City of Guelph

Stormwater Management Master Plan

Appendix C – Subwatershed Health Analysis

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Prepared for:
The City of Guelph

Stormwater Management Master Plan

Appendix C: Subwatershed Health Analysis

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1 Introduction

At the implementation phase of the City of Guelph's Stormwater Management (SWM) Master Plan, individual projects identified through technical analysis and evaluation will be prioritized as part of an implementation plan. Projects identified in the implementation plan are expected to include stream restoration works to mitigate erosion issues, drainage system improvements, retrofits to SWM facilities to improve water quality control, new SWM facilities where there are opportunities to provide quality and quantity controls where they are lacking, as well as SWM road retrofits, including Low Impact Development (LID) practices and storm sewer upgrades, to provide stormwater conveyance controls within the municipal right-of-way. Many factors including budgeting, planning, and integration with other programs and projects will contribute to prioritization of these SWM projects. While SWM system improvements provide an enhanced level of service to the public, they also provide several environmental benefits by reducing the impact of urbanized landscapes on local creeks, rivers and wetlands. Enhancements to aquatic and riparian habitat can improve water quality, reduce erosion, improve the water balance, and built resilience to climate change.

To ensure subwatersheds that would benefit most from improvements to water quality and a more natural runoff regime are targeted for SWM projects through the implementation plan, a subwatershed health analysis has been undertaken and will be used as a factor in project prioritization. As part of this subwatershed health analysis, the City's 23 subwatersheds shown in **Figure 1.1** were analysed based on existing conditions through available GIS data and information collected in the field as part of the characterization phase of the SWM Master Plan. Four Subwatershed Health Metrics were used as part of this analysis, these are:

1. Terrestrial Ecology
2. Aquatic Ecology
3. Stormwater Management
4. Erosion Condition

While the implementation of individual SWM controls will not directly influence all of the subwatershed health metrics, a primary goal of a SWM strategy focusing on providing natural hydrologic function via source, conveyance and end-of-pipe SWM controls is to mitigate the impacts of urbanization on local aquatic ecosystems. Through this approach, hydrologic functions such as infiltration, depression storage, filtration and evapotranspiration that were once provided by wetlands, forests and other natural features are reintegrated into the urban environment by a landscape-based SWM strategy.

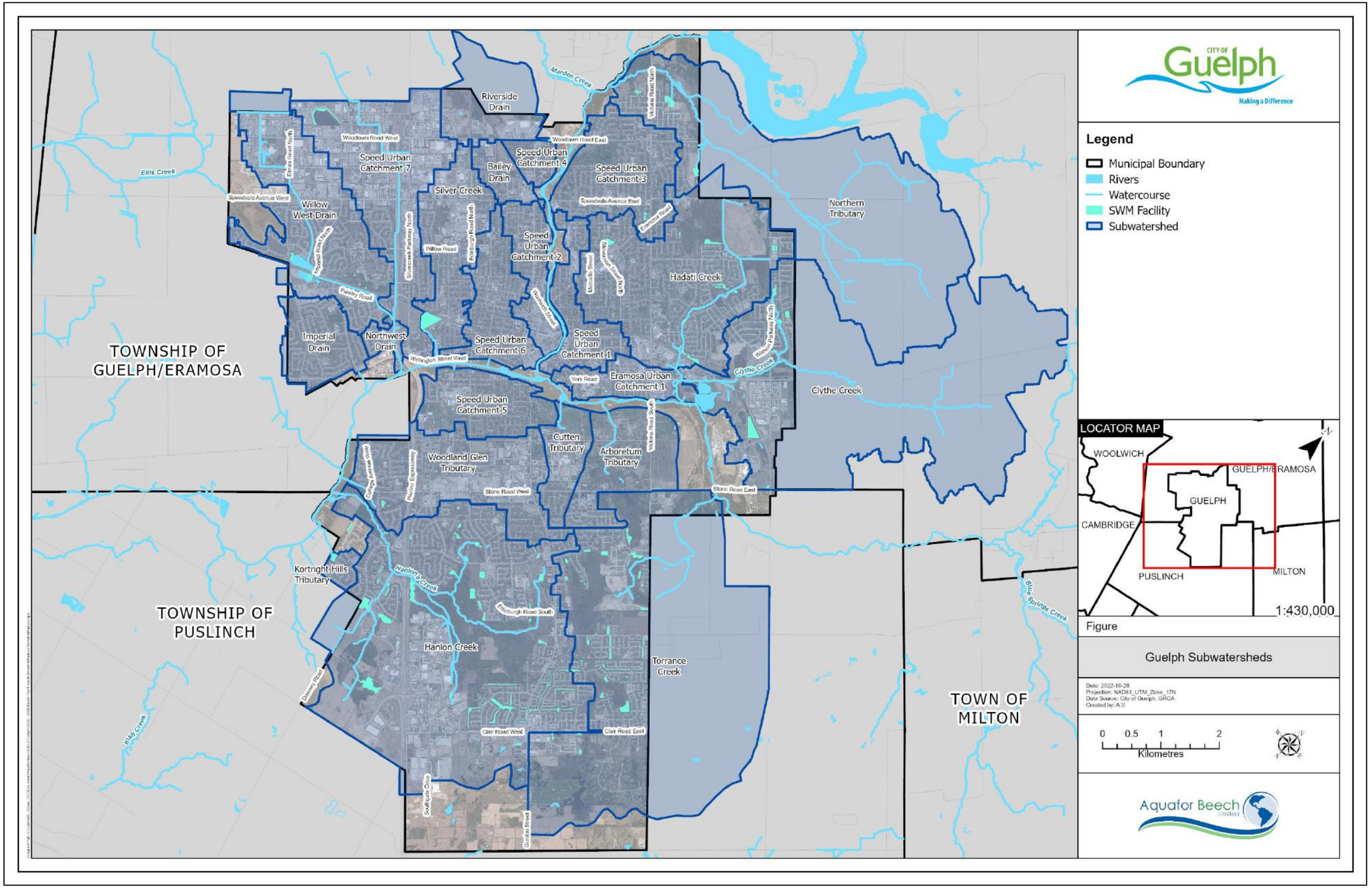

Figure 1.1: Guelph Subwatersheds

2 Terrestrial Subwatershed Health

The Southwestern Ontario landscape has experienced significant, possibly irreversible, ecological change following European settlement. Lands which were once covered in forest, wetland, savannah, and grasslands as well as watercourses have been removed or altered in favor of widespread agricultural and urban development. Many of the ecological processes the aforementioned natural heritage features provide have also been altered or eliminated. Accordingly, it is of vital importance to the natural heritage system as a whole to restore, conserve, and protect the form and function of natural areas.

In recognition of the significant landscape scale change in the country, Environment Canada has published an updated science-based guide which addresses common terrestrial vegetation community types and their roles in subwatershed health. The *How Much Habitat is Enough?* (2013) guideline is widely used by governments, NGOs, and citizen's groups as an ecology reference, and is especially valuable for watershed planning. Aquafor Beech Limited chose to use the subwatershed health criteria in the guideline in the development of terrestrial subwatershed health metrics for the City of Guelph's Subwatershed Health Analysis because of the guideline's science-based holistic approach to land use planning and management. Terrestrial subwatershed health metrics are not only interrelated, they often correspond with metrics from other disciplines such as stormwater and aquatic ecology. As such, it is recommended that the metrics are interpreted and applied in a holistic manner.

Discussion regarding the development of terrestrial subwatershed health parameters for this project are found in **Sections 2.1 to 2.4**. The calculation of subwatershed Terrestrial Health Metrics is assessed in **Section 2.5**.

Four of the five terrestrial subwatershed health metric parameters described below were adapted from the 3rd Edition of Environment Canada's *How Much Habitat is Enough?* (HMHE, 2013). The Environment Canada document provides general guidelines based on an aggregation and review of science-based literature, and encourages adaptation of the general guidelines and principles to suit local ecological contexts and priorities. Many of the criteria of the 2nd edition of the *How Much Habitat is Enough?* guidelines remain applicable in the 3rd edition. The parameters detailed below are high-level and are easily assessed using GIS technologies. Finer scale analysis of parameters related to terrestrial subwatershed health, such as the amount of suitable habitat available to target species or species-at-risk, is not included in the scope of this report.

The vegetation coverage guidelines within the How Much Habitat is Enough? (HMHE) guidelines are intended to be viewed as minimums, and are not intended to justify reduction of habitat types that are present in excess of the guideline minimums. In the case of a highly urbanized landscape like the City of Guelph, it may not be possible to meet the guideline minimums. However, as mentioned above, the guidelines can be adapted to the context in which they are applied.

The natural heritage resources within the City of Guelph are situated within an urban matrix. Disjunct habitat patches are generally less valuable to wildlife than connected patches; a connected matrix of natural heritage features will exhibit greater ecological and hydrologic function than a fragmented system and will likely be more adaptable to stressors such as climate change. Accordingly, two parameters in addition to applicable parameters of the HMHE guidelines, natural cover and connectivity, have been included in the list of metrics detailed below. The following four (4) parameters were used for each subwatershed to determine an overall terrestrial evaluation score:

- Wetland habitat;

- Forest habitat
- Natural cover
- Connectivity

2.1 Wetland Habitat

Wetlands are valuable components of a natural heritage system, often supporting a greater diversity of species than temperate upland forests and grassland on a per area basis (Cromer et al. 2005; Gibbons et al. 2006; Meyer et al. 2003). They also provide valuable hydrological functions, including but not limited to improving and maintaining water quality, flood attenuation, contributing to groundwater recharge, and reducing sediment delivery to water bodies.

Wetlands are defined as:

> lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens (OMNR, 2010).

One of the six habitat guidelines for wetlands in the HMHE is *percent cover of wetland area*. According to the guideline, "at a minimum, the greater of (a) 10% of each major watershed and 6% of each subwatershed, or (b) 40% of the historic watershed wetland coverage, should be protected and restored". Given the spatial scale of this project (i.e. the subwatershed scale), the target of **6% subwatershed wetland coverage** was chosen as the most appropriate wetland criteria for use in this watershed health analysis.

The GIS data set used to calculate the percentage of wetland coverage within each subwatershed included: "locally significant wetlands", "provincially significant wetlands", and "unevaluated/other wetlands".

2.2 Forest Habitat

Prior to European settlement, forest was the predominant vegetation type across the Mixedwood Plains (Environment Canada, 2013). Forests provide many hydrologic benefits in terms of water quality, flood attenuation, stream hydrology as well as other benefits such as oxygen production, carbon sequestration, erosion reduction, nutrient cycling, wildlife habitat, and more. For these reasons, the presence of forest habitat is a significant indicator of subwatershed health. Many species of flora and fauna are obligate forest habitat users, and as such the preservation of forested habitats are essential to their survival. There is increasing evidence that total forest cover in a given area is a major predictor of the persistence and size of bird populations, and the HMHE minimum forest cover guideline is largely based upon scientific studies that were focused on this taxon (Environmental Canada 2013). In addition to percent cover, other factors such as size, geometry, and diversity are also important to consider when evaluating forest habitat. However, given the data available for this study (Wooded Areas, City of Guelph), only percent cover in areas greater than 1500 m^2 have been included in the analysis as to eliminate individual or small clumps of trees.

For the purpose of this study, the definition of forested habitat follows the HMHE guideline where the term forest shall include: all treed communities (where trees are generally 6 metres or more in height) with a canopy cover of at least 35%, and more typically 60% or greater. This includes both upland forests and swamps as well as plantations. It generally does not include orchards or tree farms.

The HMHE guideline recommends that a minimum of 30% forest cover at the watershed scale is the minimum forest cover threshold, which represents a high-risk approach which may only support less than half of the potential species richness and marginally healthy aquatic ecosystems (Environment Canada 2013). Medium and low-risk approaches equate to 40% and 50% forest cover, respectively. For the purposes of this study, the high-risk threshold of a **minimum of 30% forest cover** per subwatershed was selected as the preferred parameter given the highly urbanized nature of the lands within the City's boundary.

The GIS data set used in the analysis of forest habitat includes the City of Guelph's urban forest layer and Land Information Ontario's wooded areas layer, which includes forested areas greater than 1500 m^2.

2.3 Natural Cover

The City of Guelph recognises the importance of the natural heritage system for maintaining biodiversity and supporting ecological and hydrological functions and is committed to the restoration and enhancement of natural features within publicly-owned land by prohibiting development within the natural heritage system. In addition to their inherent value; wetlands, forests, grasslands, and riparian areas provide many important ecological and hydrologic services to people and wildlife. As such, the parameter of "natural cover" was included in the analysis.

The GIS data set used in the analysis of natural cover includes wetlands, woodlands, and watercourses, and waterbodies. Meadow communities have been excluded from the calculation as there was no appropriate data set available at the time of this evaluation.

2.4 Connectivity

As mentioned above, the natural heritage resources within the City of Guelph are situated within an urban matrix. Urban infrastructure such as roads and buildings often bisect or surround natural areas, separating them from other natural areas. Without connection to other habitats or the greater natural heritage system, isolated habitat patches exhibit limited potential for movement and propagation of flora and fauna, genetic exchange, species interaction, etc. Connections between and amongst components of the natural heritage system contribute to the ecological function of connected habitat patches and the natural heritage system as a whole, and habitat fragmentation is commonly cited as a threat to species extinction and loss of biodiversity (D'Eon et al. 2002).

The City of Guelph recognises that natural linkages and corridors are an essential component of the natural heritage system. Connectivity is a functional relationship between physical habitat features and the flora and fauna that use them. For example: two forested habitats connected by an unvegetated stream will be used differently by aquatic or semi-aquatic organisms (functionally connected) compared to the way in which small terrestrial mammals are able to use the stream (not functionally connected). Furthermore, proximity (and organisms' dispersal abilities) also influences the ways in which flora and fauna travel between discrete habitat patches. Such nuances were not taken into consideration in this study due to the scope of such an undertaking and the limitations of the GIS-based analysis used for this study.

For this study, connectivity was calculated as the percentage of natural and semi-natural patches within each subwatershed that were directly connected physically/geographically to at least one other habitat patch either within the same subwatershed or areas outside the subwatershed by a terrestrial or aquatic linkage. The GIS data set used in the analysis of connectivity includes: woodlands, wetlands, streams, creeks, rivers, watercourses, and surface water features. In this terrestrial subwatershed health metric,

wetlands, ponds, and woodlands are considered habitat patches. Streams, creeks, rivers, and watercourses are treated as potential habitat "connectors", or linkages. Habitat patches were considered "connected" if terrestrial habitat patches are physically connected to other habitat patches either by each other or by an aquatic linkage type, or, if through air photo interpretation it was determined that unmapped natural and/or semi-natural vegetation connected habitat patches.

Minimum targets for habitat connectivity are currently not explored in the scientific literature; however, the general consensus is that greater connectivity is more desirable than less connectivity. As such, subwatershed connectivity for each subwatershed was given a score relative to the percentage of number of connected habitat patches located within the boundaries of each subwatershed, regardless of whether the habitat patches were connected to other patches within or outside of the subwatershed. Similar to the minimum recommended threshold for riparian cover, 75% was selected as the minimum recommended percentage for connectivity.

2.5 Scoring of Terrestrial Subwatershed Health Metric

The scoring system used for the Terrestrial Subwatershed Health Metric follows that of other subwatershed health metrics in that each parameter (e.g., water quality, terrestrial, aquatic, etc.) is given a score from one (1) to five (5), with 1 representing a "very good" score and 5 representing a "poor" score.

A summary of the scoring methodology for each of the metrics for terrestrial subwatershed health is presented below in **Table 2.1**, where each metric was weighted equally**.** Values in the same row as "1 (Excellent)" represent the suggested minimum described in **Section 1** under each parameter. For terrestrial subwatershed health, each parameter was given a score between one (1) and five (5)**.** In recognition of the interrelationship between all parameters, the average score is considered the overall terrestrial health score for each of the subwatershed included in the analysis.

Table 2.1: Terrestrial Subwatershed Health Thresholds and Scoring Scheme

Score	Terrestrial Subwatershed Health Parameter Thresholds			
	Wetland Habitat	**Forest Habitat**	**Natural Cover**	**Connectivity**
1 (Excellent)	≥ 6%	≥ 30%	≥ 50%	≥ 75%
2 (Good)	4.4% - 5.9%	21.5% - 29%	37.4% - 49.9%	60% - 74.9%
3 (Fair)	2.9% - 4.3%	14% - 21.4%	24.9% - 37.3%	45% - 59.9%
4 (Marginal)	1.4% - 2.8%	6.5% - 13.9%	12.4% - 24.8%	30% - 44.9%
5 (Poor)	<1.4%	< 6.5%	> 12.4%	< 30%

Table 2.2 presents an assessment of existing conditions for each subwatershed within the City of Guelph as it relates to the terrestrial health parameters described above. As mentioned above, in recognition of the interrelationship between the terrestrial subwatershed health metrics, it is recommended that the metrics are interpreted and applied in a holistic manner. The information contained in **Table 2.2** can be used to prioritize future site-specific studies or subwatershed planning; provide high-level criteria to consider when prioritizing restoration opportunities; or be correlated with water quality and/or quantity data to look for trends.

The City of Guelph is encouraged to consider prioritizing the restoration of vegetation types which may address multiple parameters. For example, treed swamp vegetation community types address both forest and wetland coverage targets and depending on their location, could also address riparian habitat targets. The City is also encouraged to look within and beyond their urban and geographical boundaries to neighbouring lands and consider how increasing landscape connectivity and representation of a diversity of ecological communities can provide an overall benefit for the ecology of the City of Guelph. Furthermore, it is recommended that metrics from other disciplines (e.g. aquatic ecology, water quality, etc.) also be considered when evaluating priorities for overall subwatershed improvement.

Overall, **Table 2.2** shows subwatersheds that were more recently developed scored better than those that were historically fully developed. In addition, subwatersheds that contain significant wetlands, such as the Hanlon Creek Provincially Significant Wetland (PSW) or the Torrance Creek PSW, generally scored better than those subwatersheds with less extensive coverage of natural heritage features, as these larger features were protected more stringently than smaller features. Terrestrial Health scores, which represent a combined average of the scores for individual parameters, varied from 1.75 (excellent – good) to 5.0 (poor), and are generally in line with the overall scores for each subwatershed. **Figure 2.1** illustrates the results obtained for the Terrestrial Subwatershed Health Assessment.

Table 2.2: Summary of Analysis of Terrestrial Health Metrics

Subwatershed	Terrestrial Health Metrics and Associated Scores								Subwatershed Terrestrial Health Score
	Wetland Habitat (ha)	Score	Forest Habitat (ha)	Score	Natural Cover (ha)	Score	Connectivity (ha)	Score	
Arboretum Tributary	23.56	1	47.94	3	50.84	4	39.62	1	2.25
Bailey Drain	0.00	5	3.39	5	3.39	5	0.09	5	5.0
Clythe Creek	151.98	1	198.82	4	259.22	4	234.35	1	2.5
Cutten Tributary	0.00	5	8.36	4	9.27	5	3.17	4	4.5
Eramosa Urban Catchment 1	6.18	3	5.13	5	7.66	5	7.11	1	3.5
Hadati Creek	115.99	1	106.57	4	126.68	4	104.23	1	2.5
Hanlon Creek	409.33	1	361.38	3	438.80	3	412.09	1	2.0
Imperial Drain	3.78	4	14.66	4	14.97	5	9.40	2	3.75
Kortright Hills Tributary	0.00	5	0.60	5	0.97	5	0.91	1	4.0
Northern Tributary	357.25	1	319.35	2	416.07	3	404.61	1	1.75
Northwest Drain	0.00	5	0.78	5	1.09	5	0.84	1	4.0
Riverside Drain	80.82	1	34.17	3	71.95	3	70.71	1	2.0
Silver Creek	0.33	5	11.75	5	12.30	5	2.73	5	5.0
Speed Urban Catchment 1	0.00	5	19.21	4	19.22	5	1.23	5	4.75
Speed Urban Catchment 2	0.00	5	6.23	5	6.23	5	0.51	5	5.0
Speed Urban Catchment 3	0.43	5	17.30	5	17.51	5	8.80	3	4.5
Speed Urban Catchment 4	1.45	4	10.43	3	10.51	4	1.73	5	4.0
Speed Urban Catchment 5	0.00	5	28.02	4	28.02	4	4.53	5	4.5
Speed Urban Catchment 6	0.00	5	12.67	5	12.68	5	0.19	5	5.0
Speed Urban Catchment 7	17.30	4	23.20	5	31.51	5	21.56	2	4.0
Torrance Creek	278.68	1	477.91	2	539.26	3	494.84	1	1.75
Willow West Drain	9.93	5	42.43	4	47.04	5	22.87	3	4.25
Woodland Glen Tributary	10.93	4	47.32	4	48.10	5	11.15	5	4.5

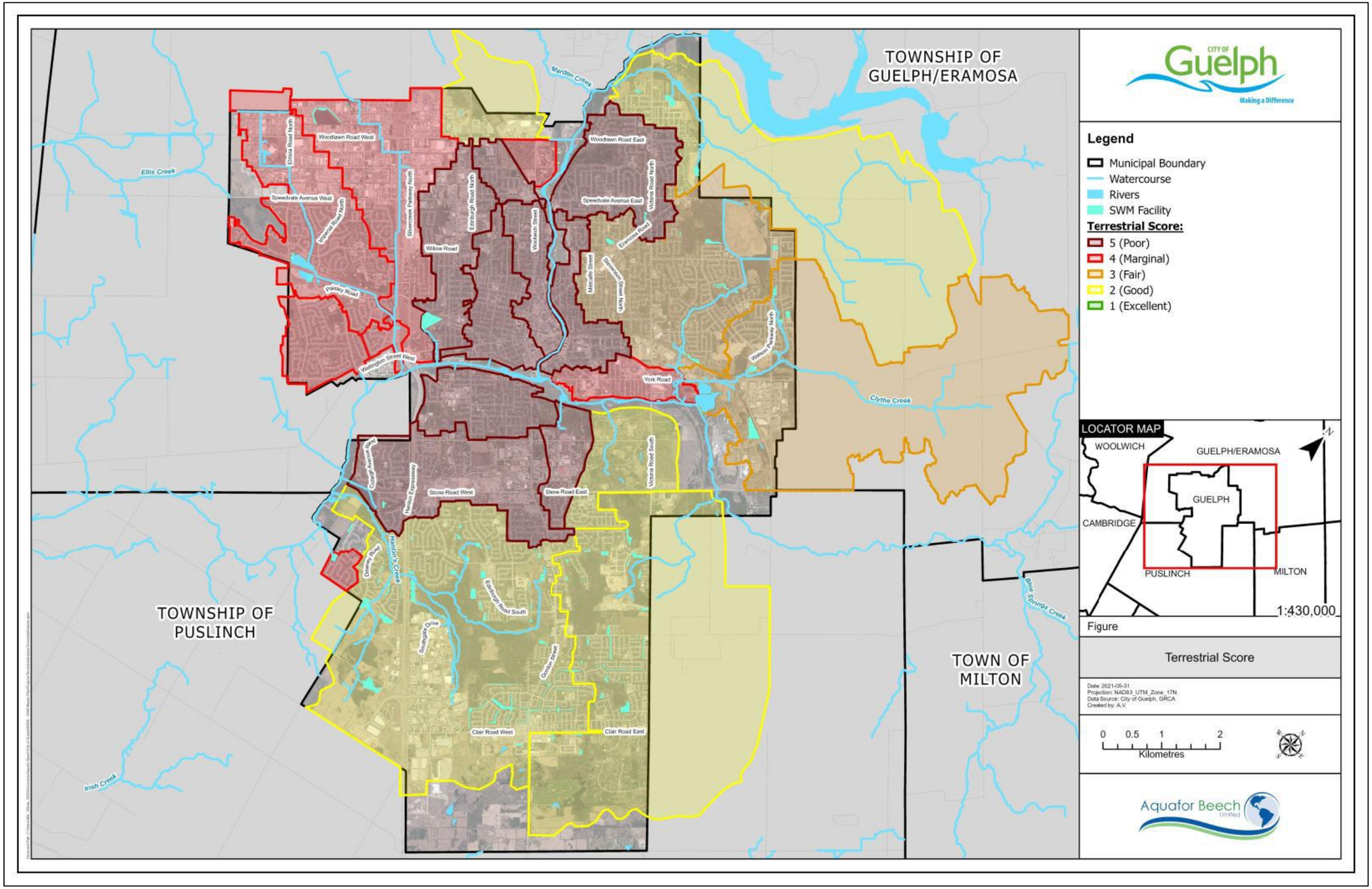

Figure 2.1: Terrestrial Ecology Score

3 Aquatic Ecology

Healthy watercourses generally support a variety of aquatic life including fish, benthic invertebrates, aquatic insects, amphibians, reptiles and water fowl. In general, higher species richness is indicative of a higher quality habitat. The presence of species intolerant of disturbance are particularly good bioindicators of subwatershed health. The following five (5) parameters were used for each subwatershed to determine an overall aquatics evaluation score:

- Species Richness
- Species Intolerant of Disturbance
- Habitat Sensitivity
- Coldwater Rehab Potential
- Channel Habitat Type

Aquatic resource data was provided by open sources through the Ontario GeoHub platform and Land Information Ontario (LIO). The open Aquatic resource area (ARA) line and polygon segment datasets describe physical characteristics and fish species of lakes, rivers or streams. This information is typically derived from monitoring programs completed by the ministry or through conservation authorities, using standardized monitoring procedures. It is therefore assumed that the same sampling effort and methodology was applied across all ARA line and polygon segments and across the subswatersheds. This spatial dataset represents the locations of ARA line and/or polygon segments derived from corresponding line features in the Ontario Hydro Network.

3.1 Species Richness

In general, a diverse, high-quality habitat is able to support a wide diversity of aquatic life consistent with natural conditions, whereas a lack of biodiversity within the watercourse is expected to be severely degraded. Therefore, higher species richness is indicative of a higher quality habitat. Fish species for the corresponding waterbody reaches were derived from the ARA data noted above. As such, only fish species are considered in the species richness metric. Scores of 0-20 were divided among the five categories as shown in **Table 3.1** to develop the ranges used in the evaluation score.

Table 3.1: Species Richness Scoring System

Species Richness	Rating	Evaluation Score
20 - 24	Excellent	1
15 - 19	Good	2
10 - 14	Fair	3
5 - 9	Marginal	4
0 - 4	Poor	5

3.2 Species Intolerant of Disturbance

The presence of fish species that are intolerant to disturbance within waterbodies are particularly good bioindicators of watershed health. Waterbodies that have historically supported coldwater species but are at risk of diminished coldwater habitat due to thermal pollution or lack of baseflow should receive higher prioritization in maintaining current conditions. Therefore, habitats with a greater number of intolerant species are higher quality than habitats with fewer intolerant species. The Ontario Freshwater Fishes Life History Database (Eakins, 2021) provides taxonomic information that is used to describe the diagnostic indicators of a species, including the general abundance of the species throughout the

province, tolerance levels and thermal preferences including spawning windows and spawning water temperature requirements. Intolerance has been determined using standardized bioassessment protocols and documented for fish species across Ontario to better understand species composition responses to changes in habitat and external influences. These resources have been updated as species are studied and have been used by fisheries professionals in similar applications by accessing the Ontario Freshwater Fishes Life History Database (Eakins, 2021). Intolerance levels are listed on the database for each species as either intolerant, intermediate, or tolerant. Scoring ranges are presented in **Table 3.2.**

Table 3.2: Species Intolerant to Disturbance Scoring System

Species Intolerant of Disturbance	Rating	Evaluation Score
4+	Excellent	1
3	Good	2
2	Fair	3
1	Marginal	4
0	Poor	5

3.3 Habitat Sensitivity Watercourse

This metric identifies the thermal regime based on the typical summer water temperature of a waterbody using measures of water temperature or inferred from knowledge of existing fish or invertebrate community present. Similar to the scoring discussed above, watercourses that have historically supported coldwater species and therefore coldwater habitat, should receive higher prioritization in maintaining current conditions to mitigate potential habitat loss due to thermal warming. Coldwater ecosystems are likely to shift towards coolwater regimes as water temperatures increase through climate change and urban development, demonstrated by a 27% decrease in coldwater habitat and an 284% increase in coolwater habitat since pre-European development (Di Rocco, Jones, & Chu, 2016). Therefore, habitats that have been classified as coldwater, either through the presence of coldwater species or through thermal regime analysis, are higher quality than habitats classified as cool or warmwater. Scoring for this metric is presented in **Table 3.3**.

Table 3.3: Habitat Sensitivity Watercourse Scoring System

Habitat Sensitivity Watercourse	Rating	Evaluation Score
Cold	Excellent	1
Warm	Poor	2

3.4 Channel Habitat Type

This metric identifies the channel habitat type present within a respective watercourse or stretch. Natural watercourses and wetlands, or aquatic features that have not been altered, are typically more prone to support ecologically significant systems and provide services to the natural environment that engineered aquatic features cannot. For example, channelized watercourses are disconnected from their floodplains so the associated hydrologic functions become degraded or destroyed. Similar to the scoring discussed above, watercourses or aquatic features that noted as natural or wetland indicate high quality, sensitive aquatic habitat, and should therefore receive higher prioritization in maintaining current conditions. Therefore, features documented as natural or wetland are higher quality habitats than those that represent partial or fully engineered characteristics. Data for channel habitat type was

obtained from the creek walks completed as part of the SWM-MP. Scoring for this metric is presented in **Table 3.4**.

Table 3.4: Channel Habitat Type Scoring System

Channel Habitat Type	Rating	Evaluation Score
Natural	Excellent	1
Wetland	Good	2
Part Natural / Part Engineered	Fair	3
Partially Engineered / Straightened	Marginal	4
SWM Facility / Part Concrete / Part Pipe	Poor	5

3.5 Scoring of Aquatic Ecology Metric

An overall aquatic ecology score was calculated for each subwatershed by averaging the scores from **Sections 3.1** to **3.4**, each of which was given equal weighting. Metrics were rated equally in this exercise as one indicator does not favour aquatic health more than another, and each metric plays an equally important role in determining the overall health of a watercourse.

A score of one (1) given to a watercourse would indicate that the watercourse is expected to currently support a wide diversity of aquatic life consistent with natural conditions. A score of five (5) given to a watercourse would indicate that biodiversity within the watercourse is expected to be severely degraded. Watercourses that have historically supported coldwater species but are at risk of diminished coldwater habitat due to thermal pollution or lack of baseflow received a score of one (1).

Table 3.5 provides a summary of biotic community health evaluation scores for each subwatershed, which is also illustrated in **Figure 3.1**.

Because there is a strong correlation between the other subwatershed metrics and the presence and health of aquatic species, the average subwatershed metric score (see **Section 6**) was used for subwatersheds where there are no aquatic species data. This was preferable to neutral scores (eg. ranking the subwatershed at 3) which would result in clustering of overall subwatershed health scores. The ten (10) subwatersheds that did not have sufficient aquatic species data to assign an overall aquatics score are:

- Bailey Drain
- Cutten Tributary
- Speed Urban Catchment 1
- Speed Urban Catchment 2
- Speed Urban Catchment 3
- Speed Urban Catchment 4
- Speed Urban Catchment 5
- Imperial Drain
- Riverside Drain
- Silver Creek

Table 3.5: Aquatic Ecology Score by Subwatershed

Subwatershed	Species Richness Score	Species Intolerant of Disturbance Score	Habitat Sensitivity Watercourse Score	Coldwater Rehab Potential Score	Channel Type Score	Aquatic Resource Area Score	Aquatic Ranking	Overall Aquatic Score
Arboretum Tributary	5	5	3	2	3	18	Marginal	4
Clythe Creek	1.03	2.03	1.01	1.01	1.85	6.93	Excellent	1
Eramosa Urban Catchment 1	4.18	4.87	1.33	1.33	2.28	13.98	Fair	3
Hadati Creek	3	5	2	2	3.57	15.57	Fair	3
Hanlon Creek	3	4	1	1	1.95	10.95	Good	2
Kortright Hills Tributary	5	5	3	2	3.49	18.49	Poor	5
Northern Tributary	5	5	3	2	1.78	16.78	Marginal	4
Northwest Drain	5	5	2	2	4.03	18.03	Marginal	4
Speed Urban Catchment 6	5	5	3	2	5	20	Poor	5
Speed Urban Catchment 7	5	5	2.75	2	3.13	17.88	Marginal	4
Torrance Creek	5	5	3	2	2.05	17.05	Marginal	4
Willow West Drain	5	5	2	2	5	19	Poor	5
Woodland Glen Tributary	5	5	3	2	1	16	Marginal	4

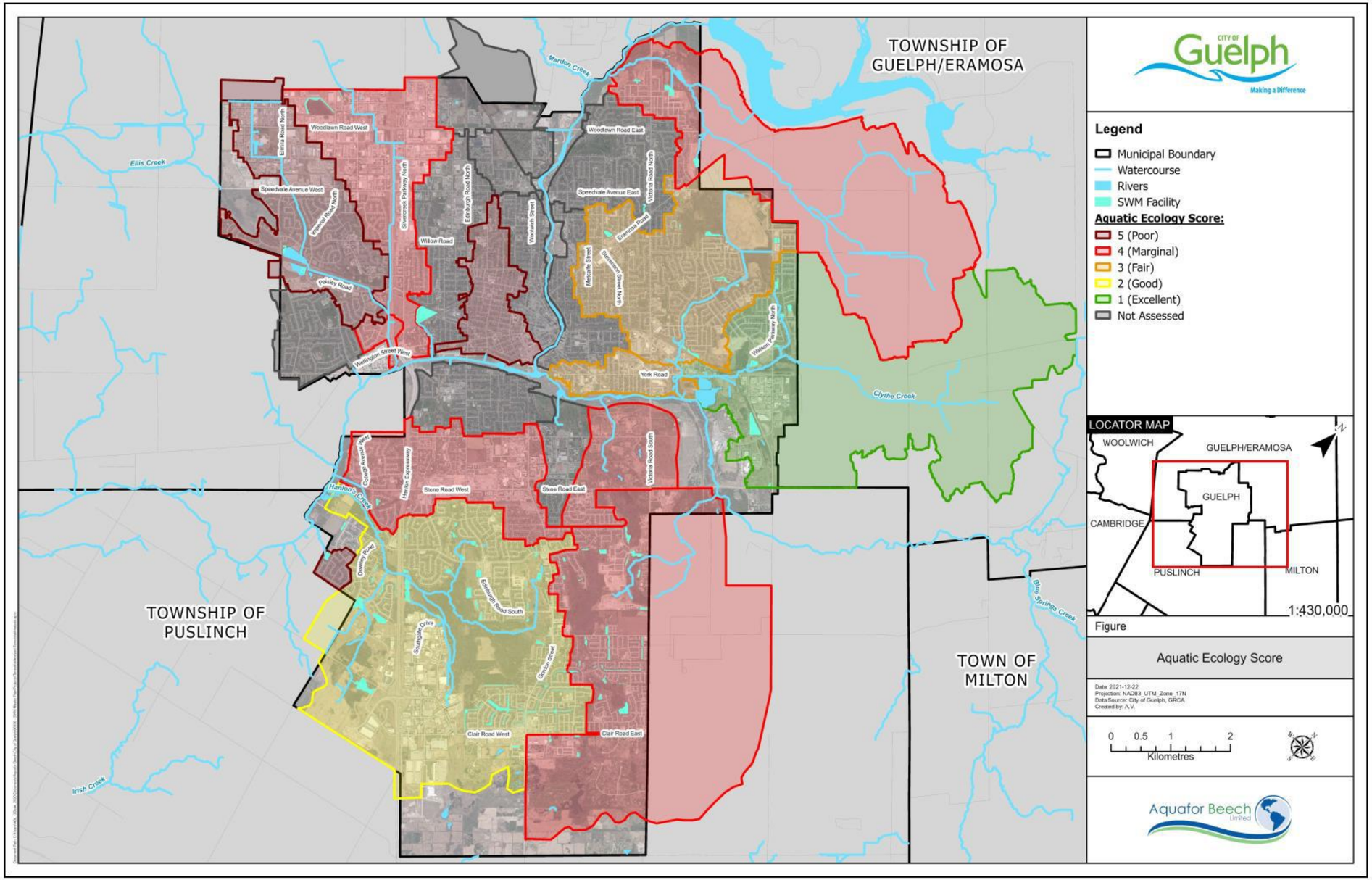

Figure 3.1: Subwatershed Aquatic Ecology Score

4 Stormwater Management

Much of the City of Guelph has urbanized, resulting in the replacement of vegetation and undisturbed terrain with impermeable surfaces (i.e. pavement, roof tops, graded surfaces and the provision of an underground storm drainage network). These surfaces intercept water that would naturally infiltrate into the ground, and provide a direct and rapid transport of surface runoff to local creeks, rivers and wetlands. Early developments in the City did not include any stormwater controls (beyond the provision of rapid conveyance systems i.e. ditches and storm sewers), resulting in an increase in the total volume, peak flow and frequency of runoff occurrences. Uncontrolled, these hydrologic changes increase flooding, channel erosion, sediment transport, and pollutant loadings. These changes can also cause deterioration in natural channel morphology, natural heritage feature water balance, fish and wildlife habitats, recreational opportunity and aesthetics.

The stormwater management (SWM) practices in the City of Guelph generally reflect the age of development of neighbourhoods within the City. As a result, areas of older development may lack stormwater quality and/or stormwater quantity infrastructure. To provide an existing conditions evaluation score for the SWM metric on a subwatershed basis, three (3) paraments were used. SWM parameters were weighted evenly, and included:

1. Stormwater Quality Control
2. Stormwater Quantity Control
3. Impervious Surface Percentage

All data were obtained from the updated SWM facility tables developed as part of the Stormwater Management Facilities, OGS and Catchments Report (November 2021) developed as part of the SWM-MP.

4.1 Stormwater Quality Control

A combination of wet SWM facilities, constructed wetlands and OGS units provide stormwater quality control for development within the City of Guelph. To provide a comparative parameter, the total area draining to stormwater quality facilities was calculated for each subwatershed. This analysis included all levels of stormwater quality protection (i.e. enhanced, normal and basic). In order to normalize the stormwater quality control metric, the area draining to stormwater quality facilities was divided by the total area of each subwatershed to provide a percent control indicator. Open space areas such as conservation lands, undeveloped lands, and agricultural areas are not typically provided with SWM quality controls and are not included in the calculation of this metric. The percent of the urban subwatershed areas provided with stormwater quality control ranges from 0% to 72%. The scoring system for the stormwater quality control parameter is presented in **Table 4.1**.

Table 4.1: Stormwater Quality Scoring System

% Quality Control	Quality Control Rating	Evaluation Score
% Control ≥ 60	Excellent	1
40 ≤ **% Control** < 60	Good	2
20 ≤ **% Control** < 40	Fair	3
10 ≤ **% Control** < 20	Marginal	4
0 ≤ **% Control** < 10	Poor	5

Table 4.4 provides a summary of stormwater quality control within the City by subwatershed.

4.2 Stormwater Quantity Control

A combination of wet and dry SWM facilities as well as subsurface detention systems (e.g., SWM chamber and superpipe storage) provide stormwater quantity control for development within the City of Guelph. Like the stormwater Quality Control metric described above in **Section 3.1**, to provide a comparative parameter, the total area draining to stormwater quantity facilities was calculated for each subwatershed. In order to normalize the stormwater quality control metric, the area draining to stormwater quality facilities was divided by the total area of each subwatershed to provide a percent control indicator. Open space areas such as conservation lands, undeveloped lands, and agricultural areas are not typically provided with SWM quantity controls and are not included in the calculation of this metric. The percent of subwatershed area provided with stormwater quantity control ranges from 0% to 96%. The scoring system for the stormwater quantity control parameter is presented in **Table 4.2**.

Table 4.2: Stormwater Quantity Scoring System

% Quantity Control	Quantity Control Rating	Evaluation Score
% Control ≥ 60	Excellent	1
40 ≤ **% Control** < 60	Good	2
20 ≤ **% Control** < 40	Fair	3
10 ≤ **% Control** < 20	Marginal	4
0 ≤ **% Control** < 10	Poor	5

Table 4.5 provides a summary of stormwater quantity control within the City of Guelph by subwatershed.

4.3 Impervious Surface Percentage

Impervious surfaces are the main source of excess stormwater runoff volume and pollutant loading when catchments are compared to pre-urbanized conditions. Impervious surfaces also significantly reduce evapotranspiration when they replace pervious surfaces and natural vegetation. To provide a comparative metric, the percent of impervious area for each subwatershed was calculated. Impervious areas used in this calculation include buildings, parking areas, roads and sidewalks. The subwatershed percent impervious ranged from 10% to 65%. The scoring system for impervious parameter is presented in **Table 4.3.**

Table 4.3: Impervious Percentage Scoring System

% Quality Control	Quality Control Rating	Evaluation Score
0 ≤ **Impervious %** < 10	Excellent	1
10 ≤ **Impervious %** < 20	Good	2
20 ≤ **Impervious %** < 30	Fair	3
30 ≤ **Impervious %** < 40	Marginal	4
Impervious % ≥ 40	Poor	5

Table 4.6 provides a summary of impervious percentage within the City by subwatershed.

Table 4.4: Stormwater Quality Control Score by Subwatershed

Subwatershed	Analysis Area (ha)	Area with Quality Control (ha)	% of Area with Quality Control	Quality Control Rating	Evaluation Score
Arboretum Tributary	205.92	7.75	3.76	Poor	5
Bailey Drain	62.22	9.65	15.50	Marginal	4
Clythe Creek	399.65	115.88	29.00	Fair	3
Cutten Tributary	94.75	0.00	0.00	Poor	5
Eramosa Urban Catchment 1	99.08	4.21	4.25	Poor	5
Hadati Creek	615.42	246.52	40.06	Good	2
Hanlon Creek	1106.82	803.45	72.59	Excellent	1
Imperial Drain	177.00	4.27	2.41	Poor	5
Kortright Hills Tributary	30.69	0.37	1.20	Poor	5
Northern Tributary	157.01	82.26	52.39	Good	2
Northwest Drain	33.53	17.21	51.33	Good	2
Riverside Drain	86.48	0.00	0.00	Poor	5
Silver Creek	281.78	0.00	0.00	Poor	5
Speed Urban Catchment 1	164.49	29.62	18.01	Marginal	4
Speed Urban Catchment 2	151.96	29.77	19.59	Marginal	4
Speed Urban Catchment 3	305.73	11.50	3.76	Poor	5
Speed Urban Catchment 4	19.83	8.92	44.98	Good	2
Speed Urban Catchment 5	226.10	16.40	7.25	Poor	5
Speed Urban Catchment 6	215.58	25.50	11.83	Marginal	4
Speed Urban Catchment 7	529.45	40.15	7.58	Poor	5
Torrance Creek	480.68	262.30	54.57	Good	2
Willow West Drain	513.47	132.78	25.86	Fair	3
Woodland Glen Tributary	462.92	29.91	6.46	Poor	5

*Undeveloped areas (valley lands, wetlands, woodlots, and agricultural lands) were excluded from the area controlled/uncontrolled analysis because they are not expected to be provided with engineered stormwater controls.

Table 4.5: Stormwater Quantity Control Score by Subwatershed

Subwatershed	Analysis Area (ha)	Area with Quantity Control (ha)	% of Area with Quantity Control	Quantity Control Rating	Evaluation Score
Arboretum Tributary	205.92	2.82	1.37	Poor	5
Bailey Drain	62.22	0.00	0.00	Poor	5
Clythe Creek	399.65	201.69	50.47	Good	2
Cutten Tributary	94.75	0.00	0.00	Poor	5
Eramosa Urban Catchment 1	99.08	0.00	0.00	Poor	5
Hadati Creek	615.42	383.57	62.33	Excellent	1
Hanlon Creek	1106.82	799.91	72.27	Excellent	1
Imperial Drain	177.00	0.13	0.08	Poor	5
Kortright Hills Tributary	30.69	29.58	96.40	Excellent	1
Northern Tributary	157.01	82.68	52.66	Good	2
Northwest Drain	33.53	0.00	0.00	Poor	5
Riverside Drain	86.48	0.00	0.00	Poor	5
Silver Creek	281.78	243.23	86.32	Excellent	1
Speed Urban Catchment 1	164.49	0.00	0.00	Poor	5
Speed Urban Catchment 2	151.96	0.00	0.00	Poor	5
Speed Urban Catchment 3	305.73	32.85	10.74	Marginal	4
Speed Urban Catchment 4	19.83	0.00	0.00	Poor	5
Speed Urban Catchment 5	226.10	0.00	0.00	Poor	5
Speed Urban Catchment 6	215.58	0.00	0.00	Poor	5
Speed Urban Catchment 7	529.45	45.39	8.57	Poor	5
Torrance Creek	480.68	278.40	57.92	Good	2
Willow West Drain	513.47	13.23	2.58	Marginal	5
Woodland Glen Tributary	462.92	29.92	6.46	Poor	5

*Undeveloped areas (valley lands, wetlands, woodlots, and agricultural lands) were excluded from the area controlled/uncontrolled analysis because they are not expected to be provided with engineered stormwater controls.

Table 4.6: Impervious Percentage Score by Subwatershed

Subwatershed	Analysis Area (ha)	Impervious Area (ha)	% Impervious (ha)	Impervious Rating	Evaluation Score
Arboretum Tributary	259.34	35.25	13.59	Good	2
Bailey Drain	73.76	31.05	42.09	Poor	5
Clythe Creek	1598.92	202.11	12.64	Good	2
Cutten Tributary	123.41	43.46	35.21	Marginal	4
Eramosa Urban Catchment 1	124.23	52.84	42.53	Poor	5
Hadati Creek	786.24	252.44	32.11	Marginal	4
Hanlon Creek	1701.08	468.54	27.54	Fair	3
Imperial Drain	177.25	68.43	38.61	Marginal	4
Kortright Hills Tributary	30.69	14.28	46.53	Poor	5
Northern Tributary	1286.65	95.15	7.40	Excellent	1
Northwest Drain	36.54	12.96	35.48	Marginal	4
Riverside Drain	230.16	45.50	19.77	Good	2
Silver Creek	286.58	135.52	47.29	Poor	5
Speed Urban Catchment 1	164.52	72.24	43.91	Poor	5
Speed Urban Catchment 2	151.00	85.95	56.92	Poor	5
Speed Urban Catchment 3	322.48	122.38	37.95	Marginal	4
Speed Urban Catchment 4	52.04	14.29	27.46	Fair	3
Speed Urban Catchment 5	219.38	78.12	35.61	Marginal	4
Speed Urban Catchment 6	214.81	100.79	46.92	Poor	5
Speed Urban Catchment 7	555.70	294.38	52.98	Poor	5
Torrance Creek	1748.88	216.97	12.41	Good	2
Willow West Drain	562.63	242.18	43.04	Poor	5
Woodland Glen Tributary	472.29	208.53	44.15	Poor	5

4.4 Scoring of Stormwater Management Metric

An overall stormwater evaluation score was calculated for each subwatershed by averaging the stormwater quality control, stormwater quantity control and impervious percentage scores. Overall SWM scores ranged from 1.67 to 5. SWM ratings from “poor” through “excellent” were assigned based on this scoring system.

Table 4.7 provides a summary of SWM evaluation scores and SWM ratings for each subwatershed. **Figure 4.1** summarizes the Subwatershed SWM Ranking Analysis in geographical context.

Table 4.7: Overall SWM Scores by Subwatershed

Subwatershed	Quality Control Evaluation Score	Quantity Control Evaluation Score	Impervious Percentage Evaluation Score	Stormwater Management Rating	Overall SWM Score
Arboretum Tributary	5	5	2	Marginal	4.00
Bailey Drain	4	5	5	Poor	4.67
Clythe Creek	3	2	2	Good	2.33
Cutten Tributary	5	5	4	Poor	4.67
Eramosa Urban Catchment 1	5	5	5	Poor	5.00
Hadati Creek	2	1	4	Good	2.33
Hanlon Creek	1	1	3	Good	1.67
Imperial Drain	5	5	4	Poor	4.67
Kortright Hills Tributary	5	1	5	Marginal	3.67
Northern Tributary	2	2	1	Good	1.67
Northwest Drain	2	5	4	Marginal	3.67
Riverside Drain	5	5	2	Marginal	4.00
Silver Creek	5	1	5	Marginal	3.67
Speed Urban Catchment 1	4	5	5	Poor	4.67
Speed Urban Catchment 2	4	5	5	Poor	4.67
Speed Urban Catchment 3	5	4	4	Marginal	4.33
Speed Urban Catchment 4	2	5	3	Fair	3.33
Speed Urban Catchment 5	5	5	4	Poor	4.67
Speed Urban Catchment 6	4	5	5	Poor	4.67
Speed Urban Catchment 7	5	5	5	Poor	5.00
Torrance Creek	2	2	2	Good	2.00
Willow West Drain	3	5	5	Marginal	4.33
Woodland Glen Tributary	5	5	5	Poor	5.00

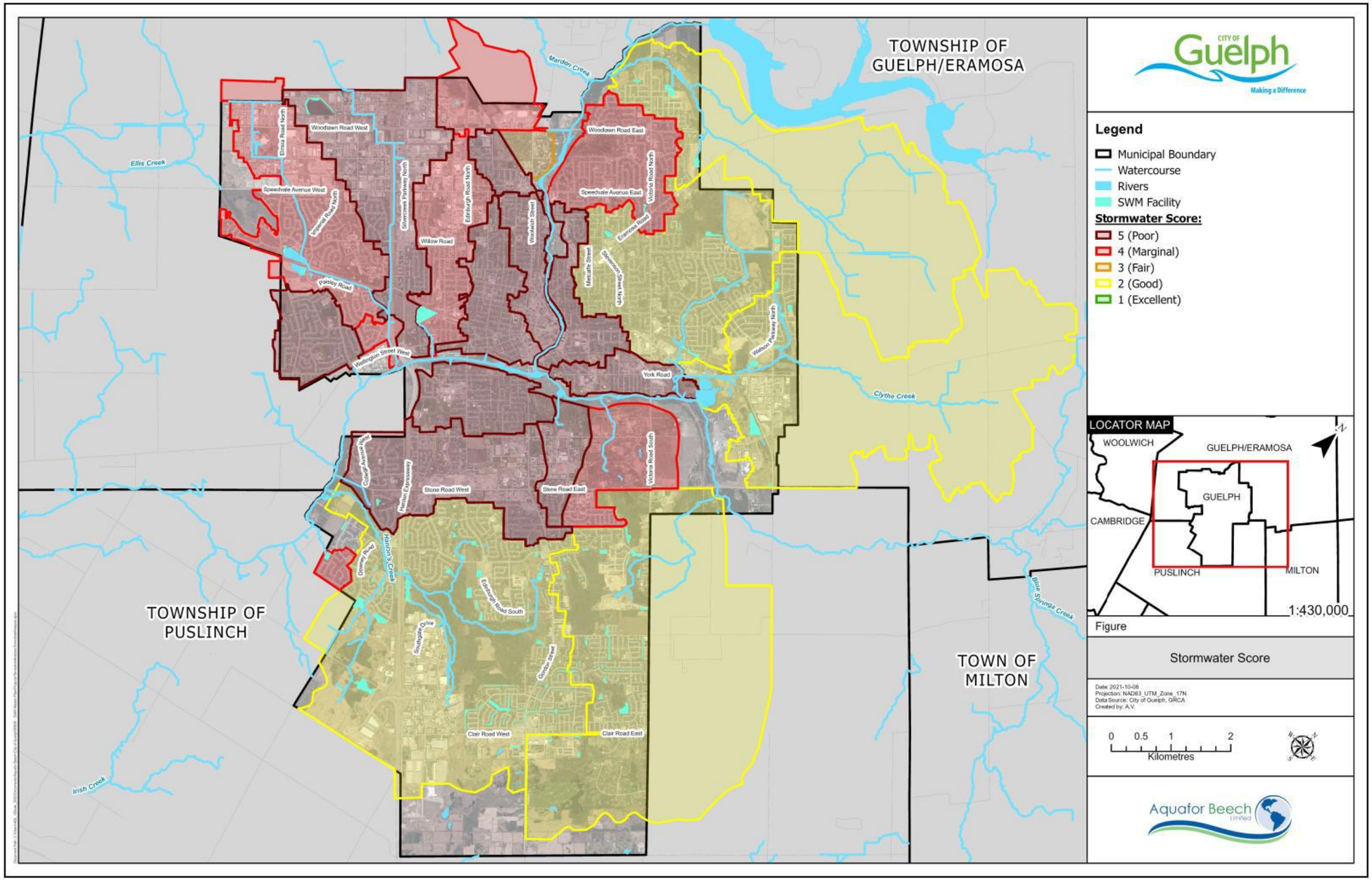

Figure 4.1: Subwatershed Stormwater Management Score

5 Erosion Condition

Channels with natural substrate and sediment deposition patterns minimally influenced by urbanization are also an indication of good stream health. As catchments urbanize, changes to the fluvial system may include excessive bank erosion and channel deepening caused by an increased frequency and intensity of flows above the erosive threshold. Urbanization may also encroach on valley lands, leading engineers to constrict the lateral migration of the channel with concrete, armourstone or other hard surfaces.

5.1 Erosion Site Inventory and Assessment

As part of the Watercourse Condition Assessment completed for the City of Guelph Stormwater Management Master Plan, Aquafor staff conducted a comprehensive erosion inventory and watercourse assessment. Watercourses that were identified during the initial background review were walked and visually assessed over the period of June-September 2020. Of the estimated 90km of watercourses measured from the City's GIS mapping database, about 75km was walked continuously. The balance of the watercourses were assessed by walking in and out from road crossings, were not accessible due to private property restrictions, or were not visually located in the field as per the referenced mapping information in the Watercourse Condition Assessment technical memos.

Erosion sites were identified as locations with erosional issues that pose risk to surrounding infrastructure or public health that would require intervention to be mitigated. Furthermore, erosion sites were in some cases also identified as having an impact on the larger reach-scale health of the stream system. Erosion sites were visually identified in the field and locations were recorded on maps. To standardize the erosion and risk, and environmental opportunity during the field assessments, a semi-quantitative technical scoring methodology was developed in consultation with City of Guelph staff as well as the Grand River Conservation Authority (GRCA). Each erosion site was given a score out of 100, with larger scores representing sites with high levels of erosion risk and/or higher degrees of environmental opportunity. **Table 5.1** summarizes the technical scoring approach including the evaluation criteria of each scoring component. The erosion risk component included an erosion index of 35% (distance, extent, stress, and erodibility) and a public health and safety index of 35% (type of risk). The environmental opportunity component included opportunities to enhance riparian cover (15%) and opportunities to enhance aquatic habitat (15%). The total score out of 100 provides a semi quantitative measure of risk and opportunity to guide subsequent decisions regarding stream restoration opportunities within the SWM-MP.

During the field walks Aquafor staff also identified Maintenance Sites and Management Issues. Maintenance sites were identified as localized erosion, deposition, structural failures or disrepairs, or flow obstructions. The maintenance sites differ from the erosion sites in that the effects of the maintenance sites were very localized and/or associated with city infrastructure included within regular operations and maintenance responsibilities. Management Issues were identified throughout the field walks. These issues did not fit consistently into the erosion inventory or maintenance site frameworks, but were identified as issues the City should be aware of for consideration in the integrated stormwater and watercourse management plans. Examples of management issues include, but are not limited to, fish barriers and hydraulic "pinch-points", and noxious weeds (e.g. Giant Hogweed). Aquafor staff reviewed and identified specific Maintenance Sites and Management Issues that were applicable (i.e. relating to erosion) to be integrated into the Erosion Assessment portion of the Subwatershed Health Analysis. These included instances of minor localized erosion or sediment deposition. In order to remain consistent, the scoring methodology used for the Erosion Sites was applied to the selected Maintenance Sites and Management Issues, but was weighted 50% lower due to the lesser and localized impact

compared to the Erosion sites, which indicated a broader issue requiring intervention to mitigate risk (see **Table 5.1**).

Table 5.1: Erosion Site Assessment Evaluation Criteria

Erosion & Risk Component							
Erosion Index							
Parameter	Definition	Evaluation Criteria					
Distance	Distance from top of bank to resource type	Small Tributaries (~ 2-15m wide)	Speed and Eramosa (~ 30m wide)	Rating			
		In channel	In channel	15			
		0 – 2 m	0 – 5 m	12			
		2 – 5 m	5 – 10 m	10			
		5 – 10 m	10 – 20 m	5			
		10 – 20 m	20 – 40 m	2			
		>20 m	>40 m	0			
Extent	The spatial area encompassed by the erosion site	Site Length	Slope Height				
			<1 m	1 – 2 m	2 – 5 m	5 – 10 m	>10 m
		<10 m	2	3	4	5	6
		10 – 20 m	3	4	5	6	7
		20 – 50 m	4	5	6	7	8
		50 – 100 m	5	6	7	8	9
		10 – 20 m	6	7	8	9	10
Stress	Stream energy and flow regime	Stream Energy	Flow Regime				
			Flashy (urban)	Transitional	Undeveloped (rural)		
		High	5	4	3		
		Moderate	4	3	2		
		Low	3	2	1		
Erodibility	Physical characteristics of bank materials	High, sand/silt	5				
		Sandy Bed	4				
		Moderate, gravel	3				
		Coarse gravel, cobble	2				
		Low, cobble, boulders, rip-rap	1				
Public Health and Safety							
Type of Risk	Identified the type of infrastructure that was closest to the Erosion Site	Critical Infrastructure (buildings, major dams, water/gas main, major roads, sanitary sewer/stormwater infrastructure, other buried utilities)	35				
		Minor Roads and Bridges; Mult-use Trails (Type 1)	30				
		Private Property (and Crossings)	25				
		Secondary Infrastructure (public parking lot, minor dams/weirs, active park land and trails (Type 2-4))	15				
		Open Park Space (inactive); Type 5 trails	5				
		Total Erosion and Risk Component Score	/70				

Environmental Component					
Riparian Cover					
Riparian Buffer	Evaluation of the quality of the surrounding riparian cover	Highest sensitivity to disturbance (i.e. endangered species)			0
		High Quality (i.e. dense, mature, native)			5
		Moderate Quality			10
		Low Quality (i.e. no buffer)			15
Aquatic Habitat					
Existing Aquatic Habitat	General evaluation of the thermal regime of the system and evaluation of the quality of the channel bed to provide suitable habitat for fish or invertebrates	Thermal Regime/Fisheries Sensitivities	High Quality Habitat (i.e. riffle/pool, natural substrates)	Moderate Quality Habitat	Low Quality Habitat (i.e. engineered channel)
		Coldwater/Intolerant fish community	1	3	5
		Mixed/Moderately tolerant fish community	5	8	10
		Warmwater/Tolerant	10	13	15
Total Environment Component Score					/30

5.2 Scoring of Erosion Condition

An overall erosion evaluation score was calculated for each subwatershed by summing the Erosion and Maintenance/Management issue scores. Each score was reclassified to a score between one (1) and five (5) using natural breaks in the data. A score of one (1) given to a subwatershed indicates that there is no evidence of erosion or sedimentation beyond what can be expected within a natural system. A score of five (5) given to a subwatershed indicates excessive erosion resulting in channel widening to the extent that property or infrastructure is at risk of failure. Encroachment, erosion or sedimentation that are not visibly resulting in immediate risk to property or infrastructure will fall between one (1) and two (2) depending on severity. Scoring for this metric is presented in **Table 5.2,** while **Table 5.3** provides a summary of erosion condition scores for each subwatershed, which is illustrated in **Figure 5.1**.

Table 5.2: Erosion Condition Scoring System

Evaluation Score	Description
1	No significant erosion issues (Erosion score = 0)
2	Low natural erosion rates and/or minor erosion issues (Erosion score >0 – 78.99)
3	Moderate natural erosion rates and/or moderate erosion issues (Erosion score 79 – 125.99)
4	High natural erosion rates and/or major erosion issues (Erosion score 126 – 192.99)
5	Excessive natural erosion rates and/or critical erosion issues (Erosion score > 193)

Table 5.3: Erosion Condition Score by Subwatershed

Subwatershed	Erosion Score	Erosion Condition Ranking	Erosion Condition Score
Arboretum Tributary	0	Excellent	1
Clythe Creek	109	Fair	3
Cutten Tributary	69	Good	2
Eramosa Urban Catchment 1	0	Excellent	1
Hadati Creek	291	Poor	5
Hanlon Creek	165	Marginal	4
Imperial Drain	0	Excellent	1
Kortright Hills Tributary	0	Excellent	1
Northern Tributary	0	Excellent	1
Northwest Drain	0	Excellent	1
Riverside Drain	0	Excellent	1
Silver Creek	193	Marginal	4
Speed Urban Catchment 7	79	Good	2
Torrance Creek	126	Fair	3
Willow West Drain	304.5	Poor	5
Woodland Glen Tributary	79	Good	2

Because there is a strong correlation between the other subwatershed metrics indicating subwatershed urbanization and erosion condition, the average subwatershed metric score was used for subwatersheds were there are no erosion condition data. This was preferable to neutral scores which would result in clustering of overall subwatershed health scores. The seven (7) subwatersheds that lack erosion condition data are:

- Bailey Drain
- Speed Urban Catchment 1
- Speed Urban Catchment 2
- Speed Urban Catchment 3
- Speed Urban Catchment 4
- Speed Urban Catchment 5
- Speed Urban Catchment 6

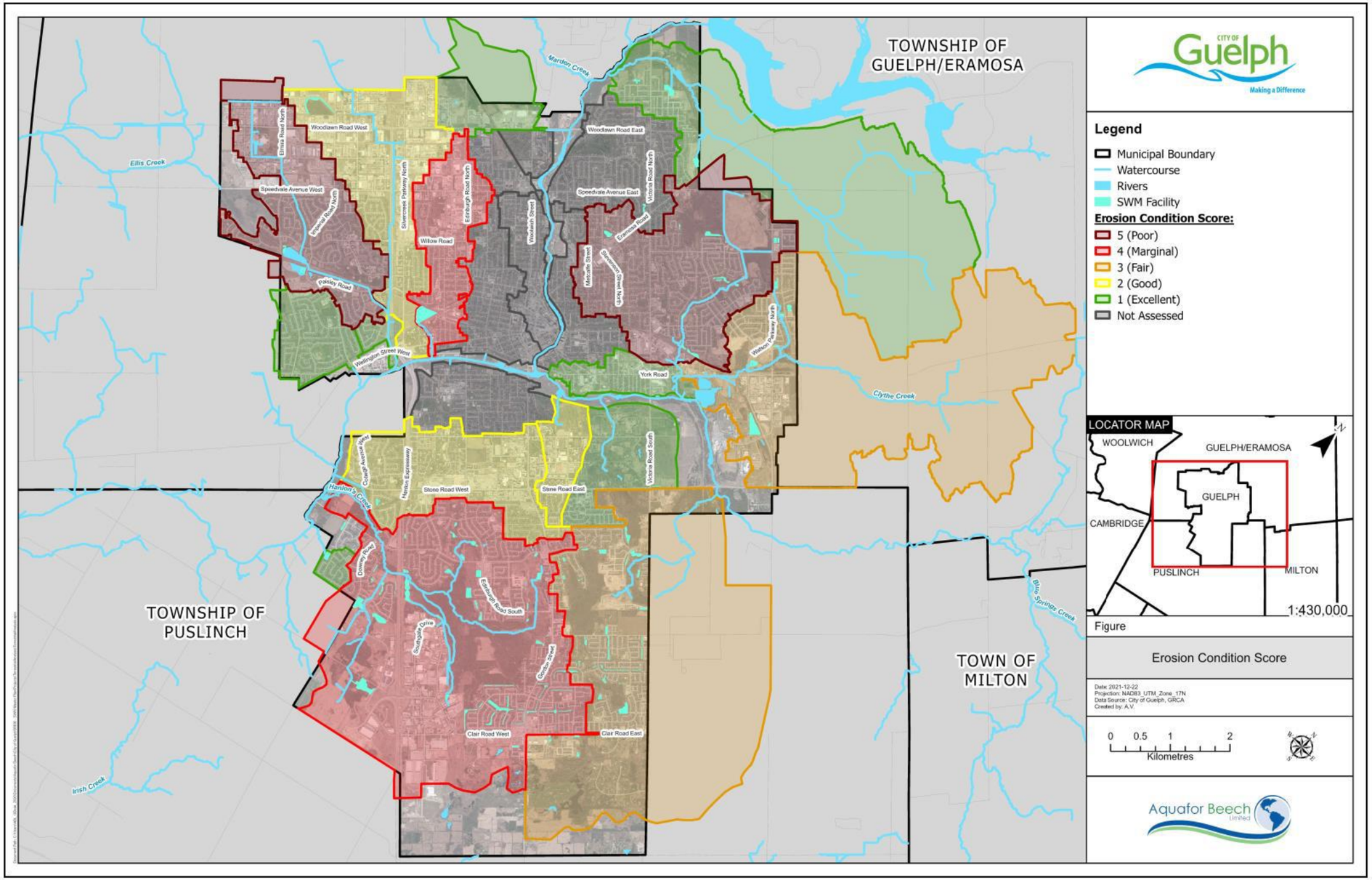

Figure 5.1: Subwatershed Erosion Condition Score

6 Subwatershed Scores

Existing conditions subwatershed scores were calculated by adding evaluation scores for each of the subwatershed health metrics:

1. Terrestrial Subwatershed Health
2. Aquatic Ecology
3. Stormwater Management
4. Erosion Condition

A maximum score of five (5) was achievable for each of the subwatershed health metrics. The maximum total subwatershed score achievable, indicting the worst possible existing conditions for any subwatershed was 20. The minimum score achievable, indicting the best possible existing conditions for any subwatershed was 4. The scoring was established for comparative purposes to enable prioritization of projects, as discussed in **Section 7**.

Upon evaluating the existing conditions subwatershed scores, the Speed Urban Catchment 6 subwatershed was determined to have the highest score, indicating the worst subwatershed conditions in the City. The existing conditions subwatershed scores of 19.56 resulted from scores of 4.67 (Poor) or higher in all evaluation categories where data was available.

The Northern Tributary subwatershed was determined to have the lowest score, indicating the best subwatershed conditions in the City. Within this creek, the existing conditions subwatershed score of 7.41 resulted from scores between 1.0 (excellent) and 3.0 (fair) in all metrics.

On average, subwatersheds within the City of Guelph received an existing conditions subwatershed score of 14.21. Individual evaluation scores and overall existing conditions subwatershed scores are shown for each subwatershed in **Table 7.2,** while **Figure 7.1** shows this scoring graphically**.**

7 Subwatershed Prioritization

Existing conditions subwatershed scores are used to establish a hierarchy of prioritization for the City to initiate subwatershed improvement projects. Four (4) levels of subwatershed priority were established, with thresholds delineated based on natural breaks in the data (**Table 7.1**). **Figure 7.2** geographically shows the distribution of priority subwatersheds across the City.

Table 7.1: Subwatershed Prioritization

Priority Level	Subwatershed Score
Priority 1	>18
Priority 2	>13–18
Priority 3	>10–13
Priority 1	≤10

Priority levels will be applied to help determine the order of implementation for projects identified as a part of the SWM-MP. For example, in a scenario where there are two equivalent projects in a Priority 1 and Priority 4 subwatershed, the project in the Priority 1 subwatershed will be implemented before the one in Priority 4.

Those subwatersheds with scores greater than 18 are classified as **Priority 1 Subwatersheds**. In order to improve the environmental conditions in these subwatersheds, municipal stormwater projects should receive high priority. The five Priority 1 subwatersheds are:

- Speed Urban Catchment 6 (Score = 19.56)
- Bailey Drain (Score = 19.33)
- Speed Urban Catchment 2 (Score = 19.33)
- Speed Urban Catchment 1 (Score = 18.83)
- Willow West Drain (Score = 18.58)
- Speed Urban Catchment 5 (Score = 18.33)

Those subwatersheds with scores greater than 13 and less than or equal to 18 are classified as **Priority 2 Subwatersheds**. In order to improve the environmental conditions in these subwatersheds, municipal stormwater projects should receive moderate priority. The seven Priority 2 subwatersheds are:

- Speed Urban Catchment 3 (Score = 17.67)
- Silver Creek (Score = 16.89)
- Woodland Glen Tributary (Score = 15.5)
- Speed Urban Catchment 7 (Score = 15)
- Cutten Tributary (Score = 14.89)
- Speed Urban Catchment 4 (Score = 14.67)
- Kortright Hills Tributary (Score = 13.67)

Those subwatersheds with scores greater than 10 but less than or equal to 13 are classified as **Priority 3 Subwatersheds**. In order to improve the environmental conditions in these subwatersheds, municipal stormwater projects should receive low priority. The six Priority 3 subwatersheds are:

- Hadati Creek (Score = 12.83)
- Northwest Drain (Score = 12.67)
- Imperial Drain (Score = 12.56)
- Eramosa Urban Catchment 1 (Score = 12.50)
- Arboretum Tributary (Score = 11.25)
- Torrance Creek (Score = 10.75)

Those subwatersheds with scores less than or equal to 10 are classified as **Priority 4 Subwatersheds**. These subwatersheds are the closest to natural environmental conditions of the subwatersheds in the City of Guelph. In order to sustain the environmental conditions in these subwatersheds, development and intensification should focus on providing sufficient buffers and maintaining the natural hydrologic cycle. The five Priority 4 subwatersheds are:

- Hanlon Creek (Score = 9.67)
- Riverside Drain (Score = 9.33)
- Clythe Creek (Score = 8.83)
- Northern Tributary (Score = 8.42)

Table 7.2: Evaluation of Existing Conditions Priority Rating

Subwatershed	Terrestrial Score	Stormwater Score	Erosion Condition Score	Aquatic Ecology Score	Total Score	Existing Conditions Priority Rating
Arboretum Tributary	2.25	4.00	1.00	4.00	11.25	3
Bailey Drain	5.00	4.67	Insufficient Data (4.84)	Insufficient Data (4.84)	19.33	1
Clythe Creek	2.50	2.33	3.00	1.00	8.83	4
Cutten Tributary	4.50	4.67	2.00	Insufficient Data (3.72)	14.89	2
Eramosa Urban Catchment 1	3.50	5.00	1.00	3.00	12.50	3
Hadati Creek	2.50	2.33	5.00	3.00	12.83	3
Hanlon Creek	2.00	1.67	4.00	2.00	9.67	4
Imperial Drain	3.75	4.67	1.00	Insufficient Data (3.14)	12.56	3
Kortright Hills Tributary	4.00	3.67	1.00	5.00	13.67	2
Northern Tributary	1.75	1.67	1.00	4.00	8.42	4
Northwest Drain	4.00	3.67	1.00	4.00	12.67	3
Riverside Drain	2.00	4.00	1.00	Insufficient Data (2.33)	9.33	4
Silver Creek	5.00	3.67	4.00	Insufficient Data (4.22)	16.89	2
Speed Urban Catchment 1	4.75	4.67	Insufficient Data (4.71)	Insufficient Data (4.71)	18.83	1
Speed Urban Catchment 2	5.00	4.67	Insufficient Data (4.84)	Insufficient Data (4.84)	19.33	1
Speed Urban Catchment 3	4.50	4.33	Insufficient Data (4.42)	Insufficient Data (4.42)	17.67	2
Speed Urban Catchment 4	4.00	3.33	Insufficient Data (3.67)	Insufficient Data (3.67)	14.67	2
Speed Urban Catchment 5	4.50	4.67	Insufficient Data (4.59)	Insufficient Data (4.59)	18.33	1
Speed Urban Catchment 6	5.00	4.67	Insufficient Data (4.89)	5.00	19.56	1
Speed Urban Catchment 7	4.00	5.00	2.00	4.00	15.00	2
Torrance Creek	1.75	2.00	3.00	4.00	10.75	3
Willow West Drain	4.25	4.33	5.00	5.00	18.58	1
Woodland Glen Tributary	4.50	5.00	2.00	4.00	15.50	2

Cells shaded orange indicate insufficient data to determine Stream Health Score or Aquatic Ecology Score. In these instances, averages of scoring categories with sufficient data were used as a surrogate to avoid skewing the data. Averages used are provided in brackets.

Figure 7.1: Evaluation of Existing Conditions Priority Rating

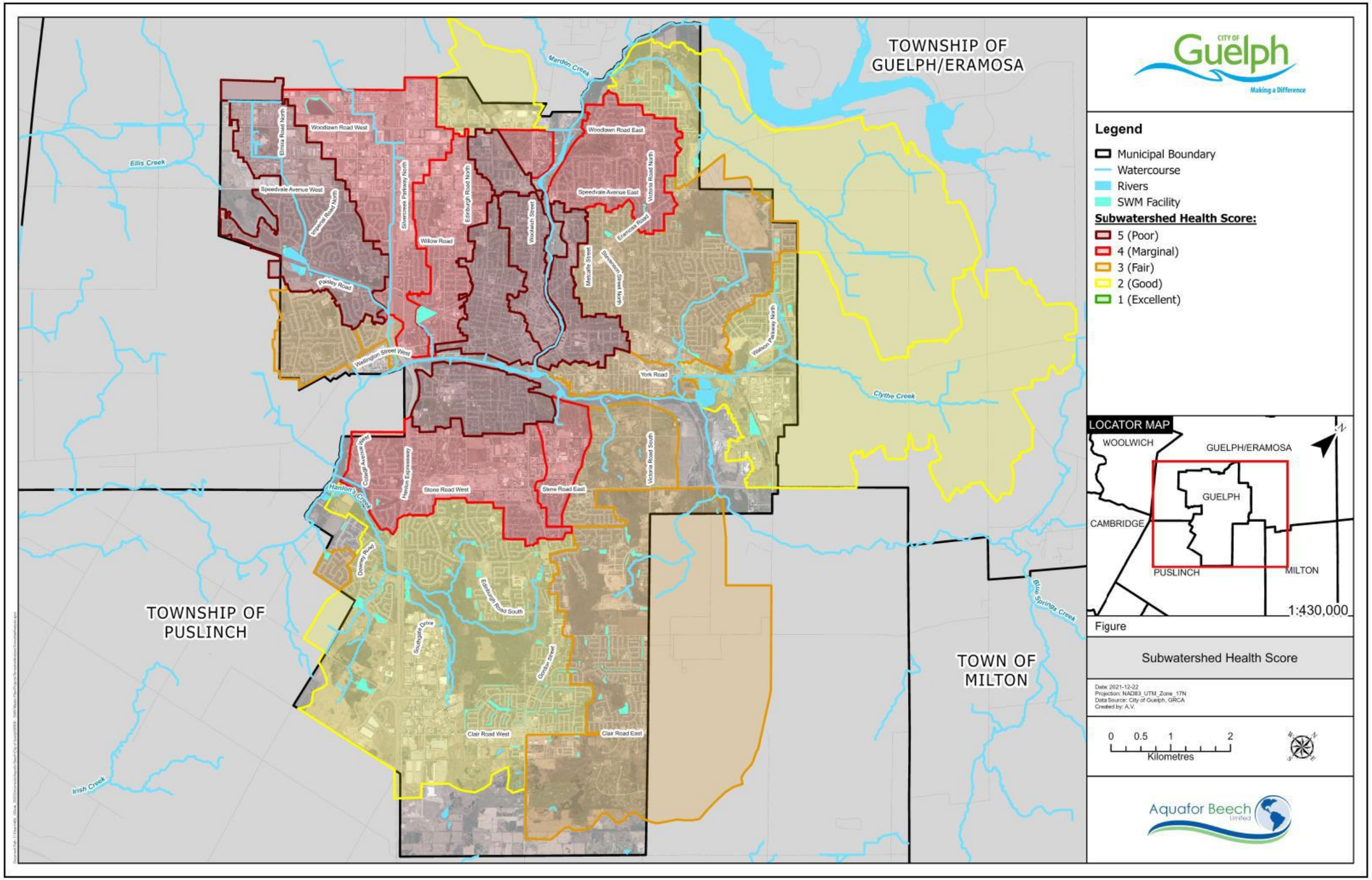

Figure 7.2: Existing Conditions Subwatershed Health Score

8 Conclusions and Next Steps

The Subwatershed Health Analysis identified five Priority 1 subwatersheds, seven Priority 2 subwatersheds, six Priority 3 subwatersheds, and five Priority 4 subwatersheds. The highest priority subwatersheds are centred around the older neighbourhoods which drain to the Speed and Eramosa Rivers. The results of this analysis will be used during the development of the Implementation Plan to help prioritize projects and programs and ultimately improve subwatershed conditions. Some small parcels within the City were not grouped into the subwatersheds; projects and programs within these parcels can be considered on an as-needed basis.

Several data gaps were identified within this assessment, as some monitoring information was not available for some subwatersheds. To address these data gaps, it is recommended that:

- The City develop and initiate a program in two (2) phases:

  Phase 1 – Local monitoring program to fill data gaps, as outlined below. The existing stormwater monitoring program can be expanded to support SWM-MP outcomes and the data gaps identified. Additionally, the City will be completing City-wide monitoring through Natural Heritage Action Plan, which can also help to support these data gaps. Subwatershed studies can also provide an opportunity to collect this kind of in-depth information.

Subwatershed	Aquatic Ecology	Erosion Condition
Bailey Drain	Y	Y
Cutten Tributary	Y	
Speed Urban Catchment 1	Y	Y
Speed Urban Catchment 2	Y	Y
Speed Urban Catchment 3	Y	Y
Speed Urban Catchment 4	Y	Y
Speed Urban Catchment 5	Y	Y
Speed Urban Catchment 6		Y
Imperial Drain	Y	
Riverside Drain	Y	
Silver Creek	Y	

  Phase 2 – A comprehensive City-wide water quality and aquatic resources monitoring program, with an initial focus on the subwatersheds with missing data. This program is recommended to include flow proportionate sampling in order to develop Event Mean Concentrations (EMCs) for water quality contaminants, as well as benthic macroinvertebrate and fisheries sampling programs.

- Once the City has collected sufficient data to fill the identified gaps, that the Subwatershed Health Assessment be repeated to recategorize the subwatershed health of the various subwatersheds.

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