Winnipeg Water Treatment Plant

AECOM

Winnipeg Water Treatment Plant

The new Winnipeg Water Treatment Plant has been delivering high quality water to the City of Winnipeg since it went online over a year ago. The facility was built to achieve water quality objectives set by the City, which were developed over 10 years of study and planning. The mandate was to reduce the risk of waterborne disease outbreak caused by chlorine-resistant micro-organisms, to reduce the existing levels of chlorinated disinfection by-products and to improve the overall taste and odour of the water. These goals were accomplished by the new WTP.

Application of Technology

The green-field site where the WTP and ancillary buildings were constructed required substantial work prior to the major construction, including: City sewer/forcemain and redundant power feed; Highway 207 and railroad crossing upgrade; and construction of four aqueduct bridges. The construction of dedicated Bulk Chemical Storage, Sodium Hypochlorite Generation, and Standby Generator Buildings, as well as the Clearwell and Surge Tower structures built concurrently with the WTP, supplement the main functionality of the facility as a whole.

The new processes housed in the WTP provide a level of safety and redundancy to the treatment process to ensure quality water is being produced at all times. Vertical turbine, Magna-drive pumps supply raw water to the different stages of treatment. Chemical injection of sulphuric acid and ferric chloride allows for coagulation and flocculation to occur prior to the dissolved air flotation (DAF) process, where most solids are removed from the water. The eight flocculation and associated DAF tanks represent one of the largest systems of its kind in North America.

Water flows through the DAF underdrains to contact tanks where ozone is injected through diffusers. Ozone is generated on site using liquid oxygen located external to the building. The ozone system can be supplemented with hydrogen peroxide (peroxone), allowing for advanced oxidation of organics and other taste and odour compounds in the water. Ozone is quenched with sodium bisulphite before entering the biologically activated carbon filters.

The eight filters, representing some of the largest in North America, each have large filtration surface areas and process the water at a very high rate. Water from the filter underdrains flows to a contact chamber where on-site generated sodium hypochlorite is injected for disinfection. Sodium hydroxide is injected at the end of the contact chamber for pH balancing before water flows to the Clearwell. The Clearwell acts as a wet well for the Deacon Booster Pumping Station (DBPS) where low lift pumps supply the City with water. Just downstream of the DBPS pumps, the UV disinfection reactors, which are some of the largest in North America, further disinfect the water before distribution.

Winnipeg Water Treatment Plant

Social/Economic/Environmental Impact

The new multi-barrier approach to water treatment provides improved drinking water quality and overall health benefits and safety to the City of Winnipeg water supply. Running parallel treatment trains within the WTP, with complete back up power, adds a level of redundancy that greatly reduces the possibility of complete shutdowns or service interruptions.

A water quality parameter comparison between results before and after the WTP going online show quantitatively how the drinking water has improved turbidity, disinfection by-products, and taste and odour numbers have all been reduced with the introduction of the new WTP processes.

The safety of operators and the public in general has been improved with the elimination of chlorine gas treatment. The new, on-site generated, low concentration, sodium hypochlorite used for disinfection in the water has replaced the need for transporting chlorine railcars through the City and storing them outside of DBPS.

The design and construction of the WTP was a significant boost to the local economy. The successful separation of the project into 56 different contracts encouraged local contractors to bid on the jobs. A total of 4,300 worker safety orientations and approximately 1,900,000 site contractor man-hours were accumulated over the time of the project.

An effort was made during design to minimize the impact of the WTP on the environment. Housing all treatment processes within the same building reduced the footprint of the WTP. It is a highly efficient, zero environmental discharge facility that treats all residuals, including filter backwash water and DAF float, on site.

Complexity

The design, construction and commissioning of the Winnipeg WTP required detailed coordination and communication between various groups over the many years of the project. Over 2,000 Issued-For-Construction drawings were produced. As well, a total volume of 50,000 m^3 of concrete was poured on the project site.

The City required extensive training on unit processes and individual pieces of equipment to be able to run the plant upon completion. The transition to a plant with 8 treatment processes, containing 40 PLCs, 140 pumps, 2,300 valves and 1,400 instruments required over a year of training.

Testing and start-up required individual equipment testing as well as unit process testing prior to the entire plant being ready to run. The 28-day System Demonstration of the WTP began in December 2009 and supplied the City with new water for the first time, running in automatic. The plant was handed over to the City on January 6, 2010 with the majority of contracts reaching final acceptance in January 2011.

Owner/Client Needs

Responsibility to the client through Value Engineering, Quality Management and Risk Analysis practices were followed throughout the duration of the project. Independent technical reviews, risk investigations, regular meetings and reporting were important to control the quality of work done at the WTP. An external audit on commissioning activities showed the effectiveness of procedures in place and gave accountability to those working on the project.

Warranty and Operations support were also provided following commissioning and hand over. The project and construction management methods brought the project in under budget in spite of the revised schedule due to a high demand on the construction industry at the time. These methods increased efficiency and fulfilled the expectations of the City and the consumers.

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City of Winnipeg

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Introduction

The Winnipeg Water Treatment Plant (WTP) is a state-of-the-art, green-field facility that provides exceptional quality drinking water to the citizens of Winnipeg. The new facility features water dissolved air flotation (DAF) units and drinking water Ultraviolet (UV) disinfection facilities, which were among the largest of their kind in North America at the time of construction. It is also the largest capital project ever undertaken by the City of Winnipeg. The new, multi-barrier WTP was designed to produce 400 ML/d of treated water, with potential expansion up to 600 ML/d. The current annual average water demand in Winnipeg is approximately 256 ML/d.

The City of Winnipeg (pop. 680,000) obtains its drinking water from Shoal Lake, which borders the provinces of Manitoba and Ontario. The raw water supply is chlorinated at the intake for pathogen, slime, and zebra mussel control. Water flows by gravity through a 159 km long aqueduct to the Deacon Reservoir east of Winnipeg. Prior to the January 2010 handover, water for distribution was treated by re-chlorination at the outlet of the Deacon reservoir, UV disinfection, dosing with fluoride and phosphoric acid, and sent to three covered in-city distribution reservoirs before being delivery to consumers. UV disinfection was designed under the Winnipeg WTP project but was accelerated for a more immediate improvement to public health. The UV disinfection process went online in 2005.

With over 10 years of study and planning, the City of Winnipeg developed water treatment objectives to reduce the risk of waterborne disease outbreaks caused by chlorine-resistant micro-organisms, to reduce the existing levels of chlorinated disinfection by-products, and to improve the overall taste and odour of water being distributed to the City. The new WTP was designed to achieve these objectives and exceed federal and provincial drinking water quality regulations.

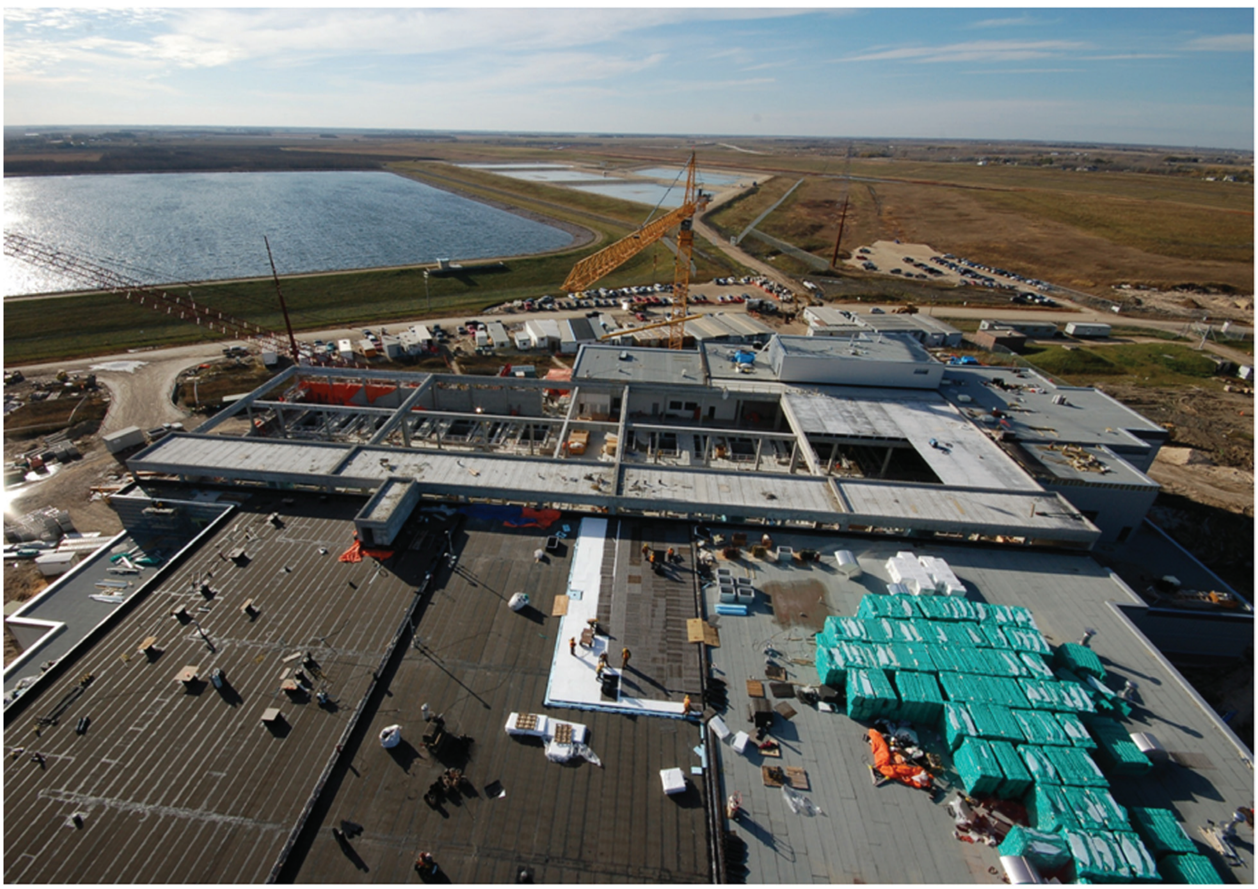
The Winnipeg WTP has complete standby capabilities and runs two parallel treatment trains. Raw water from the Deacon Reservoir enters the WTP by means of a pumping station which feeds the treatment trains, supplying eight, 3-stage flocculation tanks and corresponding DAF tanks. Ferric chloride is injected as a coagulant prior to flocculation and the DAF process in each train. Water then flows through two contact tanks where on-site generated ozone is injected for taste and odour control. The addition of hydrogen peroxide at the start of the ozone contact tanks helps with advanced oxidation of organics. Sodium bisulphite removes residual ozone before water enters eight filters filled with biologically activated carbon (BAC). Water is polished as it flows through the filter media into a chlorine contact chamber where on-site generated sodium hypochlorite is injected as a disinfectant. Finished water moves through the Clearwell to the existing Deacon Booster Pumping Station (DBPS) and UV disinfection facility, supplying drinking water via the existing distribution system.

The Winnipeg WTP is a zero environmental discharge facility that treats all residuals removed from the water using four settling tanks and two gravity thickeners. Supernatant water is recycled back to Deacon Reservoir while sludge is pumped to freeze-thaw dewatering cells on site.

The new WTP was constructed on an approximately 47,000 m^2 site and included ancillary buildings to support the treatment facility, including standby generators and main switchgear, sodium hypochlorite generation, bulk chemical storage, surge tower and clearwell structures.

Winnipeg Water Treatment Plant

Overcoming a number of challenges, the design team of AECOM (Winnipeg) and CH2MHill (Calgary), and the construction manager, AECOM (Winnipeg), delivered the completed WTP to the City under budget. Construction of the WTP and ancillary structures was completed over 60 months and was divided into 56 contracts. The completed facility consists of 8 treatment processes containing approximately 40 PLC processors, 140 pumps, 2300 valves and 1400 instruments. Beyond construction, training existing City operators and commissioning the facility in collaboration with the contractors and the City were critical to the overall success of the project and ability to transition from construction to operation for drinking water supply to the City of Winnipeg.



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1. New Application of Existing Techniques, Originality, and Innovation

The drinking water treatment process was minimal prior to the new WTP going online, and consisted only of gas chlorination with the addition of fluoride and phosphoric acid. As seen in Figure 1, the new design includes multiple processes and advanced technologies that when combined into one system, exceed regulatory requirements. The system is divided into two process trains which can run together or independently and provide complete redundancy. The site has complete standby power capabilities with three diesel generators able to provide 6MW of power for 24 hours without re-fueling.

Raw water is supplied to the WTP from four cells at the Deacon Reservoir and located adjacent to the plant. Cells 1 and 2 are hydraulically connected, as are cells 3 and 4. The supply of water for treatment is cycled between cells 1 and 3 to maintain the quality of the raw water and to maintain storage capacity in isolation of flow from Shoal Lake. The raw water pumping station (RWPS) houses four vertical turbine, Magna-driven pumps with space allowed for a future fifth pump, and supplies water from the Deacon Reservoir to the WTP process trains.

Coagulation, Flocculation and DAF

The coagulation process is critical to the WTP operation for large particulate, organics and algae removal. Sulphuric acid is first introduced to the raw water feed via injection lances to reduce the pH to 5.5-6.5 for optimum coagulation and organics removal. Ferric chloride is flash mixed as a coagulant into the raw water stream using recycled raw water prior to the flocculation tanks. The three stage flocculation process uses six vertical mixers and baffle walls per DAF tank, allowing the destabilized particles to collide and combine to form larger removable floc particles. DAF is responsible for removal of the floc particles. DAF recycled water is supersaturated with air in pressurized tanks prior to release via headers in the turbulent zone of the eight DAF tanks. The micro-bubbles released in the tanks attach to the floc particles that are skimmed off the top, while treated water flows out through a tank underdrain system. Though not considered a high rate DAF, the system installed at the Winnipeg WTP handles higher surface loading rates than a conventional system at 18m/h. In the DAF process stage, there is >95% algae, >50% TOC, and >60% TON removal, with turbidity post-DAF typically less than 1.0 NTU. At the time of construction, the Winnipeg WTP DAF tanks were the largest units for drinking water in North America.

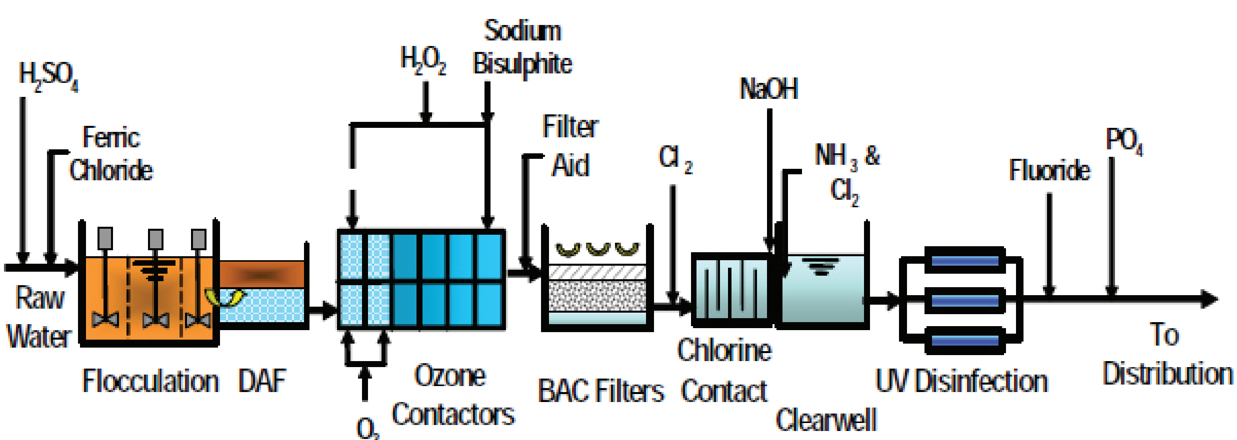


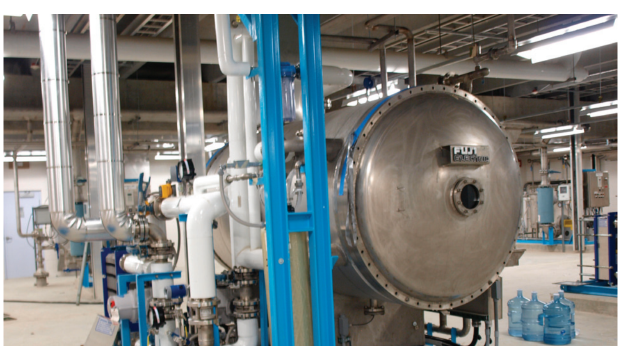
Figure 1

Winnipeg Water Treatment Plant

Ozone and Chemical Addition

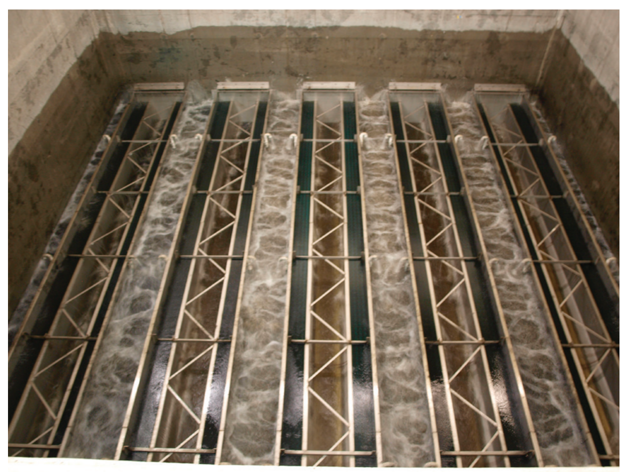
The ozone process is primarily for taste and odour control however it also enhances filter performance for particle removal, provides an additional disinfection barrier, and enables the oxidation of future potential contaminants. The ozone process is housed in a dedicated ozone room and consists of a number of ancillary systems. Three ozone generators use liquid oxygen, stored external to the WTP building, to produce ozone that is dosed directly into the water for treatment via a header and diffuser arrangement. A nitrogen boost system adds a small amount of nitrogen gas to the oxygen for more efficient ozone delivery.

A cooling water loop runs through the generators and power supply units for equipment protection. As well, each ozone generator has a dedicated ozone destruct unit for off gas that accumulates in the air space at the top of the ozone contact chamber. Hydrogen peroxide can be added to the water with ozone for advanced oxidation (peroxone process), providing more enhanced control of taste and odour than with ozone alone. The two serpentine ozone contact chambers allow for maximum chemical contact time and treatment. At the end of the ozone contactors, sodium bisulphite is dosed to quench the ozone prior to the water entering the filters.



Biologically Activated Carbon Filtration

Eight biologically activated carbon (BAC) filters physically remove particles remaining after the DAF and ozone treatment stages, while also providing biological removal of taste and odour compounds, organic matter, and ozone byproducts. The deep bed, high rate BAC filters at the Winnipeg WTP are some of the largest in North America. The effective filtration area of 80.5 m2 per filter and media depth of 2.1 m allow for a maximum hydraulic loading rate of 30 m/h per filter. Components in the filtration system include filter media, a nozzle-plenum type underdrain system, air scour blowers, backwash supply pumps, wash troughs and a media retention system. To assist in filtration, a filter aid polymer dosing system and dispersion mixers are also installed before the filters. Filters are backwashed daily to maintain their cleanliness and treatment efficiency.



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Post Filtration Chemical Treatment

Chemicals dosed after the filtration stage include both sodium hypochlorite and sodium hydroxide. Free chlorine is used for virus inactivation, and is sourced from an on-site sodium hypochlorite generation system. Sodium hypochlorite is produced using a sodium chloride brine and is stored on site in a 0.8% solution. The on-site generation has eliminated the need for transportation and storage of potentially hazardous railcars of chlorine gas. Sodium hypochlorite at a minimum dose is applied at the beginning of the chlorine contact tank, which allows for approximately 15 minutes of contact time before entering the Clearwell. The minimum dose also minimizes disinfection by-product (DBP) formation. A second dosing point is located at the end of the chlorine contact tank for boosting to the desired final concentration.

Sodium hydroxide is used for pH adjustment and control. By maintaining the pH at a steady level, the phosphoric acid used for distribution piping lead and corrosion control is more effective. The sodium hydroxide is flash mixed at the end of the chlorine contact tank to raise the pH to target levels of 7.5-7.8. Provisions were made during design and construction for the addition of aqua ammonia to the treatment process for further DBP reduction in the future. Current DBP levels are lower than expected following the WTP going online, without the addition of aqua ammonia. The dosing point for aqua ammonia is adjacent to where the sodium hydroxide is injected and storage tanks and pumps are located in the Bulk Chemical Building, along with sodium hydroxide, sulphuric acid and ferric chloride.

Deacon Booster Pumping Station (DBPS) and Ultraviolet Disinfection (UV)

The Clearwell is an underground concrete tank that has a storage capacity of 22.6 ML, and a hydraulic retention time of 1.36 hr at the maximum flow of 400 ML/d. The structure acts as a wet well for the Deacon Booster Pump Station (DBPS) which provides low lift to the reservoirs within the City. Prior to the WTP construction, water was normally supplied by gravity through two Branch Aqueducts to the City reservoirs and the DBPS pumps were only used to meet very high demands. Following construction of the new WTP, the new hydraulic gradeline necessitated the continuous use of the DBPS pumps. Two split-case centrifugal pumps with Magna-drive variable speed drives were added to supplement the three existing splitcase centrifugal pumps with two-speed drives.

Piping configuration changes introduced common intermediate and discharge headers allowing for greatly improved pumping and disinfection flexibility and redundancy. The most significant upgrade to DBPS was the addition of six UV reactors installed downstream of the booster pumps between the intermediate and discharge headers. The design and installation of the UV system was completed prior to the construction of the WTP to give immediate health benefits to the City of Winnipeg. The UV system at DBPS went online in March 2005 and is one of the largest potable water UV systems in North America. Significantly, the UV disinfection was very effective both before and after filtered water was introduced to the system. The UV design dose of 28 mJ/cm2 achieves greater than 2-log reduction of *cryptosporidium* in the water.

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Residuals Handling

Residuals from the WTP process include sanitary waste, filter backwash water and DAF float. The handling system consists of four wash water recovery tanks, two gravity thickeners, a thickened sludge equalization tank (TSET) and freeze-thaw dewatering cells. Sludge polymer is added to spent backwash water before it enters the wash water recovery tanks where it is left to settle. Settled backwash solids are pumped to the gravity thickeners where solids are further separated from the supernatant water. Three vertical turbine pumps, two with VFDs, recycle supernatant back to the Deacon Reservoir raw water cells for retreatment. Solids are collected and combined with the DAF float in the TSET tank and pumped to one of four dewatering cells on site. The thickened residuals are treated by a freeze-thaw process in the dewatering cells which separates the floc into a sludge cake of consolidated particles and free water, as seen in Figure 2. The free water is discharged into the City sewer while the sludge cake is hauled to landfill. The freeze-thaw process is chemical free; uses no power by taking advantage of the Manitoba climate; and is extremely effective in that dewatered solids approach 50% solids concentration, compared to mechanical dewatering which produces approximately 20% solids. The overall treatment efficiency of the WTP is greater than 99%, which is extremely high when compared to most other water treatment facilities.

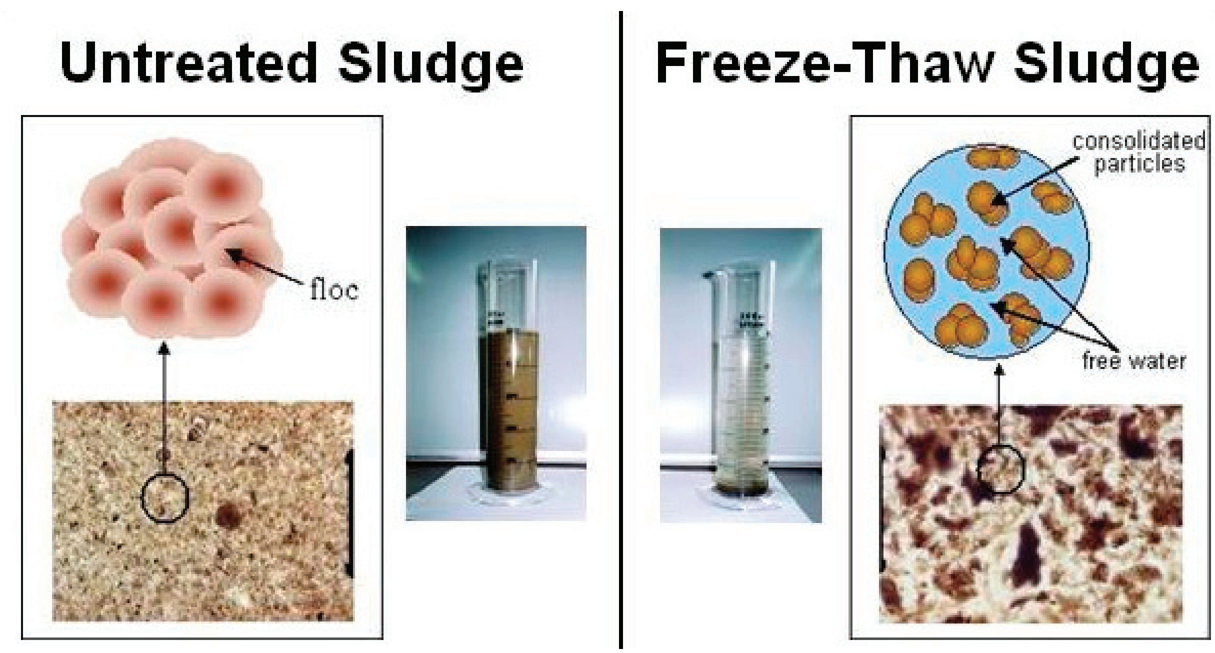

Figure 2

2. Complexity

Coordination and Construction

The designing, constructing and commissioning of such a significant piece of infrastructure for the City of Winnipeg was both challenging and rewarding. The Water Treatment Plant construction spanned 5 years, 56 contracts, and a project value of approximately $300 million. The project was constructed and integrated into service while maintaining continuous water supply to the City of Winnipeg. AECOM, in partnership with CH2MHill, was retained to provide pilot testing, conceptual and detail design, and construction management services. Over 2,000 Issued-For-Construction (IFC) drawings were created and approximately 40 PLC processors, 140 pumps, 2300 valves and 1400 instruments are now included at the WTP.

The somewhat remote site just outside the City required considerable preparation before major construction could begin. Services installed included City sewer/ forcemain and a redundant power supply, as well as upgrading Deacon Road (Hwy 207) with a railroad crossing to a class RTAC 1 Road. The location also necessitated working with Red River Floodway authorities on site layout, and Manitoba Hydro for future transmission line work. Working around the existing and functioning infrastructure, including DBPS and the City of Winnipeg Shoal Lake Aqueduct was also necessary. Four bridges were built over the Shoal Lake Aqueduct to protect it from heavy traffic and loads and to gain access to the WTP from Deacon Road.

Effective coordination and constant management was essential. Following site preparation, multiple contracts were completed simultaneously bringing required equipment and hundreds of contractor personnel on site in the compact construction area. At the peak of construction, 3 tower cranes and 3 mobile cranes were in operation. Over the duration of the project, an average of 60 m3 of concrete was poured per day. A total volume of 50,000 m^3 of concrete was incorporated into the project.

Safety and security were of the utmost importance during construction. The existing Deacon Booster Pumping Station site had significant soil and foundation issues and experienced a slope failure during original construction in the 1970's. The new WTP site foundation design and construction were challenged by a site that is surrounded by large raw water reservoirs; the Winnipeg Floodway; a railway; disturbed soils; and large, leaking, 100-year old water infrastructure. Excavation side slope monitoring, lining of excavations, groundwater control and monitoring of adjacent structures were just some of the measures taken to maintain a high quality of safety and protect personnel and the works. A dedicated AECOM Safety Coordinator was on site at all times to ensure compliance with workplace health and safety regulations, providing over 4,300 safety orientations for contractors, consultants and City staff. Over the course of the 5 year construction period, only 12 lost time accidents occurred. On average, the lost work days for the project represented less than 0.1% of the total hours worked on site.

Training + Commissioning

Training City staff on the new plant and equipment was an extensive process. The new facility involves significantly more full-time staff than the previous system, requiring City Operations to hire staff in each department: operations, maintenance, and instrumentation. Staff orientation to the facility layout and process occurred prior to training on individual systems and equipment. There was a significant adjustment from running a water distribution system with only chemical dosing for treatment, to operating a large facility consisting of two trains and numerous processes. Training took over a year to complete.

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Testing, commissioning and start-up required coordination between AECOM and the contractors, with City staff present as part of their training. Individual pieces of equipment were run before entire systems could be tested and prior to the entire plant running as a whole. Testing occurred daily for months to confirm that each of the thousands of pieces of equipment functioned properly. Numerous milestones were achieved during commissioning, culminating in the final 28-day system demonstration. For the system demonstration, the WTP was running in automatic using full chemical treatment and began supplying the City with new water. AECOM provided on site operations support 24 hours per day, 7 days per week for the 28-day demonstration, which took place over Christmas and New Years. The system demonstration was completed on January 6th, 2010 and the WTP was officially handed over to the City of Winnipeg.

3. Environmental impact

With extensive preliminary design and planning, the WTP was built on a parcel of land adjacent to the existing DBPS. The decision to house all of the treatment processes within the same building rather than using a campus style layout, reduced the footprint of the plant. The installation of UV reactors into the existing DBPS eliminated the need for a dedicated UV building. The reduction in green-field land required to construct the WTP has allowed space for future expansion. One of the most significant achievements of the WTP design is that it is a zero environmental discharge facility. The site has the capacity to treat and/or recycle all outputs from the process. Residuals collected from the DAF and filter backwash processes are treated within the facility. Recovered supernatant is piped back to the raw water cells where it is re-treated as drinking water again. Solids are held in dewatering cells over multiple seasons and are eventually used as fill in the City landfill.

4. Social and Economic Benefits

Social Impact

The years put in to planning, designing and constructing the Winnipeg WTP were all spent in an effort to improve the drinking water quality and overall health of Winnipeggers now and in the future. The project was designed in advance of drinking water regulations becoming stricter and was implemented with the technology to exceed them. The multi-barrier approach to the design as well as the ability of the plant to run with complete redundancy provides assurance of both quantity and quality of the water supply.

The sodium hypochlorite generation facility was designed and constructed for operator and public safety. Chlorine disinfection was previously carried out by chlorine gas injection in finished water, downstream of the pumping station. Chlorine gas was regularly transported by rail through the City and dosed directly from the railcar. Because chlorine gas is heavier than air and highly toxic when inhaled, the handling of the chlorine railcar required strict safety procedures and drills. The change to on-site sodium hypochlorite generation now requires tanker trucks to instead transport salt as the raw material to site. The salt is used to generate the 0.8% sodium hypochlorite solution, a low concentration of the chemical not considered a hazardous material.

The decision to construct a dedicated Bulk Chemical Storage facility on site, adjacent to the WTP was done for safety purposes as well. Ferric chloride, sulphuric acid, sodium hydroxide, and in the future aqua ammonia, are delivered regularly to site via railcar or tanker truck. The building was built with a dedicated railcar shed that spans the City owned rail line, sheltering the cars and Operators as chemicals are offloaded. The training and facilities used to offload the chemicals into the storage tanks has minimized the hazard to operations staff and the environment.

The positive impact of the WTP is most evident when looking at the water quality parameters measured before and after the plant went into operation. There has been a significant drop in effluent turbidity and particles and a logarithmic reduction of pathogens in the water supply system, to name a few. Prior to the WTP going online, turbidity ranged between 0.3 – 2.6 NTU, while post-filtration turbidity is now 0.14 NTU on average. Disinfection byproducts have seen over 50% reduction with total trihalomethanes (TTHMs) reduced from 112 µg/L to an average of 57 µg/L. The pH of the water saw significant variability in the past. Following the addition of sodium hydroxide to the water with the new treatment processes, pH is much more stable with an average value of approximately 7.8. The pH is now within the ideal limits for lead control using phosphoric acid. The multi-barrier treatment approach provides >5-log (99.999%) reduction in cryptosporidium; >7-log (99.99999%) reduction in giardia and viruses; and a >10-log (99.99999999%) reduction in bacteria. All values are current as of November – December, 2010.

Winnipeg Water Treatment Plant

Economic Impact

The design and construction of the Winnipeg WTP was a significant boost to the local economy. Design and construction management were done primarily from Winnipeg. The overall project was broken down into 56 smaller contracts and the planned schedule was modified to align with the available contractor capacity in Winnipeg to encourage local contractors to bid on the work. Local contractors were used to install equipment from supply contracts, encouraging growth and increasing employment in the local construction industry. Ultimately, breaking down the project into separate contracts allowed for it to be delivered on budget and to the agreed schedule in what was one of the busiest construction periods in recent history. The magnitude of the work required 4,300 worker safety orientations and approximately 360 workers per day on site during peak construction. The site contractor man-hours for the entire project totaled approximately 1,900,000 hours.

5. Meeting and exceeding client's needs

The Winnipeg Water Treatment Plant project has met the goals set by the City and has continued to produce high quality water for the residents of Winnipeg. The piloting, planning, design, construction management, construction, commissioning, training, and start-up of the WTP were done in the interests of the City of Winnipeg. The final outcome has been a plant that AECOM and its partners have been proud to showcase across the globe and won the 2011 Association of Consulting Engineering Companies – Manitoba Award of Excellence in Municipal & Water Technology as well as the Keystone Award for the best overall project.

The processes used in the WTP are both advanced and simple but were chosen specifically for the City's needs, focusing on pathogen removal for public safety, disinfection by-product reduction, and taste and odour control. The resulting water quality exceeds current drinking water regulations and gives reason for the City to be proud of its investment.

Throughout the project, responsibility to the Client was always a priority. A Quality Management Plan (QMP) was developed for Quality Assurance (QA) and Quality Control (QC) at the initiation of the project and was followed to its conclusion. A Value Engineering (VE) process was also implemented at the beginning of the project. The design of the WTP underwent several independent peer reviews by other consultants and a utility to ensure quality engineering and constructability.

Risk assessment began at the beginning of the project with a workshop between AECOM and the City. Regular risk management meetings followed with a comprehensive list of risks and mitigation measures developed and maintained. More risks were identified with associated mitigation strategies as construction began. By the end of the project, all identified risks had been mitigated or eliminated.

The process of quality management and risk assessment was intensive for such a large project. In spring 2009, an external audit of the AECOM site procedures, QMP and commissioning plan was completed. Overall, the procedures in practice were found to be working well and a few suggested improvements were implemented to better serve the City for the remainder of the project. Following the completion of construction and commissioning, AECOM was retained to provide warranty and operations support. The support included full–time, on site assistance by certified operators through December 2010.

The timing of the WTP construction coincided with a unique period in Winnipeg's construction history. The local labour market was stretched to accommodate a number of large projects including the expanded Winnipeg floodway, the downtown MTS Centre, the downtown Manitoba Hydro office building and a new airport terminal. Even with these competing projects the construction management approach was able to deliver the project to the City maximizing the use of local resources.

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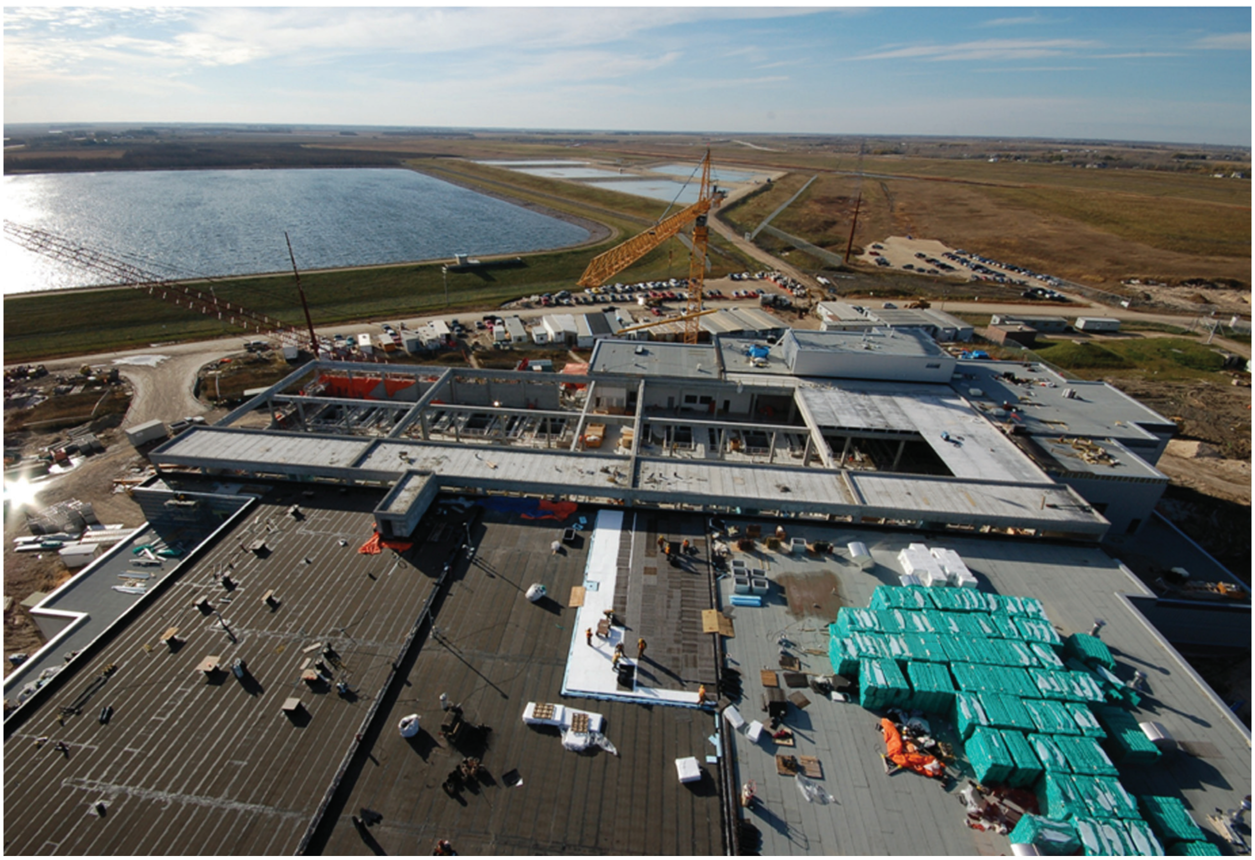
The City of Winnipeg has been operating the WTP for over a year and is happy with the function and the water being produced. The benefits to public health are a testament to the work put in over the years to make the project possible. After 10 years of planning and 5 years of construction, delivering a complex facility under budget and on schedule during a highly inflationary period is an achievement in itself. The Design Consultant and the Construction Manager, both represented by AECOM, are proud to have had a hand in the health protection of Winnipeggers now and for the future.



Winnipeg

Water and Waste Department • Service des eaux et des déchets

February 2, 2011

Our File No.: W-572, W-573

AECOM Canada Ltd.
99 Commerce Drive
Winnipeg, MB R3P 0Y7

Attention: S. R. (Ray) Bilevicius, M.A.Sc., P.Eng.
Associate Vice-President, Manitoba District, Water

Dear Mr. Bilevicius:

RE: WINNIPEG WATER TREATMENT PLANT

The City of Winnipeg would be pleased to have the Winnipeg Water Treatment Plant considered for a 2011 CEM award. Further, the City of Winnipeg would like to commend Earth Tech (now AECOM) and CH2MHill as design engineers and UMA Projects (now AECOM) as Construction Manager for collaborating to bring world class expertise to bear in the design and construction of the Water Treatment Plant. The result is nothing less than a world class facility, designed to reliably produce excellent water for Winnipeg now and for generations to come.

During the course of the project both UMA and Earth Tech became part of AECOM, but despite this restructuring the project team remained focused on the task at hand; the successful completion of the largest capital project ever undertaken by the City of Winnipeg, our $300 million Water Treatment Plant.

It has not been an easy road; after construction began in 2005 the construction industry in Winnipeg (and Canada) became overheated and it quickly became apparent that the original class 3 estimate of $230 million and completion date of late 2008 would not hold due to high inflation and resource shortages. The budget was analyzed and adjusted to $300 million, and the completion date was adjusted to late 2009. Design proceeded at a rapid pace concurrent with early construction activities to maintain the schedule. In an effort ensure competition, the project was broken into 52 separate contracts. As a result of successful coordination of all these activities, the Water Treatment Plant went on line as scheduled in December of 2009. Despite the complexity of coordinating all those contracts, extras were held to just over 6%, and the completed cost of the project was just below budget, at about $298 million.

Successful start-up of this very large, complex facility demanded much more than excellence in design and execution. It was Winnipeg's "first" water treatment plant. Standard operating and emergency response procedures needed to be developed;

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contracts for supply of the goods and services necessary to operate the facility had to be put in place; and most importantly, the staff charged with the responsibility of operating and maintaining the plant needed to be trained. It was essential that these tasks be successfully completed by the project team before plant start-up. The health and prosperity of our community depends on safe drinking water.

The processes used in the plant are the result of years of study and pilot testing, and the multiple barrier approach to design of the plant assures safe, high quality water that is aesthetically pleasing. When the Water Treatment Plant went on line, it was to rave reviews from consumers about the improved taste, odor and clarity of the finished water.

The scale and innovative nature of the facility is impressive. The Dissolved Air Flotation Clarification process and the Ultraviolet Light Disinfection process are among the largest in North America. Ozone (and the potential for perozone) in conjunction with innovative Biologically Active Carbon filters assure a high level of organics removal and a palatable water.

The design also respects the environment. On site generation of sodium hypochlorite has eliminated a hazardous chemical from the site. Residuals are dewatered using low energy freeze-thaw dewatering. The plant is also one of the most water efficient water treatment plants in the world. This will assure that we can fulfill Winnipeg's drinking water needs well into the future, without a costly expansion to our main aqueduct from Shoal Lake.

With this background, Winnipeg wishes AECOM and CH2M Hill every success during the upcoming CEM awards.

Yours truly,

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