An *ACTION* Plan for the Grand

# Grand River Water Management Action Plan

# 2014 - 2018 Summary of Accomplishments

**June 2019**

Grand River Conservation Authority

This report was prepared by the Grand River Conservation Authority on behalf of the Grand River Water Managers Working Group. The Implementation Report is the result of a collaborative water management planning process that aligns work plans, actions and activities across municipalities, provincial and federal government agencies, and First Nations to achieve a greater impact for the Grand River watershed. The collaboration and coordination of this initiative is supported by the Grand River Conservation Authority.

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# Preface

The Implementation Report is a document that catches the highlights of what actions were implemented over a specific time period. Most of the actions listed by Plan partners have either been completed or well underway to being completed. There are, however, a few actions that were not completed due to a change in priorities and new actions started, such as digital floodplain mapping, based on new funding opportunities.

Implementation reporting is part of a broader process of continuous improvement of *planning*, *doing* and *checking* to ensure the integrity and long-term sustainability of the water resources locally, regionally and across the larger Grand River watershed. By *checking* to see if we implemented the actions we said we would implement, we can be ready for the next *planning* cycle.

A companion report "*State of Water Resources"*, will be issued later in 2019. This report will enable us to check to determine whether we are achieving the goals set out by the Water Management Plan – to ensure water supplies; improve water quality; reduce flood damage potential; and to build resilience to deal with climate change.

Looking ahead, there will continue to be pressures locally, regionally and across the watershed that will challenge the integrity and sustainability of the water resources. In addition to population growth and the challenges associated with servicing the growing population, land use like agriculture and urban development will also exert pressure. A growing population will increase demand for recreation which will put more pressure on natural areas for both enjoyment and to enhance our quality of life.

These pressures can be cumulative and only will be seen once we surpass a 'tipping point' whereby the quality and health of the Grand River will start to deteriorate once again or that supplies are too difficult or too expensive to secure.

Collaborative water management in the Grand River watershed epitomizes a collective commitment among different levels of government and First Nations to manage a common resource. This is only done through working together, sharing information and strategies to achieve common goals. The ongoing success of water management can be attributed to a supportive 'backbone' agency, the GRCA that supports the collaborative effort, and the commitment of the members of the Water Managers Working Group and there representative agencies. An outcome of the original plan was to look for best value solutions to achieve desired outcomes economically.

Looking to the future, water managers must continue to collaborate, share information and work toward the goals of the Plan. We must be vigilant with managing the quality and quantity of our water resources both locally and at the watershed scale; proactively plan for future events whether they be drought or floods; and continue to work together regardless of jurisdiction as water knows no boundary.

## Water Managers Working Group

Water Managers Working Group is responsible for the Water Management Plan. By working together water is managed effectively at local, regional, watershed and provincial or binational scales.

Members of the working group are senior water/wastewater staff from various agencies including provincial and federal government, municipalities, and First Nations.

Water managers meet quarterly, discuss local, municipal, regional, or watershed issues by sharing information, working together, coordinating efforts, and collaborating. By reporting regularly on the status ***of the actions*** in the Water Management plan and the ***state of our rivers and groundwater****, collectively water managers can ensure water is managed sustainably across the watershed.*

The Grand River Conservation Authority (GRCA) coordinates and supports the implementation of the Water Management Plan on behalf of all watershed municipalities.

The following are active Plan partners or contributors to actions that improve water management in the watershed:

- Brant County
- City of Brantford
- City of Cambridge
- City of Kitchener
- City of Waterloo
- City of Guelph
- Region of Waterloo
- Haldimand County
- Township of Centre Wellington
- Township of Southgate
- Oxford County
- Dufferin County
- Ministry of Agriculture, Food and Rural Affairs
- Ministry of Environment, Conservation and Parks
- Ministry of Natural Resources and Forestry
- Six Nations of the Grand River
- Mississaugas of the New Credit
- Environment and Climate Change Canada

Members are asked to share information made available at working group meetings with their staff so that future water managers are knowledgeable about the working group and the broader watershed context that is shared at the meetings.

# Highlights

Managing water resources is a shared responsibility. Most partners – municipalities, provincial and federal government, and First Nations who endorsed the plan continue to participate in Plan implementation and attend quarterly meetings of the Water Managers working group; some municipal partners who were not active in preparing the Plan, became more active during implementation. Since water is a shared resource, the water managers working group continues to be an important mechanism to discuss water and wastewater issues, solve challenges by sharing best practices and information to manage water resources, collectively, across the watershed.

The Water Managers Working Group has maintained the momentum of the Water Management Plan and continue to meet regularly to share the status of their agency's actions to achieve the common goals of the Plan.

GRCA continues to support and facilitate the roundtable discussion and collaboration among watershed partners and provides annual reporting on the progress of the Plan.

The following are highlights of the actions that have been completed within the last five year implementation cycle of the Water Management Plan for the Grand River watershed.

### *Ensure water supply for communities, economies, and ecosystems*

- Most, but not all, municipalities have long term water supply plans
- Some municipalities have set demand management objectives and results are encouraging – they are showing a decrease in demand over time.
- The province's Water Taking Reporting System has been greatly improved as reporting has shifted from permitted to actual water takings.
- Municipal water supplies may not be '*secure'* due to changes in the approach by the regulatory authority.
- Integrated surface and ground water (Tier 3) models have improved our understanding of the reliability of water supply for municipalities as well as helped to quantify groundwater recharge
- Through active reservoir operations, reliability of meeting operational river flow targets are achieved consistently over 95% of the time which is the design standard for the reservoirs
- Local areas of water constraint include Whitemans Creek and Eramosa River however, local water plans have not been developed. However, new Tier 3 water budget models have been developed through the Source Protection Planning program for these areas which can support local water management decisions.
- A drought contingency plan (2014) and low water response continue to be tools for approaching low water conditions such as in 2016

- The Grand River Source Protection Plan continues to advance Tier III water budgets in collaboration with watershed municipalities.

*Improving water quality to improve river health and reduce the Grand's impact on Lake Erie.*

- A number of wastewater treatment plants have been upgraded and their effluent quality improved
- Improved plant performance through optimization efforts has been demonstrated at many plants in the watershed; 9 plants are achieving voluntary effluent targets for phosphorus and 16 plants are achieving voluntary effluent targets for ammonia
- Many municipalities have sewer use bylaws but only a few municipalities activity enforce them. Where they are enforced they've proven to be very effective.
- Several subwatersheds in the central region have been characterized to better inform land use planning and characterization reports were prepared for Fairchild, McKenzie, upper Grand and Conestogo subwatersheds to support local needs and wastewater assimilation studies
- A continuous nitrate monitor was installed at Bridgeport water quality station from 2013-2018 which confirmed high nitrate concentrations in the Grand River during winter months
- Between 2014 and 2018 $5.6 million in grants were provided to support 1,985 projects through the Rural Water Quality Program. Many of these projects keep an estimated 19,700 kg P on the land annually. An audit of projects implemented over the tenure of the program showed that most (96%) of structures were still in place up to 20 years later.
- Stormwater management efforts have advanced significantly in some municipalities while other municipalities are just creating dedicated funding sources for advancing their stormwater management needs
- Reducing road salt use is still the focus of active awareness programs in some municipalities while most municipalities just have road salt management plans
- An information synthesis was completed for the southern Grand River region to assist with future water management decisions
- A number of GRCA-owned dams were reviewed and assessed for priority removal.
- The Grand River Simulation Model continues to be maintained for municipal wastewater assimilation studies
- Data collection continues by all plan partners and data management systems are slowly being implemented to improve decision making and for sharing data

### *Reducing Flood Damage Potential*

- Numerous dam and dike safety studies have been completed between 2014 and 2018 to maintain the critical water management infrastructure that helps to reduce flood damages;
- Some municipalities are evaluating their minor and major secondary storm systems to determine if they are able to deal with extreme events;
- The province's acquisition of airborne topographic LiDAR in southern Ontario provides the basis for many land-water planning initiatives as well as support the development of mapping products that support flood damage reduction and emergency preparedness
- Inundation mapping has been completed for a few key flood damage centres with most recent mapping work completed for West Montrose, Grand Valley, Village of Conestogo and some specific reaches between the Irvine River and the village of Conestogo and the Conestogo River from the Grand River to Conestogo Dam.
- The acquisition of bathymetric LiDAR (detailed riverbed elevation data) was completed for the Grand, Conestogo, Irvine and Speed, rivers; Willow Brook and Moorefield creek
- Annual meetings of the Emergency Municipal Flood Coordinators and other Emergency Response have continued
- Flood warning communication technology continues to be updated when new and more efficient approaches are available i.e. automated voice notification, open web-based water data, etc.
- Provincial and watershed river flow gauge stations continue to be the data from which flood forecasting and warning are based on. These data are critical to public safety.
- Watershed conditions continue to be monitored  24 hours, 7 days a week and when warranted, Watershed conditions Statements, Flood Watch, and Flood Warning messages are issued
- Follow ups and debriefing were completed following the June 2017 and February 2018 flood events. Several debriefings were held and learnings from these floods have been incorporated into preparedness plans.
- Shoreline flood zone mapping was prepared in the fall of 2017 and an emergency preparedness exercise completed with Haldimand County staff to improve awareness and preparedness for Lake Erie surge event flooding.
- In 2018 a study was completed to investigate the February 2018 ice jam event through the City of Brantford that resulted in overtopping of the flood walls through a portion of the City. This study investigated the cause of the 2018 ice jam and ice jams in general through the Brantford reach and investigated potential mitigation options to reduce the risk of ice jams in the future.

### *Build resiliency to deal with climate change*

- Maintaining the key hydrologic processes provided by watershed features will ensure the physical resiliency of the watershed. Effort is ongoing to build the resilience in the watershed including many of the actions implemented through the Rural Water Quality Program including tree planting, stream buffer preservation, erosion control etc.
- Green infrastructure that preserves key water cycle processes like low impact development and maintaining the water balance in new developments (e.g. Blair subwatershed)
- Efforts continue to maintain *knowledge networks* among the partners in the watershed to share information and learn from one-another. This builds resilience in the people that need to deal with change, whether it be changing staff or changing conditions that require new approaches. Networks include the Community Emergency Flood Coordinators, Water Managers Working Group,
- Wastewater Managers, Source Protection Implementation Committee, Rural Water quality Advisory Committees among others
- Sewage treatment plant upgrades and waste water optimization program has help obtain the best performance from existing waste water infrastructure, this helps improve the quality of effluent and reduce impacts to the river across the full range of climate extremes
- Literature regarding climate change often cites having a plan as being one of the most important adaptive management actions to be prepared for climate change or natural variability, the water management plan and municipal emergency preparedness plans for flood fall into that categories. Municipal response plans are maturing as digital flood zone mapping is becoming available and learnings from recent floods are integrated into the warning and response plans.

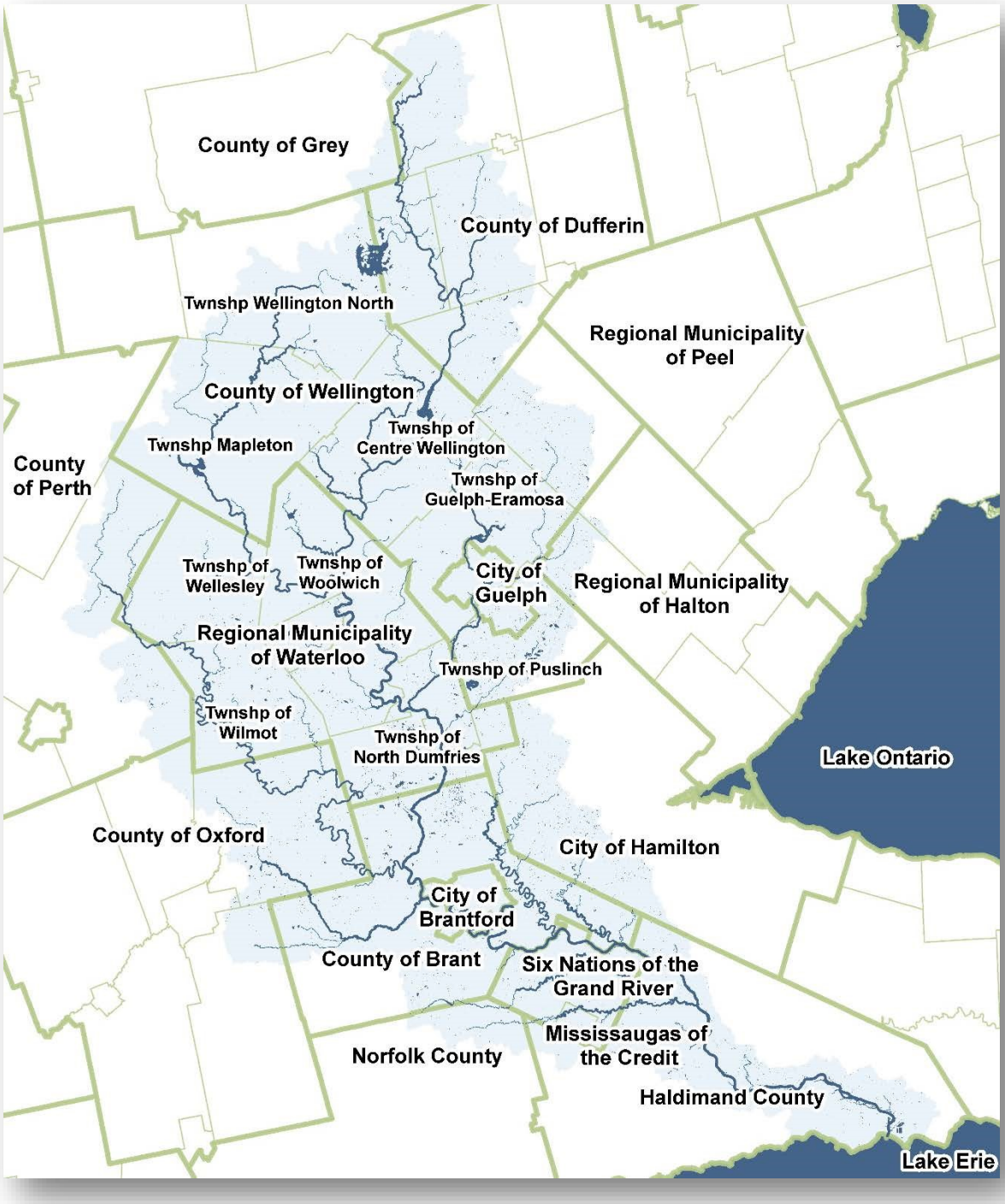


***Figure 1.*** *Southern Ontario municipalities that are connected by the Grand River and its tributaries. Area draining to the Grand River is in blue.*

# Table of Contents

# List of Figures

# Acronyms

**ATL** - Airborne Topographic LiDAR

**CoP -** Community of Practice

**ERO** – Environmental Registry of Ontario

**FDC** – Flood Damage Centre

**GRCA** – Grand River Conservation Authority

**HEC -** US Army Corps of Engineers Hydrologic Engineering Centre

**LiDAR** – Light detection and ranging

**MNRF** – Ministry of Natural Resources and Forestry

**MAFRA** – Ministry of Agriculture, Food and Rural Affairs

**MECP** – Ministry of Environment, Conservation and Parks (2018) was Ministry of

**ECCC -** Environment and Climate Change (2014-2018)

**NDMP** – National Damage Mitigation Program

**ROW** – Region of Waterloo

**RWQP** – Rural Water Quality Program

**SPP** – Source Protection Program

**WMP** – Water Management Plan

**WTRS** – Water Taking Reporting System as maintained by MECP

# Introduction

The steady trend of increasing population growth, urbanization, agricultural/rural land use changes, and the potential impacts of climate change will continue to challenge water management in the Grand River watershed. Demands on the watershed water resources for drinking water, industrial/commercial uses, agricultural needs, and the assimilation of wastewater and rural runoff. Increasing recreational pressure may also challenge the natural system. Consequently, it continues to be critical to have common goals and a Water Management Plan that can help guide the collective impact of multiple partners to achieve greater outcomes.

The Grand River Basin Water Management Plan aligned the actions of 16 partners to collectively achieve the goals of the Plan to:

- ensure water supplies for communities, economies and ecosystems;
- improve water quality and river health and reduce impact on the eastern basin of Lake Erie;
- reduce flood damage potential; and
- build resiliency to deal with climate change.

Partners of the Plan are now at a point to evaluate and adjust the path forward if needed. 2019 marks the five year implementation point within the long range planning horizon of the Water Management Plan. As per an adaptive management framework, this report summarizes the status of the 163 actions that the Partners agreed to do that were part of the Plan. A second report – the ***State of Water Resources***, will analyze and summarize water data and information to evaluate whether the goals of the Plan are being achieved.

If the actions in the Plan are not enough, then the Plan should be reviewed and updated. If the Plan continues the Partners on the path toward achieving the goals, then continued engagement and sharing of information among plan partners should continue. **Figure 2** illustrates the timeline for water management planning since 2009 the past 10 years.

The following report summarizes the status of the actions in the 2014 Plan according to the goals. The last goal – building resilience to deal with climate change was integrated into the previous three goals and will be highlighted in each section.

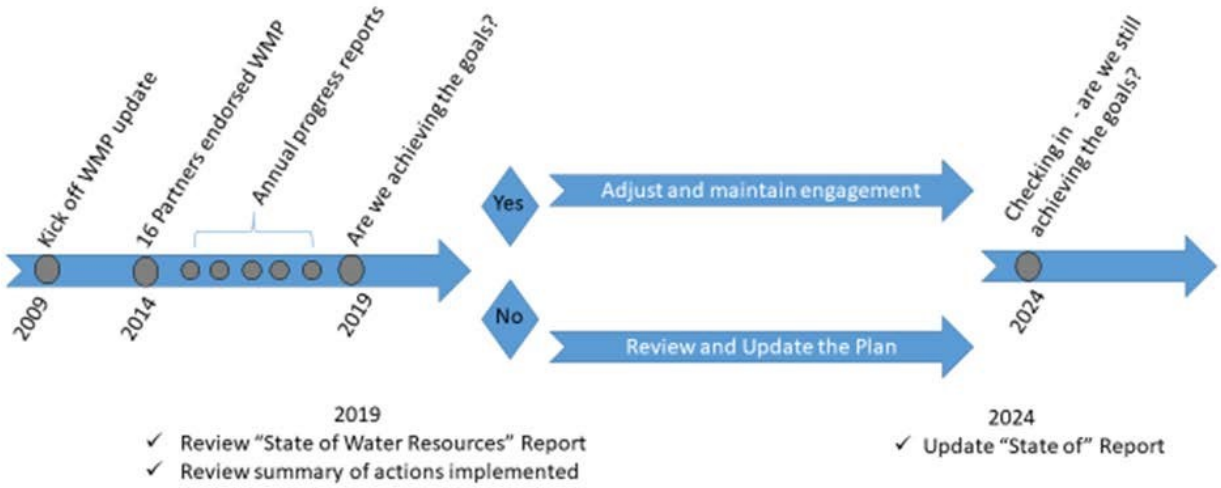


***Figure 2.*** *Timelines for adaptive water management planning in the Grand River watershed, 2009-2024.*

## A. Maintain a process for reporting, updating and continuous improvement

The Plan set out to have two committees to guide the process of implementing the Plan. One committee, the Implementation Committee, was to be composed of senior executives of Partner organizations to champion the Plan. The committee was to host annual meetings to discuss progress of Plan implementation and celebrate successes. Implementation committee meetings were hosted in three of the five years of Plan implementation. The challenges of maintaining this committee was largely due to agency staff retiring or moving on to other positions. This challenged the succession of the group thus losing the inherent knowledge of the Plan and the commitments made.

The second committee, the Water Managers Working Group, has continued to meet quarterly since the endorsement of the Plan in 2014. It's important to note that this committee has been a mechanism in place since the 1970s when the 1982 Basin Study was commissioned to discuss water issues that crossed municipal boundaries. During the development of the 2014 Plan and its implementation, this group has met at least quarterly. Additional issue-specific meetings (e.g. spills and bypasses, watershed conditions, etc.) also occurred when a partner requested it or the watershed conditions, such as low water conditions and the need to deviate from Reservoir Operating Policies, required a broader, watershed level of input.

One mechanism that enabled status reporting was the Roundtable updates from Partners that was facilitated at each meeting. Partners would share the top 3-5 water

management projects – both included and not included in the Plan, to their peers. This resulted in many advances across the watershed that helped disseminate best practices. One example is the sharing of Sewer Use Bylaws among municipalities that enabled them to advance the management and control of wastewater coming into sewage treatment plants, a second example is the mobilization of the use of Digital Elevation Models to map nutrient sources areas on the rural landscape across Ontario.

Highlights of each meeting were taken and circulated to Water Managers with the expectation that they share the information with their staff. It is unclear that this dissemination route was useful in building broader buy in and knowledge of the Plan. Further, a SharePoint site was developed for Water Managers to access agendas, minutes, reports and other support materials.

GRCA staff continue to support the collaboration among Plan partners; GRCA hosted the Water Managers and Implementation Committee meetings. Having GRCA support and facilitate these meetings is crucial for cross-jurisdictions discussions that are required for broader water management. It provides an opportunity for partners to gather in a common, neutral space to have the broader water management discussions.

Many partners view water through a sector-specific lens, including the GRCA (i.e. watershed lens) and the effort to bring together a diverse set of partners enhances our collective understanding of the needs and realities of managing a critical resource that is pervasive through our society.

Annual progress reports were generated by GRCA and provided to Water Managers for review. Each report highlighted key actions and activities done to support the goals of the Plan. These reports were sent to watershed municipalities for broader dissemination beyond committee members and to provincial and federal partners though committee members.

Finally, the companion report to this report is the State of Water Resources (2019). This report is the information that is required for Water Manages to evaluate whether the goals of the Plan are being met. This report is currently being compiled and in 2019 the process will start to review the current Plan and determine if an update is needed.

## B. Maintaining a framework for integrated water management

At the core of water management is the preservation and maintenance of the water cycle. Due to the large-scale deforestation of the late 1800's, the water or hydrologic cycle of the watershed was heavily impacted resulting in significant summer droughts, spring floods and poor water quality. The human response was to build reservoirs to replace some of the lost storage recreate a better approximation of the hydrologic cycle. Consequently, the watershed-wide water cycle is managed through the operation of

seven multi-purpose reservoirs to reduce springtime floods and augment flows during dry periods.

To encourage a more natural water cycle, land use planning, reforestation and the preservation and rehabilitation of natural areas becomes very important. Land-based plans, frameworks or policies such as the Forest Plan, Natural Heritage System Framework or the GRCA Land Acquisition Policy used to acquire and protect sensitive lands provide support for identifying, and prioritizing efforts to regain or maintain a more natural water cycle.

In 2018, the Grand River Fisheries Management Plan turned 20 years old and the Implementation group still continue to meet and implement actions that assist with maintaining and building local fisheries. Efforts in the last five years focused on improving the tail water fishery by rehabilitating channels and prioritizing small dams for removal (see *Improving Water Quality* chapter).

The Natural Heritage System Framework for the Grand River watershed was kicked off in 2014 and characterization reports for nine major subbasins are now complete. These reports provide an in-depth inventory and summary of the natural heritage features within each\h major subbasin. The series of reports represent the overall characterization of the natural heritage system within the Grand River watershed.

In 2018, the Province of Ontario updated a number of provincial plans including Places to Grow and the Greenbelt Plan. The update identified the need to identify key hydrologic features, such as permanent and intermittent streams, inland lakes, seepage areas and wetlands, and key hydrologic areas, including significant groundwater recharge areas, highly vulnerable aquifers and significant surface water contribution areas. As a result, the report "*The Grand River Watershed: Water Resource Systems*" was compiled to help identify key hydrologic features and areas in the watershed based on completed and peer-reviewed studies. This report and identified data layers would support Municipalities in their efforts to identify these areas and features in future Official Plan updates.

Ideally, the Natural Heritage System Framework combined with the key hydrologic features and areas would provide spatially referenced areas of importance to protect key hydrologic processes. Work will continue to refine these maps and inventories when better data and information is created. Effort should focus on integrating the various plans to determine key areas of interest for the preservation and maintenance of landscape hydrologic processes.

The Luther Marsh Natural Area remains the largest intact man-made marsh complex in southern Ontario. The 5,900-hectare property centres on the 1,400-hectare Luther Lake, created by Luther Dam, built in 1954. Surrounding it are wetlands, fields and forests providing habitat to a wide variety of birds, animals, plants and trees. Luther Lake

provides critical water storage in the headwaters of the Grand River watershed that allows for low-flow augmentation into the Grand River above Grand Valley and the Belwood reservoir.

An update to the Luther Marsh Wildlife Management Area Management plan was issued in 2010 jointly by the Ministry of Natural Resources and Forestry and the Grand River Conservation Authority (GRCA). A review of the low-flow augmentation targets was completed for the Ministry of the Environment, Conservation and Parks during the update to the Water Management Plan which confirmed the operational flow target and wastewater assimilation flow target of 0.42 and 0.40 $m^3$/sec, respectively. Both the MNRF and the GRCA meet annually to review priorities for the Luther Marsh Wildlife Management Area and review the need to update its Management Plan.

The Montrose reservoir project has been a proposed project since the 1930's as an option to provide flow augmentation and reduce flood damage potential. Over the years, a number of studies have evaluated the cost effectiveness of a new dam near West Montrose for water supply, water quality enhancement and flood damage reduction. In 1982, these studies were updated as part of the 1982 Grand River Basin Study. It was recommended that the Montrose reservoir lands continue to be protected for possible future water management purposes.

A Montrose reservoir is currently not in the Region of Waterloo master water supply plan, as it is considered to be beyond their current planning horizon of 2050. However, there was strong consensus with the Water Managers Working Group that it is prudent to maintain the Montrose Reservoir as a future water management option, given the uncertainties associated with climate change and the continued growth of the watershed population. See report staff report GM-12-17-135 taken to the GRCA board of directors in December of 2017 for more details.

In addition to the Montrose Reservoir, historic water management plans identified the lands in the Everton area, in the upper Eramosa subwatershed, as important for possible future reservoir options as well. Studies of the local geology and natural features that have been identified as areas of natural and scientific interest, including valley lands, suggest that a reservoir may not be suitable in this area. The significance of these features, however, provides rationale for maintaining and potentially acquiring additional lands in the Everton area.

Considering the effort over the last five years to update the Natural Heritage System Framework and compile the key hydrologic features and areas in the watershed, it may be an appropriate time to update the GRCA's land acquisition policy.

Part of a framework for water management is the ability to gauge progress toward common goals. One way to do this is to identify key indicators that are important to partners and quantifiable targets that can be measured to evaluate progress. This can

be done for both the (1) outputs – e.g. actions implemented and the (2) outcomes – e.g. changes in the quality or quantity of the resources. It is this information that allows water resource managers to learn, evaluate and adapt in a continuous improvement process and evaluate whether the goals of the water management plan are met.

Key milestones were introduced in the Water Management Plan for water quality and water quantity (river flow). Water quality milestones were for dissolved oxygen, total phosphorus, and unionized ammonia. Operational flow targets were listed for maintaining river flows, wastewater assimilation, and environmental flows.

Due to staffing constraints, staff time and effort was targeted to maintaining the Water Managers Working Group and not the Water Quality Working Group. Additional work to quantify milestones or targets for other key water quality parameters for key locations in the Grand River watershed such as suspended sediments, turbidity, and other nutrients was not undertaken.

Further, Environment and Climate Change Canada was to develop science based nutrient loading targets for the Grand River that are supportive of the Great Lakes Water Quality Agreement. A great deal of research was undertaken by ECCC to investigate the relationship between the plume of the Grand River and its potential effect on nearshore *Cladophora* (algae) growth[1]. This research has been instrumental in developing our collective understanding of the science behind nuisance algal growth in the nearshore area, however, it was insufficient to identify a science-based loading target for the Grand River at this time. ECCC continues to work on this issue.

## C. Ensuring water supply for communities, economies and ecosystems

A long standing water resources issue has been to secure water supplies for the various uses of water in the watershed. Water supplies are permitted by the Ministry of Environment, Conservation and Parks (MECP) through the Permit to Take Water Program while the proponent (e.g. municipality, farmer, industry) is responsible for the development of the water supplies.

Good knowledge and understanding of surface and ground water and its interaction in the watershed is the basis for successful water management. Further, a firm understanding of the main water uses in the watershed is a good starting point for identifying actions to conserve water use. The GRCA has compiled an inventory of water uses in 2004, 2011 and in 2018.

A critical element of water resources management is long-term water supply planning. It provides a roadmap for municipalities to plan for and acquire new supplies, whether it is by finding additional sources or through demand management.

In the watershed, the multi-purpose water management reservoirs underpin surface water supplies. Effective management of the reservoirs helps to maintain operational flow targets for both supply and wastewater management. Flows needed to maintain environmental needs are also considered.

Groundwater remains a key source of water for municipal drinking water supply yet also supports critical ecological needs for many streams, rivers and wetlands are groundwater fed. Furthering our knowledge and understanding of surface and ground water interactions continues through monitoring and intensive water budget modelling studies through Source Protection Planning.

Competing water uses remain in specific areas such as the Norfolk Sand Plain and the Eramosa subwatershed. Local water management plans for these areas of potential constraint are still needed.

## Actions for long-term water supply and demand management planning

### C1. Long term water supply planning

Municipalities who had committed to starting or completing their water supply master plans have done so.

Centre Wellington's long-term water supply plan is underway and continues concurrently with the Tier 3 water budget study being completed through Source Protection Planning.

The Region of Waterloo and City of Guelph both completed long-term water supply master plans and are considering another update in the near term.

The County of Brant finished the master servicing plan for the Town of Paris in 2016 but due to significant growth pressures, an update is scheduled for 2019.

Six Nations of the Grand River completed a full upgrade to their drinking water treatment plant in 2015.

### C2. Managing demand for water

Reducing water demand will help ensure sustainable water supplies in the future for communities, economies and the ecosystem. This can be done through the adoption of water conservation bylaws or through incentives like promoting the exchange of low flush toilets as examples. One way to facilitate the shift to lower consumption of water is through setting demand management objectives and tracking demand over time.

The MAFRA produced a series of videos on irrigation system assessments and soil moisture monitoring in 2014 to further advance water conservation on the farm.

The Region of Waterloo completed a Water Efficiency Master Plan (2015-2025) in 2015 with the goal to save 1,370 million litres of water per year by 2025. The Plan also sets

out a **Residential target of 165 litres per person per day.** This is being achieved through

- Conservation by-laws,
- financial incentives for purchasing of rain barrels, and
- Water Efficient Technology (WET) Program.

Since 2008, the Region has seen **peak demand reduced by 6% on average** as a result of these initiatives, which is equal to 400 million litres of water per year. The TriCities Kitchener, Waterloo and Cambridge) have seen a 0.9% annual decrease in water demand, despite an average annual population increase of 1.0%.

The success of the Water Efficiency Master Plan and associated programs have resulted in the postponement of a Great Lakes Pipeline project to supply water to the Region, which was initially projected for 2035, and would cost the Region hundreds of millions. These savings highlight the importance of Municipal Water Efficiency programs

The City of Guelph completed a Water Efficiency Strategy in 2016 and sets a 5-year reduction target of 2,557 $m^3$ per day and a **demand management objective of 158 litres per person per day**. In 2017, Guelph residents were using about 163 litres of water per person per day. The Strategy provides direction out to 2038. The Strategy includes many programs which will aid in achieving the water reduction targets including

- the Royal Flush program for reducing water use from residential toilets; and
- the Blue Built Home rebate program that provides financial incentives for new and
- updated homes that can achieve water use rates of 150 litres per capita per day.

The focus for managing the demand for water in the Township of Centre Wellington over the last five years was to update their long-term water supply master plan, in conjunction with the completion of the Tier 3 Water Budget study. Once this plan is completed, the soft–path approach to demand management may be considered.

The City of Brantford continues to promote conservation efforts to reduce demand on the municipal water supply. Brant County has a water bylaw that promotes conservation.

All watershed municipalities are encouraged to promote or continue to promote conservation efforts moving forward.

### C3. Confirming secure water supplies for long-term planning

Municipalities are the largest users of water in the Grand River watershed. Municipalities service not only residential users but also industrial, commercial and institutional users. Long-term water supply planning for municipalities require a high level of certainty in understanding the physical availability of water from aquifers and surface water sources but municipalities also need to know that their permitted water supply will be available to them over the long term. If a permitted supply is retracted by

the regulatory authority, it undermines the ability of a municipality to plan for the long-term.

Ensuring physical and regulatory water security requires collaboration among neighbouring municipalities, the MECP as the regulator, and the GRCA. Solid technical studies and monitoring underpin the knowledge of water availability; strong working relationships and trust among the partners underpins regulatory water security for the long-term. More work is needed to foster good working relationships among all water users in the watershed.

In 2018, GRCA updated the water use inventory for the Grand River watershed using the Ministry of Environment, Conservation and Park's (MECP) Water Taking Reporting System (WTRS). This update, using the actual takings, confirmed that municipal use of water remains the largest permitted user in the watershed. However, demand for water is decreasing from previously reported statistics. This report was shared with Water Managers and the MECP for their input and review.

Integrated surface and ground water models were developed through the provincial Source Protection Program to estimate the availability of water in aquifers in the watershed as sources of municipal drinking water. Specific effort was targeted to the Waterloo moraine region, Paris-Galt moraine region, both in the Guelph area and in the Norfolk Sand Plain, and in the sand and gravel terraces near Fergus and Elora in Centre Wellington. These studies advance the technical knowledge and understanding of the physical availability of water in these areas for municipal and other supplies.

GRCA continues to work with the MECP, Region of Waterloo, City of Guelph, County of Brant and others to ensure these models and technical information are accessible, maintained and used for informing water management decisions into the future.

Water Managers Working Group continues to be a forum for discussing water management issues that cross boundaries or mandates. The draft paper "Considerations for Securing Current and Planned Sources of Municipal Water Supply" (GRCA, 2013) has been requested to be reviewed by Municipal Water Managers and the MECP. Detailed technical information and models developed through source water protection are tools that are available for technical review staff evaluating water taking permits.

## Actions to understand water use across sectors

### C4. Inventorying water use

Understanding who is using how much water where is fundamental to managing water across sectors. MECP continues to inventory and upgrade the information system in which permits are registered. The Water Taking Reporting System (WTRS) has been greatly improved as reporting has shifted from permitted to actual water takings.

GRCA completed a review of the inventory of water taking permits and prepared an updated report in 2018. In general, municipal water use, including residential, industrial, commercial and institutional (ICI) takings are the highest (62 percent of all the takings in the watershed; 86,000,000 m3) while rural ICI, rural residential and agriculture, and remediation (i.e. pumping contaminated groundwater and treating it) take about 21, 14 and 3 percent respectively) (see **Figure 3**). The median (50th percentile) use of water *per capita* is 280 L/per person/per day while it ranges from a low of 140 L/pp/d to a high of 503 L/pp/d.

Agricultural water use remains important in the Whitemans, Mount Pleasant and McKenzie creek subwatersheds. Ministry of Agriculture, Food and Rural Affairs (MAFRA) continues to work with irrigators in this region to promote sustainable sources of water for irrigation.

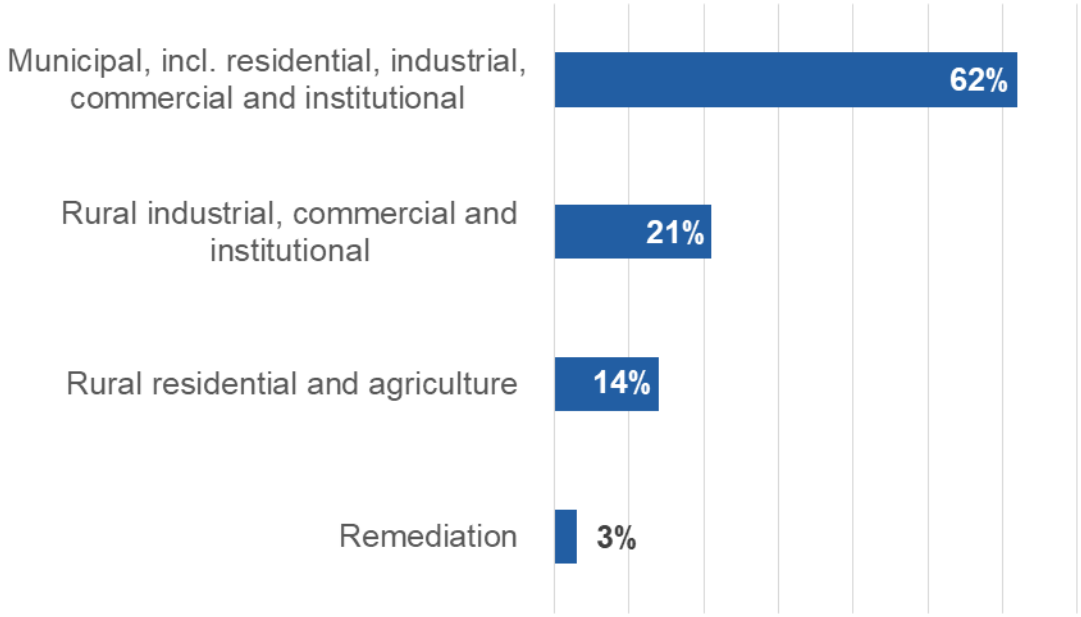


***Figure 3.*** *The actual total water takings in the Grand River watershed is 138 Mm3/year. The percent of actual total water takings is shown above by category. Based on data up until 2016. See Water Use Inventory (2018)*

## C8. Managing permits to take water

GRCA continues to screen permit applications that are posted to the Environmental Registry of Ontario (ERO) and only comment on selected permits that are on the river reaches in which flows are augmented by the large water management reservoirs or permits that are requesting quantities over 1M Liters per day.

GRCA also comments on large groundwater permits that are new or have increased takings over 1M L/day in high water use areas.

MECP and GRCA staff continue to work together to discuss and share information on Surface Water Permits to Take Water to manage consumptive water takings during low flow conditions in the reaches of the Grand, Conestogo and Speed rivers that receive discharges from the major water management reservoirs.

GRCA continues to facilitate the Grand River Low Water Response Team. It continues to have active participation from a wide range of water users including municipalities, agriculture, aggregate producers, golf courses and water bottlers. The team meets throughout the low water season and was especially active in 2016 when dry conditions resulted in very low reservoir levels.

The "Water Use Inventory Report for the Grand River Watershed" was compiled in 2018 using data up to 2016. Data sources included the MECP WTRS database, municipalities, agriculture census data and population data.

## Actions for operating water management reservoirs

### C5. & C6. Reservoir operating policy and operational flow targets

In addition to flood management, the seven major reservoirs were built to facilitate the augmentation of river flows to meet downstream flow requirements of waste assimilation and water supply. River operational flow targets were established 1982 as part of the Basin Study[3] and is part of the Reservoir Operating Policy[4]. The reliability of meeting operational flow targets is reviewed periodically. The last review was in 2013-14 as part of the Water Management Plan.

Reliability of meeting flow targets has improved for all locations. Between 2011 and 2017, reservoir operations supported achieving the operational flow targets greater than 95% of the time. Flow targets were lowered for short periods during dry conditions in 2012 and 2016. Summer flow target at the Edinburgh Rd gauge on the Speed River in Guelph continues to have the lowest percent reliability on an ongoing basis. GRCA is investigating the control weir at the Edinburgh Road flow gauge to determine whether operational issues is causing lower flows to be recorded.

New modelling tools are being acquired and implemented by GRCA in the next five years to improve river modelling and forecasting capabilities. The US Army Corps of Engineers **H**ydrologic **E**ngineering **C**enter (HEC) suite of hydrology and hydraulic modeling tools and frameworks is being implemented to provide a universal platform for river modelling. Opportunities exist to build a new reservoir operations/yield model. Once the new model is tested and refined, these new tools will allow for a complete and updated review of the reliability of meeting operational flow targets for the river. Operational constraints in the winter and a changing climate will be considered in the next review. Results from this work will inform the need if any to revise the current reservoir operating policy.

## C7. Wastewater low-flow targets

In addition to flood management, the large water management reservoirs augment river flows during low flow periods (summer, fall and winter) to assist with wastewater assimilation. There are 16 wastewater treatment plants that discharge into augmented river reaches downstream of multipurpose reservoirs.

Low river flow statistics are required to determine the appropriate effluent load into a river to protect the quality of the river and allow natural processes to break down the remaining pollutants quickly. This statistic is called a $7Q_{20}$ – the 7-day mean low flows (Q) for recurrence intervals of 20 years. For an augmented river, the low flow statistics are somewhat modified due to the active management of the river system. Thus, *$7Q_{20}$ Equivalent flows* were calculated based on the period of record (1950 – 2010) of reliable flow data at stations that are on augmented river reaches[5].

Since 2014, a data management system (e.g. WISKI – Water Information System by KISTERS) has been implemented to improve flow data management and analysis.

Flow data records are being updated and maintained to complete a review of 7Q20 equivalents in the next five years.

## C9. Environmental flow considerations

GRCA recognizes that aquatic communities require river flows that support ecological processes. These needs must be balanced with the need for flood management and reliable low flow augmentation for extended low-flow periods (e.g. summer, fall and winter). Over the past 20 years, a number of studies have been completed which reviewed of the level of flows required to help support ecological processes in the Grand River.

GRCA staff started a review of floodplain spawning flows since these flows are least met on a regular basis in river reaches in which flows are augmented by large water management reservoirs. It appears to be difficult to achieve in augmented river reaches as the active management of these reaches are for managing flood events and ensuring sufficient storage for augmentation during low flow periods.

As part of updating the reliability of meeting low flow targets, ecological flow considerations will be analyzed. Meeting ecological flow thresholds is an aspirational goal and should not be considered a requirement. The HEC suite of analysis tools includes a framework to analyze and quantify specific environmental flow thresholds such as spawning habitat. The new detailed hydraulic models being prepared to update floodplain mapping can provide the basis needed for HEC-EFM framework. The HEC-EFM framework can be used to identify restoration opportunities that could improve the connection between the floodplain and main channel creating desirable spawning habitat.

## Actions to understand surface and ground water interactions

### C10 Improving our understanding of ground water

Groundwater in the central Grand River region is valued as a municipal drinking water supply, for sustaining baseflows in small streams and larger rivers and for maintaining important coldwater aquatic habitat.

Groundwater systems are complex and much work has been done through the Source Protection Program to develop numerical groundwater flow models. This work has aided in the determination of the reliability of supply for municipalities (Tier 3 Water Budget studies). This work continues with an advanced groundwater flow model being developed for the Centre Wellington area. Advanced numerical groundwater and surface water flow models are complete for the Region of Waterloo, Guelph Guelph/Eramosa, and Whitemans Creek areas.

GRCA is the lead for two Tier 3 Water Budget studies (Centre Wellington and Whitemans Creek) undertaken through the Lake Erie Region Source Protection Program. One of the objectives is to quantify recharge to the groundwater flow system. Peer review teams consisting of hydrogeological experts in academia and consulting and experts with local knowledge in geology and water resources were consulted through the progression of these projects. A local community interest group was also involved in the Centre Wellington water budget project.

GRCA has also contributed to ROW-led studies in the Upper Blair Creek and Cedar Creek subwatersheds through monitoring shallow groundwater interactions with surface water features. Monitoring has been established to enhance the understanding of groundwater surface water interactions in Roseville Swamp, Cedar Creek, and Upper Blair Creek and its tributaries. Monitoring results are used by the Region to inform their Tier 3 numerical groundwater flow model.

*For more information on the Blair Creek Study, see www.grandriver.ca/wmp*

The City of Guelph is in the process of completing the Clair-Maltby Secondary Master Plan. This area of the Paris Galt Moraine contains numerous wetlands and no surface water outlet. Monitoring shallow groundwater and surface water levels within the wetlands improved the understanding of the hydraulic function of each of the wetlands. Knowing how these wetlands hydraulically function provides information that will feed into how storm water will be managed for this area.

### C11. Maintaining ground water recharge

The process of surface water recharge to the groundwater flow system is the primary source of water for the watershed's aquifers. Reducing the quantity of water recharged to the groundwater system, over time, will likely impact the quantity of water in the watershed's aquifers. For many people in the Grand River watershed, groundwater is the primary drinking water source. Ecologically, groundwater provides baseflow to streams and supports wetlands and aquatic habitat as well as moderates water quality and stream temperatures.

Groundwater recharge has been quantified regionally through the Grand River's Tier 2 water budget study[7], and locally refined in the Region of Waterloo, Whitemans Creek subwatershed, northern portions of the Grand River watershed, and Fairchild Creek subwatershed through projects led through the Lake Erie Region Source Protection Program. The refinement of groundwater recharge across the Fairchild Creek subwatershed incorporated areas of fractured bedrock exposed across the Flamborough Plains.

The Region of Waterloo actively works to support the maintenance of the countryside line set out in the Region's Official Plan. The countryside line is a boundary that protects the cultural, economic and environmental heritage of rural lands from the pressures of urban sprawl. The Region values the important groundwater recharge processes of the Waterloo Moraine to ensure their future water supply.

An update on watershed geology has identified the location and importance of fractured bedrock and karst features within the watershed as highly conductive features for groundwater flow[8].

Through the Tier 3 Water Budget study for Whitemans Creek, ecologically significant groundwater recharge areas are planned to be identified.

GRCA is currently undertaking a baseflow analysis for select natural streams which will create a baseline for future comparisons under a changing climate.

## Actions for local water management planning

### C12. Local water management plans in areas of constraint

Areas of constraint in the Grand River watershed were identified in the Water Management Plan in 2014. These areas – Whitemans Creek and the Eramosa River, are in response to extreme low flows during hot, dry periods and multiple demands on the river/groundwater system. Local water management plans would help facilitate a collaborative understanding of the local needs and demands and reduce the potential for water use conflicts and constraints.

The Whitemans Tier 3 Water Budget study was completed under the provincial Source Protection Program. An irrigation demand model was created and combined with an integrated groundwater/surface water model that will be used to study different irrigation and climate scenarios. Additional monitoring of stream flow has started on McKenzie Creek.

Although local water management plans have not been formalized, GRCA, MNRF and MAFRA continue to share information and support local farm and farm organizations in the Norfolk Sand Plain areas including Whitemans, Mt. Pleasant and McKenzie creek areas.

### C13. Proactive drought contingency planning

Many studies have confirmed that the change in climate patterns may result in prolonged dry periods. Low water response and drought contingency plans are valuable tools for proactive actions to deal with low water conditions.

The Drought Contingency Plan[9] (2014) puts forward priorities, roles and responsibilities for water users and managers in the Grand River Watershed. Additional drought scenario and management work in the Whitemans Creek subwatershed is planned for 2019 using the integrated water budget model.

GRCA continues to facilitate the Grand River Low Water Response Team on behalf of the MNRF. It continues to have active participation from a wide range of water users including municipalities, agriculture, aggregate producers, golf courses and water bottlers. The team meets throughout the low water season and was especially active in 2016 when dry conditions resulted in very low reservoir levels.

## D. Improving water quality to improve river health and reduce the Grand's impact on Lake Erie.

A number of actions were identified by Plan partners to address point and rural/urban non-point sources of pollutants as well as in-river improvements that can improve water quality. The following section summaries the actions to address these issues.

## Actions for point sources of pollution

### D 1. Upgrading wastewater infrastructure

There are 30 wastewater treatment plants in the Grand River watershed. Most of the treated effluent is generated by five large plants (from largest discharge to smallest): Kitchener, Waterloo, Guelph, Galt and Brantford. These five plants discharge into either the Grand or Speed rivers and treat about 82% of all the wastewater generated in the watershed. However, treated effluent from smaller wastewater plants is very important to local streams and rivers.

The Region of Waterloo continues to upgrade the Kitchener and Waterloo plants. Treatment at the Kitchener and Waterloo plants now includes nitrification since 2012 and 2017, respectively. Future objectives for ammonia nitrogen is being anticipated for the Hespeler wastewater plant. The last update to the Region of Waterloo's Wastewater Master Plan was in 2018.

The City of Guelph commissioned the Anammox process in 2017 for side-stream treatment of high strength dewatered filtrate and is currently investigating opportunities to rerate the capacity of the plant

The Elora wastewater plants was upgraded and expanded in July 2014.

The County of Brant initiated a Master Servicing Study for Paris 2018 while an Environmental Assessment study for additional treatment capacity at St. George is nearing completion. Another update to the Paris study is currently being planned due to development pressure in the town.

Oxford County's Drumbo wastewater plant was re-rated in February 2015.

### D2. Optimizing wastewater treatment for improved effluent quality

Since 2010, a community of practice (CoP) for wastewater treatment optimization has been growing in the Grand River watershed. Owners and operators of all municipal wastewater plants in the watershed actively participate and share their knowledge and experiences in improving effluent quality through improved process control.

Since 2012, annual performance reports have been completed and a recognition program launched.

Currently, 17 plants are achieving their corresponding voluntary target for phosphorus and 25 and 22 plants are achieving their targets for total ammonia nitrogen in the summer and winter, respectively (see **Figure 4**).

The GRCA continues to facilitate the CoP while the MECP has committed to five years of funding until 2022. Additional support was secured through the Canadian Federation of Municipalities to incorporate climate change adaptation into optimization activities, in particular as it relates to increased potential for inflow and infiltration impacts.

The following are specific actions completed by partners:

- Guelph continues with optimization to improve WWTP performance and secure capacity re-rating for the plant
- Since July 2016, the City of Brantford established stable nitrifying conditions and began reducing total phosphorus concentrations at the plant. Since this time, the plant has been consistently achieving the voluntary performance targets for total phosphorus and total ammonia nitrogen.

- Haldimand County continues their optimization efforts successfully and have achieved their voluntary targets.
- The County of Brant continues to participate in the CoP and will incorporate the goal of reducing final effluent total phosphorus as part of future studies.
- Centre Wellington actively participates in the CoP
- The Region of Waterloo incorporated optimization as an approach to be considered in their recent Wastewater Master Plan. They are also active members of the CoP
- Township of Southgate also participates in the CoP and GRCA has been working with them to provide some technical assistance.
- Township of Wellington North did participate in the CoP and GRCA provided technical assistance

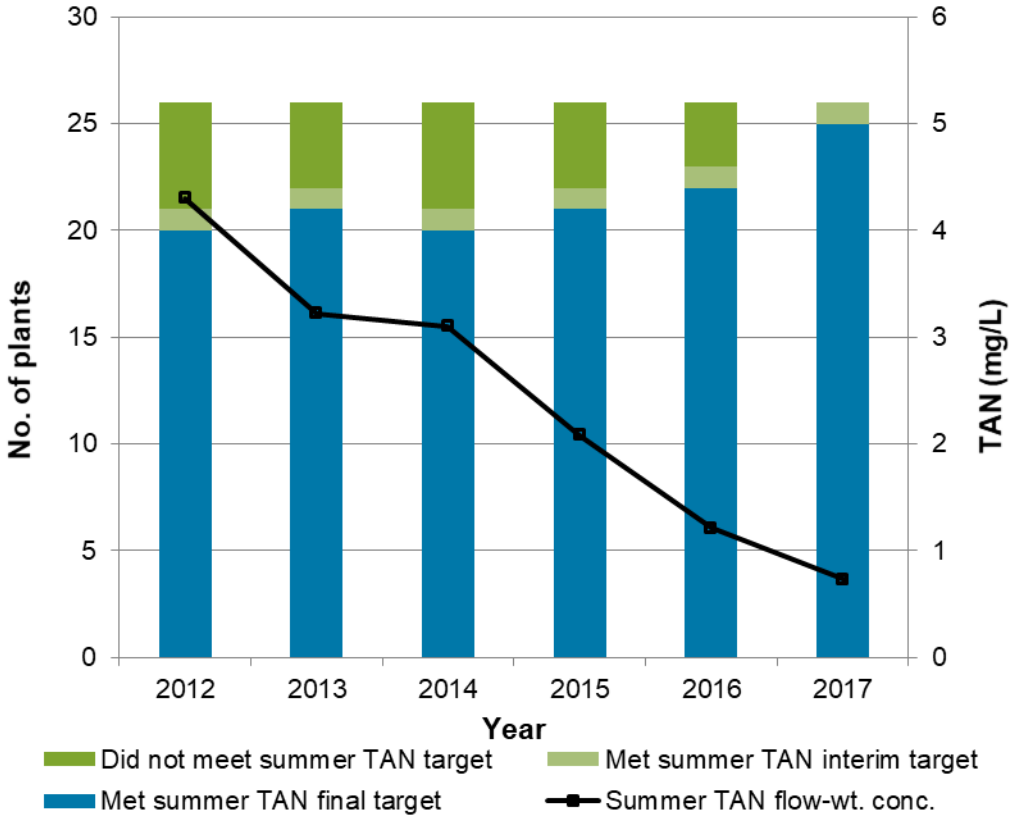


***Figure 4.*** *Number of plants achieving voluntary total ammonia nitrogen effluent targets set out in the Water Management Plan and corresponding flow weighted mean concentrations from all plants.*

### D3. Using sewer use bylaws.

Understanding the quality of influent coming into a wastewater treatment plant from upstream can assist wastewater managers with managing the effectiveness of the treatment in their plants to achieve and maintain effluent limits or targets. Also, an effective sewer use bylaw can also help to maximize the treatment capability of the plants to defer significant capital upgrades or expansion. Source/upstream control is important because many substances are not treatable or only partially treatable in conventional municipal wastewater treatment plants. Having and enforcing a sewer use bylaw enables wastewater managers to consistently achieve effluent quality limits and tap the full treatment capability of the plants while avoiding or deferring major capital expenditures.

Many municipalities in the watershed have sewer use bylaws and many have active enforcement but note that enforcement can be very difficult when a community is weighing the benefits of a potential new industry that may contribute to a future tax base. Many municipalities have acknowledged the need for updating and/or enforcing their bylaws.

An enforced sewer use bylaw helped both Guelph and Brantford control influent quality into their plants which enabled them to further optimize treatment processes to improve effluent quality.

### D4. Implementing best practices for wastewater bypasses.

A report in 2009, summarized best practices for municipalities, MECP, and GRCA can take to reduce the frequency and severity of bypasses from municipal wastewater treatment plants. Regular updates are tabled by the MECP at Water Managers, including quarterly reports on tertiary bypasses.

### D6. Subwatershed planning in support of water quantity and quality

Rural communities such as Drayton, Arthur, Grand Valley, Dundalk, Wellesley, and St. George manage small wastewater systems within a large rural area. These wastewater systems discharge treated effluent to small river systems that have limited capacity to accept additional effluent thus potentially limiting growth.

In addition to maintenance and operations of the wastewater systems, infrastructure upgrades to support growth in these rural communities can be extremely costly. An action to help inform wastewater planning in rural communities was to undertake specific subwatershed or regional studies that would pull together information in these areas that would help to identify alternative approaches to support growth and development without impacting local water resources.

Between 2015 and 2017, GRCA collected water quality samples above and below Drayton, Arthur, Grand Valley and Dundalk seasonally to assess the current impact of

these systems on the local rivers. These data were included in a characterization report on the Upper Grand River (Grand Valley, Dundalk) and upper Conestogo River (Drayton, Arthur, Moorefield) to identify the major sources of phosphorus and nitrogen to Belwood and Conestogo reservoirs. This study, in part was to assess the relative contributions of multiple sources of these nutrients to the reservoirs but will also serve to support broader wastewater planning in these areas.

In response to concerns about nutrient loading to Lake Erie, GRCA with funding from ECCC, developed subwatershed characterizations for Fairchild and McKenzie creeks, big contributors to sediment and phosphorus loading to the Grand River. These studies assembled available information and highlighted knowledge gaps.

Since 2013, the Region of Waterloo, in partnership with area municipalities and the GRCA, has undertaken 3 subwatershed studies – for Freeport Creek, and Randall and Breslau Drains in the Middle Grand River, and Cedar Creek draining to the Nith River. These studies evaluate the impacts of potential future development and make recommendations to maintain the functions and health of watercourses and natural areas.

The City of Guelph's Clair-Maltby Secondary Plan includes an innovative subwatershed study that will provide a stormwater strategy for closed drainage areas on the Paris-Galt Moraine.

GRCA and the City of Kitchener, with provincial funding, capitalized on 10+ years of monitoring Blair Creek – an urbanizing coldwater creek. This case study has established a framework for evaluating the potential impacts of development that can be applied here and in other subwatersheds in the future.

GRCA continues to compile natural heritage inventories for the major subbasins in the Grand River watershed. These reports will inform future subwatershed studies or plans.

## Actions for rural non-point sources of pollution

### D8. Understanding the diffuse sources of nitrate in the winter

Monitoring and research by GRCA and University of Waterloo, respectively, has helped to characterize winter levels of nitrate in the Grand River and possible sources. A continuous nitrate monitor was installed in the Bridgeport water quality station in 2013 by GRCA and in 2017 in the Brant water quality station.

River monitoring over the past several years have shown that nitrate levels in the winter can be much higher than during summer. Levels were shown to approach the drinking water quality standard of 10 mg/L at times. The Bridgeport water quality station is upstream of the Region of Waterloo's Mannheim Water Treatment Plant intake. Although levels were higher in the winter than the summer, they did not peak as high as the levels at Bridgeport.

In addition, winter water quality sampling was also completed to characterize the nitrate levels coming from the major tributaries between Bridgeport and the Shand Dam. Research completed by the University of Waterloo in 2015[10] suggests tile drains that are running can have very high nitrate levels.

GRCA continue to promote nutrient management planning and the use of 4R Nutrient Strategy for improved management of both nitrogen and phosphorus.

Although the continuous nitrate monitoring technology GRCA was using is no longer working, GRCA is pursuing other continuous monitors to install at both the Bridgeport and Brant water quality stations to ensure winter nitrate data are collected.

OMAFRA collaborated with University of Guelph researchers to better understand land use practices in agriculture that may impact nitrate concentrations in groundwater.

Through the RWQP, GRCA continues to promote nutrient management. In the past 5 years GRCA has supported 77 producers to complete plans for managing nutrients on more than 12,000 acres.

### D7. Implementing the Rural Water Quality Program (RWQP)

GRCA continues to deliver a Rural Water Quality Program on behalf of watershed municipalities. Since 1999, over 6000 projects have been implemented (**Figure 5**)

Watershed municipalities providing voluntary support to a local Rural Water Quality Program include the Region of Waterloo, City of Brantford, and Wellington, Brant, Haldimand, Dufferin and Oxford counties. GRCA also delivers a well decommission program on behalf of the City of Hamilton. Combined, municipal contributions of approximately $800,000 each year are provided to GRCA to offset landowner project costs in these communities. Additional funding is delivered from the Federal Habitat Stewardship Program for Aquatic Species at Risk and the provincial Forests Ontario initiative. The GRCA levy supports staff and administration costs.

Some municipalities have withdrawn their support for the program, including City of Guelph (2016), City of Brantford (2019) and County of Brant (2019). Additional federal or provincial funding sought by Plan Partners to build on the program was also not completed.

Between 2014 and 2018 $5.6 million in grants were provided to support 1985 projects through the Rural Water Quality Program. Landowners contributed $8.3 million of their own cash and in-kind for a total investment of $13.9 million in water quality improvement.

Each year, GRCA reports on the kilograms of phosphorus kept on the land as a result of implemented BMPs.

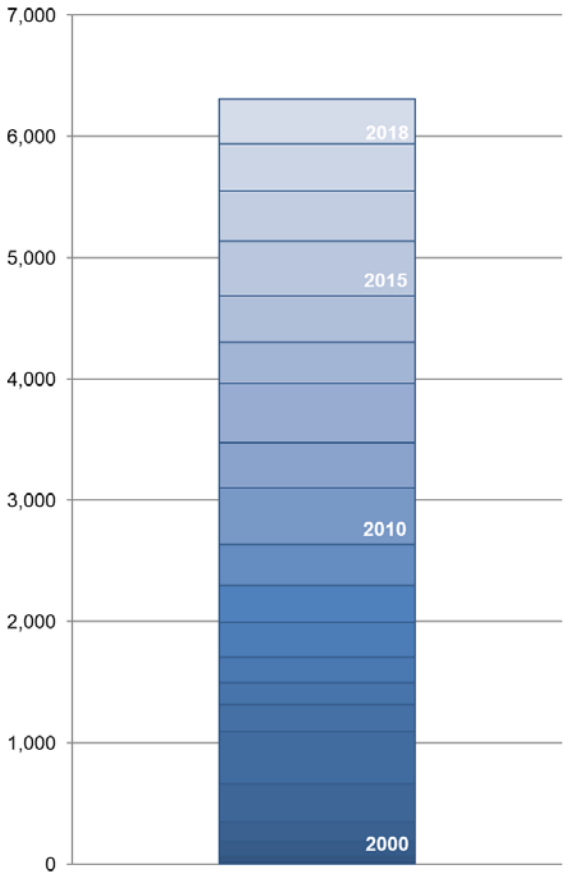


***Figure 5.*** *Over 6,000 voluntary rural water quality projects completed since 1999. An audit of the program in 2018 showed that most of the projects are still in place*

In the past 5 years (2014-2018) the RWQP supported just over 1300 projects. These projects keep an estimated 19,700 kg P on the land annually, bringing the total accumulated estimated total to more than 120,000 kg P retained each year. OMAFRA undertook studies to evaluate the effectiveness of Best Management Practices over time across the province. Results including the advantages of surface inlet loading reduction were shared with Grand River farmers through education events coordinated by the Rural Water Quality Program. OMAFRA partnered with the GRCA to pilot a soil erosion control calculator (e.g. SoilCalculator) and began development of an on-line USLE application.

Support from the provincial/federal Great Lakes Agricultural Stewardship Initiative in 2016 and 2017 increased GRCA's capacity to connect with agricultural producers to promote practices to manage nutrients, improve water quality and soil health. Over the course of the GLASI project, GRCA hosted 21 events and partnered, supported, attended or presented at an additional 39 agricultural industry events.

MAFRA launched Ontario's Soil Health Strategy in 2018 with the intent that this strategy will guide healthy soil and water systems until 2030 (see text box next page).

In 2018, commissioned by the Region of Waterloo, GRCA undertook an assessment of the condition of past RWQP projects implemented to address phosphorus movement from the landscape in the Lower Conestogo River Watershed. A resounding 96 % of structures were still in place up to 20 years later. This project was undertaken as part of an evaluation of the long term effectiveness of the Rural Water Quality Program in this priority watershed. The project provided an opportunity to re-engage past program participants.

**Ontario's Soil Health Strategy**

Healthy soil is essential for life and is the heart of our food system; it has an important role to play in our economy, environment and society.

Healthy soil helps improve crop growth and increases yields and product quality. It improves the rate at which soil absorbs and stores water, and reduces runoff, all of which enhance crop growth and resilience when water is in short supply. Healthy soil helps protect water quality by retaining nutrients for crops that might otherwise run off the land into adjacent streams and lakes.

This proposed strategy builds on the vision, goals and concepts presented in the *Sustaining Ontario's Agricultural Soils: Towards a Shared Vision* discussion document and incorporates feedback from our agricultural and academic communities, as well as technical experts, Indigenous communities, partner organizations and the public.

The final strategy will be a long-term framework, spanning 2018 – 2030, to guide soil health action, research, investments and activities for decades to come. The strategy will be nimble, providing opportunities for adaptive management.

A 2016 survey of past RWQP participants highlighted farmers' willingness to share advice and their experience implementing stewardship projects. Stories from 30 producers are shared through the 'Stories from the Field' interactive story mapping project on GRCA's website see Story map

Through the 2018 Wastewater Treatment Master Plan update, the Region of Waterloo evaluated phosphorus offsetting as a tool to manage expansion costs associated with enhanced wastewater treatment costs.

Farmers are doing their part too. The percent of farms planting cover crops in the watershed has increased since 2001 (see **Figure 6**).

### D9. Best practices for municipal drains

Municipal drains are designed to assist landowners to remove excess water from the land. In doing so, it is important to ensure proper best practices are in place for reducing soil erosion and flooding downstream.

In 2018, MAFRA, updated the publication “A Guide for Engineers working under the Drainage Act in Ontario” and continue to work with drainage superintendents throughout the province. The new LiDAR acquired by MAFRA will help drainage engineers’ map and manage municipal drains.

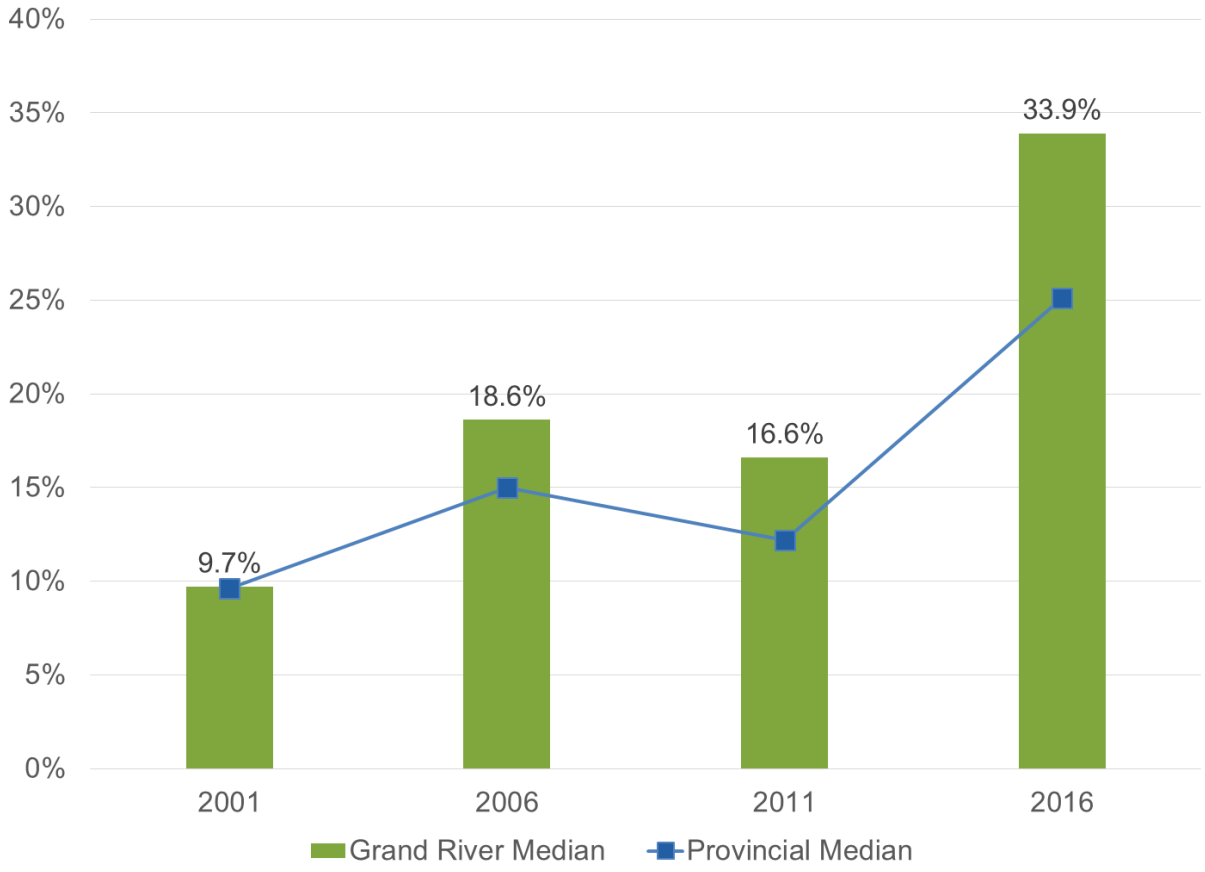


***Figure 6.*** *The percent of farms planting cover crops in the Grand River watershed has increased since 2001. Data from Census of Agriculture, Statistics Canada*

## Actions for urban non-point sources of pollution

### D10. Best practices for urban non-point sources of pollution

The Stormwater Management Working Group continued to meet, at times jointly with the Water Managers. Through invited presentations and discussion, members shared experiences, and information and discussed some common challenges. Topics included

legal outlets for stormwater discharges, stormwater quality and thermal mitigation, and low impact development.

Municipalities continued to make progress on recommended best practices that were jointly identified through the Water Management Plan, including:

- Sustainable funding to support stormwater management programs;
- Development and implementation of stormwater management master plans;
- Improvements to sediment and erosion control implementation and enforcement;
- Enhanced stormwater communication and education programs; • Opportunities to retrofit existing uncontrolled areas; and
- Maintenance and operation of facilities.

Ontario's municipalities need an estimated $681 million per year to close the investment gap for stormwater infrastructure[1]. The cities of Kitchener, Waterloo and now Guelph have implemented stormwater fees through residential and business utility bills, ensuring dedicated funding to maintain and improve stormwater infrastructure. Cambridge is investigating funding models and Brantford is reviewing this need in a future assessment of servicing.

Since 2014, the cities of Kitchener and Brantford have updated their stormwater master plans, and two municipalities have launched updates. These master plans play a key role in assessing infrastructure and prioritizing needed investments.

In response to an anticipated update to provincial stormwater guidance, municipalities are exploring stormwater volume control targets. The City of Kitchener has implemented a 12.5mm target for on-site stormwater retention for development and City projects in road rights-of-way.

Municipalities and GRCA continue to highlight the importance of erosion and sediment control during construction, to protect water quality and fish habitat. Rapid Assessment and Action Protocols (RAAP) for sediment releases to Blair Creek are helping Kitchener and GRCA to address this issue. Between 2016 and 2018, 16 RAAP events were documented, many in the winter and early spring months, reinforcing the need to improve erosion control at the end of the fall construction season.

GRCA hosted a training session for the Certified Inspector of Soil and Erosion Control program in 2014.

Municipalities are recognizing that stormwater improvements in urban areas will require buy-in from private landowners. The cities of Kitchener, Waterloo, Cambridge, and Brantford have partnered with Residential Energy Efficiency Project (REEP) Green Solutions and the RAIN program to engage residents and businesses through

[1] http://www.mah.gov.on.ca/AssetFactory.aspx?did=6050

workshops, home visits, demonstration projects, and neighbourhood blitzes. The RAIN Smart neighbourhood project in Kitchener resulted in 7 demonstration and 62 homeowner projects, and engagement of over 3,100 people in events and volunteer actions.

All three municipalities with stormwater utilities or service fees offer credits for reducing or treating runoff, and other best practices. The RAIN program engaged over 400 Waterloo residents in a door-to-door credit campaign in 2018.

The City of Kitchener has planned improvements to grey and green infrastructure, including creek realignments and restoration, and stormwater pond and wetland retrofits. Frequently occurring in municipal parks, these retrofits often are coupled with habitat creation and improvements to trails and other recreation infrastructure. The City's new requirement for stormwater volume controls in municipal projects in the rights-of-way will see low impact development best practices integrated in road and other linear infrastructure projects.

Municipalities are managing stormwater infrastructure as assets. The City of Cambridge has developed an inspection and maintenance program for stormwater ponds, and has identified at least 14 ponds requiring sediment removal[2]. The cities of Guelph, Cambridge, and Brantford have secured a combined $1.7 million federal funding for stormwater pond maintenance[3].

A Water Monitoring and Optimization Working Group met in 2015 to compile a water monitoring metadata catalogue as a demonstration of "who's doing what", and discuss how to make data "discoverable" and "shareable".

GRCA along with the Region of Waterloo, cities of Waterloo and Kitchener, and University of Waterloo, joined forces in an exploratory study of urban nonpoint source pollution in the Middle Grand River. Pooling monitoring data from programs with diverse objectives, the study highlighted the need for more coordination of monitoring to improve estimation of urban nonpoint sediment and nutrient loading[4].

*For more information on urban nonpoint source pollution in the middle Grand River region, see www.grandriver.ca/wmp*

[2] https://www.cambridge.ca/en/your-city/resources/2017-Infrastructure-Status-and-Outlook-report.pdf
[3] http://www.infrastructure.gc.ca/gmap-gcarte/index-eng.html
[4] https://www.grandriver.ca/en/our-watershed/resources/Documents/Subwatershed/Urban-NPS-Executive-Summary--FINAL.pdf

### D11. Reducing road salt use

The use of road salt has been shown to increase chloride levels in local rivers as well as in some municipal drinking water wells. Programs such as Smart about Salt, Curb the Salt and the new social media effort on #SaltingShift all aim to reduce the use of road salt to de-ice areas for walking and driving.

The Region of Waterloo, Cities of Waterloo and Guelph plan to continue activities and programs to promote reduced salt use for de-icing, targeted to both public and private operators. Other municipalities have also advanced their salt management plans and continue to reduce the use of road salt.

In 2016, the Region of Waterloo and City of Guelph finalized a report on the Environmental Impact of Residential Water Softeners.

### D12. Managing the risk of pathogens in surface waters

Pathogens like E. coli, Cryptosporidium or Giardia are a concern to surface water treatment plants in the Grand River watershed.

The City of Brantford continues to monitor pathogens in their raw water and document pathogen spike events.

## Actions for in-river opportunities to improve water quality

### D13. Improving the southern Grand River

Much effort was focused toward the southern Grand River region during the 2000s and during the development of the Water Management Plan. Many agencies came together to discuss actions that could be done to improve the water quality and river conditions in the southern Grand River. A working group at that time – the Southern Grand River Ecosystem Rehabilitation Working Group mobilized monitoring and efforts and specific studies to evaluate the role of the altered hydrology had on the local aquatic health of the river. This working group is no longer active however, some work continues through the various agencies.

MNRF and ECCC continued to support a Strategic Decision Making (SDM) approach for determining comprehensive remediation solutions for the southern Grand River. This was an extensive process that incorporated data collection, analysis, modelling and literature review specific to the biological and physical drivers of the southern Grand River. A final Decision Analysis Performance Measures document and summary of the process for the SDM is expected in 2019. Once this information is completed, GRCA will review the Dunnville Marsh Management Plan and incorporate any new findings from the SDM process.

Data collection continues. The MECP established and maintains a long-term monitoring site below the Dunnville Dam as part of the Great Lakes Index Station Monitoring Program

### D14. Understanding the impacts of weirs and in-river structures on river systems

A number of actions were identified to advance our understanding of the impacts of weirs and in-river structures on water quality and aquatic health. The Grand River Fisheries Management Plan Implementation Committee reviewed a number of GRCA owned small dams with respect to opportunities for removal and/or modification to help improve aquatic habitat.

In January 2016, GRCA staff met with MNRF and partners of the Grand River Fisheries

Management Plan to review and prioritize GRCA-owned dams. The group categorized 35 dams and fishways for further study. Structures were categorized as high priority, medium priority, and low priority or not applicable for further study. Four of those structures have been part of further investigations for modification or removal (Niska Dam & weirs on Hanlon Creek in the city of Guelph; the Dunnville Fishway on the Grand River; Reinhart Weir on the Nith River; and Victoria Mills Dam on McKenzie Creek.

In addition to small dams and weirs, channel improvements can help enhance aquatic habitat and river water quality. Two project sites in the Grand River Tail water were constructed in 2015 and 2017. These sites modelled channel modifications on a large river with dam augmented flows. Designs included elements to diversify the river geomorphology and included narrowing of channel, deepening of pools and riffle creation.

GRCA continues to maintain the dam inventory for the watershed.

There is a need to investigate the effects of small on line run of the river weirs on ice processes. New detailed hydraulic models that are currently being developed will provide the opportunity to analyze and better understand river ice processes and the influence of run of the river dams on ice processes.

## Actions for data based decision making

### D5. Maintaining decision support tools for long-term wastewater planning

GRCA continues to maintain the Grand River Simulation Model (GRSM) of behalf of Centre Wellington, Region of Waterloo, Brant County, City of Brantford, and City of Guelph, as a tool for evaluating the cumulative effects from 10 wastewater treatment plants.

Consultants for the Region of Waterloo used the GRSM for updating their 2018 Wastewater Master Plan and played a key role in the assimilative capacity studies for Waterloo, Hespeler and Kitchener WWTPs. The model was also used to support the

Guelph wastewater master plan (2009) and Elora WWTP expansion (2007), but these projects were quite a while ago.

Extending the GRSM to Lake Erie was deferred as other models were used by ECCC to evaluate the influence of the Grand River on the eastern basin of Lake Erie.

GRCA continues to maintain a monitoring network of nine stations that collect continuous data for model calibration and validation in support of long-term wastewater planning.

A novel approach to develop field-scale drainage network through the use of hydrologically conditioned digital elevation models was completed for the Conestogo, Canagagigue and Nith River basins. The 'Stream Power Index" is now available on the GRCA's on-line data warehouse, the Grand River Information Network.

### D15. Optimizing, managing and collecting data to inform decisions.

The federal and provincial government's investment in water data continue through the Federal-Provincial cost share agreement for the national hydrometric network and the provincial surface water and ground water monitoring programs. These data are fundamental to current and future water management.

Following the endorsement of the Water Management Plan, staffing resources were focused on maintaining the Water Managers Working Group and therefore the Water Quality Working Group is no longer active. However, effort was focused on identifying the various agencies who collect water data in the watershed. A Water Monitoring and Optimization Working Group met in 2015 to compile a water monitoring metadata catalogue as a demonstration of "who's doing what", and discuss how to make data "discoverable" and "shareable". Differences in monitoring objectives, design, frequency of collection and data management became barriers for truly optimizing networks across the watershed.

Through research supported by the Canadian Water Network on Aquatic Cumulative Effects Assessment, it was anticipated that biological indicators would be identified for long-term monitoring. Although some research through individual research projects (e.g. Blair, Mill Creek) by researchers at the University of Waterloo advanced local assessments of biological indicators, a review of biological indicators for the Grand River watershed was not completed.

GRCA implemented a data management system for hydrometric continuous data (KISTERS WISKI software platform). In addition, in 2018, GRCA began to build the framework for managing periodic (i.e. grab) water quality data. These platforms are fully integrated into web-services and can be used to share data among internal and external users.

The Region of Waterloo continues to monitor long-term river water quality conditions above and below their WWTPs with data shared as requested.

GRCA continues to maintain the continuous water quality monitoring network for modelling, operational and wastewater planning purposes. The SCADA system was upgraded in eight of the nine stations and new data sondes were installed in four stations. New data sondes will be deployed at the remaining stations in 2019. A dissolved phosphorus sensor was tested at the York water quality station but field testing failed to yield any useful results.

GRCA continues to partner with the MECP on the Provincial Groundwater Monitoring Network (PGMN). GRCA collects hourly groundwater levels and annual quality data from 38 groundwater monitoring wells throughout the watershed. GRCA also continues to collect continuous groundwater data from an additional18 wells that are not a part of the PGMN program.

In 2017, a continuous conductivity logger was installed at one PGMN groundwater well outside the City of Kitchener to evaluate potential impacts from road salt in the groundwater system.

A continuous nitrate monitor was installed at Bridgeport in 2013 and collected data until February 2019. An identical nitrate monitor was installed at the Brantford water quality station in February 2018 and collected data until June 2018, when the monitor failed. Options for replacing the nitrate monitors at the Bridgeport and Brantford water quality stations are being investigated.

A continuous water quality station was not installed on the Nith River at Phillipsburg as funding was not secured for collecting data for quantifying phosphorus and sediment loads from the upper Nith subwatershed, a priority nonpoint source subwatershed.

A pilot study was undertaken at the York water quality station to develop a relationship between continuous turbidity data and periodic total phosphorus data collected by ECCC using an ISCO automatic sampler. The study was to determine whether continuous data could be used to estimate total phosphorus loads from the Grand River to Lake Erie.

*For more information on the use of turbidity data to estimate phosphorus concentrations and loads, see www.grandriver.ca/wmp*

MECP, in partnership with Dr. Chris Parsons, University of Waterloo continues work on investigating the importance of dissolved phosphorus in Ontario agricultural streams The MECP continues to work on the multi-watershed nutrient study in which it explores

nutrient loading from agricultural sub-watersheds in southern Ontario. Six of the stations we monitor are those that were also included in the past Pollution from Land Use Activities Research Group (PLUARG) study from the 1970's. Through a collaboration with Ryerson University, the MECP is conducting land use/land management surveys similar to what were done as part of PLUARG study. This information will allow us to evaluate changes in nutrient loads as well as land use/land management over the past 40 years between then and now.

GRCA updated the land cover data for the watershed in 2017.

With support of ECCC, GRCA acquired 2016 agricultural and population census data to characterize the watershed for reporting purposes.

Soil mapping in the Grand River watershed is part of the MAFRA soils strategy. This portion of the strategy continues to wait for approval. MAFRA's acquisition of airborne topographic LiDAR in southern Ontario provides the basis for many land-water planning initiatives as well as support the development of mapping products that support flood damage reduction and emergency preparedness

GRCA completed a watershed wide stream hydrology network using 3D Softcopy and GIS technology in 2016. With additional support from MNRF, MECP, MAFRA and ECCC, GRCA was able to leverage this work to produce high resolution digital elevation models, critical nonpoint source area mapping, and create technical guidelines to support others in the community with similar initiatives.

## E. Reducing Flood Damage Potential

Major causes of riverine flooding in the Grand River watershed include the combined effect of winter rainfall and snowmelt, ice jams, widespread heavy and localized intense rainfall. The southern Grand River and Lake Erie shoreline also experiences flooding in response to Lake Erie surges due to strong winds.

The Grand River watershed has a long history of flood management that begins in the early 1900's. Early water management plans identified a mix of structural (e.g. dams and dikes) and non-structural measures (flood plain regulations, flood forecasting and warning) to reduce the risk to public safety and property damage from flooding. It is estimated that structural measures implemented by the early 1980's have reduced average annual flood damages by 80%[11].

Over the years, the flood management program continues to be very effective in reducing flood damage potential. There are opportunities, however, to continually improve upon and adapt the program given new improved topography, improved models, such as US Army Corps of Engineers Hydrologic Engineering Centre (HEC) suite of water management analysis software, more sophisticated communication systems and monitoring technology.

Floodplain regulations continue to help reduce and avoided the creation of any new flood damage potential. Reviewing and adapting policies with the most up to date information will also underpin future flood damage reduction.

A changing climate suggests that more intense or extreme events may increase the frequency and change the timing of when floods may occur. Senior Engineers/Dam Operators continue to collect, review and analyze river flow, weather, and climate data to understand watershed conditions and proactively manage flood risk. A changed climate may result in more dynamic shifts from extreme cold to spring melt conditions over a short period of time as was the case for the February 2018 event.

Although much has been done, there still remains the potential for large floods to occur. Therefore, flood preparedness, including forecasting, warning and communications is also critical to an effective flood program.

The following provides a status of the actions aimed to reduce flood damage potential in the Grand River watershed.

The GRCA manages riverine and coastal flooding.

**Riverine flooding is the excess of flow in a watercourse such that areas beyond the normal banks are submerged or inundated.** Within the Grand River watershed, this type of riverine flooding is typically the result of rainfall, snowmelt, or rain on snow runoff events over a very large part of the watershed. This type of flooding can also be caused or exasperated by restrictions in the natural flow capacity of the river channel through obstructions such as ice jams, debris jams, or physical infrastructure (e.g., culverts, bridges, or encroached developments). The key aspect is that there is a defined watercourse (i.e., a feature with bed and banks) that does not have the capacity to contain the flows to which it is subjected.

**Coastal flooding** within the Grand River watershed occurs along the shoreline of Lake Erie and is typically the result of high water levels, storm surges, waves or, typically, a combination of the three.

Municipalities and homeowners are responsible for localized flooding.

**Overland flooding** which can be defined as water on the landscape not associated with a watercourse. In a rural context, this type of flooding is exemplified by water ponding or flowing across fields that are typically dry, or flows in excess of roadside ditch capacity that spill onto fields or over roadways. In an urban context, this typically relates to flow on roads or across other surface areas, owing to limitations in the underlying storm sewer system (if one exists) – e.g., blockages at the storm sewer system inlets or simply flows in excess of the capacity of the system causing water to back-up onto the surface. The key aspect in differentiating this type of flooding from its riverine counterpart is that there is no associated watercourse that

the flooding is coming *from*, but more that the water cannot get *to* the receiving system.

**Basement seepage flooding** occurs when high groundwater tables occur around a building's foundation and joints, cracks, or holes allow the water to seep through the walls and into the basement. This type of flooding can occur anywhere on the landscape – i.e., it could be related to elevated levels in nearby watercourses, or may simply be a locally high groundwater table.

**Sewer backup flooding** occurs when flow in the piped portion of an urban drainage system, either storm sewer or sanitary sewer, exceeds its capacity and causes stormwater or sanitary sewage to back-up through piped connections into adjacent basements, or surcharge onto the roadways to become overland runoff.

## Actions to maintain flood damage reduction infrastructure

For large scale riverine flooding, such as the flooding on the Grand, Conestogo and Speed rivers, the critical flood damage reduction infrastructure are the dams, dikes, channels and spillways.

Infrastructure to deal with localized urban impacts include the minor stormwater systems system such as sewers and the major systems such as roadways.

An increase in the frequency and magnitude of severe storm events will put stress on both the watershed's critical dam and dike infrastructure and urban stormwater systems.

### E1. Dam and dike safety studies

The seven large dams and the three dike systems in Kitchener, Cambridge and Brantford are significant infrastructure assets that are required for managing flood risk in the watershed. These assets require a commitment to long-term maintenance and funding to ensure that they are safe and ready to respond to floods. Dam and dike safety studies provide the necessary information for maintaining and operating the infrastructure.

Each year the GRCA reviews and updates its annual and five year capital infrastructure budgets. Technical studies are identified and maintenance needs prioritized to ensure infrastructure is maintained and ready when called upon to manage floods.

GRCA accesses funding through the MNRF Water Erosion Control Infrastructure (WECI) program. This funding supports 50% of project costs. Since 2014, GRCA received about $2.5M funds for a number of dam safety and infrastructure projects.

Projects in 2018 included a gate failure study at Conestogo Dam; a study looking at the probable maximum flood at Woolwich dam; emergency planning flood thresholds study for the Cambridge Dikes; and some smaller studies updating manuals and upgrading operations lighting to the New Dundee dam.

The Bridgeport, Cambridge and Branford dikes are critical infrastructure that reduces flood damage in these communities. These dikes have been in place since the late 1970's and early 1980's. Agreements are in place with the local municipality to ensure that these dikes are maintained.

Brant County is nearing completion of a condition assessment of the Grand River Dike System through the downtown section of Paris.

In addition to having agreements for maintenance on large dikes, agreements are also in place for small dams so that operations plans are maintained. [Agreement with City of Waterloo for Columbia dam)

Work is underway to complete a multi-agency and multi-municipality test of the Conestogo Dam Emergency Preparedness Plan (EPP). Information being prepared for the Conestogo Dam EPP is developing reached based information to improve preparedness for a continuum of floods from frequent minor floods up to extreme floods such as a dam-break flood. Dam-break floods have an extremely very low probability of occurrence but carry a high consequence. Organizing information for a full range of scenarios allow emergency managers to become familiar with the requirements for managing smaller flood events thus improving their experience and preparedness for more extreme events.

### E2. Urban stormwater systems

Major and minor stormwater systems within a municipality serve to catch and divert excess water. Minor systems including sewers and stormwater ponds can accommodate relative minor runoff events while major systems, such as roadways and roadside ditches are designed to divert high runoff events. These systems require a commitment to long-term maintenance to reduce the risk of urban flooding.

Kitchener's SWM utility came into effect 2011. The master plan (2016) included a minor system (storm sewer capacity) assessment that included consideration for climate change (modelled a 20% increase in IDF curve and rainfall depths for the 5 year storm event). A potential future update of this work may include a secondary assessment including the trunk sewer model.

The City of Waterloo's Stormwater Master Plan update is currently underway.

The City of Brantford included an assessment of its stormwater infrastructure in the Master Servicing Plan (MSP) in 2014. The MSP update was initiated in 2017 and is currently in progress with the improvements to the stormwater assessment included.

GRCA continues to work with Environment Canada Meteorological Services Branch to incorporate additional hydrometric data from various sources. The Canadian Precipitation Analysis (CaPA) is completed and is now operational at ECCC. Further, the Network of Networks continues to gain interest among Ontario Conservation

Authorities and ECCC. GRCA will continue to participate in these discussions moving forward.

Updated urban drainage standards are needed by the Province of Ontario to reduce potential for flooding in new urban development for major overland flows experience during severe weather events. Current urban drainage standards for major overland flows is based on the 1% chance flood. The 1% chance flood is more vulnerable to change under climate change placing urban storm water infrastructure more at risk in the future. These standards are still outstanding.

## Actions to improve non-structural methods and approaches for reducing flood damage potential

In addition to structural (e.g. dams and dikes), GRCA uses non-structural methods for managing flood damage reduction. Improved computing technologies and geospatial data acquisition has provided for improved mapping products for emergency planning and preparedness and improved modelling for flood forecasting. Communication technologies have also improved greatly and allow for flood messaging to be fanned out to the appropriate emergency responders more seamlessly. Policies and regulatory approaches continue to provide a means with which to limit future flood damages while accurate mapping products can help with emergency preparedness.

### E3 & 4 Flood Hazard mapping products

Recent advances in technology and computing allows for the capture of geospatial data at a resolution and accuracy not seen before. A number of projects were completed to advance the development of flood mapping products.

GRCA completed a watershed wide stream hydrology network using 3D Softcopy and GIS technology in 2016. With additional support from MNRF, MECP, MAFRA and ECCC, GRCA was able to leverage this work to produce high resolution digital elevation models, critical nonpoint source area mapping, and create technical guidelines to support others in the community with similar initiatives. This data layer assisted with updating the location of the Regulation Limit – those areas that are subject to the *Development, Interference with Wetlands and Alternations to Shorelines* and *Watercourses Regulations* made under the Conservation Authorities Act.

Flood preparedness planning ensures adequate and timely response to an emergency. Planning for municipal emergency response includes knowing who and what might be located in the floodplain. In 2016, GRCA prepared 35 Flood Emergency Maps and compiled statistics of the infrastructure (roads, structures and critical infrastructure) located in the floodplain and circulated them to the relevant municipality. The algorithms used to identify the flood prone areas are freely available to municipalities in the watershed so that they can use with more accurate local mapping data. These maps will be enhanced once more detailed LiDAR data become available in early 2019.

In the future five zones of flooding will be identified along major rivers, once these zones are developed it will be possible to create a series of maps to identify the area of impact from small floods up to the Regulatory flood. In areas downstream of large dams an additional 3 zones will be added to identify the area of impact of the probable maximum flood and two dam-break floods.

The capture of elevation data, through technology like LiDAR, helps to spatially define topography and other structures (e.g. trees, buildings) on the land surface. These data, when compiled in a geographic information system, enables a deeper representation of river flow pathways, including those lands in areas where water may spill onto such as floodplains during high flows. These **highly detailed mapping products** can thus inform measures to reduce flood damage reduction and emergency preparedness.

Mapping products include flood hazard maps. **Flood hazard mapping** has evolved from the one-line outer defined limit to the characterization of the topography in three dimensions (X, Y and Z). These data can then characterize multiple elevation lines that enables the depiction of water inundation in a river reach under various flow scenarios. This allows for the development of **inundation maps** that can be used to help identify different zones of risk. An extension of this is to also illustrate the topographic elevations beyond the defined floodplain to provide context for evaluating the **probable maximum flood maps** or dam-break scenario. Floodplain maps are needed for regulating development in high-risk areas.

With the advancing sophistication of geographic information systems (GIS) and computer software, GRCA is currently migrating all floodplain mapping into the digital realm and adding additional geospatial data such as topographic and built infrastructure data, to deepen the ability to evaluate flood risk. This digital realm helps to manage the terabytes of data generated by new terrain mapping technology such as LiDAR. The products produced by the new data capture techniques can create increasingly detailed map products to inform floodplain management, emergency preparedness and flood damage assessment.

MNRF and MAFRA initiated a project to acquire Airborne Topographic LiDAR (ATL) data. This project was for acquiring classified digital elevation data and derivative products to support agricultural soil map renewal in selected areas of southern Ontario. The data acquired through this project will enable the development of high resolution three-dimensional digital elevation models (DEM) that are invaluable for agricultural soil mapping, infrastructure assessment, land hazard/erosion mapping and flood management among other applications. This data provides complete watershed coverage for all areas “above-the-banks” (i.e., not underwater) to an accuracy previously unachievable in the absence of labour-intensive field survey. Data acquisition was completed in 2017-2018 and data was transferred to the GRCA in early 2019.

The extent of the floodplain and depth of flood water assists with implementing regulations which continue to help reduce and avoided the creation of any new flood damage potential. See **Figure 7** for a summary of permits reviewed by GRCA staff since 2014.

A flood damage centre is a community that has several structures located on the floodplain. There are 33 permanent Flood Damage Centres (FDC) and 19 seasonal flood damage centre (i.e. trailer parks) in the Grand River watershed. Floodplain topographic mapping for FDCs, trailer parks and rural properties is in progress. Reasonable advancements have been made since 2014 with significant gains anticipated in coming years owing to improved technology for elevation and topographic data capture (e.g. LiDAR).

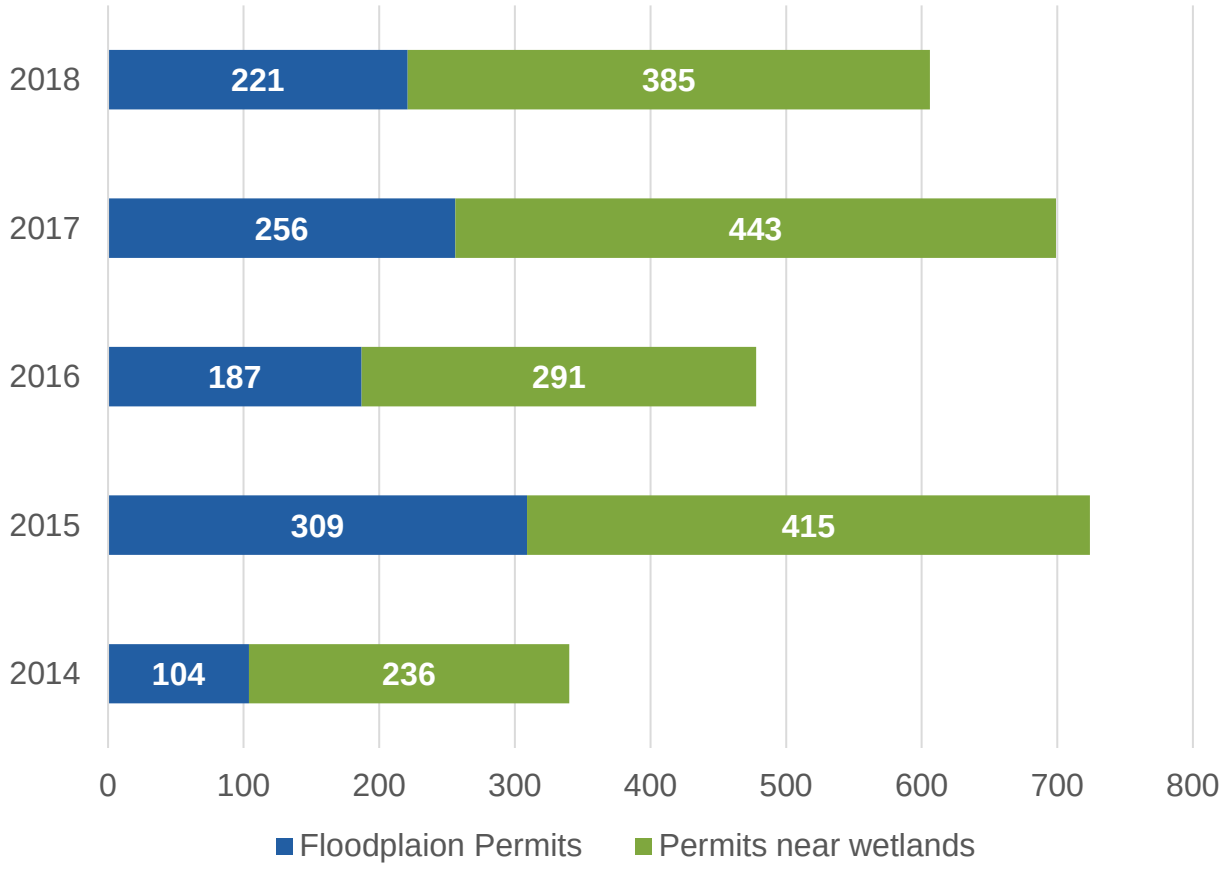


***Figure 7.*** *Total number of permits reviewed by GRCA staff each year to actively manage development in the floodplain and around wetlands to help prevent future flood damages.*

The availability of flood inundation mapping is important to support effective municipal flood preparedness plans. This mapping shows where flooding may occur over a range

of water levels. In 2014, inundation mapping was available for four of the high flood risk municipal FDCs including New Hamburg, Ayr, Drayton and Wolverton, and none of the seasonal flood damage areas. Flood inundation mapping was in progress at Grand Valley (Grand River), Waldemar (Grand River), Paris (Grand River), Paris (Nith River), Elmira (Canagagigue Creek), St. Jacobs (Conestogo River), and Glen Allen (Conestogo River).

Since that time, the inventory has since grown to include community based flood inundation mapping at an additional six municipal / permanent FDCs including West Montrose (Grand River), and the Lake Erie Shore at Port Maitland specifically, and also across the remainder of the Haldimand County frontage. Detailed inundation mapping has also been completed at one seasonal FDC, West Montrose Family Campground (Grand River).

In response to increased risk of shoreline flooding along the Lake Erie shoreline in Haldimand county the three conservation authorities covering Haldimand County participated in an emergency planning exercise in November of 2017. As part of this emergency planning exercise five flood zones were defined across the Haldimand County shoreline to improve preparedness for future Lake Erie flood events. These maps will be refined as new information is developed from the shoreline hazard mapping study currently underway.

In response to a significant flood event in 2017, GRCA further refined inundation mapping for the Grand River reach that flow past the village of West Montrose (see **Figure 8**). A list of properties in each flood zone was identified and will be integrated into the municipal community alerting system

Floodplain topographic mapping associated with dam-break analyses has been completed through Guelph (Speed River), Fergus (Grand River), and St. Jacobs (Conestogo River).

Some reaches, such as Laurel Creek through Uptown Waterloo, portions of Schneider Creek in Kitchener, and downtown Paris in the Grand / Nith confluence area have been subjected to detailed two-dimensional hydraulic modelling and mapping as part of municipal planning activities.

With funding support provided through the federal National Damage Mitigation Program (NDMP), the GRCA undertook a proof-of-concept bathymetric data acquisition project in Fall-Winter 2018-2019. This “between-the-banks” data covers the Grand River (headwaters to Lake Erie), Conestogo River (headwaters to Grand), Speed River (Guelph Dam to Grand), Willow Brook, Irvine Creek, and Moorefield Creek. The two datasets will be combined in spring 2019 to create a seamless DEM.

GRCA continues to work with municipal partners, including the cities of Waterloo, Kitchener, and Cambridge and the County of Brant to incorporate floodplain information, updated mapping, and policies into municipal planning.

Two-dimensional hydraulic modeling has been developed for Laurel Creek through Uptown Waterloo; within portions of Schneider Creek in Kitchener; and through downtown Paris in the Grand / Nith confluence area. The work was completed largely as part of municipal planning activities, but is beneficial to flood warning accuracy and provides information useful to minimizing flood risk. Information from this work will provide important based information for municipal emergency response plans for the Special Policy Areas in these communities.

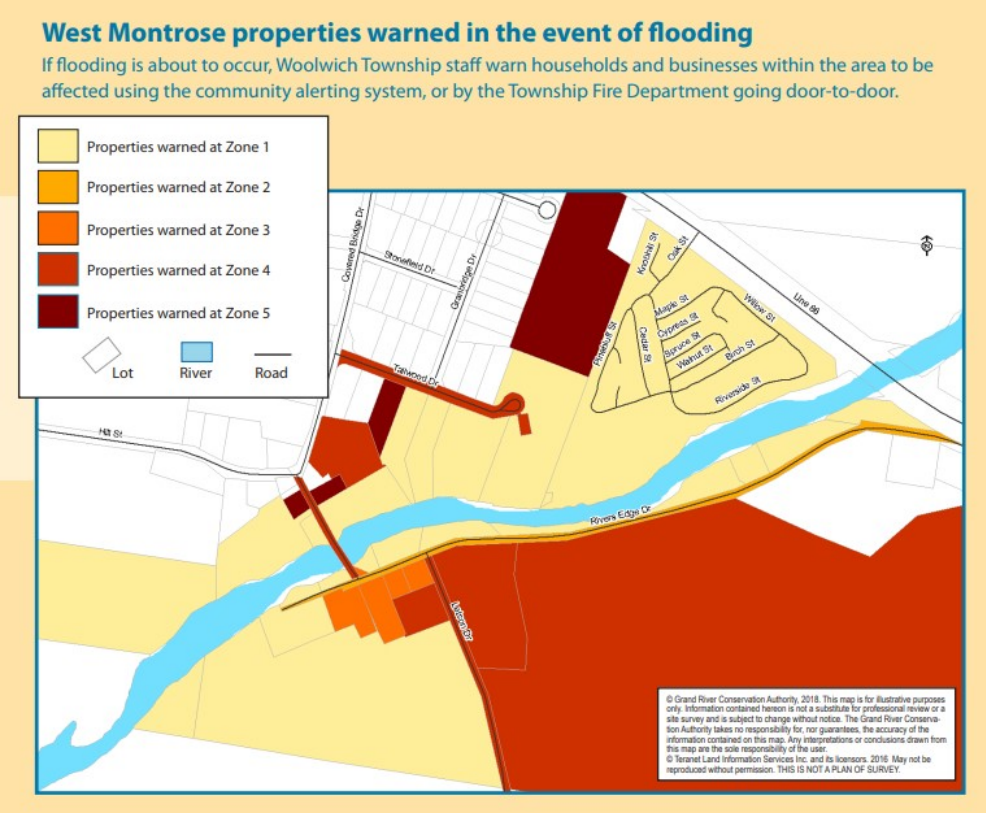


***Figure 8.*** *Flood warning zones for the village of West Montrose.*

Floodplain mapping projects have been accounted for within capital forecast budgets. August 2018 GRCA board report documented $1,300,000 in forecast expenses between 2018-2021 with funding coming from a combination of Federal Government National Disaster Mitigation Program (NDMP) and the province and the land sale reserves (as allowable). Updates are underway to the Lake Erie shoreline flood, erosion, and dynamic beach hazard mapping in Haldimand County with funding from the County and

the NDMP. The federal NDMP will continue to be leveraged as possible if/when it sees renewal.

The NDMP (2014-2018) largely replaced the Flood Damage Reduction Program. The program experienced administrative delays in its early years with relatively limited uptake, hitting its stride only in the last couple years' of intakes. With funded projects scheduled to conclude in spring 2020, the GRCA is actively engaging with CO and other partners (e.g., MNRF) in advocating for the extension / restoration of this valuable program.

Updated mapping for Special Policy and Two Zone areas have been completed by request from municipalities. Projects include:

- Laurel Creek through Waterloo (in progress)
- Reaches of Schneider Creek in Kitchener
- Groff Mill Creek in Cambridge
- Grand River / Nith River in Paris

Flood forecasting and warning is an important component of the flood management program. The advanced warning of a flood reduces the risk to life and property and supports emergency preparedness. Flood forecasts also provides the necessary information for senior flood operators to operate the large dams to safely reduce downstream flooding.

Regular communication among GRCA senior flood operators happens every day and a weekly debriefing meeting every Friday allows for the continuous operation and management of the large dams, training of new senior operations and succession planning. GRCA hosts annual meetings, held each February, of the Community Emergency Management Coordinators (CEMCs), Municipal Flood Coordinators and other Emergency Response personnel to reaffirm roles and responsibilities of the various agencies and ensure that there are established lines of communication prior to spring runoff.

### E5. Communication technology

Reliable communication technology is essential to effectively respond to flood emergencies and severe weather events. There have been significant changes in technology over the past 40 years and it continues to change. Landlines have given way to cell phones; mass notification technology; and social media among others.

GRCA continues to maintain the voice communication as a means for redundancy to newer technologies like cell phones, etc. As technology evolves, GRCA plans to explore implementing a voice radio system with public safety communications capabilities to allow seamless communications with fire, police and other emergency services staff.

A number of technology approaches to communications has been added over the past 5-10 years to keep up with changing communications technology. For instance, an email protocol for flood warning messages was implemented in 2008, automated voice notification to flood coordinators and emergency responders was implemented in 2016 as part of the GRCA flood warning system. GRCA's website was updated with self-serve information regarding river flows, precipitation, and reservoir levels (see **Figure 9**). This platform has significantly reduced the number of phone calls from the public.

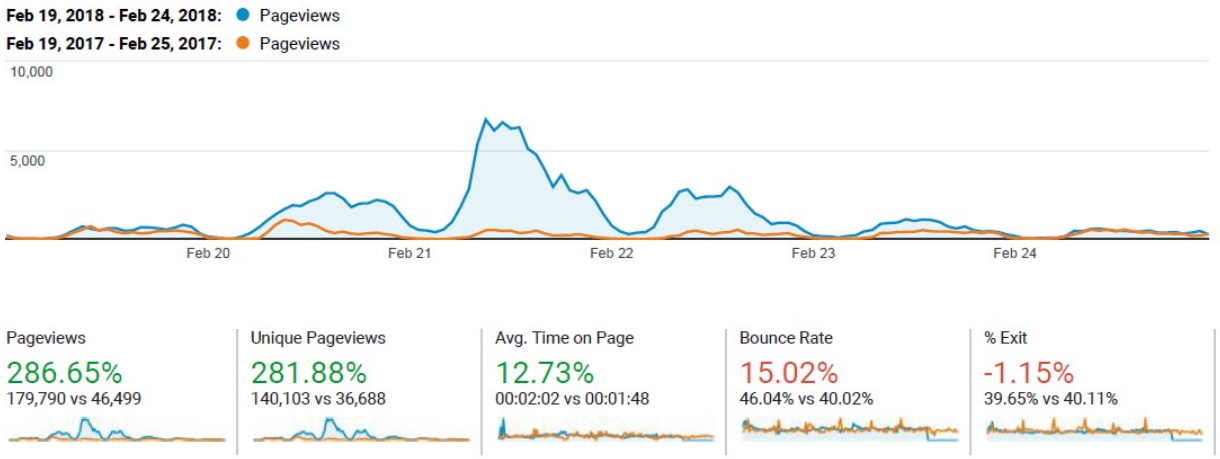


***Figure 9.*** *The GRCA Website continues to service the public during flooding events. For example, during the 2018 ice jam event in February, the website experienced up to 140K unique page-views*

Currently, GRCA is updating the flood management SCADA system to a web-based portal to the real time data by GRCA staff.

## E6. Flood forecasting

Near real-time precipitation and streamflow data are critical for flood forecasting.

Currently, GRCA, MNRF and Water Survey of Canada maintain 55 streamflow and nine precipitation gauges in the watershed. Data from these monitoring stations help to run models, such as the Guelph All-Weather Sequential-Events Runoff (GAWSER) hydrology model and the Grand River Integrated Flood Forecasting System (GRIFFS).

GRCA currently uses the GAWSER hydrology model for flood forecasting and surface water modeling. However, there is uncertainty regarding the long-term viability of this model due to its limited user-base and the future retirement of the current model developer. The GRCA is migrating the surface water modelling and flood forecasting modeling previously completed using the GAWSER model to the US Army Corps of Engineers (USACE) HEC-HMS hydrology model. The USACE'S HEC model suite is affordable, well supported and has a broad user base.

The GRCA is also migrating toward the HEC-RTS (Real Time Simulation) flood forecasting framework for real time hydrologic modelling for decision support of water control operations.

In 2018, GRCA started to acquire weather forecast information from an external provider, Meteoblue, which provides 7-day hourly forecast for temperature and precipitation. The precipitation forecast differentiates between different types of precipitation, rainfall and snowfall, using a snow fraction parameter. The hourly forecasts are downloaded for northern, center and southern portions of the watershed twice per day and through implemented procedures, are reformatted to be compatible with Grand River Flood Forecasting Software such that at every hour, an input file is automatically generated for use with  for flood forecasting software.

Having a number of different weather forecasts is important to evaluate future potential flood events including the MNRF, ECCC, NOA and Intellicast (Weather Underground). GRCA continues to implement a data management system for hydrometric data and is working with others to ensure seamless sharing of this information.  GRCA is also acquiring through web-services precipitation data that bound the watershed to improve forecasting within the watershed.

GRCA continually improves the local monitoring system to provide reliable, timely delivery of information to forecast floods and support reservoir operations decisions. Work is ongoing to upgrade the communication infrastructure to cell-base and adding satellite based communication as redundancy to improve business continuity during extreme weather events.

GRCA continues to investigate the GOES satellite communications capabilities for data collected at stations and dams as existing monitoring equipment is upgraded.

GRCA continues to participate on the Ontario Climate Advisory Committee and advocate to improve sharing of climate information and integration of a broad range of climate information into Environment Canada products to improve documentation of climate events and present the best estimate of precipitation amounts and extents.

GRCA continues to investigate and operationalize new weather forecast information and available real-time monitoring data to assemble the best estimate of precipitation in real time to input to forecast models.

### E7.  Communication and flood warning messaging

Flood warning requires network of various emergency personnel to be informed promptly so that they can adequately respond and warn those people who maybe in harm’s way. Between 1975 and 2010, the main route for disseminating flood messages went through the Canadian Police Information Centre (CPIC) communication system and then on to municipal flood coordinators.  However, recent changes have taken place.

In 2010, following two larger floods in 2008 and 2009, the Ontario Provincial Police requested to reduce their and CPICs effort in delivering flood messages. This was an opportunity to use newer communication technologies and therefore, work was initiative to modernize procedures for delivering flood messages.

GRCA issues flood warning messages directly to municipal flood coordinators,

Community Emergency Management Coordinators (CEMCs), Waterloo Region Police Services (WPRS), municipal police services and Ontario Provincial Police. WRPS distributes flood messages to WRPS detachments and act as a backup along with Provincial and municipal police services to deliver flood warning messages to Municipal Flood coordinators and CEMC's if other methods of communication fail.

The GRCA monitors watershed conditions to predict flooding; operate dams and reservoirs to reduce the effects of flooding and issue flood warning messages to Municipal Flood Coordinators or CEMCs and other first responders. GRCA has a "fan-out" flood warning system to provide timely flood warnings and information to municipal officials and watershed residents. The GRCA's fan-out system targets flood coordinators including municipal CEMC's, municipal Flood Coordinators and first responders.

Annual Flood Coordinator meetings are held to review the flood fan-out system, communication procedures and review roles and responsibilities. The primary responsibility for managing a flood emergency rests with the municipality, through its emergency plan.

Consistent terminology is fundamental to alerting the public of an emergency. In Ontario, there are three types of flood messages: Watershed Conditions Statements, Flood Watches, and Flood Warning messages:

**Watershed Condition Statements** include watershed outlooks and water safety messages. Watershed outlooks may be issued well before a flood. These messages are typically issued if the flood risk is higher than normal to create early awareness. Water safety messages are issued to make public aware of water hazards and take precautions to protect personal safety.

**Flood Watch messages** are intended to raise awareness of weather conditions that could potentially result in flooding.

**Flood Warning messages** warn of flooding in specific areas.

The number of flood messages issued since 2010 is summarized in **Figure 10**.

### E8. Additional options for flood damage reduction in small communities

Additional flood reduction measures must always be considered alongside existing structural and non-structural approaches. Many small communities including Drayton,

New Hamburg, Ayr, Grand Valley, Paris, Caledonia, Cayuga and Dunnville could benefit from additional flood damage reduction measures.

GRCA assisted the Township of Mapleton to maintain a small dike and rehabilitate the Conestogo River channel through the town of Drayton in 2015. This work helped to reduce nuisance flooding in the town.

Additional work that was undertaken or is currently underway to assist with flood damage reduction includes the newly proposed work to review the flood mitigation strategies for New Hamburg as part of the federal NDMP. Channelization of the Conestogo River through Drayton has increased the channel's capacity for moving flows through the village. Inundation mapping has been completed for West Montrose, Grand Valley, Waldemar, Conestogo, Wolverton, and Drayton. In addition, a five hour forecast system is now in place for West Montrose and emergency personnel can access this information via an application on their cell phones.

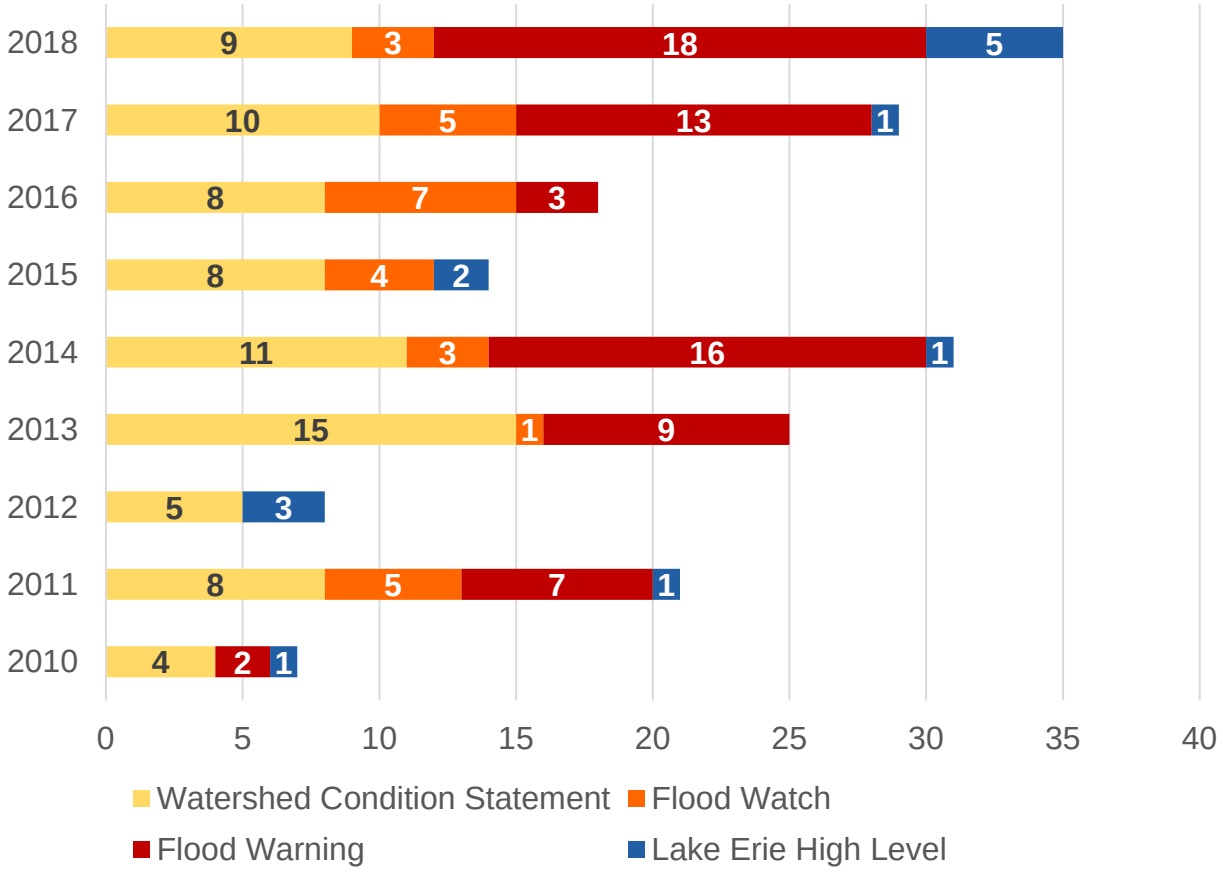


***Figure 10.*** *Number of flood messages issued by GRCA since 2010.*

### E9. Ice jams

Ice jams in the river have the potential to cause significant flooding. Grand Valley, West Montrose, Paris, Brantford, Cayuga and Dunnville are some of the communities that are more prone to ice jams. In response to the significant ice jam event in Brantford in 2018, a number of projects and studies were initiated. Significant effort was invested to document conditions leading to the ice jams in 2018 and 2019 and to document the after math of the ice jams to further the understanding of ice processes and improve awareness and preparedness for father events.

## F. Summary and Next Steps

The Water Management Plan documents 163 actions that Plan partners, and others, have contributed to achieving the goals of the Plan - to ensure water supplies, improve water quality, reduce flood damage potential and to build resilience to deal with climate change.

Most of the actions listed by Plan partners have either been completed or well underway to being completed. There are, however, a few actions that were not completed due to a change in priorities and new actions were initiated in response to opportunities that arose and in response to two large floods June 23 2017 and February 21st 2018.

The following outlines key next steps to maintain active water management in the Grand River watershed:

- Maintain the Water Managers Working Group as a mechanism to share information, align work plans for collectively managing water across jurisdictional boundaries;
- Continue to evaluate the economics of implementing wastewater treatment plant upgrades versus additional rural nonpoint source management strategies to identify best value solutions
- Continue to investigate the utility of nutrient recovery technologies for wastewater
- Investigate the feasibility for producer-municipal partnerships for jointly run manure/municipal organic waste (source separated organics, septage) biogas technology for nutrient management and energy production.
- Review and update if necessary, the 7Q20 equivalents as they related to wastewater master planning
- Determine the best management practices to reduce the influence of tiles on water quantity and quality
- Investigate the implications of climate change to inform future reservoir and river management;

Some key aspects of the Plan still require attention:

- Review and update the Drought Contingency Plan. The last Plan was documented in 2014 however, it was based on the 1998/99 drought. A renewed effort on proactive planning for drought is needed.
- Advance collaborative actions and understanding on securing current and planned sources of municipal water supply. Review and update the discussion paper with municipal water managers, and the MECP that documents considerations for securing municipal water supplies.
- Local water plans are needed in areas of constraint. Constraint can be with respect to quantity and quality. Areas of constraint include areas of Brant and Norfolk counties (quantity); Wellington County/Wellington North/Mapleton
- (quality); Wellington County/Guelph-Eramosa (quantity); East Luther-Grand Valley/Amaranth/Melancthon Townships (quality)

**What more is needed?**

Water management is not a project that is done once but rather a process for continuous improvement. Some suggestions looking forward include:

- More effort integrating land use planning and water management planning
- Re-think urban and rural water management and move toward an integrated *One Water* approach – integrating both urban and rural water cycles within a larger (Grand River) watershed. To do this, engagement of the regulatory community (MECP, MAFRA) is vital.
- Incorporate economic analyses into water projects and align with the Blue Economy of the Great Lakes Region; promote the high quality of life offered through enhanced water stewardship sustainability
- Consider a Headwater Strategy – focus on maintaining key hydrologic process in the headwaters to protect water quality and reduce flood damage potential.
- The Rural Water Quality Program is a well-established and respected mechanism in the watershed to accelerate offsetting water quality, water quantity and environmental benefits. Building and nurturing this approach requires a long-term commitment from all partners.

*"The one water approach views all water – drinking water, wastewater, stormwater, grey water and more – as resources that must be managed holistically and sustainably. Doing so, builds strong economies vibrant communities and healthy environments."*

*uswateralliance.org*

# Endnotes


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[11] Grand River Implementation Committee. 1982. Grand River Basin Water Management Study. www.grandriver.ca

# Appendices