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
Toronto Water

WEAO STUDENT DESIGN COMPETITION 2015
PROJECT STATEMENT

NUTRIENT RECOVERY AND PROCESS IMPROVEMENTS AT THE ASHBRIDGES BAY WASTEWATER TREATMENT PLANT

SEPTEMBER 2014

WEAO Student Design Competition 2015

Resource Recovery and Process Improvements at the Ashbridges Bay Wastewater Treatment Plant

BACKGROUND – THE PLANT

Figure 1: Aerial photo of Ashbridges Bay Treatment Plant including the M and T Pumping Stations (2008)

Ashbridges Bay Treatment Plant (ABTP) is located at 9 Leslie Street in the City of Toronto. It is the largest of four treatment plants operated by the City and is one of the largest wastewater treatment plants (WWTP) in Canada.

The plant was first built in 1910 and since its first major expansion in 1943 it continues to be expanded and upgraded. The site occupies a total footprint of approximately 40.5 ha. The following table summarizes the plant's capacity and sewershed information.

Table 1: ABTP Capacity and Sewershed Information

Nominal Treatment Capacity	818 ML/d
Equivalent Population	1 524 000
Sewershed Area	25 000 ha

Influent enters the plant from the surrounding sewershed which includes combined sewers. The influent is treated for removal of total suspended solids, organics and phosphorus and receives year-round disinfection before being discharged into Lake Ontario via an outfall

which extends 1 km from the shore. Influent characteristics and Environmental Compliance Approval (ECA) effluent discharge limits are listed in Table 2 and Table 2, respectively. Major processes are described in

Table 4.

ABTP treats the primary and waste activated sludge generated on site, as well as sludge and biosolids from the Humber Treatment Plant and North Toronto Treatment Plant. Partnerships with private companies including Veolia allowed ABTP to achieve 95% beneficial reuse of its biosolids in 2013. An example of beneficial reuse of the biosolids generated at this site includes land application.

Table 2: Influent Characteristics

Parameter	2013	2012	2011	2010
Influent Flow [ML/day]	631.6	576.1	622.4	596.3
Total Annual Flow [ML]	230 456	210 834	227 355	217 641
Influent TSS [mg/L]	296	275	274	260
Influent BOD_5 [mg/L]	197	178	142	137
Influent TP [mg/L]	6.2	6.2	6.4	5.9

3: **Table ABTP ECA**

Total Suspended Solids (TSS)	25 mg/L
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	25 mg/L
Total Phosphorus	1 mg/L
pH	6.5-9.5
Escherichia Coli	200 CFU/100 mL
TSS Loading Rate	20 450 kg/day
$CBOD_5$ Loading Rate	20 450 kg/day
TP Loading Rate	818 kg/day

Effluent Discharge Limits

Table 4: Major Unit Operations

Process	Equipment
Raw Sewage Pumping	15 pumps
Grit Removal	4(10) aerated grit channels

Screening	5(11) mechanical screens
Primary Clarification	6 Rectangular clarifiers - Chain and Flight (#1-6) 6 Rectangular clarifiers - Travelling Bridge (#7-12)
Secondary Treatment (Conventional Activated Sludge)	11 Aeration Reactors with 4 pass step feed and coarse bubble diffusers
Final Clarification	11 Rectangular clarifiers - Chain and Flight
Phosphorus Removal	Ferrous Chloride addition
Waste Activated Sludge Thickening	9 Dissolved Air Flotation Tanks
Digestion	8 hydraulically mixed mesophilic primary anaerobic digesters 12 gas mixed mesophilic primary anaerobic digesters
Biosolids Dewatering	12 high speed centrifuges
Disinfection	Chlorine addition
Odour Control	Carbon Filters Chemical Scrubbers (Sodium hypochlorite) Biofilters
Plant Water	Effluent is disinfected for non-potable use within the plant

More information about the performance of the treatment plant, chemical and utility consumption, operating costs and other issues may be found in the 2013 Annual Report included in the supplemental information or found on the City of Toronto website. A simplified schematic of the plant is included in Appendix A.

BACKGROUND - CHALLENGES

Process changes were recently undertaken to encourage nitrification. These included increased Sludge Retention Time (SRT) and dissolved oxygen (DO) concentrations, as well as improved DO control instrumentation and programming. These process changes have resulted in a reduced ammonia loading in the final effluent, however, energy use was greatly increased. It is estimated that an additional 10 million kWh is used per year.

The cause for the high ammonia loading in the plant was investigated. It was determined that ABTP had higher loadings than the other plants in the city because it:

1. Accepted sludge and biosolids from other facilities; and
2. Recycles centrate from biosolids dewatering into the aeration tanks increasing the load on the biological process (the anaerobic digestion process ‘releases’ biologically bound ammonia).

While the first cause cannot be helped, the high ammonia loading from the centrate could be treated separately from the activated sludge process to reduce loadings on the biological treatment system.

Background - Resource Recovery Initiatives

As part of the Toronto Water Strategic Plan, five major guiding principles were established:

I. Continuous Service Delivery Improvement
II. Financial Vitality, Viability and Sustainability
III. Operational Excellence
IV. Infrastructure Management
V. Employer of Choice

An important means of achieving these goals is approaching wastewater treatment from the resource recovery point of view. Resources that can be recovered from the process include:

- Nutrients (e.g. phosphorus and nitrogen);
- Energy in the form of heat, kinetic, methane gas or other fuels; and
- Reusable water.

Initiatives that have already been undertaken at ABTP include:

- Recycling of effluent water for non-potable use;
- Use of digester gas for process and building heat; and
- Beneficial reuse of biosolids

Objective

The Design Team will provide the following:

- Preliminary design for a means to reduce nitrogen containing species of the centrate stream to levels approaching plant influent before it is recycled to the secondary treatment process. A nutrient recovery aspect must be included in the design that results in a product that could generate revenue for ABTP.
- Conceptual design for two additional areas in which ABTP may benefit from resource recovery opportunities.

Proposed designs must take into consideration the limitations of the footprint of the existing plant. The best designs will reduce operating costs and energy use over the existing nitrification methods used at the plant and not increase the loading of other pollutants such as phosphorus to the system.

Design Criteria

Methods of loading reduction must aim to bring the TKN and Ammonia levels of the centrate stream to levels comparable to the influent as shown in Table 5.

Table 5: Average Composition (July 1, 2013 - January 1, 2014)

Stream	TSS	TKN	Ammonia

	[mg/L]	[mg/L]	[mg/L]
Centrate	1828	907	590
Influent[1]	326	50.9	25.4
Primary Effluent [2]	264	41.9	24.7
Final Effluent	5.63	9.72	7.72

SCOPE OF WORK

The project documents should address the following elements:

Phase I

Provide a proposal to reduce the ammonia loading in the dewatering centrate. The proposed method must be able to reduce the nitrogen loading to near influent levels and be achieved in conjunction with resource recovery. The primary target for resources to be recovered in this phase includes nitrogen containing species, and if feasible, phosphorus.

The proposal should include a review and comparison of various methods and the engineering feasibility of implementing them.

Phase II

Propose two other areas in which ABTP could adopt a resource recovery approach to benefit the operations, lessen the environmental impact or reduce the cost of treatment. A conceptual design must be provided including comparisons of technologies, energy demands and preliminary economics.

DESIGN REPORT REQUIREMENTS

The design should address the following points:

Background

- Analysis of the cause of high ammonia loading in the centrate and potential process/influent changes that could affect it in the future; and
- Identify challenges of the existing plant design to reduce and recover nitrogen in the centrate.

Phase I

- Comparative discussion of alternative treatment and nutrient recovery processes;
- An economic cost-benefit analysis should be conducted for the preferred and alternative methods with specific energy balances;
- Selection of the preferred treatment process (decision matrix);
- Expected effluent characteristics, energy requirements and recovered resource yield;

[1] Sampling point at head of "D" building
[2] Sampling point at discharge of "D" building

- Identify limitations of the preferred treatment process and how they may be minimized through addressing other plant processes/design in order to increase resource yield, decrease energy requirements, etc.;
- Preliminary sizing of major equipment or installations, including an outline of process control systems;
- Methods used to minimize environmental impact during construction;
- Preliminary capital cost estimate;
- Operating and Maintenance Cost; and
- Implementation schedule and the need for pilot work to verify the preferred alternatives for scale up application.

Phase II

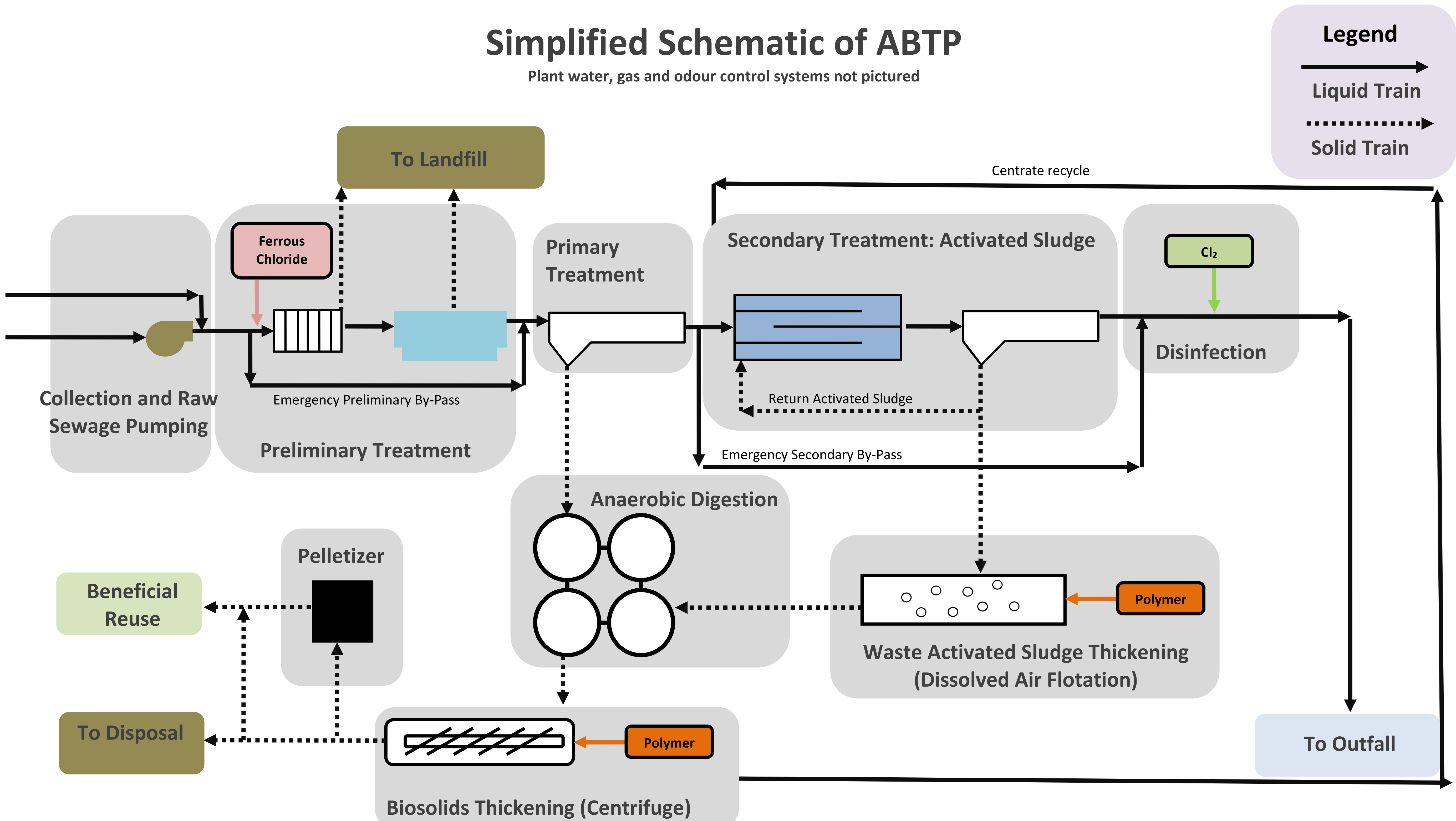
- Identification of two other areas with resource recovery potential;
- Conceptual design of the process or processes;
- Estimates of the quantity of resources that could be recovered, the cost, and income or cost avoidance.

Appendices must include:

- Calculations indicating the expected reduction of ammonia (in return sidestream and plant effluent), resource yield(s) achieved and energy requirements by the proposed design. Include all calculation spreadsheets;
- Manufacturer data sheets and catalogues of all major equipment; and
- Design drawings (see below for details).

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

1. Site Plan for the Phase I retrofit including value added component;
2. Process schematic for Phase I retrofit; and
3. A drawing identifying Phase II sites and preliminary layouts.


Simplified Schematic of ABTP
Plant water, gas and odour control systems not pictured
Legend
Liquid Train
Solid Train
To Landfill
Centrate recycle
Ferrous Chloride
Primary Treatment
Secondary Treatment: Activated Sludge
Cl_2
Disinfection
Collection and Raw Sewage Pumping
Emergency Preliminary By-Pass
Preliminary Treatment
Return Activated Sludge
Emergency Secondary By-Pass
Anaerobic Digestion
Pelletizer
Beneficial Reuse
Polymer
Waste Activated Sludge Thickening (Dissolved Air Flotation)
To Disposal
Polymer
To Outfall
Biosolids Thickening (Centrifuge)