sediment removal from catch-basins
 - o Immediate maintenance of sixteen (16) Oil and Grit Separators and the continued maintenance of all OGS per the recommended schedule.
- Source Controls: The Integrated SWM MP developed a social marketing strategy to improve the participation of the public in implementing lot-level measures and pollution prevention measures. The goal will be to achieve a twenty percent (20%) uptake over a five-year period, allowing the City to secure source-level SWM measures at just over 25 percent of non-residential properties by 2021.
- Conveyance Controls: Infiltration-based conveyance control measures were proposed, utilizing a “Risk-Based” approach for protecting groundwater resources for all land-uses including roads per the relevant Source Protection Plan (SPP). The City identified SWM measures that can be incorporated into the 10-year Capital Forecast for road right-of-way reconstruction (resurfacing) and full reconstruction projects until 2024 (none of those are located within the Study Area)
- End of Pipe Controls:
 - o Retrofit of ten (10) previously identified Stormwater Management Facilities
 - o Remove sediment from 16 Dry facilities and 27 wet facilities

- o Construct twelve (12) new stormwater facilities as part of park rehabilitation (none of those are located within the Upper Blair or Upper Cedar subwatershed)
- Stream System Understanding and Erosion: proposed to undertake the restoration of erosion sites and stream reaches along several creeks across the City (none of those are located within the Study Area.)

4.1.2 Upper Blair Considerations

For the upper Blair catchments within the Study area, the UBCFDS grouped the proposed SWM measures in the following four categories:

- Prevention
- Lot-level / At Source Controls Measures
- Conveyance Controls
- End of Pipe Controls

More than thirty (30) Best Management Practices (BMPs) were investigated as a long list, of those sixteen (16) were identified as appropriate, quantifiable for treatment benefits and acceptable for implementation.

4.1.3 Upper Cedar Considerations

For the upper Cedar Creek catchments within the Study area, the UCCSSWS grouped the proposed SWM measures into the following:

- Lot-level / At Source Controls Measures: Infiltration of clean rooftop runoff at-source to maintain groundwater recharge
- Drainage measures to convey runoff along rights-of-way to centralized facilities
- Centralized facilities: Capture of salt-laden runoff during winter conditions, provide stormwater quantity and quality control and infiltration. Three (3) Regional storm-control SWM facilities were proposed for the following areas:
 - Future Residential Lands North of New Dundee Road
 - Future Employment (West)
 - Future Employment (East)

4.1.4 Development Applications

The MTE Dundee Secondary Plan Technical Memo (2024) presents an overall review of previous technical studies, including the UBCFDS and the UCCSSWS. These findings include preliminary analysis for seven (7) proposed SWM facilities as follows:

4.1.4.1 Blair Creek SWM Facilities

SWMF1 (Drainage area: 136.0 ha)

- Major facility near Strasburg Road, receiving flow from:

- o Internal catchment
 - o 9.3 ha external drainage (Primelands)
 - o Winter bypass from SWMF5 (Cedar Creek)
- Features: Forebay, wet pond, infiltration gallery
- Outlet flow controls per combined Areas 101, 104, partial 105
- Select roof areas may bypass SWMF1 to preserve wetland baseflow
- 100-year storm captured via oversized storm sewers due to grading constraints

SWMF2 (Drainage area: 77.8 ha)

- Located west of Reidel Drive
- Dual outlet strategy:
- Primary discharge
- Secondary bypass to Stauffer Woods system for water balance (~37.1 ha)
- Receives winter bypass from SWMF4 (Cedar Creek)

SWMF3 (Drainage area: 14.5 ha)

- Serves northern Schlegel lands
- Outlet target based on remaining Area 105
- Protects upstream HWDF and wetland complex through controlled flows and possible stabilization

4.1.4.2 Cedar Creek SWM Facilities

SWMF4 (Drainage area: 14.7 ha)

- Located southwest (Activa lands)
- Winter bypass to SWMF2 (Blair Creek) for chloride control

SWMF5 (Drainage area: 36.0 ha)

- Northwest (Branthaven property)
- Winter bypass to SWMF1 (Blair Creek)

SWMF6 (Drainage area: 56.6 ha)

- At Fischer-Hallman & New Dundee Road
- May require realignment of Cedar Creek channel; bypass channel proposed

SWMF7 (Drainage area: 40.5 ha)

- Southwest (Schlegel property)
- Direct infiltration; outlet through culvert to Cedar Creek

4.2 Preliminary SWM Strategy

The preliminary Stormwater Management (SWM) Strategy is informed by hydrologic modeling (GAWSER) of both existing conditions and future scenarios without SWM controls. The impacts of future development under uncontrolled conditions are detailed in the Dundee Hydrologic Modeling Memo (Appendix A). Notably, a SWM-controlled scenario was not included in the modeling.

The SWM Strategy incorporates the following considerations:

- Review of short list of SWM measures and technologies
- Proposing nature-based solutions by understanding Natural Heritage features and linkages
- Reviewing land use considerations for various SWM measures from the short list of alternatives
- Adopting hierarchical water balance considerations based on priorities for infiltration, retention and detention (Similar to the approach recommended by MECP, 2022)

4.2.1 Short List of Alternative SWM Measures and Technologies

A combination of SWM measures (Table 4-1) has been considered, following the SWM Best Management Practices previously proposed in the UBCFDS (2009), the UCCSSWS (2019) and as per guidance of the MECP SWM Design Manual (MECP, 2003) and the MECP draft LID manual (MECP, 2022).

This categorization of alternatives encourages a Treatment Train approach as recommended by GRCA and other Conservation Authorities. It provides a solid foundation for future permit applications under the Consolidated Linear Infrastructure ECA process (MECP, 2022). The overarching purpose of this approach is to achieve a myriad of objectives, including peak flow control, runoff volume reduction, quality control, erosion control and thermal mitigation.

4.2.1.1 Lot-level Measures

Lot-level controls are physical measures that hold surface runoff and encourage the water to seep into the ground. Source control measures can include green roofs, permeable pavement, soakaway pits, rain gardens, rainwater harvesting and downspout disconnection.

4.2.1.2 Conveyance Control Measures

Conveyance control measures are stormwater systems that are generally located adjacent to roadways. They move water along the roadway and encourage infiltration of water into the ground, improve water quality and reduce runoff. Examples can include traditional curbs and gutters, bioswales (vegetated ditches which allow for water collection and conveyance), grassed channels and underground perforated pipe systems.

4.2.1.3 End of Pipe Measures

End of pipe measures are stormwater measures at the end of the storm sewer system. They are used to control erosion, water quality and water quantity and can include wet ponds, dry ponds, wetlands and underground storage tanks.

4.2.1.4 Pollution Prevention Measures

Municipal programs such as road salt management, street sweeping and parks maintenance activities (use of herbicides and pesticides) are known to improve water quality.

Table 4-1. Summary of Stormwater Management Technologies for Various SWM Objectives

Category	SWM Measure
At-Source / Lot-level controls	Infiltration galleries/soakaway pits (privately owned)
	Infiltration trenches (public ownership)
	Parking lot/rooftop storage
	Rooftop gardens/green roofs
Conveyance Controls	Grassed swales
	Off-line infiltration galleries within parkettes
	Pervious pipes (outside of road right-of-way)
	Filter/buffer strips
End-of-Pipe Controls	Wet ponds
	Constructed wetlands
	Hybrid wet pond/wetland systems
	Infiltration Basins/trenches
	Greenway infiltration systems
	Oil/grit separation units (as a component in a treatment train approach)
	Dry ponds
	Biofilters
Pollution Prevention Measures	Salt Reduction
	Street Sweeping
	Park maintenance

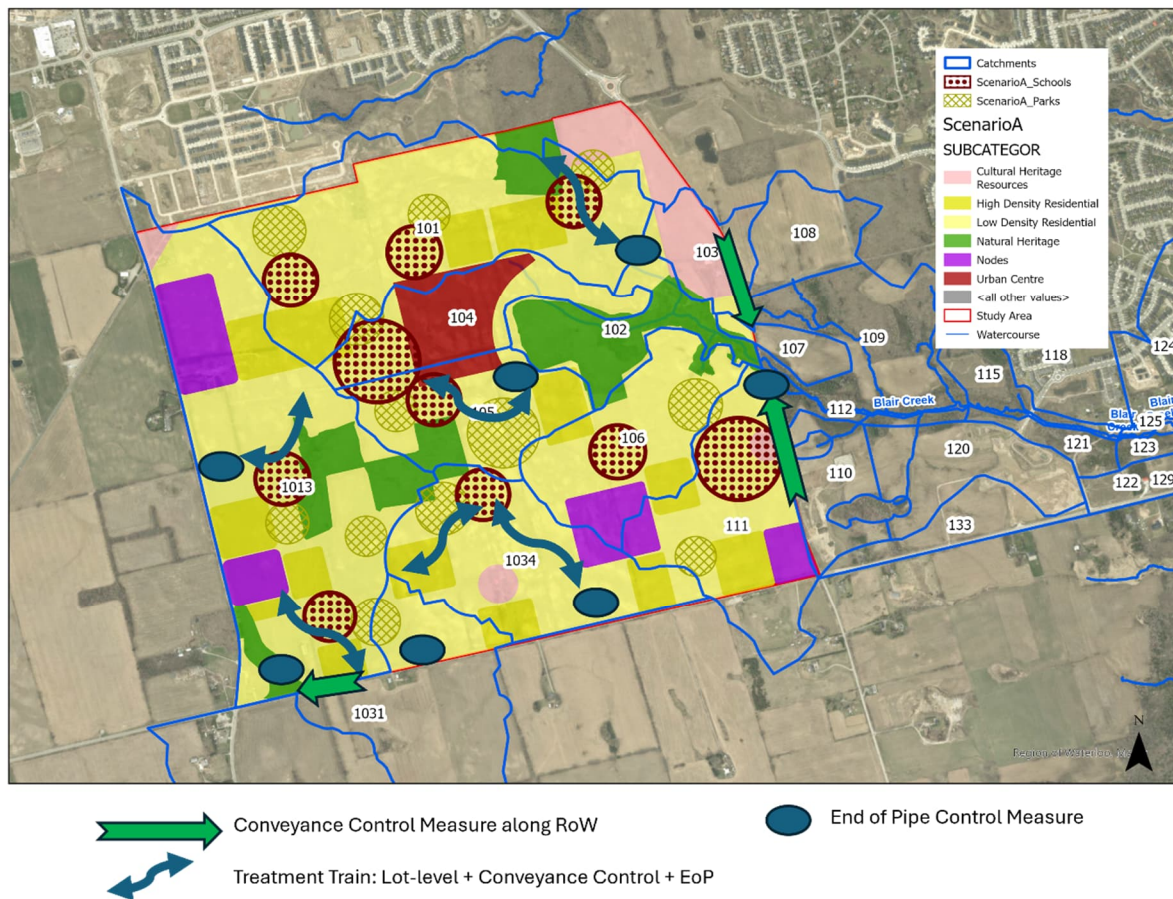
4.2.2 Nature-Based Solutions for SWM

Our multi-disciplinary team has investigated an approach to align our understanding of the Treatment Train approach with green corridors and Natural Heritage linkages. For example, two of the proposed SWM facilities from the MTE servicing study (2024) were deemed unfeasible due to their locations within or in very close proximity of Natural Heritage Features. These two SWM facilities are SWMF1 (Drainage area: 136.0 ha) within the Blair Creek subwatershed and SWMF6 (Drainage area: 56.6 ha) within the Cedar Creek subwatershed, at Fischer-Hallman & New Dundee Road.

A Treatment Train approach is considered when addressing linkages between pervious areas (e.g. parks) and areas that are indirectly connected to impervious areas, such as schools.

For End-of-Pipe measures, engineered systems, including geothermal cooling and cooling trenches may be required for proper thermal mitigation prior to draining into surface water.

Figure 4-1 Visualization of the Treatment Train Approach, including Lot-level, Conveyance controls and End-of-Pipe Controls (Seven SWM facilities) across the Study Area



4.2.3 Land Use Considerations

A mix of detention, retention and infiltration-based measures are necessary to achieve all SWM criteria and targets across the Study Area. The feasibility of each SWM measure should be investigated for each land use as assumptions about full or partial implementation within public and private properties need to be realistic to achieve the required SWM control targets. Table 4-2 below presents some land use considerations as they relate to the short list of SWM measures presented earlier, with focus on source, conveyance and End-of-Pipe control measures.

Table 4-2 Land use considerations for implementing SWM Measures

Category	SWM Measure	Land Use		
		Residential	Urban Core and Nodes	Schools
At-Source / Lot-level controls	Infiltration galleries/soakaway pits (privately owned)	X		
	Infiltration trenches (public ownership)		X	X
	Parking lot/rooftop storage		X	X
	Rooftop gardens/green roofs		X	X
Conveyance Controls	Grassed swales	X	X	X
	Off-line infiltration galleries within parkettes		X	X
	Pervious pipes (outside of road right-of-way)		X	
	Filter/buffer strips		X	X
End-of-Pipe Controls	Wet ponds	X	X	
	Constructed wetlands		X	X
	Hybrid wet pond/wetland systems	X	X	X
	Infiltration Basins/trenches	X	X	X
	Greenway infiltration systems		X	
	Oil/grit separation units (as a component in a treatment train approach)	X	X	X
	Dry ponds	X	X	X
	Biofilters	X	X	X

4.2.4 Hierarchical Water-Balance Considerations

Runoff Volume Control Target (RVCT) Hierarchy (per MECP, 2022)

- Control Hierarchy Priority 1 Retention – LID retention practices which utilize the mechanisms of infiltration, evapotranspiration and/or re-use to recharge shallow and/or deep groundwater; return collected rainwater to the atmosphere and/or use harvested rainwater. The target volume is controlled and not later discharged to the municipal sewer networks (with the exception of water re-use activities) or surface waters and does not therefore become runoff. Examples include bioretention, rain garden, green roof, permeable pavement, and rainwater harvesting.
- Control Hierarchy Priority 2 LID Filtration – LID technologies which utilize appropriate filter media. The controlled volume is filtered and released to the municipal sewer networks or surface waters at a reduced rate and volume (a portion of LID Filtration may be infiltrated or lost to evapotranspiration). Examples include biofiltration, enhanced grass swales, and filter strips.

- Control Hierarchy Priority 3 – Conventional Treatment/Practices. Examples include wet ponds, dry ponds, and constructed wetlands.

Table 4-3. Summary of LID Practices by RVCT Hierarchy Priority

Runoff Volume Control Hierarchy		
Priority 1 Retention	Priority 2 Filtration	Priority 3 Centralized/Conventional
Bioretention	Biofiltration	End of Pipe Facilities
▪ Bioretention Planter	▪ Enhanced Grass	▪ Wet Ponds
▪ Stormwater Planter	▪ Green Gutter	▪ Dry Ponds
▪ Bioretention Curb Extension / Bump-out	▪ Filter Strip/Buffer Strip	▪ Constructed Wetlands
▪ Bioretention Cell		
▪ Rain Garden		
▪ Stormwater Tree Pit		
▪ Stormwater Tree Trench		
▪ Bioswale		
Underground Retention		
▪ Drainage Well		
▪ Soakaways		
▪ Infiltration Trench		
▪ Infiltration Chamber		
Hardscape Retention		
▪ Pervious Concrete		
▪ Porous Asphalt		
▪ Porous Brick Pavers		
▪ Interlocking Precast Concrete		

5. Recommendations and Next Steps

The findings from the hydrological modeling and related analysis and metrics reinforce the importance of stormwater management measures at the Dundee Secondary Plan scale to mitigate local increases in peak flows, sustain groundwater recharge and preserve baseflow contributions to Blair Creek and Cedar Creek. Without such measures, the local hydrologic regime will shift toward more frequent and higher magnitude runoff events, increasing flood and erosion risks and degrading existing water quality and thermal regime.

Scenario A represents the preferred land use scenario. This was based on the results of the hydrologic analysis and considering both land use typologies and Natural Heritage features and linkages.

Some of the previously proposed SWM facilities may not be feasible to implement as they overlap with an existing Natural Heritage feature. These include SWMF1 (Drainage area: 136.0 ha) within the Blair Creek subwatershed and SWMF6 (Drainage area: 56.6 ha) within the Cedar Creek subwatershed, at Fischer-Hallman & New Dundee Road.

The preliminary SWM strategy is based on a multi-disciplinary investigation of environmental and human landscapes and activities. It provides a critical path to achieve SWM criteria and targets based on previous and ongoing technical and planning direction.

More details may be needed to finalize the preliminary SWM strategy. Accordingly, next steps may include:

- Connectivity and proximity of SWM measures, especially End-of-Pipe measures, to existing Natural Heritage features need to be confirmed. Buffers and opportunities for integration should be investigated to confirm feasibility and functionality of any proposed measures expected to work as part of a Treatment Train approach.
- More focus on infiltration-based conveyance control measures warrants more investigation. These measures were not examined in detail in the UBCFDS (2009) or the UCCSSWS (2019). Opportunities exist on Reidel Drive and New Dundee Road and along the proposed roads.
- More SWM opportunities may become feasible to implement as more information emerges on the proposed alignments and cross sections of Strasburg Road and Blair Creek Drive extensions.

6. References

Matrix Solutions et al. (2019). Upper Cedar Creek Scoped Subwatershed Study. Region of Waterloo, Grand River Conservation Authority.

MTE Consultants Inc. (2024). Blair Creek Drive Extension Schedule "B" Class Environmental Assessment Project File Report. Kitchener: MTE Consultants Inc.

Stantec Consulting Ltd. (2009). Upper Blair Creek (Kitchener) Functional Drainage Study Final Report. City of Kitchener

Appendix D. Natural Heritage

Appendix D-1: Natural Heritage Baseline (Draft)

Appendix D-2: Natural Heritage Strategy (Pending)

Dundee Secondary Plan Natural Heritage Baseline (draft)

Document no: 0
Revision: 0

City of Kitchener
[Client reference]

Dundee Secondary Plan
October 9, 2025

COVER 1

Replace this box with a suitable image by:

1. Right Click and use "Change picture from Brand Files" for pre-sized and brand approved imagery.
Make sure you pick the appropriate cover number option to correspond with this cover option (Cover 1...).
2. Right Click and use "Change picture" using the usual options.
Make sure your image is sized to the below specifications.

Size (w x h)
4.5in x 5in
990px x 1100px (220dpi)

(delete this placeholder image box if not required)



Dundee Secondary Plan Natural Heritage Baseline (draft)

Client name: City of Kitchener

Project name: Dundee Secondary Plan

Client reference: [Client reference]

Project no: CE805800

Document no: 0

Project manager: Tom Mahood

Revision: 0

Prepared by: P. Finigan

Date: October 9, 2025

File name: Appendix D - Dundee NH
update_Oct6-Draft

Document status: [Document suitability – Delete row if not applicable]

Document status: Draft

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	October 9, 2025	Draft Natural Heritage Baseline	M. Mortimer P. Finigan	P. Finigan	T. Mahood	J. Schmitter

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
0	October 9, 2025	October 10, 2025	City of Kitchener	Draft Natural Heritage Baseline

CH2M HILL Canada Limited

165 King Street West
Suite 201
Kitchener, ON N2G 1A7
Canada

T +1.519.579.3500
www.jacobs.com



NOTICE: This document has been prepared exclusively for the use and benefit of Jacobs Group client. Jacobs Group accepts no liability or responsibility for any use or reliance upon this document by any third party.

Statement of Limitations

This Report has been prepared exclusively for internal use by the City of Kitchener (City). Any information provided by the City and third party's and relied upon is presumed to be accurate for the purposes of this report preparation. Where baseline conditions change, additional information becomes available portions of the studies conclusions may warrant re-evaluation. This Report contains observations and professional opinions reflecting Jacobs' best judgment using information understood to be factual and correct. Jacobs will not accept responsibility for conditions arising from information or facts that were concealed or not fully disclosed to Jacobs.

This Report was not prepared in anticipation of any legal proceedings, nor is this Report intended for use or reliance in any way in any legal proceedings related to the project, or otherwise. No liability is accepted for any use or reliance on the information provided herein by third parties. Jacobs accepts no responsibility for damages, if any, suffered by any party as a result of decisions made or actions based on this Report. No other warranty, expressed or implied, is made.

This Report is to be read in full. No excerpts shall be taken to be representative of the findings. Jacobs takes no responsibility for misrepresentation or misuse of portions of this Report.

Contents

Statement of Limitations.....	iii
Acronyms and abbreviations	vii
1. Introduction	9
1.1 Study Area.....	9
1.2 Information Sources	9
2. Background Review	12
2.1 Natural Heritage Features.....	12
2.1.1 Areas of Natural and Scientific Interest (ANSIs).....	12
2.1.2 Environmentally Significant Areas (ESAs).....	12
2.1.3 Natural Heritage System (NHS)	12
2.1.4 Provincially Significant Wetlands	13
2.1.5 Wetlands	13
2.1.6 Woodlands/Valleylands	13
2.2 Wildlife and Wildlife Habitat	13
2.2.1 Significant Wildlife Habitat (SWH)	14
2.3 SAR and SAR Habitat.....	14
2.4 Six Nations of the Grand River	17
2.5 Grand River Conservation Authority (GRCA) Regulated Area	17
2.6 Aquatic Habitat.....	17
3. Field Investigations	20
4. Methodology.....	21
4.1 Vegetation and Flora Surveys.....	21
4.2 Wildlife Surveys	21
4.2.1 Breeding Bird Surveys	21
4.2.2 Herpetofauna	22
4.2.3 Vernal Pool Habitat Assessment	22
4.2.4 Road/Mortality Surveys.....	22
4.2.5 Turtle Surveys	23
4.2.6 American Badger Habitat Assessment	23
4.2.7 Wildlife Movement Opportunities.....	23
4.2.8 Significant Wildlife Habitat (SWH)	23
4.3 Aquatic Habitat.....	24
4.3.1 Headwater Drainage Features (HDFs)	24
4.3.2 Benthic Macro-Invertebrates	24

4.3.3	Brook Trout Spawning Surveys	24
4.4	Species at Risk	25
4.5	Natural Heritage System	25
5.	Results	26
5.1	Vegetation and Flora	26
5.1.1	Vegetation Communities	26
5.1.2	Vascular Plant Species	27
5.1.3	Feature Delineation	28
5.1.4	Vegetation – Cedar Creek Subwatershed Study (SWS)	28
5.2	Wildlife	29
5.2.1	Breeding Bird Surveys	29
5.2.2	Spring Breeding Amphibian Surveys	30
5.2.3	Vernal Pool Habitat Assessment	31
5.2.4	Road/Mortality Surveys	31
5.2.5	Turtle Surveys	31
5.2.6	Additional Herpetofauna Results	31
5.2.7	American Badger Habitat Assessment	31
5.2.8	Wildlife Movement Opportunities	32
5.2.9	Significant Wildlife Habitat	32
5.3	Aquatic Habitat	33
5.3.1	Headwater Drainage Features Assessment	33
5.3.2	Benthic Macro-invertebrates	33
5.3.3	Brook Trout Spawning Surveys	34
5.4	Species at Risk	34
5.5	Natural Heritage System	36
6.	Additional Information	39
6.1	Removed Wetland	39
6.2	Current Data Gaps	41
7.	Conclusion	42
8.	Works Cited	43

Appendices

No table of contents entries found.

Tables

Table 1. Species at Risk from Background Screening.....	15
---	----

Figures

Figure 1. Dundee Secondary Plan Study Area.....	11
Figure 2. Natural Heritage Features within the Dundee Secondary Plan Study Area.....	19
Figure 3. Chronological Aerial Imagery of Unauthorized Wetland Removal.....	40

Acronyms and abbreviations

Acronym	Description
ANSI	Areas of Natural and Scientific Interest
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DBH	Diameter-at-Breast Height
DFO	Department of Fisheries and Oceans Canada
ELC	Ecological Land Classification
ESA	Environmentally Significant Areas
<i>ESA</i>	<i>Endangered Species Act</i>
GRCA	Grand River Conservation Authority
km ²	kilometres squared
LIO	Land Information Ontario
m	metre
MECP	Ministry of the Environment, Conservation and Parks
MMP	Marsh Monitoring Program
MNR	Ministry of Natural Resources
NHF	Natural Heritage Features
NHIC	Natural Heritage Information Centre
NHS	Natural Heritage System
OBBA	Ontario Breeding Bird Atlas
OWES	Ontario Wetland Evaluation System
PPS	Provincial Planning Statement
PSW	Provincially Significant Wetland
SAR	Species at Risk

Dundee Secondary Plan Natural Heritage Baseline (draft)

Acronym	Description
SARA	<i>Species at Risk Act</i>
SARO	Species at Risk in Ontario
SNGREC	Six Nations of the Grand River Elected Council
SWH	Significant Wildlife Habitat
VU	Vegetation Unit
WSA	Wildlife Survey Area
WSP	WSP Canada Inc.

1. Introduction

Ontario's 2024 Provincial Planning Statement (PPS) defines Natural Heritage Features (NHF) as:

"features and areas, including significant wetlands, significant coastal wetlands, other coastal wetlands in Ecoregions 5E, 6E and 7E, fish habitat, significant woodlands and significant valleylands in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Marys River), habitat of endangered species and threatened species, significant wildlife habitat, and significant areas of natural and scientific interest, which are important for their environmental and social values as a legacy of the natural landscapes of an area." (Government of Ontario, 2024).

The objective and scope of this Natural Heritage assessment is to identify and provide information on NHFs within and proximal to the Study Area. This will assist in future development planning to ensure protection and recommendations for disturbance mitigation for NHFs.

1.1 Study Area

The Study Area, which is approximately 4.6 km², occurs within the Township of Wilmot, which is located to the southwest of Kitchener (Figure 1). The borders of the Study Area border Fischer Hallman Road to the west, New Dundee Road to the south, Reidel Drive to the east and Broadacre Drive to the north. The current landscape is comprised primarily of agricultural lands, with patches of natural areas, such as woodlands and wetlands, within and extending beyond the Study Area. WSP completed two reports, Existing Conditions & Ecological Constraints Report 2021 and 2025, for two areas surveyed within this Study Area shown Figure 1. In addition, Stantec completed a report for the northeastern portion of the Study Area in 2013, also shown in Figure 1. A 2025 desktop review of natural heritage features and fieldwork highlights from the WSP and Stantec reports will be provided within this report.

1.2 Information Sources

Available online background data were accessed in 2025 to screen for existing data on NHFs and Species at Risk (SAR) within the Study Area and 120 m adjacent lands. In accordance with the Natural Heritage Reference Manual (Ontario, 2010), 120 m is a standard distance from NHFs for which an evaluation is required to assess potential negative impacts on said features.

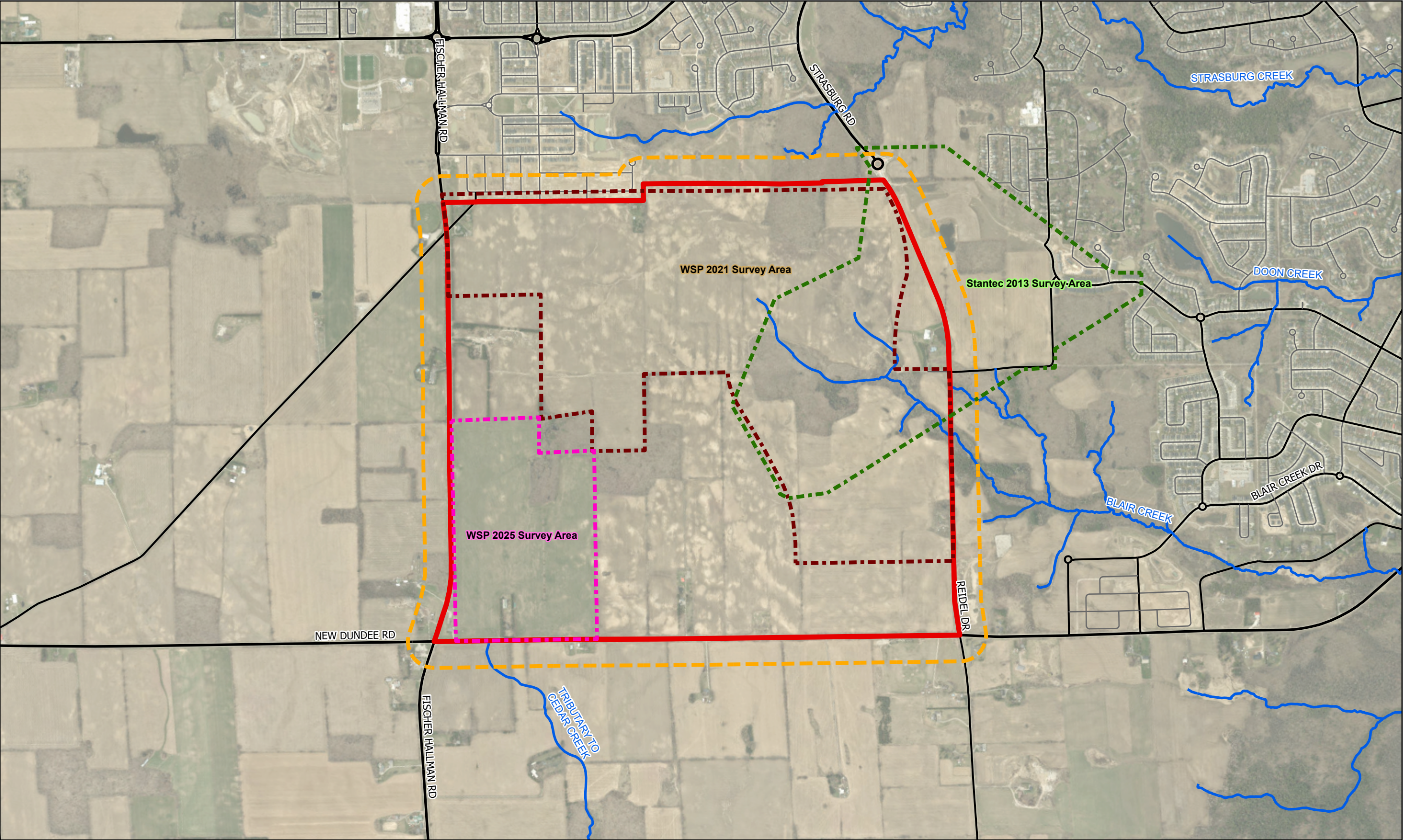
The following sources were access to identify any potential NHFs or SAR that may be present within or proximal to the Study Area:

- Department of Fisheries and Oceans Canada (DFO) online Aquatic Species at Risk Map (DFO, 2025)
- Direct consultation with the NHIC
- Grand River Conservation Authority (GRCA) mapping
- iNaturalist (iNaturalist, 2025)
- Ministry of Natural Resources (MNR) Lands Information Ontario (LIO) data sets (LIO, 2025a and 2025b) and Make a Natural Heritage Map (MNR, 2025b)
- Ontario Breeding Bird Atlas (OBBA) data (Bird Studies Canada, 2021)

Additionally, the following reports were referenced for field investigation information:

- *Existing Conditions & Ecological Constraints Report. WSP Canada Inc. 2021*
- *Existing Conditions & Ecological Constraints Report. WSP Canada Inc. 2025*

- *Robert Ferrie Drive Alignment Alternatives, Southwest Kitchener Natural Environment Existing Conditions Report.* Stantec Consulting Ltd. 2013.



Notes:
1. Aerial Source: Region of Waterloo, Maxar
2. Road network is from Land Information Ontario.

Figure 1
Study Area
Natural Heritage Re-baseline
Dundee Secondary Plan Natural Heritage Baseline
City of Kitchener
Kitchener, Ontario

DRAFT

2. Background Review

Results from the background desktop review, conducted by Jacobs in 2025, are presented below.

2.1 Natural Heritage Features

NHFs within the Study Area and 120 m adjacent lands (shown in Figure 2) were investigated by referencing available mapping from GRCA (GRCA, 2025), LIO datasets (LIO, 2025a and 2025b), City of Kitchener's Official Plan (City of Kitchener, 2014), and online Make a Natural Heritage Map (MNR, 2025b). Features reviewed included the following:

- Areas of Natural and Scientific Interest (ANSIs)
- Environmentally Significant Areas (ESAs)
- Natural Heritage System (NHS)
- Provincially Significant Wetlands (PSWs)
- Water bodies and watercourses
- Wetlands
- Woodlands and valleylands

2.1.1 Areas of Natural and Scientific Interest (ANSIs)

According to GRCA mapping (GRCA, 2025), City of Kitchener's Official Plan (City of Kitchener, 2014), and online Make a Natural Heritage Map (MNR, 2025b) ANSIs do not occur within the Study Area or 120 m adjacent lands. However, Blair Creek which originates within the Study Area, is hydrologically connected to a nearby ANSI, Roseville Swamp, that is approximately 1.3 kilometres southeast of the Study Area.

2.1.2 Environmentally Significant Areas (ESAs)

According to GRCA mapping (GRCA, 2025), City of Kitchener's Official Plan (City of Kitchener, 2014), and online Make a Natural Heritage Map (MNR, 2025b) ESAs do not occur within the Study Area or 120 m adjacent lands.

2.1.3 Natural Heritage System (NHS)

The Provincial Planning Statement, 2024 defines NHS as:

"...a system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions, and working landscapes that enable ecological functions to continue." (Government of Ontario, 2024)

An NHS may include the following:

- PSWs
- ESAs
- Significant habitat of endangered species
- Urban forests and parks
- Golf Course
- River and valley systems

The extent of the NHFs occurring within the Study Area and 120 m adjacent lands, as identified by GRCA mapping (GRCA, 2025), City of Kitchener's Official Plan (City of Kitchener, 2014), and Make a Natural Heritage Map (MNR, 2025b) are shown in Figure 2.

2.1.4 Provincially Significant Wetlands

Based on review of the online Make a Natural Heritage Map (MNR, 2025b), a PSW known as the Roseville Swamp Cedar Creek Wetland Complex occurs within the eastern portions of the Study Area and extends beyond the 120 m adjacent lands. In addition, a second PSW, Strasburg Creek Wetland Complex, occurs within and extends beyond the 120 m adjacent lands. The location of these PSWs is illustrated on Figure 2.

2.1.5 Wetlands

A review of GRCA mapping and online Make a Natural Heritage Map (MNR, 2025b) identified an unevaluated wetland present within the western portion of the Study Area. This unevaluated wetland which is approximately 0.2 km². In addition, there are two smaller unevaluated wetlands located within the 120 m adjacent lands, west of Fischer-Hallman Road, each with an area of approximately 0.001 km². These wetlands are shown on Figure 2.

2.1.6 Woodlands/Valleylands

Based on review of GRCA mapping and the Make a Natural Heritage Map (MNR, 2025b), woodlands occur with the Study Area and 120 m adjacent lands. There is a large stretch of woodlands located along Blair Creek, within the Study Area (west of Reidel Drive) and outside of the Study Area (east of Reidel Drive) as well as portions of woodlands in the northern limits of the Study Area and near the centre of the Study Area. Smaller pockets of woodlands occur intermittently throughout the Study Area. No valleylands were identified within the Study Area or 120 m adjacent lands. The extent of woodlands within the Study Area and 120 m adjacent lands are shown in Figure 2.

2.2 Wildlife and Wildlife Habitat

Background data obtained for wildlife included a review of the OBBA, which provides information on avifauna occurrences based on a 10 square kilometer (km²) area. The 2nd atlas of the OBBA was utilized, which includes data collected from 2001 to 2005. The Study Area occurs within OBBA Square Summary 17NJ44 Region # 7: Waterloo. iNaturalist was also accessed for research grade observations.

2.2.1 Significant Wildlife Habitat (SWH)

Significant Wildlife Habitat (SWH) is designated by criteria outlined within the Significant Wildlife Habitat Technical Guide (MNR, 2000) and divides habitat into four main categories:

- 1) Seasonal Concentration Areas include the following:

At certain times of the year, some species of wildlife are highly concentrated within relatively small areas. In spring and autumn, migratory species of birds and butterflies concentrate in critical stopover areas where they can rest and feed. Other examples of such habitat include winter deer yards, bird breeding colonies, and hibernation sites for bats or snakes (MNR, 2000).

- 2) Rare Vegetation Communities or Specialized Habitat for Wildlife include the following:

Areas that contain a provincially rare vegetation community and areas that contain a vegetation community that is rare within the planning area. Specialized habitats include areas that support wildlife species that have highly specific habitat requirements, and areas with exceptionally high species diversity or community diversity areas that provide habitat that greatly enhances a species' survival (MNR, 2000).

- 3) Habitat for Species of Conservation Concern (Not including Endangered or Threatened Species)

Rare species status is defined by SAR legislation and global or provincial ranks provided by the NHIC.

- 4) Animal Movement Corridors

Animal movement corridors are elongated, naturally vegetated parts of the landscape used by animals to move from one habitat to another. They exist at different scales and frequently link or border natural areas. Animal movement corridors encompass a wide variety of landscape features including riparian zones and shorelines, wetland buffers, stream and river valleys, woodlands, and anthropogenic features such as hydro and pipeline corridors, abandoned road and rail allowances, and fencerows and windbreaks (MNR, 2000).

Based on the background review, reports reviewed, and available mapping, candidate and confirmed SWH does occur within the Study Area. More details are presented in Section 4.2.

2.3 SAR and SAR Habitat

The background screening provides a list of SAR, which are flora and fauna which are at risk of extirpating from the wild due to factors such as habitat loss, anthropogenic disturbances, or climatic change. SAR within Ontario are primarily protected under the *Endangered Species Act* (ESA, 2007). Species can be ranked as follows:

1. Endangered - species facing imminent extirpation or extinction
2. Threatened - species likely to become endangered if limiting factors are not reversed
3. Special Concern - species may become threatened or endangered due to identified threats
4. Extirpated - species no longer existing in the wild at this location but may occur elsewhere

SAR listed under the ESA are under the jurisdiction of the Ministry of the Environment, Conservation and Parks (MECP) and aquatic SAR (e.g., fish and mussels) are protected federally, as administered by DFO under the *Species at Risk Act* (SARA). Special Concern species are not protected under these Acts; however, habitat for these species is typically afforded protection under SWH criteria.

The NHIC provides current and historical data on SAR and Natural Features occurrences within Ontario using 1 km² areas. The Aquatic Species at Risk Map (DFO, 2025) provides data on occurrences of critical habitat and the distribution of aquatic SAR. Available SAR data within the Study Area and 120 m adjacent lands are presented within Table 1, based on the NHIC database (MNR, 2025b), OBBA (square 17NJ40, Region #7 Waterloo), the Aquatic Species at Risk Map (DFO, 2025), and iNaturalist research grade observations (iNaturalist, 2025).

In addition to the SAR identified during 2025 background screening, consultation with MECP in 2022 indicated the potential presence of American Badger and SAR Bats within the Study Area. As such, they have been included in Table 1.

Table 1. Species at Risk from Background Screening

Common Name	Scientific Name	S Rank ^a	SARO ^b	COSEWIC ^c	SARA ^d
Birds					
Acadian Flycatcher	<i>Empidonax virescens</i>	S1B	END	END	END
Bank Swallow	<i>Riparia riparia</i>	S4B	THR	THR	THR
Barn Swallow	<i>Hirundo rustica</i>	S4B	SC	SC	THR
Black Tern	<i>Chlidonias niger</i>	S3B,S4M	SC	NAR	-
Bobolink	<i>Dolichonyx oryzivorus</i>	S4B	THR	SC	THR
Canada Warbler	<i>Cardellina canadensis</i>	S5B	SC	SC	THR
Cerulean Warbler	<i>Setophaga cerulea</i>	S2B	THR	END	END
Chimney Swift	<i>Chaetura pelagica</i>	S3B	THR	THR	THR
Common Nighthawk	<i>Chordeiles minor</i>	S4B	SC	SC	SC
Eastern Meadowlark	<i>Sturnella magna</i>	S4B,S3N	THR	THR	THR
Eastern Wood-pewee	<i>Contopus virens</i>	S4B	SC	SC	SC
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	S3B	SC	THR	THR
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	S4B	SC	SC	-
Least Bittern	<i>Botaurus exilis</i>	S4B	THR	THR	THR
Northern Bobwhite	<i>Colinus virginianus</i>	S1?	END	END	END
Olive-sided Flycatcher	<i>Contopus cooperi</i>	S4B	SC	SC	SC
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	S3	END	END	END
Short-eared Owl	<i>Asio flammeus</i>	S4?B,S2S3N	THR	THR	SC
Wood Thrush	<i>Hylocichla mustelina</i>	S4B	SC	THR	THR
Mammals					
American Badger (Southwestern Ontario population)*	<i>Taxidea taxus jacksoni</i>	S1	END	END	END
Eastern Red Bat	<i>Lasiurus borealis</i>	S3	END	END	-
Eastern Small-footed Myotis	<i>Myotis leibii</i>	S2S3	END	-	-
Little Brown Myotis	<i>Myotis lucifugus</i>	S3	END	END	END
Northern Hoary Bat	<i>Lasiurus cinereus</i>	S3	END	END	-

Common Name	Scientific Name	S Rank ^a	SARO ^b	COSEWIC ^c	SARA ^d
Northern Myotis	<i>Myotis septentrionalis</i>	S3	END	END	END
Silver-haired Bat	<i>Lasionycteris noctivagans</i>	S3	END	END	-
Tricolored Bat	<i>Perimyotis subflavus</i>	S3?	END	END	END
Amphibians					
Unisexual Ambystoma (Jefferson Salamander dependent population)	<i>Ambystoma hybrid pop. 1</i>	S2	END	END	-
Insects					
American Bumble Bee	<i>Bombus pensylvanicus</i>	S3S4	SC	SC	SC
Monarch	<i>Danaus plexippus</i>	S2N, S4B	SC	END	SC
Rapids Clubtail	<i>Phanogomphus quadricolor</i>	S2	THR	END	END
Aquatics					
Black Redhorse	<i>Moxostoma duquesnei</i>	S2	THR	THR	THR
Silver Shiner	<i>Notropis photogenis</i>	S2S3	THR	THR	THR
Wavy-rayed Lampmussel	<i>Lampsilis fasciola</i>	S2	THR	SC	SC
Herptiles					
Blanding's Turtle	<i>Emydoidea blandingii</i>	S3	THR	END	-
Eastern Milksnake	<i>Lampropeltis triangulum</i>	S4	NAR	SC	SC
Midland Painted Turtle	<i>Chrysemys picta marginata</i>	S4	-	SC	SC
Snapping Turtle	<i>Chelydra serpentina</i>	S4	SC	SC	SC
Plants					
Black Ash	<i>Fraxinus nigra</i>	S4	END	THR	-
Butternut	<i>Juglans cinerea</i>	S2?	END	END	END
Kentucky Coffee-tree	<i>Gymnocladus dioicus</i>	S2	THR	THR	THR
Scarlet Beebalm	<i>Monarda didyma</i>	S3	-	-	-

^a SRank (Subnational Rank) is the conservation status of a species/plant community within Ontario, assigned by the NHIC (MNR, 2024)

^b Species at risk in Ontario (Government of Ontario, 2025)

^c Committee on the Status of Endangered Wildlife in Canada recommended status (COSEWIC, 2025)

^d Species at Risk Act, 2002 (Government of Canada, 2025)

* Identified by MECP consultation

? = more data required

- = not at risk

B = status qualifier; breeding

END = endangered

H = status qualifier; possibly extirpated

M = status qualifier; migrant species

N = status qualifier; nonbreeding

S#S# = range given due to uncertainty

S1 = critically imperilled (often 5 or fewer occurrences)

S2 = imperilled (often 20 or fewer occurrences)

S3 = vulnerable (restricted range with relatively few populations – often 80 or fewer)

S4 = uncommon but not rare; some cause for long-term concern due to declines or other factors

S5 = secure species, common, widespread, and abundant

SC = special concern

THR = threatened

2.4 Six Nations of the Grand River

The Haudenosaunee – Six Nations of the Grand River, is the largest First Nations population in Canada. Their current territory spans 46,500 acres, in which the Study Area is situated. As such, meaningful and proactive consultations with the Six Nations of the Grand River Elected Council (SNGREC) and reference to the Six Nations of the Grand River Environmental Levy Policy are recommended to better understand the mitigations required to address the impacts of past and future development.

It is recognized that the current baseline efforts may not cover details on all natural heritage components valued by indigenous partners. For example, in addition to species afforded protections under federal and provincial legislation, special considerations should be paid for Haudenosaunee-specific species of importance (i.e. medicinal plants, clan animals, flora and fauna used as country foods or in ceremony).

2.5 Grand River Conservation Authority (GRCA) Regulated Area

A portion of the Study Area occurs within the GRCA Regulated Area. As such, the Study Area is governed in accordance with O. Reg. 150/06 Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses. The GRCA regulation limits are shown in Figure 2.

2.6 Aquatic Habitat

Two watercourses were identified within the Study Area. Tributaries and head waters to Blair Creek, a coldwater watercourse, extend west of Reidel Drive into the centre of the Study Area and are predominantly surrounded by the Roseville Swamp Cedar Creek Wetland Complex. The main branch of Blair Creek continues east beyond the Study Area. According to LIO's Aquatic Resource Area (ARA) Line Segments GU-3005-BOW, (MNR, 2025c) located within the Study Area the following fish have been identified in Blair Creek within or proximal to the Study Area:

- Brook Stickleback (*Culaea inconstans*)
- Central Mudminnow (*Umbra limi*)

In addition, further downstream, approximately 2 kilometres east of the Study Area, Brook Trout (*Salvelinus fontinalis*) was observed at LIO ARA Survey Point GU-3004-BOW.

A second, unnamed tributary to Cedar Creek is located in the southwestern portion of the Study Area. The watercourse originates just north of New Dundee Road, where it crosses underneath the road, and flows southeast beyond the 120 m adjacent lands. According to LIO's Aquatic Resource Area (ARA) Line Segments GU-3003-CED, (MNR, 2025c) located within and beyond the Study Area the following fish have been identified in the unnamed tributary to Cedar Creek:

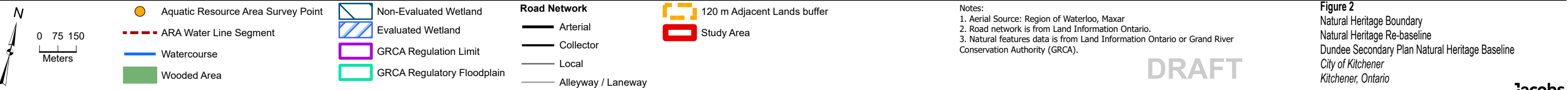
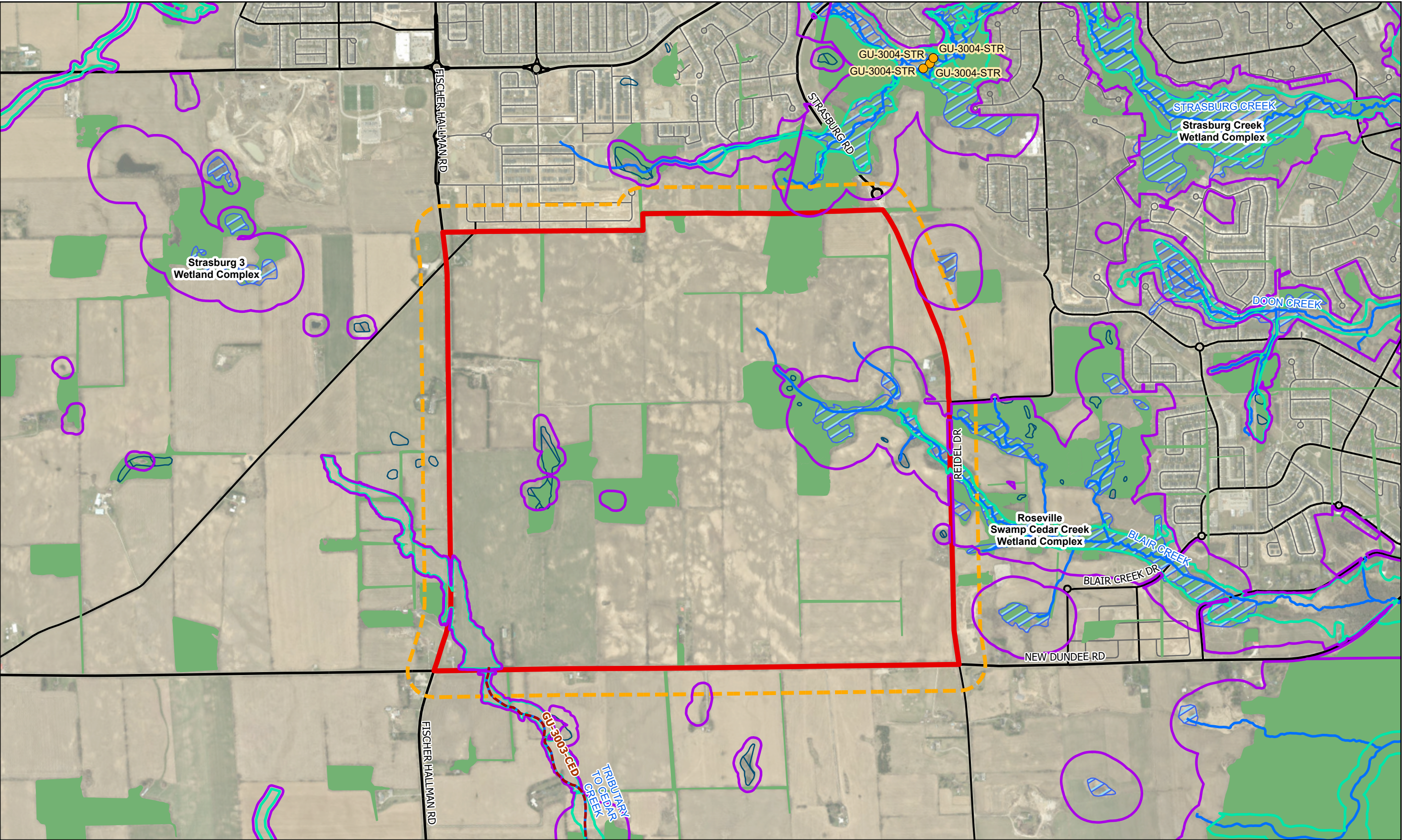
- | | |
|---|---|
| • Blacknose Dace (<i>Rhinichthys atratulus</i>) | ▪ Fathead Minnow (<i>Pimephales promelas</i>) |
| ▪ Brook Stickleback | ▪ Iowa Darter (<i>Etheostoma exile</i>) |
| ▪ Brook Trout | ▪ Johnny Darter (<i>Etheostoma nigrum</i>) |
| ▪ Creek Chub (<i>Semotilus atromaculatus</i>) | |

- Largemouth Bass (*Micropterus salmoides*)
- Mottled Sculpin (*Cottus bairdii*)
- Pumpkinseed (*Lepomis gibbosus*)
- Slimy Sculpin (*Cottus cognatus*)
- White Sucker (*Catostomus commersonii*)

Outside of the 120 m adjacent lands, just north of the Study Area, is Strasburg Creek which runs through the Strasburg Creek Wetland Complex. According to LIO ARA Survey Points GU-3004-STR (four separate points with the same identification), the following fish were identified in Strasburg Creek, downstream of the Study Area (MNR, 2025d):

- Blacknose Dace
- Brook Stickleback
- Brook Trout
- Creek Chub
- Fathead Minnow
- Goldfish (*Carassius auratus*)
- Longnose Dace (*Rhinichthys cataractae*)
- Mottled Sculpin
- Pumpkinseed
- White Sucker

These watercourses and the above mentioned LIO ARA Line Segments and Survey Points are shown in Figure 2.



3. Field Investigations

While Jacobs has not conducted field work within the Study Area to date, existing fieldwork and reports authored by other groups have been compiled. The methodologies and field results presented within this report are based on the 2021 and 2025 reports, authored by WSP Canada Inc. (WSP), *Existing Conditions & Ecological Constraints Report* (WSP, 2021; WSP, 2025) and the *Robert Ferrie Drive Alignment Alternatives, Southwest Kitchener Natural Environment Existing Conditions Report* (Stantec 2013).

The WSP's Existing Conditions & Ecological Constraints Report 2021 documented their methodology and results from field investigations within their survey area which was, located in the northern and northwestern limits of the updated Study Area. Their 2025 covered their methodology and results from field investigations within the southwestern limits of the updated Study Area. Stantec's 2013 report covers a portion of the northeastern limits of the updated Study Area and was accessed for supplementary information. Figure 1 shows these study areas in relation to the updated Study Area.

A comprehensive field survey program was conducted by WSP and Natural Resource Solution Inc. (NRSI) within the northwestern portion of the updated Study Area from 2017 – 2024. This program included the following studies:

- Vegetation and Flora – botanical inventory and ELC vegetation community classification (2017-2018, 2019, 2024)
- General Wildlife Survey (2017-2018)
- Winter Wildlife Survey (2017-2018)
- Breeding Bird Survey (2017-2019, 2024)
- Fall Migratory Bird Survey (2017-2018)
- Spring Breeding Amphibian Survey (2017-2019, 2024)
- Snake Coverboard Survey (2017-2018)
- Vernal Pool Assessment (2017-2019, 2024)
- Feature delineation (2019, 2024)
- Butternut Health Assessment (2019)
- Incidental wildlife (spring and summer 2019, spring, summer, spring and summer 2024)
- Turtle Surveys – Spring Emergence and Nesting (2020)
- American Badger den search (2020)
- Headwater Drainage Feature Assessment (2024)
- American Badger Habitat Assessment (2024)
- Turtle Nesting Survey (2024)

The methodology for these field surveys are presented below.

4. Methodology

4.1 Vegetation and Flora Surveys

Vegetation communities are distinct ecotones identified by dominant plant species, soil type, and moisture content, based on the Ecological Land Classification (ELC) for Southern Ontario (Lee et al., 1998). A botanical inventory and vegetation assessment of the Study Area was conducted on the following dates by the following entities:

- May 24th and July 25th, 2017 by NRSI and WSP
- June 21st, August 2nd, 14th, 26th and 28th, 2019 by WSP
- June 12th, 15-17th, August 20th and September 16th, 2020 by WSP
- May 29th, August 1st and September 9th, 2024 by WSP

WSP and NRSI's field investigations for vascular plants and vegetation communities included the following:

- Classifying, mapping and evaluating vegetation communities with the Project Location, using the *Ecological Land Classification (ELC) for Southern Ontario* (Lee et al., 1998) and *Vegetation Communities for Entire Toronto and Region Conservation Authority Jurisdiction*, where appropriate
- Evaluating vegetation community significance, using the NHIC's Plant Communities List (2023)
- Botanical inventory and preparation of a vascular plant species list, using NHIC nomenclature in 2025 and Database of Vascular Plants of Canada (VASCAN) in 2021 (WSP, 2005 – Appendix B). Plant species status was evaluated using the following:
 - *Region of Waterloo Significant Species List: Vascular Plants Component, PC-99-028.1* (1999) for regional significance
 - The NHIC website for provincial rarity ranks (i.e. S-Ranks)
 - The Species at Risk in Ontario list for provincial status designations
 - The Canada Species At Risk list for national status designations
 - In their 2021 report, WSP also assessed Botanical Quality, where the quality of a particular vegetation community can be reflected in its richness of conservative species as indicated by the Floristic Quality Index (FQI) number.
 - FQI is a measurement of a vegetation community's ecological quality based on its plant species composition. Generally, a FQI of 1 – 10 represents a community that is of low botanical quality, 11 – 20 is moderate, 21 – 35 is high quality, and > 35 is exceptional

4.2 Wildlife Surveys

4.2.1 Breeding Bird Surveys

WSP conducted breeding bird surveys adhering to protocols consistent with the Ontario Breeding Bird Atlas (OBBA) on the following dates, early in the morning and under appropriate weather conditions:

- May 31st and June 26th, 2019
- June 9, June 15, June 30 and July 1, 2020
- June 6th and June 26th, 2024
- In addition, NRSI conducted breeding bird surveys on June 7th and June 22nd, 2017.

WSP walked transects through natural habitats adjacent to their survey areas or used listening stations at the edges for habitats outside of their survey area. For all avifauna observed, WSP recorded species abundance and level of breeding evidence.

4.2.2 Herpetofauna

In accordance with the Marsh Monitoring Program (MMP) protocol (Bird Studies Canada, 2008), WSP conducted three rounds of spring breeding surveys for anurans (frogs and toads) during dusk/early evening under appropriate weather conditions. Survey dates are provided below:

- April 25th, May 22nd and June 23rd, 2019
- April 7th, 25th, May 21st, 22nd, June 17th and 18th, 2020
- April 15th, May 9th, and June 24th, 2024

WSP recorded Amphibian calling activity was rated using three levels:

- Level 1 (L1): individual calls can be counted with no overlap.
- Level 2 (L2): some calls can be counted or estimated, some overlap.
- Level 3 (L3): calls continuous and overlapping, individuals not distinguishable.

4.2.3 Vernal Pool Habitat Assessment

In 2019, WSP conducted Vernal Pool Habitat Assessments due to records of Jefferson Salamander (*Ambystoma jeffersonianum*), an Endangered species both provincially and federally. Surveys were completed every two weeks, from mid-May until early August on the following dates:

- May 10th and May 13th
- June 14th
- July 3rd and 19th
- August 6th

10 vernal pools, located in Unit 3 and 4, identified for assessment of habitat suitability. The first 2019 survey collected detailed habitat information from each pool including multiple depth measurements, habitat mapping and an estimate of pool dimensions. Subsequent surveys included updates to the habitat assessment and recording of water levels, as well as photos and notes of incidental amphibian/egg observations. WSP adhered to the following criteria, per MNR/MECP, to assess each vernal pool for Jefferson Salamander breeding suitability:

- Sufficient hydroperiod for salamander larvae to develop and emerge (maintain standing water through July)
- Confirmed use by other breeding amphibian species
- Absence of predatory fish
- Presence of suitable egg attachment sites (i.e. living or dead vegetation)

In addition, supplementary searches for salamanders/eggs were conducted during spring surveys in 2024.

4.2.4 Road/Mortality Surveys

WSP conducted Road/Mortality surveys along the west end of Stauffer Drive and along the north end of Reidel Drive in 2020, and along Fischer-Hallman Road and New Dundee road in 2024. Surveys were conducted at night during suitable wet / humid weather conditions between April and July. All occurrences of amphibian species (dead or alive) were recorded.

4.2.5 Turtle Surveys

WSP conducted surveys for turtles due to the potential habitat suitability and presence of Blanding's Turtle and Snapping Turtle. Surveys were conducted on the following dates:

- May 6th, June 15th, 16th, 30th, and July 8th, 2020
- June 6th, June 26th, and July 9th, 2024

Surveys included searching for signs of nesting (nests, digs, disturbed ground with tracks/trails from turtles, or predated nests) and searching for turtles basking within ponds.

4.2.6 American Badger Habitat Assessment

As a result of local records, habitat range and current land use in the survey areas, the potential for American Badger, an Endangered Species both provincially and federally, to be present was assessed in the 2021 and 2025 reports. Two rounds of targeted surveys were conducted in 2020 survey area and three rounds in the 2024 survey area. Surveys were conducted on the following dates:

- June 15th, 16th, June 30th and July 8th, 2020
- June 6th, June 26th and July 9th, 2024

WSP searched for evidence of Badger use and Badger/prey species dens in potentially suitable habitat across the primary study area (i.e., agricultural field edges, hedgerows and woodland edges) in accordance with the Recovery Strategy for American Badger (Ontario American Badger Recovery Team, 2010) and previous discussions with MNR. All burrows observed were examined for the following characteristics:

- "D" shaped burrow entrance (i.e., bottom of burrow entrance is wider than the height of the burrow)
- Large mound (i.e. 1 m²) of burrow material (i.e. sand and soil)
- Tracks in the fresh soil
- Claw marks along edges of burrow entrance and sides of burrow
- Scent reminiscent of mustelids (e.g., skunks and weasels) at active den sites
- Active burrow entrances are free of debris (e.g., leaves).

In addition, the following information was collected for each burrow:

- Representative photos
- Dimensions measured
- Exteriors examined for claw marks
- Interior edges examined for claw marks with a flashlight
- Interiors examined for badger hairs

4.2.7 Wildlife Movement Opportunities

WSP assessed wildlife movement areas/opportunities and ecological connectivity through the results of their field surveys within their survey areas and review of available background information.

4.2.8 Significant Wildlife Habitat (SWH)

For their 2021 report, WSP completed an evaluation of SWH using the Significant Wildlife Habitat Criterion Schedules for Ecoregion 6E (MNRF 2015), based on 2020 field work and in consideration of previous field survey results.

4.3 Aquatic Habitat

WSP assessed Upper Blair Creek in their 2021 report and defined the morphology, flow type, substrate, surrounding vegetation and inputs.

4.3.1 Headwater Drainage Features (HDFs)

In 2018, WSP had previously assessed aquatic habitat to support the Cedar Creek Subwatershed Study and also evaluated Headwater Drainage Features (HDFs) in adherence with the *Evaluation, Classification and Management of Headwater Drainage Features Guideline* (TRCA & CVC, 2014). Additional surveys were conducted in March 15, 2024, following 30 mm of rain in the previous 12 hours, to verify/refine earlier findings (WSP, 2025). Their assessment included the following:

- Searching for and documenting and surface water features/flow paths or evidence of those features in their survey area
- Assessing the areas identified as *Stream/Ecological Restoration Area* and *Core Natural Heritage Features (CNHF)* for presence of any aquatic/surface flow features
- Assessing flows or evidence of previous flows upstream and downstream of the culvert at New Dundee Road

4.3.2 Benthic Macro-Invertebrates

WSP conducted benthic surveys in Upper Blair Creek, which will continue to be assessed as a part of the Stauffer Woods development annual Biological Monitoring program. That monitoring includes a reach of stream within their survey area (WSP, 2021). The design and methodology of the benthic monitoring program has been informed by the FDS (2009), and subsequent meetings and correspondence with GRCA, City and Regional staff through 2009-2020 and uses the Before / After / Control / Impact (BACI) experimental design, generally following the procedures outlined in the Ontario Benthos Biomonitoring Network Protocol Manual.

Samples were enumerated and identified to species or genus when possible. A standard set of analyses were conducted on the raw data set, following OBBN protocol, including the following:

- Sample size
- Taxa Richness
- EPT (i.e., Ephemeroptera, Plecoptera, and Trichoptera) taxa richness
- Dominant and sub-dominant taxa abundance
- % Oligochaeta
- % Chironomidae
- % functional feeding groups (i.e., collector-gatherers, collector-filterers, predators, scrapers, and shredders)
- Shannon Wiener Index (H')
- Biotic Index (BI)
- Family Biotic Index (FBI)

4.3.3 Brook Trout Spawning Surveys

Due to the potential for Brook Trout spawning in Upper Blair Creek, WSP conducted Brook Trout Spawning Surveys, which will continue to be assessed as part of the Stauffer Woods development annual Biological Monitoring program (WSP, 2021).

Surveys were undertaken from mid-late October to late November/early December depending on temperatures and evidence of activity. Surveys involved walking transects along reaches of Blair Creek and searching for visual evidence of Brook Trout spawning (i.e. redds, scrapes, upwellings and fish presence). Surveys also included some updates to aquatic habitat mapping, GPS coordinates for redds, scrapes and upwellings, spot temperature measurements, representative photographs, and incidental wildlife observations.

4.4 Species at Risk

WSP conducted a preliminary habitat suitability evaluation for provincially designated SAR through sources including the NHIC website, MNR Species at Risk list for Waterloo Region, Ebird website, Ontario Reptile and Amphibian Atlas website, DFO aquatic species at risk mapping and previous correspondences with MNR (WSP, 2021). For their 2025 report, WSP utilized similar sources to conduct their background screening, but accessed OBBA instead of Ebird.

WSP considered the results of their field surveys and habitat suitability to assess the likelihood and/or magnitudes of impacts to species and/or habitats.

4.5 Natural Heritage System

Using existing natural environment designations, the results of field surveys conducted, and the wide array of natural heritage data collected over many years of surveys WSP assessed areas within and immediately adjacent to the Primary Study Area to be recommended for retention through the secondary plan process. Preliminary development setbacks and potential enhancement measures were also identified, subject to further studies in support of future development applications

5. Results

As stated above, Jacobs has not conducted field work within the Study Area to date. The summarized results below are based on the 2021 and 2025 reports, authored by WSP Canada Inc. (WSP), Existing Conditions & Ecological Constraints Report (WSP, 2021; WSP, 2025) and the Robert Ferrie Drive Alignment Alternatives, Southwest Kitchener Natural Environment Existing Conditions Report (Stantec 2013). These reports provide more detailed information about their recorded observations and results from field surveys.

5.1 Vegetation and Flora

5.1.1 Vegetation Communities

While the updated Study Area consists primarily of active agricultural fields, WSP identified a total of twenty-six (26) ecological communities in their 2021 report and ten (10) natural/cultural vegetation communities in their 2025 report. These communities are identified by a Vegetation Unit number (Unit #) and associated with an ELC code. The location of these vegetation communities is shown in Appendix A – WSP ELC Figures while a description of each community, can be found in the WSP NH overview and constraint reports (WSP, 2021 and 2025). The following Vegetation Communities have been identified within the updated Study Area:

- Cultural Areas:
 - CUS1: Mineral Cultural Savannah
 - CUH1-A: Hedgerow
 - CUT1: Mineral Cultural Thicket
 - CUW1: Mineral Cultural Woodland
 - CUM1-1: Dry-Moist Old Field Meadow
- Forested Areas:
 - FOD3-1: Dry-Fresh Poplar Deciduous Forest
 - FOD5-2: Dry-Fresh Sugar Maple-Beech Deciduous Forest
 - FOD5-6: Dry-Fresh Sugar Maple-Basswood Deciduous Forest
 - FOD8-1: Fresh-Moist Poplar Deciduous Forest
- Wetlands:
 - MAM2: Mineral Meadow Marsh
 - MAM3: Organic Meadow Marsh
 - MAS2: Mineral Shallow Marsh
 - MAS2-1: Cattail Mineral Shallow Marsh
 - MAM2-2: Reed Canary Grass Mineral Meadow Marsh
 - SWD2-2: Green Ash Mineral Deciduous Swamp
 - MAM2-10: Forb Mineral Meadow Marsh
 - SWT3-5: Red-osier Dogwood Organic Thicket Swamp
 - MAM3-9: Forb Organic Meadow Marsh
 - SWM6-1: Birch – Conifer Organic Mixed Swamp

Additionally, the area north of the Stauffer Drive and Reidel Drive intersection was identified as a cultural area with only agricultural and residential lands as well as some hedgerows (Stantec, 2013).

Cultural vegetative communities are anthropogenically disturbed and therefore do not contribute the same quality of ecological value and are therefore awarded less protection.

5.1.2 Vascular Plant Species

WSP identified a total of 285 vascular plant species within their 2025 report and a total of 370 in their 2021 report. No globally rare species (i.e. G-rank G1-G3) were identified and most species were common and secure or apparently secure in Ontario (i.e. ranked S5, S4, SE5 or SE4). However, there were three SAR identified during field investigation:

- American Chestnut (*Castanea dentata*), an Endangered species under the *ESA* and *SARA*. There were two planted individuals that were observed within Unit 7 (WSP, 2025). Despite being planted, these individuals are subject to provisions under the *ESA*.
 - Note: Native American Chestnut is considered provincially critically imperiled/imperiled (S1S2)
- Black Ash (*Fraxinus nigra*), an Endangered species under the *ESA*. There were seven individuals observed within Vegetation Unit 3 (WSP, 2025) and three individuals identified in Units 7 and 14 (WSP, 2021). However, as per the *ESA*, Black Ash over 8 cm DBH, deemed healthy through a Black Ash assessment, receive legal protection. Only 2 of these individuals were over 8 cm DBH and will require a Black Ash assessment to determine whether provisions under the *ESA* apply.
- Butternut (*Juglans cinerea*), an Endangered species under the *ESA* and *SARA*. There were six individuals identified within Units 7 and 14 (WSP, 2021).
 - In addition, 81 putative Hybrid Butternut (*Juglans x bixbyi*) were observed in Vegetation Unit 7 (WSP, 2025). However, morphological evidence and DNA testing confirmed that these were hybrids, not true Butternut (*Juglans cinerea*), which is an Endangered species both provincially and federally. As such, they are not afforded any legal protections under the *ESA*.

24 species identified within the WSP 2021 and 2025 reports are considered significant within the Regional Municipality of Waterloo (RMV), as per the *Region of Waterloo Significant Species List: Vascular Plants Component*, PC-99-028.1 (1999):

- **WSP, 2021**
 - Black Walnut^{1,2} – identified in Unit 1-6, 9-11, 13, 15, 17, 23 and 25 (scarce to frequent)
 - Burreed Sedge (*Carex sparganioides*)¹ – identified in Units 15, 18, and 20 (occasional to frequent)
 - Dotted Smartweed (*Persicaria punctata*)¹ – identified in Unit 13 (scarce)
 - Early Lowbush Blueberry (*Vaccinium angustifolium*)² – identified in Unit 14 (scarce)
 - Eastern Cottonwood (*Populus deltoides* ssp. *deltoides*)² – identified in Units 2, 21, and 22 (scarce to occasional)
 - Flat-branched Tree-clubmoss (*Dendrolycopodium obscurum*)¹ – identified in Unit 15 (scarce)
 - Grey Sedge (*Carex grisea*) – identified in Unit 16 (occasional)
 - Highbush Blueberry (*Vaccinium corymbosum*)¹ – identified in Units 14 and 15 (occasional)
 - Hoary Sedge (*Carex canescens* ssp. *canescens*)¹ – identified in Unit 14 (scarce)
 - Interrupted Fern (*Osmunda claytoniana*) – identified in Unit 4 (scarce)
 - Leatherleaf (*Chamaedaphne calyculata*) – identified in Unit 14 (scarce)
 - Lesser Clearweed (*Pilea fontana*) – identified in Units 1, 4 and 14 (occasional)
 - Open Woodland Bluegrass (*Poa saltuensis*) – identified in Unit 15 (scarce)
 - Short-awned Foxtail (*Alopecurus aequalis*) – identified in Unit 21 (scarce)
 - Spreading Sedge (*Carex laxiculmis* var. *laxiculmis*) – identified in Units 5, 10, 15, and 20 (scarce)

- Summer Grape (*Vitis aestivalis*) – identified in Unit 2 (scarce)
- Tuckerman's Sedge (*Carex tuckermanii*) – identified in Units 4 and 14 (scarce to occasional)
- Virginia Creeper (*Parthenocissus quinquefolia*)² – identified in Units 4, 10 and 14 (scarce)
- Virginia Stickseed (*Hackelia virginiana*)¹ – identified in Units 10, 15 and 18 (scarce to occasional)
- White Spruce (*Picea glauca*)² – identified in Unit 5 (scarce)
- Wild Calla (*Calla palustris*)¹ – identified in Units 4 and 14 (scarce to occasional)
- **WSP, 2025**
 - American Chestnut (planted) – identified in Unit 7
 - Black Walnut (*Juglans nigra*)^{1,2} – identified in Units 2 -5
 - Canada Moonseed (*Menispermum canadense*) – identified in Unit 3
 - Common Hackberry (*Celtis occidentalis*)¹ – identified in Unit 2
 - Eastern Cottonwood (*Populus deltoides* ssp. *Deltoides*)² - identified in Unit 1
 - Tuckerman's Sedge (*Carex tuckermanii*) - identified in Unit 3
 - Virginia Creeper (*Parthenocissus quinquefolia*)² – identified in Units 1-4
 - White Spruce (*Picea glauca*) (planted)² – identified in Unit 7

¹ Significant in the RMW but with the expectation that addition research may prove otherwise

² Significant in the RMW ONLY if demonstrably indigenous – most populations with the RMW are thought to be of non-indigenous origin.

Note: WSP determined that the American Chestnut and White Spruce had been obviously planted around the residence in Unit 7 (WSP, 2025), and therefore did not represent spontaneously occurring, wild populations. As such, WSP did not consider them Regionally and/or Provincially significant, however provided an update in their 2025 report stating new legislated changes would technically protect the planted American Chestnut on site.

Black Walnut is only considered Regionally Significant if it is demonstrably native. Black Walnut is typically associated with floodplains but is also commonly planted. In their 2025 report, WSP concluded that due to the fragmentation of their study area and its isolation from any sizable watercourses in addition to the Black Walnut observed were found in hedgerows and along the margins of the woodlot, these Black Walnuts were not demonstrably native (WSP, 2025).

Eastern Cottonwood is only considered Regionally Significant if it is demonstrably native. Eastern Cottonwood is typically associated with floodplains, dunes, and shoreline habitats. In their 2025 report, WSP concluded that due to the fragmentation and isolation of their study area from any sizable watercourses or shorelines, it was unlikely that the observed Eastern Cottonwood represented spontaneously occurring native populations and as such, did not consider them Regionally Significant (WSP, 2025).

5.1.3 Feature Delineation

Wetland limits and the Core Environmental Feature (CEF) / dripline limits were delineated by WSP in 2019 and 2020. WSP conducted in-person and email correspondence to confirm the wetland limits.

5.1.4 Vegetation – Cedar Creek Subwatershed Study (SWS)

In their 2025 report, WSP identified the following species of conservation concern which had not previously been recorded in the SWS conducted by NRSI in 2019.

- American Chestnut – regionally rare, *Endangered* Federally and Provincially
- Burreed Sedge – regionally rare
- Canada Moonseed – regionally rare
- Common Hackberry – regionally rare
- Tuckerman’s Sedge – regionally rare
- White Spruce – regionally rare

In addition, a large White Oak (*Quercus alba*) with a diameter-at-breast height of 103 cm was identified in the agricultural field in the northeast portion of their study area, east of Unit 4.

5.2 Wildlife

A full list of wildlife species identified by WSP within their 2021 and 2025 reports. The following results summarize the species identified and/or results of targeted surveys.

5.2.1 Breeding Bird Surveys

WSP recorded 54 avifauna species in their 2021 report and 48 species in their 2025 report.

Breeding Species

- 2021: 45 species were considered ‘breeding’ (i.e., ‘possible’, ‘probable’ or ‘confirmed’ breeding evidence). The following 9 species are potential breeders within the local landscape but with no evidence of nesting on the subject property:
 - Bank Swallow (*Riparia riparia*) and Barn Swallow (*Hirundo rustica*) – recorded as foraging visitants.
 - Mallard (*Anas platyrhynchos*), White-throated Sparrow (*Zonotrichia albicollis*) and Wood Duck (*Aix sponsa*) – recorded incidentally during other field surveys, outside of the breeding season.
 - Canada Goose (*Branta canadensis*), Great Blue Heron (*Ardea herodias*), Ringbilled Gull (*Larus delawarensis*) and Turkey Vulture (*Cathartes aura*) – recorded flying over the survey area.
- 2025: 48 species were considered ‘breeding’ (i.e., ‘possible’, ‘probable’ or ‘confirmed’ breeding evidence). The following 3 species are potential breeders within the local landscape but with no evidence of nesting on the subject property:
 - Black-and-white Warbler (*Mniotilta varia*) – recorded incidentally during other field surveys, outside of the breeding season.
 - Ring-billed Gull, Rock Pigeon (*Columba livia*) and Turkey Vulture – recorded flying over survey area with no breeding evidence

SAR

- 2021: Four observed species are designated as SAR provincially and / or federally:
 - Bank Swallow – Threatened, *ESA* and *SARA*
 - Recorded without breeding evidence.
 - Barn Swallow – Special Concern, *ESA* and Threatened, *SARA*
 - Recorded without breeding evidence.
 - Eastern Wood-peewee (*Contopus virens*) – Special Concern, *ESA* and *SARA*
 - Recorded with ‘Probable’ breeding evidence.
 - Wood Thrush (*Hylocichla mustelina*) – Special Concern, *ESA* and Threatened, *SARA*
 - Recorded with ‘Probable’ breeding evidence.

- 2025: Two observed species are designated as SAR provincially and / or federally:
 - Barn Swallow – Special Concern, *ESA* and Threatened, *SARA*
 - Recorded with 'Confirmed' breeding evidence in 2019 and 2024.
 - Eastern Wood-pewee – Special Concern, *ESA* and *SARA*
 - Recorded with 'Probable' breeding evidence.

Regionally Significant

- 2021: Twelve species are considered Significant in the Region of Waterloo:

- Black-billed Cuckoo (<i>Coccyzus erythrophthalmus</i>). - Brown Thrasher (<i>Toxostoma rufum</i>). - Great Blue Heron. - Northern Waterthrush (<i>Parkesia noveboracensis</i>). - Pine Warbler (<i>Setophaga pinus</i>). - Red-bellied Woodpecker (<i>Melanerpes carolinus</i>).	- Scarlet Tanager (<i>Piranga olivacea</i>). - Turkey Vulture. - Vesper Sparrow (<i>Pooecetes gramineus</i>) - White-throated Sparrow - Wood Duck - Yellow-billed Cuckoo (<i>Coccyzus americanus</i>).
---	---
- 2025: Twelve species are considered Significant in the Region of Waterloo:

- American Redstart (<i>Setophaga ruticilla</i>) - Brown Thrasher - Pine Warbler	- Red-bellied Woodpecker - Scarlet Tanager - Vesper Sparrow
--	---

Area Sensitive

- 2021: Five species are considered Area Sensitive (per OMNR 2000 and MNRF 2015):
 - Hairy Woodpecker (*Picoides villosus*).
 - Pine Warbler
 - Savannah Sparrow (*Passerculus sandwichensis*)
 - Scarlet Tanager.
 - White-breasted Nuthatch (*Sitta carolinensis*)
- 2025:
 - Savannah Sparrow
 - Scarlet Tanager
 - Vesper Sparrow

5.2.2 Spring Breeding Amphibian Surveys

WSP recorded 6 anuran species in their 2021 report and in their 2025 reports. Some stations had multiple species present while a few did not have any observations of amphibians. The following amphibians and call levels were recorded:

- **2021 and 2025:**
 - American Toad (*Anaxyrus americanus*) – recorded in low numbers (L1)
 - Gray Treefrog (*Hyla versicolor*) – recorded in low numbers (L1)
 - Green Frog (*Lithobates clamitans*) – recorded in low numbers (L1)
 - Northern Leopard Frog (*Lithobates pipiens*) – recorded in low numbers (L1)

- Spring Peeper (*Pseudacris crucifer*) – recorded in varying abundance (L1-L3)
- Wood Frog (*Lithobates sylvaticus*) – recorded in low numbers (L1)

5.2.3 Vernal Pool Habitat Assessment

Based on the MNR/MECP criteria listed above, WSP determined that vernal pools VP4a, VP5, VP7 and VP9 (located in Units 3 and 4) may provide suitable habitat for Jefferson Salamander (WSP, 2025). As such, further documentation of ESA compliance may be required.

5.2.4 Road/Mortality Surveys

WSP recorded 3 road-killed American Toads along the surveyed portion of Reidel Drive in their 2021 report and no species in their 2025 report.

5.2.5 Turtle Surveys

WSP recorded no observations of turtles or evidence of turtle nesting in their 2021 and 2025 reports.

5.2.6 Additional Herpetofauna Results

In addition to the results described above, WSP recorded the following amphibians and reptiles in their 2021 report:

- Eastern Red-backed Salamander (*Plethodon cinereus*) – recorded incidentally during 2020 breeding bird surveys
- Jefferson Salamander – confirmed breeding habitat is present on adjacent lands and regulated habitat for this species is present in portions of the survey area. However no confirmed Jefferson Salamander individuals have been recorded within this survey area during the years of study.
- Spotted Salamander (*Ambystoma maculatum*) – recorded during breeding bird surveys. In addition, there are historical recordings of this species within the survey area from 2008-2017.
- Dekay's Brownsnake (*Storeria dekayi*) – recorded incidentally during 2020 wildlife surveys
- Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) – recorded during 2020 breeding bird surveys. In addition, there have been historical recordings of this species within the survey area (2008, 2016 – 2018)
- Snapping Turtle - recorded occasionally in low abundance in Wildlife Survey Area (WSA) 11 as part of on-going monitoring
- Midland Painted Turtle – recorded occasionally in low abundance in WSA 11 as part of on-going monitoring

5.2.7 American Badger Habitat Assessment

None of the surveyed burrows reported by WSP in their 2021 and 2025 reports demonstrated the characteristics of potential Badger burrows nor was any evidence of badgers observed during targeted or incidental surveys. In addition, WSP did not find any recent or historic records of American Badger within 1 km of their survey areas and there were no rail lines present (which are known to act as dispersal routes). As such WSP concluded that there was no evidence of American Badger presence or use.

5.2.8 Wildlife Movement Opportunities

After assessing potential wildlife movement throughout different portions of their survey areas, WSP concluded in both their 2021 and 2025 reports that while the agricultural fields might provide movement opportunities for more tolerant species, they do not contain defined wildlife movement areas, nor do they provide opportunities for movement of more sensitive species.

In their 2021 report, WSP notes that the important natural linkages / corridors for wildlife movement in their survey area are the Blair Creek and Strasburg Creek valleylands and associated natural areas. As such, they did not recommend establishing linkages/wildlife movement areas through the agricultural fields and instead recommended that the existing movement areas be maintained and enhanced through improved buffers (WSP, 2021).

5.2.9 Significant Wildlife Habitat

WSP reported that they found evidence of the following SWH (WSP, 2021):

- | | |
|---|--|
| <ul style="list-style-type: none">▪ Candidate SWH:<ul style="list-style-type: none">- Bat Maternity Colonies- Turtle Wintering Areas- Reptile Hibernaculum | <ul style="list-style-type: none">▪ Confirmed SWH<ul style="list-style-type: none">- Seeps and Springs- Amphibian Breeding Habitat- Special Concern and Rare Wildlife Species |
|---|--|

As such, in their 2021 report, WSP recommended that all confirmed SWH are included in the Natural Heritage System and are retained in full. They also recommended that candidate/unconfirmed SWH, were also retained within the NHS.

In their 2025 report, WSP reported the following SWH but determined that no impacts were anticipated due to the SWH being retained in full with a naturalized buffer:

- **Candidate SWH:**
 - Bat Maternity Colonies
- **Confirmed SWH**
 - Amphibian Breeding Habitat
 - Special Concern and Rare Wildlife Species

5.3 Aquatic Habitat

In their 2021 report, WSP concluded based on their field surveys that Upper Blair Creek, within their study area, features not well-developed morphology that has predominantly riffle/flat morphology with some deeper 'pools'. The substrate was dominated by detritus, silt, and sand, overlying clay, such that the soft substrate and location of this reach, within an area that seasonally floods, makes the morphology less stable. This allows some alterations to occur from year to year, especially with high flows.

Overhead cover is provided by dogwood shrubs and herbaceous wetland plants and there were observations of iron staining and watercress throughout this area indicate presence of local groundwater inputs.

Agricultural field Drainage Features were identified in the survey areas, and as such were assessed by WSP, using the TRCA / CVC HDF Guidelines. The reaches of these Drainage Features which extend through active crop fields are typically intermittent, undefined features with limited to no natural vegetation. As such, the management recommendation identified in the reports listed below was "Maintain Recharge".

Drainage features with reaches within natural areas typically have more defined channels and/or evident flow and standing water. These reaches are associated with wetland, woodland and wildlife habitat such as amphibian breeding. As such, the management recommendation identified in the reports below was "Conservation" or "Protection."

Further information can be found within the following reports:

- WSP. September 2017. Activa Southwest Kitchener Lands – Headwater Drainage Feature Assessment
- WSP. September 2018. Grambian Southwest Kitchener Lands - Headwater Drainage Features Assessment Report

5.3.1 Headwater Drainage Features Assessment

WSP reported that only one HDF was present within their survey area extending southwest of Fischer Hallman Road. Assessment of this HDF determined that there was 'No Management Required' for this feature, which was consistent with earlier reports (WSP, 2025). A full summary of the HDF results is presented in in the WSP 2025 report.

5.3.2 Benthic Macro-invertebrates

WSP found that Upper Blair Creek appears to support a moderately healthy benthic community, with a range of tolerant and intolerant organisms, and although the taxa richness is not high – which is expected with headwater stream – the high Dissolved Oxygen concentrations and cool stream temperatures measured at all stations appear to help to maintain the moderately high quality benthic community (WSP, 2021).

No obvious water quality degradation due to nutrient loading was recorded throughout the sampled reaches. Dissolved chloride measurements recorded in groundwater monitoring wells have been typically less than 25 mg/L. WSP found that stations closest to existing roads have exhibited predominantly "good" or "fair" water quality on average over the monitoring period, and have shown relatively stable taxa richness, EPT richness and % EPT. As such WSP suggested that road salt, if applied, has not had enough impact to negatively affect the existing benthic community.

5.3.3 Brook Trout Spawning Surveys

Results recorded by WSP in their 2021 report confirmed Brook Trout spawning in Upper Blair Creek, downstream of Dodge Drive which was outside of their survey area and outside of the updated 2025 Study Area. These findings were consistent with previously collected fisheries data.

5.4 Species at Risk

WSP concluded in both their 2021 and 2025 reports that for many of the species identified during the background screening the likelihood of them occurring within their survey areas was 'none' or 'minimal' due to a lack of suitable or preferred habitat and/or rarity of the species.

For species with some potential to occur within the survey areas due to the presence of potentially suitable habitat, WSP provided comments and/or recommendations for future work which are summarized below:

2021

- **Threatened/Endangered Species:** subject to provisions under the *ESA*
 - Regulated habitat for **Jefferson Salamander** (Endangered) is present within this survey area, and this species is known to occur on adjacent lands.
 - A small area of Regulated (Category 3) habitat for **Blanding's Turtle** (Threatened) may extend within the northeast portion of the Study Area – subject to confirmation by MECP
 - **6 Butternut**, an Endangered species, was observed during field surveys. All recorded trees are within areas recommended for retention in the Natural Heritage System (NHS). Further assessment is required at the time of development applications to confirm *ESA* compliance.
 - Potential maternity roosting habitat for Endangered **SAR bats** is present within the survey area, however no impact to potential bat habitat is anticipated with the retention of woodland habitats and implementation of development setbacks and buffer enhancements.
 - Mitigation of potential impacts to isolated trees and hedgerows and buildings to be identified through future studies.
 - **Bank Swallow**, a threatened species was recorded as foraging visitants. Suitable nesting habitat for is present in the local landscape.
- **Special Concern Species:** not subject to provisions under the *ESA*:
 - **Barn Swallow:** Recorded as foraging visitants. Suitable nesting habitat is present in the local landscape.
 - **Eastern Wood-pewee:** Probable breeders recorded in low numbers (1-2 individuals) across various dates within the survey area in addition to a single individual with 'Possible' breeding evidence. No impacts to Eastern Wood Pewee habitat are anticipated with retention of woodland habitats and implementation of development setbacks and buffer enhancements.
 - **Monarch:** Single individual recorded flying through /foraging in active cropland and suitable habitat is abundant in the local landscape although no impacts to Monarch habitat are anticipated with retention of natural habitats and implementation of development setbacks and buffer enhancements.
 - **Wood Thrush:** Single individual recorded with 'Probable' breeding evidence within the survey area and no impacts to Wood Thrush habitat are anticipated with retention of woodland habitats and implementation of development setbacks and buffer enhancements

- For other SAR species with some potentially suitable habitat present, but not recorded during field surveys, no impacts are anticipated, based on one or more of the following factors
 - The most sensitive natural features with potential SAR habitat (i.e., woodlands and associated wetlands) are proposed for retention within the NHS, with development setbacks and future naturalized and enhanced buffers
 - The small size and/or marginal quality of potentially suitable habitat outside of the larger, contiguous habitat features
 - Potential impacts are restricted to non-critical habitat
 - Presence of abundant and generally much larger/higher quality habitat in the local landscape
 - Low likelihood of occurrence
 - Implementation of additional mitigation/protection measures to be determined during future development applications.

2025

- Threatened/Endangered Species: subject to provisions under the *ESA*
 - **Jefferson Salamander**: potentially suitable breeding and overwintering habitat is present within their survey area, however all forested habitat containing potential habitat for Jefferson Salamander will be retained, in addition to implementation of recommended mitigation measures, no impacts to potential habitat are anticipated.
 - **American Chestnut**: two planted American Chestnuts were observed and are subject to provision under the *ESA*.
 - **Black Ash**: Seven individuals were observed however, only two trees met the criteria of being over 8 cm. As such, only two of the individuals are subject to provisions under the *ESA* and will require a 30 m radial buffer from each stem. No impacts to these individuals or their potential habitat are anticipated.
 - It is recommended that a Black Ash health assessment report is completed to demonstrate *ESA* compliance.
 - **SAR Bats**: potential suitable habitat is present within the survey area, however since all woodland habitat encompassing this potential suitable habitat will be retained, and appropriate vegetation clearing timing will be implemented, impacts to potential habitats and individuals can be mitigated
 - Note that for the above species/groups, WSP recommended that compliance/documentation requirements under applicable legislation in force at the time of application are followed.
- Special Concern Species: not subject to provisions under the *ESA*:
 - **Eastern Wood-pewee**: confirmed habitat is present within the survey area however all forested habitats containing confirmed habitat will be retained with setbacks. As such, no impacts to potential Eastern Wood Pewee habitat are anticipated.
 - **Barn Swallow**: confirmed nesting habitat is present within buildings located in the survey area, whose nests are protected under the *Migratory Birds Convention Act (MBCA)* and *SARA*. As such, building/structure removals or other works that impact Barn Swallow nesting habitat must be completed outside of the protected nesting period.

5.5 Natural Heritage System

WSP determined that the following areas within and immediately adjacent to the Primary Study Area are recommended for retention through the secondary plan process. Preliminary development setbacks and potential enhancement measures have also been identified, subject to further studies in support of future development applications.

2021

- WSA 1 – Agricultural Field
 - May include Category 3 Habitat for Blanding's Turtle (pending confirmation from MECP)
 - Recommendations: Enhance portions of the current agricultural field within future naturalized buffers to WSA 2, 4 and 5
- WSA 2 – Wetland
 - Identified as a *Core Natural Heritage Feature* and an *Ecological Restoration Area* in the City of Kitchener Official Plan (OP) and as a *Core Environmental Feature* in the Region of Waterloo Official Plan
 - Includes candidate/unconfirmed SWH: Turtle Wintering Areas
 - Recommendations: Retain in full, with 15m development setback from the identified wetland limit, incorporate buffer enhancements into future development plans and maintain water inputs
- WSA 3 – Agricultural Field
 - No natural heritage designations, candidate/confirmed SWH or SAR habitat
 - Recommendation: Enhance portions of the current agricultural field within future naturalized buffers to WSA 8 and WSA 9
- WSA 4 – Strasburg South Natural Area
 - Identified as a *Core Natural Heritage Feature* and the southern edge is identified as an *Ecological Restoration Area* in the City of Kitchener OP and as a *Core Environmental Feature* in the Region of Waterloo OP
 - Includes candidate SWH (Bat Maternity Colonies, Reptile Hibernaculum), confirmed SWH (Special Concern and Rare Wildlife Species) and potential and confirmed SAR habitat (SAR bats, Eastern Wood-pewee)
 - Recommendations: Retain and protect with a minimum 10 m development setback from the dripline and incorporate buffer enhancements into future development plans to protect the woodland edge
- WSA 5 – Doon South/Blair Creek Natural Area
 - Identified as a *Core Natural Heritage Feature* with portions identified as an *Ecological Restoration Area* in the City of Kitchener OP and as a *Core Environmental Feature* in the Region of Waterloo OP
 - Contains a portion of the Roseville Swamp – Cedar Creek Provincially Significant Wetland (PSW) Complex
 - Includes candidate SWH (Bat Maternity Colonies, Turtle Wintering Areas, Reptile Hibernaculum), confirmed SWH (Seeps and Springs, Woodland Amphibian Breeding Habitat, Special Concern and

- Rare Wildlife Species), potential and confirmed SAR habitat (Butternut, SAR bats, Black Ash, Eastern Wood-pewee, Wood Thrush) and Regulated habitat for Jefferson Salamander
- Recommendations: Incorporate buffer enhancements into future development plans to protect the habitat edges, maintain water inputs to receiving areas and retain/protect with the following development setbacks (with the greater setback in any given area identified as the development limit at that location):
 - Dripline + 10 m
 - Blair Creek + 30 m
 - Roseville Swamp – Cedar Creek PSW + 30 m
 - Unevaluated wetlands + 15 m
- WSA 6 – Agricultural Field
 - Includes an area of Regulated JESA habitat movement/dispersal between breeding ponds but no natural heritage designations, candidate/confirmed SWH or confirmed SAR habitat
 - Recommendations: Enhance portions of the current agricultural field within future naturalized buffers to WSA 5 and demonstrate ESA compliance re; JESA habitat through a future development application
- WSA 7 – Residential Property
 - Includes candidate/unconfirmed SWH (Reptile Hibernaculum) but no natural heritage designations, confirmed SWH or confirmed SAR habitat
 - Recommendations: Not within the recommended NHS, therefore functions to be maintained elsewhere in the survey area via enhancements as part of the recommended NHS. Further analysis to be included in future studies
- WSA 8 – Cedar Creek Natural Area (west) – located outside of WSP's survey area
 - Identified as a *Core Natural Heritage Feature* with portions identified as an *Ecological Restoration Area* in the City of Kitchener OP and as a *Core Environmental Feature* in the Region of Waterloo OP
 - Includes candidate SWH (Bat Maternity Colonies, Turtle Wintering Areas, Reptile Hibernaculum), confirmed SWH (Special Concern and Rare Wildlife Species) and potential and confirmed SAR habitat (SAR bats, Eastern Wood-pewee)
 - Recommendations: Retain and protect with a minimum 10 m development setback from the identified dripline, incorporate buffer enhancements into future development plans to protect the woodland edge and maintain water inputs, as required
- Area 9 – Cedar Creek Natural Area (east) – located outside of WSP's survey area
 - Identified as a *Core Natural Heritage Feature* in the City of Kitchener OP and as a *Core Environmental Feature* in the Region of Waterloo OP
 - Includes candidate SWH (Bat Maternity Colonies, Reptile Hibernaculum), confirmed SWH (Special Concern and Rare Wildlife Species) and potential and confirmed SAR habitat (SAR bats, Eastern Wood-pewee)

- Recommendations: Retain and protect with a minimum 10 m development setback from the identified dripline, incorporate buffer enhancements into future development plans to protect the woodland edge and maintain water inputs, as required
- WSA 10 – Reidel Drive and Stauffer Drive – located outside of WSP's survey area
 - Recommendations: Future improvements and/or planning should consider incorporating design elements to enhance connectivity between the natural areas associated with the Blair Creek valleylands (e.g., wildlife crossings, funnel fencing, lighting considerations), where appropriate and in consideration of future land uses.
- WSA 11 – Stauffer Woods Development – located outside of WSP's survey area
 - Protection and enhancement measures have been incorporated into approved development plans.

2025

- Unit 3 wetland/Unit 4 woodland
 - Identified as a *Core Natural Heritage Feature* and as an *Ecological Restoration Area* in the City of Kitchener OP and as a *Core Environmental Feature* in the Region of Waterloo OP
 - Includes confirmed SWH, candidate/unconfirmed SWH and potential habitat for SAR as well as amphibian breeding habitat
 - Recommendations: Retain in full and protect with a minimum 10 m development setback from the dripline/15 m setback from the wetland habitat along the edge of the woodland, incorporate buffer enhancements into future development plans and maintain water inputs, as required
- Unit 8 woodland
 - Identified as a *Core Natural Heritage Feature* in the City of Kitchener OP and as a *Core Environmental Feature* in the Region of Waterloo OP
 - Includes confirmed SWH, candidate/unconfirmed SWH and potential habitat for SAR as well as potential amphibian breeding habitat
 - Retain in full and protect with a minimum 10 m development setback from the dripline, incorporate buffer enhancements into future development plans and maintain water inputs, as required

WSP noted in their 2025 report that documentation of compliance with relevant natural heritage policies for those mapped and other features would be undertaken as part of a planning application and may require additional study or documentation.

6. Additional Information

6.1 Removed Wetland

During the Knowledge Transfer Workshop meeting on January 27, 2022, with the City of Kitchener, Jacobs was notified by Tina Malone-Wright (former City Co-Project Manager), that a wetland within the Study Area was removed.

As identified in the *Blair, Bechtel, and Bauman Creeks Subwatershed Plan* completed in 1997 (CH2M, 1997), this wetland was located northwest of Reidel Drive and was:

- 1.3 ha in size, receiving 1km² of runoff from the Blair uplands (CH2M, 1997)
- Identified as a waterfowl staging/breeding area (CH2M, 1997)
- Dominated by Burreed marsh, the only representation of this vegetation type in the area (CH2M, 1997)
- Designated in 1997 as a Class 1, 2, 3 wetland (CH2M, 1997)
- It appears the wetland swath was once connected to the PSW Roseville Swamp Cedar Creek Wetland Complex to the south and would have connected Roseville Swamp Cedar Creek Wetland Complex to Strausburg Creek Wetland Complex in the north (CH2M, 1997)
- Would be considered a swamp by the OWES (Government of Ontario, 2014), because it has a greater than 25 percent tree cover, but it is more correctly classed as a treed fen with abundant Sphagnum moss present (CH2M, 1997)
- Steep slopes on the south and west sides of this kettle wetland combined with slow flowthrough of water have created a nutrient poor, cool microclimate that favours plant species more typical of northern wetlands (CH2M, 1997)
- Currently PSW wetlands are afforded protection under the PPS (Government of Ontario, 2021) and all wetlands are afforded protection within GRCA's Regulated Area as per *O. Reg.150/06*. Generally, development within wetland features is prohibited without authorization, and often development is not approved within these areas

Aerial imagery (Figure 3) from the City of Kitchener *Interactive Mapping* (City of Kitchener, 2021) shows the undisturbed wetland in 1997 (top left), tree removal in 2000 (top centre), unchanged in 2003 (top right), wetland being filled (bottom left) and trucks driving in with fill (bottom centre) in 2006, with the wetland completely gone in 2007 (bottom right).

Figure 3. Chronological Aerial Imagery of Unauthorized Wetland Removal



At this time, the City of Kitchener:

- Has stated that this may be the last opportunity to restore some historic natural heritage linkages that were disconnected due to an unauthorized removal of a wetland feature within, and adjacent to, the Study Area.
- Recommends reviewing the City's Ecological Restoration, Linkages & Corridors, and Recreational Needs & Parks planning Policies to identify opportunities to re-establish these historic habitat and natural heritage corridor linkages. City added that it may be useful to incorporate into that review the Provincial Policy Statement which shifted from emphasizing protecting features to protecting systems.
- Recommends reviewing aerial photographs of the area to establish historic corridors.

GRCA was contacted with inquiries on January 31, 2022, on wetland evaluations that supported the Blair, Bechtel, and Bauman Creeks Subwatershed Plan as well as further information about this wetland. GRCA Watershed Ecologist Anthony Zammit replied on February 1, 2022, with the following:

- The wetland in question (north of Stauffer Drive) was plowed and filled over time through normal farming practices. The GRCA does not regulate normal farming activity so there are likely no formal documentation of when or how this occurred.
- GRCA's regulation at the time did not allow GRCA to regulate any activity that would "interfere with a wetland".
- The Ontario wetland evaluation record, which pertains [to] the entire wetland complex, would not provide much information on this particular wetland unit.
- The GRCA's wetland mapping generally does not document biophysical attributes of functions of wetlands.

- They can confirm this small wetland was identified as a waterfowl breeding and staging area in the Blair, Bechtel, and Bauman Creeks Subwatershed Plan. Unfortunately, the subwatershed study report did not include detailed vegetation mapping but based on air photo it would be classified as a shallow marsh by current ELC standards.
- The wetland referred to as a “treed fen” in the subwatershed study is in fact located within the woodland to the south of Stauffer Drive. This wetland remains intact and likely continues to contain regionally rare plants and birds. The wetland is still identified as a treed swamp in the MNR wetland layer

6.2 Current Data Gaps

Data Gaps should be addressed prior to any development decisions in the updated Study Area.

- Bat acoustic surveys are required in areas of potential habitat and roosting snags to confirm presence or absence of SAR bats if tree removals are proposed
- Black Ash Health Assessment and DNA analysis have not been completed.
- Butternut Health Assessment (BHA) may be required, and the (6) Butternut locations from the WSP 2021 report need to be confirmed as either missing, dead or hybrids; this was not clearly stated in the 2025 report.
- There are physical gaps in the Study Area, that were not covered by the WSP's *Existing Conditions & Ecological Constraints Report* 2021 and 2025 reports, during their ELC and wildlife surveys.
- Data presented in Stantec's 2013 *Robert Ferrie Drive Alignment Alternatives, Southwest Kitchener Natural Environment Existing Conditions Report* is now over a decade old and will require updated fieldwork to reflect current natural heritage and wildlife features
- The southeastern portion of the updated Study Area has not been covered by any of the above reports, and as such, field investigations are necessary to determine current natural heritage and wildlife features
- Desktop analysis appears to show that these gaps are all either residential or agricultural fields.
 - Note: Agriculture lands were not included in the ELC assessments. Often marginal agricultural land is wetland that is too wet for farming and missed in ELC assessments. Careful assessment of vegetative community among the crops and soil samples in these areas can identify missed ELC community(ies) within agricultural lands.

7. Conclusion

The baseline summarized natural heritage field study efforts between 2013 and 2024 and provided a comprehensive NHFs 2025 desktop screening. The Study Area extent encompasses NHFs including Grand River Conservation Authority Regulated Area, Provincially Significant Roseville Swamp Cedar Creek Wetland Complex and Strasburg Creek Wetland Complex, unevaluated wetland, woodlands, SWH, 3 watercourses, SAR habitat, Core Natural Heritage Feature, Ecological Restoration Area, and Core Environmental Feature. In addition, the presence of several SAR (American Chestnut, Bank Swallow, Black Ash, Butternut, etc.) have been confirmed within the Study Area. Proposed works should strive to avoid, reduce, and mitigate the impact on these features, as well as the SAR and SAR habitats they support.

8. Works Cited

Blair, Bechtel, and Bauman Creeks Subwatershed Plan. CH2M Gore & Storrie Limited. 1997.

Bird Studies Canada. 1995. Marsh Monitoring Program (MMP).

City of Kitchener. 2014. Official Plan. Accessed 2025. <https://www.kitchener.ca/en/development-and-construction/official-plan.aspx>

Fisheries and Oceans Canada (DFO). 2025. Aquatic species at risk map. Accessed 2025. <http://www.dfo-mpo.gc.ca/species-especes/sara-lep/map-carte/index-eng.html>.

Government of Canada. 2025. *Species at risk public registry*. Accessed 2025. <https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html>.

Government of Canada. 2018. *Nesting Periods*. Accessed 2025. <https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods/nesting-periods.html>

Government of Ontario. 2014. *Ontario Wetland Evaluation System (OWES)*. Accessed 2025. <https://files.ontario.ca/environment-and-energy/parks-and-protected-areas/ontario-wetland-evaluation-system-southern-manual-2014.pdf>

Government of Canada. 2002. Species at Risk Act. <https://laws-lois.justice.gc.ca/eng/acts/s-15.3/>

Government of Ontario. 2025. Greenbelt Act, 2005. <https://www.ontario.ca/laws/statute/05g01>

Government of Ontario. 2024. Provincial Policy Statement, 2024. Accessed 2025. <https://www.ontario.ca/files/2024-10/mmah-provincial-planning-statement-en-2024-10-23.pdf>

Government of Ontario. 2025. Species at risk in Ontario. <https://www.ontario.ca/page/species-risk-ontario>.

Grand River Conservation Authority (GRCA). 2025. General Mapping. Accessed 2025. <https://maps.grandriver.ca/web-gis/public/?theme=General&bbox=>

iNaturalist. 2025. Ontario, CA Province. Accessed 2025. <https://www.inaturalist.org/places/ontario-ca>.

Lee et al. 1998. *Ecological Land Classification for Southern Ontario*.

Ministry of Natural Resources and Forestry (MNR). 2016. *Best Management Practices for Mitigating the Effects of Roads on Amphibian and Reptile Species at Risk in Ontario*.

Ministry of Natural Resources (MNR). 2025a. Land Information Ontario. Accessed 2025. <https://www.ontario.ca/page/land-information-ontario>.

Ministry of Natural Resources (MNR). 2025b. Make a Map: Natural Heritage Areas. Accessed 2025. https://www.lioapplications.lrc.gov.on.ca/Natural_Heritage/index.html?viewer=Natural_Heritage.Natural_Heritage&locale=en-CA

Ministry of Natural Resources (MNR). 2025c. Aquatic Resource Area Line Segment. Accessed 2025. <https://geohub.lio.gov.on.ca/datasets/lio::aquatic-resource-area-line-segment/explore?location>

Ministry of Natural Resources (MNR). 2025d. Aquatic Resource Area Survey Point. Accessed 2025. https://geohub.lio.gov.on.ca/datasets/bb56b3df8a544ecdb37e9cc2a7ccfd18_0/explore?location

Ministry of Natural Resources and Forestry (MNR), Guelph Office. 2017. *Survey Protocol for Species at Risk Bats within Treed Habitats. Little Brown Myotis, Northern Myotis & Tri-Colored Bat.*

Ministry of Natural Resources (MNR). 2000 *Significant Wildlife Habitat Technical Guide*. Accessed 2025. <https://www.ontario.ca/document/guide-significant-wildlife-habitat>.

Ministry of Natural Resources (MNR). 2015. *Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E* (MNR, 2015). Accessed 2025. <https://dr6j45jk9xcmk.cloudfront.net/documents/4775/schedule-6e-jan-2015-access-ver-final-s.pdf>

Natural Heritage information Centre (NHIC). 2023. Plant Communities List. <https://www.ontario.ca/page/get-natural-heritage-information>

Ontario Breeding Bird Atlas. 2021. *Ontario Breeding Bird Atlas*. Accessed 2025. <http://www.birdsontario.org/atlas/>

Region of Waterloo. 1999. Revisions to Waterloo Region's Significant Species List: Vascular Plants Component. Report to Planning and Culture Committee PC-99-028.1. Approved by Council June 23, 1999.

Regional Municipality of Waterloo. 2015. *Regional Official Plan*. https://www.kitchener.ca/en/resourcesGeneral/Documents/DSD_PLAN_OP_Map_6_Natural_Heritage_System.pdf

Stantec Consulting Ltd. 2013. *Robert Ferrie Drive Alignment Alternatives, Southwest Kitchener Natural Environment Existing Conditions Report*.

WSP Canada Inc. 2021. *Existing Conditions & Ecological Constraints Report*.

WSP Canada Inc. 2025. *Existing Conditions & Ecological Constraints Report*.

Appendix E. Monitoring Plan



Dundee Secondary Plan - Monitoring Plan (Draft)

Document no: 0
Revision: 0

City of Kitchener
0

Dundee Secondary Plan
October 10, 2025



Dundee Secondary Plan - Monitoring Plan (Draft)

Client name: City of Kitchener

Project name: Dundee Secondary Plan

Client reference: 0

Project no: CE805800

Document no: 0

Project manager: Jillian Schmitter, Tom Mahood

Revision: 0

Prepared by: Various

Date: October 10, 2025

File name: Draft-MonitoringPlan_R1

Document status: Draft

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	October 9, 2025	Draft Monitoring Plan	J. Andres J. Schmitter	T.Mahood	J.Schmitter	J.Schmitter

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
0	October 9, 2025	October 10, 2025	City of Kitchener	Draft for review

Jacobs Consultancy Canada Inc.

165 King Street West
Suite 201
Kitchener, ON N2G 1A7
Canada

T +1.519.579.3500
www.jacobs.com

© Copyright 2025 Jacobs Consultancy Canada Inc.. All rights reserved. The content and information contained in this document are the property of the Jacobs group of companies ("Jacobs Group"). Publication, distribution, or reproduction of this document in whole or in part without the written permission of Jacobs Group constitutes an infringement of copyright. Jacobs, the Jacobs logo, and all other Jacobs Group trademarks are the property of Jacobs Group.

NOTICE: This document has been prepared exclusively for the use and benefit of Jacobs Group client. Jacobs Group accepts no liability or responsibility for any use or reliance upon this document by any third party.

Statement of Limitations

This Report has been prepared exclusively for internal use by the City of Kitchener (City). Any information provided by the City and third party's and relied upon is presumed to be accurate for the purposes of this report preparation. Where baseline conditions change, additional information becomes available portions of the studies conclusions may warrant re-evaluation. This Report contains observations and professional opinions reflecting Jacobs' best judgment using information understood to be factual and correct. Jacobs will not accept responsibility for conditions arising from information or facts that were concealed or not fully disclosed to Jacobs.

This Report was not prepared in anticipation of any legal proceedings, nor is this Report intended for use or reliance in any way in any legal proceedings related to the project, or otherwise. No liability is accepted for any use or reliance on the information provided herein by third parties. Jacobs accepts no responsibility for damages, if any, suffered by any party as a result of decisions made or actions based on this Report. No other warranty, expressed or implied, is made.

This Report is to be read in full. No excerpts shall be taken to be representative of the findings. Jacobs takes no responsibility for misrepresentation or misuse of portions of this Report

Contents

Acronyms and abbreviations	v
1. Introduction	1
1.1 Background.....	1
1.1.1 Blair Creek Monitoring Program.....	2
1.1.2 Cedar Creek Monitoring Program	3
1.2 Purpose and Objectives	4
2. Existing Monitoring Program.....	1
3. Additions to Existing Monitoring Program.....	10
3.1 Blair Creek Monitoring	10
3.2 Cedar Creek Monitoring.....	11
4. Goals, Targets, and Objectives	12
4.1 Identified Subwatershed Goals	12
4.2 Subwatershed Objectives	12
4.2.1 Objectives for Goal 1 – Surface Water Protection.....	12
4.2.2 Objectives for Goal 2 – Groundwater Protection.....	13
4.2.3 Objectives for Goal 3 – Natural Heritage Preservation	13
4.2.4 Objectives for Goal 4 – Protection from Natural Hazards.....	13
4.3 Subwatershed Targets.....	14
4.4 Targets for Goal 1 – Surface Water Protection	14
4.5 Targets for Goal 2 – Groundwater Protection	16
4.6 Targets for Goal 3 – Natural Heritage Preservation.....	18
4.7 Targets for Goal 4 – Protection from Natural Hazards	20
5. References	21

Tables

Table 4-1. Objective 1a: Control Sediment Discharges and Provide Erosion Control.....	14
Table 4-2. Objective 1b: Maintain, enhance, or restore natural stream processes to achieve a balance of flow and sediment transport, and to maintain/reduce rates post-development (stream stability)	14
Table 4-3. Objective 1c: Maintain, enhance, or restore coldwater fisheries potential of the watercourses..	15
Table 4-4. Objective 1d: Maintain existing water quality and contribute to achieving federal, provincial, and municipal water and sediment quality objectives and guidelines in watercourses	15
Table 5-5. Objective 1e: Preserve and re-establish the natural hydrologic cycle	16
Table 4-6. Objective 1f: Manage wet weather flows to maintain ecohydrology	16

Table 4-7: Objective 1g: Protect, mitigate, and adapt the watercourse from the impacts of climate change	16
Table 5-8: Objective 2a: Maintain infiltration, baseflow, and discharge to natural features	17
Table 5-9: Objective 2b: Maintain groundwater levels and baseflows (groundwater discharge to watercourses and wetlands) to sustain watershed functions, human uses, and mitigate climate change impacts	17
Table 5-10: Objective 2c: Maintain groundwater quality to support watershed functions	17
Table 5-11: Objective 3a: Protect, restore, or enhance the integrity of the watershed ecosystem through an integration approach of natural areas, habitats, and connected links.....	18
Table 5-12: Objective 3b: Design and operated stormwater management facilities to maintain a healthy aquatic ecosystem, including the existing coldwater fisheries.....	18
Table 5-13: Objective 3c: Maintain or improve the ecohydrology of wetlands, especially the Roseville Swamp Complex and wetlands within the Endangered Species Habitat.....	19
Table 5-14: Objective 3d: Protect, mitigate, and adapt the natural heritage system from the impacts of climate change.....	20

Acronyms and abbreviations

Acronym	Description
BBB	Blair, Bechal, Bauman
CEA	Cumulative Effects Monitoring
City	City of Kitchener
FDS	Functional Drainage Study
GRCA	Grand River Conservation Authority
MMM	Monitoring, Maintenance and Mitigation
SKSP	Southwest Kitchener Special Policy
SWM	stormwater management
UBC SOW	Upper Blair Creek State of the Watershed

1. Introduction

A monitoring program has been established for Blair Creek in cooperation with the City of Kitchener (City), Grand River Conservation Authority (GRCA), and landowners. The collection of monitoring data has been ongoing in the Blair Creek Subwatershed since it was initiated in 1994 with the Blair, Bechtal, Bauman (BBB) Study. The existing program focuses on monitoring Blair Creek east of Riedel Drive. The purpose of this monitoring plan is to define modifications to the existing program to monitor Blair Creek west of Riedel Drive as the Dundee Secondary Plan study area is developed.

The intent of this monitoring program is to provide guidance for changes to the existing monitoring program to include the Dundee Secondary Plan lands west of Riedel Drive. The objective of this monitoring plan is to maintain the Blair Creek Monitoring program, practices, and standards previously established in the existing monitoring program. This monitoring program incorporates the adaptive management approaches established by the GRCA in 2017 and in the 2020 Upper Blair State of the Watershed ([SOW] Jacobs, 2020) to include the portion of the Blair Creek Subwatershed within the Dundee Secondary Plan study area.

Monitoring of the Cedar Creek Subwatershed is currently outside of the jurisdiction of the City and is currently the responsibility of the GRCA. The monitoring plan put forward in the Cedar Creek Subwatershed Study identifies monitoring specifically for the southwest Kitchener Special Policy (SKSP) area which is within the Dundee Secondary Plan Study area and the City's jurisdiction. This monitoring plan will focus on incorporating the recommended monitoring for the SKSP area put forward in the Cedar Creek Subwatershed Study Report.

1.1 Background

The Blair Creek has been monitored since the mid 1990's and was evaluated in two separate SOWs. Blair Creek is classified as a sensitive cold-water urban fishery in its middle and lower reaches. Due to developer interest and its inherent sensitivity, multiple studies have been conducted where it was concluded that development should be limited to a maximum of 25% impervious cover or if a higher density is desired a strong stormwater management (SWM) plan along with an adaptive management strategy to monitor the effectiveness of the SWM.

To date there have been four major evaluations of the Upper Blair Creek subwatershed:

1. Blair Bechtel, and Bauman Creeks Subwatershed Plan (BBB Study) (CH2M Gore & Storrie Limited 1997)
2. Upper Blair Creek (Kitchener) Functional Drainage Study (FDS) (Stantec 2009)
3. 2016 Upper Blair Creek State of the Watershed (2016 SOW) (Aquafor Beech Limited 2016)
4. Cumulative Effects Monitoring – Blair Creek Case Study (CEA) (GRCA 2018)

The relevant background information is summarized in the Dundee Secondary Plan Scoped Subwatershed Study Report (Jacobs, 2025) and the Upper Blair State of the Watershed Reports. Therefore, a summary of these reports are not repeated in this monitoring plan.

1.1.1 Blair Creek Monitoring Program

Section 6.0 of the FDS (Stantec Consulting Ltd, 2009) recommends a comprehensive Monitoring, Maintenance and Mitigation (MMM) program to ensure that development and stormwater management strategies were implemented and function as designed.

The MMM program is designed to be flexible, with modifications occurring over time to reflect observed changes in the systems (e.g., increases or decreases in work completed, shift in resources, focus to the most appropriate parameters). Since the publishing of the FDS, further consideration regarding available budgets and staffing has taken place. As a result, the City and Agencies have worked collectively to develop the 'Minimum Requirements' monitoring program which reflects the intent of the FDS while implementing more practical changes with available monitoring budgets and staffing resources considered. The 2016 State of the Watershed report **Invalid source specified**. outlines the typical monitoring minimum requirements.

Monitoring components were designed to provide the agencies with sufficient field data to observe watershed conditions under existing conditions, during the development period and over the long-term to identify alterations to hydrology and ecological conditions.

The goal of the UBC SOW Monitoring Program is to observe watershed conditions on a micro- and macro-scale to accomplish the following:

- Gain a comprehensive understanding of the natural systems under existing conditions and establish target criteria for the future.
- Permit the continuing validity of hydrologic modeling to be maintained.
- Confirm assumptions / predictions incorporated within the proposed conditions design.
- Ensure the measures developed and approved through the design process are implemented correctly.

System monitoring includes observation and assessment of watershed conditions on a macro-scale. Monitoring includes stations within and downstream of the Upper Blair watershed to monitor the overall health of the ecosystem and receiving environment downstream.

During-development monitoring is intended to observe detailed characteristics of each development and adjacent areas. This micro-scale observation is anticipated to provide sufficient information so potential offsite impacts during- or post-construction can be easily identified and traced to the source to the extent possible. During development monitoring is divided into three phases: Pre-, During- and Post-Construction.

- Pre-Construction monitoring was done to determine baseline conditions within and adjacent to development areas. The information will be used to compare conditions during- and post-construction, and to facilitate and evaluation of the mitigation measures implemented. Pre-Construction monitoring is done seasonally, and includes surface water, groundwater, benthics and fisheries, and terrestrial parameters.
- During-Construction monitoring is intended to evaluate the effectiveness of erosion and sediment controls established at development sites during-development and determine if targets established in the monitoring program are being met. The During-Construction Monitoring should address the following activities and annual reports summarizing applicable information with mitigation implemented will be prepared.
 - Surface water: surface water monitoring should occur at the end-of-pipe facility outlet(s) (both temporary sediment basins and ultimate SWM facilities) and analyzed for TSS and temperature monthly and after significant rainfall events (i.e., equal to or greater than a 15 mm event).

- Temperature: continuous monitoring of surface water and groundwater temperatures should be monitored to evaluate cooling measures with results interpreted in the context of climate conditions.
- Terrestrial: buffers should be inspected to ensure that construction activities did not influence the greenspace system.
- Post-Construction monitoring will occur for two years after 90 percent of the pond catchment area is stabilized, including the construction of buildings, sodding of lots and stabilization of undeveloped lots. This phase will evaluate how well the constructed stormwater management facilities performed to confirm design functionality and determine if the required control targets are met. This stage will also include monitoring of the completed SWM facilities. It is recommended that the following parameters are included. Terrestrial parameters are the same as the Pre-Construction and During-Construction monitoring.
 - Water quality and quantity: monitoring of temperature, TSS and flows at outlets from the SWM facilities and infiltration systems, specifically, following rainfall and runoff events. Outflow occurring from end-of-pipe facilities as a result of small rainfall events during non-winter periods may be evidence that the infiltration system is not functioning properly.
 - General inspection: including regular inspections of vegetation, any evidence of issues at the inlet and/or outlet structures, and general operational characteristics of the facilities (e.g., observed vs. designed drawdown characteristics). Seasonal inspections should occur.

Post-Development monitoring is intended to confirm that SWM facilities and maintenance requirements are operating as expected.

1.1.2 Cedar Creek Monitoring Program

To support future planning studies and data collection to establish baselines, continued monitoring is recommended (Matrix Solutions et al, 2019). This monitoring program is largely outside of the jurisdiction of the City and will likely be implemented in part by the GRCA in collaboration with member municipalities and the Region. The recommended watershed-scale monitoring activities have been organized into two groupings:

- monitoring that should continue now (i.e. Continued Monitoring); and
- monitoring activities that should be undertaken for the SKPA (i.e. Future Monitoring).

These activities are expected to include (Matrix Solutions et al, 2019):

- Continued Monitoring:
 - Climate observations – Ongoing monitoring of climate (temperature and precipitation) will assist in understanding where variations from baseline are caused by climate variability rather than land use impacts. The existing climate network is anticipated to be sufficient.
 - Groundwater monitoring - Use the current monitoring well network drilled and installed as part of the Upper Cedar Creek Scoped Subwatershed Study to collect continuously monitored water levels. Biannual (or more) manual measurements are required to confirm logger readings. Leverage the network of groundwater wells included in the Upper Blair Creek Monitoring program to monitor for potential impacts migrating north toward the Strasburg wellfield.
 - Surface Water Monitoring:
 - Water Quantity – Continue monitoring at the GRCA flow station located on Cedar Creek Road. This location has been heavily impacted by beaver activity, which is affecting the accuracy of flow estimates. The location of this monitor may have been relocated by the GRCA. Stream gauges on Blair Creek and the Roseville Tributary at Kings Road, albeit potentially impacted

by stressors other than the SKPA or Prime Industrial Strategic Reserve (PISR) lands, could also inform on potential impacts.

- Surface water temperature monitoring - Continuous temperature loggers should be collected at the same locations that streamflow is being captured. As most equipment used for streamflow monitoring also allows the capture of water temperature data, the incremental cost to collect this information is negligible.
- Future Monitoring:
 - Groundwater water quality monitoring – Sample dissolved water quality parameters biannually or seasonally. Parameters will include major anions and cations and any known groundwater contaminants of concern (specifically chloride and nitrate).
 - Surface water quality monitoring – There is an opportunity to focus the existing surface water quality monitoring network on reaches most likely to receive impacts (e.g. Western tributary of Cedar Creek, main stem of Cedar Creek above Alps Road, and Roseville Swamp). To ensure compatibility with previous monitoring programs, sampling should be completed at the same frequency as the GRCA had completed to support this Subwatershed Study (15 times per year) and at the same monitoring locations. Furthermore, the monitoring should capture a range of flow and seasonal conditions. Analyzed parameters should replicate those included in the GRCA's 2017 water quality monitoring program (dissolved phosphorous, total phosphorous, total suspended solids, dissolved chloride, nitrate, nitrite, hardness, copper, lead, zinc)
 - Surface water temperature monitoring - Continuous temperature loggers should be installed from April 1 to November 30 at key discharge areas, specifically the western tributary of Cedar Creek, should site access allow.
 - Geomorphic monitoring – Three detailed survey locations have been developed as part of this study. Continued monitoring of these locations would assist in understanding how dynamic the channel form is.
 - Benthic surveys – Benthic invertebrate surveys are useful as an overall indicator of stream health. If site access allows, these monitoring sites would benefit from being moved into reaches that are closer to the headwaters (western tributary of Cedar Creek).
 - Fish community surveys – To date, the majority of fish community surveys completed for Cedar have focused on the main stem of the creek, or downstream reaches. As the study has identified reaches with key aquatic habitat near the headwaters, it would be prudent to conduct fish community surveys in those areas (e.g., western tributary of Cedar Creek), should site access allow.

1.2 Purpose and Objectives

The purpose of this monitoring plan is to expand the established monitoring program for Blair Creek to include the lands west of Reidel Drive, known as the Dundee Secondary Plan Study Area. The Dundee Secondary Plan area also includes the SPSP area within the Cedar Creek Subwatershed, monitoring this portion of the Cedar Creek Subwatershed within the City boundary is put forward in this plan. This monitoring program puts forward monitoring parameters, frequencies, and locations to expand the existing Blair Creek Monitoring Program to include the lands within the Dundee Secondary Plan Study Area.

The established goals of the Upper Blair Monitoring Program are:

1. To restore, protect, and enhance surface water quality, surface water quantity, and associated aquatic resources and water supplies;
2. To protect, restore, and enhance groundwater quality and quantity

3. To conserve, protect, and restore natural aquatic, wetland, woodland, and wildlife habitats.

The objective of the monitoring program is to support the State of the Watershed (SOW) reporting. The purpose of the SOW is to compare indicator thresholds established for pre-development conditions with the results of the monitoring program for the during-development period, and eventually the post-development monitoring period.

2. Existing Monitoring Program

The existing monitoring program was developed in accordance with the Functional Drainage Study (Stantec, 2009). Table 2-1 summarizes the existing monitoring locations, monitoring parameters, the responsible entity, monitoring timeframe, and frequency.

Table 2-1: Existing Typical Monitoring Minimum Requirements

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
Surface Water Quality	- Downstream Fountain Street – mouth (GRCA) - Upstream Dickie Settlement Road – main branch (GRCA) - Reichert Drive - Roseville tributary (GRCA) - Reichert Drive – main branch (GRCA) - Reichert Drive ditch (Monarch Stage 1) - Upstream New Dundee Road – main branch (GRCA, Monarch) - Upstream New Dundee Road – main branch - upstream of Dodge Drive tributary (GRCA) - Dodge Drive - Dodge Drive Dr tributary (Monarch, Hallman) - Dodge Drive - main branch (Activa)		<u>Landowners</u> 12 times per year: monthly, including all rainfall events >15mm	<u>Landowners</u> 8 times per year: 1 high flow, 1 low flow event per season (winter, spring, summer, fall)	<u>GRCA sites</u> 22 times per year: 16x spring-summer-fall: minimum 5 times per season with at least 1 high flow, 1 low flow event per season - Attempt to capture 3 high flow events in spring and 2 in summer 6 times in winter

Dundee Secondary Plan - Monitoring Plan (Draft)

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
	- Reidel Drive – main branch (GRCA, Activa) - Downstream New Dundee Road – culvert east of Robt. Ferrie Drive (Ormston) - SWM facility outlets (Hallman, Monarch)				
Surface Water Turbidity	- Upstream Dickie Settlement Road – main branch (spring, summer, fall only) - Upstream New Dundee Road - main branch - Downstream Reichert Drive – main branch - Reichert Drive – Roseville tributary(spring, summer, fall only) - Reidel Drive – main branch (winter only) - SWM facility outlets (Hallman, Monarch)				Continuous – recorded every 15 minutes
Surface Water – TSS	Downstream Reichert Drive Dr – main branch	<u>Landowners</u> Conducted seasonally	<u>Landowners</u> Monitored monthly and after significant		<u>GRCA</u> Grab samples – 60 samples/year

Dundee Secondary Plan - Monitoring Plan (Draft)

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
			rainfall events (>15mm)		Since 2011 60 samples was the goal, actual was less
Surface Water Temperature	- Upstream mouth – main branch (GRCA) - Upstream Dickie Settlement Road – main branch (GRCA) - Downstream Reichert Drive – main branch (GRCA) - Downstream Reichert Drive - Roseville tributary (GRCA) - New Dundee Road – main branch (GRCA, Monarch) - Downstream Dodge Drive – Dodge Drive tributary upstream of confluence with main branch (GRCA, Hallman) - Upstream of Dodge Drive – Dodge Drive tributary (Hallman, Monarch) - Upstream New Dundee Road – main branch upstream of Dodge Drive tributary (GRCA)		<u>Landowners</u> Monitored monthly and after significant rainfall events (>15mm)		Continuous – record every 30 minutes

Dundee Secondary Plan - Monitoring Plan (Draft)

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
	- Between Dodge Drive and Reidel Drive – main branch (Activa - 4 locations) - Upstream Reidel Drive – main branch (GRCA) - Wetland downstream of New Dundee Road (Ormston) - SWM outlets (Hallman, Monarch)				
Fish – Spawning	- Between Dodge Drive and Reidel Drive – main branch (Activa) - Between confluence with main branch to upstream of Dodge Drive – Dodge Drive tributary (Hallman/Monarch) - Upstream of New Dundee Road – main branch (Hallman/Monarch) - Downstream of New Dundee Road – main branch (Hallman/Monarch) - Upstream of Reichert Drive – main branch (Hallman/Monarch)	<u>Landowners</u> Conducted seasonally			Annual – 3-4 visits/year in late Fall (Ecoplans)

Dundee Secondary Plan - Monitoring Plan (Draft)

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
	Downstream of Reichert Drive – main branch (Hallman/Monarch)				
Fish – Electrofishing	<u>Biomass survey</u> - Upstream Dickie Settlement Road – main branch - Upstream Reichert Drive – Roseville tributary <u>Presence/absence</u> - Upstream Dickie Settlement Road – main branch (if time allows) - Upstream Highway 401 – main branch - Upstream New Dundee Road – main branch	<u>Landowners</u> Conducted seasonally			<u>Biomass survey</u> Summer – repeat every 2 years <u>Presence/Absence</u> Summer – annually <u>GRCA</u> Since 2006
Benthics	- Dickie Settlement Road – main branch (GRCA) - Upstream Hwy 401 – main branch (GRCA) - Reichert Drive Road – main branch (GRCA) - Reichert Drive Road – Roseville tributary (GRCA) - Halfway between Reichert Drive Rd and New Dundee Road -	<u>Landowners</u> Conducted seasonally			- Spring only (Ecoplans) - Spring and Fall (GRCA)

Dundee Secondary Plan - Monitoring Plan (Draft)

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
	main branch (Monarch/Hallman) - Upstream New Dundee Road, upstream Dodge Drive Dr confluence – main branch (Monarch/Hallman) - Downstream of Dodge Drive – Dodge Drive tributary (Monarch/Hallman) - Upstream of Dodge Drive – Dodge Drive tributary (Monarch/Hallman) 3 sites upstream of Dodge Drive – main branch (Activa) - Upstream of Reidel Drive (Activa)				
Groundwater Levels	5 locations (GRCA) 4 locations East of Reidel Drive (Activa) 4 locations west of Reidel Drive (Activa) 2 locations (Hallman) 5 locations (Ormston) 9 locations (Monarch Stage 1) 16 locations (Monarch Stage 2)	<u>Landowners</u> Conducted seasonally			4 times per year: first week of March, June, September, and December (avoid sampling after storm event, coordinate sampling days)

Dundee Secondary Plan - Monitoring Plan (Draft)

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
Groundwater Quality	5 locations (GRCA) 4 locations East of Reidel Drive 4 locations west of Reidel Drive (Activa) 2 locations (Hallman) 5 locations (Ormston) 9 locations (Monarch Stage 1) 4 locations (Monarch Stage 2)	<u>Landowners</u> Conducted seasonally			Annually – first week of June (avoid sampling after storm event, coordinate sampling day)
Groundwater Temperature	6 locations (Activa) 2 locations downstream of Dodge Drive Dr (Hallman) 9 locations (Monarch Stage 1) 4 locations (Monarch Stage 2) 2 locations (Ormston)				Continuous
Surface Water Quantity – Flow	- Dickie Settlement Road - New Dundee Road	<u>Landowners</u> Conducted seasonally			Continuous – hourly measurements
Fluvial Geomorphology	- Upstream Old Mill Road – main branch at 2 cross sections - Halfway between Old Mill Road and Dickie Settlement Road – main branch at 1 cross section - Upstream Dickie Settlement Road – main branch at 3 cross sections				Annually – spring and fall, contingency for high flow event <u>GRCA</u> Annual reports since 2003

Dundee Secondary Plan - Monitoring Plan (Draft)

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
	- Upstream Reichert Drive Road – main branch at 3 cross sections - Upstream Reichert Drive Road – Roseville tributary at 3 cross sections				
Weather Station	West of Reidel Drive				Continuous
Vegetation	2 stations at the Dodge Drive Wetland north of Dodge Drive (Hallman/Monarch) 2 stations at the Roseville Swamp north of New Dundee Road (Hallman/Monarch) 10 stations (Activa) 2 stations proposed at the Roseville Swamp south of New Dundee Road (Ormston)	<u>Landowners</u> Conducted seasonally	<u>Landowners</u> Buffers inspected to ensure construction did not influence greenspace	<u>Landowners</u> Regular inspection (for 2 years after 90% of pond catchment is stabilized)	2 times per year (June and September)
Amphibian Calling	1 station at the Dodge Drive Wetland (Hallman/Monarch) 1 station at New Dundee Road (Activa) 3 stations at Environmentally Sensitive Policy Area No. 33 (Activa) 5 stations at Blair Creek Valley (Activa)				3 times per year (spring)

Parameters	Locations (Responsibility)	Frequency			
		Pre-Construction	During Construction	Post-Construction	Ongoing
	1 station west of Reidel Drive Road (Activa)				
Breeding Birds	- Five stations / areas - Dodge Drive roadside approximately 300 m east of Groh Drive - Dodge Drive Wetland - New Dundee Roadside at hydro corridor - Reichert Drive roadside – west side - Reichert Drive roadside – east side) (Hallman / Monarch) 3 areas - ESPA 33 - Blair Creek Valley - New Dundee Road 1 area proposed - Roseville Swamp (Ormston)				2 times per year (summer)
Road Mortality	Reidel Drive, Stauffer Drive, Dodge Drive (Activa)				5 times per year during suitable wet/humid nights in spring/summer

3. Additions to Existing Monitoring Program

Additional monitoring locations for each parameter are outlined in Table 3-1. Landowner monitoring locations, parameters, frequency, and reporting requirements must meet the following requirements:

- Consistent with requirements in the City's most recent Development Manual (Summer 2021 at the time of this report) (Kitchener, 2021)
- Consistent with the Ontario Municipal Board and Local Planning Appeal Tribunal Decisions relevant to the subject lands (PL150200, 2019).

3.1 Blair Creek Monitoring

Additional monitoring locations for Blair Creek monitoring program by parameter are outlined in Table 3-1.

Table 3-1: Additional Monitoring Locations Blair Creek Subwatershed

Parameters	Landowners	GRCA / City
Weather Station	In accordance with the City's Development Manual, OMB, and Local Planning Appeal Tribunal Decisions relevant to subject lands.	New Dundee Dam (TA) [existing air temperature monitoring station]
Surface Water Quality		
Surface Water Turbidity		
Surface Water – TSS		
Surface Water Temperature		
Surface Water Quantity – Flow		Ayr (QR) [existing flow monitoring station]
Groundwater Levels		
Groundwater Quality		
Groundwater Temperature		
Fish – Spawning		
Fish – Electrofishing		
Benthics		
Fluvial Geomorphology		Relocate XS-7, 8 and 9 upstream of New Dundee Road

Parameters	Landowners	GRCA / City
Vegetation		
Amphibian Calling		
Breeding Birds		
Road Mortality		

3.2 Cedar Creek Monitoring

The monitoring program outlined for the Cedar Creek Subwatershed within the Dundee Secondary Plan Study Area is consistent with the program proposed for the Blair Creek Monitoring program. As identified in TM1: Subwatershed, Goals, Objectives, Targets, and Draft Land Uses (Jacobs, 2025), the Goal, Targets, Objectives for the portion of the Cedar Creek Subwatershed within the Dundee Secondary Plan area are consistent. Local monitoring identified in the Cedar Creek Subwatershed Study Report is as follows:

- Pre-construction monitoring to establish baseline conditions
- During Construction Monitoring including:
 - Sediment and erosion control measures
 - Tree protection fencing
 - Groundwater level and baseflow monitoring during dewatering activities
 - Mitigation measures during construction should be consistent with those identified for the Blair Creek Program
- Post construction monitoring, including:
 - Monitoring of buffer, restoration, and compensation plantings.
 - Monitoring of stormwater discharge. Facilities should be monitored for inflow, outflow, and temperature. The type of monitoring instrumentation will need to reflect the type of stormwater management facilities to achieve the objectives of the monitoring program.

4. Goals, Targets, and Objectives

This monitoring plan maintains the goals, targets, and objectives established through the existing monitoring programs for the Blair and Cedar Creeks.

The primary goal for the subwatershed is to maintain, restore, or enhance the health of the subwatersheds of which the Study Area is tributary. These include the Blair Creek, Cedar Creek, and Strasburg Creek subwatersheds. A series of goals for the Study Area have been established based on the characterization of the Study Area within the context of the previous studies completed within these watersheds. Objectives and targets will be identified for each of the goals. These objectives and targets will guide the evaluation and development of land uses, impact assessment, and identification of mitigation measures.

4.1 Identified Subwatershed Goals

The BBB Study and the Cedar Creek SWS identified subwatershed goals which the following targets are based on the goals identified for the Dundee Secondary Plan include:

1. **Surface Water Protection.** To restore, protect, and enhance surface water quality, surface water quantity, and associated aquatic resources and water supplies and to mitigate impacts within, adjacent to, and downstream of the Study Area.
2. **Groundwater Protection.** To protect, restore, and enhance the quantity, quality, and ecological, hydrologic, and hydrogeologic functions of water quality resources within and downstream of the Study Area.
3. **Natural Heritage Preservation.** To conserve, protect, and restore biodiversity, connectivity, and ecological function of natural land, water, forest, and wildlife resources and features within, adjacent to, and downstream of the Study Area.
4. **Protection from Natural Hazards.** To mitigate the risks to life and the destruction of property and natural resources from flooding and erosion and preserve natural and regulatory floodplain hydrologic functions, and to not create new natural hazards in, adjacent to, or downstream of the Study Area.

4.2 Subwatershed Objectives

Most the Study Area is tributary to the Blair Creek subwatershed. The City, GRCA, and stakeholders have completed several detailed studies establishing subwatershed objectives. The City, GRCA, and stakeholders are responsible for carrying out a monitoring program for the eastern portion of the Study Area. The current approach to subwatershed management is an adaptive approach where the monitoring information is evaluated against the targets and mitigation measures and monitoring activities can be adjusted accordingly. The objectives for the subwatershed were most recently reviewed during the 2020 Upper Blair Creek State of the Watershed report.

For the purposes of the Study Area for this assignment these objectives have been reviewed and determined to be appropriate to be used as the basis for this study. The subwatershed objectives are outlined below.

4.2.1 Objectives for Goal 1 – Surface Water Protection

- a) To restore, protect, and enhance surface water quality, surface water quantity, and associated aquatic resources and water supplies within, adjacent to, and downstream of the Study Area.

- b) To control sediment discharges and provide erosion control.
- c) To maintain, enhance, or restore natural stream processes to achieve a balance of flow and sediment transport, and to maintain/reduce rates post-development (stream stability).
- d) To maintain, enhance, or restore coldwater fisheries potential of the watercourses.
- e) To maintain existing water quality and contribute to achieving federal, provincial, and municipal water and sediment quality objectives and guidelines in watercourses.
- f) Preserve and re-establish the natural hydrologic cycle.
- g) Manage wet weather flows to maintain ecohydrology (e.g. stream, riparian, wetland).
- h) To protect, mitigate, and adapt the watercourse from the impacts of climate change.

4.2.2 Objectives for Goal 2 – Groundwater Protection

- a) To conserve, protect, and restore biodiversity, connectivity, and ecological function of natural land, water, forest, and wildlife resources and features within, adjacent to, and downstream of the Study Area.
- b) To maintain infiltration, baseflow, and discharge to natural features.
- c) To maintain groundwater levels and baseflows (groundwater discharge to watercourses and wetlands) to sustain watershed functions, human uses, and mitigate climate change impacts.
- d) To maintain groundwater quality to support watershed functions.

4.2.3 Objectives for Goal 3 – Natural Heritage Preservation

- a) To conserve, protect, and restore biodiversity, connectivity, and ecological function of natural land, water, forest, and wildlife resources and features within, adjacent to, and downstream of the Study Area.
- b) To protect, restore, or enhance the integrity of the watershed ecosystem through an integration approach of natural areas, habitats, and connected links.
- c) To design and operate stormwater management facilities to maintain a healthy aquatic ecosystem, including the existing coldwater fisheries.
- d) To maintain or improve the ecohydrology of wetlands, especially the Roseville Swamp Complex and wetlands within the Endangered Species Habitat.
- e) To protect, mitigate, and adapt the natural heritage system from the impacts of climate change.

4.2.4 Objectives for Goal 4 – Protection from Natural Hazards

- a) To mitigate the risks to life and the destruction of property and natural resources from flooding and erosion and preserve natural and regulatory floodplain hydrologic functions, and to not create new natural hazards in, adjacent to, or downstream of the Study Area.
- b) To prevent an increase in the frequency and intensity of flooding, the rate of natural stream erosion, or increase slope instability caused by new development.
- c) To establish land use controls such that development is appropriately setback from flooding and erosion hazards.

- d) To establish appropriate mitigation measures to avoid adverse impacts to natural features and areas as it relates to natural hazards in new development infrastructure.
- e) To understand and identify how climate change may introduce new natural hazards and incorporate this understanding in land use planning and management strategies.

4.3 Subwatershed Targets

Subwatershed targets establish functional requirements to implement and provide objective measurable methods to determine if subwatershed goals are being achieved. Targets are important to achieving management objectives. For the Study Area, targets have been established through previous studies. These were reviewed for appropriateness and modified where appropriate.

4.4 Targets for Goal 1 – Surface Water Protection

To restore, protect, and enhance surface water quality, surface water quantity, and associated aquatic resources and water supplies and to mitigate impacts within, adjacent to, and downstream of the Study Area.

- a) To control sediment discharges and provide erosion control.

Table 4-1. Objective 1a: Control Sediment Discharges and Provide Erosion Control

Target Indicator	Rationale	Source for Established Baseline
Sediment TSS (mg/L)	High sediment loads (measured as total suspended solids [TSS]) negatively impact aquatic habitat.	UBC SOW Cedar Creek SWS

- b) To maintain, enhance, or restore natural stream processes to achieve a balance of flow and sediment transport, and to maintain/reduce rates post-development (stream stability).

Table 4-2. Objective 1b: Maintain, enhance, or restore natural stream processes to achieve a balance of flow and sediment transport, and to maintain/reduce rates post-development (stream stability)

Target Indicator	Rationale	Source for Established Baseline
Change in stream flow exceedance volume and hours above critical discharge ^[a]	Maintaining stream flows, volumes, and hours above the critical threshold is important to preserving natural levels of erosion and sediment transport.	UBC SOW Cedar Creek SWS
Change in bankfull cross sectional area	Cross-section enlargement generally results from an urbanized flow regime.	UBC SOW
Change in bankfull channel depth	Aggradation or degradation of the channel generally results from an urbanized flow regime.	UBC SOW
Change in bank migration rate	Accelerated planform adjustment can occur from an urbanize flow regime.	UBC SOW

Change in substrate particle size distribution	Maintaining particle size distribution helps provide stable channels and suitable habitats for different stages of aquatic life.	UBC SOW
Riparian Vegetation communities	Vegetation communities will respond to significant changes in watercourse erosion and bank migration. Riparian areas provide habitat for wildlife.	UBC SOW Cedar Creek SWS

Notes:

^[a] Critical discharge threshold was established for Blair Creek in the 2009 FDS (Stantec Consulting Ltd, 2009).

c) To maintain, enhance, or restore coldwater fisheries potential of the watercourses.

Table 4-3. Objective 1c: Maintain, enhance, or restore coldwater fisheries potential of the watercourses

Target Indicator	Rationale	Source for Established Baseline
Water Temperature (continuous)	Maximum instream temperatures need to be low to support coldwater fisheries.	UBC SOW Cedar Creek SWS

d) To maintain existing water quality and contribute to achieving federal, provincial, and municipal water and sediment quality objectives and guidelines in watercourses.

Table 4-4: Objective 1d: Maintain existing water quality and contribute to achieving federal, provincial, and municipal water and sediment quality objectives and guidelines in watercourses

Target Indicator	Rationale	Source for Established Baseline
Dissolved Oxygen	Maintaining dissolved oxygen (DO) saturation levels is important to support respiration and decomposition in aquatic ecosystems.	UBC SOW Cedar Creek SWS
Nutrients	Nutrient loading often results in eutrophication of water bodies, which leads to decreased aquatic habitat quality.	UBC SOW Cedar Creek SWS
Chlorides	Chlorides is a surrogate indicator of urbanization (e.g. sewage, road salt) and can negatively impact aquatic and terrestrial wildlife as well as the quality of drinking water supply.	UBC SOW Cedar Creek SWS
Inorganic compounds (metals)	The presence and accumulation of metals (e.g. copper and zinc) can lead to acute and lethal toxicity in aquatic organisms. These compounds are indicators of urbanization.	UBC SOW Cedar Creek SWS

e) Preserve and re-establish the natural hydrologic cycle.

Table 4-5: Objective 1e: Preserve and re-establish the natural hydrologic cycle

Target Indicator	Rationale	Source for Established Baseline
Watershed peakiness (flow rate)	Maintaining the peakiness factor at natural (historic) levels to reduce erosive stresses on aquatic habitats.	UBC SOW Cedar Creek SWS
Annual Water Balance (hydrologic regime)	Maintaining the historic (baseline) unit area runoff volumes is important to sustain natural processes, including streamflow continuity, habitat requirements, and channel processes.	UBC SOW Cedar Creek SWS
Groundwater functions (surface-groundwater interaction)	Groundwater infiltration needed to maintain runoff volume at current level and increase stream baseflows. Refer to objective 2b	UBC SOW Cedar Creek SWS

f) Manage wet weather flows to maintain ecohydrology (e.g. stream, riparian, wetland).

Table 4-6: Objective 1f: Manage wet weather flows to maintain ecohydrology

Target Indicator	Rationale	Source for Established Baseline
In-channel high flows	Maintenance of habitat in the floodplains.	UBC SOW
In-channel flushing flows	Maintenance of habitat in the watercourse (channel).	UBC SOW

g) To protect, mitigate, and adapt the watercourse from the impacts of climate change.

Table 4-7: Objective 1g: Protect, mitigate, and adapt the watercourse from the impacts of climate change

Target Indicator	Rationale
Air Temperature	Air temperature can influence surface water temperature. As the average air temperature is predicted to change over time due to climate change. Evaluating trends in air temperature over time can indicate if changes in stream temperature are related to urbanization or to changes in climate.
Return Period Events	Changes in the frequency and intensity of storm events is an indicator of climate change. Evaluating the local conditions with respect to rainfall event frequency and intensity for trends can help determine if changes in the hydrologic cycle of the watershed are due to urbanization or due to changes in climate.

These target indicators support the adaptive management approach established for the Blair Creek subwatershed in previous studies and recommended for the Upper Cedar Creek Scoped Subwatershed study.

4.5 Targets for Goal 2 - Groundwater Protection

To protect, restore, and enhance the quantity, quality, and ecological, hydrologic, and hydrogeologic functions of water quality resources within and downstream of the Study Area.

The Upper Blair State of the Watershed and monitoring program includes data collection of groundwater parameters for the targets identified for this goal. However, baselines for the target indicators and threshold parameters have not yet been established for the subwatershed.

- a) To maintain infiltration, baseflow, and discharge to natural features.

Table 4-8: Objective 2a: Maintain infiltration, baseflow, and discharge to natural features

Target Indicator	Rationale	Source for Established Baseline
Groundwater levels	Groundwater levels are critical to maintaining wetland hydrology (hydroperiod).	UBC SOW Cedar Creek SWS

- b) To maintain groundwater levels and baseflows (groundwater discharge to watercourses and wetlands) to sustain watershed functions, human uses, and mitigate climate change impacts.

Table 4-9: Objective 2b: Maintain groundwater levels and baseflows (groundwater discharge to watercourses and wetlands) to sustain watershed functions, human uses, and mitigate climate change impacts

Target Indicator	Rationale	Source for Established Baseline
Baseflows in streams	Baseflow sustains flow in streams in the low flow season and provides habitat for fisheries and the benthic zone.	UBC SOW Cedar Creek SWS
Groundwater discharge and recharge	Surface groundwater interaction provides hydrological connections with wetlands and replenishes groundwater. Discharge supporting wetlands supports biodiversity.	UBC SOW Cedar Creek SWS
Water table elevation	Water table elevation is an indicator of groundwater resources available to support baseflow and groundwater recharge and discharge.	UBC SOW Cedar Creek SWS

- c) To maintain groundwater quality to support watershed functions.

Table 4-10: Objective 2c: Maintain groundwater quality to support watershed functions

Target Indicator	Rationale	Source for Established Baseline
Nutrients	Nutrient loading often results in eutrophication of water bodies which in turn decreases aquatic habitat. Nutrient inputs can arrive from both surface runoff and contaminated groundwater sources.	UBC SOW
Chlorides	Chlorides from infiltration runoff can negatively impact groundwater quality and drinking water supply. Chlorides in groundwater can impact surface water quality as chlorides will be present in groundwater discharge.	UBC SOW

Inorganic compounds (metals)	Metals in groundwater have impacts on receiving waters through groundwater discharge. These include Calcium, Copper, Lead, Magnesium, and Zinc.	UBC SOW
pH	Deviations outside of the accepted range (6.5-8.5) may negatively impact aquatic vegetation and can mobilize retained metals in the soil matrix.	UBC SOW

4.6 Targets for Goal 3 – Natural Heritage Preservation

To conserve, protect, and restore biodiversity, connectivity, and ecological function of natural land, water, forest, and wildlife resources and features within, adjacent to, and downstream of the Study Area.

1. To protect, restore, or enhance the integrity of the watershed ecosystem through an integration approach of natural areas, habitats, and connected links.

Table 4-11: Objective 3a: Protect, restore, or enhance the integrity of the watershed ecosystem through an integration approach of natural areas, habitats, and connected links

Target Indicator	Rationale	Source for Established Baseline
Riparian Corridors Structural quality of riparian vegetation Aquatic microhabitat	Increasing the proportion of riparian corridors covered by wetlands and forests helps restore the natural hydrologic cycle (water quantity) and improves quality of ground and surface waters. Aquatic microhabitat is an important component of the habitat of fish and benthic zone and is usually the first morphological component of a watercourse to respond to change. Terrestrial species use riparian corridors for movement and habitat needs.	UBC SOW Cedar Creek SWS
Aquatic in-stream corridors	Removal of in-stream barriers increases access to streams by fish.	UBC SOW Cedar Creek SWS

2. To design and operated stormwater management facilities to maintain a healthy aquatic ecosystem, including the existing coldwater fisheries.

Table 4-12: Objective 3b: Design and operated stormwater management facilities to maintain a healthy aquatic ecosystem, including the existing coldwater fisheries

Target Indicator	Rationale	Source for Established Baseline
Riparian Aquatic Communities	Fish and aquatic invertebrates are barometers of healthy waterbodies. Specific habitat requirements for coldwater fish communities must be present on a subwatershed basis for survival. Brook trout are sensitive to water quality (temperature and pollutants).	UBC SOW

Aquatic Community Diversity	Higher values of fish and benthic indices (e.g. IBI, BioMap, EPT) indicate improved water quality, quantity, and aquatic habitats.	UBC SOW
Aquatic Community Abundance	Greater densities of fish indicate improved water quality and aquatic habitats.	UBC SOW
Aquatic Community Health	Dissolved oxygen saturation levels to be maintained or increased to support respiration and decomposition. Maximum in-stream temperatures to be maintain/support sensitive coldwater fish communities. Total suspended solids to be maintained to a minimum siltation of aquatic habitats and clogging of fish gills. Nutrients to be lowered to avoid excessive algae growth and decrease dissolved oxygen.	UBC SOW
Aquatic Habitat Integrity	Supporting the aquatic habitat integrity is key to maintaining a functioning coldwater fishery. Objectives 1e, 2c, and 3d support this target.	UBC SOW

3. To maintain or improve the ecohydrology of wetlands, especially the Roseville Swamp Complex and wetlands within the Endangered Species Habitat.

Table 4-13: Objective 3c: Maintain or improve the ecohydrology of wetlands, especially the Roseville Swamp Complex and wetlands within the Endangered Species Habitat

Target Indicator	Rationale	Source for Established Baseline
Annual Water Balance (Hydrologic regime)	Refer to objective 1e. Vegetation monitoring sites in wetland areas have been identified in the UBC monitoring program. A change in the number of vascular cryptogram species at the identified locations is a likely indicator of hydrologic change.	UBC SOW Cedar Creek SWS
Groundwater functions (surface-groundwater interaction)	Refer to objective 1e. Groundwater is the primary function in the Roseville Swamp. Vegetation monitoring at known locations with groundwater upwelling are identified in the UBC monitoring program and can be used as indicators of change in groundwater elevation.	UBC SOW Cedar Creek SWS

4. To protect, mitigate, and adapt the natural heritage system from the impacts of climate change.

Table 4-14: Objective 3d: Protect, mitigate, and adapt the natural heritage system from the impacts of climate change

Target Indicator	Rationale	Source for Established Baseline
Vegetation	Vegetation communities provide habitats for wildlife within the subwatersheds. Increased development pressure has the potential to impact vegetation communities and the wildlife dependent on them. Vegetation contributes to the maintenance of the quality and quantity of groundwater and surface water.	UBC SOW
Representative Terrestrial Communities	Sensitive communities within the UBC subwatershed have been identified through previous studies. Changes in these communities are early indicators of shifts in habitat type, abundance, and quality.	UBC SOW
Community Diversity	Diverse communities are more robust and are an indicator of healthy or improved habitat.	UBC SOW
Community Abundance	Greater densities of native species indicate a healthy or improved terrestrial habitat.	UBC SOW
Buffers	Buffers aid in mitigating the potential negative effects of development and urban activity on the natural heritage system. Buffer monitoring in UBC has not yet been initiated.	UBC SOW Cedar Creek SWS

4.7 Targets for Goal 4 – Protection from Natural Hazards

To mitigate the risks to life and the destruction of property and natural resources from flooding and erosion and preserve natural and regulatory floodplain hydrologic functions, and to not create new natural hazards in, adjacent to, or downstream of the Study Area.

Goals for protection from natural hazards were not established for the Blair Creek Subwatershed in previous studies. The Cedar Creek Subwatershed identified targets to provide natural hazard protection. The targets in this section are based on those identified in the Upper Cedar Creek Scoped Subwatershed Study (Matrix Solutions et al, 2019).

1. To prevent an increase in the frequency and intensity of flooding, the rate of natural stream erosion, or increase slope instability caused by new development.
2. To establish land use controls such that development is appropriately setback from flooding and erosion hazards.
3. To establish appropriate mitigation measures to avoid adverse impacts to natural features and areas as it relates to natural hazards in new development infrastructure.
4. To understand and identify how climate change may introduce new natural hazards and incorporate this understanding in land use planning and management strategies.

5. References

Aquafor Beech Ltd. (2016). *2016 Final Report State of the Watershed (SOW) Report Upper Blair Creek*. Kitchener.

CH2M Gore & Storrie Ltd. (1997). *Blair, Bechtel, and Bauman Creeks Subwatershed Plan*.

Grand River Conservation Authority. (2018). *Cumulative Effects Monitoring - Blair Creek Case Study*. Kitchener: GRCA.

Jacobs Engineering Group. (2020). *2020 Upper Blair State of the Watershed (SOW) Final Report*. Kitchener.

Jacobs Engineering Group (2025). *Technical Memorandum 1: Subwatershed Goals, Objectives, Targets, and Draft Land Uses*. Dundee Secondary Plan. City of Kitchener. April 21, 2025.

Kitchener (2021). *Development Manual*. City of Kitchener. Summer 2021.

Local Planning Appeal Tribunal. Case No. PL502000. March 21, 2029. URL: <https://www.omb.gov.on.ca/e-decisions/pl150200-Mar-21-2019.pdf>

Matrix Solutions et al. (2019). *Upper Cedar Creek Scoped Subwatershed Study*. Region of Waterloo, Grand River Conservation Authority.

Stantec Consulting Ltd. (2009). *Upper Blair Creek (Kitchener) Functional Drainage Study Final Report*. City of Kitchener.