



Lake Simcoe Region
conservation authority

Lake Simcoe watershed land cover update: 2018

September 2022

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Recommended Citation:

Lake Simcoe Region Conservation Authority. 2022. Lake Simcoe watershed land cover update: 2022.



Acknowledgement

This project has received funding support from the Government of Ontario. Such support does not indicate endorsement by the Government of Ontario of the contents of this material

Executive Summary

Comprehensive air photo coverage of the Lake Simcoe watershed in 2018 was used to update Lake Simcoe Region Conservation Authorities seamless land cover map of the watershed. Comparison to similar maps created based on air photos captured in 2002/2003, 2008, and 2013 allow the Conservation Authority to describe general trends in land use over the last fifteen years.

Over that time, as watershed population has increased, we have documented an increase in impervious cover (i.e. roads, parking lots and buildings). At the time of the initial land cover map, it made up approximately 3.4% of the watershed; by 2018, it had increased to 4.7% of the watershed.

Over the same time period however, we have also documented an increase in natural heritage cover in the Lake Simcoe watershed, from 43.6% in 2003 to 44.4% in 2018. This definition of natural heritage feature follows the Province's Ecological Land Classification scheme, which has a broader definition of natural heritage than that described in the Lake Simcoe Protection Plan as 'natural vegetative cover.' Even that more conservative definition of natural heritage feature has increased in coverage in the watershed since 2003, due to active habitat restoration efforts, as well as natural succession converting early successional features into forests.

As growth and development proceed in the watershed, ongoing changes in land cover will be inevitable. Effective municipal land use plans and ongoing efforts by the Conservation Authority and its partners will be necessary to ensure that these gains in natural heritage cover are protected, and that similar gains are achieved in the future.



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1.0 Introduction

Land cover has a major influence on watershed function, including influencing the volume and rate of stream flow (e.g. Shuster et al. 2007), the export of phosphorus and sediment (e.g., Brabec et al. 2002), the rate and volume of aquifer recharge (e.g. Howard and Gerber 2018), and the abundance and diversity of species living in both terrestrial and aquatic habitats (e.g., Fahrig 2003, Stanfield and Kilgour 2006).

Like many watersheds around the world, land cover within the Lake Simcoe watershed has been undergoing constant change since the time of European settlement (Wilson and Ryan 1988, Palmer et al. 2011). In recent years, Lake Simcoe Region Conservation Authority has been documenting land cover and land cover change within the watershed, using orthoimagery, on a five-year cycle.

This report summarizes work completed to update the Conservation Authorities data using 2018 orthoimagery, as well as summary statistics emerging from that new data.



2.0 Methods

2.1. Data capture

Complete airphoto coverage for the Lake Simcoe watershed was captured in spring 2018, supplementing similar photos captured in 2002/2003, 2008, and 2013. As was done in those earlier time periods, a seamless land cover map was created for the watershed, through visual airphoto interpretation and classification by LSRCA staff. Land use was classified as being one of 13 categories (Table 1) in ArcMap with the resulting data incorporated into a GIS featureclass.

Table 1. Land use classification in Lake Simcoe watershed map

Land use class	Definition
Active Aggregate	Identified by pits, extraction machinery, unvegetated landscape, and piles of extracted materials; may also contain open water
Commercial	Properties that contain a building and adjacent parking lot, including shopping malls and strip malls
Estate Residential	Includes a home within a natural heritage feature including the manicured area around the home and driveway, but not the natural heritage feature
Industrial	Larger areas than commercial; includes large factories, etc
Institutional	Includes schools, churches, hospitals and other institutional structure and adjacent fields. Sometimes it includes large stormwater ponds
Intensive agriculture	Cultivated fields producing crops (e.g. corn and wheat). This includes specialty agriculture, which consists of orchards, market gardens, Christmas tree plantations, and nurseries. Interpreted from air photos by plow marks, signs of harvesting and tile drainage.
Manicured open space	Dominated by gardens, parkland, and lawn areas. For example, cemeteries, golf courses, urban parks, ski hills, and residential/industrial open space with a minimum size of 2 hectares. This did not include backyards or school yards.



Land use class	Definition
Natural heritage feature	Woodlands, wetlands, and grasslands which meet the definition of “communities” in the Ecological Land Classification for Southern Ontario, or wetlands in the Ontario Wetland Evaluation System
Non-intensive agriculture	Fields dominated with herbaceous vegetation and grasses, including pasture/grazing areas. Weedy hay and/or pasture cover more than 50% of the area. Associated with extensive or unconfined grazing of livestock and minimal evidence of recent cultivation.
Rail	Rail corridors with tracks, including both track and shoulder
Road	Roads, including both surface and shoulder
Rural development	These are lands between 0.5 and 2.0 ha that contain residential, commercial or other buildings not directly associated with a farming operation, and manicured open space (e.g. estate residential or service station).
Urban residential	Urban related uses including continuous ribbon development. Interpreted from air photos by number of roof tops, and groupings of 5 or more residential units equaling 2 or more hectares (i.e. the presence of pavement, buildings and structures).

Each feature was also assigned a ‘Surface Type’ attribute composed of four categories (Table 2). As with the land use attribute, features were classified as belonging to one of the defined SurfaceType classes, based on visual interpretation of the air photos by LSRCA staff. Where necessary, land use polygons were split by digitizing boundaries between surface types to ensure each polygon represents a single surface type category.

Table 2. Surface type classification in Lake Simcoe land cover map

Surface Type class	Definition
Building	Building footprints of houses, commercial, industrial, farm, and institutional buildings.
Paved	Areas covered in asphalt or gravel, including roads and parking lots



Surface Type class	Definition
Stormwater pond	Open water features, predominantly occurring in urban areas, interpreted as performing a role in stormwater management
Unpaved	All other features

Areas classified as natural heritage features were further distinguished to ecosystem type, using the Ecological Land Classification scheme (Lee et al. 1998) to community series (Table 3). Features were classified based on visual interpretation. Where field data (such as wetland evaluations) existed, those data were relied upon instead to determine community series classification.

Table 3. Community series classification in Lake Simcoe land cover map

Community series code	Community series	Definition
ALO	Open alvar	Sites underlain by shallow soils over limestone bedrock; plant cover varies from patchy to barren
ALS	Shrub alvar	Sites underlain by shallow soils over limestone bedrock; greater than 25% shrub cover
BOS	Shrub bog	Wetland sites with greater than 40 cm of sphagnum, less than 10% tree cover, and more than 25% shrub cover
BOT	Treed bog	Wetland sites with greater than 40 cm of sphagnum and more than 10% tree cover
CUM	Cultural meadow	Open herbaceous (often grass-dominated) communities with a cultural legacy (e.g. historic pasture)
CUP	Cultural plantation	Plantation forests, often conifer-dominated, rows of trees often clearly visible
CUS	Cultural savanna	Sites with a cultural legacy (e.g. historic pasture), with more between 25% and 35% tree cover
CUT	Cultural thicket	Sites with a cultural legacy (e.g. historic pasture), with more than 25% shrub cover and less than 25% tree cover



Community series code	Community series	Definition
CUW	Cultural woodland	Sites with a cultural legacy (e.g. historic pasture), with more between 35% and 60% tree cover
FEO	Open fen	Wetland sites with greater than 40 cm of brown moss or sedge peat; less than 10% tree cover, and less than 25% shrub cover
FES	Shrub fen	Wetland sites with greater than 40 cm of brown moss or sedge peat; less than 10% tree cover, and more than 25% shrub cover
FET	Treed fen	Wetland sites with greater than 40 cm of brown moss or sedge peat; greater than 10% tree cover
FOC	Conifer forest	Forests with conifers making up more than 75% of the canopy
FOD	Deciduous forest	Forests with deciduous species making up more than 75% of the canopy
FOM	Mixed forest	Forests with neither deciduous nor coniferous species making up more than 75% of the canopy
MAM	Meadow marsh	Seasonally flooded wetland, dominated by herbaceous vegetation (often grass)
MAS	Shallow marsh	Wetlands with water up to 2 m deep for most or all of growing season
OAD	Open aquatic	Water more than 2 m deep; no aquatic vegetation
SAF	Floating-leaved shallow aquatic	Wetlands with water up to 2 m deep, vegetation dominated by floating-leaved aquatic species
SAM	Mixed shallow aquatic	Wetlands with water up to 2 m deep, vegetation composed of a mix of floating-leaved and submerged species
SAS	Submerged shallow aquatic	Wetlands with water up to 2 m deep, vegetation dominated by submerged aquatic species
SBO	Open sand barren	Active and droughty sands, less than 25% tree or shrub cover
SWC	Conifer swamp	Treed swamps with coniferous species making up more than 75% of canopy



Community series code	Community series	Definition
SWD	Deciduous swamp	Treed swamps with deciduous species making up more than 75% of canopy
SWM	Mixed swamp	Treed swamps with neither deciduous nor coniferous species making up more than 75% of canopy
SWT	Thicket swamp	Wetlands with more than 25% shrub cover and less than 25% tree cover
TPO	Open tallgrass prairie	Vegetation dominated by prairie grasses, less than 25% cover of trees or shrubs

Data was captured at a scale of 1:1,500, to ensure consistency in boundary editing, with sticky move tolerance set to 1,000,000 pixels to avoid unintentional polygon movement. For impervious features, no area narrower than 3 metres or polygon smaller than 10.5 m² was digitized. For natural heritage features, no polygon smaller than 0.5 ha was distinguished.

2.2. Change analysis

Land use was summarized per land use class from the 2018 imagery, and compared with similar summarizes from the land cover maps developed in 2002/2003, 2008, and 2013 to describe overall trends in land use (see Appendices). Analysis was conducted for the entire watershed, as well on a municipality- and subwatershed-scale to assess how changes in land use were distributed throughout the watershed. Given the significant role that both impervious features and natural heritage features play in watershed function, specific reference to these types of land cover will be made in this report.



3.0 Results and discussion

3.1. Land cover

Land cover in the Lake Simcoe watershed is currently composed of 12.3% developed land uses (aggregate, commercial, estate residential, industrial, institutional, manicured open space, road, rail, and urban residential), 43.3% rural land uses (intensive and non-intensive agriculture, and rural development), and 44.4% natural heritage feature (Figure 1). As can be seen from Figure 2, this is associated with an increase in the amount of developed and natural heritage land cover since 2003, and a decrease in rural land uses.



Figure 1. Generalized land cover in the Lake Simcoe watershed (2018)

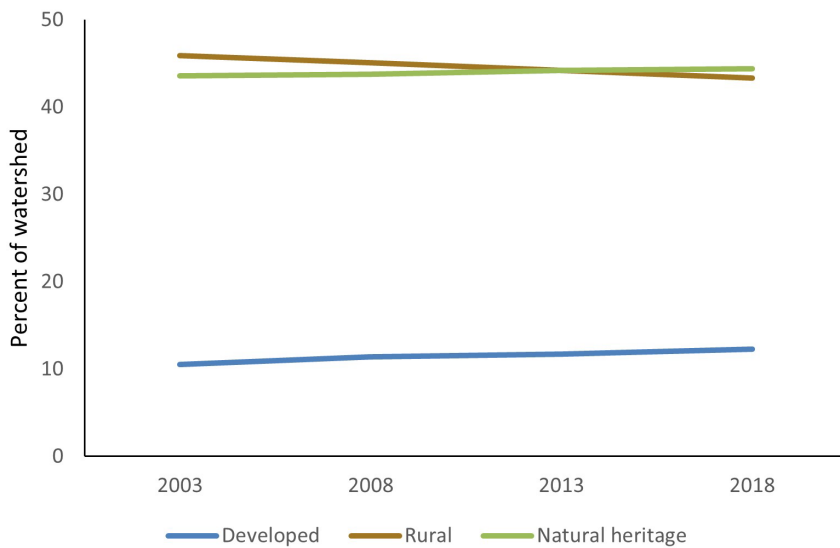


Figure 2. Trends in generalized land use in the Lake Simcoe watershed (2003 to 2018)

3.2. Impervious cover

Areas with impervious cover (i.e. those with a surface type of ‘building’ or ‘paved’) currently represent 4.7% of the Lake Simcoe watershed, up from 3.4% in 2003 (Figure 3). Not surprisingly, impervious cover ranges substantially across subwatersheds, with those subwatersheds in urban municipalities tending to have much higher rates than those in more rural municipalities (Figure 4).

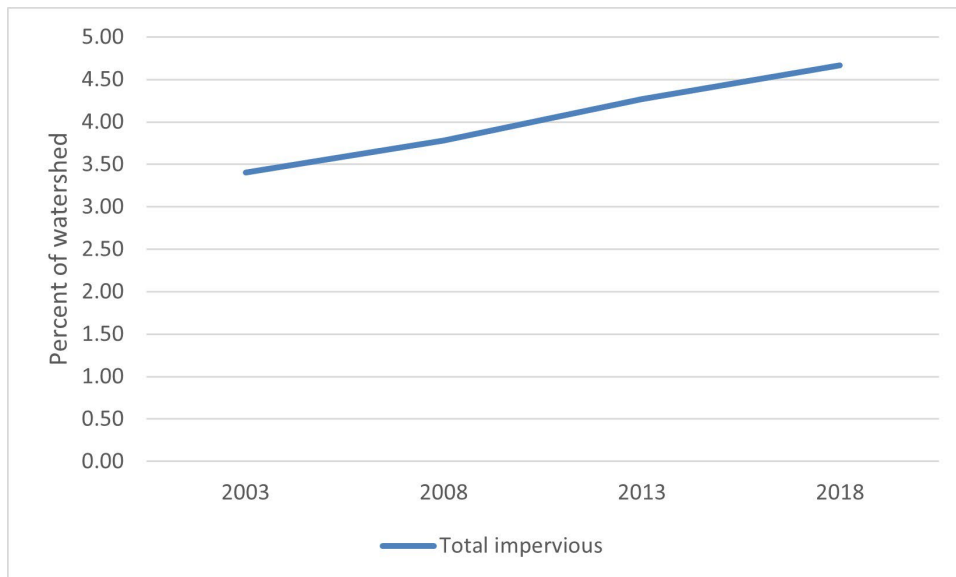


Figure 3. Impervious cover in the Lake Simcoe watershed (2003-2018)

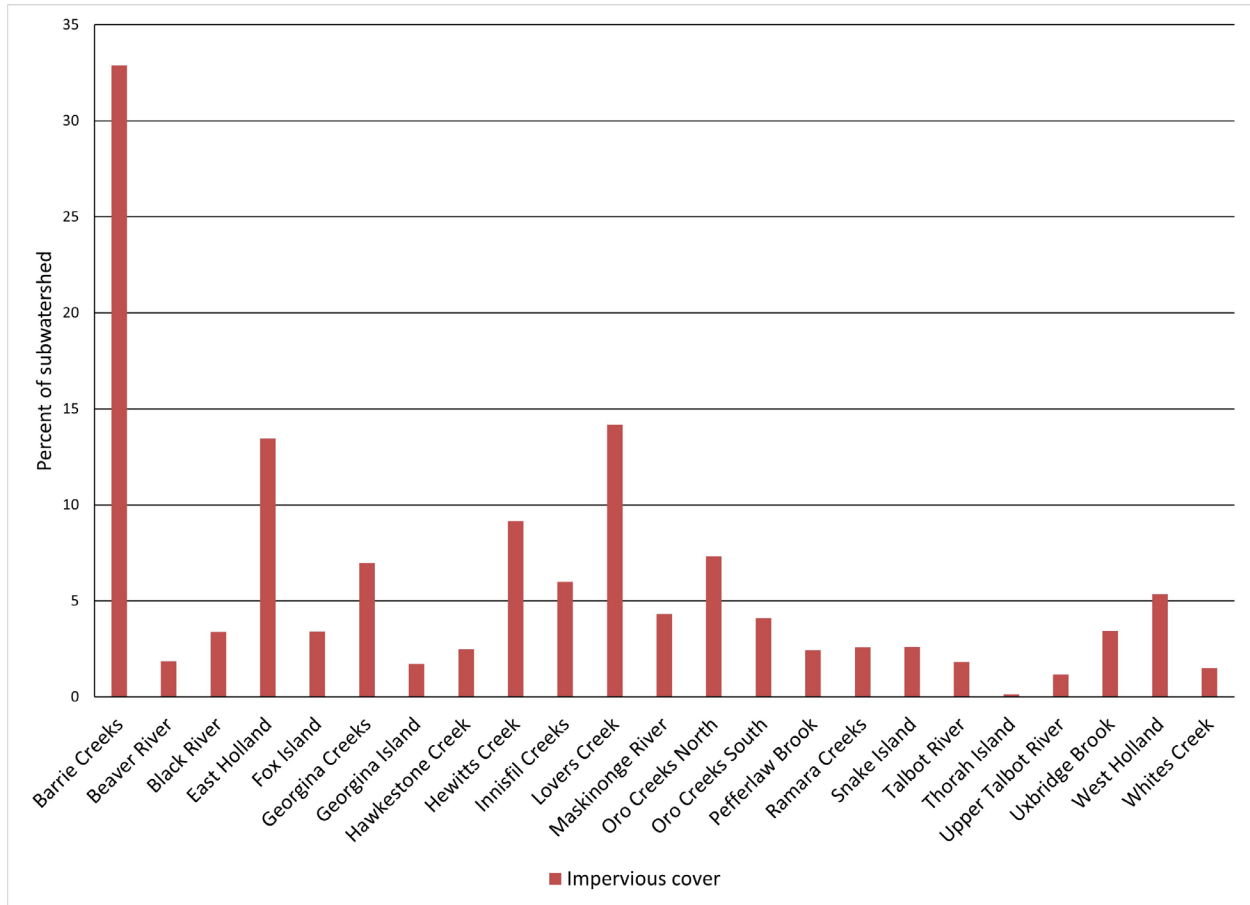


Figure 4. Impervious cover in Lake Simcoe's subwatersheds (2018)

This project has documented an increase of 1154 ha of impervious cover since 2013, and a total increase of 3646 ha since 2003, which averages to 243 ha conversion per year. The greatest rate of change in impervious cover over time has been in parking lots (Figure 5).

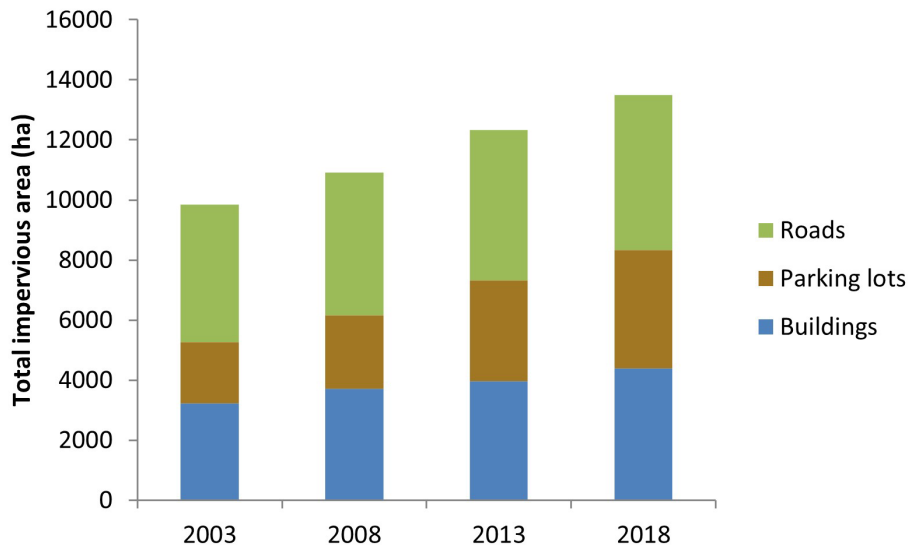


Figure 5. Impervious cover type in the Lake Simcoe watershed (2003 - 2018)

This increase in impervious area is associated with an increase in watershed population since 2003, as growth and development has proceeded. However, this project has also documented, for those municipalities fully within the Lake Simcoe watershed, a negative correlation between municipal population and the ‘per capita’ area of impervious cover in that municipality (Figure 6), which reiterates the value of directing growth to existing settlement areas.

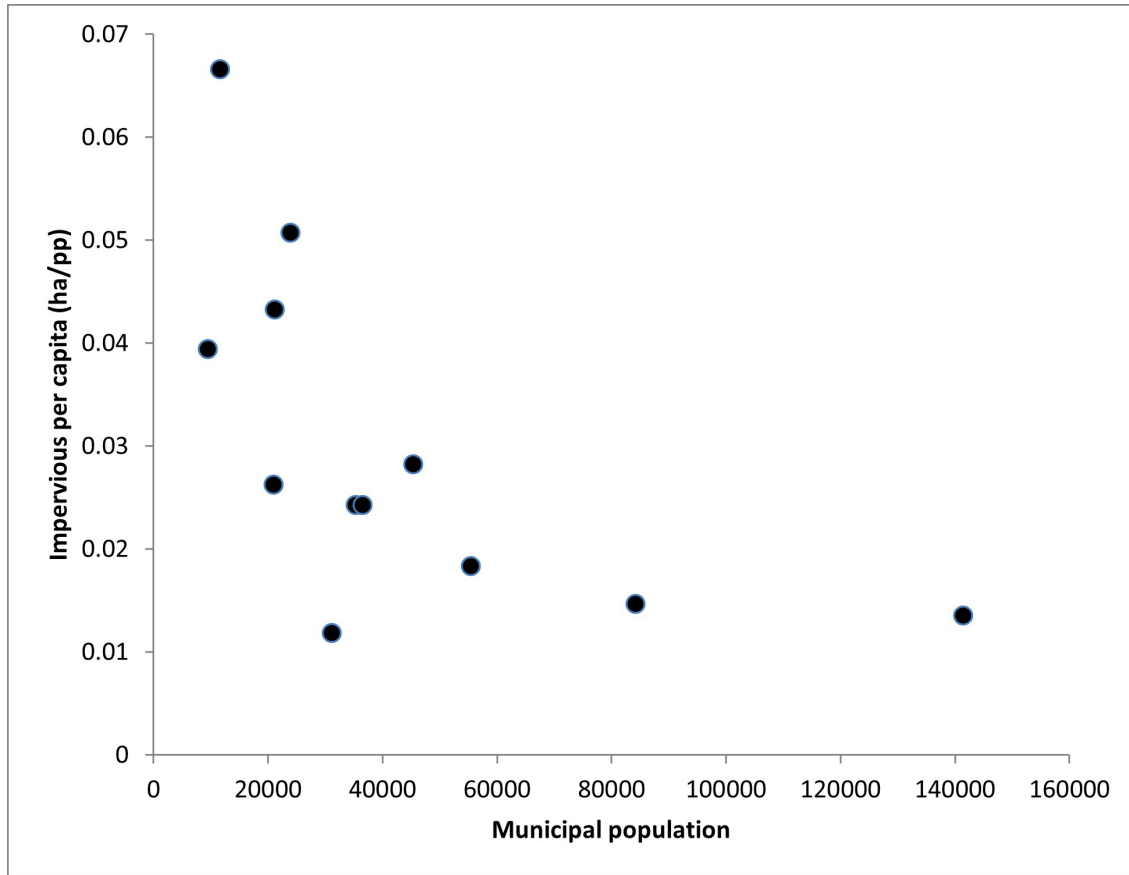


Figure 6. Per capita impervious cover in municipalities entirely within the Lake Simcoe watershed (2018)

3.3. Natural heritage cover

Surprisingly, at the same time as the watershed’s population has grown, and impervious cover has increased, the extent of natural heritage features in the watershed has increased as well (Figure 7). Currently, 44.4% of the Lake Simcoe watershed is mapped as being some sort of natural heritage feature (i.e., following Table 3) up from 43.6% in 2003.

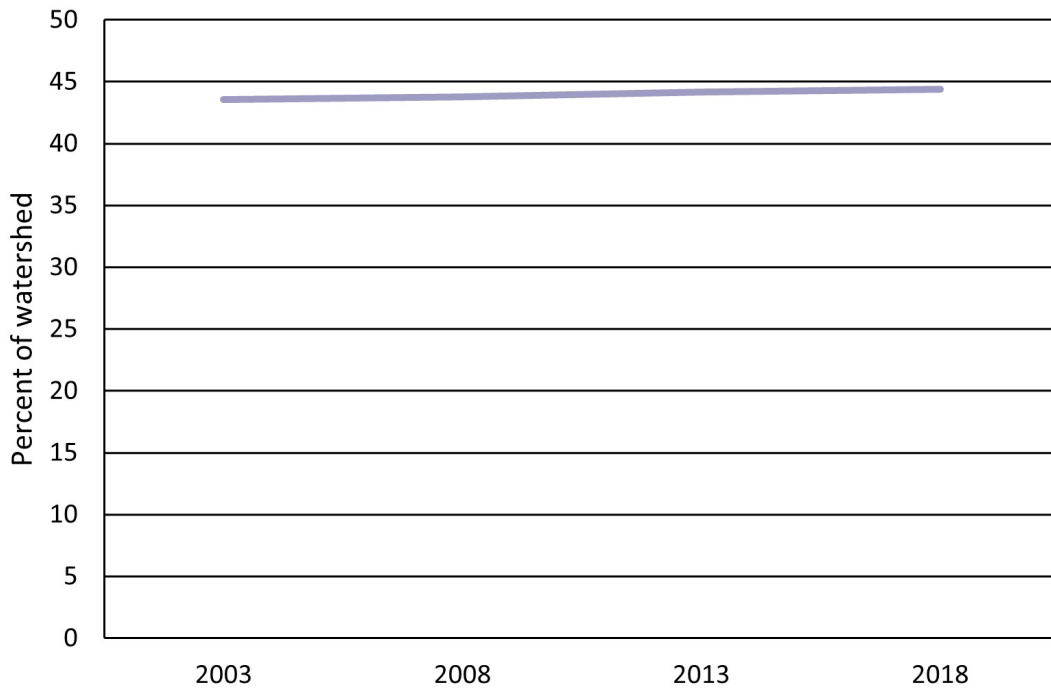


Figure 7. Natural heritage in the Lake Simcoe watershed (2003 - 2018)

It is important to note that the definition of natural heritage feature in Table 3 differs from that of ‘natural vegetative cover’ in the Lake Simcoe Protection Plan. The definition in the Lake Simcoe Protection Plan typically refers to woodlands and wetlands, but excludes sites defined as ‘cultural’ under the Ecological Land Classification scheme. However this project has documented an increase in features that fall within even that more conservative definition of natural cover, from 33% in 2003 to 34% in 2018.

This increase in natural heritage cover is associated both with active restoration (i.e. afforestation, wetland creation and grassland creation), as well as natural succession. Agricultural lands succeeding to cultural features, and cultural features succeeding to forests are both evident in the data.

Succession on farm lands may be traced back to changes in farm practices and commodity prices in recent years. As such, future years may see a shift to increases in rural use and a decrease in natural heritage cover. Similarly, some cultural sites which exist within areas slated for future growth may be lost as development proceeds. As cultural (or early successional) features do not fit within the Provincial definition of natural heritage features, such losses would be permitted under Provincial policy.



4.0 References

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5.0 Appendices

Land use and surface type (in hectares), 2002	19
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Land use and surface type (in hectares), 2002	Aggregate (Building)	Aggregate (Paved)	Aggregate (Unpaved)	Commercial (Building)	Commercial (Paved)	Commercial (Unpaved)	Commercial (Storm Pond)	Estate Residential (Building)	Estate Residential (Paved)	Estate Residential (Unpaved)	Industrial (Building)	Industrial (Paved)	Industrial (Unpaved)	Industrial (Storm Pond)	Institutional (Building)	Institutional (Paved)	Institutional (Unpaved)	Institutional (Storm Pond)	Intensive Agriculture (Building)	Intensive Agriculture (Unpaved)	Intensive Agriculture (Storm Pond)	Manicured Open Space (Building)	Manicured Open Space (Paved)	Manicured Open Space (Unpaved)	Manicured Open Space (Storm Pond)	Natural Heritage Feature	Non-intensive Agriculture (Building)	Non-intensive Agriculture (Unpaved)	Rail (Unpaved)	Road (Paved)	Road (Unpaved)	Rural Development (Building)	Rural Development (Paved)	Rural Development (Unpaved)	Rural Development (Storm Pond)	Urban Residential (Building)	Urban Residential (Unpaved)	Urban Residential (Storm Pond)				
Barrie Creeks	0.01	0.00	45.71	64.79	157.73	122.74	0.00	0.86	1.57	16.65	60.24	110.56	102.48	0.06	25.54	55.53	109.53	0.00	0.30	138.81	0.00	0.45	9.28	171.99	0.00	723.15	0.00	0.05	24.18	349.14	0.00	0.26	0.48	8.33	0.00	251.30	1201.69	0.00				
Beaver River	0.30	1.55	377.95	1.88	7.50	14.27	0.00	2.84	5.19	61.03	1.24	4.23	7.99	0.00	3.54	9.85	51.40	0.00	51.54	20252.25	0.00	0.28	0.91	146.04	0.00	10462.36	4.43	245.54	7.68	291.54	0.20	12.63	16.75	361.15	0.00	37.18	284.13	0.00				
Black River	1.17	7.61	276.05	3.33	14.94	9.85	0.00	14.91	14.31	227.21	4.07	13.64	14.20	0.14	5.83	14.30	27.53	6.13	57.35	14262.51	0.34	2.03	6.11	282.18	0.61	18977.64	10.65	119.27	79.60	456.64	0.20	59.69	92.80	1382.54	0.36	95.93	993.39	1.08				
East Holland	0.24	0.26	93.84	67.21	194.55	171.75	2.59	24.97	19.49	240.29	106.15	176.38	392.19	0.64	42.43	109.89	282.70	15.42	30.78	8093.76	0.14	5.16	31.07	994.68	2.91	8184.98	4.12	124.62	46.38	852.03	0.00	23.06	31.51	469.80	0.00	681.31	3192.95	4.64				
Fox Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Georgina Creeks	0.11	0.15	21.77	4.32	11.08	15.75	0.00	0.91	0.85	13.60	0.00	0.00	0.00	0.00	3.35	12.36	30.44	0.00	3.99	1531.64	0.00	1.20	4.12	110.22	0.00	2168.90	0.24	39.88	0.00	127.60	0.00	9.06	5.60	130.28	0.00	101.83	584.05	0.00				
Georgina Island	0.00	0.00	6.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.17	5.74	0.00	0.03	7.24	0.00	0.00	0.00	1.76	0.00	1181.75	0.00	0.03	0.00	10.32	0.00	4.05	1.41	71.58	0.00	0.00	0.44	0.00				
Hawkestone Creek	0.22	3.04	77.23	0.51	4.28	17.43	0.00	0.90	1.29	10.70	0.00	0.00	0.00	0.00	0.05	1.07	1.38	0.00	5.47	1619.51	0.00	0.07	0.64	35.44	0.00	2753.15	0.45	1.20	0.00	48.89	0.00	2.46	6.46	110.47	0.06	6.04	75.44	0.00				
Hewitts Creek	0.00	0.00	0.00	0.59	2.06	1.17	0.00	0.64	0.14	8.19	0.00	0.00	0.00	0.00	0.32	1.27	5.54	0.00	3.66	1027.18	0.00	0.03	0.07	7.73	0.00	430.14	0.23	0.61	13.03	33.67	0.00	1.14	1.26	25.50	0.00	14.54	172.08	0.71				
Innisfil Creeks	0.05	0.00	61.47	2.74	16.70	38.19	0.00	3.49	2.42	43.99	0.11	0.38	0.63	0.00	5.23	10.60	28.71	0.65	11.73	4870.72	0.00	0.58	4.20	190.89	0.00	3696.05	1.50	45.89	18.09	204.60	0.00	7.54	9.49	163.79	0.00	135.07	1139.65	0.00				
Lovers Creek	0.03	0.00	16.11	23.31	78.60	132.61	0.61	3.02	3.16	59.71	35.33	102.14	172.59	0.00	4.71	10.51	25.21	0.60	4.65	2179.37	0.00	0.26	3.87	130.42	0.09	2199.52	0.45	10.63	23.79	192.50	0.00	2.88	4.67	97.14	0.00	67.81	406.65	1.80				
Maskinonge River	0.00	0.00	0.00	3.52	13.14	14.21	0.00	0.37	0.37	6.84	0.00	0.00	0.00	0.00	3.65	9.60	22.68	0.00	14.01	4485.73	0.00	0.00	0.00	26.85	0.00	1353.47	1.22	3.47	0.00	86.67	0.00	5.35	6.74	117.16	0.00	32.58	138.87	0.00				
Oro Creeks North	0.14	0.05	94.82	16.80	50.56	44.17	0.00	1.04	2.02	11.32	17.43	40.30	86.64	0.00	12.52	31.97	83.20	0.23	6.62	2694.69	0.00	0.49	3.80	33.56	0.00	3320.62	1.35	2.76	0.00	152.73	0.00	5.90	8.72	177.46	0.11	85.44	538.90	0.00				
Oro Creeks South	0.00	0.00	0.00	0.50	4.27	4.88	0.00	2.55	2.76	29.34	0.66	1.64	2.89	0.00	1.22	13.78	116.92	0.00	6.09	2241.34	0.00	0.43	5.26	69.93	1.21	2582.61	0.25	4.12	0.00	76.16	0.02	7.43	16.52	173.17	0.49	26.44	345.82	0.00				
Pefferlaw Brook	0.65	1.94	862.97	0.95	4.89	2.96	0.00	10.08	10.82	245.85	0.39	0.38	0.43	0.00	2.79	6.93	42.62	0.00	30.93	10896.33	0.00	0.94	4.48	254.38	0.00	13075.12	8.93	1288.59	33.08	302.52	0.19	28.09	32.56	751.67	0.00	49.76	537.04	0.00				
Ramara Creeks	0.03	0.00	16.77	2.19	19.15	26.52	0.00	0.17	0.30	2.30	0.30	2.96	5.18	0.00	1.65	7.06	19.39	0.00	12.52	7094.54	0.00	0.37	6.39	63.46	0.00	5555.20	0.79	19.83	22.04	129.60	0.06	4.42	6.29	112.93	0.00	46.59	551.84	0.21				
Snake Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	88.61	0.00	0.00	0.00	0.00	0.00	3.08	0.00	43.79	0.00	0.00	0.00	0.00				
Talbot River	0.05	0.00	114.76	0.31	1.77	2.46	0.00	0.34	0.50	5.42	0.18	1.34	1.55	0.00	0.03	0.12	0.56	0.00	5.52	3676.97	0.00	0.12	4.20	25.41	0.00	2911.33	0.46	1.38	9.32	57.53	0.10	2.00	6.85	57.76	0.00	7.56	118.18	0.00				
Thorah Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	50.89	0.00	0.00	0.00	0.00	0.00	368.06	0.00	0.00	0.00	0.00	0.00	0.73	0.00	19.42	0.00	0.00	0.00	0.00				
Upper Talbot River	0.06	0.22	116.49	0.39	1.39	5.79	0.00	2.54	4.44	40.90	0.00	0.00	0.00	0.00	0.40	0.75	3.80	0.00	5.13	662.38	0.00	0.17	1.37	39.94	0.00	24920.02	2.73	2977.44	0.00	212.32	0.07	5.99	15.16	158.60	0.00	18.26	258.29	0.00				
Uxbridge Brook	0.35	2.73	177.05	5.33	18.61	5.77	0.00	5.59	7.77	129.07	1.37	2.15	8.02	0.00	6.15	15.22	46.28	0.00	22.74	7401.85	0.00	0.60	2.03	157.33	0.00	6225.49	5.81	548.10	13.12	215.40	0.00	17.52	23.28	556.60	0.00	60.31	452.70	0.00				
West Holland	0.10	0.00	8.31	9.47	34.00	33.85	0.00	15.08	11.79	187.84	14.96	38.10	74.26	0.00	8.05	27.17	64.39	11.02	109.59	19989.67	0.00	2.22	7.62	361.97	0.00	10837.57	11.28	520.90	22.18	705.70	6.40	52.37	63.68	1070.96	0.00	102.96	788.66	0.00				
Whites Creek	0.00	0.06	14.88	0.46	3.10	2.53	0.00	0.33	0.28	5.99	0.69	1.61	6.88	0.00	0.52	1.41	4.66	0.00	13.38	6233.48	0.00	0.00	0.17	0.43	0.00	3894.41	0.42	55.61	11.83	76.26	0.00	2.54	2.97	67.64	0.00	8.84	68.51	0.00				
Total	3.51	17.58	2382.74	208.60	638.31	666.92	3.19	90.70	89.46	1346.50	243.12	495.81	875.92	0.84	128.15	339.54	972.66	34.07	396.11	119470.83	0.48	15.39	95.58	3104.62	4.82	125923.73	55.30	6009.93	324.33	4581.83	7.26	258.74	353.19	6134.01	1.01	1829.75	11849.30	8.45				

Land use and surface type (in hectares), 2008	Aggregate (Building)	Aggregate (Paved)	Aggregate (Unpaved)	Commercial (Building)	Commercial (Paved)	Commercial (Unpaved)	Commercial (Storm Pond)	Estate Residential (Building)	Estate Residential (Paved)	Estate Residential (Unpaved)	Industrial (Building)	Industrial (Paved)	Industrial (Unpaved)	Industrial (Storm Pond)	Institutional (Building)	Institutional (Paved)	Institutional (Unpaved)	Institutional (Storm Pond)	Intensive Agriculture (Building)	Intensive Agriculture (Unpaved)	Intensive Agriculture (Storm Pond)	Manicured Open Space (Building)	Manicured Open Space (Paved)	Manicured Open Space (Unpaved)	Manicured Open Space (Storm Pond)	Natural Heritage Feature	Non-intensive Agriculture (Building)	Non-intensive Agriculture (Unpaved)	Rail (Building)	Rail (Paved)	Rail (Unpaved)	Road (Paved)	Road (Unpaved)	Rural Development (Building)	Rural Development (Paved)	Rural Development (Unpaved)	Rural Development (Storm Pond)	Urban Residential (Building)	Urban Residential (Unpaved)	Urban Residential (Storm Pond)	
Barrie Creeks	0.21	2.51	59.79	53.26	134.93	83.93	0.00	1.15	1.93	11.00	74.47	145.62	142.72	0.06	27.10	62.26	101.68	0.27	0.29	136.57	0.00	0.45	11.42	157.23	0.00	689.99	0.00	0.05	0.00	0.00	23.63	350.18	0.00	0.43	0.75	13.63	0.00	274.35	1191.58	0.00	
Beaver River	0.44	2.53	435.84	3.97	9.55	9.49	0.00	3.33	4.80	54.60	2.15	5.84	6.44	0.00	3.49	8.61	48.15	0.00	58.93	20211.61	0.00	0.46	2.36	139.69	0.00	10709.91	0.37	17.82	0.00	0.00	8.15	293.43	0.20	11.05	23.28	308.00	0.00	36.31	304.63	0.00	
Black River	1.51	8.69	269.56	6.99	24.53	57.35	0.00	16.44	15.82	164.34	3.69	13.66	38.16	0.21	9.97	21.74	39.55	9.27	66.45	14344.84	0.34	2.27	12.04	327.69	0.00	18969.31	4.14	60.51	0.00	0.00	67.39	468.39	0.56	56.93	107.89	1418.13	1.04	110.58	815.64	0.40	
East Holland	0.14	0.60	50.57	99.45	274.30	239.14	2.85	27.58	26.33	247.67	126.49	219.48	322.26	2.25	49.21	131.95	300.20	21.00	33.78	7312.24	0.14	4.21	20.40	963.80	3.03	8366.04	0.44	28.74	0.02	0.06	46.29	921.77	0.01	18.90	31.76	503.28	0.00	812.98	3501.25	4.21	
Fox Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Georgina Creeks	0.14	0.37	9.28	5.19	13.25	14.60	0.00	1.26	1.39	12.45	0.00	0.00	0.00	0.00	5.27	14.20	56.61	0.00	3.80	1541.18	0.00	1.17	5.45	130.83	0.00	2162.53	0.14	0.26	0.00	0.00	129.75	0.00	3.85	5.00	67.36	0.00	113.00	634.99	0.00		
Georgina Island	0.00	0.00	12.05	0.00	0.00	0.00	0.00	0.09	0.15	0.87	0.00	0.00	0.00	0.00	0.38	0.17	7.43	0.00	0.00	3.78	0.00	0.00	0.00	0.04	0.00	1160.49	0.00	0.00	0.00	0.00	10.00	0.00	5.37	3.18	87.22	0.00	0.00	0.00	0.00	0.00	0.00
Hawkestone Creek	0.22	2.85	100.83	1.00	7.72	30.26	0.00	0.58	1.12	11.43	0.00	0.00	0.00	0.00	0.05	0.97	1.60	0.00	6.32	1670.53	0.00	0.07	0.65	34.47	0.00	2670.06	0.13	1.30	0.00	0.00	0.00	47.94	0.00	1.83	3.61	95.64	0.00	7.19	85.46	0.00	
Hewitts Creek	0.00	0.00	0.00	0.78	2.60	3.40	0.00	0.14	0.09	5.81	0.00	0.00	0.00	0.00	1.02	4.48	11.61	1.50	3.76	943.38	0.00	0.03	0.25	17.39	0.00	365.41	0.00	15.23	0.00	0.00	11.89	53.63	0.00	1.29	1.58	24.15	0.00	43.55	238.54	0.00	
Innisfil Creeks	0.04	0.02	22.55	3.96	19.73	34.56	0.00	4.78	5.55	36.32	0.00	0.00	0.00	0.00	5.75	12.55	41.03	0.65	12.63	4804.23	0.00	0.38	3.94	122.52	0.00	3605.93	0.31	30.84	0.00	0.00	17.77	218.13	0.00	5.84	10.32	360.45	0.00	156.98	1177.03	0.37	
Lovers Creek	0.00	0.00	19.61	22.88	65.42	97.89	0.00	4.21	5.55	85.51	55.80	177.43	242.10	2.00	6.37	14.02	46.25	1.92	4.64	2040.00	0.00	0.11	2.91	124.70	0.58	2069.21	0.11	18.95	0.00	0.00	21.79	212.46	0.00	2.37	4.72	96.65	0.00	97.48	451.11	0.00	
Maskinonge River	0.00	0.00	0.00	4.58	15.83	16.36	0.00	0.32	0.39	4.51	0.17	0.61	4.44	0.00	3.49	8.90	17.07	0.00	15.92	4462.50	0.00	0.00	0.00	3.85	0.00	1373.31	0.11	0.55	0.00	0.00	90.45	0.01	4.18	7.71	101.13	0.00	39.18	170.92	0.00		
Oro Creeks North	0.36	0.76	162.32	18.39	50.80	59.39	0.00	1.28	2.40	17.76	18.83	46.02	102.60	0.00	13.27	37.64	103.89	0.23	7.96	2541.36	0.00	0.43	4.41	33.29	0.00	3404.99	0.04	3.28	0.00	0.00	149.60	0.00	4.47	10.54	119.22	0.00	86.80	524.20	0.00		
Oro Creeks South	0.00	0.00	0.00	0.92	5.38	12.25	0.00	4.01	6.37	49.78	0.75	2.93	2.53	0.00	1.96	17.60	116.24	0.00	6.49	2163.63	0.00	0.57	8.75	66.81	1.35	2672.61	0.09	0.29	0.00	0.00	75.01	0.02	4.06	10.70	102.10	0.40	31.72	373.40	0.00		
Pefferlaw Brook	0.85	3.00	780.09	3.33	9.45	36.88	0.00	15.35	15.35	209.42	0.00	0.09	0.04	0.00	2.14	4.57	37.29	0.00	40.10	11734.45	0.00	1.66	7.91	496.38	0.00	13277.54	0.70	35.51	0.00	0.01	51.16	311.58	0.19	22.57	38.50	636.98	0.00	57.75	658.69	0.00	
Ramara Creeks	0.03	0.00	44.64	2.38	22.30	33.10	0.00	0.14	0.25	3.22	0.63	5.36	8.78	0.00	1.87	8.05	20.82	0.00	14.30	6891.63	0.00	0.59	7.32	80.23	0.00	5622.04	0.17	25.72	0.00	0.00	22.78	137.44	0.05	2.82	6.59	100.82	0.00	53.01	614.02	0.22	
Snake Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Talbot River	0.16	2.64	170.77	0.15	1.33	1.37	0.00	0.42	0.61	7.37	0.00	0.00	0.00	0.00	0.59	3.28	16.59	0.00	5.96	3629.64	0.00	0.02	1.89	18.54	0.00	2867.14	0.20	31.11	0.00	0.00	9.33	58.04	0.10	1.90	5.82	80.54	0.00	6.66	91.90	0.00	
Thorah Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	380.54	0.08	39.00	0.00	0.00	0.00	0.00	0.72	0.00	18.71	0.00	0.00	0.00	0.00	0.00	
Upper Talbot River	0.06	3.70	167.87	0.44	1.35	5.34	0.00	2.43	4.24	54.44	0.00	0.00	0.00	0.00	0.40	0.75	3.80	0.00	8.49	3242.36	0.00	0.33	2.15	43.03	0.00	24234.75	0.50	420.61	0.00	0.00	0.00	218.38	0.08	4.42	15.64	733.13	0.00	19.05	268.11	0.00	
Uxbridge Brook	0.35	2.92	178.54	8.56	23.62	15.51	0.00	7.45	8.90	114.00	2.76	2.62	13.69	0.00	7.93	16.50	54.33	0.00	28.73	772.19	0.00	0.64	2.60	177.36	0.00	6292.92	1.12	77.27	0.00	0.00	11.89	226.79	0.03	15.75	27.82	475.45	0.00	76.88	489.80	0.00	
West Holland	0.00	0.00	0.19	13.80	53.24	63.64	0.00	15.83	12.43	213.06	21.85	58.18	110.49	0.00	10.06	28.15	80.36	11.26	134.59	19788.25	0.00	2.74	10.81	414.05	0.00	10799.43	1.76	88.90	0.00	0.00	22.55	705.42	11.17	50.33	66.98	1344.21	0.00	140.65	918.52	0.44	
Whites Creek	0.00	0.06	14.95	0.70	3.64	2.39	0.00	0.43	0.31	5.96	0.00	0.00	0.00	0.00	0.57	1.52	43.41	0.00	14.23	6161.43	0.00	0.00	0.17	0.67	0.00	4040.59	0.01	0.52	0.00	0.00	6.45	76.08	0.00	2.65	5.29	69.75	0.00	9.50	78.58	0.00	
Total	4.53	30.64	2499.46	250.72	738.96	816.83	2.85	107.28	113.40	1309.93	307.41	677.84	994.25	4.51	150.90	397.92	1147.92	46.11	467.36	121395.78	0.48	16.14	105.43	3352.58	4.95	125835.96	10.42	896.46	0.02	0.07	321.07	4754.47	12.44	225.52	387.68	6807.31	1.43	2173.74	12588.37	5.64	

Change in land use and surface type (in hectares), 2008 to 2013	Aggregate (Buildings)	Aggregate (Paved)	Aggregate (Unpaved)	Commercial (Buildings)	Commercial (Paved)	Commercial (Unpaved)	Commercial (Storm Pond)	Estate Residential (Buildings)	Estate Residential (Paved)	Estate Residential (Unpaved)	Estate Residential (Storm Pond)	Industrial (Buildings)	Industrial (Paved)	Industrial (Unpaved)	Industrial (Storm Pond)	Institutional (Buildings)	Institutional (Paved)	Institutional (Unpaved)	Institutional (Storm Pond)	Intensive Agriculture (Buildings)	Intensive Agriculture (Paved)	Intensive Agriculture (Unpaved)	Intensive Agriculture (Storm Pond)	Manicured Open Space (Buildings)	Manicured Open Space (Paved)	Manicured Open Space (Unpaved)	Manicured Open Space (Storm Pond)	Natural Heritage Features	Non-intensive Agriculture (Buildings)	Non-intensive Agriculture (Paved)	Non-intensive Agriculture (Unpaved)	Non-intensive Agriculture (Storm Pond)	Rail (Building)	Rail (Paved)	Rail (Unpaved)	Road (Buildings)	Road (Paved)	Road (Unpaved)	Rural Development (Buildings)	Rural Development (Paved)	Rural Development (Unpaved)	Rural Development (Storm Pond)	Urban Residential (Buildings)	Urban Residential (Paved)	Urban Residential (Storm Pond)
Barrie Creek	-0.18	-2.51	48.41	7.87	12.87	4.08	0.04	-0.09	0.22	-0.58	0.00	-12.18	-19.35	-5.88	0.00	3.35	14.06	63.88	1.22	-0.19	0.08	-11.20	0.00	0.01	1.79	27.25	0.03	-51.23	0.17	0.25	12.59	0.00	0.03	0.00	-2.60	0.00	9.29	0.00	0.15	0.75	0.57	0.00	-9.56	3.41	0.00
Beaver River	-0.02	-0.98	27.83	-0.94	2.19	9.26	0.00	-0.46	1.34	6.37	0.00	0.58	2.88	5.29	0.00	0.36	1.60	13.97	0.00	-22.14	52.42	-3083.46	0.00	-0.21	-1.36	-4.16	0.00	-123.24	20.10	24.77	2965.68	0.00	0.00	0.00	-4.21	0.00	5.88	-0.20	2.93	5.56	94.25	0.00	2.88	-4.77	0.00
Black River	-0.70	-1.54	43.30	-0.22	-4.49	12.64	0.00	1.81	5.35	4.16	0.13	1.87	4.11	-13.14	-0.08	-0.27	0.66	32.84	1.50	-40.38	37.39	-3426.09	-0.34	0.13	-3.03	-22.89	0.61	-100.14	44.56	58.42	3341.88	0.33	0.00	0.00	-13.57	0.00	16.02	-0.56	4.07	0.71	45.48	-0.48	7.40	-20.75	1.58
East Holland	0.16	0.15	23.00	13.67	23.66	-36.74	2.47	3.16	-3.28	22.61	0.48	-1.00	-1.83	-54.75	-1.61	7.61	23.51	50.52	-4.54	-21.80	22.88	-1565.36	0.00	-0.66	6.34	2.78	1.05	-3.07	20.56	27.82	1334.29	0.00	-0.02	-0.06	-2.36	0.02	62.77	-0.01	5.66	7.96	45.58	0.00	46.30	-62.06	4.12
Fox Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Georgia Creeks	-0.07	-0.22	-1.46	0.13	1.08	-4.43	0.00	-0.54	-0.52	-2.78	0.00	0.14	0.43	0.12	0.00	0.26	1.80	-6.99	0.00	-1.60	1.90	-113.22	0.00	0.35	2.23	20.30	0.84	-24.65	1.40	1.60	76.18	0.00	0.00	0.00	3.73	0.00	1.87	1.37	37.74	0.00	8.41	-5.40	0.00		
Georgina Island	0.00	0.00	-0.90	0.03	0.00	1.80	0.00	0.08	0.20	0.32	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.57	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.21	0.00	-4.06	0.10	0.03	9.56	0.00	0.00	0.00	0.00	0.01	0.00	-1.31	-1.13	-47.70	0.00	4.02	38.09	0.00	
Hawkestone Creek	-0.10	6.55	-0.83	-0.12	1.76	-22.93	0.00	-0.01	0.24	-4.72	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	-5.11	1.73	-547.53	0.00	0.00	1.86	-0.01	0.00	-46.48	3.59	8.76	564.08	0.00	0.00	0.00	0.00	6.72	0.00	0.75	6.93	25.19	0.06	0.18	-0.58	0.00	
Hewitts Creek	0.00	0.00	0.00	-0.17	-0.28	1.65	0.00	-0.11	-0.05	-5.52	0.00	0.00	0.00	0.00	0.00	3.82	5.15	4.62	-1.31	-1.37	3.81	-153.15	0.00	0.00	0.70	9.09	1.22	-36.36	0.88	1.07	112.07	0.00	0.00	0.00	0.58	0.00	3.91	0.00	0.74	2.74	28.74	0.00	0.06	5.75	0.71
Inouff Creeks	-0.03	0.00	6.41	2.34	-1.22	-6.01	0.00	0.39	1.50	5.29	0.05	0.13	0.38	0.81	0.00	-0.02	-0.40	-10.29	0.49	-6.30	13.65	-758.18	0.00	0.09	1.84	34.59	0.00	-119.88	5.73	8.89	548.99	0.00	0.00	0.00	18.35	0.00	3.85	6.15	133.10	0.63	14.89	94.47	-0.37		
Lovers Creek	0.00	0.00	-1.06	8.53	30.62	-46.60	0.61	-0.19	-0.13	-18.43	0.22	3.87	8.74	12.29	-0.05	-0.28	3.26	-4.99	-1.11	-2.46	5.90	-150.29	0.24	0.20	1.37	37.32	-0.05	-41.66	1.13	1.62	92.47	0.00	0.00	0.00	0.75	0.00	0.90	3.47	47.52	0.34	4.09	-19.37	2.23		
Maskonge River	0.00	0.00	0.00	0.72	0.65	3.19	0.00	0.05	0.23	2.23	0.00	0.06	-0.61	0.80	0.00	0.86	0.60	7.35	0.37	-10.48	10.60	-688.97	0.00	0.00	0.00	0.92	0.00	-29.30	9.54	9.72	576.01	0.00	0.00	0.00	0.00	3.43	-0.01	1.24	1.10	102.13	0.00	0.76	-3.17	0.00	
Oro Creeks North	-0.31	4.63	-33.28	-3.31	1.01	-13.57	0.00	0.04	-0.19	-3.39	0.00	0.43	12.90	-9.31	0.00	0.22	7.49	-9.24	3.16	-6.57	7.33	-1051.34	0.00	0.02	0.16	22.19	0.00	-132.94	6.23	9.88	1046.01	0.00	0.00	0.00	9.90	0.00	1.56	7.73	112.69	0.11	6.13	2.25	0.00		
Oro Creeks South	0.00	0.00	0.00	0.51	15.83	97.94	0.00	-2.70	-4.02	-36.61	0.00	-0.03	0.16	0.26	0.00	-0.63	-12.35	-104.29	0.00	-4.61	3.68	-367.20	0.00	-0.10	9.36	-18.94	-0.14	-63.37	3.73	6.91	346.39	0.00	0.00	0.00	3.05	-0.02	4.11	16.96	106.77	0.22	0.99	-1.87	0.00		
Pefflerlaw Brook	-0.13	7.22	64.77	-0.31	-3.16	-16.50	0.00	-1.66	0.19	-2.55	0.00	0.03	-0.06	0.76	0.00	1.26	3.27	6.44	0.00	-24.75	23.86	-2789.32	0.00	-0.40	1.13	-44.42	0.62	35.33	27.69	38.88	2718.89	0.00	0.00	-0.01	-20.68	0.00	7.30	-0.19	1.64	0.66	-10.97	0.00	6.87	-32.02	0.00
Ranara Creeks	0.02	0.00	0.56	3.43	2.43	15.87	0.00	0.02	0.44	1.53	0.00	-0.08	-0.37	-1.14	0.00	-0.23	-2.27	-1.33	0.00	-11.74	6.02	-1081.77	0.00	-0.23	2.43	3.93	0.00	-112.82	8.20	16.18	2591.98	0.00	0.00	0.00	-0.38	0.00	18.01	-0.05	2.44	5.19	156.90	0.00	1.86	-23.76	0.00
Snake Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.83	0.00	7.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.82	0.00	-17.20	0.00	0.00	0.00	0.00			
Talbot River	-0.12	-2.64	-7.18	-0.02	0.35	2.64	0.00	-0.02	0.27	1.37	0.00	0.24	1.64	2.97	0.00	-0.55	-3.14	-15.29	0.00	-1.82	5.43	-1912.74	0.00	0.10	-1.54	8.77	0.00	-57.47	1.42	4.66	1960.62	0.00	0.00	0.00	-0.04	0.00	4.00	-0.10	1.24	6.12	-1.80	0.00	-2.95	7.59	0.00
Thorah Island	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.06	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-6.77	-0.08	0.00	1.63	0.00	0.00	0.00	0.00	-0.72	0.00	5.87	0.00	0.00	0.00	0.00			
Upper Talbot River	-0.03	-3.51	10.35	0.14	0.30	8.45	0.00	0.25	0.91	51.60	0.00	0.03	0.00	3.84	0.00	0.00	-0.06	0.00	0.00	-3.38	8.32	-1113.78	0.00	-0.25	-1.15	-3.76	0.00	30.50	2.76	5.82	1437.07	0.00	0.00	0.00	-3.28	-0.08	1.90	4.74	-449.84	0.00	-0.56	13.83	0.00		
Uxbridge Brook	-0.20	0.58	17.83	1.42	5.42	-0.50	0.00	-1.24	0.86	-0.67	0.00	-0.15	0.97	-0.09	0.00	-0.33	-1.13	-12.94	0.00	-14.62	20.10	-1348.50	0.00	-0.03	0.64	-9.25	0.00	-80.35	18.06	25.28	1423.91	0.00	0.08	0.00	-0.05	0.00	1.64	-0.03	0.03	-2.85	-55.96	0.00	4.04	8.03	0.00
West Holland	0.00	0.00	-0.19	3.07	2.75	-1.13	0.43	-1.22	-1.99	-42.29	0.00	1.44	4.89	-34.25	0.00	4.03	11.65	51.30	-7.88	-41.86	66.59	-1993.21	0.00	-1.03	-2.21	36.28	1.17	-37.56	47.53	64.17	3625.41	0.00	0.00	0.00	-0.81	0.00	57.93	-11.17	9.51	21.55	-111.03	0.00	56.04	218.82	-0.44
Whites Creek	0.00	0.00	0.00	0.45	1.16	7.99	0.00	-0.06	0.93	6.01	0.00	0.00	1.37	3.13	0.00	0.13	0.68	37.30	0.00	-4.86	10.46	-1576.56	0.00	0.00	0.00	9.42	0.00	-40.21	3.38	3.63	1570.32	0.00	0.00	0.00	-5.93	0.00	6.90	0.00	0.54	8.74	0.00	0.64	8.74	0.00	
Total	-1.70	7.73	100.75	39.21	92.93	-8.09	3.54	-1.72	2.50	-8.35	0.87	-4.82	16.35	-91.87	-1.74	17.58	54.18	28.45	-10.89	-228.05	302.15	-27331.87	-0.09	-2.01	20.53	109.61	7.33	-1030.53	226.72	318.36	26355.92	0.33	0.10	-0.07	-39.57	0.02	254.68	-12.44	42.26	96.44	271.50	0.68	159.91	231.15	7.82

