

Appendix III: Master List of Gaps and Needs

I. SOURCE WATER PROTECTION:

Gaps for current conditions:

- Delineation of well-head protection areas
- Vulnerability scoring for well-head protection areas
- Threats and issues evaluation
- Calculation of managed lands
- Calculation of livestock density
- Data base of Federal lands within the region
- Geographical gaps in surficial water mapping
- Limited number of stream flow gauges
- Limited coverage for shoreline conditions classification
- Data on actual water takings; not just maximum permitted
- Absence of active weather stations at north end of Mississippi Watershed – guidance/tools to extrapolate and extend projections
- Insufficient population statistics to calculate the population of development areas
- Insufficient population statistics to calculate private services areas
- Insufficient population statistics to calculate seasonal residents
- Digital Official Plan mapping for some areas
- Lack of surface water quality monitoring stations/programs beyond the municipal groundwater systems
- Lack of data on actual water taking from private wells
- Lack of data on water taking from agricultural water users
- Lack of data on non-permitted water users
- Lack of information around groundwater recharge and discharge
- Lack of information around evapotranspiration
- Need to improve our understanding of sub-surface conditions for water well records
- Need to improve our ability to calibrate our groundwater model that better captures water well records
- Limitations with provincial water well records; such as static water levels
- Limitations with provincial water well records such as well locations
- Limitations with provincial water well records such as geological descriptions
- Lack of information about the hydraulic conductivity of our aquifers
- Lack of information about the porosity of our aquifers
- Lack of information about the transmissivity of our aquifers
- Lack of information about the storativity of our aquifers
- Lack of information about water levels of our aquifers
- Lack of information on overburden conditions

- Limited information about bedrock faults
- Lack of information on the characterization of groundwater movement in fractured bedrock
- Lack of information about the location of abandoned wells
- Limited documentation available to confirm conditions regarding spills
- Help in delineating the IPZ-2 for water intakes on Quebec side of the Ottawa River
- Limited information on transport pathways in the IPZ-3
- Improved information on the extent of drains in the IPZ-3
- Improved information on the extent of trenches in the IPZ-3
- Improved information on drain features
- Improved information on karst features
- Incomplete hydrologic information upstream and in vicinity of each intake
- Incomplete hydraulic information upstream and in vicinity of each intake

From Hydrologic Guide:

Meteorological data:

- Meteorological data on hydrology
- Meteorological data on evaporation
- Meteorological data on wind speed
- Meteorological data on relative humidity
- Meteorological data on solar radiation
- Mean temperature: annual
- Mean temperature: seasonal
- Mean temperature: monthly
- Mean temperature: daily
- Maximum and minimum temperature: daily
- Mean total precipitation: annual
- Mean total precipitation: seasonal
- Mean total precipitation: monthly
- Mean total precipitation: daily
- Mean total snowfall: annual
- Mean total snowfall: seasonal
- Mean total snowfall: monthly
- Mean total snowfall: daily
- Mean total rainfall: annual
- Mean total rainfall: seasonal
- Mean total rainfall: monthly
- Mean total rainfall: daily
- Mean total rainfall: hourly
- Mean total rainfall: 30 minutes
- Date of spring break up

- Frequency of severe weather events
- Frequency of severe winter storms
- Frequency of extreme rainfall
- Frequency in drought or dry periods

Hydrologic data:

- Data on runoff
- Variability; amount and seasonality of streamflow
- Water temperature
- Changes in water use requirements
- Inadequate baseload information in current streamflow gauge network
- More continuous data
- Lack of standardization in stream flow gauges
- Data on headwater sites
- Data on near shore sites
- Data where watercourses are not typically flood prone

Gaps for Climate Change:

- Projections of river and stream water flow under climate change
- Regional and local-scale projections on temperature and precipitation and uncertainties around them
- Future water budgets projected under climate change; for precipitation and evapotranspiration

From Hydrologic Guide:

- Projections for extreme events
- More accurate projections of light precipitation
- More accurate projections of heavy precipitation
- Need for multiple scenarios (and updated scenarios)
- Need for multiple storylines for non-climate changes
- Projections for near term; mid century and towards the end of the century
- Baseline information from 1961-1990 and 1971-2000
- Improved coupling of climate change models to hydrologic models; that addresses inter-annual conditions
- Improved coupling of climate change models to hydrological models; that address day-to-day variability
- Modeling of sequences in wet and dry days
- Modeling of patterns of intense precipitation
- Improved estimation of future floods
- Improved estimation of future droughts
- Improved estimation of future ground-water recharge

- Improved estimation of future timing of snow-melt
- Improved estimation of future peak stream flows
- Improved estimation of future short-duration precipitation events
- Ability to capture locally significant features in climate change projections
- Limitations in local conditions from GCM output; especially in projections of precipitation an hour or less in duration
- Future daily streamflow
- Future hourly streamflow
- Future monthly evapotranspiration
- Future direct overland runoff
- Future groundwater recharge
- Future aquifer water levels
- Future discharge to streams

II. LOW WATER RESPONSE:

Gaps for current conditions:

- Annual mean temperature
- Seasonal mean temperature
- Monthly mean temperature
- Daily mean temperature
- Daily maximum temperature
- Daily minimum temperature
- Water temperature
- Annual mean precipitation
- Annual mean snowfall
- Annual mean rainfall
- Seasonal mean precipitation
- Seasonal mean snowfall
- Seasonal mean rainfall
- Monthly mean precipitation
- Monthly mean snowfall
- Monthly mean rainfall
- Daily mean precipitation
- Daily mean snowfall
- Daily mean rainfall
- Improved stream flow data
- Improved stream depth data
- Gaps in stream inflow data
- Gap in identifying alternatives to surface water supply
- Gap in documenting water conservation practices among main water takers
- Gap in documenting water conservation practices among agricultural producers
- Gaps in documenting changes in timing of water taking
- Gaps in documenting efficiency of irrigation practices and systems
- Gaps in measuring ecological health and for thresholds and trigger levels
- Gap in reporting on what constitutes a scientifically defensible threshold for ecological damage for fish and aquatic species
- Gap in reporting on what constitutes ecological damage on wildlife
- Gaps in monitoring relationships between aquatic and terrestrial ecosystems
- Seasonal water use
- Economic evaluation of drought impacts on agriculture
- Recommendations for prioritization of water use restrictions
- Impact assessments of water restrictions
- Need for updated water budgets
- Gap in estimates of rainfall required to alleviate low water conditions
- Gap in monitoring of real time water takings

- Calculating the impact of conservation measures adopted by large water takers
- Populated AgRI mapping from OMAFRA in key suspect subwatersheds along with delineation of irrigation networks (if possible);
- Watershed characterization: mapping of crop type (similar to the AgRI mapping completed by OMAFRA) done on an annual basis.
- Watershed characterization: Mapping of the irrigation network on an annual basis.
- Watershed characterization: Annual production numbers of core; irrigation-dependent crops (e.g. sod; potatoes; carrots; onions; etc) including tonnage.
- Watershed characterization: Annual economic value of crop;
- Watershed characterization: Summary of crop insurance pay-outs (to determine economic impacts);
- Watershed characterization: Other sector impacts; e.g. socio-economic impacts to golf courses;
- Municipal water restriction: summary of the municipal water restriction programs;
- Municipal water restriction: description of impacts to water levels from water restriction programs;
- Chemistry/biology: surface water and sediment chemistry data and fish; benthic macroinvertebrate; and algae data to detail the environmental impacts to water courses;
- Assistance in finalizaing and rolling out of the groundwater low water indicator methodology; and
- Help produce case studies on past rainfall events to take them out of a drought situation;
- Need to draw from the SWP program that has actual water use numbers;
- Utilize groundwater data to identify trends in seasonality; recharge periods and volumes; and baseflow data;
- Update the subwatershed water balance (budget);
- Additional data for guidance available from various Ministries; including data for socio-economic analysis.

Gaps for Climate Change:

No data or information gaps identified

III. STORMWATER FLOODING AND MANAGEMENT:

Gaps for current conditions:

- Long-term baseline weather data;
- Expanded coverage for long-term baseline weather data;
- Expansion of stream monitoring network (and sharing and standardization of data?);
- Expansion of rain gauge network;
- Improved groundwater monitoring;
- Improved monitoring and assessment of water flows between stream flows and groundwater;
- Updating of IDF curves;
- Inventory and mapping of stormwater systems;
- Measuring differences between design standards and actual performance of stormwater systems; both current and changes over time;
- Long-term meteorological monitoring stations to produce baseline climate/weather data;
- Need for an integrated ecosystem approach to stormwater management planning;

Gaps for Climate change:

- More general education on climate change risks on watershed issues
- Limited capacity to deal with climate change risks in future planning
- Addressing potential for increased flooding (especially flash flooding) from more frequent and severe storms;
- Rainfall;
- Streamflows;
- Groundwater;
- Temperature (and evapotranspiration);
- Floodplain vulnerability analysis for development;
- Low water levels;
- Impacts from prolonged periods of drought;
- Impacts on water quality;
- Changes in ecosystem health;
- Shifts in cold water to warm water fish species;
- Application of climate change scenarios on IDF curves;
- Education and outreach to inform political decision-making to ensure climate change resilient development;
- Lack of understanding of which existing policies; standards; by-laws; codes and guidelines need to be reviewed and updated to reflect climate change;
- Infrastructure design standards that consider climate change;
- More funding required to support Conservation Authorities to develop the next generation of flood risk assessments and make changes to management

- policies governing floodplain development that accommodates the potential for greater flooding in the future;
- More examples are needed of climate change adaptation plans by government agencies; municipalities or other sectors that are both prescriptive and detailed.
 - Uncertainty about the magnitude of potential climatic changes; and their manifestation at the local scale in terms of changes in seasonal precipitation distribution and changes in the frequency and magnitude of extreme events.
 - Difficulty in defining new standards in the face of such high levels of uncertainty as the costs associated with upgrading or replacing infrastructure that are in many cases directly correlated to the magnitude of climate change.
 - While there are many provincial climate change action plans that recommend undertaking infrastructure vulnerability studies assuming future climatic conditions will change; there is little guidance available on how climate change impacts can be assessed or on specific adaptation.
 - No federal or provincial initiatives provide sufficient guidance or insights on climate change adaptation in stormwater or floodplain management.

PIEVC climate change risk assessment:

- Maximum Temperature;
- Minimum Temperature;
- Heat Waves;
- Cold spells;
- Extreme Diurnal Temperature Variability;
- Freeze Thaw;
- Heavy Rain;
- Heavy 5-Day Total Rainfall;
- Winter Rain;
- Freezing Rain;
- Ice Storm;
- Heavy Snow;
- Snow Accumulation;
- Blowing Snow/Blizzard;
- Lightning;
- Hailstorm;
- Hurricane/Tropical Storm;
- High Wind
- Tornado;
- Drought/Dry Period;
- Heavy Fog

McMaster Report:

- Given the coarse resolution of Canadian Global Circulation Models (CGCM), downscaling is necessary to obtain appropriate local scale information (precipitation series) representing the future climate conditions
- Projected intensity-duration-frequency (IDF) curves with analysis and comparison based on the downscaled data for each local weather station
- Updated weather station records of daily precipitation
- Trend analysis on maximum daily precipitation for local weather stations
- Assistance in selecting the appropriate climate change scenario that is the most likely to reflect the future climate trend in Ontario
- Assistance in using spatial downscaling technique to downscale the GCM outputs and generate future precipitation series representing the local conditions.
- Assistance in performing time series analysis on predicted precipitation data to assess possible trend in the frequency and magnitude of storm events in the selected study regions.
- Assistance in addressing the regional and local details of the climate which are influenced by spatial heterogeneities in the regional physiography and how they affect regional downscaling of GCM's.

IV. INTEGRATED WATERSHED MANAGEMENT:

Gaps for current conditions:

- Limited information on drainage infrastructure such as type, size, location, age and conveyance capacity;
- PIEVC study recommendation for database of hydraulic information for city culverts

Gaps for Climate Change:

- Projections for average temperature: 2020s;
- Projections for average temperature: 2050s;
- Projections for average temperature: 2080s;
- Projections for mean annual temperature: 2020s;
- Projections for mean annual temperature: 2050s;
- Projections for mean annual temperature: 2080s ;
- Projections for mean seasonal temperature: 2020s;
- Projections for mean seasonal temperature: 2050s;
- Projections for mean seasonal temperature: 2080s;
- Projections in precipitation in mm, mean annual for 2020s;
- Projections in precipitation in mm, mean annual for 2050s;
- Projections in precipitation in mm, mean annual for 2080s;
- Projections in precipitation in mm, seasonal for 2020s;
- Projections in precipitation in mm, seasonal for 2050s;
- Projections in precipitation in mm, seasonal for 2080s;
- Projections in the number of frost free days for 2020s;
- Projections in the number of frost free days for 2050s;
- Projections in the number of frost free days for 2080s;
- Projections in the length of the growing season for 2020s;
- Projections in the length of the growing season for 2050s;
- Projections in the length of the growing season for 2080s;
- Projections in heat wave duration for the 2020s;
- Projections in heat wave duration for the 2050s;
- Projections in heat wave duration for the 2080s;
- Projections of impacts of climate change on soil erosion;
- Projections of impacts on pests and invasive species such as weeds and algae;
- Projections of cumulative effects;
- Projections of impacts on natural ecosystems;
- Projections of increased fire damage;
- Emergence of new disease vectors;
- Emergence of more invasive species;
- Potential decrease in water quality (more eutrophication and algal blooms);
- Possible changes in water quantity due to higher temperatures and less

- precipitation;
- Projections in extreme weather events;
 - Projections of lower lake levels due to higher temperatures and less precipitation;
 - Impacts from sulfur and heavy metal release due to drying up of lakes and marshes;
 - Impacts on cold water aquatic species, such as lake trout, as water temperatures increase, water levels decrease and development pressures increase;
 - Projected impacts on winter tourism from shorter ice fishing season;
 - Projected impacts on summer tourism from less clean water for boating and swimming;
 - Projected impacts on Municipal infrastructure from more flooding;
 - Projected impacts on electricity generation from lower water levels resulting in less hydropower production;
 - Impacts on agriculture from reduction in soil moisture;
 - Impacts on human health from increased risk from contaminated drinking water;
 - Impacts on human health from increased risk to water-borne and infectious diseases;
 - Impacts on human health from increased risk from contaminated beaches and swimming areas;
 - Impacts on Mining sector needs for large amounts of water;
 - Development of new safeguards for the building sector to protect shorelines and wetlands;
 - Projected impacts on insurance costs;
 - Increased stress on drinking water supplies;
 - Increased shoreline erosion and increased pesticide and fertilizer run-off;
 - Increased risks from flash flooding in later winter months due to changes in spring rainfall intensity and snowmelt runoff;
 - Increasing water temperatures and decreasing water levels could lead to increased health risks, and put significant pressure on infrastructure;
 - Projected impacts from increased development along shores of lakes used for municipal or private drinking water which will exacerbate these problems;
 - Lake Wahnapiatae could become the primary municipal drinking water supply source, and steps need to be taken now to protect this vitally important water resource;
 - Increased threat of invasive species upon water quality;

V. PROCESS AND POLICY ISSUES:

- Financial constraints;
- Need to justify costs of changes in design standards to account for climate change;
- Guidance from Stormwater Management Planning and Design Manual (2003)
- Guidance from the Provincial Policy Statement
- Funding gap for further study on instream flows;
- Need for partnerships with University and Government scientists
- Education and outreach to inform political decision-making on climate change adaptation;
- Outreach materials: Fact sheets developed by the province to delineate potential impacts of climate change to various water use sectors via the WRT;
- Outreach materials: Annual release of level 1;2;3 that occurred throughout the province and length of the declaration to all WRTs;
- On-going provincial support for local agricultural based water users groups; associations; etc.;
- Uncertainty regarding the data/information requirements to establish a Level 3 declaration;
- the disconnect between actual water level conditions and monitoring and reporting requirements;
- Provincially outlined and agency-agreed upon standards to delineate that voluntary actions in level 1 and 2 has been accomplished to declare a level 3 for the significant sectors- agricultural and municipal;
- Agreed upon process by the water directors to move quickly (within 5 days) to a level 3 condition;
- Frequent MOE inspections to get the non-PTTW holders into compliance. (e.g. why should the program aim at those who are following compared to those who are taking water illegally);
- The EBR release of the updated MNR low water document;
- Permit to take water: location of the extraction; site of application; real time to annual records of water taking; and annually updated PTTW list provided to the WRT by June 15 cleaned of expired permits; temporary permits;
- Outreach materials: Actions like water conservation outreach; public education on water resources should be the part of this program. This could include fact sheets developed by the province to delineate potential impacts of climate change to various water use sectors via the WRT. Annual release of level 1;2;3 that occurred throughout the province and length of the declaration to all WRTs.
- Provincial Policy Statement 2005 (PPS) – wise water management at the watershed level;
- Source water protection legislation;
- Intergovernmental Action Plan;
- Nottawasaga Valley Watershed Management Plan (1996-2015) deals with water management issues across the entire Nottawasaga River Valley; a drainage area of 3,360km²;

- Oak Ridges Moraine Conservation Plan;
- Other policy areas: Conservation Authorities Act R.S.O. 1990 (CAA); Provincial Policy Statement (2005) – issued under Section 3 of the Planning Act; Nottawasaga Valley Watershed Management Plan (1995); and Watershed Plan Strategic Review (2006); Stormwater Management Planning and Design Manual (MOE; 2003); Fish Habitat Protection Guidelines for Developing Areas (MNR; 1994); *NVCA Engineering Development Review Guidelines*; Fisheries Habitat Management Plan – Nottawasaga Valley Conservation Authority Area of Jurisdiction (March 2009); Erosion & Sediment Control Guideline for Urban Construction (TRCA; 2006) Natural Channel Systems: Adaptive Management of Stream Corridors in Ontario; including Natural Hazards Technical Guides for River and Stream Systems: Flooding Hazard Limit; Erosion Hazard Limit and Hazardous Sites Technical Guides (MNR 2002); Great Lakes – St. Lawrence River System and Large Inland Lakes Technical Guides for Flooding; Erosion and Dynamic Beaches in support of Natural Hazards Policies 3.1 of the Provincial Policy Statement (MNR 2002).
- Lack of understanding of which existing policies; standards; by-laws; codes and guidelines need to be reviewed and updated to reflect climate change;
- Infrastructure design standards that consider climate change;
- More funding required to support Conservation Authorities to develop the next generation of flood risk assessments and make changes to management policies governing floodplain development that accommodates the potential for greater flooding in the future;
- Need for an integrated ecosystem approach to stormwater management planning;
- Increased awareness and development of option for alternative storage, from basement storage;
- Need to assess the range of municipal, provincial and federal policies that affect local decision-making, including those around land use planning;
- Increased public education needed on drought and more frequent storm events;
- Increased need for more in depth flood plain management planning;
- First generation Source Protection Plan needs to include climate change considerations; and
- Need for more stringent development standards for shorelines.