Submission for Canadian Consulting Engineering Awards 2021

Category C - Water Resources

Alloa Reservoir and Pumping Station

Managing Agency:
Regional Municipality of Peel

Primary Consultant:
R.J. Burnside & Associates Limited

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Project Highlights

The Region of Peel's (Region) Alloa Reservoir and Pumping Station is located on Mayfield Road on the boundary between the City of Brampton and the Town of Caledon, situated 30 minutes west of Toronto, Ontario, Canada. The Alloa facility is the final reservoir and pumping station on the western transmission system, fed by the City of Mississauga's Lorne Park Water Treatment Plant, which draws its water from Lake Ontario. The facility is essential in order to meet the emerging municipal water demands for development growth in the Northwest Development Area of the City of Brampton (Region Zone 6W and 7W).

Alloa Reservoir and Pumping Station

The $45 million project included the design and construction of a pumping station with an ultimate capacity of 165 ML/d and the design and construction of a 35 ML, two-celled water reservoir with design provisions for a future expansion to 70 ML. The facility's electrical supply included twinned 750 kVA transformers, a 5 kV switchgear, 4,160 V feeds to pump starters and 4,160 V-600/347 V transformers to feed a 600 V MCC. A 2,000 kW diesel generator, provision for top-up chlorination, emergency reservoir overflow pond and a dedicated administration area with a boardroom and offices were also included in the design. The facility is also provided with two independent overhead electrical power feeds from Hydro One and Brampton Hydro to secure uninterrupted power supply.

The high local groundwater table in the vicinity of the project posed a major challenge during both the design and construction phases, requiring the use of caissons and rock anchors in the administration building design, and a permanent dewatering system to prevent the reservoir from floating. The construction was also appropriately staged in consideration of the high water table to maintain construction integrity as the work progressed.

Facility Pump Room

The Region's 1999 Water and Wastewater Master Plan and 2002 Addendum identified the need for the Alloa facility. These needs were revisited in the Region's 2007 Master Plan update, and the Municipal Class EA for the facility was completed in December 2008, identifying the preferred project solution.

The Region awarded the detailed design and construction field services assignment for the Alloa Reservoir and Pumping Station project to **R.J. Burnside & Associates Limited** (Burnside) and their core team of **Stanford Downey Architects Inc.** (SDA) for the architecture scope and **Eramosa Engineering Inc.** (Eramosa) for the electrical, Instrumentation & Control and SCADA scope. Through the competitive bidding process, the construction contract was awarded to **ROMAG Contracting Ltd.** (ROMAG), and the entire project team worked collaboratively to successfully complete the project, attaining Substantial Performance in October 2019.

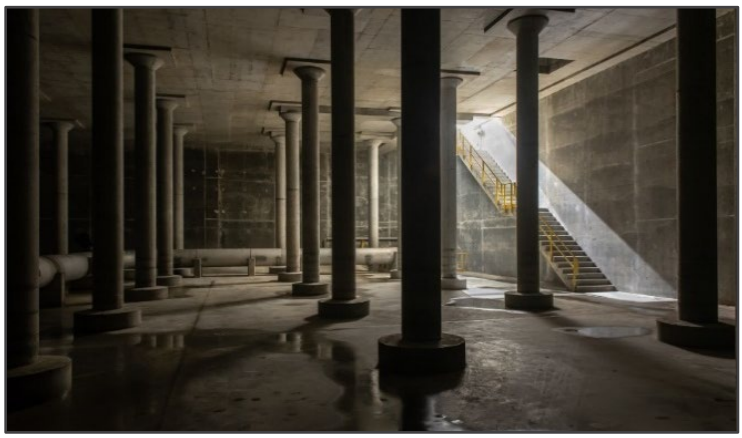
Aerial View of Partially Constructed Facility

Construction Management

ROMAG was the general contractor for the project and was responsible for the overall construction management, including the coordination of their own forces as well as specialized sub-trades.

ROMAG provided an experienced Project Manager to oversee the construction activity and to interact with the Region and Burnside. A dedicated Construction Manager was provided on-site by ROMAG and further supported by a site superintendent, an assistant superintendent, a project coordinator and a shop drawing (submittals) coordinator. The general contractor held regular weekly meetings with their key sub-contractors to plan and track construction progress and to coordinate site activities in order to maintain schedule.

ROMAG engaged a specialized sub-contractor for the concrete works who was supported by their own structural engineer and reputable supplier for the concrete. Burnside's Contract Administrator monitored this activity and coordinated Burnside's own specialist inspections at key junctures (i.e., prior to concrete pours). As well, materials testing sub-consultants were utilized throughout construction as part of the quality



Interior of One Reservoir Cell

Reservoir Cell Concrete Support Columns

Reservoir Inlet and Flooded Suction Outlet

control process to ensure that the works were being constructed in conformance with the contract documents and permits.

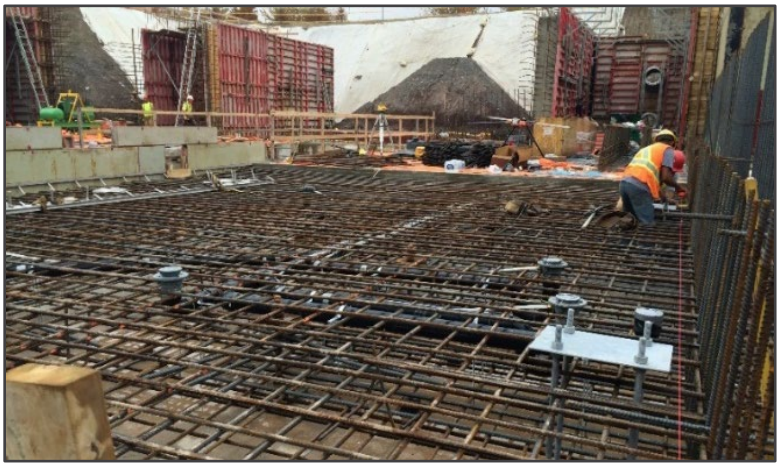
Commissioning a large Regional water facility such as the Alloa facility is an intricate process as there are multiple integrated systems to be proven out, both individually and as a whole. The Alloa system includes a high level of instrumentation and automation as the facility can be operated entirely remotely. ROMAG engaged the services of a commissioning specialist to develop a verification plan and lead the contractor through the start-up / testing / commissioning phases. Burnside's own commissioning expert worked closely with both the Contractor and the Region's operations staff to refine the commissioning plan and to oversee the commissioning process.

The construction contract between the Region and ROMAG commenced on November 15, 2015, and Substantial Performance of the construction contract was achieved on October 1, 2019 after the successful commissioning of the Alloa facility. The project was completed and in service in time for the Region to provide the necessary water to support the growth needs of the North Development Area in the City of Brampton (Region Zone 6W and 7W).

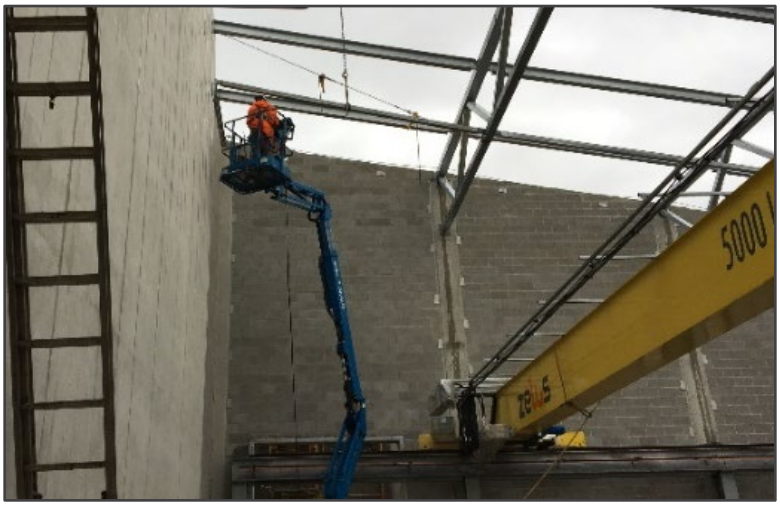
Aerial View of Finished Project

Safety Performance

The project team's dedication to health and safety began with the review of the past health and safety performance of the construction firms evaluated during the formal Pre-Qualification of general contractors, and this focus on health and safety continued throughout the four-year construction project. ROMAG provided a safety manager throughout the construction, relying on a combination of their own internal safety manager and a third party safety services provider. ROMAG submitted a Safety Policy and Site-Specific Safety Plan prior to beginning construction.



Installing Plumbing in Pumping Station Floor



Worker at Height Installing Metal Roof Structure

ROMAG conducted weekly safety meetings for all site staff which where attended by Burnside's full time resident inspector. ROMAG also conducted daily safety inspections and reported on safety related items at each bi-weekly construction meeting to ensure that any safety related matters were quickly addressed. All appropriate personnel were suitably trained in excavation and trench safety, confined space safety and working at heights. Access to the site was controlled and visitors were provided with a health and safety briefing before entering the construction area.

The extraordinary due diligence of the entire project team over the four-year construction period resulted in the project being completed with no time lost due to injuries.

Community Relations

A public and agency notification program was undertaken by the Region as part of the Municipal Class EA process. Notices of commencement were sent to the applicable agencies and were published in the Brampton Guardian and Caledon Enterprise on December 16, 2006. Two separate Public Information Centres (PICs) were held on May 15, 2007 and June 18, 2008 at the Alloa Public School (adjacent to the project site) to review the preferred solutions and provide an opportunity to discuss issues or concerns.

Key issues raised at the PICs related to the potential impact of construction on existing wells and groundwater, the lack of water in the Town of Caledon, aesthetics, and landscaping. The Architects at SDA responded to the aesthetic concern by designing the facility's exterior to blend in with future area development by using a warmly coloured, pavilion-like building set in a field of native plantings as a counterpoint to a large and complex engineering facility. Furthermore, the Region continued to address any concerns raised by stakeholders during the construction period and incorporated them into the project as needed.

The site had a single entrance via Mayfield Road, and advance signage was in place to identify that trucks would be entering and exiting the construction site entrance, which helped facilitate uninterrupted, safe and continuous traffic flow both on Mayfield Road and to the site.

Environmental Protection

The completion of a Municipal Class Environmental Assessment by the Region finalized the site selection for the facility. The associated Environmental Study Report fully characterized the natural environment and identified mitigating measures to be incorporated into the design, as well as temporary measures to reduce potential environmental impacts during construction.

During design, a geotechnical investigation (28 boreholes and three groundwater monitoring wells) was completed to assess the potential for environmental impacts which would need to be considered during the design and construction phases. The study identified that the groundwater table was only 1.5 m below grade and seasonally at the surface, and the soils were identified as having low hydraulic conductivity; findings which significantly impacted the design approach.

Burnside completed a Phase I Environmental Site Assessment (ESA) to support the purchase of the land required for the new facility as the site had previously been used for agricultural crop production. A Phase II ESA was subsequently recommended and was also completed.

Burnside coordinated the preparation of a Stage I and a Stage II Archeological Assessment which identified that the site had not been previously registered. These assessments confirmed that no archeological material was present on site.

The Alloa facility was equipped with a combination stormwater management pond and overflow facility to receive excess water from the pumping station in the event of an overflow. The facility was originally designed and approved to discharge this overflow in a controlled manner to the south. Early in the construction phase, the Region decided to redirect this overflow to the north to Etobicoke Creek to preclude any infrastructure impacts on the future widening of Mayfield Road.

Construction of Overflow Channel

The design team developed an alternate design and worked closely with Credit Valley Conservation to amend the approvals to the project permit which allowed the overflow works to be constructed without negatively affecting the project timelines. The overflow pond was designed to handle the entire flow of 172 ML/d for a two-hour duration, as well as the contribution from a coinciding 100-year storm controlled from post to pre-development flows.

Completed Stormwater Management and Overflow Pond

Due to climate change, there is the additional risk of adverse weather potentially disrupting the power supply to the Alloa facility. As a result, the facility is provided with two independent overhead electrical power feeds to secure uninterrupted power supply, one from Hydro One Networks, the other from Brampton Hydro. In the event that both feeds are disrupted, the facility is equipped with a 2,000 kW generator set and approximately 52,000 L of fuel storage to run the facility for 48 hours. The fuel storage facility is located external to the main building and visually screened using architectural privacy walls.

2,000 kW Diesel Generator Set

In order to prevent the off-site transport of sediment, a number of silt and erosion control measures were put into place including the stormwater management pond, silt fencing and check dams. Burnside's Contract Administrator and ROMAG's site supervisors conducted regular inspections of these devices, as well as post-precipitation event inspections to ensure that the measures were maintained in good working order during the four year construction period.

Complexity and Innovation

The groundwater table at the site was a significant design challenge for both the reservoir and pumping station structures. The geotechnical report prepared during the preliminary design phase identified the subgrade as consisting of clayey silt glacial till over silt and sand glacial till over weathered shale bedrock. Additionally, the geotechnical report identified groundwater at approximately 1.5 m below grade and recommended that structures be designed for seasonal groundwater at the existing grade elevation. A combination of active and passive design measures were implemented in order to manage these hydrostatic forces from the high water table.

Active measures were implemented to manage the groundwater table around the reservoir portion of the construction in order to reduce the water table on an ongoing basis. The groundwater collection system for the reservoir consists of a perforated subdrain piping on a regular grid in a granular drainage layer below the reservoir base slab, as well as a second perimeter drain at a higher elevation that outlets to a dedicated groundwater pumping station. This station is equipped with 100% standby pump capacity as well as drawing power from the redundant power supply to the site and standby power generator. The second or upper perimeter drain is set at a level which safely balances uplift forces against the weight of the structure in the event of failure of the groundwater pumping station. To reduce the impact of surface runoff on the groundwater collection system, impervious soils were used over the drain areas to prevent water from percolating down to the collection system.

Groundwater Pumping Station
Wet Well Placement

Due to its lower depth, the pump gallery portion of the pumping station could not employ this same active approach and instead employed rock anchors in combination with the weight of the structure to balance the hydrostatic uplift forces.

In the Alloa facility's adjacent administration and support services area, it was necessary for caissons to be installed to support this area of the building on the same strata as the pump gallery and secured to the bedrock using rock anchors to resist the hydrostatic uplift.

As required by the Region, the Alloa facility was designed to run in a completely automated mode that could be controlled remotely. The complete instrumentation and controls and network design was completed in accordance with the Region's Process Automation and Instrumentation Design Standards (PAIDS). The facility included a dedicated instrument control panel (ICP) for plant process monitoring and control, communication control panel (CCP) for facility network communications, wide area network (WAN) panel for connection to the Region's network, dedicated ICP for the switchgear and generation control and a dedicated ICP for a new on-site bulk water system. Overall, this resulted in a truly state-of-the-art facility with the latest technology.

Electrical Room

Pump Gallery

The facility has been designed with provisions to readily accommodate significant future expansion to double the water storage volume to 70 ML. Furthermore, provisions are in place to allow for the increase in the Zone 6 pump capacity from 84 MLD to 100 MLD (by adding a third identical 350 hp, 42 MLD duty pump) and the increase in the Zone 7 pump capacity from 27 MLD to 45 MLD (by adding a third identical 300 hp, 15 MLD duty pump). The Zone 6 and Zone 7 pumps and main piping gallery were set at an elevation to provide "flooded suction" to the pumps even at low reservoir levels, thus eliminating the need for vacuum priming systems for the pumps. All Zone 6 and 7 pumps are controlled through VFDs to reduce electrical power consumption and water surges, and all pumps are capable of operating in automatic local pressure control mode should a there be a loss of external communication from the Zone 6 and Zone 7 water storage facilities.

Sustainability

The Region was focused on ensuring the project's design and construction were undertaken in an environmentally friendly, fiscally responsible, sustainable manner. Pumping stations use large amounts of electricity, and energy efficiency was a key focus of the station design. The Region undertook a pump selection process that evaluated the pumping system's life cycle cost based on the pump capital cost and the associated pump and motor efficiencies to identify the true low cost approach, allowing suppliers of energy efficient pumps to compete effectively. Furthermore, the piping system and associated appurtenances (i.e., valves, fittings, flow meters) were selected to minimize energy losses due to friction.

The building's HVAC design was undertaken by a LEED® Accredited Professional who incorporated energy efficiency measures such as heat recovery systems and programmable thermostats tied to the building automation system. Additional efficiency measures included daylight sensors on the exterior lighting system and occupancy sensors on the interior lighting system such that they engaged only when necessary. Furthermore, natural daylight was leveraged for interior illumination when permissible from a security perspective.

The facility's stormwater management design employed several low impact development strategies to minimize increases in stormwater runoff. All runoff generated by the site is directed to a stormwater management pond, which includes swales that promote infiltration and pre-treatment for quality, prior to being discharged from the site during larger storm events.

Closing

On behalf of the Region of Peel and the entire project team, we thank Canadian Consulting Engineer for its consideration of the Alloa Reservoir and Pumping Station project for the Canadian Consulting Engineering Awards 2021 (Category C – Water Resources). We trust that we have demonstrated how this complex and important water infrastructure project meets the six selection criteria, resulting in a strong project candidate for award.

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