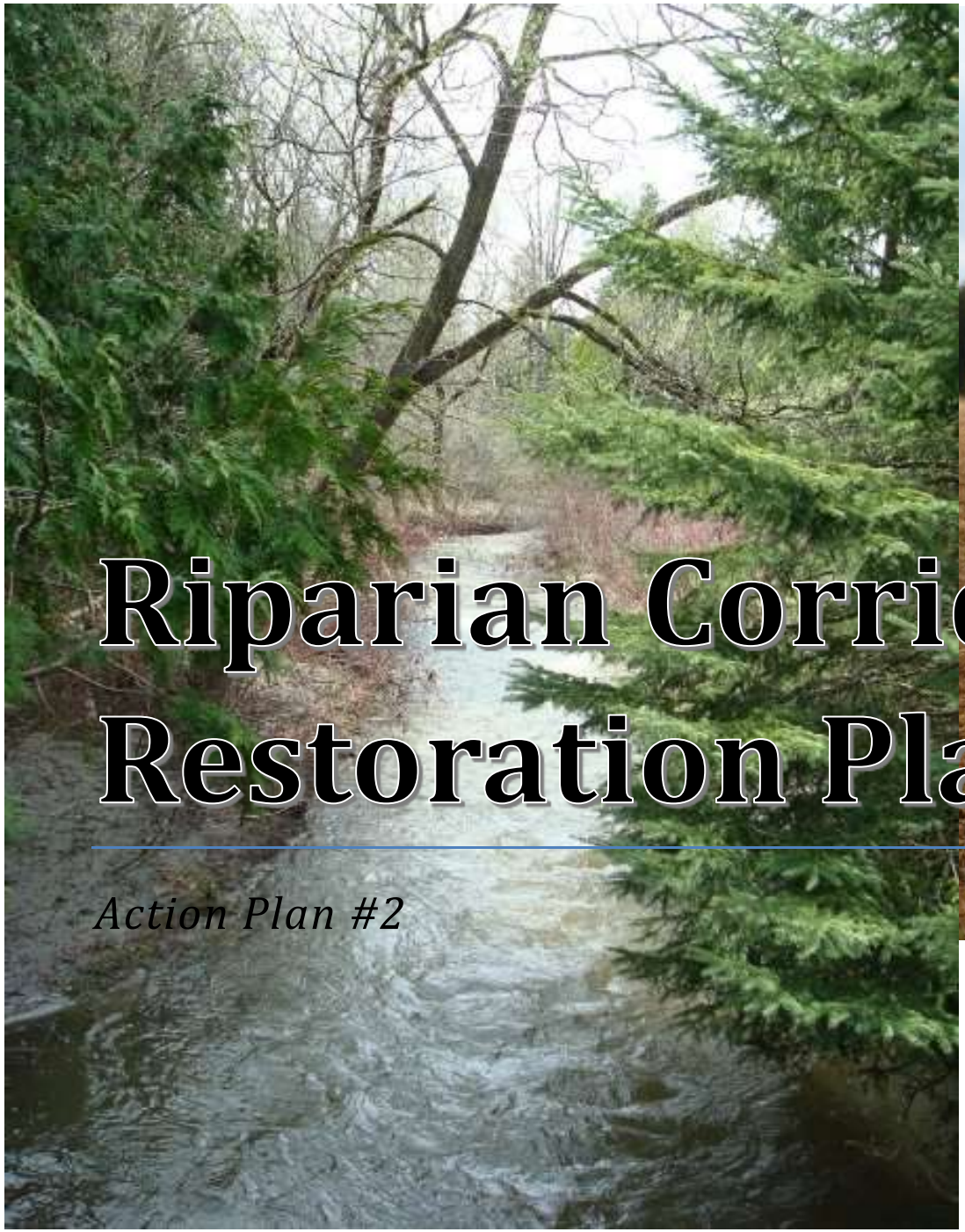

Riparian Corridors Restoration Plan

Action Plan #2

Central Lake Ontario Conservation

October 2017

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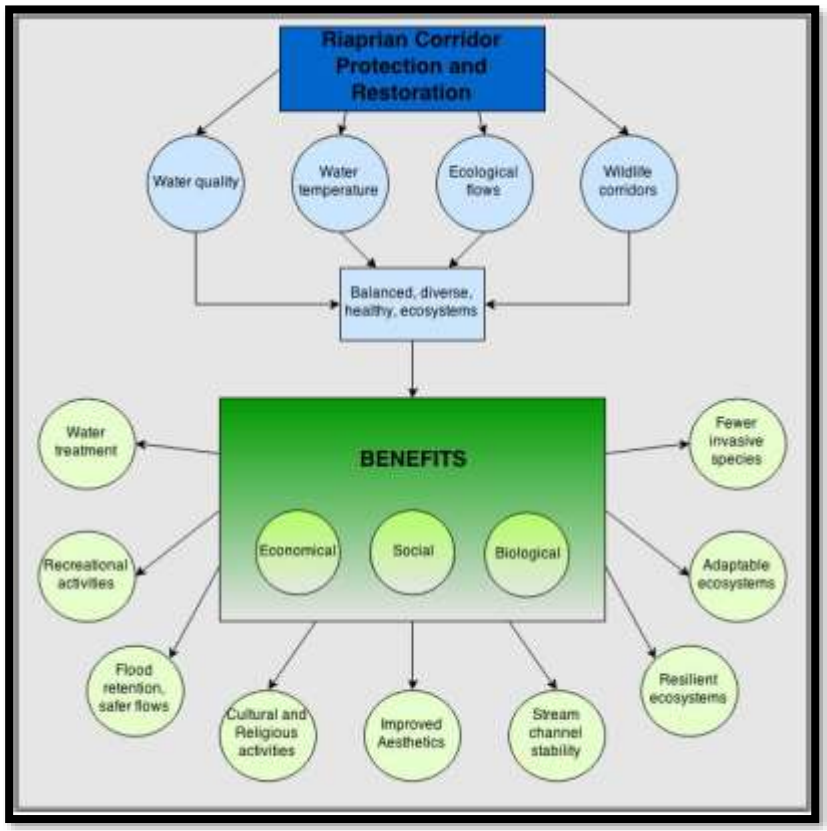
EXECUTIVE SUMMARY

Riparian corridors are vegetated areas adjacent to watercourses and these areas have numerous benefits ranging from reducing riverine hazards (flooding and erosion), mitigating climate change impacts, improving water quality, offering biologically diverse habitats, providing corridors for wildlife movement and improving people's recreational experience. CLOCA's watershed plans acknowledged these benefits, recommending that adequate riparian corridors (30m on both sides) along 75% of the watershed's stream length be a fundamental watershed health target. To support achieving this recommendation, a Riparian Corridors Restoration Plan (Watershed Action Plan #2) has been prepared. This report provides information describing the characteristics of riparian corridors, the ecological importance of these areas and offers an overview of types of restoration techniques. Each watershed has had the extent of adequate riparian corridors mapped at the watershed, subwatershed and catchment scale. The percentage of adequate riparian corridors are provided for each subwatershed within a watershed and supplemental information identifying the percentage of adequate riparian corridors by catchments has been included in the appendix. Headwaters and low order streams are critically important to a stream's ecosystem and due to their small size are extremely susceptible to land use change and land care practices. As such, additional attention was placed on measuring adequate riparian corridors along these small watercourses. For each watershed, areas where adequate riparian corridors are lacking are identified and recommendations are provided to improve riparian conditions. With the information provided in this Action Plan, CLOCA, municipalities and watershed stakeholders can work towards improving the percentage of adequate riparian corridors within our watersheds. Restoration of riparian corridors is needed in all CLOCA's watersheds. Changes over time will be monitored and evaluated by CLOCA and updated through future watershed plan work.

1. INTRODUCTION

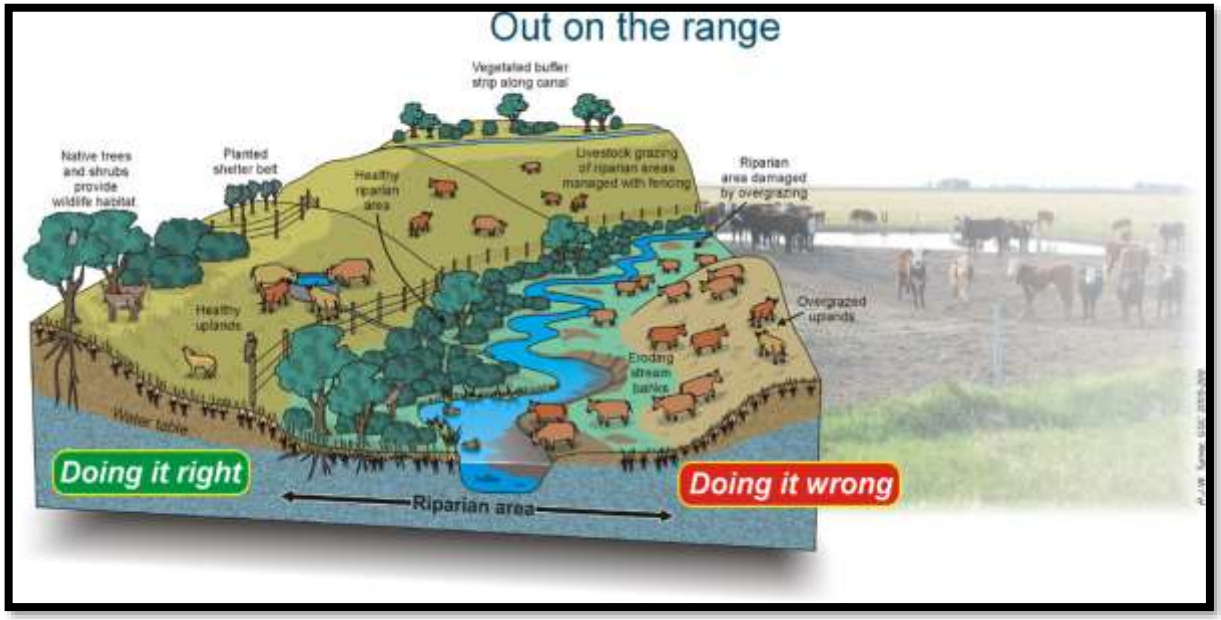
By 2031, an additional 300,000 people are anticipated to be living in Durham Region. In order to accommodate this population growth, a considerable amount of land will need to be urbanized. During the development process, protection of natural heritage features, such as, wildlife habitat, wetlands, woodlands, and riparian areas, are important in mitigating the impacts of urbanization. This action plan focuses specifically on the role of riparian vegetation and ensuring its protection and restoration.



Plants along the edges of rivers, wetlands, and ponds are referred to as riparian vegetation, and a riparian corridor is the area of transition between the terrestrial and aquatic ecosystems. These areas are typically species rich, providing feeding, nesting, shelter opportunities, and movement corridors for wildlife. In addition, a well vegetated riparian corridor provides important ecosystem functions, including improving and maintaining water quality, water temperature, in-stream sediment levels, channel structure, fish habitat and diversity. Exactly how much vegetation is necessary to provide these functions can be difficult to define, but recommendations are provided from Environment Canada and Climate Change which CLOCA refers to for guidance.

To better understand how vegetated riparian corridors improve and support healthy streams, a simple understanding of the structure of vegetation is needed. Riparian vegetation is not just the visible foliage, but includes the dense network of roots in the soil which prevents erosion by giving the ground strength, stabilizing valley walls and stream banks. This, in combination with the visible vegetation, absorbs and filters water and slows surface water flow into streams and creeks, preventing erosion. Without riparian vegetation, unimpeded water results in fast water flow, eliminating infiltration and eroding stream banks resulting in deposition of sediment on the stream bed smothering aquatic life. Vegetation along riparian areas also offers shade, protecting creeks from over-heating. Brook Trout, for example, are very dependent on stream temperature and are rarely found in areas without riparian

vegetation. Vegetated riparian corridors also produce leaf litter (detritus) providing aquatic insects with shelter and food sources, which in turn are a source of food for fish and other terrestrial animals. Riparian corridors also offer relief from soaring summer temperatures, provide desirable aesthetics, recreational opportunities, and help to lessen climate change impacts like flooding and drought.



Without vegetated riparian corridors, degraded environments are inevitable. Flooding potential will increase, stream slopes will destabilize, turbid water, poor water quality, and increased water temperatures, will result. Overall ecosystem health will be reduced impacting the natural system and peoples' quality of life. Ensuring long-term health and sustainability of CLOCA's watersheds needs to consider both the protection of existing riparian corridors through development and identification of impacted riparian corridors for restoration consideration.

This report was completed as a high level, desktop exercise to guide restoration, focusing efforts where the largest ecological gains could be had. This Action Plan will provide important input in the development of the Natural Heritage System Restoration Plan which will target areas most in need of restoration from a watershed ecosystem health perspective. An overview of the importance of riparian corridors from a watershed context is provided and a number of watershed–wide general riparian restoration and enhancement recommendations are identified. The sections following describe the characteristics of riparian corridors in the individual watersheds, including watershed specific riparian restoration and enhancement recommendations. Implementation of the watershed specific and general recommendations will help to achieve the healthy watershed target of 75% adequate riparian corridors.

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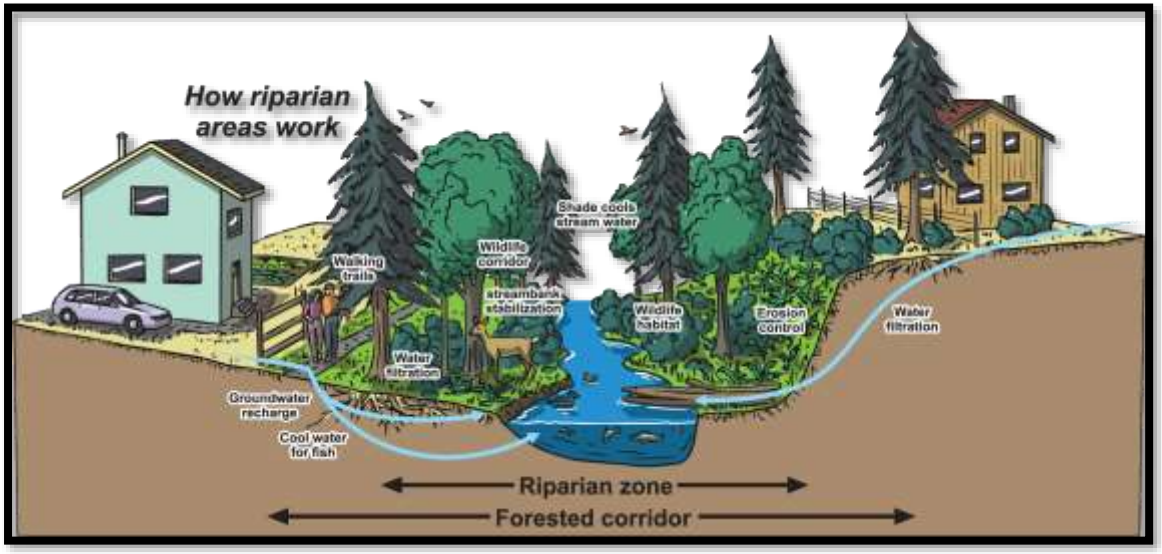
1.1 PURPOSE OF THE RIPARIAN CORRIDORS ACTION PLAN

Some areas within the CLOCA jurisdiction have riparian corridors that are not present or are not large enough to function properly. The purpose of this report is to identify, on a catchment, subwatershed, and watershed scale, where there is adequate riparian vegetation and where improvement is needed. A goal identified in each of the watershed plans is for 75% of the stream length to have adequate riparian corridors. Adequate riparian corridor is 30 meters of vegetation extending perpendicular from each side of the watercourse. Since achieving this goal will be a long-term project, this Action Plan will help prioritize areas that could provide the most benefit to watershed health through restoration. The amount of stream length having adequate riparian corridors was mapped at the watershed, subwatershed and drainage catchment scale. Including catchment areas in the mapping can direct restoration and enhancement efforts to more specific areas. Over time, new mapping will be prepared, to identify the changing riparian corridors.

1.2 CONTEXT OF THIS PLAN AND WATERSHED PLANNING



The goal of watershed planning is to provide a framework to protect, restore and enhance a healthy and resilient watershed. A Watershed Plan examines the environment and human activities within a watershed and assesses these relationships to determine how the ecosystems of the watershed should be managed to ensure that they retain their ecological integrity and health. In 2012 and 2013, Watershed Plans for CLOCA's 4 large watersheds were completed; the watershed management recommendations that were made in these Plans will, when implemented, work to achieve specific watershed goals and targets. In order to achieve these goals, CLOCA has provided a suite of tools, including 24 Action Plans, to direct and support the implementation of the Watershed Plan recommendations.

CLOCA Action Plans

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The 24 Action Plans described in the Watershed Plans work to achieve specific ecosystem health objectives, contributing to the fundamental goal of a healthy and resilient watershed. All of the Action Plans address watershed concerns, issues and actions identified during development of the Watershed Plans. These Plans will provide greater detail for achieving specific watershed goals and targets, and will provide the framework and implementation planning necessary to complete future on-the-ground monitoring, research, restoration and rehabilitation work. Some of the Action Plans are designed to be implemented at a larger scale, i.e., the CLOCA jurisdiction, while other Action Plans will be directed to specific watersheds, subwatersheds or even a site specific area. While CLOCA is taking the lead on preparing these Action Plans, the completion of some Plans will compliment, support and/or inform Regional and/or Municipal programs.

Action Plan #2 – the *Riparian Corridors Restoration Plan* identifies adequate riparian corridors and where restoration opportunities exist. The riparian corridor restoration recommendations and mapping will be incorporated into *Action Plan #1: Natural Heritage System Restoration Plan* to support achievement of a healthy and resilient watershed. This report will also inform other Action Plans, including *Action Plan #10: Stewardship and Education Priorities and Plan.*

Planning Context

The Provincial Planning Framework has focused on containing urban sprawl, in part through identification of a Provincial Greenbelt. Urbanization of lands within the Greenbelt are not permitted. The polices of the Greenbelt require a 30m vegetation protection zone to be identified and protected around watercourses including seepage areas and springs, permanent and intermittent streams and watercourses providing fish habitat. Unfortunately protection of riparian corridors are not legislated in Settlement Areas, rather development will be "generally directed away from hazardous lands" and that future growth will "support the environmental and agricultural protection and conservation objectives" of the Growth Plan (Growth Plan, 2017). Where vegetation protection zones are to be established, they are to be maintained as natural, self-sustaining vegetation (Growth Plan, 2017). These provincial policies support the principle of protecting water resources through the establishment of natural self-sustaining vegetation cover; in other words, requiring and sustaining adequate riparian corridors where appropriate.

CLOCA provides planning advice, as set out in a Memorandum of Understanding (MOU), with our partner municipalities. This MOU recognizes CLOCA's expertise in the areas of watershed management, natural heritage and natural hazard planning, and identifies CLOCA as the agency to provide advice and comments on these matters. CLOCA not only provides comments on planning applications relating to the identification, function and significance of natural heritage and hydrological features and systems, and reviews studies that assess impacts on watershed resources; advice is also provided to support the implementation of the Authority's resource management plans including Watershed Plans and Action Plans. CLOCA also reviews and comments on projects conducted in accordance with the Environmental Assessment Act, bringing local

environmental and watershed knowledge into this review and assessment process. CLOCA's involvement in both the local land use and EA review processes ensures that regard for the integrity of CLOCA's Natural Heritage System can be maintained throughout the planning process, and the information and recommendations contained within this Action Plan can be applied.

2 IDENTIFYING AND EVALUATING RIPARIAN CORRIDORS

A target identified in CLOCA's Watershed Plans is to achieve 75% of stream length having 30 meters of riparian vegetation on both sides of the creek. This target is consistent with Environment Canada and Climate Change's document "How Much Habitat is Enough" which identifies the amount of riparian vegetation required to maintain a healthy aquatic ecosystem. CLOCA's Fisheries Management Plan reports that in Lynde Creek "the effects of limited riparian cover have taken the form of increased creek temperatures, stream instability, reduced fish habitat and reduction in water quality" (FMP, 2013). Lower order streams are more heavily influenced by land use than higher order streams so it is particularly important that an emphasis be placed on restoring and enhancing riparian cover along lower order streams.

As there was no standard method available, the methodology used to calculate adequate riparian vegetation was developed by CLOCA and is contained in Appendix 2. Using this methodology, areas where there are 30m riparian vegetation on both sides of the stream are identified and mapped, leaving those areas lacking adequate riparian corridors unmapped, informing potential restoration and enhancement locations.

2.1 DEFINING THE EXTENT OF THE RIPARIAN CORRIDOR

It is important that both sides of the creek have, at a minimum, adequate naturally vegetated corridors starting at the creek's edge. One bank having good riparian cover is not enough to mitigate potential impacts on the opposite bank. This being said, if there are unavoidable restrictions on one side or the other, some riparian buffer is better than none. If the site is found to have a steep slope down to the watercourse, or if the soils are less stable and more susceptible to erosion, increasing the width of the 30 meter riparian corridor to better protect this area should be considered. On-site information can help make these decisions.

2.2 CHARACTERISTICS OF A RIPARIAN CORRIDOR

The area of the riparian corridor captures the processes and functions of the floodplain and includes the adjacent upland transition habitat. Vegetation community composition in the riparian corridor varies depending on proximity to water, soil type, and slope influencing vegetation type (meadow, shrub, or woodland). Different types of vegetation can provide different functions. For example, dense, early successional woody vegetation has been found to be effective at absorbing nutrients and ground vegetation is most effective for filtering sediments. A grassland habitat adjacent to the creek is a very different habitat than a cedar forest, providing different nutritional resources and temperature regulation,

for example. As the influence of the floodplain dissipates, the vegetation community transitions to more of an upland habitat. With larger creeks, it is not uncommon that the dominant vegetation within the floodplain will be herbaceous plants, such as, wildflowers (e.g. aster and goldenrod species) and grasses, because flooding and ice can prevent trees from establishing. For forested riparian areas, there can be variation in the composition of the forest communities with water tolerant species located closer to the watercourse, such as, Eastern White Cedar, Red Osier Dogwood, and Red Maple. Variety in vegetation communities provides a greater diversity of habitat and biodiversity increases in areas where different habitat types converge. It is this blending of habitat types that makes riparian corridors species rich.

For the purposes of this plan, CLOCA recognizes the value of many different types of natural vegetation. Therefore, regardless of whether the riparian corridors are comprised of grasses or mature trees, this natural vegetation will help to maintain ecosystem functions and is included as being adequate cover. Vegetation that is manicured, such as a park or lawn, does not provide the full suite of functions offered by natural or un-maintained vegetated riparian corridor. As such, these areas have not been included as riparian corridors and will be included as areas that may be considered for restoration and enhancement.

2.3 IMPROVING RIPARIAN AREAS

Restoring riparian areas can be a relatively easy endeavor in the right conditions and very difficult in others. Depending on the budget and time constraints of the restoration, different approaches can be taken. In the case of a small budget where time is not an issue, some areas could be left to naturalize by themselves. By simply not mowing the grass for 30 meters on both sides of the creek, grass, shrubs, and eventually trees will grow without any assistance. Costs for this approach are minimal as only monitoring of the area, to evaluate success and ensure invasive species are not taking over the site, is required. This approach can be advantageous for a landowner or business as less time and money need to be spent on maintenance. The same approach can be applied to marginal lands previously used as pasture. Preventing livestock access to the riparian area will enable trees, shrubs, forbs, and grasses to naturally colonize the area. If the desired end result is treed, and money is available, tree planting, bioengineering, and live stakes are options that speed up the naturalization process. The budget required for these jobs will vary considerably

based on site preparation, type of tree, the size of the tree at planting, the source of tree planters, and long-term maintenance, etc. Deciding on the size of tree to be planted takes some consideration. Small trees are more affordable so you can plant them in higher numbers, but they will take longer to establish and typically have a lower chance of survival. Depending on the species, they may also be more prone to browse and stress. Often planting plans will incorporate a mix of tree and shrub species which improves overall diversity. Tree planting activities planned as community events are an excellent way to share with volunteers the importance of these areas to watershed and aquatic health and can be completed at a much lower cost than formal tree planting contracts. It is important to be aware of the potential for invasive species to colonize the restoration site. Many invasive species grow and expand their range rapidly, potentially outcompeting native species. Continued monitoring to ensure limited role of invasive species is recommended.

Different Best Management Practices (BMPs) have been developed for rural and agricultural properties. The Ontario Ministry of Agriculture, Food and Rural Affairs provide farmers with practical, affordable approaches to conserving a farm's soil and water resources without sacrificing productivity. On their website, information is provided about a wide range of BMPs including two which are specific to riparian corridors: *"BMP10E: Fish and Wildlife Habitat Management*" and "*BMP19E: Streamside Grazing*". Finding a balance between the needs of the farmer and the requirements of an ecosystem can be done following these documents.

Within urban areas or areas with hard infrastructure and impervious surfaces, restoring the riparian corridor can be more challenging. When sites are redeveloped, retrofitted, or undergo site improvements, opportunities to improve riparian habitat should be considered. This can include incorporation of buffers, plantings, and green infrastructure. Every site is unique and poses different challenges. Despite this, solutions can be found that when incorporated into design and construction will help increase ecosystem function.

These are just some examples of methods to improve the conditions of riparian corridors. As mentioned, site-specific opportunities and challenges will play a significant role in the successful implementation of riparian corridor restoration. Other tools that can help to improve the percentage of naturally vegetated riparian corridors include landowner stewardship, increased public outreach to inform landowners about the benefits and opportunities associated with riparian restoration, and public land acquisition.

2.4 GENERAL RIPARIAN RESTORATION AND ENHANCEMENT RECOMMENDATIONS

The following general recommendations are to be considered on their own and/or in concert with specific watershed recommendations provided for each of CLOCA's watersheds. The fundamental goal of these recommendations is to achieve adequate riparian corridors within the watershed, meeting the 75% target. An adequate riparian corridor provides 30m natural vegetation on both sides of a watercourse.

- Protect, maintain and enhance existing riparian vegetation and riparian corridors wherever possible.
- Through development approvals and/or stewardship efforts, increase the percentage of adequate riparian corridors in the Provincial Greenbelt and the Lake Iroquois Beach physiographic unit.
- Increase the percentage of adequate riparian corridors along first order streams and adopt a "Protect the Headwaters" stewardship campaign.
- Continue to seek incorporation of policies in municipal plans and operational guidelines which: identify the importance of adequate riparian corridors; support the protection of these corridors; and pursue implementation actions which protect and/or restore riparian corridors.
- Require protection and restoration of adequate riparian corridors through planning and permitting review.
- Through a condition of development approval, redevelopment and infill projects shall at a minimum, improve existing riparian vegetation on-site and provide riparian vegetation where none currently exists.
- Local municipalities are encouraged to continue the practice of securing valleylands through development approvals to protect adequate riparian corridors.
- Bioengineering for erosion control, instream realignment and restoration projects is required.
- Management of public areas shall incorporate best management practices within riparian corridors.
- Adopt an awareness campaign within public areas focused on the adverse impacts of unsanctioned trails with an emphasis along stream banks.
- Adopt stewardship and education programs which focus on improving riparian vegetation on private property in urban and rural areas.
- Adopt a program focused on improving the quality of riparian vegetation and corridors on agricultural lands.
- Implement aquatic monitoring efforts to evaluation riparian corridor restoration efforts.

3 LYNDE CREEK

3.1 EXISTING CONDITIONS

The Lynde Creek watershed is comprised of 302 km of stream length and drains an area approximately 130 km^2. Five subwatersheds make up the Lynde Creek watershed; Lynde Main, Kinsale, Heber Down, Ashburn and Myrtle Station. To ensure stream health, Environment Canada and Climate Change sets a target of 75% of the stream length requiring a minimum 30m riparian corridors on both sides of the stream. The adequate riparian corridor target for Lynde Creek, as identified in the Watershed Plan, is consistent with Environment Canada and Climate Change's standard. All forms of natural vegetation, which refers to any vegetation not managed by people, have been digitally mapped, measured and identified to determine where adequate riparian corridors currently exist. Forests, wetlands, and grasslands are examples of natural vegetation types; manicured parklands are not included as natural vegetation. Existing adequate riparian corridors (minimum of 30 m on each side of the stream) are mapped (shown in yellow on Figure 1) and have been calculated by catchment and subwatershed. Detailed calculations on the current status of riparian corridors in Lynde Creek watershed are provided in Appendix 1.

In the eastern portion of this watershed, from the shore of Lake Ontario to Columbus Road, the landscape is dominated by urban development. Through the western half of the watershed, and areas north of Columbus Road, agriculture is currently the foremost land use. However, this is changing as growth in the Town of Whitby continues, resulting in the conversion of agricultural lands to urban land uses. The major urbanizing areas within this watershed are identified on Figure 1. If current development practices persist, urbanization could have significant negative impacts on watershed resources, including water quality, aquatic habitat, and wildlife functions. A watershed meeting the adequate riparian corridor target will help to reduce the impacts of urbanization.

Over 128km, or 42% of the Lynde Creek system, currently has adequate riparian corridors. The Lynde Main subwatershed has the highest percentage (51%) of streams with adequate riparian cover, and Kinsale subwatershed the lowest (38%). To refine restoration and enhancement opportunities, adequate riparian corridors were mapped and calculated by catchments. In Lynde Creek watershed only three catchments meet the watershed target for adequate riparian corridors and many of the catchments with limited riparian cover fall within the urban or urbanizing areas of the watershed. In those catchments where development will occur, development standards including watershed plan recommendations, Municipal Official Plans, and Provincial Plans will see that adequate riparian

Percentage of Stream Length having Adequate Riparian Corridors in Lynde Creek Subwatersheds

Subwatershed	Stream %
Ashburn	46%
Heber Down	40%
Kinsale	38%
Lynde Main	51%
Myrtle Station	44%
Total	**42%**

corridors will be protected through development approvals. However, for those catchments within the Greenbelt, the Oak Ridges Moraine, and the Lake Iroquois Beach, opportunities to achieve gains in adequate riparian corridors through development approvals will be limited. Improving and protecting riparian corridors in these areas will need to be achieved through other programs such as landowner stewardship and beneficial land care practices.

Small streams, otherwise referred to as low order or headwater streams, are integral to stream health. Despite their small size, the positive effects these tributaries have on a downstream watercourse is considerable. Often originating in groundwater discharge areas, these tributaries are important for maintaining downstream water supply, quality, and water temperature. When properly vegetated, first order streams are important for collecting organic matter and providing nutrients that support downstream aquatic habitat. However, because they are small, they are more susceptible to habitat degradation from land use, land care practices and environmental impacts, particularly when riparian cover is lacking. The contribution of these tributaries to the overall system heightens the importance of protecting/restoring riparian cover along lower order streams. Targeting restoration on first order streams will provide additional stream protection supporting downstream habitat, water quality, water flow, and improving overall watershed health. In the Lynde Creek watershed, 1st order streams comprise a considerable proportion (41%) of the stream length but only 33% of these streams have adequate riparian cover. A concerted effort to restore riparian corridors along 1st order streams would bring this watershed closer to achieving the 75% target, providing significant downstream ecological benefits.

Length of 1st Order Streams Lacking Adequate Riparian Corridors in Lynde Creek Subwatersheds

Subwatershed	Stream length (km)
Ashburn	10
Heber Down	34
Kinsale	14
Lynde Main	9
Myrtle Station	15
Total	**82**

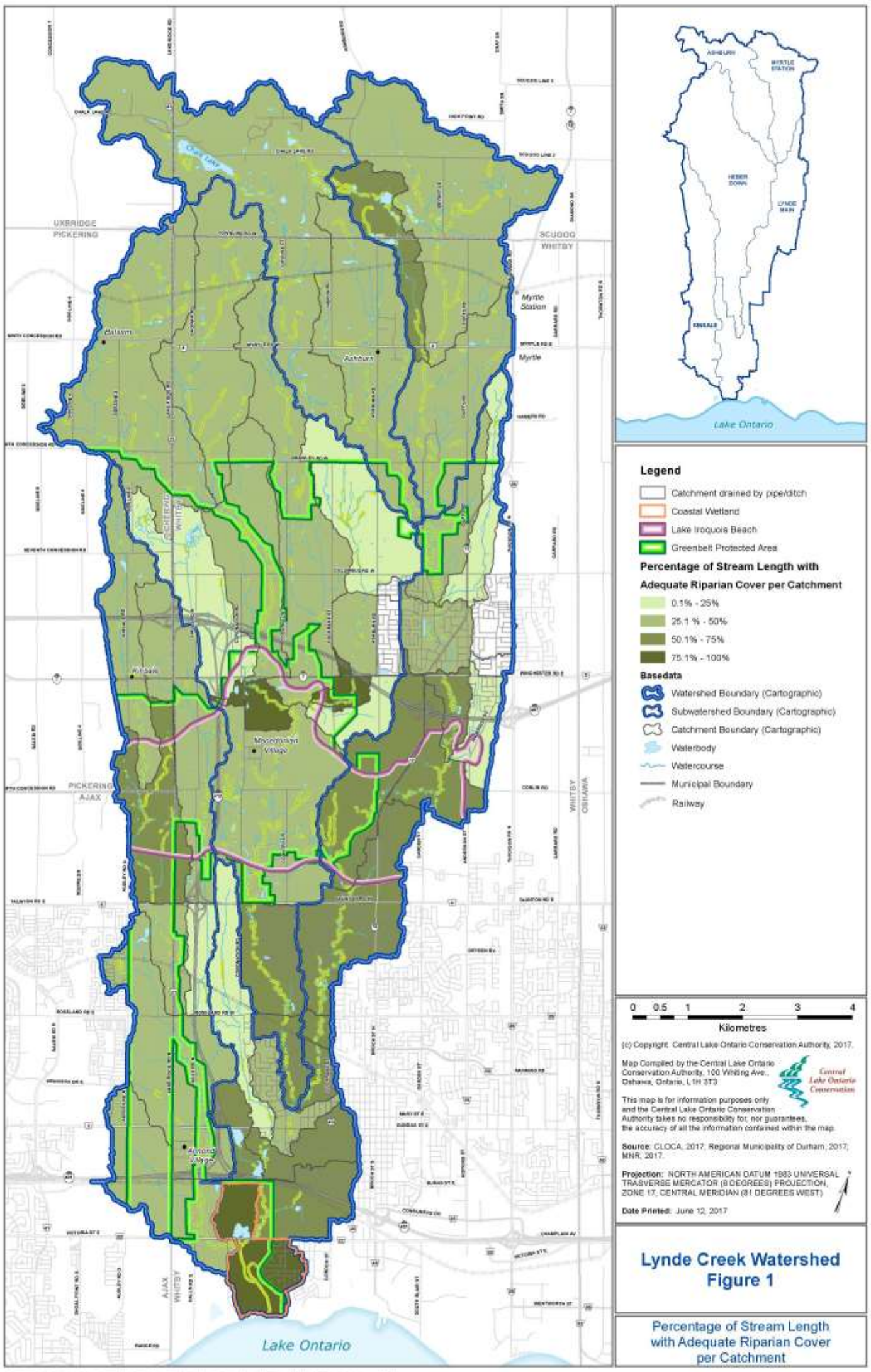
3.2 RECOMMENDATIONS AND IMPLEMENTATION OPPORTUNITIES

Improving riparian vegetation benefits water quality, fish and invertebrate community health, diversity within the watershed, provides opportunities for wildlife movement, reduces risks associated with flooding and erosion, helps mitigate the impacts of climate change and offers people with natural areas they can visit. General recommendations that are applicable throughout the CLOCA jurisdiction are found in Section 2.4 of this report. Below are recommendations specific to the Lynde Creek watershed that, when implemented, will work towards achieving the watershed target of 75% adequate riparian corridors. Implementation of these general recommendations in concert with the watershed specific recommendations below will improve watershed health. Further review, including site inspections, will be required to inform restoration activities on site specific recommendations (e.g appropriate plant species and vegetation densities), invasive species best management practices, and monitoring plans.

3.2 Lynde Creek Riparian Restoration and Enhancement Recommendations

With reference to Figure 1, these recommendations provide specific suggestions which work towards achieving adequate riparian corridors within the Lynde Creek watershed. It is recommended that the reader and implementer also refer to the "General Riparian Restoration and Enhancement Recommendations" provided in Section 2.4 when considering riparian restoration projects. An adequate riparian corridor provides 30m natural vegetation on both sides of a watercourse.

- Through review and approval of planning and permitting applications, CLOCA will work with local municipalities and development proponents to ensure that adequate riparian corridors are attained, that planting plans are implemented, and that satisfactory monitoring programs are conducted post-planting.
- All opportunities to improve riparian vegetation and corridors in urban areas should be realized including requiring (through conditions of development approval) redevelopment and infill projects to improve existing riparian vegetation on-site and provide riparian vegetation where none currently exists.
- To help offset impacts due to downstream urbanization, riparian corridors within those catchments in the Provincial Greenbelt and, in particular, along the watercourses north of Brawley Road in the north-east quadrant of the Lynde Main Subwatershed, shall be improved.
- Increase the percentage of adequate riparian corridors along first order streams and adopt a "Protect the Headwaters" stewardship campaign.
- CLOCA will continue to work to enhance and restore existing riparian vegetation and corridors in Conservation Areas including: restoration of the riparian corridor south of Springbank Trail adjacent to the picnic shelter area in Heber Down Conservation Area, and improve the riparian corridor in Audley Conservation Area.
- CLOCA will continue to work in partnership with the Region of Durham and local municipalities to achieve on their landholdings, wherever possible, adequate riparian corridors.
- Encourage golf course operators to improve and enhance riparian areas within their golf courses.



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4 OSHAWA CREEK

4.1 EXISTING CONDITIONS

The Oshawa Creek Watershed drains an area of approximately 120 km^2. Eight subwatersheds make up the Oshawa Creek Watershed being; Enfield Branch, Windfield Branch, Kedron Branch, Raglan Branch, Goodman Creek, Oshawa Main Branch, Montgomery Creek, and the Harbour Branch. To ensure stream health, Environment Canada and Climate Change sets a target of 75% of the stream length requiring a minimum 30m riparian corridors on both sides of the stream. The adequate riparian corridor target set for Oshawa Creek, as identified in the Watershed Plan, is consistent with Environment Canada and Climate Change's standard. All forms of natural vegetation, which refers to any vegetation not managed by people, have been digitally mapped, measured and identified to determine where adequate riparian corridors currently exist. Forests, wetlands, and grasslands are examples of natural vegetation types; manicured parklands are not included as natural vegetation. Existing adequate riparian corridors (minimum of 30 m on each side of the stream) are mapped and have been calculated by catchment and subwatershed (Figure 2). Detailed calculations on the current status of riparian corridors in Oshawa Creek watershed are provided in Appendix 1.

Percentage of Stream Length Having Adequate Riparian Corridors in Oshawa Creek Subwatersheds

Subwatershed	Stream %
Enfield Branch	36%
Raglan Branch	34%
Kedron Branch	31%
Windfield Branch	43%
Oshawa Main Branch	44%
Goodman Creek	35%
Montgomery Creek	66%
Harbour Branch	1%
Total	**36%**

Urbanization has been quickly moving northwards resulting in the conversion of agricultural lands to urban lands (major urbanizing areas are shown on Figure 2). Changing land use will have a significant impact on watershed resources including water quality, aquatic habitat, and wildlife functions. Adequate riparian cover is important in mitigating the impacts that come with land use change. The Oshawa Creek Watershed goal of achieving a minimum 30m riparian corridor along 75% of the system's watercourse is the target that this Action Plan is working towards achieving.

Oshawa Creek has 321 km of stream length and 36% of the system has adequate riparian cover. Six of the subwatersheds have between 31% - 44% adequate riparian corridors. To refine restoration and enhancement opportunities, adequate riparian corridors were mapped and calculated by catchments (Figure 2). Only 1 catchment meets the watershed target for adequate riparian corridors and there are 2 catchments with no adequate riparian corridors. Eight catchments located in the northern portion of the watershed have less than 25% adequate riparian corridors. Improving the percentage of riparian corridors within the upper reaches of the watershed will help to mitigate the impacts of downstream urbanization. In those catchments where growth will occur,

watershed plan recommendations, Municipal Official Plans, and Provincial Plans will see that adequate riparian corridors will be protected through development approvals. However, opportunities to protect and restore riparian corridors beyond the urban boundaries through development approvals will be limited. Programs such as landowner stewardship and the promotion of best land care practices may be the best way to protect and restore riparian corridors in the rural areas.

Length of 1st Order Streams Lacking Adequate Riparian Corridors in Oshawa Creek Subwatersheds

Subwatershed	Stream Length (km)
Enfield Branch	45
Raglan Branch	43
Kedron Branch	10
Windfield Branch	6
Oshawa Main Branch	3
Goodman Creek	3
Montgomery Creek	0.6
Harbour Branch	0.3
Total	**110.9**

Headwater or low order streams, despite their size, are integral to stream health. They are important for maintaining downstream flow, water quality, and water temperature. Riparian corridors along these streams provide organic matter and nutrients offering important contribution to downstream aquatic ecosystems. The small size of these streams makes them susceptible to land use change and habitat degradation, particularly when adequate riparian vegetation is lacking. Due to the contribution of these small streams to the overall health of the aquatic ecosystem, it is extremely important that effort be focused on restoring the riparian corridors along these watercourses. In the Oshawa Creek watershed, 1st order streams comprise 43% of stream length. Targeted restoration to these headwater systems will provide additional stream protection supporting downstream habitat, water quality, water flow, improving overall watershed health. Restoring adequate riparian along these 1st order streams would result in 70% of the watershed possessing adequate riparian corridors, as such, it is recommended that there be a concerted effort to restore riparian cover along these 1st order streams.

4.2 RECOMMENDATIONS AND IMPLEMENTATION OPPORTUNITIES

There are many ecosystem benefits which result when riparian vegetation is enhanced and restored. General recommendations that are applicable throughout the CLOCA jurisdiction are found in Section 2.4 of this report. Below are recommendations specific to the Oshawa Creek watershed that, when implemented, will work towards achieving the watershed target of 75% adequate riparian corridors. Further review, including site inspections, will be required to inform restoration activities on site specific recommendations (e.g appropriate plant species and vegetation densities), invasive species best management practices, and monitoring plans.

4.3 OSHAWA CREEK SPECIFIC RIPARIAN RESTORATION AND ENHANCEMENT RECOMMENDATIONS

With reference to Figure 2, these recommendations provide specific suggestions which work towards achieving adequate riparian corridors within the Oshawa Creek watershed. It is recommended that the reader and implementer also refer to the "General Riparian Restoration and Enhancement Recommendations" provided in Section 2.4 when considering riparian restoration projects. An adequate riparian corridor provides 30m natural vegetation on both sides of a watercourse.

- Through review and approval of planning and permitting applications, CLOCA will work with local municipalities and development proponents to ensure that adequate riparian corridors are attained, that planting plans are implemented and that satisfactory monitoring programs are conducted post-planting.
- All opportunities to improve riparian vegetation and corridors in urban areas should be realized including requiring (through conditions of development approval) redevelopment and infill projects to improve existing riparian vegetation on-site and provide riparian vegetation where none currently exists.
- Investigate the two catchments having zero adequate riparian corridors to evaluate opportunities to improve riparian cover.
- To help offset impacts due to downstream urbanization, riparian corridors within those catchments in the Provincial Greenbelt and in particular, in the catchments north of Howden Road shall be improved.
- Increase the percentage of adequate riparian corridors along first order streams and adopt a "Protect the Headwaters" stewardship campaign.
- CLOCA will continue to enhance and restore existing riparian vegetation and corridors in Conservation Areas in the Oshawa Creek watershed.
- CLOCA will continue to work in partnership with the Region of Durham and local municipalities to achieve on their landholdings, wherever possible, adequate riparian corridors. Encouraging improvement in the existing riparian cover on public lands between Adelaide Avenue and Simcoe Street South would result in significantly increasing the percentage of adequate riparian corridors in the Oshawa Main Subwatershed.
- Encourage golf course operators to improve and enhance riparian areas within their golf courses.


SCUGOG
OSHAWA
Myrtle Station
Myrtle
Enfield
OSHAWA
CLARINGTON
Mitchell's Corners
Lake Ontario
RAGLAN
ENFIELD
WHITBY
BEACH
OSHAWA MAIN
GOODMAN
MONTGOMERY
HARBOUR
Lake Ontario
Legend
Adequate Riparian
No Adequate Riparian
Catchment drained by pipe/ditch
Coastal Wetland
Greenbelt Protected Area
Lake Iroquois Beach
Percentage of Stream Length with
Adequate Riparian Cover per Catchment
0.1% - 25%
25% - 50%
50% - 75%
75% - 100%
Basedata
Watershed Boundary (Cartographic)
Subwatershed Boundary (Cartographic)
Catchment Boundary (Cartographic)
Waterbody
Watercourse
Municipal Boundary
Railway
0 0.5 1 2 3 4
Kilometres
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Date Printed: June 12, 2017
Central Lake Ontario Conservation
Oshawa Creek Watershed
Figure 2
Percentage of Stream Length with Adequate Riparian Cover per Catchment

5 BLACK/HARMONY/FAREWELL CREEK

5.1 EXISTING CONDITIONS

The Black/Harmony/Farewell Creek watershed covers an area of approximately 108 km^2 and has a total stream length of 216 km. This watershed is divided into 3 primary subwatersheds: Black Creek (24 km^2), Harmony Creek (47 km^2) and Farewell Creek (36 km^2). Harmony Creek is further divided into 5 subwatersheds; Ritson, Wilson, Grandview, Taunton and Mitchell. To ensure stream health, Environment Canada and Climate Change sets a target of 75% of the stream length requiring a minimum 30m riparian corridors on both sides of the stream. The adequate riparian corridor target set for the Harmony/Black/Farewell Creek, as identified in the Watershed Plan, is consistent with Environment Canada and Climate Change's standard as well as that of Provincial Plans and local Municipal Official Plans. All forms of natural vegetation, which refers to any vegetation not managed by people, have been digitally mapped, measured and identified to determine where adequate riparian corridors currently exist. Forests, wetlands, and grasslands are examples of natural vegetation types; manicured parklands are not included as natural vegetation. Existing adequate riparian corridors (minimum of 30 m on each side of the stream) are mapped and have been calculated by catchment and subwatershed (Figure 3). Detailed calculations on the current status of riparian corridors in this watershed are provided in Appendix 1.

This watershed drains lands within the City of Oshawa and the Municipality of Clarington. The urban form and the amount of urbanization in this watershed is varied with the majority of developed lands in Oshawa. Much of the housing within the Harmony Creek subwatershed was built at a time when there was little regard for the natural systems, resulting in limited riparian cover. By contrast, the majority of the landscape within the Black and Farewell Creek subwatersheds is dominated by agriculture and natural cover. Noticeable in the middle and eastern portion of the watershed, is the physiographic landform known as the Lake Iroquois Beach. With its gravelly, sandy soils and high water table, there is more natural cover on the Beach than on surrounding lands.

Despite the low percentage of riparian cover in the Harmony Creek subwatershed (29%), the total percentage of adequate riparian corridor is influenced by the higher level of riparian cover in the Black and Farewell Creek watersheds (46% & 50%). The influence of the Lake Iroquois Beach on the amount of riparian cover in the Farewell and Black Creek watersheds is quite evident (Figure 3) as is the impact urbanization has had on the amount of riparian cover in Harmony Creek.

Percentage of Stream Length Having Adequate Riparian Corridors in Black/Harmony/Farewell Creek Subwatersheds

Subwatershed	Stream %
Ritson Branch	24%
Wilson Branch	20%
Grandview Branch	27%
Taunton Branch	33%
Mitchell Branch	35%
Harmony Creek Total	**29%**
Farewell Creek	50%
Black Creek	46%
Total	**41%**

To refine restoration and enhancement opportunities, adequate riparian corridors were also mapped and calculated by catchments. There are 7 catchments which meet the watershed target for adequate riparian corridors (more than any other CLOCA watershed), 5 of which are situated within, or partially within, the Lake Iroquois Beach. Catchments having less than 25% riparian cover are mostly located within the Harmony Creek subwatershed, almost all of which have been developed. Improving the percentage of riparian corridors in the upper reaches of the watershed will help to mitigate the impacts of downstream urban development.

Lower order streams, despite their size, are integral to stream health. They are important for maintaining downstream water supply, quality, and water temperature. Riparian corridors along these streams provide organic matter and nutrients offering important contribution to downstream aquatic ecosystems. However, the small size of these streams makes them susceptible to habitat degradation from land use, land care practices and environmental impacts, particularly when riparian cover is lacking. Due to the important contribution of these streams to the overall health of the aquatic ecosystem, it is important that focused effort be placed on restoring the riparian corridors along these watercourses. In the Black/Harmony/Farewell Creek Watershed, 50 km, of first order streams have insufficient riparian cover. Targeting restoration on first order streams will provide additional stream protection supporting downstream habitat, water quality, water flow, improving overall watershed health. Restoring adequate riparian along these streams would result in 64% of the watershed possessing adequate riparian cover, as such, it is recommended that there be a concerted effort to restore riparian cover along the 1st order streams in this watershed.

Length of 1st Order Streams Lacking Adequate Riparian Corridors in Black/Harmony/Farewell Creek Subwatersheds

Subwatershed	Stream Length (km)
Ritson Branch	4.5
Wilson Branch	1.4
Grandview Branch	6.7
Taunton Branch	3.6
Mitchell Branch	3.8
Harmony Creek Total	**20**
Farewell Creek	16.9
Black Creek	13.5
Total	**50.4**

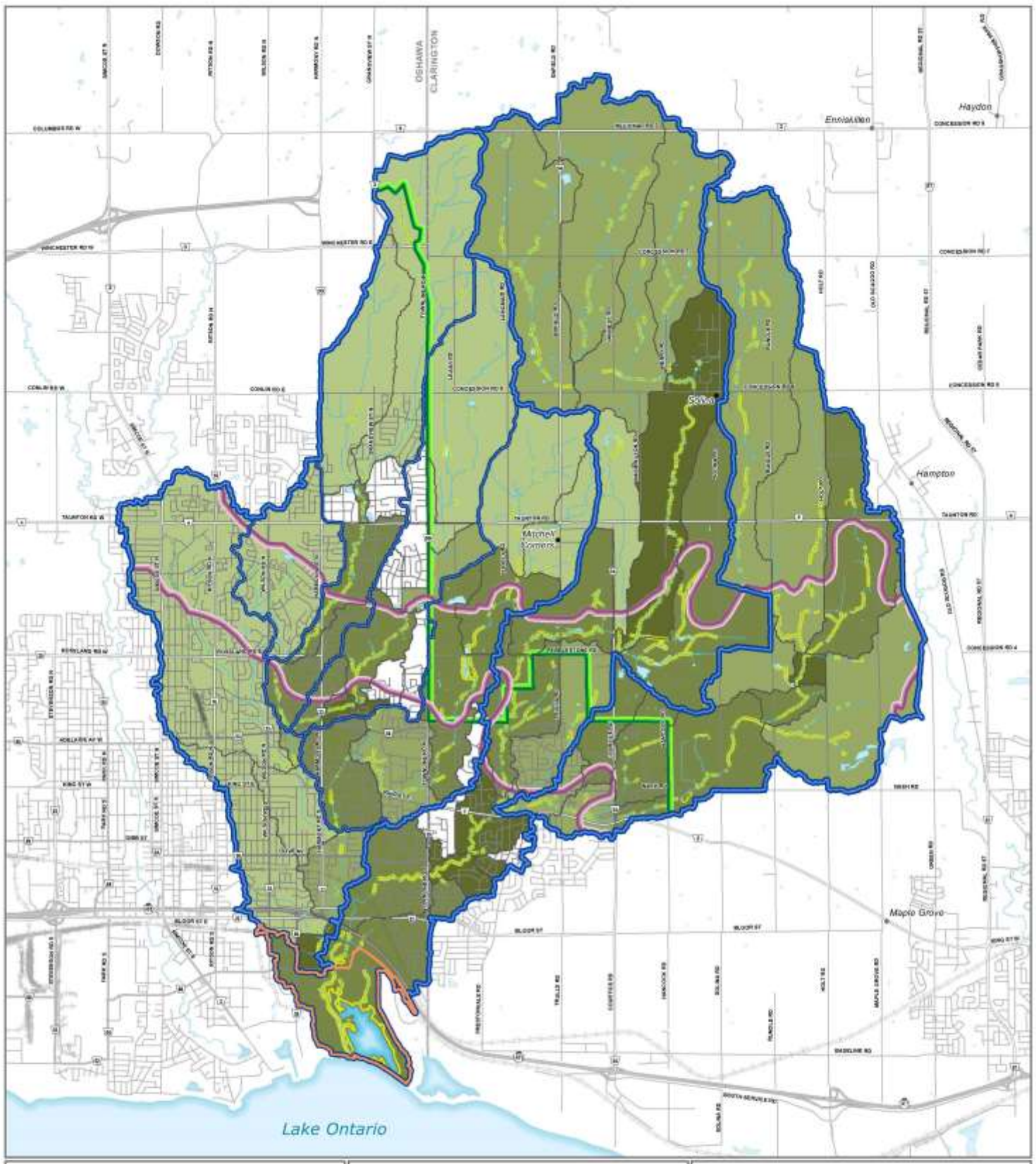
5.2 RECOMMENDATIONS AND IMPLEMENTATION OPPORTUNITIES

We know that improving riparian vegetation benefits water quality, downstream habitat and ecosystem health as well as helps mitigate the impacts of climate change. General recommendations that are applicable throughout the CLOCA jurisdiction to improve riparian corridors are found in Section 2.4 of this report. Below are recommendations specific to this watershed that when implemented in concert with the general recommendations will help to achieve the 75% watershed target. Further review, including site inspections, will be required to inform restoration activities on site specific recommendations (e.g appropriate plant species and vegetation densities), invasive species best management practices, and monitoring plans.

5.3 BLACK/HARMONY/FAREWELL CREEK RIPARIAN RESTORATION AND ENHANCEMENT RECOMMENDATIONS

With reference to Figure 3, these recommendations provide specific suggestions which work towards achieving adequate riparian corridors within the Black/Harmony/Farewell Creek watershed. It is recommended that the reader and implementer also refer to the "General Riparian Restoration and Enhancement Recommendations" provided in Section 2.4 when considering riparian restoration projects. An adequate riparian corridor provides 30m natural vegetation on both sides of a watercourse.

- Through review and approval of planning and permitting applications, CLOCA will work with local municipalities and development proponents to ensure that adequate riparian corridors are attained, that planting plans are implemented, and that satisfactory monitoring programs are conducted post-planting.
- The City of Oshawa is encouraged to continue their efforts to naturalize stream reaches through the developed portions of the watershed.
- All opportunities to improve riparian vegetation and corridors in urban areas should be realized including requiring (through conditions of development approval) redevelopment and infill projects to improve existing riparian vegetation on-site and provide riparian vegetation where none currently exists.
- To help offset downstream urbanization impacts, riparian corridors within the Provincial Greenbelt and, in particular, within the Harmony catchments located in the Greenbelt, shall be improved.
- Promote implementation of agricultural best management practices for riparian areas within the Provincial Greenbelt and in particular, in the upper reaches of the Mitchell, Taunton and Grandview subwatersheds.
- Increase the percentage of adequate riparian corridors along first order streams and adopt a "Protect the Headwaters" stewardship campaign.
- Improve riparian corridors within the Lake Iroquois Beach physiographic unit with an emphasis on catchments within the Black and Farewell Creek watersheds.
- CLOCA will continue to work in partnership with the Region of Durham and local municipalities to achieve on their landholdings, wherever possible, adequate riparian corridors.


OSHAWA
CLARINGTON
Enniskillen
Haydon
Hampton
Mitchell Corners
Maple Grove
Lake Ontario

Adequate Riparian
Catchment drained by pipe/ditch
Coastal Wetland
Lake Iroquois Beach
Greenbelt Protected Area
Percentage of Stream Length with
Adequate Riparian Cover per Catchment
0.1% - 25%
25% - 50%
51% - 75%
75% - 100%
Basedata
Watershed Boundary (Cartographic)
Subwatershed Boundary (Cartographic)
Catchment Boundary (Cartographic)
Waterbody
Watercourse
Municipal Boundary
Railway
0 0.5 1 2 3 4
Kilometres
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Date Printed: June 12, 2017
Black/Harmony/Farewell Creek Watershed
Figure 3
Percentage of Stream Length with Adequate Riparian Cover per Catchment
GRANDVIEW
FAREWELL
HARMONY
BLACK
WILSON
BITSON
TAUNTON
MITCHELL
Lake Ontario

6 BOWMANVILLE/SOPER CREEK

6.1 EXISTING CONDITIONS

The Bowmanville/Soper Creek Watershed drains an area of approximately 165 km^2 and possesses a stream length of 462 km. This watershed is comprised of two main creek systems; the Bowmanville and Soper Creeks. The Bowmanville Creek is divided into five subwatersheds and the Soper Creek has four subwatersheds. To ensure stream health, Environment Canada and Climate Change sets a target of 75% of the stream length requiring a minimum 30m riparian corridors on both sides of the stream. The adequate riparian corridor target set for Bowmanville/Soper Creek, as identified in the Watershed Plan, is consistent with Provincial Plans and local Municipal Official Plans and with the standard set established by Environment Canada and Climate Change. All forms of natural vegetation, which refers to any vegetation not managed by people, have been digitally mapped, measured and identified to determine where adequate riparian corridors currently exist. Forests, wetlands, and grasslands are examples of natural vegetation types; manicured parklands are not included as natural vegetation. Existing adequate riparian corridors (minimum of 30 m on each side of the stream) are mapped and have been calculated by catchment and subwatershed (Figure 4). Detailed calculations on the current status of riparian corridors in this watershed are provided in Appendix 1.

Percentage of Stream Length Having Adequate Riparian Corridors in Bowmanville/Soper Creek Subwatersheds

Subwatershed	Stream %
Hampton	53%
Haydon	44%
Tyrone	65%
Bowmanville Main	61%
Bowmanville Marsh	38%
Bowmanville Creek Total	**45%**
Mackie	53%
Soper North	48%
Soper Main	47%
Soper East	28%
Soper Creek Total	**45%**
Total	**49%**

The urban area of the Town of Bowmanville occupies most of the southwest portion of the watershed. The remainder of the watershed is comprised largely of agricultural land uses or natural areas. Of CLOCA's watersheds, the Bowmanville/Soper Creek Watershed has the greatest percentage of natural and forest cover (37% and 25% respectively), which is reflected in the amount of adequate riparian cover in this watershed (49%). To refine restoration and enhancement opportunities, adequate riparian corridors were mapped and calculated by catchment (Figure 4). In this watershed, there are only 2 catchments that meet the watershed target for adequate riparian corridors and there are 2 catchments that do not have any adequate riparian corridors. Many of the catchments having minimal riparian corridors are located within the built up area of Bowmanville. Due to existing land use constraints, opportunities to increase the riparian cover in these urban catchments will be challenging. Nevertheless, when improvements, no matter how small, to riparian

cover can be made, this should be a priority. Beyond the urban area, the dominant landuse in this watershed is agricultural and it is recommended that a dedicated stewardship program be implemented to encourage agricultural operations and rural landowners to adopt best management practices which protect riparian corridors.

Headwater or low order streams, despite their size, are integral to stream health. They are important for maintaining downstream flow, water quality, and water temperature. Riparian corridors along these streams provide organic matter and nutrients offering important contribution to downstream aquatic ecosystems. However, there small size makes them susceptible to habitat degradation from land use, land care practices and environmental impacts, particularly if riparian cover is lacking. Due to the contribution of these streams to the overall system, protecting/restoring riparian corridors along these streams should be emphasized. Almost 60% of the 1st order streams in this watershed lack adequate riparian cover. Restoring adequate riparian along these 1st order streams would result in 73% of the watershed possessing adequate riparian cover. As such, undertaking a concerted effort to restore riparian cover along 1st order streams would bring this watershed closer to achieving the 75% target and provide significant downstream ecological benefits.

Length of 1st Order Streams lacking Adequate Riparian Corridors in Bowmanville/Soper Creek Subwatersheds

Subwatershed	Stream Length (km)
Hampton	34
Haydon	16
Tyrone	6
Bowmanville Main	5
Bowmanville Marsh	1
Bowmanville Creek Total	**62**
Mackie	8
Soper North	16
Soper Main	20
Soper East	7
Soper Creek Total	**51**
Total	**113**

6.2 RECOMMENDATIONS AND IMPLEMENTATION OPPORTUNITIES

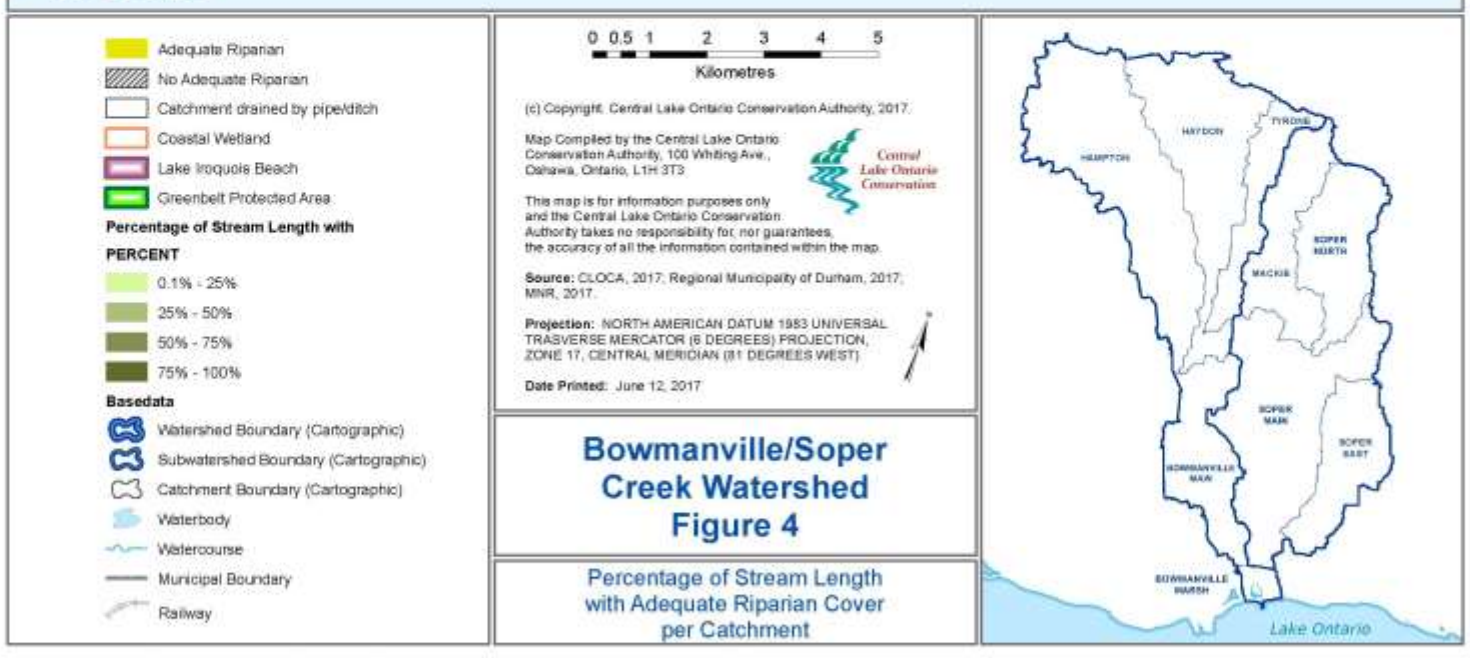
It is acknowledged that improving riparian vegetation benefits water quality, fish and invertebrate community health, diversity within the watershed, provides opportunities for wildlife movement, reduces risks associated with flooding and erosion, helps mitigate the impacts of climate change and offers people with natural areas they can visit. General recommendations to improve riparian corridors are found in Section 2.4 of this report. Below are recommendations specific to the Bowmanville/Soper Creek watershed that, when implemented, in concert with recommendations contained in Section 2.4 will work towards achieving the watershed target of 75% adequate riparian corridors. Further review, including site inspections, will be required to inform restoration activities on site specific recommendations (e.g appropriate plant species and vegetation densities), invasive species best management practices, and monitoring plans.

6.3 BOWMANVILLE/SOPER CREEK RIPARIAN RESTORATION AND ENHANCEMENT RECOMMENDATIONS

With reference to Figure 4, these recommendations provide specific suggestions which work towards achieving adequate riparian corridors in the Bowmanville/Soper Creek watershed. It is recommended that the reader and implementer also refer to the "General Riparian Restoration and Enhancement Recommendations" provided in Section 2.4 when considering riparian restoration projects. An adequate riparian corridor provides 30m natural vegetation on both sides of a watercourse.

- Through review and approval of planning and permitting applications, CLOCA will work with the Municipality of Clarington and development proponents to ensure that adequate riparian corridors are attained, that planting plans are implemented and that satisfactory monitoring programs are conducted post-planting.
- All opportunities to improve riparian vegetation and corridors in the existing urban area of Bowmanville should be realized including requiring (through conditions of development approval) redevelopment and infill projects to improve existing riparian vegetation on-site and provide riparian vegetation where none currently exists.
- Investigate the two catchments having zero adequate riparian corridors to evaluate opportunities to improve riparian cover.
- To help offset downstream urbanization impacts, riparian corridors within the Provincial Greenbelt shall be improved.
- Promote implementation of agricultural best management practices for riparian areas within the Provincial Greenbelt and in particular, in the Soper East, Haydon, Hampton, Soper North and Mackie subwatersheds.
- Increase the percentage of adequate riparian corridors along first order streams and adopt a "Protect the Headwaters" stewardship campaign.
- Improve riparian corridors within the Lake Iroquois Beach physiographic unit with an emphasis on catchments within Soper Creek watershed.
- CLOCA will continue to work to enhance and restore existing riparian vegetation and corridors in Conservation Areas in the Bowmanville/Soper Creek watershed.
- Work with Hydro One Networks INC to limit agricultural activities within 30m of watercourses and implement a native vegetation planting plan to restore riparian corridors on their landholdings.
- CLOCA will continue to work in partnership with the Region of Durham and the Municipality of Clarington to achieve on their landholdings, wherever possible, adequate riparian corridors. The riparian corridor between King Street and Baseline Road (Soper Main Subwatershed) can be significantly improved.
- Encourage golf course operators to improve and enhance riparian areas within their golf courses.


Clarke
Tyrone
Solina
Mitchell Corners
Maple Grove
Lake Ontario


Adequate Riparian
No Adequate Riparian
Catchment drained by pipe/ditch
Coastal Wetland
Lake Iroquois Beach
Greenbelt Protected Area
Percentage of Stream Length with
PERCENT
0.1% - 25%
25% - 50%
50% - 75%
75% - 100%
Basedata
Watershed Boundary (Cartographic)
Subwatershed Boundary (Cartographic)
Catchment Boundary (Cartographic)
Waterbody
Watercourse
Municipal Boundary
Railway
0 0.5 1 2 3 4 5
Kilometres
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Date Printed: June 12, 2017
Bowmanville/Soper Creek Watershed
Figure 4
Percentage of Stream Length with Adequate Riparian Cover per Catchment
HAYDON
TYRONE
HAMPTON
SOPER NORTH
MACKIE
SOPER MAIN
SOPER EAST
BOWMANVILLE MAIN
BOWMANVILLE MARSH
Lake Ontario

7 SMALL WATERSHEDS

7.1 EXISTING CONDITIONS

To ensure stream health, Environment Canada and Climate Change sets a target of 75% of the stream length requiring a minimum 30m riparian corridors on both sides of the stream. The adequate riparian corridor target set for each Small watersheds, is consistent with Provincial Plans and local Municipal Official Plans and with the standard set established by Environment Canada and Climate Change. All forms of natural vegetation, which refers to any vegetation not managed by people, have been digitally mapped, measured and identified to determine where adequate riparian corridors currently exist. Forests, wetlands, and grasslands are examples of natural vegetation types; manicured parklands are not included as natural vegetation. Existing adequate riparian corridors (minimum of 30 m on each side of the stream) are mapped and have been calculated by catchment and subwatershed (Figure 5 & 6). Detailed calculations on the current status of riparian corridors in the Small watersheds are provided in Appendix 1.

All of the Small Watersheds are located within the Regional Municipality of Durham and as they span the CLOCA jurisdiction, they have been divided into west and east (Figures 5 & 6). Seven watersheds make up the westerly small watersheds and 10 are in the east. Aptly named, the individual watershed areas drained by these small watersheds range 0.22 km^2 to 31 km^2 and stream length ranges from 0.56 km to 40 km. They all drain directly into Lake Ontario and only three are large enough that their northern reaches extend to the Lake Iroquois Beach physiographic region: Pringle Creek (West); Tooley Creek (East); and Darlington Creek (East). The Lake Iroquois Beach is a significant groundwater recharge and discharge area, and supports downstream flow and thermal regime through seeps, springs and groundwater discharge directly to streams. Three of the watersheds (Cranberry, Burk and St. Marys) do not have any discernable watercourse or stream system. Eleven of these watersheds are self-contained catchments, and 6 have more than 1 drainage catchment (Pringle, Robinson, Tooley, Darlington, Westside and Bennett). Due to their small size, these watersheds are susceptible to land use impacts. Adequate riparian corridors help offset land use impacts so it is important in these small systems that the amount of riparian cover is increased. Due to the small drainage areas of these watersheds it is recommended that riparian cover improvements along any part of the system be encouraged. It is acknowledged that for a number of reasons, such as existing urban form and land ownership; it will be difficult to achieve the 75% target in each watershed. Despite this, every effort should be extended to capitalize on all opportunities to improve riparian cover.

West Small Watersheds

For the most part, the small watersheds in the west are urbanized with the majority of the Lake Ontario shoreline being industrialized. However, the Warbler and Cranberry watersheds are not urbanized and both fall within the Provincial Greenbelt. A golf course and agricultural uses comprise much of the land area in the Warbler watershed. There is no adequate riparian corridors in the Warbler watershed and every effort should be made to improve riparian cover in this watershed. The Cranberry watershed has no discernable watercourse. CLOCA owns the majority of the lands in the Cranberry watershed and the management plan for this area identifies that natural cover will predominate.

The Pringle Creek watershed's headwaters arise from the Lake Iroquois Beach and the groundwater resources of the Beach supply this creek with cold, clean water. The contribution of headwater creeks and groundwater inputs in maintaining creek water quality and flow has previously been identified in this report. Attaining adequate riparian cover along these headwater streams helps to mitigate the impact of downstream development as well as support aquatic habitat. In the Pringle Creek watershed, the Town of Whitby has been successful in securing much of the valleylands through development approvals, but not in all instances has 30m on both sides of these creeks been acquired and protected. It is recommended that the Town continue to secure the Pringle Creek valleylands, including the headwaters, through development approvals, ensuring that adequate riparian cover is protected.

Percentage of Stream Length Having Adequate Riparian Corridors in the Small Watersheds

Watershed	Stream %
Warbler	0%
Cranberry	---
Whitby Shores	45%
Pringle Creek	42%
Heydenshore	75%
Corbett Creek	49%
Pumphouse	20%
Small Watersheds – West Total	**42%**
McLaughlin Bay	43%
Robinson Creek	49%
Tooley Creek	28%
Burk	---
Osbourne	23%
St. Marys	---
Westside Creek	25%
Bennet Creek	4%
Rickard	0%
Small Watersheds - East Total	**26%**
Total	**32%**

East Small Watersheds

The cultural landscape of the eastern Small watersheds is diverse, with the Robinson and Westside watersheds being quite urbanized, St. Mary's and Osborne watersheds influenced by industrial uses, and McLaughlin Bay's watershed dominated by a Provincial Park and industrial uses. The predominant land use in the remaining five watersheds is agriculture. Over time, these five watersheds will experience a change in land use from agricultural/rural to urban. Despite the eventual change in landcover, all opportunities to protect and improve riparian cover should be engaged. The headwaters of the Tooley and Darlington Creek watersheds arise from the Lake Iroquois Beach and these headwaters need to be protected and adequate riparian corridors attained. Unlike the Pringle Creek headwaters, it is unlikely that the headwaters of the Darlington and

Tooley watersheds will be urbanized as they are located within the Provincial Greenbelt. For this reason, it is important to implement a targeted stewardship program in these two small watersheds.

7.2 RECOMMENDATIONS AND IMPLEMENTATION OPPORTUNITIES

The small size of these watersheds and the urbanized nature of many of these watersheds will make it difficult, if not impossible to achieve the 75% riparian cover target. However, every effort to make improvements, no matter how small, will have a positive influence on water quality and natural habitat. Below are recommendations that, when implemented in concert with the general recommendations in Section 2.4, will work towards improving the percentage of adequate riparian corridors in these watersheds. Further review, including site inspections, will be required to inform restoration activities on site specific recommendations (e.g appropriate plant species and vegetation densities), invasive species best management practices, and monitoring plans.

7.3 SMALL WATERSHEDS RIPARIAN RESTORATION AND ENHANCEMENT RECOMMENDATIONS

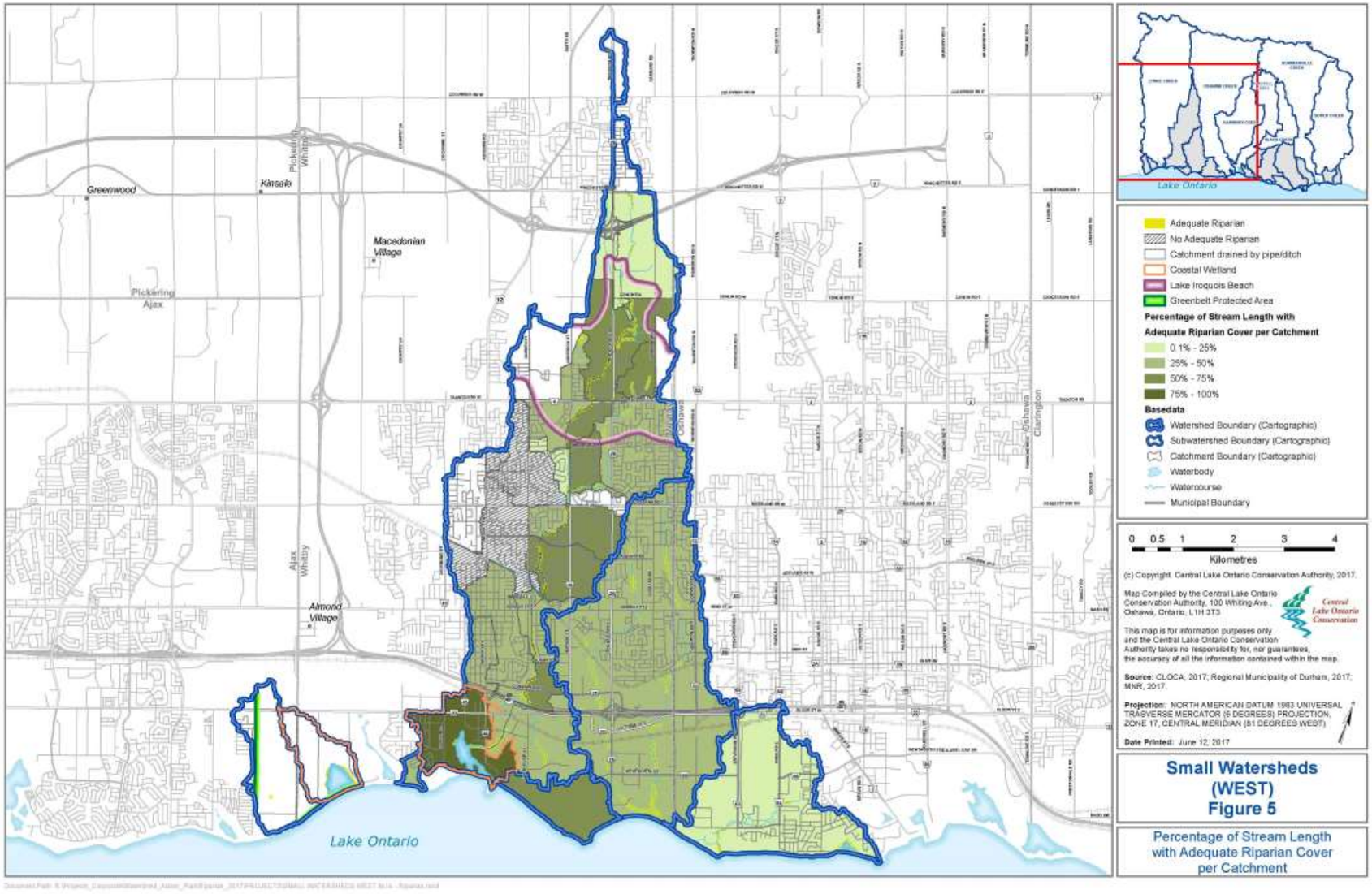
With reference to Figures 5 & 6, these recommendations provide specific suggestions which work towards achieving adequate riparian corridors in CLOCA's Small watersheds. It is recommended that the reader and implementer also refer to the "General Riparian Restoration and Enhancement Recommendations" provided in Section 2.4 when considering riparian restoration projects. An adequate riparian corridor provides 30m natural vegetation on both sides of a watercourse.

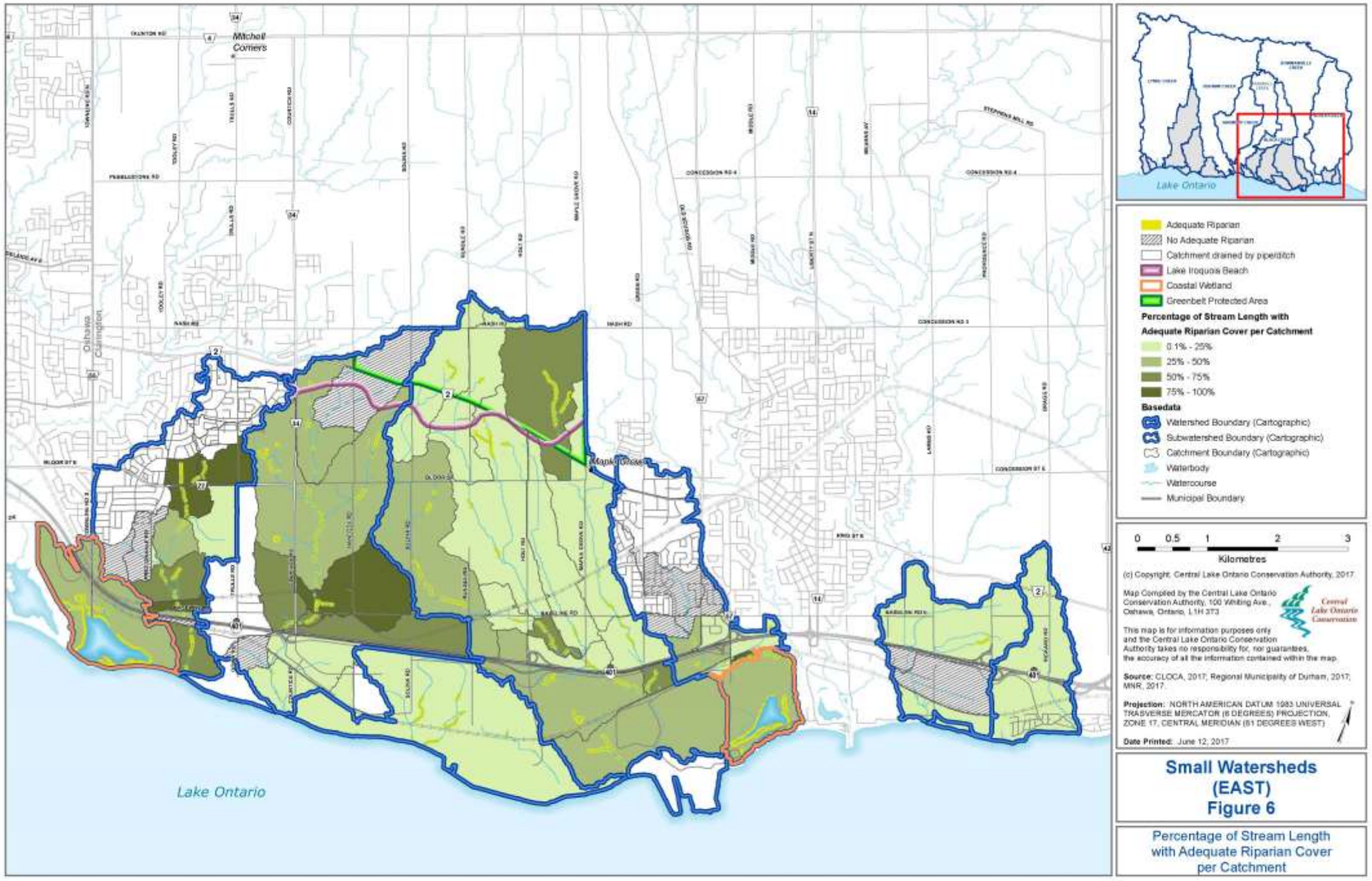
West Small Watersheds

- Through review and approval of planning and permitting applications, CLOCA will work with local municipalities and development proponents to ensure that adequate riparian corridors are attained, that planting plans are implemented and that satisfactory monitoring programs are conducted post-planting.
- All opportunities to improve riparian vegetation and corridors in urban areas should be realized including requiring (through conditions of development approval) redevelopment and infill projects to improve existing riparian vegetation on-site and provide riparian vegetation where none currently exists.
- Investigate the catchments having zero adequate riparian corridors to evaluate opportunities to improve riparian cover.
- Improve riparian corridors within the Lake Iroquois Beach physiographic unit with an emphasis on first order streams and the headwaters of Pringle Creek.
- Work with GM Canada to improve riparian cover on their landholdings in Pumphouse Watershed.
- Encourage the use of best management practices in the Warbler watershed to improve riparian cover and corridors.
- CLOCA will continue to enhance and restore existing riparian vegetation and corridors in Conservation Areas.
- CLOCA will continue to work in partnership with the Region of Durham and local municipalities to achieve on their landholdings, wherever possible, adequate riparian corridors. The riparian corridor through the Pringle Creek valley from Dundas Street south to Hwy 401 can be significantly improved.

East Small Watersheds

- Through review and approval of planning and permitting applications, CLOCA will work with local municipalities and development proponents to ensure that adequate riparian corridors are attained, that planting plans are implemented and that satisfactory monitoring programs are conducted post-planting.
- All opportunities to improve riparian vegetation and corridors in urban areas should be realized including requiring (through conditions of development approval) redevelopment and infill projects to improve existing riparian vegetation on-site and provide riparian vegetation where none currently exists.
- Investigate the catchments having zero adequate riparian corridors to evaluate opportunities to improve riparian cover.
- Improve riparian corridors within the Lake Iroquois Beach physiographic unit with an emphasis on first order streams and the headwaters of Tooley and Darlington Creeks.
- CLOCA will continue to enhance and restore riparian vegetation and corridors in Conservation Areas.
- CLOCA will continue to work in partnership with the Region of Durham and local municipalities to achieve on their landholdings, wherever possible, adequate riparian corridors.


Greenwood
Kinsale
Pickering Whitby
Macedonian Village
Pickering Ajax
Ajax Whitby
Oshawa
Oshawa Clarington
Almond Village
Lake Ontario
Lake Ontario
Adequate Riparian
No Adequate Riparian
Catchment drained by pipe/ditch
Coastal Wetland
Lake Iroquois Beach
Greenbelt Protected Area
Percentage of Stream Length with Adequate Riparian Cover per Catchment
0.1% - 25%
25% - 50%
50% - 75%
75% - 100%
Basedata
Watershed Boundary (Cartographic)
Subwatershed Boundary (Cartographic)
Catchment Boundary (Cartographic)
Waterbody
Watercourse
Municipal Boundary
0 0.5 1 2 3 4
Kilometres
(c) Copyright. Central Lake Ontario Conservation Authority, 2017.
Map Compiled by the Central Lake Ontario Conservation Authority, 100 Whiting Ave., Oshawa, Ontario, L1H 3T3
This map is for information purposes only and the Central Lake Ontario Conservation Authority takes no responsibility for, nor guarantees, the accuracy of all the information contained within the map.
Source: CLOCA, 2017; Regional Municipality of Durham, 2017; MNR, 2017.
Projection: NORTH AMERICAN DATUM 1983 UNIVERSAL TRASVERSE MERCATOR (6 DEGREES) PROJECTION, ZONE 17, CENTRAL MERIDIAN (81 DEGREES WEST)
Date Printed: June 12, 2017
Small Watersheds (WEST) Figure 5
Percentage of Stream Length with Adequate Riparian Cover per Catchment


Mitchell Corners
Oshawa
Clarington
Lake Ontario
Maple Grove
Lake Ontario
Adequate Riparian
No Adequate Riparian
Catchment drained by pipe/ditch
Lake Iroquois Beach
Coastal Wetland
Greenbelt Protected Area
Percentage of Stream Length with
Adequate Riparian Cover per Catchment
0.1% - 25%
25% - 50%
50% - 75%
75% - 100%
Basedata
Watershed Boundary (Cartographic)
Subwatershed Boundary (Cartographic)
Catchment Boundary (Cartographic)
Waterbody
Watercourse
Municipal Boundary
0 0.5 1 2 3
Kilometres
(c) Copyright: Central Lake Ontario Conservation Authority, 2017
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Source: CLOCA, 2017; Regional Municipality of Durham, 2017; MNR, 2017.
Projection: NORTH AMERICAN DATUM 1983 UNIVERSAL TRASVERSE MERCATOR (6 DEGREES) PROJECTION, ZONE 17, CENTRAL MERIDIAN (81 DEGREES WEST)
Date Printed: June 12, 2017
Small Watersheds (EAST) Figure 6
Percentage of Stream Length with Adequate Riparian Cover per Catchment

8 CONCLUSION

Riparian areas offer many important ecological and cultural benefits to watersheds. Having 75% of watershed stream length with adequate riparian corridors (30m of natural vegetation on both sides of a watercourse) is a fundamental target that CLOCA has identified to be achieved. This Action Plan documents the amount of adequate riparian corridors within all of CLOCA's watersheds, subwatersheds and catchments revealing that the percentage of adequate riparian corridors within CLOCA's 4 large watersheds ranges from 36% - 49%. In the small watersheds, a far greater range exists largely due to small watershed size, land use and watercourse length. Mapping adequate riparian corridors at the subwatershed and catchment level helped in the identification of areas where restoration efforts will have the greatest impact. A variety of tools can be used to support restoration, some of which are identified in the general and watershed specific recommendations. Acknowledging the significant contribution of headwater and low order streams to stream health, this Action Plan also quantified the percentage of adequate riparian corridors found along small watercourses. A focus on restoring riparian corridors along these small streams could result in significant gains, moving watersheds closer to attaining the targeted 75%.

Many municipal and watershed policies already exist that require protection of riparian corridors through the development review process. The implementation of stewardship and education programs which support best land management practices and vegetation plantings will also have a positive effect. Improving riparian cover will have a positive impact on the health and sustainability of CLOCA's watersheds. Achieving watershed recommendation of 75% adequate riparian corridors is not impossible, but it will be challenging and will require the support of landowners and watershed stakeholders. With the information presented in this report as a baseline, CLOCA will be monitoring the amount of adequate riparian corridors within the watersheds and reporting on changes during regular updates to CLOCA's watershed plans.

GLOSSARY

Adequate Riparian Corridor – a **Riparian Corridor** having 30 meters of natural vegetation extending perpendicular from the stream, on **both** sides of a watercourse.

Natural Vegetation (for the purposes of this report only) – vegetated area that is NOT a manicured (park or lawn).

Riparian Corridor – a linear section of natural vegetation being of undefined width, adjacent and parallel to a watercourse.

Riparian Vegetation – natural vegetation immediately adjacent to a watercourse.

REFERENCES

Environment Canada. (2013). How Much Habitat is Enough? A Framework for Building Habitat Rehabilitation in Great Lakes Areas of Concern. 3rd Edition.

Ontario Ministry of Municipal Affairs and Housing. (2016). Proposed Growth Plan for the Greater Golden Horseshoe, 2016. Queen's printer for Ontario, 114pp.

Ontario Ministry of Municipal Affairs and Housing. (2017). Greenbelt Plan, 2017. Queen's printer for Ontario, 98pp.

Central Lake Ontario Conservation Authority. (2013). Central Lake Ontario Fisheries Management Plan. 517pp.

APPENDIX 1 WATERSHED RIPARIAN CORRIDOR STATISTICS

Lynde Creek

Lynde Creek Stream Length with Adequate Riparian Corridors

Subwatershed Stream Length (km)	Total Stream Length with Adequate Riparian Corridors		Total Stream Length as 1st Order Streams		Total 1st Order Stream Length with Adequate Riparian Cover	
	km	%	km	%	km	%
Ashburn 37.4	16.7	45	16.4	43	6.0	37
Heber Down 115.5	45.7	40	50.5	43	15.9	31
Kinsale 54.6	20.9	38	18.7	35	5.2	28
Lynde Main 55.5	28.2	51	14.8	27	5.8	39
Myrtle Station 38.7	16.6	43	22.5	59	7.6	36
Total 301.7	**128.2**	**42**	**122.9**	**41**	**40.4**	**33**

Stream Length having Adequate Riparian Corridors in Lynde Creek Drainage Catchments

Percent of Stream Length with Adequate Riparian Corridors	Number of Drainage Catchments
0 - 25%	7
25 - 50%	18
50 - 75%	12
75 - 100%	3
Subtotal	40
Catchment drained by pipe/ditch	4
Total	**44**

Oshawa Creek

Oshawa Creek Stream Length with Adequate Riparian Corridors

Subwatershed Stream Length (km)	Total Stream Length with Adequate Riparian Corridors		Total Stream Length as 1st Order Streams		Total 1st Order Stream Length with Adequate Riparian Cover	
	km	%	km	%	km	%
Enfield Branch 116.9	42.5	36	56.9	49	11.5	20
Raglan Branch 118.9	40.8	34	50.6	43	8.1	16
Kedron Branch 26.7	8.2	31	11.6	44	1.6	14
Windfield Branch 23.7	10.3	43	6.8	29	1.1	16
Oshawa Main Branch 15.7	6.9	44	3.3	19	0.8	24
Goodman Creek 15.5	5.4	35	5.5	31	2.1	38
Montgomery Creek 2.9	1.9	66	1.5	50	0.9	60
Harbour Branch 0.7	0.01	1	0.3	33	0.0	0
Total 321.0	**116.0**	**36%**	**136.3**	**43%**	**26.0**	**19%**

Stream Length having Adequate Riparian Corridors in Oshawa Creek Drainage Catchments

Percent of Stream Length with Adequate Riparian Corridors	Number of Drainage Catchments
NO (0) Corridors	2
0.1 - 25%	18
25 - 50%	16
50 - 75%	15
75 - 100%	1
Subtotal	52
Catchment drained by pipe/ditch	8
Total	**60**

Black/Harmony/Farewell Creek

Black/Harmony/Farewell Creek Stream Length with Adequate Riparian Corridors

Subwatershed Stream Length (km)	Total Stream Length with Adequate Riparian Corridors		Total Stream Length as 1st Order Streams		Total 1st Order Stream Length with Adequate Riparian Cover	
	km	%	km	%	km	%
Ritson 15.8	15.8	24	5.2	31	0.7	13
Wilson 4.6	4.6	20	1.8	40	0.4	22
Grandview 28.2	28.2	27	8.0	29	1.3	16
Taunton 16.3	16.3	33	4.7	29	1.1	23
Mitchell 22.6	22.6	35	5.9	26	2.1	36
Harmony Creek – Total 87.4	**25.6**	**29**	**25.5**	**29**	**5.5**	**22**
Farewell Creek 80.3	40	50	25.9	33	9.0	35
Black Creek 47.5	22	46	19.6	42	6.1	**31**
Total 215.2	**87.6**	**41**	**71**	**33**	**20.6**	**29**

Stream Length having Adequate Riparian Corridors in Black/Harmony/Farewell Creek Drainage Catchments

Percent of Stream Length with Adequate Riparian Corridors	Number of Drainage Catchments
0 - 25%	12
25 - 50%	14
50 - 75%	21
75 - 100%	7
Subtotal	54
Catchment drained by pipe/ditch	10
Total	**64**

Bowmanville/Soper Creek

Bowmanville/Soper Creek Stream Length with Adequate Riparian Corridors

Subwatershed Stream Length (km)	Total Stream Length with Adequate Riparian Corridors		Total Stream Length as 1st Order Streams		Total 1st Order Stream Length with Adequate Riparian Cover	
	km	%	km	%	km	%
Hampton 120	63.3	53	56.7	48	23.0	41
Haydon 67.9	30.1	44	22.9	34	7.2	31
Tyrone 28.7	18.6	65	14.4	48	8.2	57
Bowmanville Main 30.6	18.6	61	10.4	32	5.6	54
Bowmanville Marsh 3.7	1.4	38	1.0	28	0.14	14
Bowmanville Creek Total 250.9	**132**	**53**	**105.5**	**42**	**44.2**	**42**
Mackie 42.4	22.6	53	15.2	36	7.5	49
Soper North 52.9	25.3	48	24.3	45	8.6	35
Soper Main 79.4	37.7	47	33.3	42	13.1	39
Soper East 36.4	10.1	28	10.1	28	3.3	33
Soper Creek Total 211.1	**95.7**	**45**	**82.9**	**39**	**32.5**	**39**
Total 462			**188.4**	**40**	**76.7**	**41**

Stream Length having Adequate Riparian Corridors in Bowmanville/Soper Creek Drainage Catchments

Percent of Stream Length with Adequate Riparian Corridors	Number of Drainage Catchments
NO (0) Corridors	2
0.1 - 25%	4
25 - 50%	15
50 - 75%	17
75 - 100%	2
Subtotal	40
Catchment drained by pipe/ditch	2
Total	**42**

Small Watersheds

Small Watershed Stream Length with Adequate Riparian Corridors

Subwatershed Stream Length (km)	Drainage Area (km2)	Total Stream Length with Adequate Riparian Corridors		Total Stream Length as 1st Order Streams		Total 1st Order Stream Length with Adequate Riparian Cover	
		km	%	km	%	km	%
Warbler 0.6	2.55	0.00	0	0.3	59	0.0	0
Cranberry ---	1.58	----	----	----	----	----	----
Whitby Shores 1.1	0.22	0.5	45	1.1	100	0.5	45
Pringle Creek 35.8	31.02	15.2	42	12.1	33	3.6	30
Heydenshore 0.8	1.67	0.6	75	0.5	58	0.4	80
Corbett Creek 18.9	14	9.2	49	5.6	31	2.7	48
Pumphouse 6.5	6.22	1.3	20	3.1	44	0.4	13
Small Watersheds – West Total 63.7	**58.14**	**26.8**	**42**	**22.7**	**35**	**7.6**	**33**
McLaughlin Bay 5.1	2.11	2.2	43	0.6	11	0.1	17
Robinson Creek 6.9	5.93	3.4	49	1.3	18	0.5	38
Tooley Creek 17.4	11.57	4.8	28	7.8	47	1.6	21
Burk ---	0.35	----	----	----	----	----	----
Osbourne 6.5	4.37	1.5	23	3.1	44	0.4	13
Darlington Creek 40.1	17.82	9.6	24	14.6	38	3.8	26
St. Marys ---	0.73	----	----	----	----	----	----
Westside Creek 9.9	5.38	2.5	25	4.2	42	1.3	31
Bennet Creek 7.3	3.21	0.3	4	2.2	32	0.0	0
Rickard 1.8	2.24	0.1	0	1.8	100	0.1	6
Small Watersheds – East Total 95	**53.73**	24.4	26	**35.6**	**38**	**7.8**	**22**
Total	**111.87**	**51.2**	**32**	**58.3**	**37**	**15.4**	**26**

Stream Length having Adequate Riparian Corridors in Small Watershed Drainage Catchments

Percent of Stream Length with Adequate Riparian Corridors	Number of Drainage Catchments
NO (0) Corridors	13
0.1 - 25%	24
25 - 50%	26
50 - 75%	17
75 - 100%	9
Subtotal	89
Catchment drained by pipe/ditch	18
Overland flow (Cranberry)	1
Total	**108**

APPENDIX 2: Determining the amount of stream length with adequate riparian corridors.

Purpose

Development impacts, if unmanaged, can place significant stress on the environment. With development continuing to expand in the CLOCA jurisdiction and an additional 300,000 people living in Durham Region by 2031, it is important to know current environmental existing conditions so that we can support and manage watershed responses to this growth. Information regarding existing conditions also enables us to identify restoration needs to achieve the healthy watershed targets identified in CLOCA's Watershed Plans.

One of the watershed targets identified in CLOCA's Watershed Plans is to achieve 75% riparian cover. This target is consistent with Environmental Canada's (EC) document "How Much Habitat is Enough" (Environment Canada, 2013) which identifies the amount of riparian habitat required to maintain a healthy aquatic system. Table 1 summarizes the riparian habitat guidelines identified in "How Much Habitat is Enough". Attaining this target is important as it plays a significant role in improving and maintaining water quality, water temperature, in-stream sediment levels, channel morphology, fish habitat and diversity, and natural system connectivity (LeBlanc et al., 1997; Jones III et al., 1999; Ebersole et al., 2001; Wang et al., 2001; Gergel et al., 2002; King et al., 2005; Moore and Palmer, 2005; Utz et al., 2010). In support of achieving this target, the Watershed Plans include the Riparian Corridors Restoration Plan and a component of this Action Plan is the development of a methodology for reporting riparian cover.

Table 1: Summary of Riparian Habitat Guidelines. Table is from the Environment Canada document "How Much Habitat Is Enough" (EC, 2013).

Parameter	Guideline
Percent of stream naturally vegetated	Seventy-five percent of stream length should be naturally vegetated.
Amount of natural vegetation adjacent to streams	Stream should have a minimum thirty meter wide naturally vegetated adjacent-lands areas on both sides, greater depending on site-specific conditions.

There has been no standard method for calculating the amount of stream length with adequate riparian cover. With the release of CLOCA's Watershed Plans which identifies healthy riparian cover targets and a monitoring requirement to effectively gauge progress in achieving watershed

targets, a methodology to calculate the amount of riparian cover along both sides of a stream was needed. Previous methodologies used at CLOCA were not designed to look at both sides of the creek when determining if riparian cover was adequate.

Scope

This riparian methodology was designed to allow comparability with the riparian habitat requirements set out in the EC (2013) document. With identification of 75% riparian cover as a watershed target we need to be able to identify current conditions to determine if adequate riparian cover is present or if more is needed. However, this tool will be used beyond simply determining our current riparian habitat status. It will help identify those areas where 30m riparian habitat on both sides of a stream is found, and often more importantly, where it is not. This will help identify areas that are in need of restoration, supporting CLOCA's Riparian Corridors Restoration Action Plan. When the riparian corridor is overlaid with other land uses (e.g. paved surfaces associated with Commercial or Industrial land use), areas that lack 30m riparian cover on both sides are identified and can be evaluated for future restoration opportunities.

The establishment of a consistent and scientifically defensible methodology will also inform and contribute too many other CLOCA programs and projects including, for example, the Natural Heritage Restoration Action Plan, the Barriers Action Plan and the Watershed Report Card assigns a health score based on the percent of stream length with riparian cover.

Methodology: Development of a GIS Method to Map CLOCA Riparian Corridor

The objective of this project was to develop a geographic information system based-methodology to map riparian corridors that can be effectively implemented at a watershed scale. For this project, the methodology for mapping riparian corridor consisted of 3 major steps: the first step was to develop a methodology for delineating a riparian corridor along single-lined streams, the second was to create riparian zone along double-lined rivers, and the third was to create a riparian buffer around the inline ponds.

All the models are date stamped and can be found in the GIS geodatabases.

The first step, delineating a riparian corridor along single lined streams consisted of:

1- Identifying and selecting drainage features that met the following criteria:
   a. Streams, ditches and agricultural drains that are identified as surface water or virtual segments and are found within the Natural Heritage System.

2- Building equal-area strips – 30m wide on each side. The strips are perpendicular to each stream segment (stream segment length specified by user). The area of each polygon is calculated and stored as a static number.
3- Clipping the strips to ELC polygons and further selecting only those strips that are fully covered by natural vegetation.

The second step, creating the riparian zone along double lined rivers consisted of:

1- Identifying and selecting drainage features that met the following criteria:
    a. Shoreline of streams, rivers and side channels
2- Creating polygons from the above selection by filling and closing gaps within the linework
3- Creating a 30m buffer around the polygons
4- Erasing the river~~s~~ polygons from the buffer
5- Creating the 'Fishnet' – a grid of vertical and a grid of horizontal strips at 10m intervals.
6- Clipping 'Vertical Fishnet' and 'Horizontal Fishnet' to the 30m buffer~~s~~
7- Selecting only the Fishnet strips that are fully covered by natural vegetation
8- The Fishnet with greater area gets selected as part of the final Riparian
9- Some manual cleanup may be necessary

The third step, creating riparian corridor around in-line ponds consisted of:

1- Identifying and selecting drainage features that met the following criteria:
    a. Shorelines of lakes and ponds that are within a Natural Heritage System.
2- Creating polygons from the selection by filling and closing gaps within the linework
3- Creating a 30m buffer around the waterbody polygons
4- Erasing the waterbody from the buffer
5- Clipping the resulting polygons to ELC polygons regardless of the amount of ELC within the buffer.

All three components were merged together to create the final CLOCA Riparian Corridor.
The entire process was developed in ESRI's Model Builder allowing end users to re-run the model for different study areas, or different scenarios.