THUNDER BAY COGENERATION

SECTOR	DEPARTMENT	ADAPTATION TYPE	DRIVER	FUNDING SOURCE
○ Food ○ Health ● Infrastructure ○ Natural Systems ○ Planning ○ Water Conservation	○ Communications ● Environment ● Finance/Purchasing ● Infrastructure ○ Parks & Rec ● Planning ○ Public Health ● Water/Stormwater	○ Decision Support Tools ○ Delivery of Adaptation Options ○ Plans + Policies ● Programs + Initiatives	● Anticipatory ○ Reactive	● Federal ● Municipal ○ Other ○ Private ○ Provincial

PROFILE *Aging infrastructure in many Canadian municipalities provides an opportunity for investment in new or retrofitted infrastructure to contribute to municipal resilience in the face of climate change. As municipalities repair or retrofit their assets, adapting design to accommodate expected climate impacts can increase municipal preparedness and reduce the likelihood of damage suffered during future climate events.*

In 2005, Thunder Bay's sole waste water treatment plant was retrofitted, enabling it to more efficiently manage increasing volumes of waste water and to improve the effluent quality that re-enters the watershed. Thunder Bay used this opportunity to invest in a new waste water treatment facility that reduces pollution and contributes to both climate change mitigation and adaptation efforts.

GEOGRAPHIC CONTEXT The City of Thunder Bay is located on the north-western shore of Lake Superior. With a population of roughly 110,000, it is one of the largest municipalities in Northern Ontario.

Thunder Bay's relative isolation from other cities increases its vulnerability to climate impacts. In the event of an extreme weather event overwhelming the City's capacity to respond, external aid is between 7.5hrs (Kenora, population 15,000) and 11hrs (Sault Ste. Marie, population 80,000) away. In this respect, critical infrastructure must be built and maintained with the explicit understanding that damage may result in loss of access to external aid (as in the case of damage to highways) or that repairs may require parts or labour that must travel (as in the case of a major failure in the electricity grid). An important feature of Thunder Bay's emergency management plan therefore, is that critical infrastructure has a high level of built-in resilience to reduce the risk of damage during an extreme event.

Additionally, located on Lake Superior and discharging into the watershed, Thunder Bay's waste water treatment plant has a significant effect on the health of the lake ecosystem. Changes in temperature, pH, bacterial or pollution levels caused by the facility can have widespread negative impacts on the region's ecosystem.

CLIMATE CHANGE CONTEXT Thunder Bay experiences many climate impacts that are directly related to their proximity to Lake Superior. Flooding, lake-effect snow, lake temperatures and fluctuating lake levels can all impact the municipality's infrastructure at different times of the year. Climate projections for Thunder Bay indicate an increasing trend for extreme weather events and a gradual increase in temperature and precipitation levels as well. Under a rapid growth emissions scenario, reflecting current trends (A1B),[1]

[1] The A1B scenario assume rapid population growth and reliance on a variety of energy sources thus producing a medium level of greenhouse gas emissions.

Thunder Bay is expected to experience a 2.8°C increase in average annual temperature and a 50mm increase in average annual precipitation by the 2050's. The change in precipitation will be especially prevalent in the winter and spring months, while the summer and fall seasons will see little change, if any.

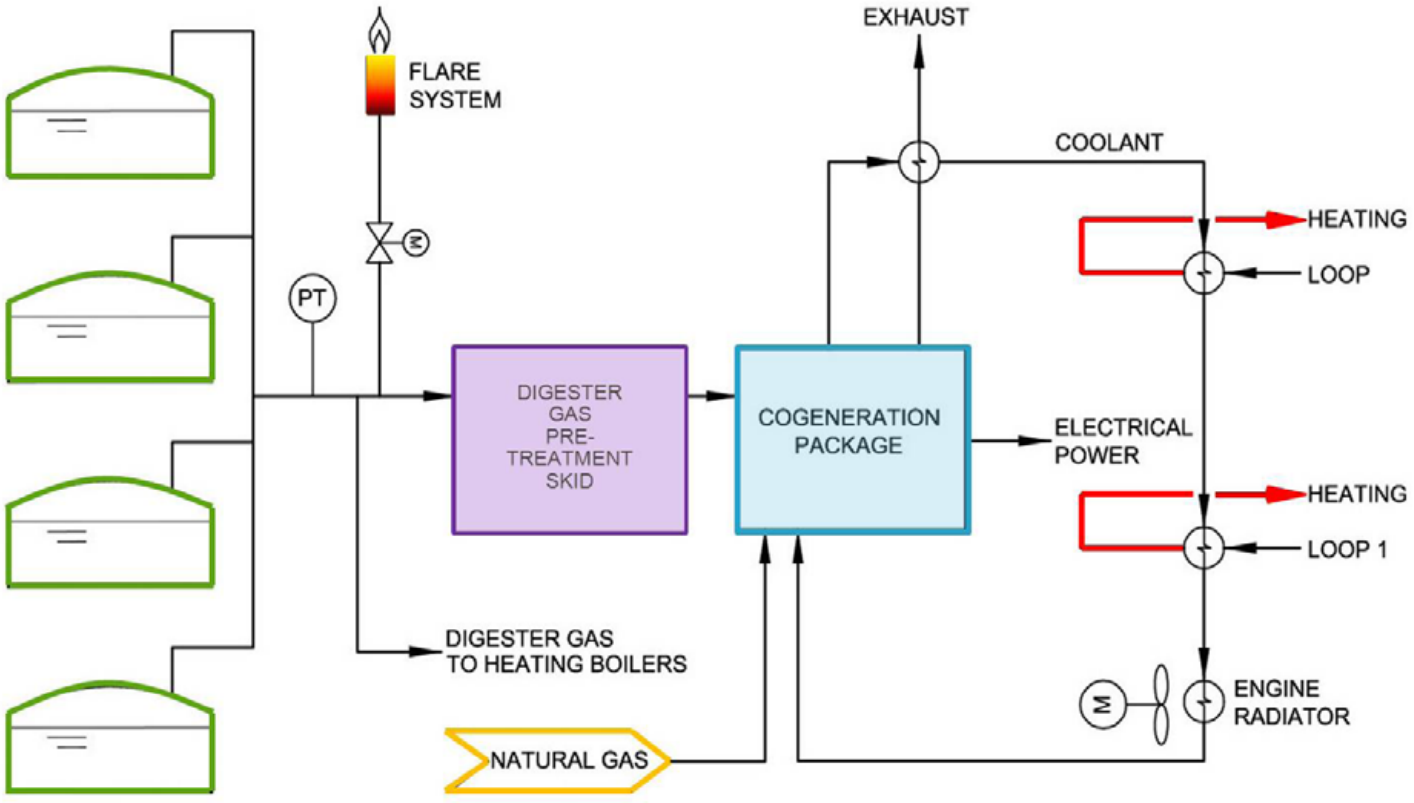
ISSUE Over a five year period, Thunder Bay initiated a four step program to upgrade their waste water management facility. The ultimate goal was to design and build a more efficient waste water facility that would improve facility capacity and water quality while reducing reliance on external power. Adapting to climate change was not explicit in the development, but by decreasing reliance on external energy sources in the plant, adaptation resiliency was achieved as an ancillary co-benefit.

Pollution Prevention and Control Plan

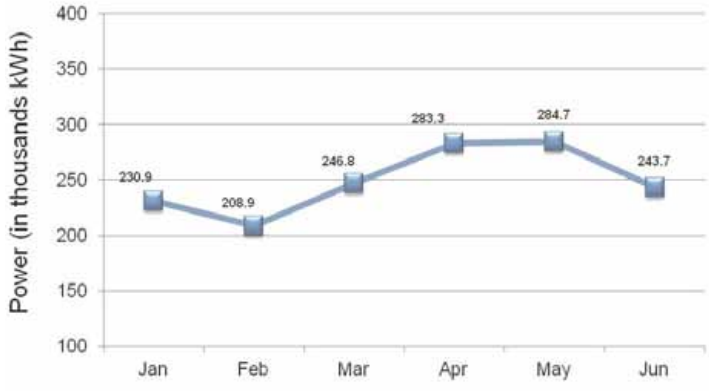
In 1999, the City of Thunder Bay hired a consultant to prepare a Pollution Prevention and Control Plan (PPCP). The study examined municipal waste water facilities, collection systems and water resources; sought to identify limitations in the existing infrastructure and developed recommendations to address these shortcomings. Highlighting the need to treat an increasing volume of wastewater, the PPCP established the framework for a treatment plant with greater capacity. Municipal staff then worked with consultant engineers to design the new facility so that it integrated well with overarching municipal goals including energy efficiency and reduction of chemical use.

Secondary Treatment Plant

The recommendations from the PPCP led to the decision to invest in a secondary treatment plant, UV disinfection system and cogeneration facility for the waste water treatment plant on Atlantic Avenue. In 2005, Thunder Bay constructed an additional treatment plant adjacent to the original plant. The waste is treated once in the primary facility and then again in the secondary treatment plant. The new plant removes ammonia and carbonaceous materials from the waste water, improving the quality of effluent released from the plant into the watershed. The secondary treatment plant demanded more energy and additional chemicals to treat the waste water, but improved the quality of the effluent by approximately 80%. To minimise reliance on external energy supplies, Thunder Bay designed a cogeneration facility at the primary plant to produce electricity.



Cogeneration System Schematic



1,500,000 kWh generated on-site through cogeneration in first 6 months of 2011

Cogeneration

To increase energy independence in the secondary treatment plant, Thunder Bay designed and constructed a cogeneration system within the facility in 2010. This system uses gas captured from digesters, where the waste is stored before treatment process, to generate electricity which is then used to power the treatment process. Cogeneration has three major benefits for a wastewater treatment plant. First, the system reduces the municipality's greenhouse gas emissions. The cogeneration system captures digester gas from the waste that is processed at the plant. This gas is then used in the generation process instead of being burned off as a waste product.

Secondly, the system produces electricity. The captured gas is passed through a cleaning system and then fed into an engine as fuel. Currently, the cogeneration system at the Atlantic Avenue plant produces approximately 9,000 kW per day or about 18% of the electricity used by the facility. As the system requires waste to produce fuel, cogeneration can offset a greater portion of the plants electricity use as the municipal population grows. This is an adaptive process. Although electricity must still be brought in to the facility, the cogeneration system provides some energy independence for the facility generally, and provides complete independence for certain processes within the facility. Over the first six months of operation, the plant realized $142,500 in avoided electrical costs.

Finally, the cogeneration system is designed to capture all heat produced by the engine. Heat exchangers collect heat from the coolant and reuse it to heat the plant, reducing the amount of energy required to operate the facility. Again, this is an adaptive process.

These functions reduce the plant's reliance on the electricity grid and also reduce the environmental impact that wastewater treatment has in the region. The reduction in demand lessens potential strain on the electricity grid due to summer cooling demands, and can contribute to the prevention of power outages. Thunder Bay prioritized reducing the plant's environmental impact because they recognized that their watershed was already vulnerable to climate change. By limiting the plant's environmental impact, the local ecosystem will be better able to absorb the impacts of climate events. Moreover, when under contract with Ontario's Renewable Energy Standard Offer Program, electricity generation produces real monetary savings. By undertaking these four projects, Thunder Bay has helped to offset the cost and energy requirements of the new technology, whilst also providing both climate change mitigation and adaptation services.

PROCESS To facilitate an upgrade of this magnitude, staff from the Engineering and Environment Divisions of the Infrastructure and Operations Department developed a business case that demonstrated the long-term benefits and costs. Additionally, the design team identified key short term environmental goals surrounding energy independence and pollution reduction. Using this data, Thunder Bay designed a facility that would achieve the needed reductions while simultaneously reducing costs. Following a presentation to Council, the team received approval to undertake the project.

FUNDING Thunder Bay capitalized on available funding from the Canadian government under the Canadian Strategic Infrastructure Fund to fund this multi-stage, multi-million dollar project. To qualify for this $25 million grant, Thunder Bay had to demonstrate that they were spending at least $75 million overall. Thunder Bay's contribution consisted of the capital budget dedicated to the PPCP, the construction of the secondary treatment plant and contributions to the UV treatment and cogeneration systems.

To justify and offset the cost of the upgrades, municipal staff calculated the savings that the upgrades would create in terms of reductions in energy and chemical use. This was added to environmental savings related to higher quality effluent, healthier lake water (also used as source water) and a reduction in greenhouse gas emissions.

CHALLENGES Thunder Bay encountered a number of challenges during the design and retrofit of the Atlantic Avenue waste water treatment plant. Some examples include:

Regulatory Uncertainty

During the design and planning stages, the federal government was considering the establishment of a carbon market. The City of Thunder Bay had to make assumptions about the potential for offsetting costs. This uncertainty made it difficult for Thunder Bay to generate accurate long-term cost projections thus increasing the risk that the facility may become a fiscal burden for the municipality in the future. Developing a business plan that carefully considered potential incomes and costs related to the establishment of a carbon market as well as a plan that excluded these items, helped Thunder Bay to consider the implications of such a regulatory move.

Uncertainty Surrounding Incentives Programs

During the design stage, the Ontario Government's Renewable Energy Standard Offer Program was undergoing review. The program provided a guaranteed price for all energy generators that was added on to the market value of electricity. Unsure of how the program and pricing formula would change, Thunder Bay had difficulty estimating the annual costs that the new facility would incur or the income that it could generate. Since long-term cost-benefit analysis is important to the business case of new technology, uncertainty regarding the incentives program made it difficult to establish the business case.

Technological Glitches

Though technological glitches are a common occurrence when implementing a new technology, this process was exacerbated by the fact that the technology had not been tested in many communities before it was installed in Thunder Bay. Thus there were few examples that Thunder Bay could replicate to smooth the process of getting their cogeneration plant online. Though easily remedied, these glitches required expertise and parts that delayed the project.

LESSONS LEARNED *There were several important lessons learned by the City during this process. These include:*

- **A realistic business case is absolutely essential to get a large and costly project implemented**.
- **Timing is vital.** This project was well timed to capitalize on available federal funding and upgrades that were occurring in other parts of the plant.
- **Sewage treatment plants are complex facilities, with many distinct processes.** Building resilience in a plant may not happen in one attempt, but instead over time as each individual processes is adapted.
- **A champion within municipal staff can help to establish a good business case for investing in municipal infrastructure**.

SOURCES

Thunder Bay Funding for Atlantic Avenue Plant

Thunder Bay Pollution Prevention and Control Plan

Ultraviolet Disinfection for Wastewater

Natural Resources Canada Ressources naturelles Canada

Canada

With federal funding support through Natural Resources Canada's Regional Adaptation Collaborative Program.