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Williams Engineering Canada

18 P3 Core ASAP Schools
Edmonton & Calgary, Alberta

Technical Category:
Buildings

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April 26, 2011

Canadian Consulting Engineer Magazine
12 Concorde Place, Suite 800
Toronto, ON M3C 4J2

Attention: Bronwen Parsons
Editor

Subject: ASAP P3 for 18 Core Schools
2011 Canadian Consulting Engineering Awards

Williams Engineering Canada is pleased to submit our award application for the Alberta Schools Alternative Procurement (ASAP) P3, 18 Core Schools project in the technical category of Buildings.

We appreciate your consideration of our award application.

Yours truly,

Williams Engineering Canada Inc.

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2-Page Project Highlights

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Introduction

Phase 1 of the 18 P3 Core Alberta Schools Alternative Procurement (ASAP) School's project included collaboration between Alberta Infrastructure, Alberta Education, two architectural firms, Williams Engineering Canada, another engineering firm, and Bird-Graham Schools (Alberta). The schools were rapidly produced and are energy efficient, highly functioning, and environmentally conscious. They are currently in review to be LEED® Silver certified and they meet all municipal, provincial, and school board performance criteria. This is the Province's first infrastructure project using the P3 model and is the first time a number of these highly efficient technologies were used in a school.

To support the demographic bulge promised by a young community, Alberta's children were given every opportunity to excel with 18 new schools constructed in the province's two most populous cities, Edmonton and Calgary. ASAP represents a series of productive partnerships. In September 2008, the Province of Alberta (Province) signed an agreement with BBPP Alberta Schools Limited to design, build, finance, and maintain the new state-of-the-art schools. Construction and operation of the schools were funded through a P3; after 30 years, the facilities will be turned back over to the Province.

The project includes K-4, K-6, and K-9 schools; each consists of classrooms, student gathering areas, administration space, and gymnasiums that are designed and built for optimal energy efficiency and healthier indoor environments. Preliminary design for these high-quality, long-lasting, and innovative schools commenced in September of 2007. They were completed in June of 2010 and opened for the 2010/11 school year.

Innovation

Mechanical

The scope of mechanical work for the core space included heating, ventilation, plumbing, fire protection, and control systems sufficient for effective and reliable facility operations. A number of innovative designs were implemented including thermal displacement ventilation, condensing boilers that use a cascading heating loop, heat recovery technology, and water saving techniques.

Thermal displacement ventilation was designed for all classrooms and gathering areas. Displacement ventilation is characterized by naturally generated stratification in density (thermal) and scalar concentration (pollutant). It discharges supply air of low velocity near the floor and, in turn, cool supplied air spreads over the floor and forms a pool of conditioned air. When this cool air meets a heat source, because of the temperature difference and resulting buoyant force, convection plume is generated through which warmed and polluted air goes upwards to the ceiling where it exits through the exhaust. This aspect is one of the most beneficial factors in thermal displacement ventilation over the conventional mixing type ventilation. As a result, only heating/cooling loads affecting the lower part of the space (i.e., occupied zone) are taken care of and more importantly, this process can improve air quality in the occupied zone. This naturally leads to energy savings, as well as enhanced indoor air quality. Ventilation is also demand-controlled with CO_2 sensors that ramp up air flow during high demand or occupancy and lowers it during low demand, such as in rooms with few or no occupants.

The building's heating system consists of perimeter passive radiant heating panels. The system provides the occupants with a high level of thermal comfort with a passive and quiet delivery of radiant energy. This system affords the appropriate level of zoning and controls to suit space requirements in concert with air system functions. The heating system uses condensing boilers with a cascading heating loop, which provides high ΔT to reduce heating system water flow rate by 2/3 compared to a conventional heating system. Lowering return water temperature also helps to increase boiler thermal efficiency, especially when the condensing boiler is running at partial load. Mechanical cooling is provided to high-heat areas (server rooms) and free-cooling air-systems for classroom and administration areas, as outdoor conditions permit. The air systems are intended to be used in concert with operable windows. All systems are equipped with a return fan, isolation dampers, filter bank, glycol heating coil supplied from the heat exchangers, enthalpy wheel, and a draw-through supply fan. All components are selected for a life expectancy of 30 years based on ASHRAE standards.

Ventilation to the classroom areas is 100% outdoor air. The displacement ventilation system supplements the operable windows in the building. All air systems use heat recovery systems on the facility exhaust air streams to improve operating efficiency and serves to preheat the outdoor air for the new building ventilation systems. Air system filtration on all units is two-stage and meets MERV 13 for LEED® compliance and air quality control.

Optimal water saving techniques include low-flow and sensor-operated plumbing fixtures. All plumbing systems are of the latest design and of the highest degree of water consumption efficiency. Low flow urinals and low flow toilets were used as a sustainable design measure and further water conservation measure. The water use reduction for the building is 45.95% compared to the baseline building.

Mechanical system designs reflect a prudent blend of life cycle cost considerations including capital costs, utility consumption costs, and simple straightforward systems that can be understood and operated in an effective manner. Considerable thought was given to provide accessibility for maintenance. Canadian products were specified wherever possible to facilitate the easy replacement of parts.

Electrical

The electrical design includes fixtures that minimize and control energy consumption consistent with LEED® performance criteria. Sustainable, efficient, and functional system features that are incorporated into the school's electrical system include energy efficient lamps and ballasts; multi-level local lighting controllability; BMCS control of car park receptacle operation; use of fluorescent T8 and T5 technology; occupancy sensor control of lighting in all washrooms and daylight control of corridors; electric vehicle charging stations; electrical infrastructure to support the latest Smartboard™ technology; and dark sky compliant lighting for the exterior of the buildings.

Challenges

There are always challenges with large projects—and certainly 18 schools being designed and constructed at the same time is no exception. The design included exhaustive reviews for constructability and maintenance. The numerous design reviews were hectic and concluded with three main design models, each of which had two footprints depending on the lot size. Meetings took place once a week with the contractor and once a month with representatives of the user's groups. It required above average organization and coordination skills to keep up with the meetings.

The short timeframe in which to coordinate, design, and construct interdisciplinary efforts was a significant challenge. Williams Engineering Canada's design team had to work collaboratively, seamlessly, effectively, and quickly in order to turn all stakeholders' requests into presentable designs, which were tirelessly narrowed down week after week. Satisfying all of the clients including Alberta infrastructure, Alberta Education, and various school boards was no small feat. While similar design initiatives were needed across the facilities, all required slightly different execution. In the end, the three core designs had to be constructed simultaneously, which meant performing construction administration on 18 facilities at the same time and attending monthly meetings for each.

Civil

Williams Engineering Canada's civil team provided the grading design, stormwater management, and utility services. The City of Edmonton (City) servicing agreements were included in the scope, and liaisons with municipal and private services were part of the scope. Challenges included grading and drainage near the modulars due to crawl space requirements underneath that needed to be accommodated; a Municipal Improvement Servicing Agreement was required for one school in the City for a shared storm service with adjacent landowner; and Municipal Improvement Servicing Agreements drawings were completed for six of the schools to address shared work with the City on the street-front.

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Full Project Description

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Introduction

The recent population explosion in Alberta necessitated the rapid expansion of local infrastructure. Schools to support the demographic bulge, promised by a young community, were key to the future success of the province. To ensure Alberta's children were given every opportunity to excel, 18 new schools were constructed in the province's two most populous cities, Edmonton and Calgary. The 18 schools represent Phase One of the Province of Alberta's (Province) first infrastructure project using a Public Private Partnership (P3) model and is called Alberta Schools Alternative Procurement (ASAP).

ASAP represents a series of productive partnerships. In September 2008, the Province signed an agreement with BBPP Alberta Schools Ltd. to design, build, finance, and maintain the new state-of-the-art schools. Construction and operation of the schools were funded through a P3; after 30 years, the facilities will be turned back over to the Province. Architectural designs were facilitated through both Barr Ryder Architects & Interior Designers (Edmonton) and GEC Architecture (Calgary). With regional offices in both cities, Williams Engineering Canada Inc. (WEC) was situated perfectly to provide mechanical, electrical, and civil engineering designs for all 18 schools, each of which was designed to LEED® Silver certification guidelines.

The project includes K-4, K-6, and K-9 schools. Each school consists of classrooms, student gathering areas, administration space, and gymnasiums that are all designed and built for optimal energy efficiency and healthier indoor environments. The 18 new schools are as follows:

Calgary Board of Education	
Community/School (Grade Structure)	**Student Capacity**
Bridlewood Elementary School (K-6)	600
Cranston Elementary School (K-4)	600
Evergreen Elementary School (K-4)	600
Royal Oak Elementary School (K-4)	600
Saddle Ridge Elementary School (K-4)	600
West Springs Elementary School (K-4)	600

Calgary Roman Catholic Separate School District	
Community/School (Grade Structure)	**Student Capacity**
Cranston Elementary/Junior High School (K-9)	900
Evergreen Elementary School (K-6)	600
Saddle Ridge Elementary/Junior High School (K-9)	900

Edmonton Catholic Separate School District	
Community/School (Grade Structure)	**Student Capacity**
Hamptons Elementary/Junior High School (K-9)	600
Rutherford East Elementary/Junior High School (K-9)	600
Terwillegar Heights Elementary School (K-6)	600

Edmonton Public School Board	
Community/School (Grade Structure)	**Student Capacity**
Belle Rive Elementary/Junior High School (K-9)	900
Carlton Elementary/Junior High School (K-9)	900
Hollick-Kenyon Elementary/Junior High School (K-9)	900
Rutherford West Elementary/Junior High School (K-9)	900
Tamarack Elementary/Junior High School (K-9)	900
Terwillegar Towne Elementary/Junior High School (K-9)	900

Preliminary design for these high-quality, long-lasting, and innovative schools commenced in September of 2007. The schools were completed in June of 2010 and opened for the 2010/11 school year.

Innovation

Mechanical

The mechanical scope of work for the core space included heating, ventilation, plumbing, fire protection, and control systems that were sufficient for effective and reliable facility operations. A number of innovative designs were implemented including thermal displacement ventilation, condensing boilers that use a cascading heating loop, heat recovery technology, and water saving techniques.

Thermal displacement ventilation was designed for all classrooms and gathering areas. Displacement ventilation is characterized by naturally generated stratification in density (thermal) and scalar concentration (pollutant). It discharges supply air of low velocity near the floor and in turn cool supplied air spreads over the floor and forms a pool of conditioned air. When this cool air meets a heat source, because of the temperature difference and resulting buoyant force, convection plume is generated through which warmed and polluted air goes upwards to the ceiling where it exits through the exhaust. This aspect is one of the most beneficial factors in thermal displacement ventilation over the conventional mixing type ventilation. As a result, only heating/cooling loads affecting the lower part of the space (e.g., occupied zone) are taken care of and more importantly, this process can improve air quality in the occupied zone. This naturally leads to energy savings, as well as enhanced indoor air quality. Ventilation is also demand-controlled with CO_2 sensors that ramp up air flow during high demand or occupancy and lowers it during low demand, such as in rooms with few or no occupants.

The building's heating system consists of perimeter passive radiant heating panels suspended from the structure. The system provides the occupants with a high level of thermal comfort with a passive and quiet delivery of radiant energy to the building structure. This system affords the appropriate level of zoning and controls to suit space requirements in concert with air system functions. The heating system uses condensing boilers with a cascading heating loop, which provides high ΔT to reduce the heating system water flow rate by two thirds compared to a conventional heating system. Lowering return water temperature also helps to increase boiler thermal efficiency, especially when the condensing boiler is running at partial load. Air handling systems encompass heat recovery technology. Mechanical cooling is provided to high-heat areas (server rooms) and free-cooling air-systems for classroom and administration areas as outdoor conditions permit. The air systems are intended to be used in concert with operable windows to provide for occupant comfort in summer months. All systems are equipped with a return fan, isolation dampers, filter bank, glycol heating coil supplied from the heat exchangers, enthalpy wheel, and a draw-through supply fan. All components are selected for a life expectancy of 30 years based on ASHRAE standards.

Ventilation to the classroom areas is 100% outdoor air. The displacement ventilation system supplements the operable windows in the building. All air systems use heat recovery systems on the facility exhaust air streams to improve operating efficiency and serve to preheat the outdoor air for the new building ventilation systems. Air system filtration on all units is two-stage and meets MERV 13 for LEED® compliance and air quality control.

Optimal water saving techniques included low-flow and sensor-operated plumbing fixtures. All plumbing systems are of the latest design and of the highest degree of water consumption efficiency. Low flow urinals and low flow toilets were used as a sustainable design measure and further water conservation measures. The water use reduction for the building is 45.95% compared to the baseline building.

Mechanical system designs reflect a prudent blend of life cycle cost considerations including capital costs, utility consumption costs, and simple straightforward systems that can be understood and operated in an effective manner. Considerable thought was given to provide accessibility for maintenance. Canadian products were specified, wherever possible, to ease the replacement of parts.

Electrical

The electrical design includes fixtures that minimize and control energy consumption consistent with LEED® performance criteria. The following sustainable, efficient, and functional system features are incorporated into the school's electrical system:

- Energy efficient lamps and ballasts
- Multi-level local lighting controllability
- BMCS control of car park receptacle operation
- Use of fluorescent T8 and T5 technology
- Occupancy sensor control of lighting in all washrooms and daylight control of corridors
- Electric vehicle charging stations
- Electrical infrastructure to support the latest Smartboard™ technology
- Dark sky compliant lighting for the exterior of the buildings

Civil

The civil works consists primarily of three major components. These work phases are the development of:

- Earthworks and building floor slab elevation
- Stormwater management and drainage design
- Site services

Although each school site is unique in the positioning of the building, parking areas, surrounding utility mains, and grading, WEC applied the same basic design fundamentals in the design of all 18 school sites. The design for each site accommodates both the core school with and without modular attachments. This allows for growth in both the number of students and class sizes.

Technical Excellence and Advancement of Technology

Mechanical

Due to the high volume of air that is exhausted from the classrooms, heat recovery is incorporated into the air system operation. A minimum of 95% efficient condensing boilers were used. High efficiency pump motors, fans, and VFD systems were also specified and heating and domestic water piping was insulated. Heat-wheel heat-recovery technology is also used as an energy saving option.

Direct Digital Control (DDC) of systems enables exhaust fans and ventilation air units to shut down during unoccupied periods. An unoccupied space temperature setback system was incorporated to lower room temperatures. On the night cycle, the fan systems are off and room temperatures are maintained at the night setting by the hot water heating system. Controls in the ventilation supply system allow the reset of the mixed air temperature to minimize the amount of air tempering.

CO_2 monitoring helps to sustain long-term occupant comfort and well-being, and the cascading heating loop helps to reduce heating system flow rate and increase condensing boiler thermal efficiency.

Electrical

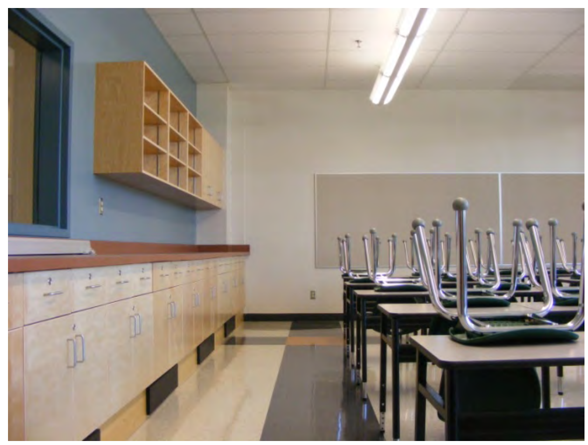
WEC performed protective coordination studies to ensure proper equipment protection. Our firm also designed fire alarm and digital master clock systems and incorporated infrastructure required to support the latest Smartboard™ technology. Electric vehicle charging stations were installed in the parking lots. Voice and data cabling was designed to meet individual school boards' requirements and the latest VOIP protocols.

Civil

The goals and objectives of the civil design were:

- To provide a design that met the client's needs as defined by the ASAP Schools documentation, while ensuring that designs met municipal and provincial requirements.
- To provide a design that represented a good value to all partners involved in the P3 project, including the citizens of Alberta.
- To provide a design that was generally consistent with the current Alberta Infrastructure technical standards and guidelines, which relate to facilities of this nature.
- To provide a sustainable, efficient, and functional system for the facility that was consistent with LEED® performance criteria.
- To use generally accepted design practices throughout the project, for grading stormwater management, and servicing.

Risk Management



There are always risks associated with large projects and certainly with 18 schools being designed and constructed at the same time under a tight deadline. The design included exhaustive reviews for constructability and maintenance. The many design reviews were hectic and concluded with three main design models, each of which had two footprints depending on the lot size. Meetings took place once a week with the contractor and once a month with representatives of user's groups. Keeping up with meetings alone required above average organization and coordination skills.

Civil

WEC's civil team provided grading design, stormwater management, and utility services. The schools involved a core school design and attached modular classroom units. The City of Edmonton (City) servicing agreements were included in the scope, as were liaisons of municipal and private services.

- There were challenges to grading and drainage near the modulars due to crawl space requirements underneath that needed to be accommodated.
- One school in the City required a Municipal Improvement Servicing Agreement for a shared storm service with an adjacent landowner.
- Municipal Improvement Servicing Agreements drawings were completed for six of the schools to address shared work with the City on the street-front.
- The schedule was demanding and civil was on a critical path due to the requirements of civil drawings for permitting stipulations.
- Two Stormwater Management (SWM) reports were completed to address City of Calgary requirements for sites over two hectares. WEC coordinated sub-consultant efforts on five further SWM reports.

Environmental Value

Mechanical

By employing a variety of sustainable design strategies, each school provides better indoor air quality, higher comfort levels, and reduced energy consumption. This improves the daily experience for students and staff, making the schools an optimal learning and working environment. Mechanical technologies were elaborated on in the previous Innovation section; however, the following points should be highlighted:

- Improvements to plumbing facilities and fixtures to enhance water use efficiency and functionality.
- Improvements to heating systems for control and heat distribution management to ensure blanket coverage of exterior zones.
- Addition of mechanical cooling systems in the form of unitary systems where supplemental cooling is required.
- Addition of heat recovery systems to reduce outdoor air heating loads.
- Ventilation systems' improvements to ensure low level displacement ventilation air are accurately and unobtrusively delivered to occupied spaces that can be further enhanced by the use of operable windows.
- Addition of minimal humidification control for occupant comfort in the building.

Electrical

In an effort to minimize and control energy consumption and provide sustainable, efficient, and functional systems for the facility that is consistent with LEED® criteria, a number of features were incorporated into the electrical systems of the schools. Energy efficient lighting is accomplished with T5 and T8 lamps and electronic ballasts were used in order to reduce energy consumption. The luminaires were equipped with energy efficient T5/HO lamps and electronic ballasts. Daylight sensors were provided for fluorescent lighting controllability and they adjust the light levels automatically with the amount of natural light within each classroom. Occupancy sensors were used in storage, washrooms, and service rooms. The lighting was designed to achieve less than 1 watt/ft^2 of lighting power density.

Incoming power is at 600 Volts and distributed throughout the schools with 120/208 Volts at key locations. Larger mechanical loads and lighting was designed to run on single phase 347 Volts to avoid transformation losses.

Exterior lighting was designed and modeled by WEC to achieve LEED® dark sky compliance. The principle is quite simple and straightforward; light when you need it, where you need it, and no more. Not only were energy efficient lamps and ballasts designed, but they emit minimal or no up-light; in other words, they do not create unnecessary light pollution.

Added Value

The development of the facilities was driven by an optimal balance of comfort and efficiency. The intent was to provide a sustainable and environmentally conscience system design. In addition, functionality and controllability are added benefits to these facilities that were completed in a short time frame within a strict budget. A life-cycle costing model was analyzed and the best 30-year model was designed.

Degree of Difficulty

The short timeframe in which to coordinate, design, and construct inter-disciplinary efforts was a significant challenge. WEC's design team had to work collaboratively, seamlessly, effectively, and quickly in order to turn all stakeholders' requests into presentable designs, which were tirelessly narrowed down week after week. Satisfying all of the clients including Alberta infrastructure, Alberta Education, and various school boards was no small feat. While similar design initiatives were needed across the facilities, all required a slightly different execution.

In the end, the three core designs had to be constructed simultaneously, which meant performing construction administration on 18 facilities at the same time and attending monthly meetings for each.

Benefit to Society

In addition to WEC assisting in the rapid production of 18 desperately needed schools, WEC also provided sustainable, efficient, and functional systems consistent with LEED® guidelines and Alberta Infrastructure performance criteria while meeting budgetary and schedule requirements. The benefits will continue to be seen—healthier children, increased learning, and less time spent on school buses.