

Canadian Consulting Engineering Awards 2011

Mona Campbell Academic Building, Dalhousie University



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Prepared for:



Prepared by:



building atrium provides passive solar heating directly to the building. The energy use associated with artificial lighting systems has been minimized, whilst lighting quality and user functionality maximized. This is achieved through collaboration with the project Architects to optimize window locations, glass properties and interior color to enhance daylight penetration into the building. Selection of state of the art artificial light fixtures and lamps to optimize light output whilst minimizing lighting power consumption (low installed lighting power density). The design included a fully digital lighting control system that uses vacancy sensing , daylight sensors to dim or turn off lights based on the amount of ambient natural light and permits occupant changes to interior light levels to optimize visual comfort in the space. Computerized building control systems and lighting controls are integrated to operate the heating, cooling, lighting and ventilation systems for each building zone in response to changing occupancy, occupant adjustments, ambient conditions and sunlight.

Adding to the renewable energy and lighting system energy performance, other energy reduction strategies in the heating, cooling, pumping, air circulation and domestic hot water use result in overall predicted energy savings of 52% compared to the equivalent energy code compliant building.

Water Conservation measures are one of the key environmental achievements of this design. Collectively the rainwater collection system and efficient plumbing fixtures reduce the quantity of treated municipal water used for nothing more than sewage conveyance by 90%. I.e. this building uses only 10% of the potable water that would normally expect to be used for sewage conveyance in a conventional facility of equal size and occupancy. Overall treated municipal water use in this building is reduced by 75%.

The water conservation design features not only result in significant reductions in the use of municipal treated water but when combined with the green vegetated roof over the classroom area are responsible for contributing to notable reductions in storm water runoff quantities that exceed municipal and LEED reduction targets.

Dalhousie University challenged the design team to optimize the interior environment for human comfort, maintenance simplicity, air quality, acoustics and lighting. In response CBCL designed a ventilation system that carefully distributes air to every interior space at a rate that exceeds the minimum requirements of the building code by 30%. A ventilation control system, in real time, monitors and takes action within the mechanical systems to limit interior levels of pollutants like Carbon Dioxide, small particles (PM2.5), Volatile Organic Compounds (VOCs) and excessive humidity. Carbon dioxide levels in classrooms and densely occupied spaces is monitored and controlled to appropriate levels so that the amount of fresh air brought into the building matches the actual needs of the number of occupants at that moment. Other indoor air quality strategies included operable windows in regularly occupied spaces, integrated lighting controls and ventilation controls systems, avoidance of on-site combustion and the careful material selection to limit VOC and formaldehyde presence within the building.

At the conclusion of the construction phase CBCL completed a rigorous building commissioning program that verified the performance of the building mechanical and electrical systems. CBCL also conducted an education/training program for both the building occupants and the Universities operations and maintenance staff informing them of proper use and function of the various building systems. This project close out activity is being followed up by a 2 year Measurement and Verification Program that will provide accurate data to verify the success of the building systems design and to allow the University to make any small on-going adjustments to maintain their highly efficient and sustainable building.



Project Information

The Mona Campbell Academic Building, Dalhousie University, Halifax, Nova Scotia

A product of an integrated engineering approach.

In the fall of 2007, Dalhousie University in Halifax commissioned Fowler Bauld and Mitchell Architecture and CBCL Limited Consulting Engineers to complete the design of a new Academic Building on the site of their former School of Business. The project involved the demolition of a 1968 vintage six storey office building and adjoining masonry structure and the construction of a new 105,000ft² new academic building.

CBCL provided core Engineering services in the disciplines of; Civil Engineering, Structural Engineering, Mechanical Engineering, Electrical Engineering and Landscape Architecture. We also provided specialist services for; Commissioning, Energy Simulation, Daylight Simulation and LEED Consulting.

The new academic building, now renamed the Mona Campbell Building acts as a gateway from the North West side of the city of Halifax, Nova Scotia into the Studley Campus of Dalhousie University. Located at the intersection of two main streets, Coburg Road and LeMarchant Street, the building interacts with the university campus and the surrounding residential communities. The building is programmatically diverse, housing four departments: Dalhousie University College of Continuing Education, School of Social Work, Faculty of Computer Science research space and the College of Sustainability. It also contains the PCPC computer retail store, a pizza shop and 10,000 ft² of mixed use classroom space. Such density of program was only possible by the careful integration of mechanical, structural, electrical and architectural systems and taking full advantage of key building features to serve multiple functions.

Building construction started in the summer of 2008 and was completed in time for the new academic year of 2010/2011.



Integration of electrical, mechanical, structural and architectural systems overcomes low floor to floor height.

Originality & Innovation

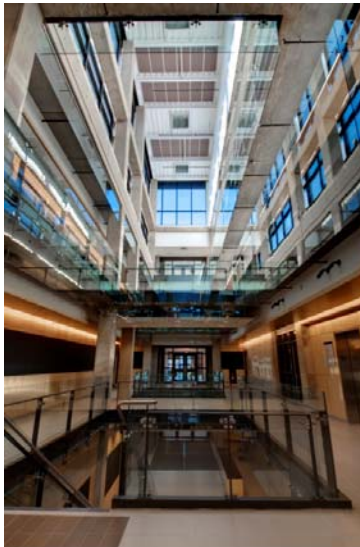
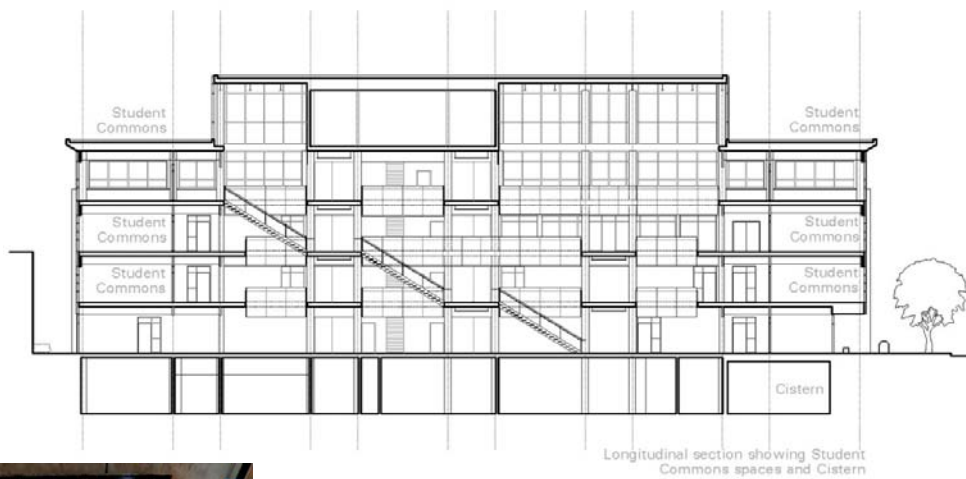
Society's awareness of the impacts of building projects on our environment, both in terms of the energy and resource consumption, is higher today than perhaps any other point in history. As a result Engineers are being called upon to meet ever higher standards of design. The fundamental challenge of "doing more with less" establishes engineering challenges and objectives that go well beyond those of years ago. Energy efficiency, environmental stewardship, increased functionality, adaptability and durability are now rightly given the same attention as the traditional cost and schedule concerns.

Today's engineers have no new "magic bullets" that will address some or all of these challenges and objectives. The innovation and originality in today's modern building design requires a higher level of design expertise, more analytical and detailed simulations of building systems and an innovative and integrated approach to the application of existing technologies. It comes from looking at challenges and objectives in a holistic fashion rather than the tradition compartmentalized yet parallel solution.

The advancement in the state of engineer's art and skills lies in the demonstration of how multidisciplinary innovative and integrated solutions can be woven together in ways that don't negatively impact the constructability, functionality, operational performance and financial cost of the building project.

We believe the engineering accomplishments in the Mona Campbell Building demonstrate such innovative and integrated design in a successful way. There aren't necessarily one or two "sound-bite" innovations or original applications in this project. The innovation is the integration of building design engineering and architectural disciplines and the application of engineering skills across all disciplines and building systems.

The main examples of engineering innovation and originality are listed below. The reader is then invited to learn more in the discussion on Complexity and Environmental Impacts.



Central atrium with smoke exhaust outlets visible in the roof.

Maximizing Site Potential

Innovative precast concrete slab system, Bubbledeck®, achieves the clear span arrangements within the classroom area whilst minimizing the structural slab depth and the building floor to floor heights.

The use of engineering design, analysis, and hands on commissioning/start-up produce a complex smoke management system in the atrium area which is part of an alternative compliance solution meeting the performance requirements of the National Building Code. This building feature, invisible to the building occupants, saved one of the most valued and remarkable architectural features of this building, the Atrium, and permitted greater leasable floor space around it.

Site design enhances the safe and convenient flow of pedestrians, provides new and restored natural ecological habitat and limits stormwater run-off.

Site design maximizes connection to public transportation, provides access to residential neighborhoods, facilitates active transportation options and avoids light trespass.

Energy Efficiency

- Integrated building systems that operate only when required for building use and occupancy;
- Building envelope systems are coordinated with heating, cooling and lighting systems to balance and optimize impacts;
- Performance of detailed pre-construction energy simulations optimized building heating, cooling and envelope systems with the cost of operation and construction;
- Application of cost effective renewable energy systems (Solar Air Heating) to take advantage of the solar resource on the site for reduced energy consumption; and
- Collaboration with design team partners and the use of complex computer analysis tools optimized the benefits of daylight penetration and passive solar heating, whilst limiting excessive cooling penalties.

Water Conservation

- Engineering design and analysis to take advantage of the abundant natural resource of rain in this climate and limit the use of highly treated potable water in non-potable applications;
- Integration of different engineering disciplines (civil and mechanical) to take advantage of the rainfall resource whilst simultaneously reducing the environmental damage associated with excessive surface stormwater run-off; and



- Integration of different engineering disciplines (structural and mechanical) permit the location of the large rainwater collection cistern within the structural foundation systems.

Indoor Environment

- Engineered mechanical and electrical systems optimize comfort and controllability for the building occupants;
- The design engineers took time to meet and discuss engineering systems, prior to construction and post construction, with building occupants ensuring appropriate application of technologies and a greater understanding of opportunities for occupant interaction with the building systems; and
- Proper allowance of ventilation system purging prior to occupancy to minimize potential construction related air quality issues.

Performance Verification

During construction and post occupancy hands on Engineering skills complement professional constructors and building operators to ensure:

- Building mechanical and electrical systems are installed and tested to operate as intended;
- Building occupants and maintenance staff are trained and aware of how to get the most from their new building;
- The complex smoke management life safety system operates as required under both normal and emergency power conditions;
- Non-potable water systems are never interconnected with potable water systems;
- Designed water and energy efficiency measures are installed and operating as intended; and
- Continuous post occupancy evaluation of energy and water consumption to verify pre-construction performance predictions.

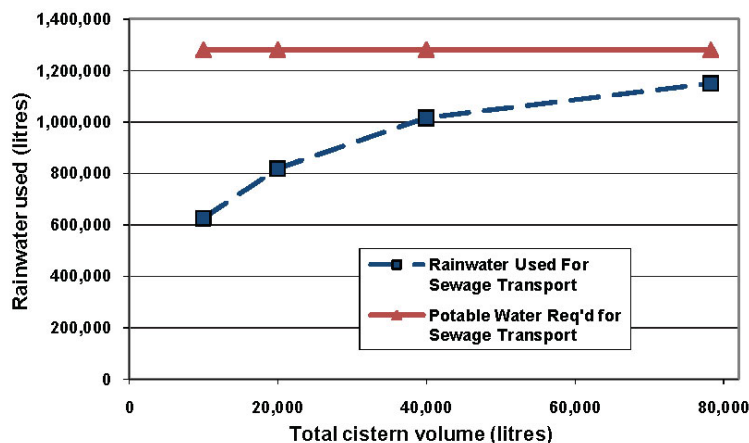


Chart showing optimization of rainwater cistern volume.



Complexity & Environmental Impacts

The Challenges

The Solutions

The Environmental Impacts

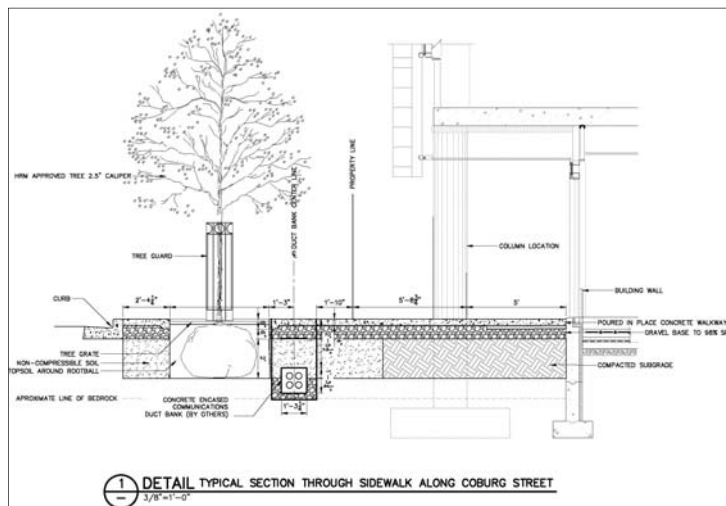
MAXIMIZE SITE POTENTIAL

The Challenge

A directive to the design team of particular importance to the Owner, was to maximize the building program opportunities on the identified project site. The pre-development site was an urban property with a mixture of existing and abandoned buildings, asphalt and gravel parking areas and a small area of unkempt vegetation. The design team was challenged to maximize program space within municipal zoning restrictions on development height and building code issues related to egress and the tight urban construction site.

The Solution

Site: In order to meet the Owners goal of “maximizing the potential of the site” the new building takes up over three quarters of the site area and the majority of the remaining site area is allocated for the necessary building service functions and urban pedestrian walkways.



The replacement facility includes a green roof garden, street trees and a native perennial garden. This site development creates an environment that rehabilitates the previously derelict urban site and enhances the continuity of the ecosystem within the neighbourhood and region

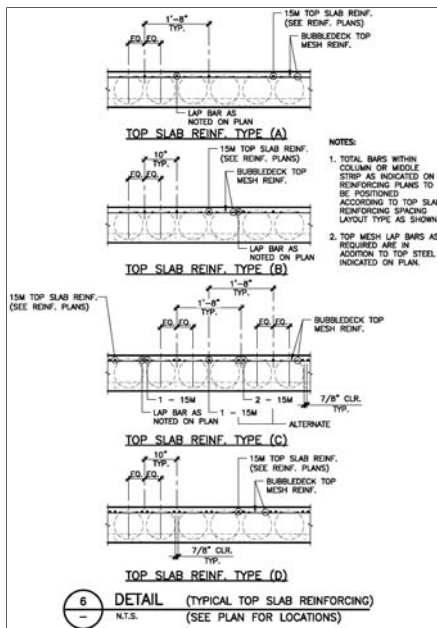
The green roof, comprised of sedums, grasses and alliums planted in a lightweight soilless growing medium, provides new habitat, mitigates urban heat island effects, reduces and filters stormwater runoff from the building's roof.

Street trees are planted around the perimeter of the building in large planting trenches that extend underneath the sidewalk and plaza areas. An engineered mix of non-compressible soils was

Solving Today's problems with Tomorrow in mind



Locally fabricated pre-cast Bubbledeck® slab panels.



selected to allow for better air/water/ soil porosity and tree-root development within the hardscaped environment. Trees, selected for their large canopy potential, add structure and shade to the streetscape in keeping with the neighbourhood vision and regional plan.

In collaboration with Dalhousie University and their master parking planning strategy, a plan was developed which eliminated the requirement for any on-site parking, further maximizing programme space available on-site.

Minimized Floor to Floor Height: Given the zoning building height limitation, floor to floor heights had to be minimized to achieve the desired program space. A floor to floor height of 11'-10" dictated a conventional reinforced concrete two way flat slab system. Lateral resistance for wind and earthquake loads are provided by concrete elevator and stair shafts. The primary exposed structural elements are the main atriums stairs and the bridges that connect the main building and classroom areas.

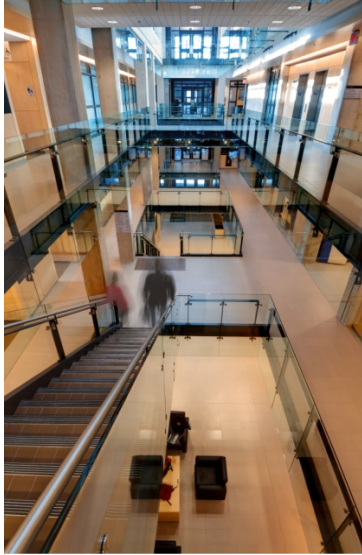
Of particular interest in the concrete structure is the use of the Bubbledeck® system, only the second application in Canada and the first in Atlantic Canada. This system utilizes precast concrete planks with cast in reinforcing cages and void-forming plastic balls which, in addition to eliminating expensive horizontal formwork, alters the conventional dead to live load ratios and allows lighter slabs to span further and carry more load than comparable conventional reinforced concrete systems.

The Bubbledeck® system was initially considered as a potential solution to the long span arrangements required in the classroom areas. The limited floor to floor height precluded a structural steel solution and conventional reinforced concrete slab beam alternatives were deeper than desired and prone to potential long term deflection and creep. The Bubbledeck® slab arrangements provide a thinner, flat soffit design solution that satisfied strength and deflection serviceability criteria and allowed the mechanical and architectural designers the freedom to rationalize a clean "ceiling less" arrangement that gave the classrooms the perception of volume they otherwise would have lacked.

The proposed Bubbledeck® solution for the classroom wing was viewed by designers, constructors and the University as an innovative and elegant solution for this project and hence this solution was ultimately extended beyond the classroom area to include the entire structural floor plates.

Selection of Bubbledeck® structural system created a uniform flat soffit that maximizes the space available for distribution of electrical and mechanical services and maximizing interior finished ceiling height. Limiting the overall

Coburg Road Façade



building height also provided an overall reduction in building elements, including façade, column heights, elevator shafts and shear walls.

Light Trespass Reduction: The project site borders on three adjacent properties with buildings and two urban streets. The design challenge was to provide lighting levels and systems that enhance the building night-time presence, promote pedestrian safety and security, whilst also minimizing the quantity of light that extended beyond the site boundaries or into the sky.

The interior and exterior lighting systems were designed to limit the quantity of light which spills beyond the project site boundary. Interior lighting was located such that all light fixture's maximum candela falls within the building envelope (not directed at any building opening/window or door). Exterior lighting fixtures are dark sky compliant, reducing the contribution to sky glow and trespass lighting is limited to the recommendations of an LZ3 as prescribed by Illuminating Engineering Society Recommended Practices for Lighting of Exterior Environments (IES RP-33-99). Design of the exterior lighting system in collaboration with the Landscape Architect ensured that zero illumination extends onto any of the three adjacent properties. In addition to the light trespass limitations, the exterior lighting power density is less than 80% of the requirements of ASHRAE 90.1. Further contributing to the overall energy reduction strategies of the building design.

Interior Program Space: The atrium provides the building with a central meeting and circulation zone of great importance to the architectural design. The four storey atrium creates an interconnected floor space condition. An analysis of the Building Code requirements for interconnected floor spaces determined that a performance based smoke evacuation system as opposed to the prescriptive requirements of the NBCC, could reduce the dimensions required for the two main egress stairwells, providing additional program space on all five occupied floor levels.

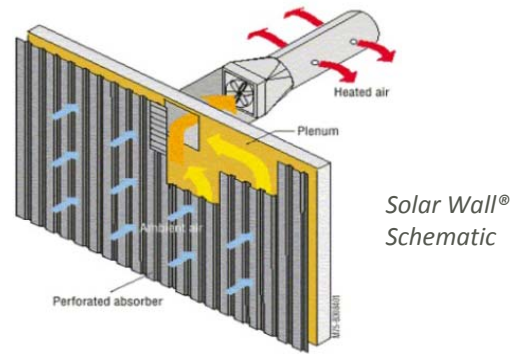
The design included use of the existing ventilation systems in order to contribute towards the required make-up air volume of 100,000 cfm. The remainder of the make-up air was provided through power operated doors on the ground level. Integration with multiple systems including the fire alarm, BMS, access control, intrusion alarm and smoke exhaust equipment, stairwell pressurization units, building ventilation system, motorized louvers, electrical distribution and emergency generation system was essential to the successful operation of this system.

Environmental Impact

The design solutions presented to maximize the potential of the site contributed to an overall reduction in stormwater runoff as compared to the



Maturing vegetated green roof with Solar Wall® panel in background



Solar Wall® Schematic

pre-development condition; reduced construction materials, especially concrete and associated cement relating to the façade, columns, elevator shafts and shear walls; minimized lighting that extends beyond the site boundaries and could have contributed to unwanted sky glow; maximized interior program areas whilst keeping building area and volume to the minimum necessary to meet the Universities financial and program requirements.

ENERGY EFFICIENCY

The Challenge

Energy costs are rising, operating budgets are under pressure and the broader environmental impact of energy use in the form of Green House Gas emissions and Urban Air Pollution, led Dalhousie University to challenge the design team to optimise energy efficiency.

The solution

In Nova Scotia's climate, primary energy demands are for heating and lighting. In the Mona Campbell building heating efficiency is optimized by an efficient building envelope, heat recovery ventilation, demand controlled ventilation for all densely occupied spaces (particularly the classrooms), a heat pump system that takes advantage of waste heat from the building's core and server room to provide useful heating at the perimeter and variable speed pumping systems that connect to a campus district heating plant.

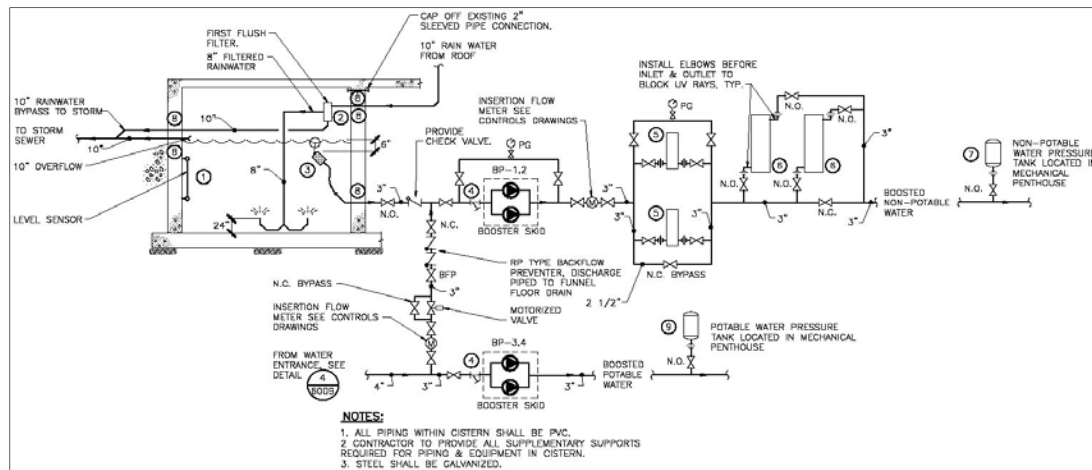
An active Solar Air Heating system takes advantage of free solar energy and is a renewable energy system for the preheating of building ventilation air, while a large area of vision glazing on the south side of the building atrium provides passive solar heating directly to the building.

The energy use associated with lighting systems has been minimized, whilst lighting quality and user functionality is maximized. CBCL's engineers achieved this in four primary ways. Through lighting simulations and collaboration with the Architects to optimize window locations, selection of glass properties, programming around a large central daylight atrium and interior color choices to enhance daylight penetration into the building. Selection of light fixtures and lamps optimizes light output whilst minimizing lighting power consumption (low installed lighting power density). Careful design of artificial lighting systems matched best practice illumination levels, (i.e., not exceed or fall short). The design also included fully digital lighting control system that uses vacancy sensing in most spaces, astronomical time scheduling, daylight sensors to dim or turn off lights based on the amount of ambient natural light and permits occupant changes to interior light levels to optimize visual comfort in the space.

52% better energy consumption than the MNECB



Passive solar heating in the upper atrium area.



The computerized building control systems are integrated with the building mechanical systems to operate the heating, cooling, lighting and ventilation systems for each building zone in response to changing occupancy, occupant adjustments, ambient conditions and sunlight.

Much effort was also given to local sourcing and fabrication of construction materials resulting in 33% (by cost) of construction materials being used from the local region. Special arrangements were made with the Masonry subcontractor to have Shouldice Stone used as part of the building cladding shipped by rail rather than by road greatly reducing the environmental transportation related impact.



Finished concrete pour over Bubbledeck® slab panels.

Environmental Impact – Reduced Pollution and Minimized Cost Associated with Building Energy Consumption and Construction Specifically:

- 16% contribution by renewable energy systems to the total building heating energy need;
- 47% less energy consumption for artificial lighting;
- Absolute lighting energy use of 21.3kWh/m²;
- Total third party verified predicted energy savings of 52%;
- Total predicted energy use of 416MJ/m² compared to the Canadian national average for office buildings of 868MJ/m²;
- Total predicted GHG emissions associated with building energy consumption are 652-tonnes. Approximately 308-tonnes less than average; and
- Reduced embodied energy of construction materials by limiting transportation and reducing cement in concrete (through the use of supplementary cementitious materials – Flyash).

Reductions are calculated through comparison with the reference data of National Model Energy Code for buildings.

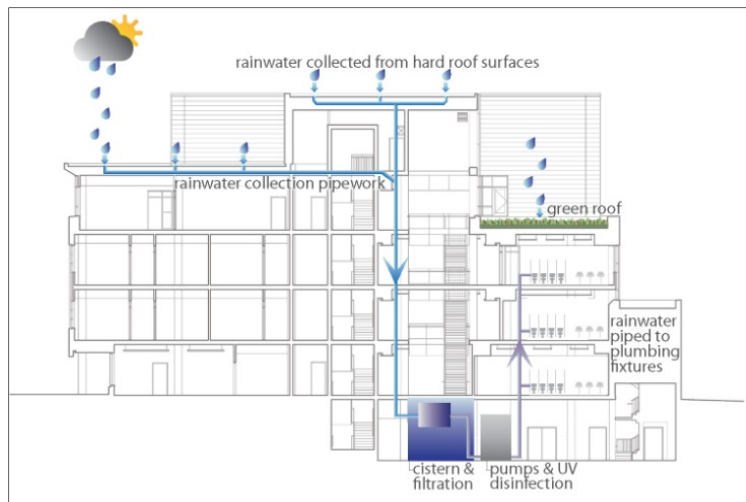
WATER CONSERVATION

The Challenge

The Halifax Regional Municipality has an old combined sanitary and storm wastewater system with new sewage treatment plants designed to operate at four times the normal design peak dry flow. This means that under many rain conditions the treatment plants are overwhelmed and sewage is discharged directly into Halifax Harbour. Dalhousie University challenged CBCL to minimise this new building's contribution to this problem and to minimise the wasteful use of treated potable water in applications that don't need it.

Rainwater Collection Schematic

- **Potable water use for sewage conveyance reduced by 90%**



The Solution

Plumbing fixtures are selected to minimize water use whilst ensuring robust reliable operation. Water for exterior cleaning and sewage conveyance is provided by an engineered rainwater collection system and green spaces are designed to avoid the need for any irrigation water.

Rainwater from hard roof surfaces is piped and collected in a 80,000L cistern. A green roof delays storm runoff and reduces the water volume by around 40% by plant evaporation. The green roof was not used to collect rainwater as the organic matter present in this water could create maintenance problems in the collection cistern.

Roof drains collect precipitation from the roof into piped gravity drainage systems. Centrifugal "first flush" filters separate the initial 5% of rain fall (the dirtiest water) and redirect it to the city combination storm and sanitary system, the remaining 95% is further piped to calming inlets strategically located at the bottom of the concrete collection cistern. The cistern is integrated into the building structure and waterproofed within the building basement. The calming inlets avoid disturbance of sediment at the bottom of the cistern. This sediment can be removed after it builds up to the point that it's problematic (anticipated to be ten years for Halifax). From the collection cistern non-potable water treatment and distribution pumps provide treated rainwater to all the building's flush plumbing fixtures and exterior hose bibs. The treatment consists of particle filtration and ultra violet disinfection to create clear water for distribution around the building and provide a measure of safety for building occupants who might accidentally come into contact with the non-potable water.

In the event that insufficient rainwater is available potable water is automatically supplied to the non-potable water system. This changeover is achieved by level sensors in the cistern and motorized valves that open to allow a connection between the potable and non-potable systems. City water is never supplied directly into the cistern as the small quantity of chlorine in the city water would kill the desirable bacteria in the cistern that help to maintain clean and odour free non-potable water.

The buildings plumbing fixtures include carefully selected ultra low flow urinals, dual flush toilets; low flow shower heads and sensor operated low flow faucets.

Environmental Impact - Reduction in the Use of Treated Potable Water

Collectively the rainwater system and efficient plumbing fixtures reduce the quantity of treated municipal water used for nothing more than sewage conveyance by 90%. i.e. this building uses only 10% of the potable water that

Interface of lighting and building ventilation controls.



would normally expect to be used for sewage conveyance in a conventional facility of equal size and occupancy. Overall treated municipal water use in this building is reduced by 75%. Potable water use is calculated to be 2040 Litres per occupant per year or 96.9 Litres per square meter per year.

This level of water efficiency dramatically exceeds the requirements of the LEED system for water conservation. The predicted water use reductions were significant enough to justify the application for an innovation credit for exemplary water efficiency under the LEED system. The LEED system awards one point for reducing water consumption for sewage conveyance by 50%, and two points for reducing total water consumption by 30%.

OPTIMISED INDOOR ENVIROMENT



The Challenge

Buildings provide shelter and comfort for human activity and protection from the often harsh exterior ambient conditions. Dalhousie University challenged the design team to optimise the interior environment for human comfort, maintenance simplicity, air quality, acoustics and lighting. The Mona Campbell building used many engineering techniques and systems to optimise the interior conditions.

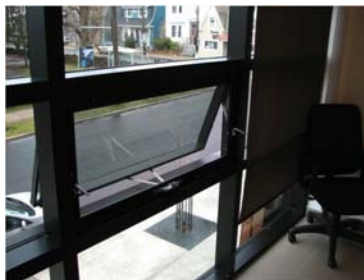
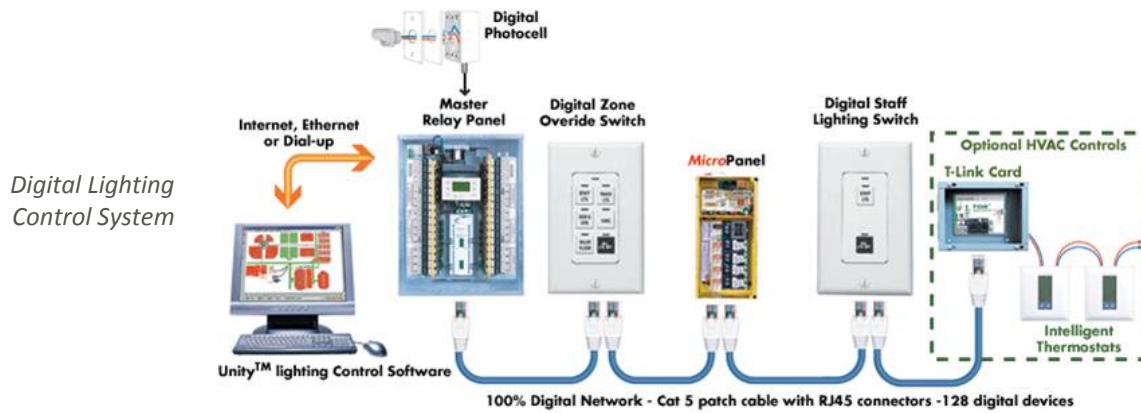
The Solution

Ventilation: Fresh air is drawn into the Mona Campbell building and distributed to every interior space at a rate that exceeds the minimum requirements of the building code by 30%. The computer control system, in real time, monitors and takes action within the mechanical systems to limit interior levels of pollutants like Carbon Dioxide, small particles (PM2.5), Volatile Organic Compounds (VOCs) and excessive humidity. Carbon dioxide levels in classrooms and densely occupied spaces is monitored and controlled to appropriate levels so that the amount of fresh air brought into the building matches the actual needs of the number of occupants at that moment. Other pollutants are monitored for step changes in values, in the event of a step change, indicative of a rapid release of a pollutant through occupant activity, the ventilation systems automatically purges the space to exhaust the pollutant and replace fresh air. The monitoring system also provides ongoing monitoring of interior conditions for the reassurance of the owner and building occupants.

Windows for Natural Light: Carefully placed windows provide natural light deep into the building footprint. CBCLs analysis of daylight penetration into the building informed the positions and quantity of these windows, optimized the performance of the glass between solar heat gain criteria and visible light transmission and informed the architects how the choice of color for various surfaces would impact the daylight penetration into the interior space. In



Daylighting Simulations



addition to natural light the windows also provide views of the surrounding green roof and natural/urban environment beyond.

User Control of the HVAC Systems: HVAC systems provide considerable occupant control of comfort conditions. Each heat pump can be controlled for heating or cooling and scheduled based on the occupancy needs of the associated zones. Occupancy sensors and carbon dioxide monitoring also limit the operation of this equipment when it's not required. Additional perimeter radiant heating provides further "sub-zone" control for individual perimeter offices served by the same heat pump.

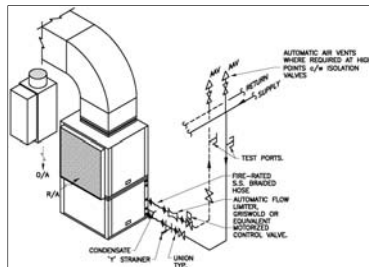
Lighting Controls: The lighting system design includes a fully digital control system. Each light switch has a RJ45 computer network connection and can be monitored and controlled remotely as well as by the local user. The light switching is designed for manual on and off control by the occupant and manual raise lower dimming to suit the occupants lighting needs. In addition vacancy sensing in most spaces, astronomical time scheduling and daylight sensors will automatically switch lights off, or dim them, to maintain the appropriate light level in each space. Educational sessions informed building occupants and operators of the functional capabilities and operating characteristics of the lighting control system.

Natural Ventilation: Operable windows are provided for most regularly occupied perimeter spaces. This natural ventilation strategy provides a connection for building occupants to the ambient outside environment and this "connection" is of greater importance than any energy savings (or penalty) associated with the operable windows. Nova Scotia has a long heating season and a humid summer so there are relatively few hours where natural ventilation is an energy benefit. However, CBCL supported the occupant desire for operable windows and recognizes the wellness benefit that occasional operation of the windows can generate. To help ensure successful use of the windows and minimize operational inefficiency CBCL participated in well attended occupant information presentations that communicated their proper use. Currently anecdotal observation of building operation indicates that the occupants understand this proper use and are practicing it. Further analytical observation will be conducted under a measurement and verification role that CBCL has for the first 18 – 24 months of building operation (2011-2012).

Maintenance: The heat pump system offers many installation and operational efficiency advantages. But over 88-individual heat pump units, each with its own refrigeration compressor circuit, controls, air filtration and supply fan; air distribution could have been burdensome on building operations and tight maintenance budgets.

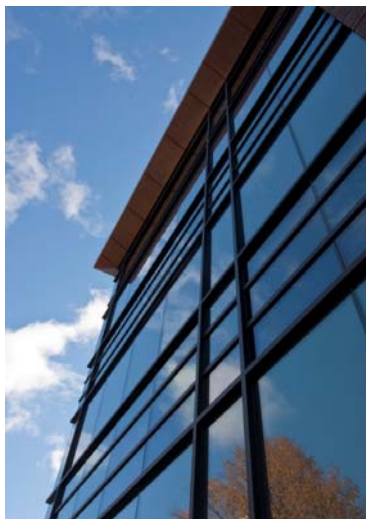


Heat Pump Rooms
- **Easy access for filter changing and maintenance.**



The Engineering design of the Mona Campbell building addressed this challenge in two primary ways. A central building computer control system constantly monitors all aspects of the building systems operation and provides automated diagnostics and alarm function in the event of abnormal energy or operational situations.

Normally heat pump systems are installed above finished ceilings. In the Mona Campbell building the integrated design team was able to implement an alternative that greatly reduced installation costs and will reduced maintenance costs for the life of the building. All the heat pumps are vertical orientation units and located in central equipment closets on each level. Housing the heat pumps in these central closets allows for consolidation and easy access to the equipment for filter changing. No step ladders and disruption to occupants is necessary to change 88 or more filters in the building and storage and movement of filters around the building is limited to the main circulation areas and these service rooms. Furthermore all the electrical connections to the heat pumps, condensate drainage, controls and fresh air supply connections are all consolidated into these service spaces. Finally the service spaces allowed acoustic control of the heat pumps to be consolidated into one location creating an unusually high quality acoustic environment in this heat pump serviced building. This simple decision was very well received by the construction and facilities maintenance staff and although invisible to the building occupants has also significantly benefited them.



No On-Site Combustion: The Mona Campbell building connects to Dalhousie's Central Heating plant. During the design and construction of the building CBCL also coordinated and provided engineering services to Dalhousie to convert their number 4 fuel oil (bunker C) central plant heating system into a substantially cleaner Natural Gas fired plant. This conversation greatly improves local air quality around the central heating plant as well as eliminating the frequent delivery by large heated fuel tankers to the central boiler plant. Connecting to the central heating plant also ensures that no combustion occurs at the Mona Campbell site ensuring that local emissions cannot affect the ventilation air quality for the occupants of the Mona Campbell building or surrounding residential and University properties.

Material Selection and Air Quality: Air quality in the Mona Campbell building was further enhanced by specification of low-emission materials. No materials containing ureaformaldehyde were used in the building and all finishes, paints and adhesives had low or no VOC content. In addition, during construction a careful Indoor Air Quality (IAQ) plan was adhered to so that construction materials were protected from the weather and ventilation systems were all protected from the ingress of dust and debris. Finally prior to permanent



Real-time indoor air quality monitoring.

occupancy the building was “flushed out” with 14,100 ft³ of fresh air for every occupied ft² of the building.

Environmental Impact

The Mona Campbell building has improved the environment for the building occupants and simplified maintenance. This best practice environment endears the building to the occupants and owner making it better utilized and longer lasting. This reduces the negative environmental impact of wasteful space and excessive use of materials. Specifically this building has:

- Improved indoor air quality for occupants by:
 - increased ventilation rates
 - real time monitoring/control of typical interior pollutants;
 - ventilation purge prior to occupancy;
 - no on-site combustion;
 - protection of materials and ventilation system for contamination during construction; and
 - selection of interior materials to limit exposure to toxic chemicals.
- Maximized natural light for occupant comfort and wellness.
- Improved occupant control over lighting for visual comfort.
- Improved occupant control over heating and cooling for thermal comfort.
- Improved acoustic comfort with a quiet HVAC system.
- Simple connection to the outside ambient environment (operable windows).
- Simplified maintenance and reduced HVAC equipment noise with the use of heat pump mechanical rooms.



Student common room off the Atrium.

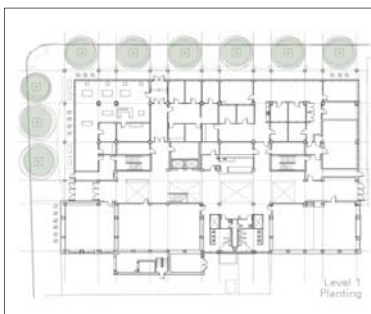
PERFORMANCE VERIFICATION

The Challenge

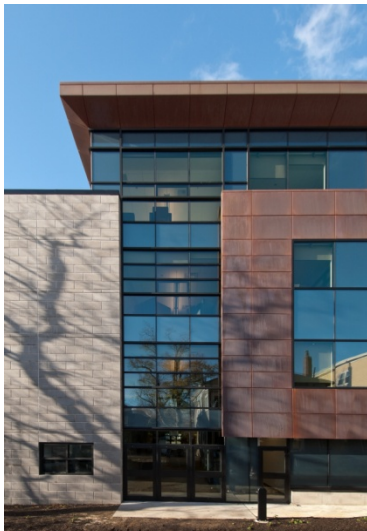
Traditionally the design team completes the design documentations and verifies that the Contractor has provided the necessary components identified in the Contract Documents. Once complete, the building is turned over to the Owner for their use, occupancy, operation and maintenance for the remainder of the building life, with little to no interaction from the original building designers.

The Owner and their staff are asked to operate complex building systems, informing occupants on how to best utilize these systems as well as reconcile energy and water consumption with no baseline information to compare to.

Recognizing this knowledge gap, the University asked the Design Team to devise ways to bridge this gap between building construction and building operation/occupancy.



EXPERIENCE VISION COMMITMENT



The Solution

Commissioning of Building Systems: CBCL Limited acted as the Commissioning Agent, coordinating and specifying commissioning for all energy and water related systems activities.

An exhaustive process was included to ensure that the building systems were not only installed as intended, but were calibrated, adjusted, tested and documented, thus verifying that they operate within the design parameters as efficiently and effectively as possible.

This process included preparation of commissioning specifications in the Tender documents; development of commissioning forms required for various systems and system components; development of commissioning sequences/activities; review of Contractor product and product performance submittals; pre-functional testing which confirms the installation and basic operation of individual system components and interfaces; functional performance testing which confirms the operation of the entire building system as well as interfaces with other building systems; review of project operation and maintenance information; preparation of a commissioning binder which is turned over to the Owner at the completion of the project ensuring the necessary building system operational set points and adjustments are available to the Owner for ongoing troubleshooting, maintenance and re-commissioning activities they may perform.

The building systems that were included in the commissioning process include:

- Building Automation System
- Ventilation Systems
- Potable Water System
- Non-Potable Water System
- Wet Side HVAC Systems
- Server Room Environmental Control System
- Fire Alarm System
- Performance Based Smoke Evacuation System
- Electrical Distribution System
- Emergency/Standby Generation System
- Automatic Transfer System
- Lighting Control System
- Electrical Metering System

Each of the commissioned systems presented a unique set of challenges. Of particular concern to both the design team and building officials were the performance based smoke exhaust system and non-potable water systems.

Smoke Management System Commissioning: The performance based smoke exhaust system required multiple interfaces with other building systems,



Ceiling heights maximize by an integrated design approach.



including; the fire alarm system, security system, access control system and HVAC system. To ensure all of these interconnected systems performed the necessary functions, CBCL in collaboration with the Code Consultants, performed an actual smoke simulation system test. This test verified that when smoke is present the building; the exterior door electronic locking devices were released and power operators actuated; the fire alarm system sent smoke condition signals to the BMS as well as shut down all non essential mechanical ventilation equipment; the BMS actuated motorized controllers to redirect 100% of supply air from one of the air handling units (AHU) to the ground floor level and operated the AHU at 100% flow/outside air; roof mounted smoke exhaust fans started, and the fire alarm system sent appropriate signals to the Dalhousie central security office located in another building on Campus.

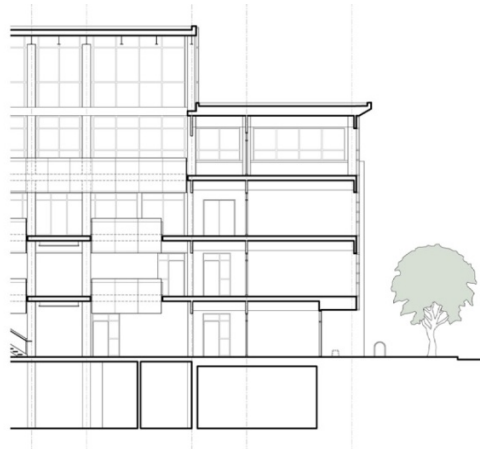
Potable/Non-potable Water System Commissioning: CBCL ensured that the hundreds of meters of potable and non-potable water distributed around the building were never cross connected by conducting commissioning tests on the finished building systems. During a weekend we physically isolated the city water from the building and flushed/opened every plumbing fixture to verify that flow only existed in the non-potable system. Following that we isolated the non-potable system and repeated the test of the interior fixtures to verify that only potable water was connected to all the sinks, showers and drinking fountains. This testing gives us and the building owner confidence that the complex systems are properly installed.

Measurement and Verification: Dalhousie University recognized the value in on-going monitoring and verification of the buildings systems after the completion of construction. As such, CBCL is contracted to perform this measurement and verification service over the first two years of occupancy.

The Mona Campbell building design includes a high level of segregated metering and monitoring of all energy and water related services. These features will be used during the measurement and verification period to review the operational use of each of the systems and compare the actual use and consumption to the estimates developed during design. Where variances are found between the actual usage and anticipated usage, corrective recommendations will be developed and presented to the Owner and their operation staff, be it operational or equipment related.

This service is providing the Owner with the information, supervision and recommendations necessary to ensure the building operates as efficiently as intended, ultimately providing overall reductions in energy and water consumption.

*Translation of design
into operation by user
education.*



Training and Awareness: The design intent of the building systems as well as the associated user interfaces are rarely conveyed directly to the building occupants. To ensure the complex engineering systems are operated and utilized as efficiently and effectively as possible, CBCL participated in numerous training sessions provided to building occupants. These provided the occupants with the opportunity to understand design decisions made as well as how systems are to function. The benefit of these have been noted on numerous occasions where design team members have conducted checks on the building operation and noted efficient use of operable windows, lighting controls and heating/cooling controls.

Environmental Impact

The design solution and professional engineering services provided verify the building performance and provide significant environmental and economic benefits to the University. The commissioning process ensures the designed and installed systems are operating at peak efficiency, minimize health and safety risks, and minimize water and/or energy use. The process provides a reference document for ongoing commissioning and calibration of systems. Ongoing verification of building system performance is achieved through the measurement and verification service, providing operational saving opportunities which arise during the first year of occupancy. Training sessions for building occupants, operation and maintenance staff provide the necessary information to ensure the building is operated effectively, further contributing to overall energy savings, improved indoor air quality and reduced potable water use.



Social & Economic Benefits

“The Greenest Building on Campus” and home to the University College of Sustainability.

Located within the centre of Halifax, the Mona Campbell Building adds density to an eclectic neighbourhood. Close to many amenities the building has a diverse program. In addition to the academic spaces retail, restaurants and lifelong learning are accommodated, making this both a community and a university building. Extended hours of operation and student commons spaces make this a lively study space throughout the day and evening.

Served by many bus routes the first floor creates a colonnade along the Coburg Road and LeMarchant Street sidewalks providing covered bicycle storage and weather protection for pedestrians.

The building actively discourages automobile use and offers no parking. There are a total of 78 bike racks, with over half of them being inside, located near to shower and change facilities.

Life cycle operation was a significant design directive given by Dalhousie to the design team. Dalhousie envisions that this building will accommodate many faculties throughout its lifespan, so the building has been designed with good, almost generic office and classroom space to facilitate this philosophy. Unable to predict exactly where additional space will be required on campus, the university needed this highly flexible space. Almost all the lighting devices (switches, sensors, etc) are intelligent networked components and the operation of these devices can be changed at a central computer programming point. In addition centralized electrical and communications rooms, located on each level of the building, allow easier reconfiguration of interior spaces. All of the buildings heat pumps are located in central mechanical rooms (three on each level). Centralizing the heat pumps in this way greatly simplified installation and will simplify maintenance for the life of the building. Maximizing structural spans in the building with the use of bubbledeck allows the large assembly spaces to be subdivided if required. Copper, curtainwall and shouldice stone were selected as cladding materials for durability and their timeless elegance.

***10% under budget
while maintaining the
project schedule.***



A university is a place to promote the exchange of ideas. It is important to provide not only teaching and learning spaces but in-between spaces, where opportunities for the informal discussion of ideas occur between staff, students and visitors. These connective, non-programmed spaces form the soul of the Mona Campbell Building, in the four storey, south facing central spine or atrium. This provides both physical and visual interaction with all departments, access to daylight and the exterior green space.

The form of the building and the building section address sustainability, programme and context. The building is clearly ordered – with zones for each function. The office spaces are located on the north and the classroom spaces are located to the south with the interstitial south facing atrium encouraging socializing, integration and learning.

The building will also interact with the occupants and visitors in a number of other ways. Dalhousie University and the design team created a demonstration and education program showcasing sustainable features of this building.

1. Building tours, both guided and self guided, with a comprehensive green directory, and signage explaining prominent green features are on-going.
2. A video, produced by Water Street West, summarizes Dalhousie's approach to sustainability. Posted in numerous places online i.e.; <http://www.youtube.com/user/DalhousieU#p/a/f/0/1uNuVPoSGOY>
3. A highly visible art piece by Stephen Kelly entitled "Info Glow" will be located in the atrium. A national peer review jury for Canada Council for the Arts awarded a \$60,000 grant for this art piece which uses the building's real-time internal environmental conditions and energy use data to create a sensory experience in textile with 3-D digital LED lighting and subtle sounds.
4. The design team has presented the building's features at well attended building occupant information sessions and all of the technical building operator training sessions were video recorded for future reference.



Meeting & Exceeding the Clients Needs

PROJECT BUDGET AND COST

As part of the integrated team approach in this project the University engaged the services of a construction manager, Aecon Atlantic Group. Apart from their contribution to construction activities, Aecon were tasked with the development of a project cost plan and with monitoring the projected costs through the progressive phases of design and through the sequentially tendered procurement process.

The initial project estimates assumed a 7,340 m² net building area and a \$18.60 m capital cost. Evolutions in the building design including additions to the building programme resulted in a pre-construction estimate of \$33 million for a 105,000 ft² final building design. The final construction costs at \$30 m, were well within this pre-construction budget.



PROJECT SCHEDULE

Completion of the assignment was targeted for August 2010 in time for occupancy at the beginning of the 2010/ 2011 academic year. Failure to meet this goal would have had serious implication on the University given the impact on class scheduling and the existing tenancy leases that were terminated in the expectation of this project completion date. The project team delivered this project on time and the University took occupancy in July/ August of 2011.

Achieving this schedule involved a multi- package sequentially tendered approach that accelerated the building structure and envelope trade packages ahead of the mechanical and electrical and interior finishes components. The use of the bubbledeck precast flat slab system, allowed the upper floors above grade to proceed quickly through the late fall and early winter of 2008 and gain valuable time at the back end of the schedule. Building commissioning, construction cleaning and off gassing procedures were carefully planned in the final few months to meet the required schedule without compromising indoor air quality.

*Pre-heating of
building ventilation
air via solar wall*

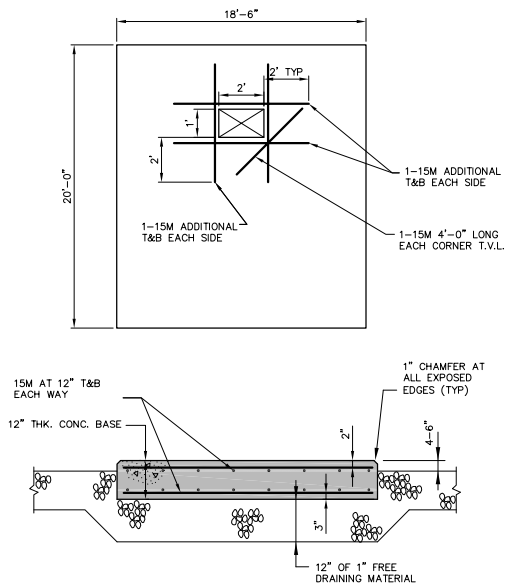
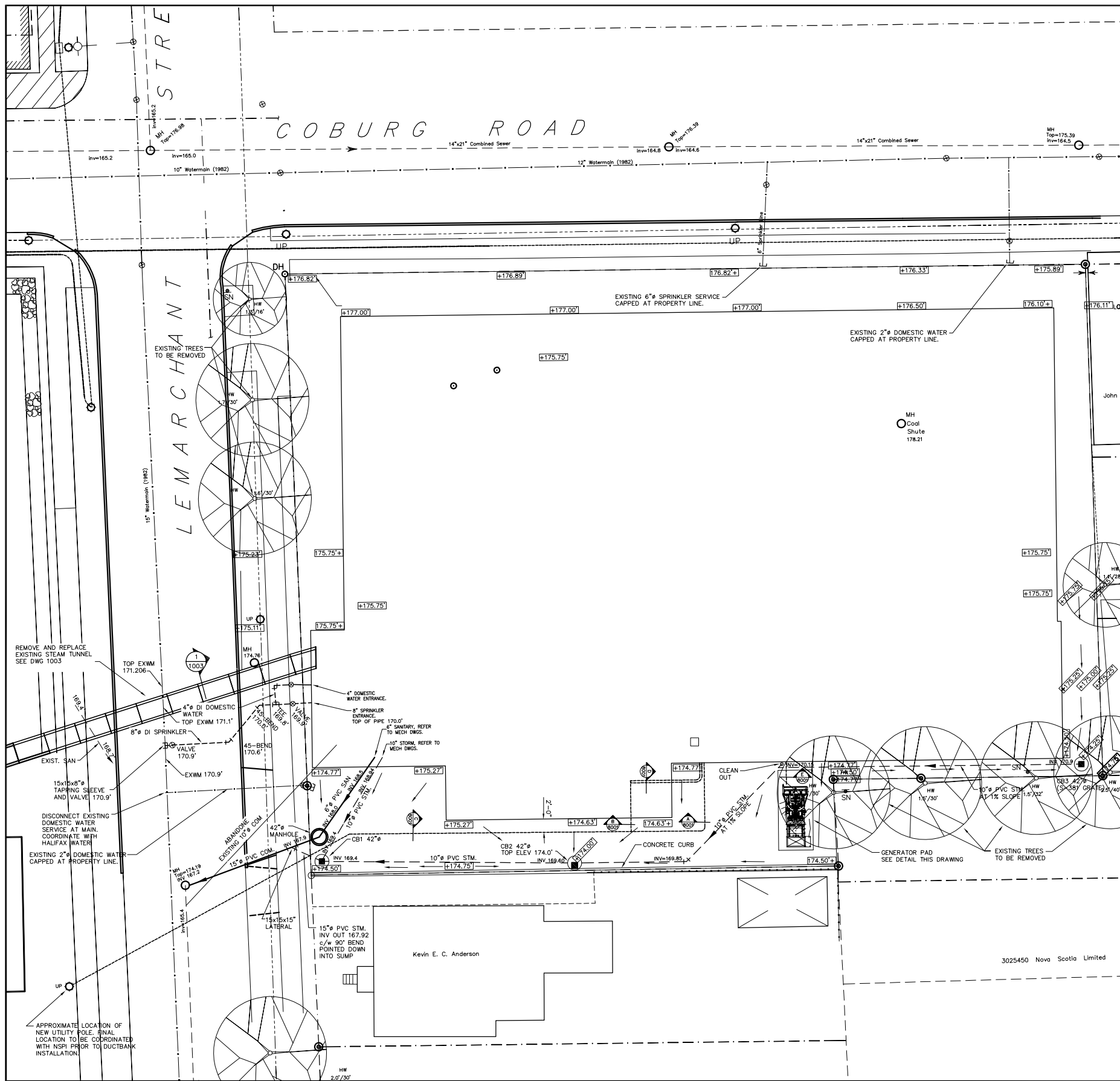


MEETING OVERALL GOALS

Apart from the fundamental capital cost and schedule goals the project as designed and constructed has proven to be a valuable addition to the University Campus. The building has been in full operation since the beginning of the 2010/11 academic year and has met all of the intended functional needs of the University.

This new academic building has also allowed the University to showcase their commitment to sustainability and environmental stewardship. One of the primary tenant groups in the Mona Campbell Building is the Universities, College of Sustainability, who through both class work and interactive displays that monitor the buildings energy consumption and indoor air quality, increase the already high level of awareness amongst the faculty and student body of issues of sustainability.

Dalhousie University Facilities Management staff, designers and constructors are all equally proud of our contributions to this important campus development as was noted at the buildings official opening by the Premier of Nova Scotia, Darrell Dexter and in the official press release. www.dal.ca/News/2010/09/09/NAB.html.



DETAIL GENERATOR PAD
N.T.S.

FOWLER BAULD & MITCHELL
architecture

Fowler Bauld & Mitchell Ltd.
PO Box 514, Suite 102
1660 Hollis Street, Halifax, Nova Scotia B3J 2R7
Tel: 902 429 4100 Fax: 902 423 3063
email: architects@fbm.ns.ca www.fbm.ns.ca

MacFawn and Rogers Architects Limited
1657 Barrington Street
Suite 504
Halifax, Nova Scotia
Canada B3J 2A1
Telephone 902-423-6378
Fax 902-429-8097
e-mail macrog@estlink.ca

CBCL LIMITED
Consulting Engineers
ISO 9001 CERTIFIED
1489 Hollis Street
Halifax, N.S.
B3J 3B5
Tel. (902) 421-7241
Fax (902) 423-3088
Email info@cbcl.ca

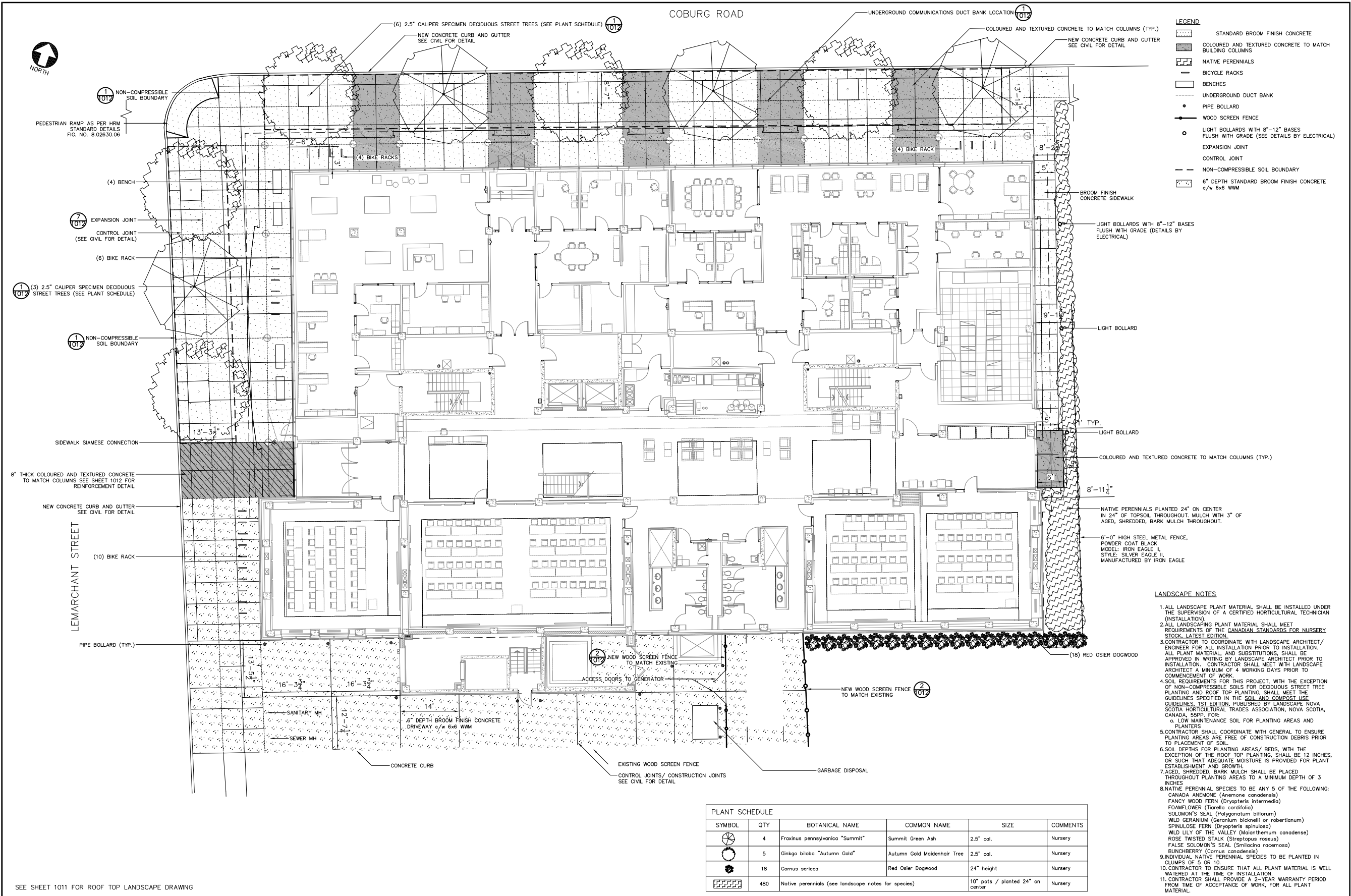
Record Drawing
This record drawing is prepared by CBCL Limited as an engineering document in accordance with the Engineering Council of Canada (ECC) and the Engineering Council of Nova Scotia (ECNS) standards. It is the responsibility of the engineer to ensure that the drawing is accurate and complete. The drawing is the property of CBCL Limited and shall remain the property of CBCL Limited. No part of this drawing may be reproduced or transmitted in any form or by any means electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without permission in writing from CBCL Limited.

STAMP

No.	REVISION	BY	DATE
1	ISSUED FOR DESIGN DEVELOPMENT	JH	10 JUN 08
2	ISSUED FOR TP 2008-122	JH	22 JUL 08
3	ISSUED FOR BUILDING PERMIT	JH	29 JUL 08
4	ISSUED FOR CONSTRUCTION (2008-122)	JH	06 AUG 08
5	RE-ISSUED FOR BUILDING PERMIT	JH	25 AUG 08
6	ISSUED FOR INFORMATION	JH	23 JAN 09
7	ISSUED FOR RECORD DRAWING	JH	13 JAN 11

NEW ACADEMIC BUILDING
HALIFAX, NOVA SCOTIA
DATE MAY 2008
JOB 076921
CLIENT DALHOUSIE University

SITE SERVICES PLAN
1001A
DWG BG CHK JH/MDW SCALE 1"=10'



SEE SHEET 1011 FOR ROOF TOP LANDSCAPE DRAWING

SYMBOL	QTY	BOTANICAL NAME	COMMON NAME	SIZE	COMMENTS
	4	Fraxinus pennsylvanica "Summit"	Summit Green Ash	2.5" cal.	Nursery
	5	Ginkgo biloba "Autumn Gold"	Autumn Gold Maidenhair Tree	2.5" cal.	Nursery
	18	Cornus sericea	Red Osier Dogwood	24" height	Nursery
	480	Native perennials (see landscape notes for species)		10" pots / planted 24" on center	Nursery

LANDSCAPE NOTES

- ALL LANDSCAPE PLANT MATERIAL SHALL BE INSTALLED UNDER THE SUPERVISION OF A CERTIFIED HORTICULTURAL TECHNICIAN (INSTALLATION).
- ALL LANDSCAPING PLANT MATERIAL SHALL MEET REQUIREMENTS OF THE CANADIAN STANDARDS FOR NURSERY STOCK, LATEST EDITION.
- CONTRACTOR TO COORDINATE WITH LANDSCAPE ARCHITECT/ENGINEER FOR ALL INSTALLATION PRIOR TO INSTALLATION. ALL PLANT MATERIAL, AND SUBSTITUTIONS, SHALL BE APPROVED IN WRITING BY LANDSCAPE ARCHITECT PRIOR TO INSTALLATION. CONTRACTOR SHALL MEET WITH LANDSCAPE ARCHITECT A MINIMUM OF 4 WORKING DAYS PRIOR TO COMMENCEMENT OF WORK.
- SOIL REQUIREMENTS FOR THIS PROJECT, WITH THE EXCEPTION OF NON-COMPRESSIBLE SOILS FOR DECIDUOUS STREET TREE PLANTING AND ROOF TOP PLANTING, SHALL MEET THE GUIDELINES SPECIFIED IN THE SOIL AND COMPOST USE GUIDELINES, 1ST EDITION, PUBLISHED BY LANDSCAPE NOVA SCOTIA HORTICULTURAL TRADES ASSOCIATION, NOVA SCOTIA, CANADA, 55PP. FOR:
 - LOW MAINTENANCE SOIL FOR PLANTING AREAS AND PLANTERS
- CONTRACTOR SHALL COORDINATE WITH GENERAL TO ENSURE PLANTING AREAS ARE FREE OF CONSTRUCTION DEBRIS PRIOR TO PLACEMENT OF SOIL.
- SOIL DEPTHS FOR PLANTING AREAS/ BEDS, WITH THE EXCEPTION OF THE ROOF TOP PLANTING, SHALL BE 12 INCHES, OR SUCH THAT ADEQUATE MOISTURE IS PROVIDED FOR PLANT ESTABLISHMENT AND GROWTH.
- AGED, SHREDDED, BARK MULCH SHALL BE PLACED THROUGHOUT PLANTING AREAS TO A MINIMUM DEPTH OF 3 INCHES.
- NATIVE PERENNIAL SPECIES TO BE ANY 5 OF THE FOLLOWING:
 - CANADA ANEMONE (Anemone canadensis)
 - FANCY WOOD FERN (Dryopteris intermedia)
 - FOAMFLOWER (Tiarella cordifolia)
 - SOLOMON'S SEAL (Polygonatum biflorum)
 - WILD GERANIUM (Geranium bicknellii or robertianum)
 - SPINULOSE FERN (Dryopteris spinulosa)
 - WILD LILY OF THE VALLEY (Maianthemum canadense)
 - ROSE TWISTED STALK (Streptopus roseus)
 - FALSE SOLOMON'S SEAL (Smilacina racemosa)
 - BUNCHBERRY (Cornus canadensis)
- INDIVIDUAL NATIVE PERENNIAL SPECIES TO BE PLANTED IN CLUMPS OF 5 OR 10.
- CONTRACTOR TO ENSURE THAT ALL PLANT MATERIAL IS WELL WATERED AT THE TIME OF INSTALLATION.
- CONTRACTOR SHALL PROVIDE A 2-YEAR WARRANTY PERIOD FROM TIME OF ACCEPTANCE OF WORK, FOR ALL PLANT MATERIAL.

FOWLER BAULD & MITCHELL
architecture

Fowler Bauld & Mitchell Ltd.
PO Box 514, Suite 102
1660 Hollis Street, Halifax, Nova Scotia B3J 2R7
Tel: 902-429-4100 Fax: 902-423-3063
email: architects@fbm.ns.ca www.fbm.ns.ca

MacFawn and Rogers Architects Limited
1657 Barrington Street
Suite 504
Halifax, Nova Scotia
Canada B3J 2A1
Telephone 902-423-4378
Fax 902-429-9097
e-mail macrog@astik.ca

CBCL LIMITED
Consulting Engineers
ISO 9001 CERTIFIED
1489 Hollis Street
Halifax, N.S.
B3J 3B5
Tel: (902) 421-7241
Fax: (902) 421-9838
Email: info@cbcl.ca

Record Drawing

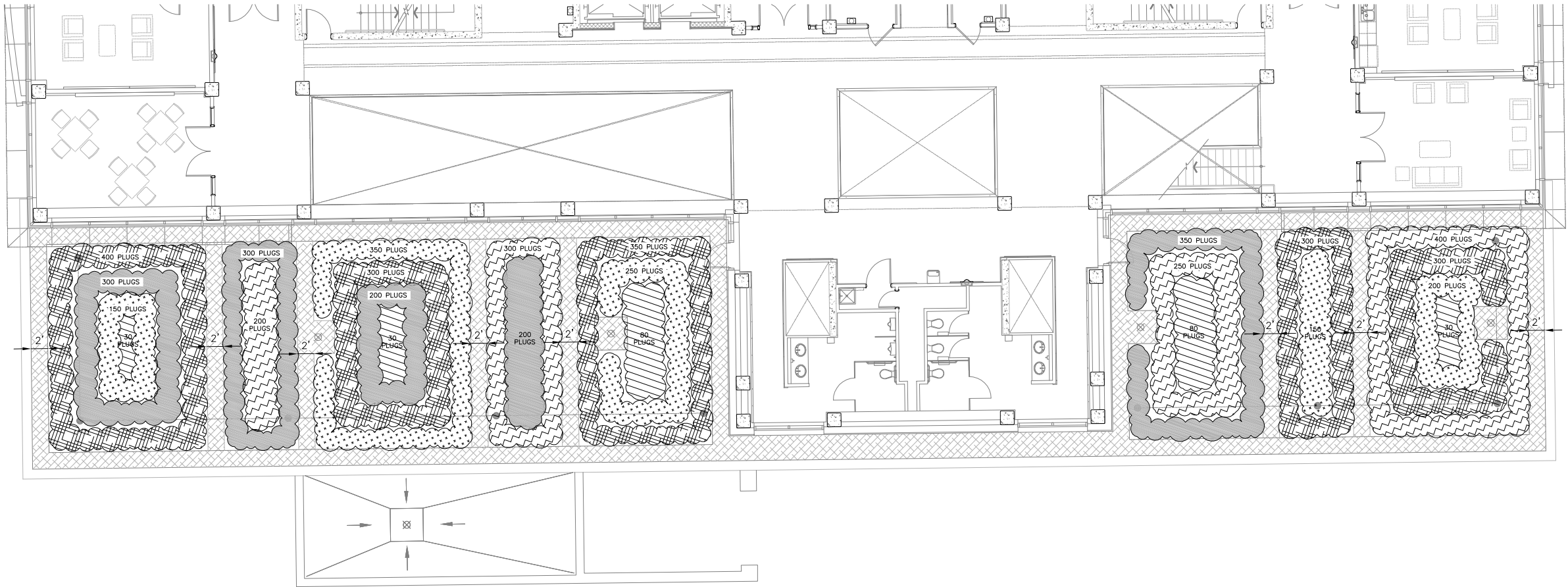
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1	ISSUED FOR L&M & E	CMP	21 NOV 08
2	ISSUED FOR CONSTRUCTION	CMP	23 JAN 09
3	ISSUED FOR TENDER	CMP	15 FEB 10
4	ISSUED FOR RECORD DRAWINGS	CMP	13 JAN 11

NEW ACADEMIC BUILDING
HALIFAX, NOVA SCOTIA
JOB 2007-043 DATE 21 NOV. 2008
CLIENT DALHOUSIE University

LANDSCAPE PLAN
1010A
SCALE 1/8"=1'-0"

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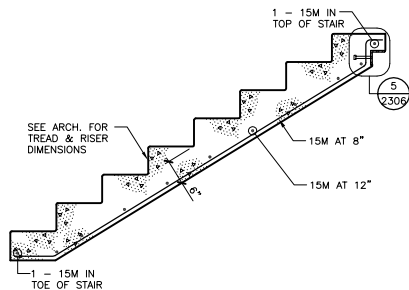


PLANT SCHEDULE FOR GREENROOF					
SYMBOL	QTY	BOTANICAL NAME	COMMON NAME	SIZE/SPACING	COMMENTS
	100 150	Allium schoenoprasum Festuca glauca	Wild Chives Blue Fescue	plugs / 12" on center	Nursery
	400 350 400	Sedum album Sedum kamtschaticum Sedum reflexum	White Stonecrop Orange Stonecrop Jenny's Stonecrop	plugs / 6" on center	Nursery
	550 550 550	Sedum acre 'Aureum' Sedum floriferum 'Weiherstephaner Gold' Sedum album 'Murale'	Golden Stonecrop Weiherstephaner Gold Stonecrop Murale White Stonecrop	plugs / 6" on center	Nursery
	375 375 350	Sedum ewersii Sedum sexangulare Sedum spurium 'White Form'	Pink Stonecrop Tasteless Stonecrop White Form Two Row Stonecrop	plugs / 6" on center	Nursery
	450 450 450	Sedum spurium 'Fuldaglut' Sedum spurium 'John Creech' Sedum spurium 'Roseum'	Caucasian Stonecrop John Creech Sedum Roseum Sedum	plugs / 6" on center	Nursery

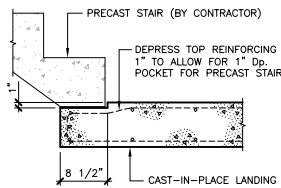
GREENROOF NOTES

1. ALL LANDSCAPE PLANT MATERIAL SHALL BE INSTALLED UNDER THE SUPERVISION OF A CERTIFIED HORTICULTURAL TECHNICIAN (INSTALLATION).
2. CONTRACTOR TO COORDINATE WITH LANDSCAPE ARCHITECT/ENGINEER FOR ALL INSTALLATION PRIOR TO INSTALLATION. ALL PLANT MATERIAL, AND SUBSTITUTIONS, SHALL BE APPROVED IN WRITING BY LANDSCAPE ARCHITECT PRIOR TO INSTALLATION. CONTRACTOR SHALL MEET WITH LANDSCAPE ARCHITECT A MINIMUM OF 4 WORKING DAYS PRIOR TO COMMENCEMENT OF WORK.
3. PLUGS ARE TO BE PLANTED TO ALLOW FOR EQUAL DISTRIBUTION OF EACH SPECIES THROUGHOUT THE PLANTING AREA TO PREVENT GROUPINGS OF INDIVIDUAL SPECIES.
4. CONTRACTOR TO ENSURE THAT ALL PLANT MATERIAL IS WELL WATERED AT THE TIME OF INSTALLATION.
5. CONTRACTOR SHALL PROVIDE A 2-YEAR WARRANTY PERIOD FROM TIME OF ACCEPTANCE OF WORK, FOR ALL PLANT MATERIAL.

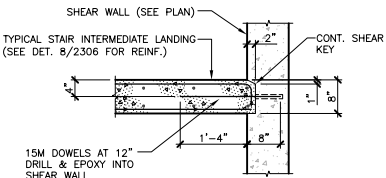
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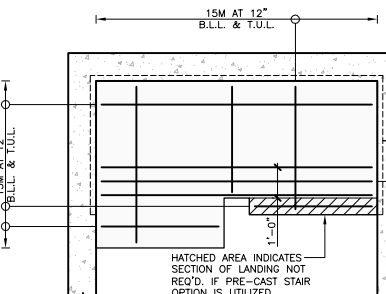
1 DETAIL (TYPICAL PRE-CAST STAIR REINF.)
N.T.S.



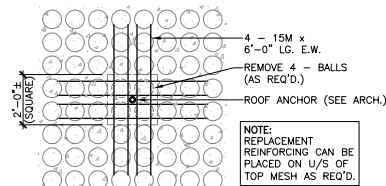
4 DETAIL (STAIR LANDING TO TOP OF PRE-CAST STAIR CONNECTION)
N.T.S.



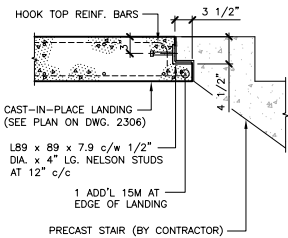
7 DETAIL (TYPICAL LANDING)
N.T.S.



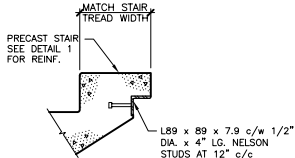
8 DETAIL (TYPICAL STAIR LANDING REINF. PLAN)
N.T.S. (SEE ARCH. FOR ALL LANDING LOC'S.)



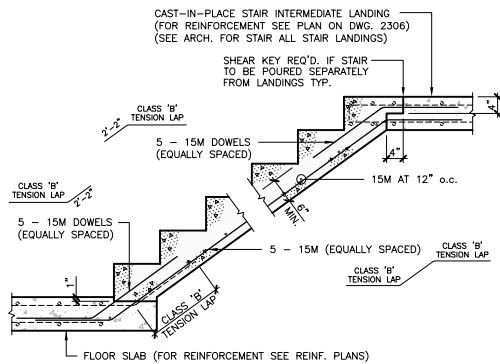
TYPICAL MESH REPLACEMENT DETAIL
N.T.S. (AT ROOF ANCHOR LOCATIONS)



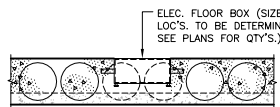
2 DETAIL (STAIR LANDING TO TOP OF PRE-CAST STAIR CONNECTION)
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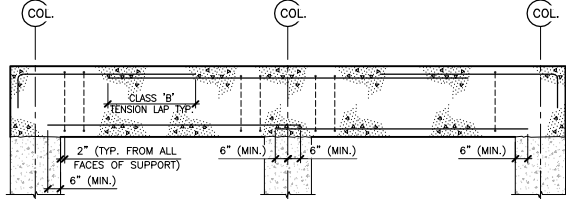
5 DETAIL (PRE-CAST STAIR EMBEDDED ANGLE)
N.T.S.



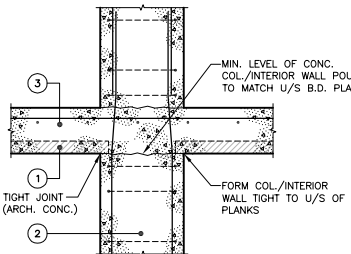
9 DETAIL (TYPICAL CAST IN PLACE STAIRS)
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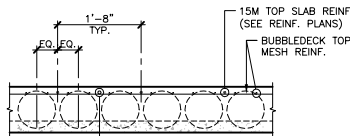
13 DETAIL (TYPICAL ELECTRICAL FLOOR BOX.)
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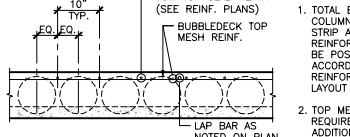
12 DETAIL (TYPICAL BEAM BAR SPLICE & CURTAILMENT)
N.T.S.



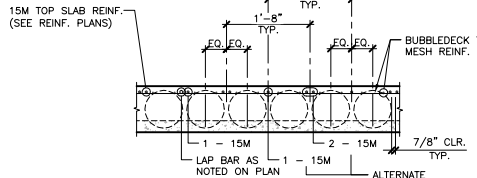
3 DETAIL (TYPICAL PROCEDURE FOR SLAB POUR SCHEDULING)
N.T.S.



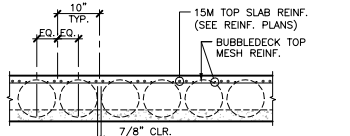
TOP SLAB REINF. TYPE (A)



TOP SLAB REINF. TYPE (B)

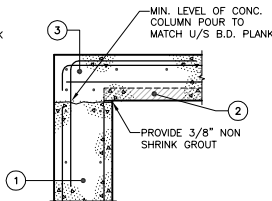


TOP SLAB REINF. TYPE (C)



TOP SLAB REINF. TYPE (D)

6 DETAIL (TYPICAL TOP SLAB REINFORCING)
N.T.S. (SEE PLAN FOR LOCATIONS)

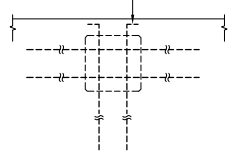


PROCEDURE FOR TYP. FDN. WALL/SLAB POUR SCHEDULING:
1 FORM & POUR CONCRETE FDN. WALLS.
2 INSTALL BUBBLE DECK PLANKS, GROUT & SHORE (INSTALL C.I.P. REINF.)
3 POUR CONCRETE SLAB.

- NOTES:
1. TOTAL BARS WITHIN COLUMN OR MIDDLE STRIP AS INDICATED ON REINFORCING PLANS TO BE POSITIONED ACCORDING TO TOP SLAB REINFORCING SPACING LAYOUT TYPE AS SHOWN.
 2. TOP MESH LAP BARS AS REQUIRED ARE IN ADDITION TO TOP STEEL INDICATED ON PLAN.

2 - 20M x 10'-0" LG. E.W. TYP. EXCEPT AT THE FOLLOWING GRID LOC'S. WHICH REQ. 3 - 20M: LEVEL 2 & 3: B1,B12,C1,C12 LEVEL 5: B1,B12,C1,C12,F4,F5,J7,J8

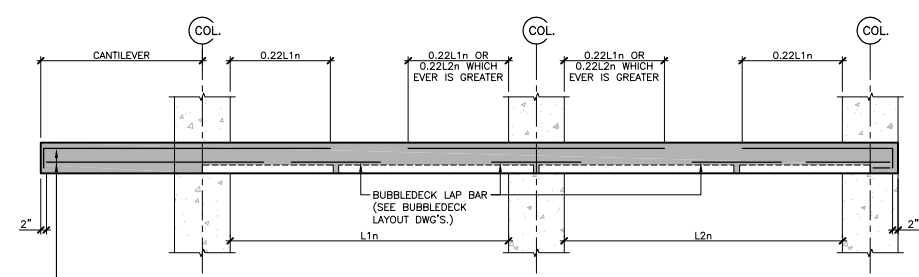
2 - 20M x 10'-0" LG. E.W. TYP. EXCEPT AT THE FOLLOWING GRID LOC'S. WHICH REQ. 3 - 20M: LEVEL 2 & 3: B1,B12,C1,C12 LEVEL 5: B1,B12,C1,C12,F4,F5,J7,J8



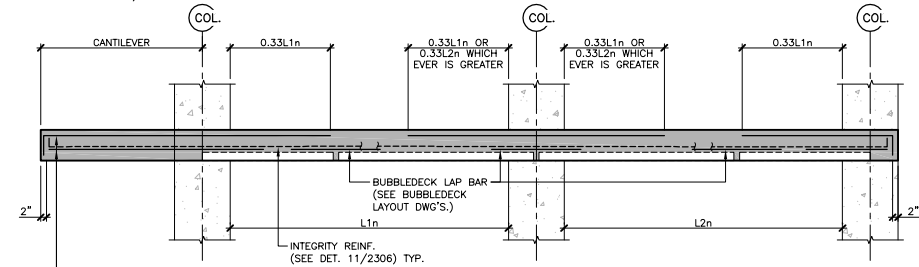
TYPICAL INTERIOR COLUMN

- NOTES:
1. ALL INTEGRITY STEEL TO BE PLACED IN BOTTOM LAYER. PLACE BARS DIRECTLY ON BUBBLE DECK PANEL WHERE REQUIRED.
 2. INTEGRITY STEEL IS NOT REQUIRED IN SPANS THAT CONTAIN BEAMS FRAMING INTO COLUMNS.
 3. ALL INTEGRITY STEEL TO BE HOOKED AT DISCONTINUOUS EDGES, AT EDGE OF SLABS & SLAB OPENINGS.
 4. INTEGRITY STEEL IS IN ADDITION TO STEEL SHOWN ON REINFORCING PLANS.

11 DETAIL (COLUMN INTEGRITY STEEL)
N.T.S. (TYPICAL U.N.O. ON SLAB REINF. PLANS)



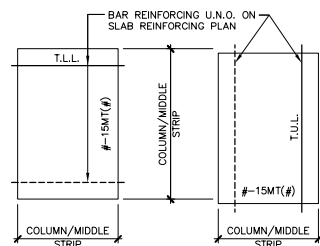
MIDDLE STRIP



COLUMN STRIP

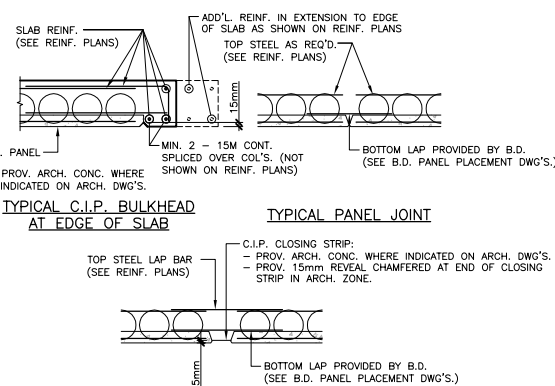
- NOTES:
- IN ADDITION TO THE ABOVE GENERAL REQUIREMENTS THE FOLLOWING SPECIFIC BOTTOM REINFORCING DETAILS ARE REQUIRED AT COLUMNS AND DISCONTINUOUS EDGES:
1. AT INTERIOR COLUMNS IN BOTH DIRECTIONS ADD ADDITIONAL BOTTOM REINFORCING BARS OVER TOP COLUMNS FOR COLUMN INTEGRITY REINFORCING AS PER DETAIL 11/2306. ALL BOTTOM SLAB REINFORCING IN LINE WITH THE COLUMN TO STOP AT THE COLUMN FACE. ALL OTHER BOTTOM REINFORCING TO LAP PAST COLUMN CENTERLINE BY 3\"/>
 2. AT EXTERIOR COLUMNS IN BOTH DIRECTIONS ADD ADDITIONAL BOTTOM REINFORCING BARS OVER TOP COLUMNS FOR COLUMN INTEGRITY REINFORCING AS PER DETAIL 11/2306. ALL BOTTOM SLAB REINFORCING IN LINE WITH THE COLUMN TO STOP AT THE COLUMN FACE. ALL OTHER BOTTOM REINFORCING TO EXTEND TO EDGE OF SLAB.
 3. ALL INTEGRITY REINFORCING TO BE HOOKED AT DISCONTINUOUS EDGES AT EDGE OF SLAB AND SLAB OPENINGS.
 4. ALL BOTTOM REINFORCING IN COLUMN STRIPS INTERRUPTED BY SLAB OPENINGS TO BE HOOKED AT THE DISCONTINUOUS EDGE OF THE OPENING.
 5. WHERE SLAB CANTILEVERS, SLAB STEEL IS TO EXTEND TO EDGE OF CANTILEVER AS SHOWN.

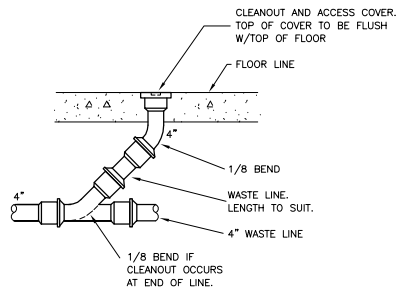
10 DETAIL (TYPICAL TWO WAY BUBBLEDECK FLAT PLATE)
N.T.S.



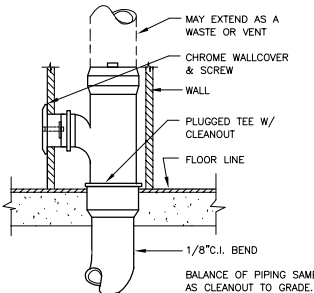
- NOTE:
1. SEE DET. 10/2306 FOR MINIMUM REINFORCING LENGTH AND LAYOUT.
 2. SEE DET. 6/2306 FOR REINF. SPACING BETWEEN BUBBLES.

14 DETAIL (TYPICAL SLAB REINFORCING LEGEND)
N.T.S.

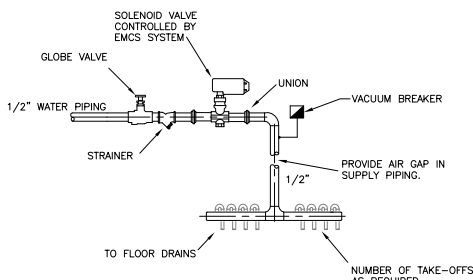




1 DETAIL- FLOOR CLEANOUT
N.T.S.

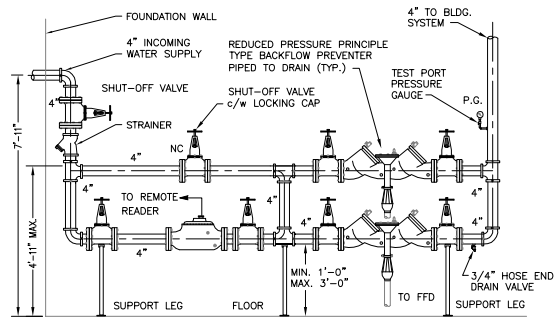


2 DETAIL- WALL CLEANOUT
N.T.S.

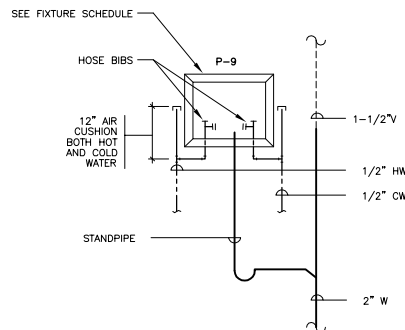


3 DETAIL- TRAP PRIMER
N.T.S.

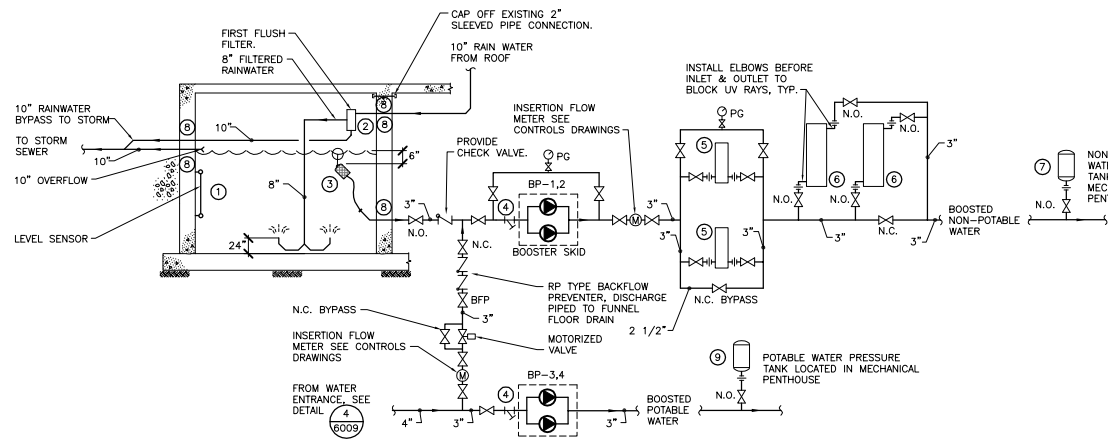
NOTES:
1. ALL SOLENOID VALVES TO BE SUPPLIED BY CONTROLS CONTRACTOR & CONTROLLED BY THE DDC SYSTEM.
2. COORDINATE LOCATIONS OF ALL VALVES WITH CONTROLS CONTRACTOR



4 DETAIL- PRV, BACKFLOW PREVENTER & MAIN DOMESTIC COLD WATER METER
6001.2 N.T.S.



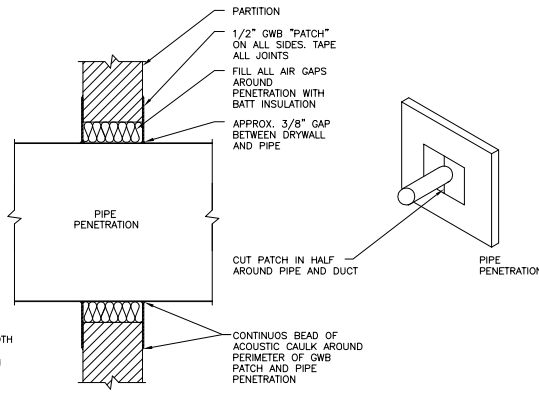
6 DETAIL- WASHING MACHINE BOX
6001.2 N.T.S.



NOTES:
1. ALL PIPING WITHIN CISTERN SHALL BE PVC.
2. CONTRACTOR TO PROVIDE ALL SUPPLEMENTARY SUPPORTS REQUIRED FOR PIPING & EQUIPMENT IN CISTERN.
3. STEEL SHALL BE GALVANIZED.

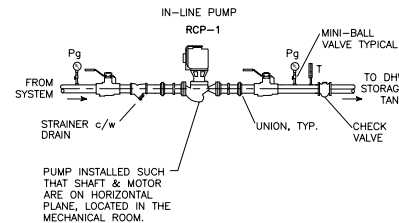
ID	DESCRIPTION	LOCATION	COMMENTS
1	LEVEL SENSOR	CISTERN	LEVEL SENSOR PROVIDED BY JOHNSON CONTROLS.
2	FIRST FLUSH FILTER	CISTERN	WISY WFF300 VORTEX FINE FILTER C/W ACCESSIBLE STAINLESS STEEL FILTER INSERT, POLYPROPYLENE BODY, MAXIMUM CAPACITY OF 250 GPM, DN200 RAINWATER INLET AND FLUSH OUTLET, DN200 FILTERED WATER OUTLET
3	FLOATING STRAINER BASKET	CISTERN	STAINLESS STEEL FLOATING FINE SUCTION FILTER (WISY SZ 3051) C/W 2" EXTERNAL THREAD CONNECTION, 8" DIAMETER FLOATING BALL, STAINLESS STEEL NON-RETURN VALVE, 10' FLEXIBLE SUCTION HOSE
4	STRAINER	B006	REFER TO SPECIFICATION SECTION 15181.
5	FILTER	B006	R-CAN FS18-HF-316 HIGH FLOW FILTER HOUSING C/W 128 GPM MAXIMUM FLOW RATE, 150 PSI MAXIMUM OPERATING PRESSURE, 2" MNPT CONNECTION SIZE, 1/2" NPT DRAIN CONNECTION, 1/4" NPT VENT CONNECTION, 2 FULL SETS OF 20 MICRON CARTRIDGE FILTERS
6	ULTRAVIOLET DISINFECTION	B006	STERILIGHT SM80 ULTRAVIOLET DISINFECTION SYSTEM C/W 80 GPM CAPACITY, 2" MNPT INLET AND OUTLET CONNECTIONS, 200 W POWER CONSUMPTION (120V/1PH/60HZ), 125 PSI MAXIMUM OPERATING PRESSURE, 2" MNPT CONNECTION SIZE, 1/2" NPT DRAIN CONNECTION, 316L STAINLESS STEEL REACTOR CHAMBER, UV INTENSITY MONITOR, REMOTE ALARM, HOUR METER
7	NON POTABLE PRESSURE TANK	MECHANICAL PENTHOUSE	ASME RATED DIAPHRAGM TYPE PRESSURE TANK WITH AN ACCEPTANCE CAPACITY OF 52 GALLONS. SEE BOOSTER PUMP SCHEDULE DRAWING 6010
8	MECHANICAL GASKET AND PIPE SLEEVE	CISTERN/B006	LINKSEAL MODULAR SEAL, SIZED FOR PIPE SIZE C/W PVC WALL SLEEVE. SEE DETAIL 9 DWG 6009
9	POTABLE PRESSURE TANK	MECHANICAL PENTHOUSE	ASME RATED DIAPHRAGM TYPE PRESSURE TANK WITH AN ACCEPTANCE CAPACITY OF 34 GALLONS. SEE BOOSTER PUMP SCHEDULE DRAWING 6010

5 SCHEMATIC- NON-POTABLE WATER SYSTEM
6001 N.T.S.

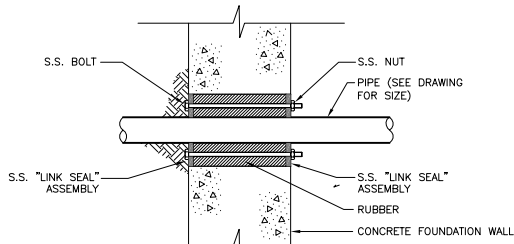


APPLICATION: - HEAT PUMP RM. 1,2,3 & 4
- SERVER ROOM LEVEL 1.

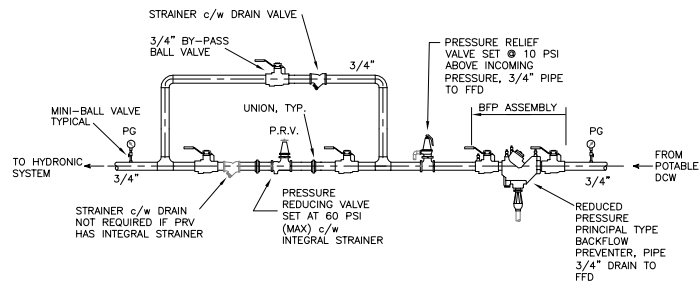
7 DETAIL-TYPICAL PIPE PENETRATION
N.T.S.



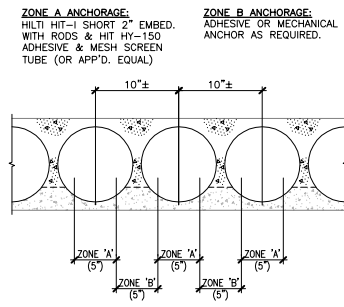
8 DETAIL - DHW RECIRC. PUMP
6001.2 N.T.S.



9 DETAIL- TYPICAL DRAIN PIPES THROUGH EXTERIOR & CISTERN WALLS
6001 N.T.S.

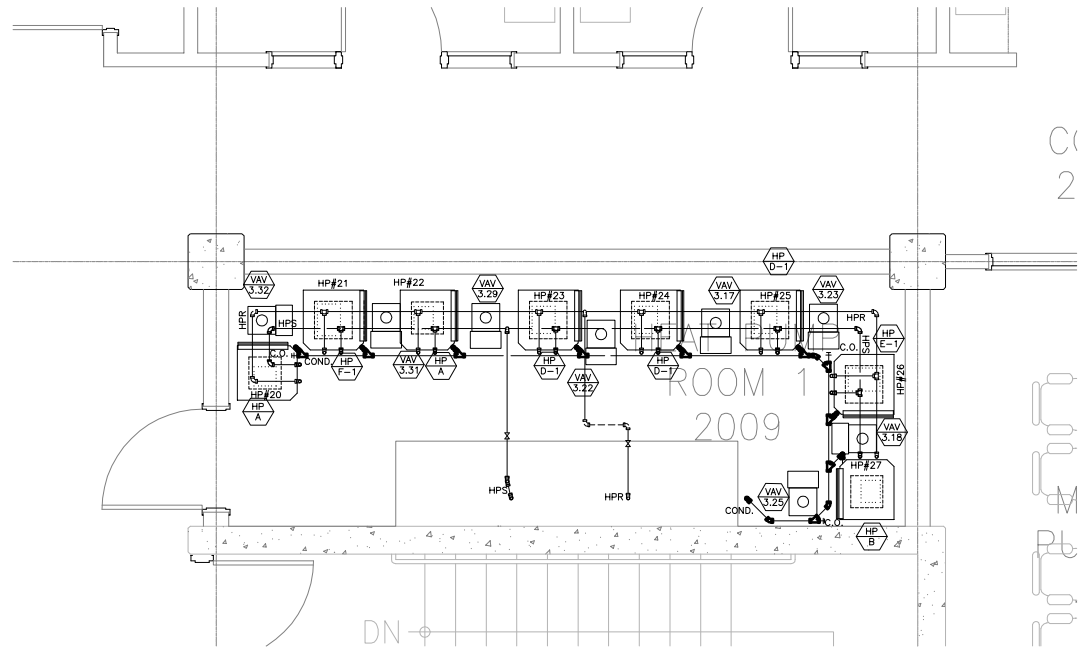


10 DETAIL - DCW HYDRONIC SYSTEM MAKE-UP
6006 N.T.S.

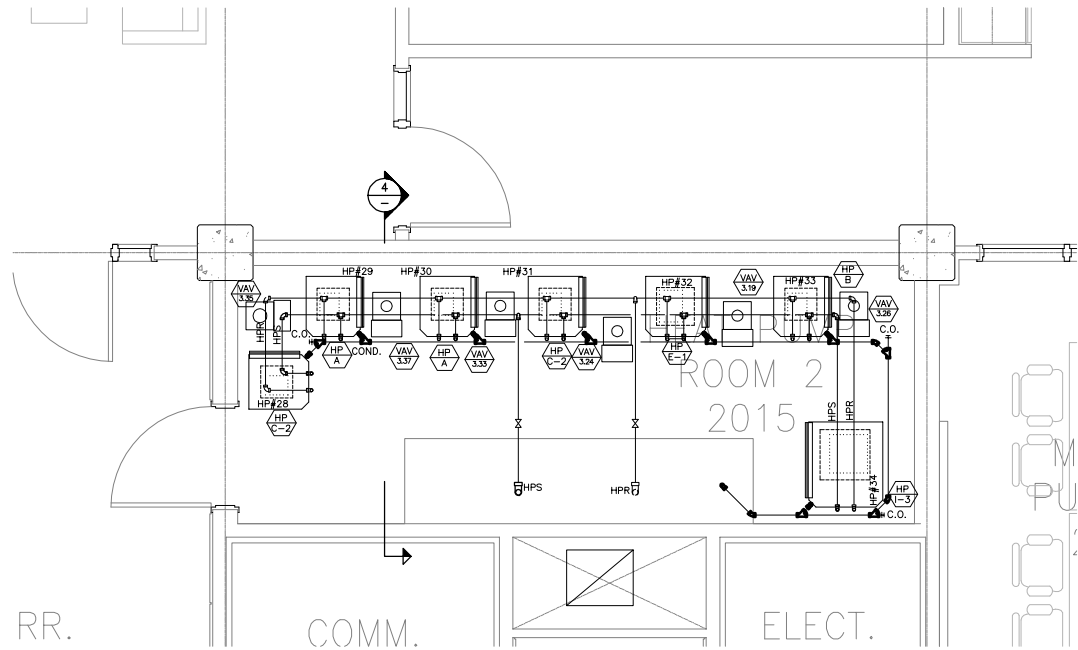


11 DETAIL - TYPICAL SLAB ANCHORING
N.T.S.

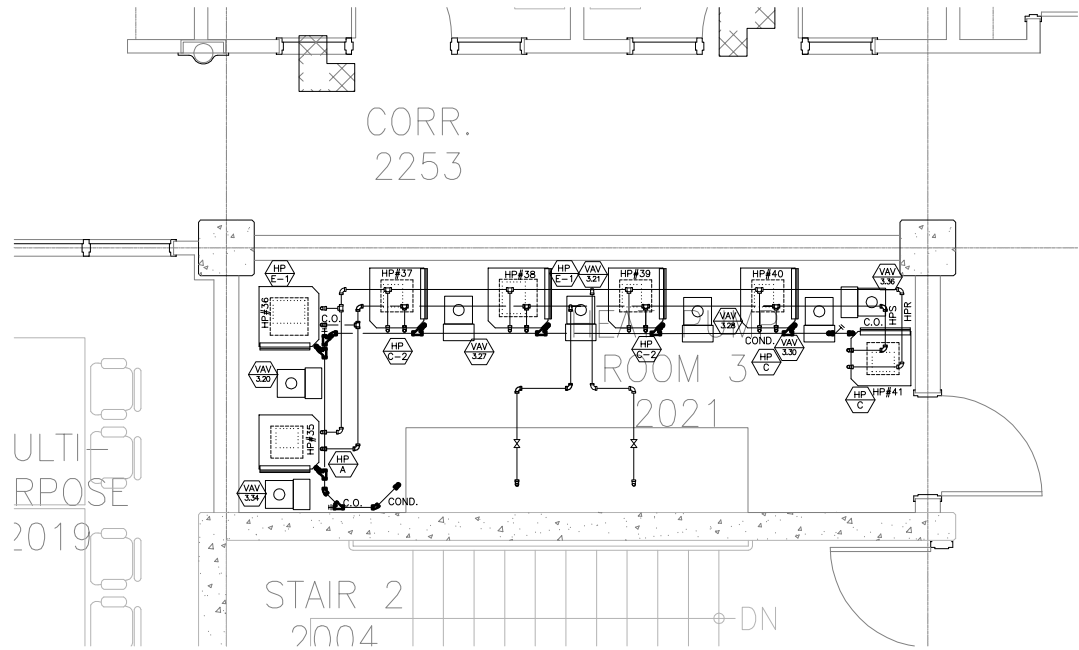
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1 PLAN -HEAT PUMP ROOM 2009 LEVEL 2 PIPING
1/2"=1'-0"

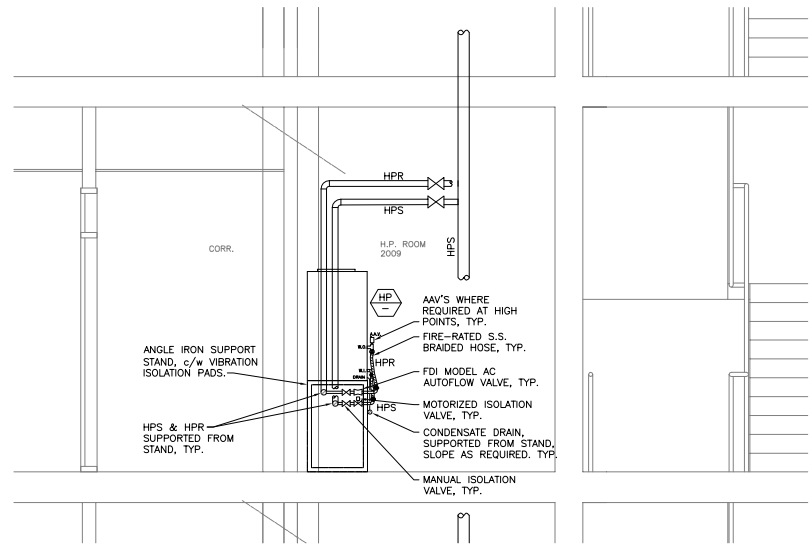


2 PLAN -HEAT PUMP ROOM 2015 LEVEL 2 PIPING
1/2"=1'-0"



3 PLAN -HEAT PUMP ROOM 2021 LEVEL 2 PIPING
1/2"=1'-0"

HEAT PUMP PIPE SIZING			
UNIT #	HEAT PUMP LOOP FLOW (USGPM)	SUPPLY & RETURN PIPE SIZE	CONDENSATE OUTLET PIPE SIZE
HP-A	1.5	3/4"	3/4"
HP-B	2.1	3/4"	3/4"
HP-C	2.6	3/4"	3/4"
HP-D	4.1	1"	3/4"
HP-E	6.0	1"	3/4"
HP-F	6.0	1"	1"
HP-G	6.8	1"	1"
HP-H	8.3	1 1/4"	1"
HP-I	9.0	1 1/4"	1"
HP-J	11.3	1 1/4"	1"
HP-K	12.4	1 1/4"	1 1/4"



4 SECTION- HEAT PUMP ROOM TYPICAL PIPING
1/2"=1'-0"

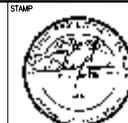
FOWLER BAULD & MITCHELL
architecture

Fowler Bauld & Mitchell Ltd.
PO Box 514, Suite 102
1660 Hollis Street, Halifax, Nova Scotia B3J 2R7
Tel: 902 429 4100 Fax: 902 423 3063
email: architects@fbm.ns.ca www.fbm.ns.ca

MacFawn and Rogers Architects Limited
1657 Barrington Street
Suite 504
Halifax, Nova Scotia
Canada B3J 2A1
Telephone 902-423-6378
Fax 902-429-2007
e-mail: macrog@eastlink.ca

CBCL CBCL LIMITED
Consulting Engineers
ISO 9001 CERTIFIED
1488 Hollis Street
Halifax, N.S.
B3J 3M5
Tel: (902) 421-7241
Fax: (902) 423-3588
Email: info@cbcl.ca

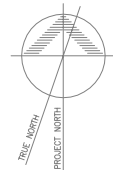
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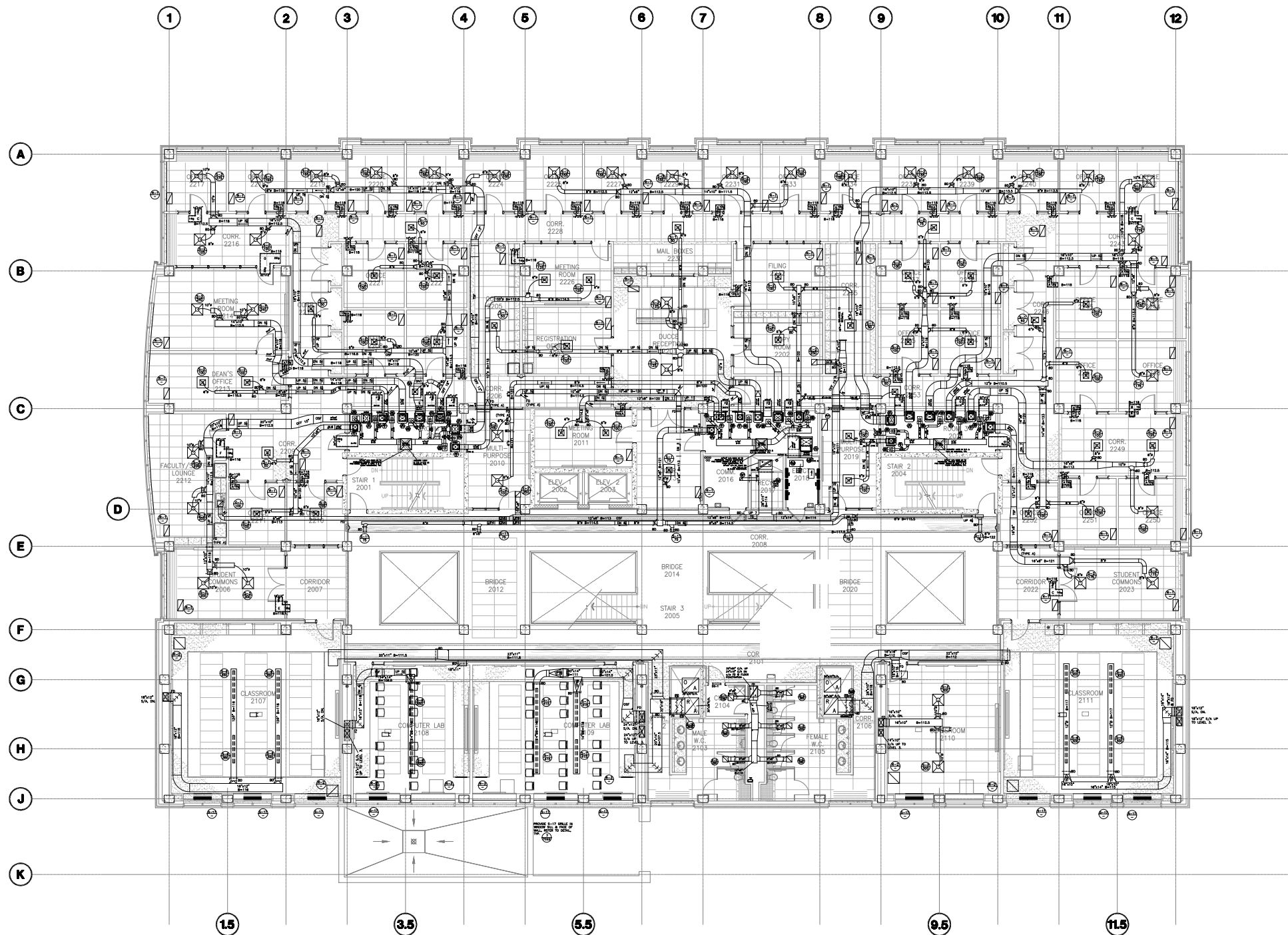
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1	ISSUED FOR L&M & E	KF	21 NOV 08
2	ISSUED FOR CONSTRUCTION	KF	23 JAN 09
3	ISSUED FOR RECORD DRAWINGS	KF	13 JAN 11

NEW ACADEMIC BUILDING
HALIFAX, NOVA SCOTIA
JOB: 076921 DATE: 21 NOV. 2008
CLIENT: DALHOUSIE University

MECHANICAL LEVEL 2 HEAT PUMP ROOMS
7008A
OWN: KRG CHK: DKF SCALE: AS NOTED



- NOTES:
1. CLASSROOM DIFFUSERS SHALL BE LOCATED SUCH THAT BOTTOM ELEVATION=ELEVATION OF FLOATING CEILING, APPROX. 9'-8" AFF.
 2. PROVIDE COMBINATION FIRE-SMOKE DAMPER @ R/A & SMOKE MAKE UP AIR PENETRATION OF SHAFT WALL.
 3. PROVIDE GRILLE IN FACE OF WALL FOR SMOKE MAKE UP AIR SYSTEM. GRILLE HEIGHT TO MATCH HEIGHT FROM BASEBOARD TO U/S OF CEILING.
 4. BALANCE SMOKE MAKE UP AIR TO VALUES INDICATED ON SMOKE EXHAUST SCHEMATIC, DRAWING 7122.



1 PLAN — LEVEL 2 VENTILATION
1/8"=1'-0"

File Name: G:\CAD ARCH\2011\7103A - DAL COBALT\RECORD DRAWINGS - RECORD DRAWINGS - DAL COBALT\RECORD DRAWINGS - 17 JAN 2011\NEW CAMPBELL BUILDING - 7103A LEVEL 2 VENTILATION.DWG Date: 5/2/2011 4:08:06 PM Layout: 7103A

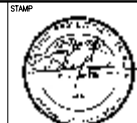
**FOWLER
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architecture

Fowler Bauld & Mitchell Ltd.
PO Box 514, Suite 102
1660 Hollis Street, Halifax, Nova Scotia B3J 2R7
Tel: 902 429 4100 Fax: 902 423 3063
email: architects@fbm.ns.ca www.fbm.ns.ca

**MacFawn
and Rogers
Architects Limited**
1657 Barrington Street
Suite 504
Halifax, Nova Scotia
Canada B3J 2A1
Telephone 902-423-6378
Fax 902-429-2007
e-mail: macrog@eastlink.ca

CBCL CBCL LIMITED
Consulting Engineers
ISO 9001 CERTIFIED
1488 Hollis Street
Halifax, N.S.
B3J 3M5
Tel: (902) 421-7241
Fax: (902) 423-3588
Email: info@cbcl.ca

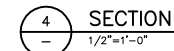
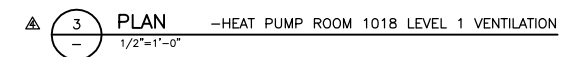
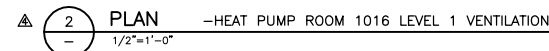
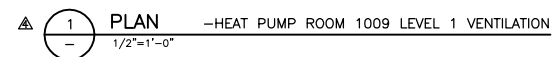
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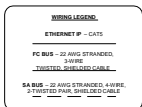


No.	REVISION	BY	DATE
1	ISSUED FOR BUILDING PERMIT	KF	29/JUL/08
2	ISSUED FOR LAM & E	KF	21 NOV 08
3	REVISED FOR ADD.#1 LAM & E	KF	4 DEC 08
4	ISSUED FOR CONSTRUCTION	KF	23 JAN 09
5	ISSUED FOR SITE INSTRUCTION #18	KF	22 APR 09
6	ISSUED FOR LIGHTING CONFLICTS	KF	-
7	ISSUED FOR RECORD DRAWINGS	KF	13 JAN 11

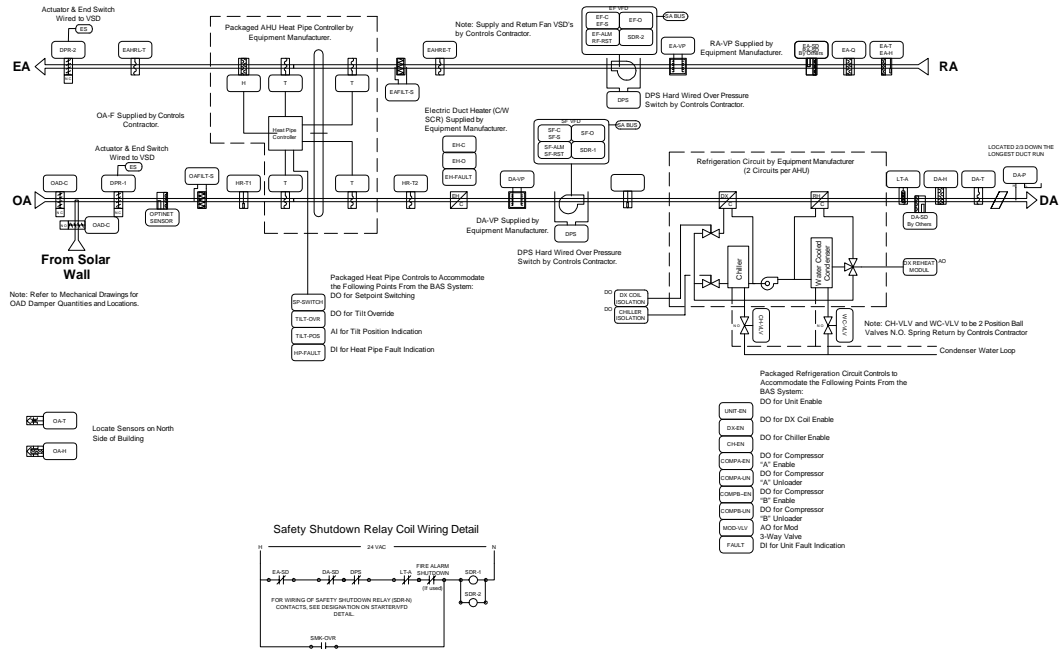
NEW ACADEMIC BUILDING
HALIFAX, NOVA SCOTIA
DATE: 21 NOV. 2008
JOB: 076921
CLIENT: DALHOUSIE University

**MECHANICAL
LEVEL 2
VENTILATION**
7103A
OWN: KRG
CHK: DKF
SCALE: AS NOTED





b. EACH AHU COMPRESSOR RUN TIME AND LOAD/UNLOAD STATUS SHALL BE TREND LOGGED IN REAL TIME AND TOTALIZED FOR EACH DAY, WEEK, MONTH AND YEAR. TREND LOGS SHALL BE STORED IN A "NAB AHU-1 (OR 2) COMPRESSOR ENERGY CONSUMPTION_N.CSV" TREND LOG FILE. THESE FILES SHALL BE ARCHIVED IN SEPARATE FILES FOR EVERY DAY, WEEK, MONTH AND YEAR TO A "ENERGY MONITORING TREND LOGS" FILE FOLDER ON THE OPERATORS TERMINAL PC.



AHU 3 SEQUENCE OF OPERATION

REFERENCE JOHNSON CONTROLS DRAWING 102A, 19-SEPT-2008, WITH CBCL MARK-UPS.

ALL SET POINTS AND VARIABLES INDICATED IN [SQUARE BRACKETS] SHALL BE EASILY ADJUSTABLE BY THE BUILDING OPERATOR AT THE SYSTEM GRAPHIC.

GENERAL: AHU-3 IS A DEDICATED OUTSIDE AIR UNIT SERVING VENTILATION AIR TO INDIVIDUAL SPACE HEAT PUMPS. THE HEAT PUMPS SERVE OFFICE, ADMINISTRATION AND COMPUTER ROOM AREAS OF THE NEW ACADEMIC BUILDING. THE UNIT CONSISTS OF OUTSIDE AIR AND EXHAUST AIR DAMPERS, VARIABLE SPEED HEAT WHEEL HEAT RECOVERY UNIT, VARIABLE SPEED SUPPLY AND RETURN FANS, FROST PROTECTION ELECTRIC HEATING COIL WITH SCR CONTROL, AIR FILTERS, DX COOLING COIL, AIR COOLED CONDENSER HEATING COIL, CHILLER, WATER COOLED CONDENSER AND TWO REFRIGERATION CIRCUITS EACH WITH A PAIR OF COMPRESSORS.

- OCCUPIED MODE:** THE OCCUPANCY MODE WILL BE CONTROLLED VIA A NETWORK INPUT. THE OCCUPIED MODE WILL BE SET BASED ON ANY OF THE ASSOCIATED HEAT PUMPS BEING IN THEIR OCCUPANCY MODE. REFER TO THE HEAT PUMP UNIT SEQUENCE OF OPERATION. ONCE AN OCCUPANCY SIGNAL HAS BEEN RECEIVED THE AHU WILL BE ENABLED. THE OUTSIDE AIR AND EXHAUST AIR DAMPERS SHALL OPEN AND AFTER A SHORT TIME DELAY THE SUPPLY FAN WILL BE STARTED.
- UNOCCUPIED MODE:** THE UNIT WILL REMAIN OFF DURING UNOCCUPIED PERIODS. THE UNOCCUPIED MODE WILL BE SET WHEN ALL ASSOCIATED HEAT PUMPS ARE IN THEIR UNOCCUPIED MODE. IN THE OFF MODE THE REFRIGERATION SYSTEMS SHALL BE DISABLED, THE SUPPLY AND EXHAUST FANS SHALL BE OFF, THE OUTSIDE AIR AND EXHAUST AIR DAMPERS SHALL BE CLOSED. ALL ALARMS AND OTHER SEQUENCE PROGRAMMING SHALL BE DISABLED DURING UNOCCUPIED PERIODS.
- SUPPLY FAN CONTROL:** THE VARIABLE SPEED SUPPLY FAN WILL BE STARTED BASED ON OCCUPANCY MODE. WHEN THE SUPPLY FAN STATUS INDICATES THAT THE FAN IS RUNNING, THE CONTROL SEQUENCE WILL BE ENABLED. THE SUPPLY FAN WILL MODULATE IN ACCORDANCE WITH THE DICTATES OF A PROPORTIONAL PLUS INTEGRAL CONTROL ALGORITHM TO MAINTAIN THE DISCHARGE STATIC PRESSURE AT SETPOINT. UPON A LOSS OF AIRFLOW, THE SYSTEM WILL AUTOMATICALLY RESTART. IF THE RETURN FAN FAILS (STOPS DUE TO VFD FAULT, SMOKE DETECTED, OVER PRESSURE, ETC) THEN THE SUPPLY FAN SHALL AUTOMATICALLY SHUT DOWN.
- RETURN FAN CONTROL:** AFTER THE SUPPLY FAN HAS BEEN STARTED, THE VARIABLE SPEED RETURN FAN WILL BE STARTED. THE RETURN FAN WILL MODULATE IN ACCORDANCE WITH THE DICTATES OF A PROPORTIONAL PLUS INTEGRAL CONTROL ALGORITHM AND IN ORDER TO MAINTAIN THE RETURN FAN AIRFLOW, AS MEASURED AT THE FAN INLET PITOT TUBE, AT 10% LESS THAN THE SUPPLY FAN AIRFLOW.
- DISCHARGE STATIC PRESSURE RE-SET:**
 - THE "DESIGN" OR "MAXIMUM" DISCHARGE AIR STATIC PRESSURE SETPOINT SHALL BE ESTABLISHED WITH THE BALANCING CONTRACTOR AND AT THE MINIMUM VALUE REQUIRED IN ORDER TO ACHIEVE THE DESIGN AIRFLOW AT EVERY VAV BOX. IN ORDER TO MINIMIZE FAN POWER CONSUMPTION THE STATIC PRESSURE SET POINT WILL BE RESET IN AN ATTEMPT TO KEEP THE VAV TERMINAL BOXES FULLY OPEN WHILST SUPPLYING AIRFLOW AT THEIR CURRENT SETPOINT.
 - WHENEVER ALL VAV TERMINAL UNITS IN THE ASSOCIATED SYSTEM ARE AT 90% OPEN OR LESS, THE SUPPLY FAN STATIC PRESSURE SHALL BE REDUCED BY 10% OF THE MAXIMUM VALUE. THE MINIMUM SETPOINT SHALL BE 10% OF THE MAXIMUM SETPOINT.
 - IN THE EVENT THAT ANY VAV TERMINAL UNIT IS AT 100% OPEN AND THE MEASURED AIRFLOW VOLUME IS 10% OR MORE BELOW ITS SETPOINT VALUE THE DUCT STATIC PRESSURE SENSOR SHALL BE RESET BACK UP IN 10% INCREMENTS.
 - THE DUCT STATIC PRESSURE RESET SEQUENCE SHALL OCCUR IN [THREE] MINUTE INTERVALS WHENEVER THE AHU SEQUENCE IS ENABLED.
- HEAT RECOVERY MODE:**
 - THE HEAT WHEEL HEAT RECOVERY SYSTEM SHALL BE CONTROLLED BY ITS OWN PACKAGED UNIT HEAT RECOVERY CONTROLLER (Q-TRAC WITH THE BASIS OF DESIGN ENGINEERED AIR AHUS). THIS CONTROLLER WILL VARY THE SPEED OF THE WHEEL IN ORDER TO MAINTAIN THE SUPPLY AIR "OFF HEAT WHEEL" TEMPERATURE AT ONE OF TWO SETPOINTS. THESE SETPOINTS SHALL BE MANUALLY ADJUSTABLE AT THE HEAT WHEEL CONTROLLER. THE BMS SHALL, THROUGH A DO POINT, BE ABLE TO SWITCH THE SETPOINT BETWEEN THESE TWO VALUES. THE TWO VALUES SHALL BE FACTORY SET AT 55DEG F AND 60DEG F. THE HEAT WHEEL CONTROLLER WILL VARY THE SPEED OF THE WHEEL TO RECOVER HEATING ENERGY OR COOLING ENERGY, DEPENDING ON THE OUTSIDE AIR TEMPERATURE, RETURN AIR TEMPERATURE AND TO MAINTAIN THE HEAT WHEEL DISCHARGE AIR TEMPERATURE.
 - THE BMS SHALL BE ABLE TO OVERRIDE THE HEAT WHEEL (FOR ECONOMIZER COOLING) BY A DO POINT CONTROLLING A RELY THAT WILL STOP THE WHEEL PUTTING IT INTO THE "NO HEAT RECOVERY MODE". REFER TO THE ECONOMIZER CONTROL SEQUENCE BELOW.
- HEAT RECOVERY SYSTEM FROST PROTECTION:** WHENEVER THE EXHAUST AIR TEMPERATURE IS BELOW THE FREEZING POINT, THE HEAT PIPE CONTROLLER (PACKAGED CONTROLS WITH THE AHU) SHALL OVERRIDE THE HEAT RECOVERY WHEEL SPEED IN ORDER TO MAINTAIN THE EXHAUST AIR ABOVE THE DEW POINT TEMPERATURE AND AVOID FREEZING ON THE HEAT RECOVERY SYSTEM.
- ECONOMIZER CONTROL:**
 - MODE 1: COOLING RECOVERY. IF THE RETURN AIR ENTHALPY IS LESS THAN THE OUTSIDE AIR ENTHALPY ENABLE THE HEAT WHEEL TO OPERATE IN COOLING RECLAIM MODE AND MAINTAIN THE MIXED AIR TEMPERATURE AT THE DISCHARGE AIR TEMPERATURE SETPOINT.
 - MODE 2: PARTIAL FREE COOLING. IF THE RETURN AIR ENTHALPY IS HIGHER THAN THE OUTSIDE AIR ENTHALPY, AND THE OUTSIDE AIR TEMPERATURE AS MEASURED AT THE INLET TO THE HEAT PIPE, IS BETWEEN THE DISCHARGE AIR TEMPERATURE SETPOINT AND THE RETURN AIR TEMPERATURE, SET THE HEAT PIPE INTO THE "NO HEAT RECOVERY POSITION".
 - MODE 3: FREE COOLING AND HEAT RECOVERY. IF THE OUTSIDE AIR TEMPERATURE AS MEASURED AT THE INLET TO THE HEAT WHEEL, IS LESS THAN THE DISCHARGE AIR TEMPERATURE SETPOINT ENABLE THE HEAT WHEEL TO MODULATE AND MAINTAIN THE OFF HEAT WHEEL TEMPERATURE AT THE DISCHARGE AIR TEMPERATURE SETPOINT.
- MINIMUM OA CONTROL:**
 - THE DESIGN VENTILATION RATE IS INDICATED ON THE AHU EQUIPMENT SCHEDULES. THE REAL TIME VENTILATION RATE SHALL BE CONTINUOUSLY MEASURED AT THE SUPPLY FAN AIRFLOW MEASURING STATION AND DISPLAYED ON THE SYSTEM GRAPHIC.
 - A TREND LOG OF THE TOTAL SUPPLY FAN VOLUME (VENTILATION RATE) IN CFM SHALL BE SET UP MAINTAINED AND ARCHIVED INTO A "AHU 3 VENTILATION RATE.CSV" TREND LOG FILE. SEPARATE FILES SHALL BE NAMED CLEARLY AND SAVED FOR EVERY DAY, WEEK, MONTH AND YEAR TO A "ENERGY MONITORING TREND LOGS" FILE FOLDER ON THE OPERATORS TERMINAL PC.

MINIMUM OUTSIDE AIR FROST PROTECTION MODE:

- IN THE EVENT THAT THE HEAT WHEEL DISCHARGE AIR TEMPERATURE DROPS TO 32DEG F OR BELOW THE ELECTRIC HEATING COIL WILL BE ENABLED AND ITS OUTPUT MODULATED BY AN SCR AND IN ACCORDANCE WITH THE DICTATES OF A PROPORTIONAL PLUS INTEGRAL CONTROL ALGORITHM IN ORDER TO MAINTAIN THE AIR TEMPERATURE ENTERING THE REFRIGERANT COILS AT A MINIMUM OF 32DEG F. IN THIS EVENT A WARNING "FROST PROTECTION HEATING ENABLED FOR AHU-3" ALARM SHALL BE SENT TO THE BUILDING OPERATORS TERMINAL. IF THE AIR TEMPERATURE AFTER THE ELECTRIC HEATING COIL DROPS TO 25DEG F OR BELOW THEN THE AHU SHALL BE SHUTDOWN AND A CRITICAL "AHU-3 SHUT DOWN IN FROST PROTECTION MODE" ALARM SHALL BE TRANSFERRED TO THE BUILDING OPERATOR.
- THE AHU SHALL ALSO BE SHUTDOWN BY A HARD WIRE "FREEZE STAT" ALARM. IN THIS EVENT A FAN FAILED ALARM SHALL OCCUR AND A CRITICAL ALARM RAISED AT THE OPERATORS TERMINAL. THE "FREEZE STAT" PROTECTS THE REFRIGERATION SYSTEM FROM A LOW ENTERING TEMPERATURE, NOT FREEZING, AND SO SHALL BE SET FOR 25DEG F.

11. TEMPERATURE CONTROL:

- WHENEVER THE CONTROL SEQUENCE IS ENABLED AN ENABLE SIGNAL SHALL BE TRANSFERRED TO THE AHU REFRIGERATION AND HEAT PUMP SYSTEM. ONCE ENABLED THE BMS SHALL CONTROL THE STAGES OF COOLING, HEATING AND THE POSITION OF A THREE WAY VALVE TO CONTROL REHEAT IN ACCORDANCE WITH THE DICTATES OF A PROPORTIONAL PLUS INTEGRAL CONTROL LOOP AND IN ORDER TO MAINTAIN THE DISCHARGE AIR TEMPERATURE AT ITS SETPOINT. THE SETPOINT SHALL BE [55] DEG F WHEN THE OUTSIDE AIR TEMPERATURE IS [55]DEG F OR ABOVE AND [65]DEG F WHEN THE OUTSIDE AIR TEMPERATURE IS [54]DEG F OR BELOW.
 - THE BASIS OF DESIGN ENGINEERED AIR AHUS CONTAIN THE FOLLOWING COMPONENTS THAT THE BMS SHALL HAVE CONTROL OVER: TWO TANDEM COMPRESSORS, DX COOLING COIL, COLD REFRIGERANT GAS TO HEAT PUMP LOOP WATER HEAT EXCHANGER (CHILLER), WARM REFRIGERANT LIQUID TO HEAT PUMP LOOP WATER HEAT EXCHANGER (WATER COOLED CONDENSER) AND CONDENSER REHEAT COIL. THE AHUS ALSO CONTAIN THERMAL EXPANSION VALVES, REFRIGERANT FILTERS, REFRIGERANT DRYERS, HEAD PRESSURE CONTROL VALVES, RECEIVER, SIGHT GLASS, TIMERS, ETC FOR THE PROPER OPERATION OF THE REFRIGERANT SYSTEM. THESE CONTROL AND SAFETY DEVICES SHALL NOT BE OVERRIDDEN OR CONTROLLED BY THE BMS.
 - THE BMS SHALL CONTROL TWO SOLENOID VALVES THAT DIRECT THE REFRIGERANT GAS FLOW TO THE EITHER THE DX COOLING COIL FOR DEHUMIDIFICATION/COOLING, OR TO THE CHILLER FOR COOLING REJECTION TO THE HEAT PUMP LOOP. THE SOLENOID VALVES ARE PROVIDED WITH THE AHU MANUFACTURER BUT CONTROLLED BY THE BMS.
 - THE BMS SHALL CONTROL THE MODULATING THREE WAY VALVE TO CONTROL THE FLOW OF HOT GAS TO EITHER THE REHEAT CONDENSER FOR AHU SUPPLY AIR HEATING OR TO THE WATER COOLED CONDENSER FOR HEAT REJECTION TO THE BUILDING HEAT PUMP WATER LOOP.
 - THE BMS SHALL CONTROL THE STAGES OF COMPRESSOR OPERATION TO PROVIDE EITHER MORE HEATING OR MORE COOLING. EACH AHU HAS TWO PAIRS OF COMPRESSORS, FOUR TOTAL. IN ADDITION EACH COMPRESSOR HAS ONE OFFLOADING POSITION. THEREFORE THERE IS A TOTAL OF EIGHT STAGES OF COMPRESSOR OPERATION AND EIGHT ASSOCIATED DIGITAL OUTPUTS FROM THE BMS.
- 12. DEHUMIDIFICATION:** IF THE RETURN AIR RELATIVE HUMIDITY RISES TO [80%] OR MORE, THE COOLING COIL STAGES WILL BE COMMANDED TO MAINTAIN THE RETURN AIR HUMIDITY BELOW THE RETURN AIR DEHUMIDIFICATION SETPOINT. THE REHEAT CONTROL WILL MAINTAIN THE TEMPERATURE AT SETPOINT.

13. SOLAR AIR HEATING SYSTEM:

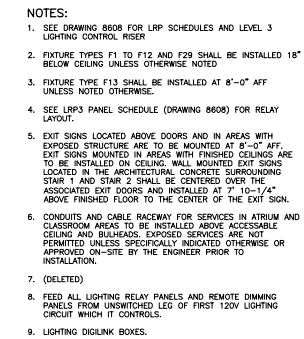
- OUTSIDE AIR IS PROVIDED TO ALL THREE MAIN AIR HANDLING UNITS VIA THE SOLAR AIR HEATING SYSTEM. THE SOLAR AIR HEATING SYSTEM HAS A BY-PASS SO THAT IN THE WARM MONTHS NO SOLAR HEATING IS PROVIDED. REFER TO THE MECHANICAL PLANS FOR THE NUMBERS AND LOCATIONS OF DAMPERS.
- WHENEVER THE OUTSIDE AIR TEMPERATURE IS EQUAL TO OR ABOVE THE DISCHARGE AIR TEMPERATURE SENSOR THE SOLAR WALL BYPASS DAMPER SHALL OPEN AND THE SOLAR WALL ISOLATION DAMPERS SHALL CLOSE.
- WHENEVER THE OUTSIDE AIR TEMPERATURE IS BELOW THE DISCHARGE AIR TEMPERATURE SETPOINTS THE SOLAR WALL BYPASS DAMPERS AND SOLAR WALL ISOLATION DAMPERS SHALL MODULATE IN ORDER TO MAINTAIN THE INLET AIR TEMPERATURE AT THE AHU DISCHARGE AIR TEMPERATURE SETPOINT.
- THE OUTSIDE AIR TEMPERATURE, AHU ENTERING AIR TEMPERATURE (ON ALL THREE AHUS) AND THE SUPPLY FAN VOLUME ON AHU-3 AND THE OUTSIDE AIR VOLUME ON AHU-1 AND 2 SHALL ALL BE MONITORED ON A 15 MINUTE SAMPLE RATE. THESE PARAMETERS SHALL BE TREND LOGGED IN REAL TIME IN ORDER TO CALCULATE THE EFFECTIVENESS OF THE SOLARWALL SYSTEM. THE TREND LOG SHALL TRACK THE DATA, CONVERT IT INTO A "SOLAR WALL PERFORMANCE.CSV" FILE FORMAT AND ARCHIVE IT IN SEPARATE FILES FOR EVERY DAY, WEEK, MONTH AND YEAR TO A "ENERGY MONITORING TREND LOGS" FILE FOLDER ON THE OPERATORS TERMINAL PC.

14. UNIT ENABLE: A NETWORK UNIT ENABLE SIGNAL WILL CONTROL THE MODE OF THE UNIT.**15. UL-864-UUKL SMOKE CONTROL SUPPORT:** THE AIR HANDLING UNIT WILL SUPPORT UL-864-UUKL SMOKE CONTROL SEQUENCES.**16. POWER FAIL RESTART:** UPON POWER RESTORATION, THE UNIT RESTART SHALL BE DELAYED.**17. OVER PRESSURE:** A HARD WIRE FAN OVERPRESSURE SWITCH SHALL BE PROVIDED TO PROTECT AGAINST THE POSSIBILITY OF DAMAGE TO THE DUCT SYSTEMS IN THE EVENT OF THE FANS OPERATING AGAINST A DEAD HEAD. THIS HARDWIRED INTERLOCK WILL ALSO BE MONITORED BY THE BMS AND A CRITICAL ALARM RAISED IF THE FANS ARE SHUTDOWN DUE TO OVERPRESSURE.**18. CONDENSER WATER VALVE, TO BE DETERMINED:** THE AHU SHALL HAVE TWO CONDENSER WATER VALVES ONE FOR THE WATER COOLED CONDENSER AND ONE FOR THE CHILLER. THE AHUS PACKAGED UNIT CONTROLLER WILL CONTROL THE OPERATION OF THESE VALVES BASED ON THE OPERATION OF THE COMPRESSORS AND SOLENOID VALVES. WHENEVER THE CHILLER SOLENOID VALVE IS OPEN AND AN ASSOCIATED COMPRESSOR IS RUNNING THE HEAT PUMP LOOP WATER VALVE SHALL BE OPEN. WHENEVER THE WATER COOLED CONDENSER THREE WAY VALVE IS 10% OR MORE OPEN TO THE WATER COOLED CONDENSER AND THE ASSOCIATED COMPRESSOR IS RUNNING, THE HEAT PUMP LOOP WATER VALVE SHALL BE OPEN.**19. ADDITIONAL POINTS MONITORED BY THE FMS:**

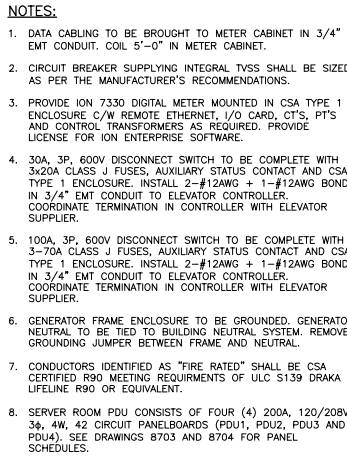
- OUTDOOR AIR FLOW (OA-F)
- DISCHARGE AIR VELOCITY PRESSURE (DA-VP)
- RETURN FAN STATUS (RF-S)
- RETURN AIR VELOCITY PRESSURE (RA-VP)
- EXHAUST AIR FILTER STATUS (EAFILT-S)
- OUTSIDE AIR FILTER STATUS (OAFILT-S)
- DISCHARGE AIR SMOKE ALARM (DA-SD)
- RETURN AIR SMOKE ALARM (RA-SD)
- LOW TEMPERATURE ALARM (LT-A)

20. ADDITIONAL ENERGY MONITORING TREND LOGS

- THE REAL TIME SPEED, DIFFERENTIAL PRESSURE, KW DEMAND, SYSTEM STATIC PRESSURE, OUTSIDE AIR TEMPERATURE, HEAT WHEEL SPEED, ON HEAT WHEEL TEMPERATURE, OFF HEAT WHEEL TEMPERATURE, RETURN AIR TEMPERATURE, SUPPLY (DISCHARGE AIR TEMPERATURE), RETURN AIR RELATIVE HUMIDITY AND SUPPLY AIR RELATIVE HUMIDITY FOR EACH OF THE SUPPLY AND EXHAUST FAN SHALL BE LOGGED EVERY 15 MINUTES AND STORED IN A "AHU-AHU-3 ENERGY CONSUMPTION.N.CSV" TREND LOG FILE. THESE FILES SHALL BE ARCHIVED IN SEPARATE FILES FOR EVERY DAY, WEEK, MONTH AND YEAR TO A "ENERGY MONITORING TREND LOGS" FILE FOLDER ON THE OPERATORS TERMINAL PC.
- EACH AHU COMPRESSOR RUN TIME AND LOAD/UNLOAD STATUS SHALL BE TREND LOGGED IN REAL TIME AND TOTALIZED FOR EACH DAY, WEEK, MONTH AND YEAR. TREND LOGS SHALL BE STORED IN A "AHU-AHU-3 COMPRESSOR ENERGY CONSUMPTION.N.CSV" TREND LOG FILE. THESE FILES SHALL BE ARCHIVED IN SEPARATE FILES FOR EVERY DAY, WEEK, MONTH AND YEAR TO A "ENERGY MONITORING TREND LOGS" FILE FOLDER ON THE OPERATORS TERMINAL PC.



LIGHTING FIXTURE SCHEDULE					
TYPE	DESCRIPTION	LAMP TYPE	NO. OF LAMPS		FIXTURE WATTAGE
A1	RECESSED INCANDESCENT AMBABLE DOWNLIGHT	35W AR11	3	120-12V TRANSFORMER	140W
F1	8" SUSPENDED INDIRECT CW INTEGRAL PHOTOCCELL	32W T8	4	0-10V DIMMING	128W
F4	4" SUSPENDED INDIRECT CW INTEGRAL PHOTOCCELL	32W T8	2	0-10V DIMMING	64W
F3	8" SUSPENDED INDIRECT	32W T8	4	0-10V DIMMING	128W
F4	4" SUSPENDED INDIRECT	32W T8	2	0-10V DIMMING	64W
F5	8" SUSPENDED INDIRECT	32W T8	4	PROG. RAPID START	118W
F4	4" SUSPENDED INDIRECT	32W T8	2	PROG. RAPID START	59W
F7	4" SUSPENDED INDIRECT	32W T8	2	PROG. RAPID START	52W
F8	12" SUSPENDED INDIRECT	32W T8	6	0-10V DIMMING	192W
F9	8" SUSPENDED DIRECT/INDIRECT	32W T8	6	0-10V DIMMING	192W
F10	4" SUSPENDED DIRECT/INDIRECT	32W T8	3	0-10V DIMMING	64W
F11	12" SUSPENDED INDIRECT	32W T8	6	PROG. RAPID START	177W
F12	12" SUSPENDED INDIRECT CW INTEGRAL PHOTOCCELL	32W T8	6	0-10V DIMMING	192W
F13	4" SUSPENDED INDUSTRIAL STRIP CW 5% UPLIGHT REFLECTOR	32W T8	2	PROG. RAPID START	59W
F14	4" SURFACE MOUNTED WRAPAROUND	32W T8	2	PROG. RAPID START	59W
F15	8" RECESSED DOWNLIGHT	32W CFL	2	0-10V DIMMING	69W
F16	8" RECESSED DOWNLIGHT	26W CFL	2	PROG. RAPID START	54W
F17	6" RECESSED DOWNLIGHT	26W CFL	1	PROG. RAPID START	28W
F18	4" RECESSED WHITEBOARD LIGHT	32W T8	1	PROG. RAPID START	28W
F19	4" INDUSTRIAL STRIP	32W T8	1	PROG. RAPID START	28W
F20	2" INDUSTRIAL STRIP	17W T8	1	PROG. RAPID START	15W
F21	3" INDUSTRIAL STRIP	25W T8	1	PROG. RAPID START	22W
F22	TRACK MOUNTED WALL WASHER	18W CFL	2	PROG. RAPID START	38W
F23	4" UNDER-CABINET LIGHT	32W T8	1	PROG. RAPID START	28W
F24	4" VAPORTIGHT	32W T8	2	PROG. RAPID START	59W
F25	WALL MOUNTED VAPORTIGHT	23W CFL	1	SELF BALLASTED	23W
F26	4" WALL MOUNTED INDUSTRIAL STRIP CW WIRE GUARD	32W T8	2	PROG. RAPID START	59W
F27	2" WALL MOUNTED FLUORESCENT FIXTURE	17W T8	2	PROG. RAPID START	32W
F28	4" WALL MOUNTED FLUORESCENT FIXTURE	32W T8	2	PROG. RAPID START	59W
F29	12" SUSPENDED DIRECT/INDIRECT	32W T8	9	PROG. RAPID START	177W
F30	4" INDUSTRIAL STRIP	32W T8	1	0-10V DIMMING	33W
F31	2" INDUSTRIAL STRIP	17W T8	1	0-10V DIMMING	17W
F32	3" INDUSTRIAL STRIP	25W T8	1	0-10V DIMMING	25W
F33	3" UNDER-CABINET LIGHT	25W T8	1	PROG. RAPID START	22W
F34	2" UNDER-CABINET LIGHT	17W T8	1	PROG. RAPID START	15W
F35	2x2 RECESSED FLUORESCENT FIXTURE	17W T8	2	0-10V DIMMING	34W
F36	4" DIAGONAL STAGGERED STRIP	32W T8	2	PROG. RAPID START	59W
F37	2" DIAGONAL STAGGERED STRIP	17W T8	2	PROG. RAPID START	32W
F38	3" DIAGONAL STAGGERED STRIP	25W T8	2	PROG. RAPID START	46W
F39	8" SUSPENDED DIRECT/INDIRECT	32W T8	6	PROG. RAPID START	177W
F40	2x2" RECESSED LENSED TROFFER	40W BIAx	2	T5 BIAx INSTANT START	76
F41	4" WALL MOUNTED LINEAR DIRECT/INDIRECT	32W T8	1	PROG. RAPID START	28
L1					



- NOTES:
1. DATA CABLING TO BE BROUGHT TO METER CABINET IN 3/4" EMT CONDUIT. COIL 5'-0" IN METER CABINET.
 2. VARIABLE FREQUENCY DRIVES (VFD's) ARE SUPPLIED BY DIVISION 15. DIVISION 16 CONTRACTOR IS TO COORDINATE INSTALLATION IN MOTOR CONTROL CENTERS WITH MCC MANUFACTURER AND DIVISION 15 CONTRACTOR.
 3. TERMINATION LOCATION FOR FAN MOTOR TO BE IN TERMINAL BOX ON AIR HANDLING UNIT. COORDINATE EXACT LOCATION ON SITE WITH EQUIPMENT SUPPLIER.
 4. VFD OUTPUT FILTER TO BE SUPPLIED BY DIVISION 15. COORDINATE INSTALLATION LOCATION (IF REQUIRED) ON SITE.
 5. DUPLEX PUMP CONTROL SUPPLIED BY DIVISION 15 CONTRACTOR.
 6. VOLTAGE MONITOR RELAY TO MONITOR INCOMING VOLTAGE AND ALARM IF BELOW 10% NOMINAL. CONNECT OUTPUT TO FIRE ALARM SYSTEM. PROVIDE FUSED PROTECTION AS RECOMMENDED BY THE MANUFACTURER. STANDARD OF ACCEPTANCE: ROCKWELL AUTOMATION 8135 PHASE MONITOR (RATING AS REQUIRED)
 7. CONDUCTORS IDENTIFIED AS "FIRE RATED" SHALL BE CSA CERTIFIED R90 MEETING REQUIREMENTS OF ULC S139 DRAGA LIFELINE R90 OR EQUIPMENT.

