Water Environment Association of Ontario

Young Professionals Committee and Student Design Competition Sub-Committee

and the

Ontario Ministry of the Environment and Climate Change

In Collaboration with

The City of London

WEAO STUDENT DESIGN COMPETITION 2018 PROJECT STATEMENT

Reducing Phosphorus Loadings to the Thames River

JULY 2017

WEAO Student Design Competition 2018
Reducing Phosphorus Loadings to the Thames River

BACKGROUND – CITY OF LONDON

Figure 1: Photo of the City of London

The City of London is located in southwestern Ontario, approximately mid-way between Toronto and Windsor along highway 401. London is approximately 420 km^2 in size, with a population of over 380,000.

The Thames River flows through the heart of London, with the North and South branches of the Thames River converging in the downtown core. The Thames drains a watershed of 5,285 km^2 along its 279 km of length before emptying into Lake St. Clair.

The City of London takes its role in the stewardship of the Thames River very seriously, through its management of facilities and practices within the City, as well as its membership in and support of various initiatives, boards and partnerships. It is a priority watershed for the management of phosphorus loads to Lake Erie, and the City is actively pursuing phosphorus reduction options for its wastewater and stormwater treatment facilities in addition to supporting other programs for non-point source control.

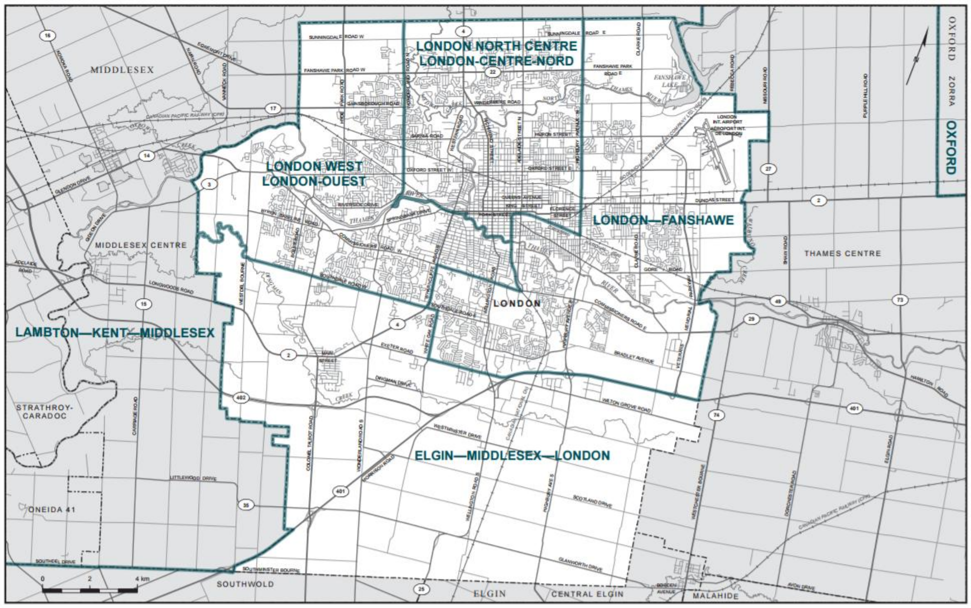

Figure 2: Map of the City of London, denoted by the dashed black line.

Figure 2 represents the boundaries of the City of London, comprising of both urban and agricultural land.

This area (Figure 2) is serviced by thirty five (35) pumping stations and six (6) WWTPs. The WWTPs in London currently achieve levels of treatment that are better than those required by the operating Approvals. However, this likely represents the best performance that can be achieved with conventional activated sludge process. In order to achieve even lower phosphorus loading, the City is currently investigating opportunities for implementation of newer treatment techniques and processes that could enable the existing infrastructure to achieve the desired reductions. Some are being reviewed as part of planned plant expansion projects, with certain technologies holding promise both for improved effluent quality and increased capacity within existing tankage.

There are approximately 140 stormwater management facilities (SWMFs) located within the City of London. Please refer to the Appendix for available phosphorus monitoring results for some of the SWMFs.

The City of London has conducted a waterway monitoring program within the multiple watersheds in London. Please refer to the Appendix for available phosphorus monitoring results at select locations for the Medway Creek, Stoney Creek, Dingman Creek and Snake Creek. It is noted that some samples are collected under dry weather conditions while other samples are collected under wet weather conditions.

More information about the City of London's management of stormwater and wastewater, may be found in subsequent sections, and in the supplemental information.

BACKGROUND – MEDWAY SUBWATERSHED

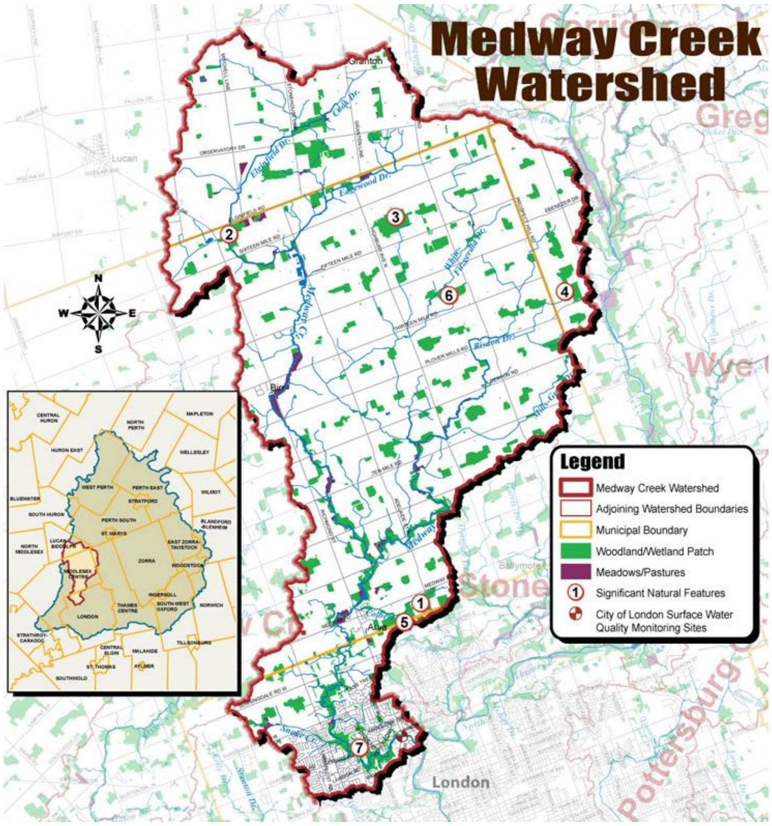

Figure 3: Aerial view of the Medway subwatershed

The Medway Creek Watershed is approximately 20,490 ha in area and consists of mainly agriculture land use. The population for the watershed is approximately 26,040. Please refer to the attached 2012 and 2017 Medway Creek Watershed Report Cards for further information in regards to the Medway Creek watershed.

There are 17 stormwater management SWMFs located within the Medway Creek watershed. Please refer to the Appendix for available phosphorus monitoring results for some of the SWMFs.

The City of London has conducted a waterway monitoring program within the Medway Creek watershed. Please refer to the Appendix for available phosphorus monitoring results at select locations for the Medway Creek. It is noted that some samples are collected under dry weather conditions while other samples are collected under wet weather conditions.

BACKGROUND - CHALLENGES

The City of London has faced and continues to face challenges in implementing phosphorus reduction strategies throughout the City.

A large portion of the wastewater collection and treatment systems in the City are over 50 years old, with some sewer systems exceeding 100 years old. Combined sewers are still present in the collection system, and there are 9 combined sewer overflow (CSO) outlets to the Thames River, in addition to 42 separated sewer overflow (SSO) outlets. A Pollution Prevention and Control Plan (PPCP) is currently underway that seeks to identify sources of untreated overflows to the Thames River and model them to establish frequency, duration and volume of potential overflow events. Upgrade and remediation of old existing infrastructure is difficult and costly.

Inflow and infiltration (I&I) is a measure used to define the impacts rainfall/snowmelt and other sources of water external to the collection system can have on sanitary wastewater flows. These external sources include combined sewers, weeping tiles and sump pumps connected to the sanitary sewer, groundwater entering leaking sanitary sewers and direct inflow of rainwater through sanitary maintenance hole lids, among other things. This inflow results in short duration high flow events that challenge Wastewater Treatment Plants (WWTPs) both hydraulically and biologically. However, it is impractical to construct WWTPs that can handle all peaks flows, since a plant sized for very large flows would operate less effectively at the lower flows experienced the majority of the time. However, an inability to handle these high peak flow events can lead to plant bypasses that allow untreated or partially treated wastewater to flow directly to the River.

WWTPs are typically built in low-lying areas adjacent to the receiving water course and remote from their respective service areas. However, with time the service areas grow and the space previously available for plant expansions can be re-purposed to serve other community needs, meaning options for an expansion of plant footprint are limited. The characteristics of the watercourse can change as well. Climate change has led to predictions of higher flood levels occurring more frequently in many areas, meaning the hydraulic grade line of plants and SWM facilities discharging to that watercourse can be impacted.

In addition to physical and technological challenges, plant expansions or upgrades have high capital costs (often estimated at $3M per million litres per day (MLD) for secondary treatment capacity). Identifying and obtaining the required funds for this type of major infrastructure projects can be challenging.

Regarding stormwater management, similar challenges exist in retrofitting existing infrastructure such as SWMFs. Also, constructing new practices such as LID in existing built out areas, especially in higher density areas (eg. downtown core), can prove challenging due to site constraints and competing priorities.

Lastly, non-point source runoff from agricultural lands can be difficult to manage and treat. Challenges arise from its non-point nature where nutrient-laden runoff is generated across vast areas of land. Application of agricultural best management practices to control runoff and prevent soil erosion requires the cooperation, collaboration and engagement of many agricultural land owners.

BACKGROUND – LAKE ERIE ACTION PLAN

With the assistance of many partners, the Ontario government and the Government of Canada have developed a Canada-Ontario draft action plan for

Lake Erie to reduce algal blooms and phosphorus loads in Lake Erie. Without reducing the amount of phosphorus entering the lake, we will continue to see extensive algal growth and low oxygen conditions in Lake Erie. Ambitious and aggressive actions to reduce phosphorus loads are needed to restore and protect the lake's water quality and ecological health.

This draft action plan sets out a series of commitments to be undertaken by a variety of stakeholders to achieve the 40% phosphorus loading reduction target for Lake Erie by 2025.

A link to the draft action plan is included in the supplemental information.

BACKGROUND – INNOVATIVE SOLUTIONS

Innovation, through new technologies and new approaches, will play a key role to achieve these phosphorus load reduction targets set for Lake Erie.

Amongst the actions to take, partnerships and collaboration between watershed stakeholders (e.g. rural land owners, residential homeowners, etc.) will be crucial to making progress on the targets in a cost-effective manner.

Innovative water resource management tools and techniques (stormwater and wastewater) that take a holistic approach in siting, designing and implementing best management practices to reduce phosphorus will also play a significant role. New techniques include managing precipitation on site where it falls by applying the treatment train approach, including source/conveyance control otherwise known as low impact development (LID) practices. This not only reduces the amount of stormwater generated, but can also reduce the number of combined sewer overflows and wastewater treatment plant bypasses and overflows.

Emerging technologies can also be implemented to improve resource recovery at municipal wastewater treatment plants and reduce nutrient loading to the environment.

OBJECTIVES

The Design Team is required to provide the following:

Phase I:

- Evaluation of all phosphorus loadings from all relevant sources within the City of London (Figure 2) to establish baseline loadings. Findings are to be summarized in an infographic for purposes of presenting to the public.
- Conceptual design and evaluation (i.e. decision matrix) for strategies to reduce phosphorus from the Medway Creek Subwatershed (Figure 3) and from the Adelaide WWTP.

Phase II:

- Preliminary design for the preferred solution identified in Phase I. Designs

are to include a climate change vulnerability assessment to assess the robustness of the proposed design.
- Identify and discuss other policies and best practices (non-infrastructure) to limit phosphorus loadings.

Proposed solutions may include site retrofits or new construction. Solutions must be designed such that it addresses/evaluates the key issues of:
- Water Quality
- Climate Change
- Cost-effectiveness

Additional issues, depending on the proposed solution may include but are not limited to:
- Water Quantity
- Water Balance
- Erosion and Sediment Control
- Nutrient recovery

Site features open to stormwater retrofits include, but are not limited to: parking lots, sidewalks, road right-of-way, buildings/rooftops, grassed areas/open spaces, and sewer/plumbing systems including catch basins and manholes. New stormwater infrastructure or retrofit of existing stormwater infrastructure is acceptable in both agricultural and municipal land uses.

Retrofits to existing wastewater treatment plants and pumping stations must remain within existing fencelines, and at no time should the improvement of one element of effluent quality lead to the deterioration of performance in any other element.

The preliminary design should also account for the human and business aspects of sound engineering design. It should align with engineering principles, standards and guidelines; and enhance safety and aesthetics of public space.

When designing the site retrofit, teams must review the key principles and guidelines of the City's Sewer-Use By-Laws, the City's erosion and sediment control requirements, the Upper Thames River Conservation Authority's studies and/or projects, the Ministry of the Environment and Climate Change's 2003 Stormwater Management Planning and Design Manual and Interpretation Bulletin on LID (2015), and the draft Canada-Ontario Action Plan for Lake Erie (2017). Additional details are included in the supplemental information.

DESIGN CRITERIA

Designs must meet the following design criteria:

Water Quality Targets – Total Phosphorus (TP)
Using the TP baselines established in the Phase I evaluation, reduce the annual TP load by 40% from the site/geographic scope.

Climate Change
Account for climate change in the designs to aid in the mitigation of forecasted impacts for the specified area. Use the climate change projections with the PRECIS model under A1B emissions scenario (http://www.ontarioccdp.ca/). Demonstrate how proposed designs will be able to achieve the TP water quality target in light of climate change impacts (e.g. shift in annual precipitation throughout the seasons, how to maintain healthy landscaping under a drought, how to manage large peak flows and volumes from extreme events).

Cost-Effectiveness
Solutions must be cost-effective and be within the $9M capital budget to reduce the phosphorus loadings.

Additional Design Criteria – Specific to the Infrastructure

Stormwater Infrastructure:
Water Quality Targets – Total Suspended Solids (TSS)
The water quality target for new stormwater best management practices must meet the long-term average removal of 80 % of Total Suspended Solids (TSS) on an annual loading basis from all runoff leaving the site based on the post-development level of imperviousness.

Water Balance and Quantity Targets
For new or retrofitting of existing stormwater management practices, encourage:

- On-site volume retention of 29 mm (the 90th percentile rainfall event for the London area).
- 5 mm of precipitation managed on-site through infiltration, evapotranspiration or rainwater reuse for irrigation.

Flood Flow Management Criteria
The City of London has adopted the 100-year storm as the level of protection for properties, where feasible, against surface flooding from ponding on streets, and/or when a proper major overland flow stormwater drainage system does not exist.

Wastewater Treatment Plant Criteria:

Methods of phosphorus loading reduction from the plant must not hinder achievement of the non-phosphorus effluent limit parameters as specified in the chosen plant's Environmental Compliance Approval.

Other:
Proposed designs must take into consideration construction phase activities and their impacts on WWTP capacity, stormwater LID performance, aquatic/fish habitat requirements (if any), cost, and limitations of the site (e.g. available footprint, underground services, and competing uses of the site).

Information on the City of London's Intensity-Duration-Frequency (IDF) curves is available in Section 6.4.3.5 of the attached City of London Stormwater Management Pond Requirements – Design Specifications and Requirements Manual.

SCOPE OF WORK

The scope of work consists of two phases impacting different scales within the northern part of the City of London.

The project documents should address the following elements:

Phase I – Phosphorus Baseline Analysis and Conceptual Design

Identify, compile and evaluate all of the phosphorus loading sources within the City of London (Figure 2) to establish a baseline. Sources include, but are not limited to, urban stormwater, wastewater, agricultural stormwater, and atmospheric deposition. The phosphorus loading information should be summarized in an infographic with the public being the target audience, and include options on how the infographic could be disseminated (e.g. website, mobile app, public information sessions).

The proposal should also include a conceptual design and evaluation for 40% reduced phosphorus loading from:

1. The Adelaide wastewater treatment plant (WWTP) within the geographic scope indicated by Figure 2; AND
2. The Medway subwatershed (Figure 3), including the portion of the subwatershed that is outside the boundaries of the City of London.

The purpose of Phase I is to:

- Evaluate and quantify the phosphorus loadings in the specified area to develop a baseline;
- Provide conceptual designs that reduce phosphorus loadings by a total of 40%;
- Using those conceptual designs (WWTP and subwatershed scope), evaluate and identify the cost-effective preferred solution to undergo detailed design during Phase II.

The proposals must address the Objectives. The methods must take into consideration the challenges of the site listed in the Background.

The proposal should include an analysis of the phosphorus sources and loadings, a review and comparison of various alternatives to reduce the loadings from both the identified WWTP and the Medway subwatershed, a conceptual design for each scope, the engineering feasibility and economic evaluation (cost-benefit analysis) for implementation, and identification of the cost-effective preferred solution.

<u>Phase II – Conceptual Design</u>

Provide a preliminary design proposal to address the Objectives for the preferred solution identified in Phase I through completion of a decision matrix. A climate change vulnerability assessment of the preferred solution must be included, as well as recommended City policies and/or best practices (non-infrastructure related; e.g. policies or programs related to foundation drain, downspouts, urban/rural fertilizer use, education) to further reduce phosphorus loadings.

Methods must take into consideration the challenges of the site listed in the Background.

DESIGN REPORT REQUIREMENTS

Please refer to the WEAO SDC Guidelines for the acceptable format of the report. The design report should address the following points:

Background

- Description of the site (Figure 2)
- Analysis of the existing urban and rural infrastructure and best practices (stormwater and wastewater) and their performance
- Description of the current challenges with regards to reducing phosphorus loads from urban and rural landscapes, as well as challenges with retrofitting/adding infrastructure.

Phase I

- Identification and analysis of the phosphorus sources within the site (Figure 2), to establish a baseline of the total load leaving the site
- Create an infographic that summarizes the results of the phosphorus sources and loading analysis. Include options on how the infographic could be shared with the public. The language, format and user-interface must be accessible and easy to understand for the public.
- Identify any assumptions made regarding the specified sites (WWTP and Medway subwatershed) or when selecting parameters, and their rationale (e.g. imperviousness, run-off coefficient, stormwater influent quality and quantity, soil infiltration capabilities, rainfall statistics, evapotranspiration rates, design storm, etc.);
- Conceptual designs for the two sites, including comparative discussion of alternative methods for each of the specified sites;

- Economic cost-benefit analysis for each of the conceptual designs of the two sites in relation to achieving the 40% phosphorus load reduction;
- Identification of the cost-effective preferred conceptual solution that will undergo preliminary design during Phase II (including a decision matrix).

Phase II

- Comparative discussion of alternatives for the method of the preferred solution identified in Phase I
- Economic cost-benefit analysis for the preferred and alternative methods
- Selection of the preferred method (including a decision matrix)
- Demonstrate how the preferred method for the site retrofit achieves the design criteria (e.g. before and after retrofit scenarios);
- Demonstrate that the proposal is cost-effective;
- Identify any groundwater contamination concerns if preferred solution involves stormwater management practices;
- Identify limitations of the preferred method and how they may be minimized;
- Siting of the best management practices/infrastructure/equipment
- Preliminary sizing of the equipment/best management practices (BMPs);
- Methods used to minimize environmental/commercial/social impact during construction, including erosion and sediment control and protection for any proposed stormwater practices (e.g. LID);
- Description of a suitable operations and maintenance program;
- Preliminary capital cost estimate of the preferred alternative for Phase II;
- Operations and maintenance cost of the preferred alternative for Phase II; and
- Implementation schedule for Phase II and any need for pilot work to verify approach for scaled up application. Indicate if other agency approvals are needed.
- Identification of additional information needed to complete a detailed design
- Recommendation of non-infrastructure City policies, programs or best practices to further reduce phosphorus loadings
- Additional environmental benefits to the preferred method beyond reduced phosphorus loadings
- Climate change vulnerability assessment for the preferred method and determination if the objectives and design criteria will still be achieved

There is no limit to the number of appendices attached to the design report. However, the appendices must contain, as a minimum, the following:

- Calculations indicating current phosphorus loading from the variety of sources in the site, expected phosphorus loading reductions after retrofits, and, if applicable, expected reduction of volume and peak flow for stormwater infrastructure by the Phase I and II proposed designs. Include all calculation spreadsheets;
- Manufacturer data sheets and catalogues of all major equipment used for stormwater management, if applicable; and
- Design drawings (see below for details).

Design teams may use modelling software. If used, an appendix must be attached to the design report containing the model input data and output and the rationale for selection of the chosen model(s).

DESIGN DRAWING REQUIREMENTS

Design drawings must be provided that clearly show the layout of the site retrofit. As a minimum, the following drawings must be included:

- Drawings identifying the Phase I sites (WWTP and subwatershed scope) and preliminary layouts;
- Site plan for the Phase II retrofits
- Schematic for Phase II retrofits. If preferred solution involves stormwater management, indicate how the proposed infrastructure functions as a treatment train, as applicable.
- Hydraulic profiles for the Phase II retrofits if preferred solution involves stormwater treatment, or impacts the existing hydraulic profile at the WWTP.

The drawings must be printed on 11” x 17” landscape sheets, folded and included as an appendix in the design report. A digital copy of the drawing will also be required.

SUPPLEMENTAL INFORMATION

The following documents are provided to aid in the preparation of the design report.

- City of London Sanitary Sewersheds Map
- City of London Design Specifications and Requirements Manual, 2017 – Sections for Stormwater and Sediment and Erosion Control
- City of London Waterway Monitoring Results, 2010-2015 – Medway Creek, Stoney Creek, Snake Creek
- City of London Map of Monitored Stormwater Management Facilities and

Results

- City of London Map of Stormwater Inventory in Medway Creek
- City of London Map of Regulated Areas and Stormwater Management Facilities in Medway Creek
- City of London Map of Land Use and Development in Medway Creek
- City of London Monitoring of Water Quality and Benthics in the Thames River and its Tributaries: https://www.london.ca/residents/Environment/Rivers-Creeks/Pages/Thames-River.aspx
- City of London Wastewater Treatment Plant Monitoring: https://www.london.ca/residents/Sewers-Flooding/Sewage-Treatment/Pages/Wastewater-Treatment.aspx
- City of London Wastewater Bypass and Overflow: https://www.london.ca/residents/Sewers-Flooding/Sewage-Treatment/Pages/Byass-and-Overflow-Activity.aspx
- UTRCA Medway Creek Report Card, 2012 and 2017
- UTRCA Stoney Creek Report Card, 2012
- UTRCA Dingman Creek Report Card, 2012
- Draft Canada-Ontario Action Plan for Lake Erie (2017): https://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTMxOTM3&statusId=MjAwMjQ2
- Environment Canada and Climate Change Water Survey of Canada: https://wateroffice.ec.gc.ca/google_map/google_map_e.html?search_type=region&region=ONT
- Ministry of the Environment and Climate Change Provincial Water Quality Monitoring Network (PWQMN): https://www.ontario.ca/environment-and-‘energy/map-provincial-stream-water-quality-monitoring-network
- Ministry of Environment and Climate Change Interpretation Bulletin on LID: http://www.sustainabletechnologies.ca/wp/wp-content/uploads/2015/02/MOECC-Interpretation-Bulletin-Stormwater-Management.pdf
- Ministry of Environment and Climate Change 2003 Stormwater Management Planning & Design Manual: https://www.ontario.ca/document/stormwater-management-planning-and-design-manual
- Ontario Climate Change Data Portal: http://www.ontarioccdp.ca/
- TRCA and CVC Low Impact Development Manual: http://sustainabletechnologies.ca/wp/wp-content/uploads/2013/01/LID-SWM-Guide-v1.0_2010_1_no-appendices.pdf

Appendix

Appendix – Map of the Upper Thames River Watershed