PANELIZED DEEP RETROFITS OF MUNICIPAL BUILDINGS

Burlington Seniors Centre

Case Study Report

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CITY OF Burlington
Natural Resources Canada | Ressources naturelles Canada
ReCover

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Acknowledgements

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Project Team

Timon Bruulsema, P.E. (CA)	Energy Consultant, RDH Building Science
Stanley Francispillai, PEng	WUFI Modeling
Mark Gardin, PQS(F), MRICS	Cost Consultant, Qsolv Incorporated,
Liam Kidson, PEng	Electrical Consultant, M&R Engineering
Hayley Knowles, EIT	Mechanical Consultant, M&R Engineering
Aidan McCracken, EIT	Structural Consultant, DesignPoint Engineering
Amanda McNeil, PEng	Project Management, ReCover
Jim Nostedt, PEng	TCBO Analysis, SEEFAR Building Analytics
Fatma Osman	Embodied Carbon Accounting
Andrea Pietila, PEng CPHD	Energy Consultant, RDH Building Science
Lorrie Rand, BEDS CPHD	Architecture, Habit Studio
Nick Rudnicki	Project Lead, RSI Projects
Aaron Smith, PEng	Mechanical Consultant, M&R Engineering
Evan Teasdale, PEng	Structural Consultant, DesignPoint Engineering

This research project was led by The ReCover Initiative, a Nova Scotia based non-profit organization working to accelerate deep retrofits in Canada.

Burlington Seniors Centre

Executive Summary

Who is ReCover

ReCover is a Nova Scotia-based non-profit focused on revolutionizing Canada's buildings to combat climate change. Through innovative research, technology, and partnerships, they lead in scalable deep retrofit solutions. Their efforts in Canada lower energy costs and enhance well-being by collaborating with communities, building owners, and financial institutions.

What is the Project

This project examines six cases of municipally owned buildings, inspired by the successful Energiesprong approach from the Netherlands, which streamlines retrofits. Despite challenges adapting to Canada's diverse buildings and climates, some projects have successfully implemented some Energiesprong-inspired retrofits. The ReCover Initiative found cost-effective benefits in panelized retrofits for multi-unit dwellings, aiming for Net Zero Energy. The study seeks to apply effective residential retrofit strategies to support municipal decarbonization.

Project Objectives

The project objectives are to make deep retrofits in Canada more feasible, showcase a panelized retrofit approach, and enhance confidence in retrofits. It aims for a 50% reduction in EUI, a NZER scenario with potential for NZE through solar PV, minimal disruption to occupants, low embodied carbon solutions, cost-effectiveness, and a payback period of 20 years or less.

Methods Used

The project progressed through several phases : building selection based on criteria and evaluation, data collection including utility info and drawings, baseline energy modeling, designing retrofit scenarios with energy conservation measures, and cost analysis involving Class D cost estimation and TCBO modeling.

Building Performance Improvements

EUI

100% improvement

Existing : 435 kWh/m^2

Recommend : 0 kWh/m^2

GHG

100% improvement

Existing : 96,836 kg/yr

Recommend : 0 kg/yr

ROI

34 Years

When whole building cost of doing nothing exceeds whole building cost of deep retrofit.

Lifetime Savings

$10.2 Million

Existing : $34.6 M

Recommend : $24.4 M

Retrofit Measures

2x8 ReCover wall panels

EPS roof insulation

High performance windows and doors

Ground source heat pump

New ventilation system

220 kW Solar PV system

Acronyms and Definitions

ACH	**A**ir **C**hanges per **H**our, measured with a blower door test
CO_2e	**C**arbon di**O**xide **E**quivalent
Deep Retrofit	A project involving multiple energy efficiency and/or renewable energy measures in an existing building, designed to achieve major reductions in energy use. A deep retrofit usually includes reducing energy demand and switching from fossil fuels to electricity for space and water heating – to achieve 70% energy savings and 80% to 100% GHG emissions reductions.
Energiesprong	A retrofit methodology developed in the Netherlands to implement Net-Zero retrofits using prefabricated envelope panels and compact exterior mechanical pods. Energiesprong retrofits are financed by the cost savings from future energy consumption and required maintenance. Translation: Energy Leap.
EUI	**E**nergy **U**se **I**ntensity
FCA	**F**acility **C**ondition **A**ssessment: a comprehensive evaluation of a building's physical condition.
GHG	**G**reen**H**ouse **G**as
GWP	**G**lobal **W**arming **P**otential: a measure of how much energy the emissions of 1 ton of gas will absorb over a given time, relative to the emissions of 1 ton of carbon dioxide.
NZE	**N**et-**Z**ero **E**nergy building: a building in which on-site renewable energy generated equals the annual energy consumption of the building
NZER	**N**et-**Z**ero **E**nergy **R**eady building: a building whose annual energy consumption is low enough that it could be Net-Zero Energy with the addition of a source of renewable energy
PV	Solar **P**hoto**V**oltaic array
TCBO	**T**otal **C**ost of **B**uilding **O**wnership: building life cycle cost analysis that includes all major operating costs over the useful life of the building.
WRB	**W**ater-**R**esistive **B**arrier: a synthetic membrane installed outside of the building's sheathing to protect it from the impacts of bulk water.
ZCB	**Z**ero **C**arbon **B**uilding:

Introduction

Over one-third of Canada's planned greenhouse gas (GHG) emissions reductions will come from energy efficiency measures.[1] Increasing the pace and scale of deep retrofits is imperative to achieving net-zero emissions, as most buildings standing today will still exist in 2050.

Municipalities across Canada are working to implement climate action plans to reduce their GHGs and to protect people and infrastructure from the impacts of climate change. Deep retrofits support both efforts.

The Panelized Deep Retrofits of Municipal Buildings project includes six deep retrofit case studies of municipally owned buildings in Canada. The buildings studied are representative of buildings in municipalities throughout the country. Their uses include community centres, administration, transit, and maintenance facilities in three Canadian climate zones.

Conventional retrofit practices are not scalable. They require large budgets, custom design, and invasive construction. The only retrofit initiative to be successfully scaled to date is the Dutch approach, Energiesprong, which involves prefabricated panelized envelope over-cladding and systematic mechanical upgrades. This approach reduces time on site and project complexity compared with common retrofit practices and permits buildings to continue to be used during the work.

Energiesprong has succeeded in part because of the Netherlands' homogenous building stock. The diversity of buildings and range of climate conditions in Canada pose challenges in adapting the approach to this country, yet several Energiesprong-inspired projects have been completed or are under way. These include Ottawa Community Housing's four-unit townhouse retrofit completed in 2021, Sundance Housing Cooperative in Edmonton, which is mid-way through retrofits on their 59 townhouses, and three single family homes in Alberta.

Measures that focus on simple payback and short-term return on investment can be counterproductive with assets as long lasting as buildings. Economic evaluation through Total Cost of Building Ownership (TCBO) analysis is more appropriate for complex retrofit projects that make changes to multiple interrelated building systems.

The ReCover Initiative has studied the potential for prefabricated panelized deep retrofits in low-rise multi-unit dwellings in two previous case studies[2]. These studies found the lowest TCBO over the anticipated life of the building was achieved through Net Zero Energy retrofits where the targets were met with an Energy Use Intensity (EUI) reduction of at least 75% before adding solar PV.

This study of Panelized Deep Retrofits of Municipal Buildings was undertaken to develop deep retrofit strategies to support municipal decarbonization efforts.

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[1] IEA (2022), *Canada 2022*, IEA, Paris https://www.iea.org/reports/canada-2022 , License: CC BY 4.0

[2] ReCover Initiative (2020) *ReCover Phase One Case Study Report* and ReCover Initiative (2022) *Scarlettwood Court Deep Retrofit Case Study Repor*t, https://www.recoverinitiative.ca/about-us/our-results/report-request

Project Objectives

The objectives of this study were to de-risk investment in deep retrofits in Canada, to provide evidence on the effectiveness and scalability of a panelized deep retrofit approach and to build confidence and experience in deep retrofits among Canadian municipalities and industry stakeholders.

The goals for the Deep Retrofits explored included:

1. Develop a scenario that achieves an Energy Use Intensity (EUI) reduction of 50%.
2. Develop a Net Zero Energy Ready (NZER) scenario that can achieve Net Zero Energy (NZE) with the addition of solar PV.
3. All solutions minimize occupant disruption during construction.
4. All solutions target minimal embodied carbon.
5. Identify the retrofit pathway to the lowest Total Cost of Building Ownership.
6. Demonstrate a calculated payback of 20 years or better.

Methodology

The project was completed in the following phases:

1. Building selection.
   a) Definition of selection criteria.
   b) Building evaluation and selection.
2. Data and document collection, including:
   a) Utility data
   b) Building drawings
   c) Facility Condition Assessment, ideally no more than five years old
   d) Field Review
3. Baseline energy modeling (hourly analysis).
   a) Determination of model inputs
   b) Energy Model Calibration
   c) Baseline energy model results
4. Design Energy Conservation Measures (ECMs) for retrofit scenarios, including:
   a) u-values, window, and door performance specifications
   b) mechanical and electrical systems upgrades
   c) panel design, including:
      i) structural design and fastening details.
      ii) panel dimensions and layouts.
      iii) hygrothermal modeling with WUFI Pro to assess moisture risk.
      iv) embodied carbon accounting.
      v) aesthetic upgrades.
5. Cost Analysis.
   a) Class D cost estimate.
   b) TCBO modeling.

Building Selection

The Burlington Seniors Centre was selected for study by the City of Burlington with input from the ReCover team. Criteria for consideration included the following:

- high EUI
- potential to eliminate fossil fuel-based building systems.
- high maintenance deficit
- simple form
- ample space to stage a panelized construction project.
- solar potential

The Burlington Seniors Centre was selected as it has a high energy use intensity (EUI) using on average 340,000 kWh of electricity and 1,720 GJ of gas annually. The building also has a history of comfort issues at all times of year.

The one-storey structure is suitable for a panelized retrofit despite its irregular footprint because the geometry has consistent 135-degree angles. There is generous space around the structure to stage construction work. The building has good solar potential.

Data and Document Collection

The City of Burlington provided the following data and supporting documents pertaining to the Municipal Operations Building:

- 1978 construction drawings (Appendix A)
- 2005 expansion drawings
- Natural gas consumption records January 2018 – March 2022 (Appendix F)
- Electrical consumption records January 2018 – March 2022 (Appendix F)
- 2017 Roof Condition Assessment.

Typically, a minimum of two years of consumption records for all utilities serving a building is required. As the time frame for this project included reduced building occupancy during the pandemic, at least one year preceding the beginning of the pandemic was included in analysis.

Smarter Spaces was engaged to complete **LiDAR** (Light Detection and Ranging) imaging to capture the external building geometry. The 3D point cloud generated from the scan was interpreted to produce CAD and BIM drawing files for use by the design team (Appendix A).

A site visit was conducted by design team members to verify structural, mechanical, and electrical details from the resources provided and to understand building conditions. The team also engaged with City of Burlington staff to understand building usage patterns, baseline operational settings for mechanical systems and for information on occupant comfort and building deficiencies.

A new **Facility Condition Assessment** (FCA) was obtained. (Appendix B).

Building Description

Figure 1 Burlington Seniors Centre

The Burlington Seniors Centre is a one storey structure with a gross floor area of 2,000m^2 (21,526 sq.ft.). Its footprint is irregularly shaped with many 135-degree angles. The original building was built in 1979 and it underwent a renovation and expansion in 2005.

The Burlington Seniors Centre offers a variety of recreation services for people aged 55 and older, including fitness and art classes, social events, church services, and workshops. It is also rented out for events such as parties, meetings, and trade shows. The facility is open year-round from 7am to 10pm on weekdays and 8:30am to 4:30pm on weekends. The space is well used with programing offered most days continuously between 8:30am to 9pm. As services are offered both on a pre-registered and a drop-in basis, the number of daily visitors to the facility fluctuates. The building also contains administration offices, a 420m^2 (4,500 sq. ft) auditorium and a commercial kitchen. Prior to the pandemic the kitchen served breakfast and lunch through the week, however currently the kitchen prepares only baked goods and drinks.

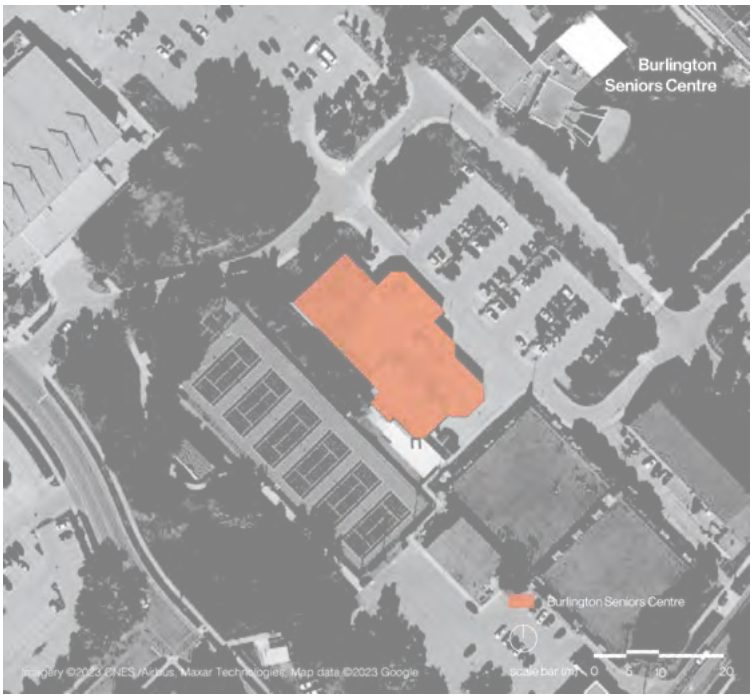

Figure 2 Site Plan: Burlington Seniors Centre

Context

The Burlington Seniors Centre is located at 2285 New Street, Burlington, Ontario. It is one of several recreation facilities in Burlington's Central Park, an activity hub located less than a kilometer inland from Lake Ontario. The building is surrounded by sports fields, gardens, a library, theatre, an arena and more.

Southern Ontario has a humid continental climate and experiences periods of high heat and humidity in summer. The region is expected to experience continued temperature increases in both summer and winter and higher annual precipitation.[3] The site is in Canadian building code climate zone 5.

The City of Burlington is working towards being a net carbon zero community by 2050.[4]

Building Code Considerations

A preliminary review of the National Building Code of Canada (NBCC) and the Ontario Building Code (OBC) has been completed to determine building code implications of a panelized retrofit to the Burlington Seniors Centre (Appendix L). The primary focus of the review was to determine if panels made with combustible materials may be permitted to be installed on the existing structure.

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[3] City of Burlington, (2022) *Climate Resilient Burlington*, https://burlingtonpublishing.escribemeetings.com/filestream.ashx?DocumentId=62452

[4] City of Burlington (2020) *Climate Action Plan*, https://www.getinvolvedburlington.ca/9946/widgets/38577/documents/33658

As the building's primary use is a community centre, the structure is categorized as a **High Importance Building** as per Sentence 4.1.2.1.(3) in the 2015 edition of the National Building Code of Canada (NBCC). High Importance structures are subject to higher environmental loading, including snow, wind, and seismic loads, than a normal importance building.

The construction type, cladding and fire rating requirements for each exterior wall of a building are based on the area of the wall and its proximity to the property boundaries and the building's occupancy classification. The existing building is sprinklered. Based the building's use as a recreation centre it is classified as **NBCC Group A2 - Assembly Occupancy.**

The property line setbacks from the building were obtained through Burlington's online interactive mapping tool. The building has an irregular shape, with the north-west wall of the building approximately parallel to the nearest lot line and set back 9.5m. This is the closest part of the building to the property line.

Based on the scaled setbacks, both the structure and the cladding are permitted to be of either combustible or noncombustible construction. This indicates that ReCover panels may be permitted to be installed on the building.

Cellulose insulation has a Class 1 fire rating, which is the best fire rating for materials with the lowest level of risk. It is treated with borate which acts as both a fire retardant and pest repellant.

Building Enclosures

Table 1 Opaque Enclosure		
	Effective USI $W/m^2 \cdot K$ ($Btu/h \cdot ft^2 \cdot °F$	Effective RSI $m^2 \cdot K/W$ ($ft^2 \cdot °F \cdot h/BTU$)
weighted average walls	USI-0.80 (U-0.14)	RSI-1.25 (R-7.1)
weighted average roofs	USI-0.27 (U-0.05)	RSI-3.66 (R-20.8)
slab	USI-4.1 (U-0.7)	RSI-0.24 (R-1.36)
windows	USI-3.4 (U-0.6)	RSI-0.29 (R-1.66)

The walls are assumed to be insulated with 50mm (2") extruded polystyrene (XPS) insulation between the brick cladding and concrete block. Phenolic panel accent walls are assumed to have 75mm (3") of XPS insulation. The original drawings show 50-75mm (2"- 3") of roof insulation beneath a layer of tapered insulation. This is also assumed to be extruded polystyrene (XPS) based on the 2017 Roof Condition Assessment (Appendix B). The concrete floor slab is shown as uninsulated in the original building and the addition drawings show slab insulation at the perimeter only.

Assumptions were made where references in original documents were unspecific, for example existing roof drawings reference 'roof insulation' but do not state the type (Figure 3.) and walls show insulation but do not note it in the assembly (Figure 4).

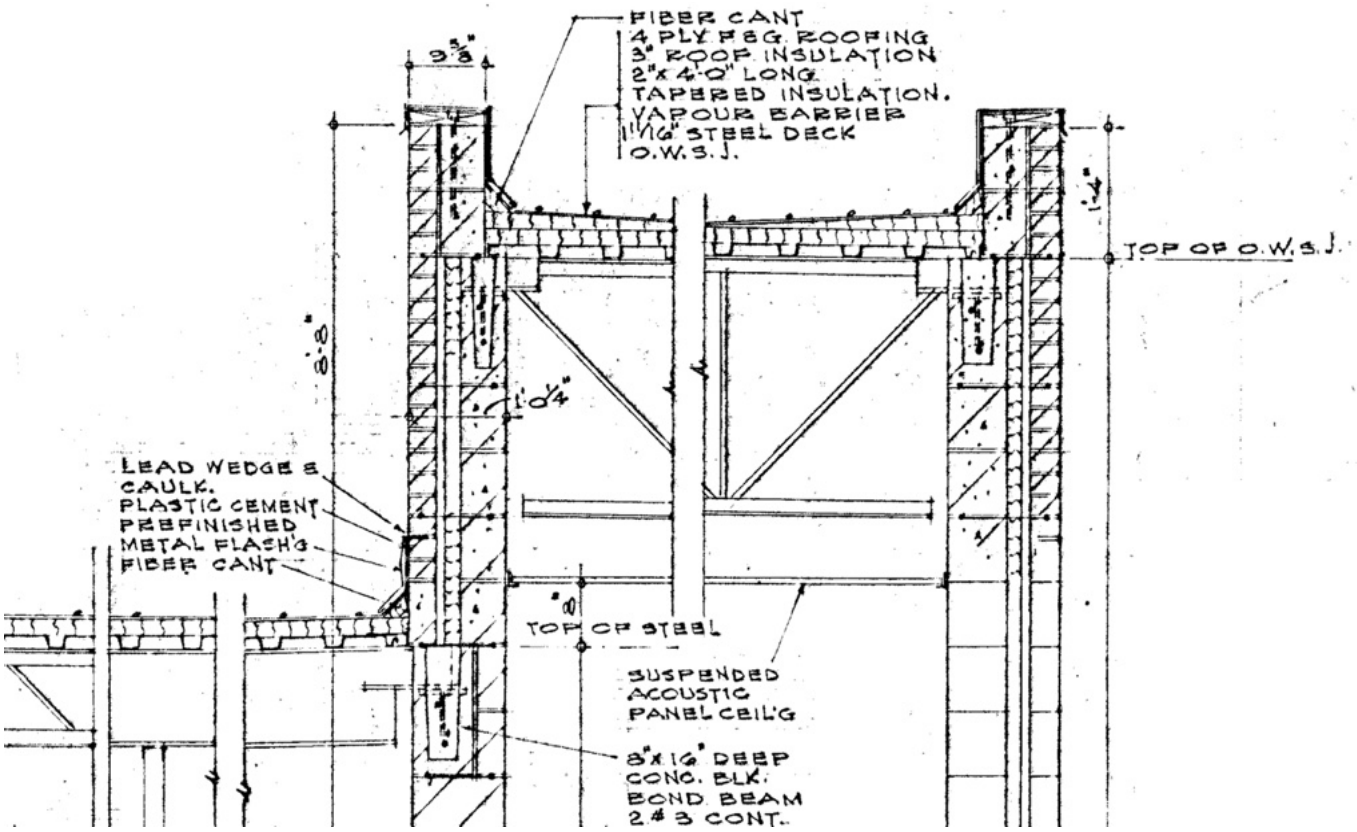


Figure 3 Partial roof to wall section detail.

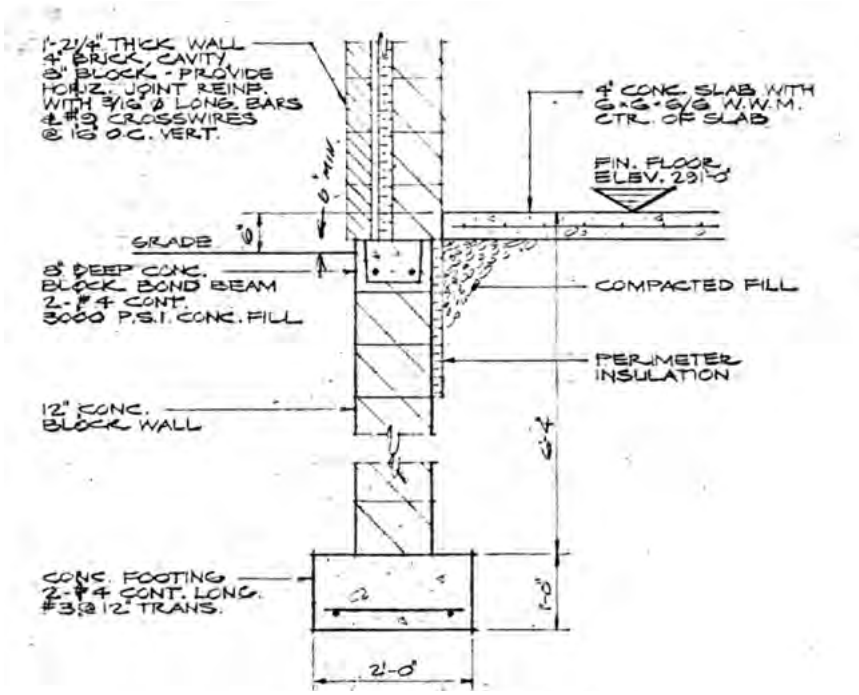


Figure 4 Partial foundation to wall section detail.

Existing Structure

The **foundation** and **above grade wall** structure are 200mm and 305mm (8” and 12”) concrete masonry unit (CMU) blocks installed on **cast-in-place concrete strip footings** (Figure 4). There is capacity in the masonry walls to accommodate additional loading.

The **roof structure** is a system of pre-engineered open web steel joists (OWSJs) bearing on the CMU walls (Figure 3). Specifics of the steel strength were not available.

There is no evidence to suggest structural deficiencies in the structure of the building, however confirmation of the wall condition through selective destructive testing is recommended prior to panelized over-cladding.

The results of structural assessment are that the existing walls are suitable for a panelized retrofit but that adding prefabricated panels is not viable for the roofs.

Details of the existing structure and Structural Outline Specifications are in Appendix C.

Existing Mechanical Systems

The building has a flat roof, sloped to internal **rainwater drains** and numerous mechanical penetrations which must be carefully detailed in a panelized retrofit.

The **hot water** service includes a natural gas tankless water heater with a separate 80-gallon storage tank.

Space heating and cooling is provided by a combination of Constant Air Volume (CAV), Variable Air Volume (VAV) and Variable Volume and Temperature (VVT) rooftop air handling units complete with natural gas burners.

Due to occupant comfort complaints, electric heaters have also been added in the offices and games room. The boutique room has electric reheat for hot yoga programs.

Two small storage rooms in the kitchen area have supplemental cooling provided by mini split heat pumps. These units were recently installed due to the heat gain of commercial fridges and freezers in the storage rooms.

Ventilation is provided by the rooftop units. There are four exhaust fans that serve the kitchen, two-bathroom facilities, and kiln room. A make-up air unit is installed in the kitchen.

Apart from the multi-zone VAV system, most HVAC units are nearing the end of their 20-year lifetime and will need to be replaced.

There is no record of updates to the ductwork in the original building. As ductwork typically has a service life of 30-40 years, the efficiency of the original facility’s distribution system is likely to be lower than industry norm.

Details of the existing mechanical systems and Mechanical Outline Specifications are provided in Appendix D.

Existing Electrical Systems

The incoming **power service** consists of two, 4" PVC conduits servicing a pad mount transformer. The main incoming secondary service is sized at 400A, 600V, 3P and consists of two 4" PVC conduits. The secondary service entrance enters the building in the main electrical room and terminates onto the main service entrance rated main breaker. The building's main disconnect is a 400A, 100% rated loose main breaker.

The **main distribution** is original to the building and consists of a main disconnect, a main 600V panelboard and multiple branch circuit panelboards throughout the building.

The **main building disconnect** is a 100% rated 400A fused disconnect switch. All other disconnects for panels, motors etc. are also fusible disconnects.

Several 120-208V **branch circuit panelboards** exist throughout the building servicing various areas. All panelboards appear to be original to the building and range from okay to good condition. No mini breakers are present in the existing panelboards. There is limited breaker space available for additional equipment. Depending on the scope of proposed electrical changes, additional distribution may need to be added.

No **emergency power distribution** is present on site. Emergency lighting, exit signage and the building fire alarm panel are battery operated.

Electric baseboard heaters are located throughout the building to support the main heating.

Throughout the building, most of the **interior lighting** fixtures are rectangular or linear fluorescent fixtures with T8 lamps. The office area of the building has been retrofit LED flat panel fixtures.

The **exterior lighting** has been retrofit to LED. Several LED wall-packs exist around the perimeter of the building which are controlled by a timeclock. The wall-packs appear to be in good condition.

The building lacks an automatic lighting control system relying entirely on manual control. This could lead to energy waste if lights are left on in unoccupied areas of the building for extended periods of time (overnight).

Details on the existing electrical systems and Electrical Outline Specifications are provided in Appendix E.

Energy Consumption

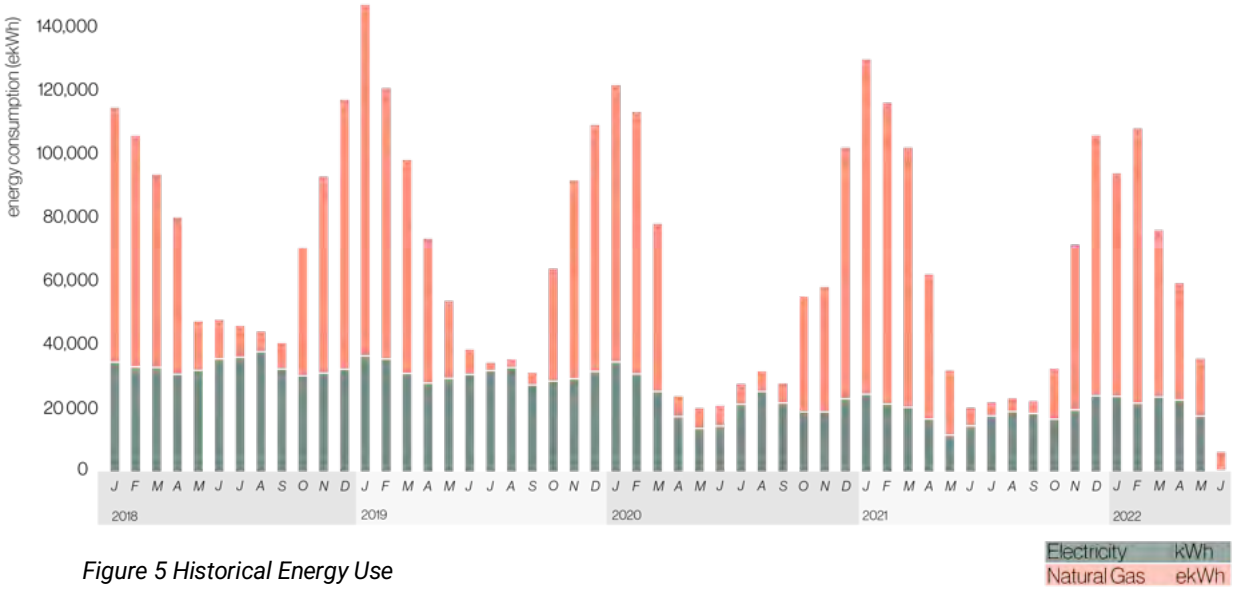


Figure 5 Historical Energy Use

Energy analysis was based on electrical and natural gas records spanning January 2018 through March 2022 (Appendix F). The earlier years are more representative of typical building operations as the Burlington Seniors Centre experienced periods of reduced building occupation due to the COVID-19 pandemic during the documented time span.

The building used an annual average of 343,746 kWh of electricity and 45,906 m3 (ekWh) of natural gas over that time span. The data shows that energy use was reduced by approximately 35% starting in 2020.

Baseline Energy Model and Calibration

Whole building energy modeling was conducted with eQUEST to understand existing performance and to inform the development of retrofit scenarios. Energy model inputs (Appendix G) were based on data and documentation described earlier in this report and in consultation with City of Oakville staff on occupancy patterns and operational set points of the mechanical and electrical equipment.

The energy model was calibrated with the historical utility data to closely reflect the current building performance. As occupancy fluctuated during the pandemic, the calibration was based on consumption prior to March 2020 to best reflect energy use during standard operations.

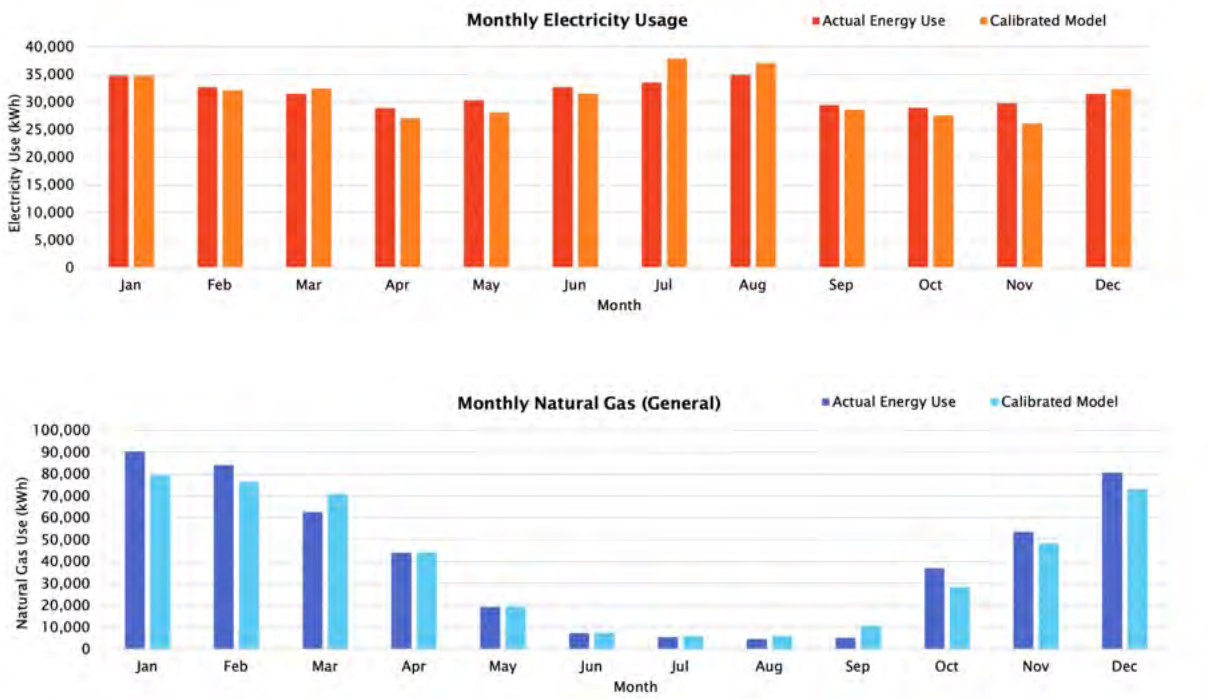


Figure 6 Calibrated Energy Use

Summertime electrical calibration did not align as closely to actual energy use as the rest of the year. This is assumed to be due to higher levels of programming in summer months. The annual calibrated electrical consumption is within 1% of actual use. Natural gas calibration deviates from actual use through the heating season. The gas heating system is supplemented with electricity in some spaces and the relative proportion of heating provided by the two systems is inconsistent. The calibrated natural gas consumption varies 5% from actual use.

Results

The design team worked collaboratively to develop retrofit scenarios targeting the project objectives. The analysis assumes a 'like for like' retrofit where space usage, occupancy schedules, internal geometry, volume of conditioned space, and window and door dimensions and locations are consistent with existing conditions.

The strategy for building enclosure upgrades is to retrofit the walls with prefabricated ReCover panels and to complete a conventional retrofit to the roof by adding outboard rigid insulation as a panelized roof retrofit is not structurally viable.

Figure 7 Burlington Seniors Centre partial elevation and section.

Energy Conservation Measures

Energy conservation measures for the following four scenarios were developed:

1. **Minimum Upgrade** Scenario targeting a 50% reduction in TEUI from the baseline.
2. **NZER – ASHP** targeting a 75% reduction in TEUI from the baseline.
3. **NZER - GSHP** targeting a 75% reduction in TEUI from the baseline.
4. Net Zero Energy (**NZE**).

Building enclosure upgrades were developed for each scenario with post-retrofit airtightness targeting 0.5 L/s·m^2, a 75% reduction from the estimated existing air infiltration. All scenarios propose upgrading to high performance windows.

Mechanical and electrical retrofits were developed based on ease of integration with existing systems and installation cost. As the building has a high occupant density, the heating and cooling systems were designed around the cooling loads.

For the NZER scenarios, both air source heat pumps (ASHP) and ground source heat pumps (GSHP) were considered in the design analysis. A GSHP is more energy efficient than an ASHP, however the capital costs of installing an GSHP system are typically much higher. Depending on the specific building details it is not immediately apparent which option is the better investment. The Net Zero Energy scenario is based on the GSHP option which resulted in the lowest TCBO. Details of the retrofit scenarios are summarized in Table 2.

Table 2 Retrofit Scenarios Summary				
Item	**Existing Building**	**Minimum Upgrade**	**NZE – ASHP[1]**	**NZE – GSHP[1]**
Effective Wall R-value	RSI-1.23 (R-7)	2x4 ReCover panel RSI-2.64 (R-15)	2x8 ReCover panel RSI-4.4 (R-25)	2x8 ReCover panel RSI-4.4 (R-25)
Effective Roof R-value	RSI-3.7 (R-21)	Add 4" EPS RSI-4.4 (R-25)	Add 8" EPS RSI-10.57 (R-60)	Add 8" EPS RSI-10.57 (R-60)
windows	Aluminum double glazed RSI-0.44 (R-2.5)	triple pane RSI-1.02 (R-5.56)	triple pane RSI-1.02 (R-5.56)	triple pane RSI-1.02 (R-5.56)
Air Tightness at 75Pa	3.0 L/s·m2	0.5 L/s·m2	0.5 L/s·m2	0.5 L/s·m2
Central Heating Equipment	Natural gas rooftop units	Natural gas rooftop units	Air source VRF	Ground source VRF
Heating System	Combination ducted VAV/CAV and electric baseboards	Ducted VAV AHUs and electric baseboards	Ducted fan coil units	Ducted fan coil units
Cooling System	Combination ducted VAV/CAV and mini split units in storage rooms	Combination ducted VAV AHUs and mini split units in storage rooms	Ducted fan coil units	Ducted fan coil units
DHW Equipment	Natural gas tankless water heater and storage tank	Natural gas tankless water heater and storage tank	HP Water Heater	HP Water Heater
Ventilation Equipment	Combination ducted CAV/VAV natural gas rooftop units	Ducted VAV natural gas rooftop unit	90% SRE ERVs[2] with VAV boxes in zones	90% SRE ERVs[2] with VAV boxes in zones
Renewables	-	-	220kW (DC)	220kW (DC)

[1]Net Zero Energy Ready systems are identical with exclusion of renewables

[2] SRE ERV: Sensible heat-recovery efficiency energy/enthalpy recovery ventilator (Tempeff Dualcore or similar).

The Thermal Energy Demand Intensity (TEDI) provides a breakdown of heat losses by building component in the existing building (Figure 8). Ventilation heat losses account for 55% of heat losses and the building enclosures are responsible for the remaining 45%. This indicates that design options that upgrade the efficiency of the building's ventilation system will be impactful in reducing energy use.

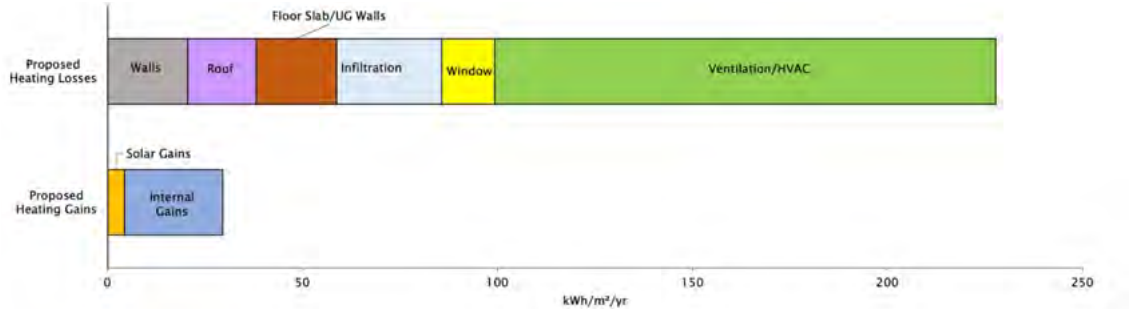


Figure 8 Thermal Energy Demand Intensity (TEDI)

The existing **Total Energy Use Intensity** (TEUI) of the Burlington Seniors Centre is 435.4

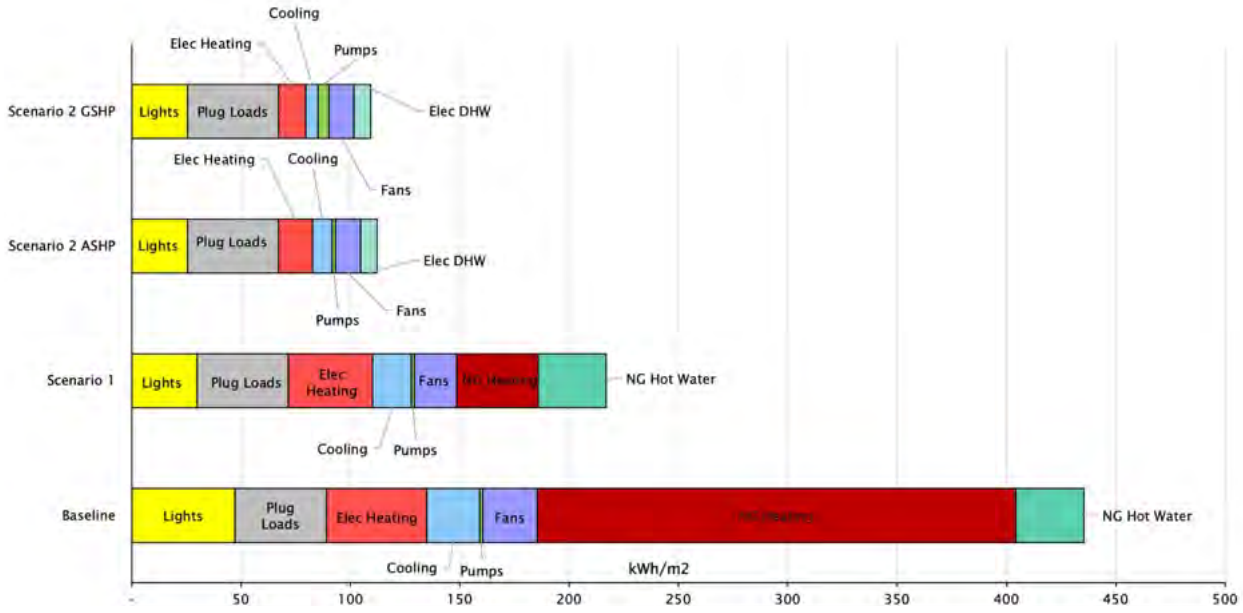


Figure 9 Total Energy Use Intensity (TEUI) kWh/m²/yr

ekWh/m²/yr with 60% of energy use for space heating (Figure 9).

Table 3 Retrofit Scenario Results

	Target TEUI		TEUI kWh/m²	TEUI reduction
Existing	-		435.4	-
Minimum Upgrade	50% savings	217	50%	
NZER ASHP	75% savings	113.4	74%	
NZER GSHP	75% savings	110.1	75%	
NZE	100% savings	0	100%	

Figure 10 Design concept

Design

Thoughtful design decisions can reduce time and expense in ongoing maintenance and replacement of building components. In consideration for the maintenance burden facing municipalities, the design recommendations in this study prioritize durability and longevity. The proposed new cladding for the Burlington Seniors Centre is corrugated metal, which is inexpensive, low maintenance and long-lasting.

Different sizes of a corrugated profile in a subdued green colour create a textural palette that harmonizes with the park setting and makes an understated backdrop to the myriad recreation activities that take place in the park.

To improve wayfinding and to create a sense of warmth and welcome, the recessed entrances are wrapped with cedar siding. These will be illuminated with warm lighting to mark the doors with a golden glow.

Architectural Elevation drawings are provided in Appendix L.

Figure 11 Entry Concept

Panelized Wall Design

The prototype ReCover panel is a wood framed box which holds carbon storing cellulose insulation. The depth of the frame is flexible depending on the needed performance.

The existing brick will be removed, and panels will be installed in front of existing rigid insulation on the CMU wall structure. A decision can be made when this is exposed whether to install a vapour retarding membrane on its surface prior to panel installation.

The panel components were specified to minimize moisture risks by shedding precipitation on the outside and by promoting drying activity to the exterior through the panel assembly. This is important as the existing assemblies include vapour retarding materials, including polyethylene vapour barrier and rigid foam insulation, which will inhibit drying to the interior of the building. These materials will also inhibit outward vapour drive, from the interior into the panels, however given the age and condition of the building it is highly unlikely that these materials comprise a continuous vapour barrier. The panels are be designed to promote any moisture movement that occurs from the interior to dry to the exterior.

Strapping on the interior side of the panel permits fitting adjustments against the existing walls and provides an internal air cavity that serves as a moisture buffer space for vapour diffusion from the inside to pass out through the panels. The frame backing layer is a “smart” vapour control membrane which varies in permeability depending on the relative humidity of its environment. If moisture is present between the panel and the existing walls the membrane fibers open to let moisture escape. Wood panel framing, plywood sheathing and cellulose insulation are all hygroscopic materials, meaning their fibers transport moisture from areas of higher humidity to those of lower humidity. A vapour-open water-resistive barrier (WRB) protects the outer plywood sheathing and provides a drainage plane behind the rainscreen cavity and metal siding.

Panel schematics and connection details for each scenario are in Appendix H.

Proposed NZER ReCover Panel RSI-3.7 (R-21)

1. metal cladding [5]
2. 19mm strapping/rainscreen cavity
3. WRB membrane
4. plywood sheathing
5. dense-pack cellulose
6. framing: 2x8 wood studs 24” o.c.[6]
7. variable permeability vapour control membrane
8. interior strapping

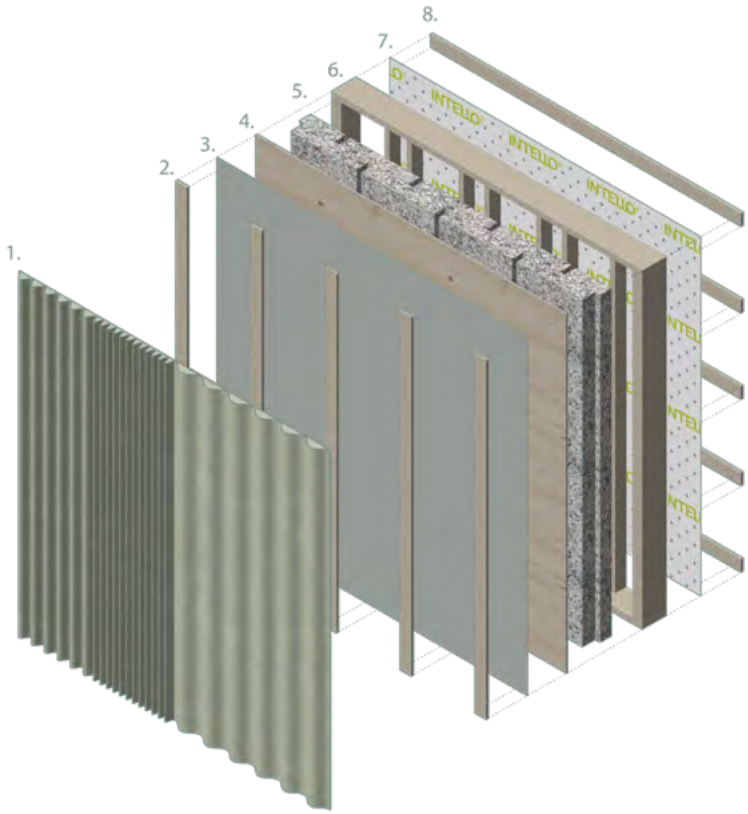


Figure 12 wall panel schematic

[5] Panels will be assembled remotely; however, the cladding will be installed on site.
[6] Panel framing is based on 2x4s in the Minimum Upgrade scenario.

Structural Design

The existing brick veneer will be removed, and the wall panels will sit on the existing brick ledge on the foundation wall (Figure 13).

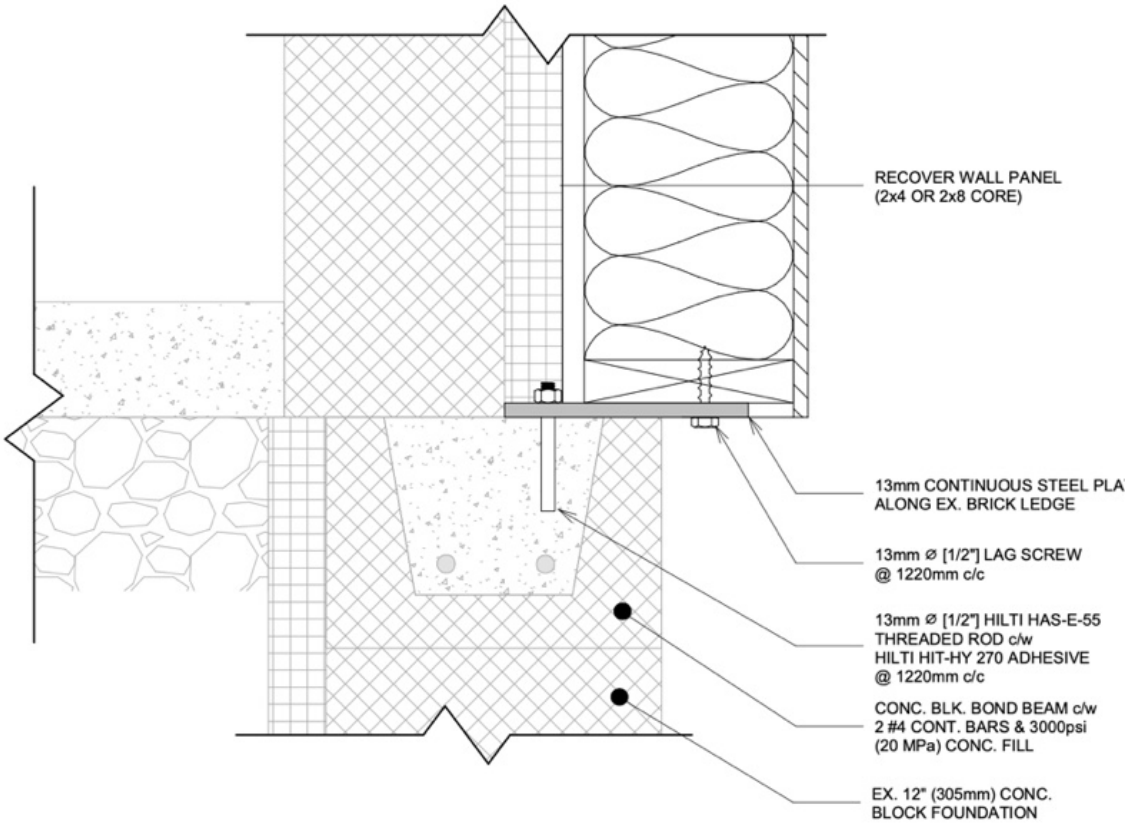


Figure 13 Panel connection at foundation.

102mm long pieces of structural steel angle will be installed to fasten the top plate of the wall panels to the existing structure at the roof diaphragm, with field- installed masonry anchors and lag screws fastened into to the parapet wall and panel top plate, respectively (Figure 14).

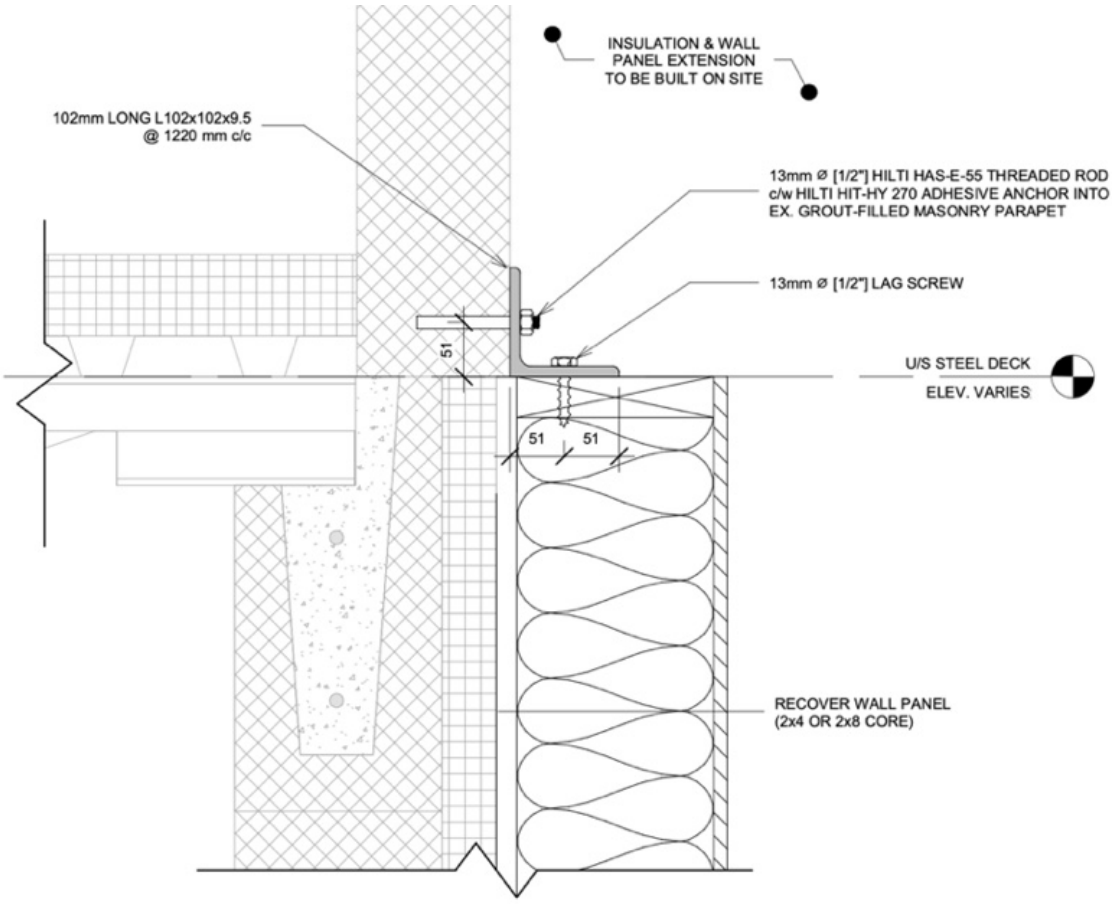


Figure 14 Panel connection at roof.

The panels will be installed in two courses with heights between 1.5m to 2m depending on their location on the building. Attachment of the panels in the middle of the wall (Figure 15) alters the wind loads impacting the structure (Figure 16 (next page). To complete the analysis on the proposed panel connection details it is necessary to confirm the presence of reinforcing bars and grout in the CMU walls.

The panel widths vary based on optimized spacing around the building with a standard width of 2.4m (8') with modifications to suit the building geometry and window and door positions. The design includes prefabricated corner panels, to simplify installation in the field. These are 0.6m (2') wide in each direction.

The proposed panel layout is provided in Appendix I.

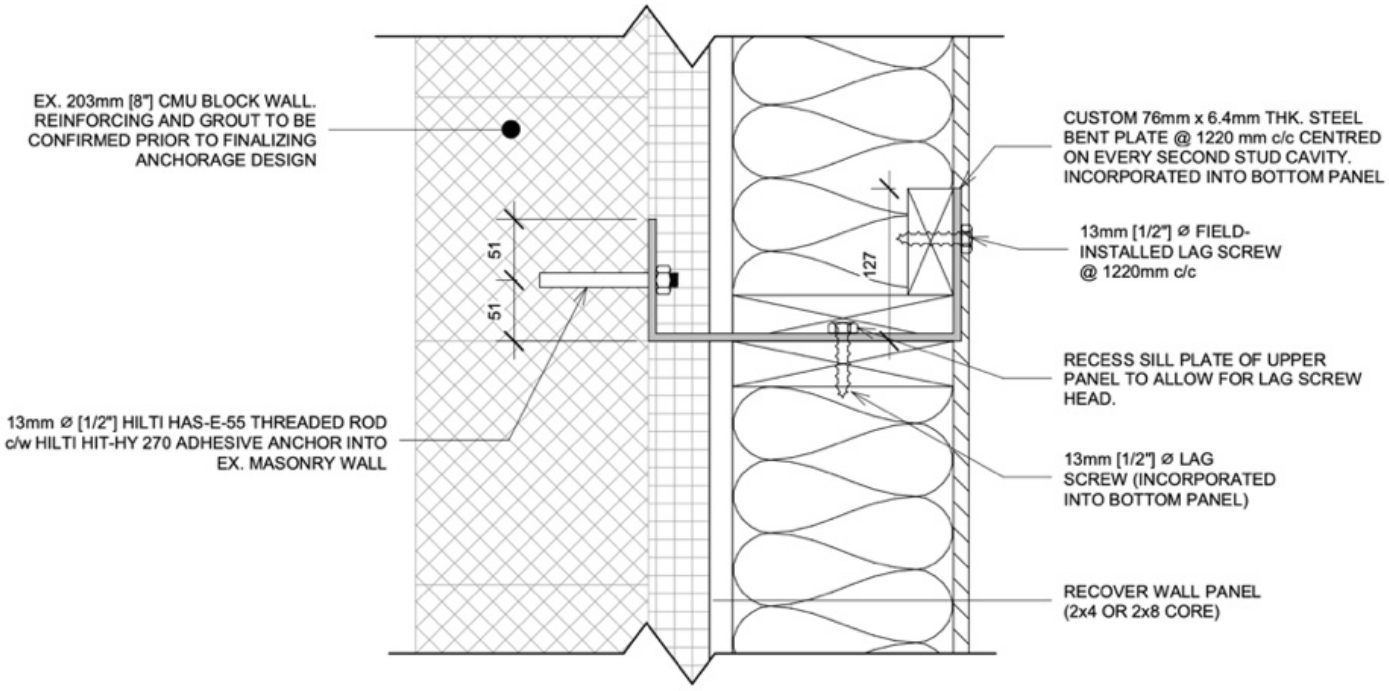


Figure 15 Mid-height panel connection

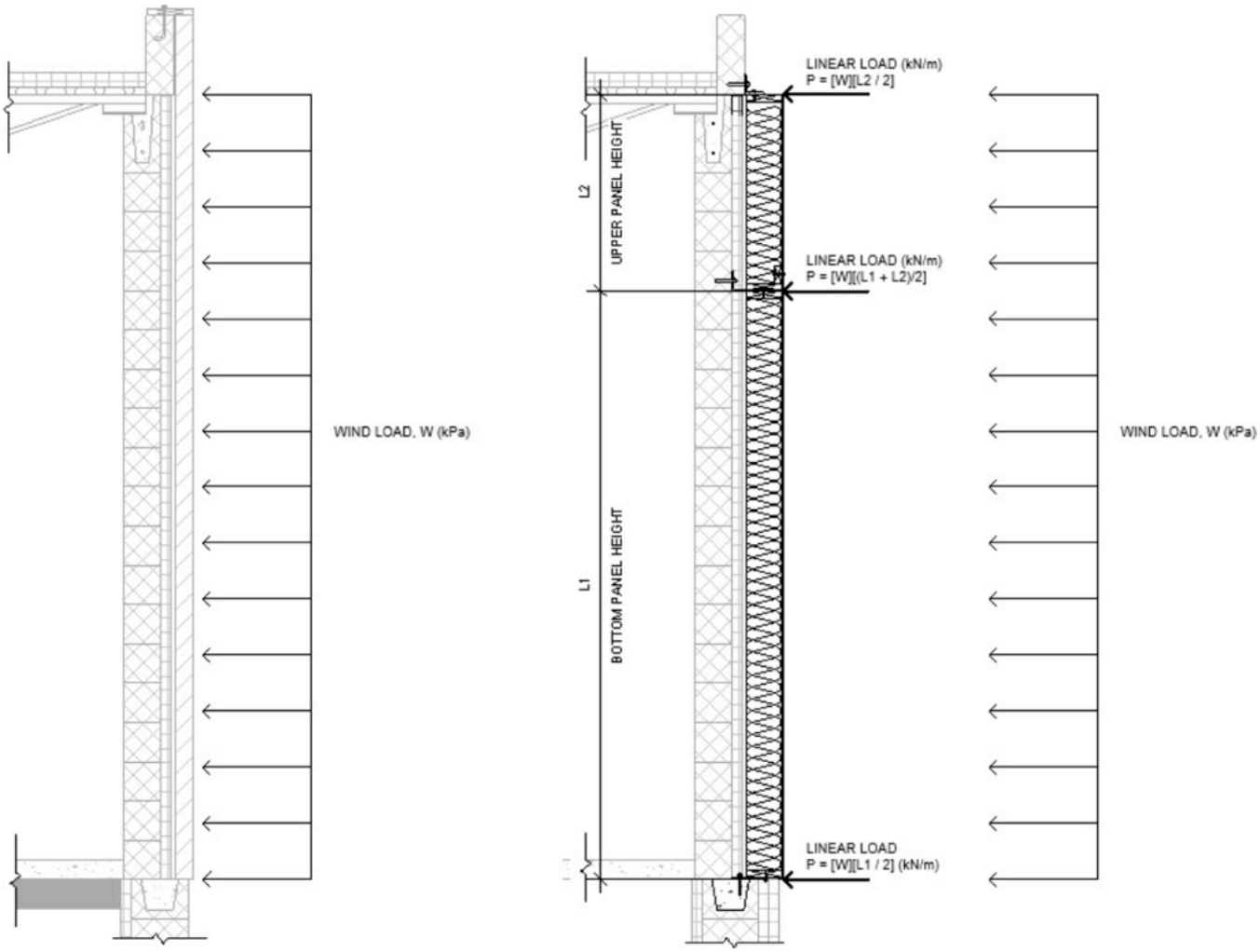


Figure 16 wind load path with and without panels

Hygrothermal Modeling

The analysis of moisture and temperature over time is called hygrothermal analysis. Adding new materials to the exterior of a building can slow or block moisture from passing through, and prolonged exposure to moisture in the building assemblies can lead to durability issues including mold growth and decay.

Hygrothermal simulations were conducted on the Burlington Seniors Centre NZER wall and roof assemblies using WUFI® Pro (Appendix J). The analysis focused on the plywood sheathing and cellulose insulation in the assemblies, as biogenic materials are most susceptible to moisture damage. When moisture content of wood exceeds 20% for prolonged periods it can decay.

Hygrothermal performance is dependent on the material characteristics of each component of a building assembly. Assumptions were made regarding the materials in the existing walls and roof and confirmation of the assumptions is required prior to finalizing the retrofit designs.

Simulations were run for each orientation of each assembly for a 10-year period post-retrofit. All assemblies displayed cyclical seasonal moisture fluctuations consistent with expectations for buildings in the southern Ontario climate. Specifically, moisture content peaks in winter, with the greatest peak occurring in the first year post-retrofit, and spikes decrease in subsequent years. An example of this cyclical pattern is shown in Figure 17. A moisture spike that exceeds 20% in one winter does not typically damage the building so long as drying occurs in the summer. Spikes above 20% that persist for several years indicate a potential for mould and eventual decay.

The north-east walls demonstrate moisture content spikes above 20% in all 10 years of the analysis (Figure 18). This pattern is an indication of a risk to the wall assembly which requires further review. As assumptions were made regarding specific material properties of the components in the existing assemblies, confirmation of existing materials should inform next steps. Additionally, it is the outer surface of the plywood which displays the greatest moisture content. High moisture content may be related to precipitation rather than vapour drive, in which case a more robust WRB or gypsum based sheathing could improve the results.
The plywood layers and outermost cellulose in all orientations simulated present acceptable durability with respect to potential mold growth. Simulations indicate a higher risk of mold in the outermost layer of plywood in the North-East orientation, however the risk is still within acceptable limits.

If the retrofit proceeds, is recommended that hygrothermal monitoring be implemented on selected assemblies to verify actual performance against modeling.

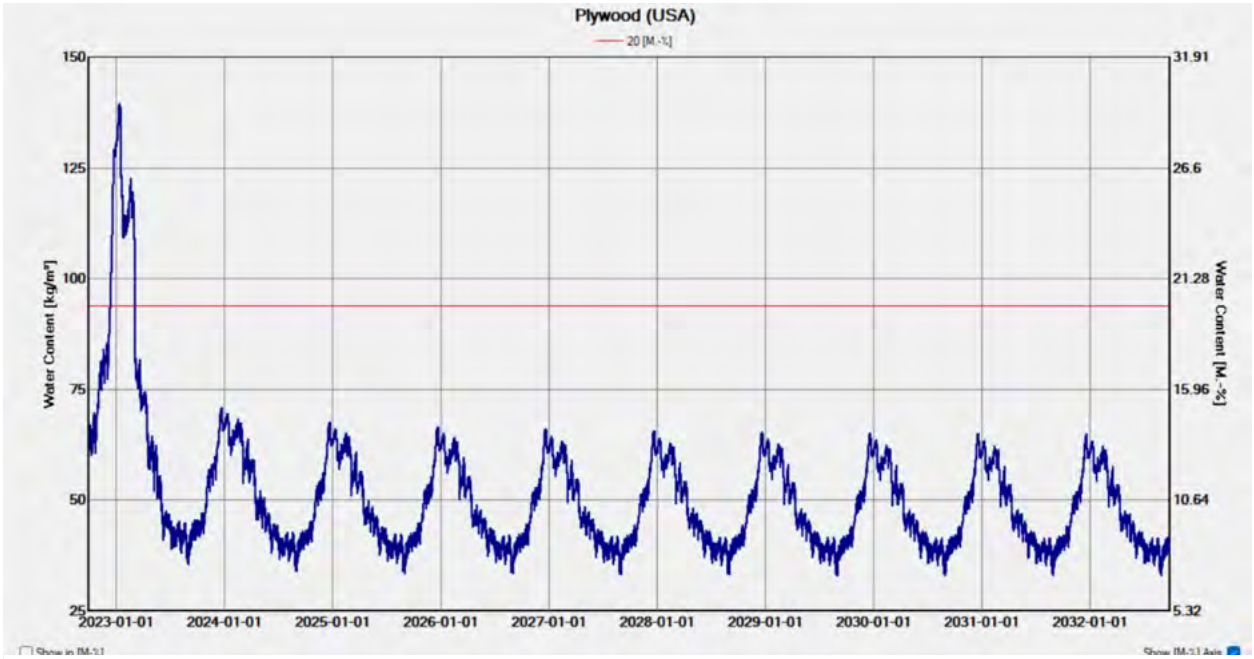


Figure 18 WUFI output south-east wall (inner plywood layer)

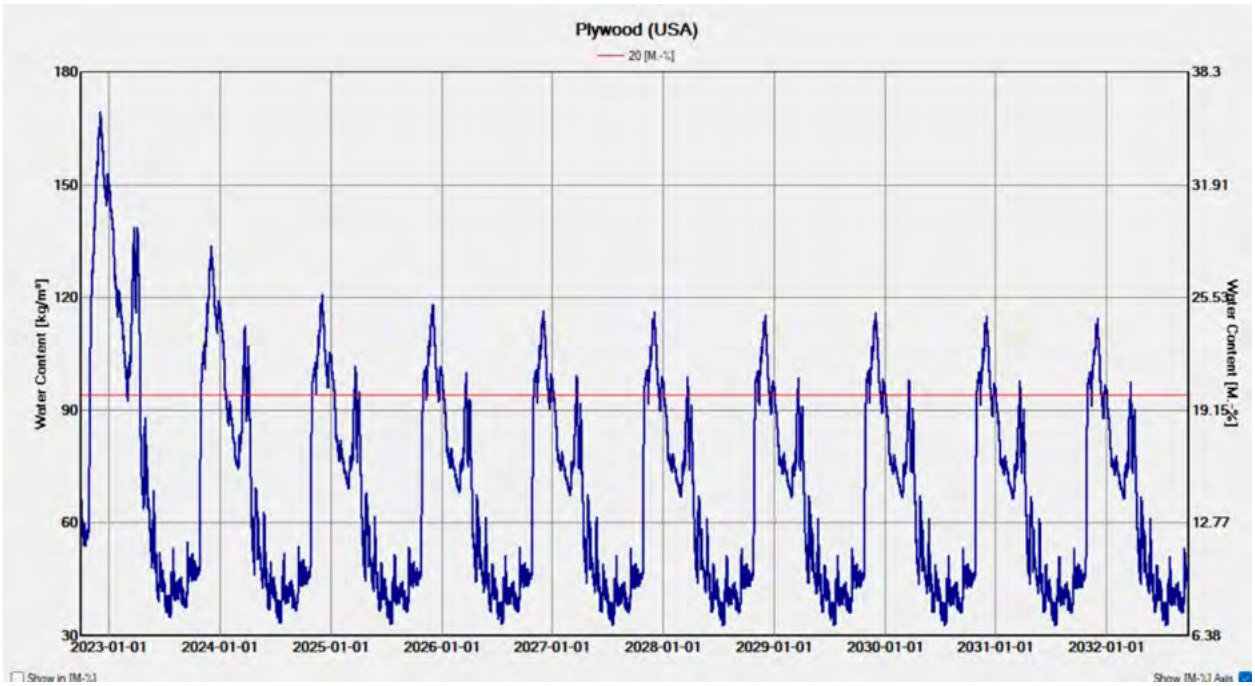


Figure 17 WUFI output north-east wall (outer plywood layer)

Embodied Carbon

With the short time remaining to limit the impacts of climate change, it is not responsible to complete retrofits that reduce long-term operational emissions while emitting high up-front embodied carbon. Materials used in retrofits must emit the lowest possible carbon or the construction emissions may offset the intended GHGs saved through the retrofit.

Carbon accounting is complex and imperfect. This is frequently used as justification for not factoring embodied carbon into decision making. The objective of including it in this study is not to deliver a definitive value for embodied carbon in the building, rather it is to contribute to the necessary discourse in the building industry, so that the impacts of embodied carbon on GHG emissions are more widely understood.

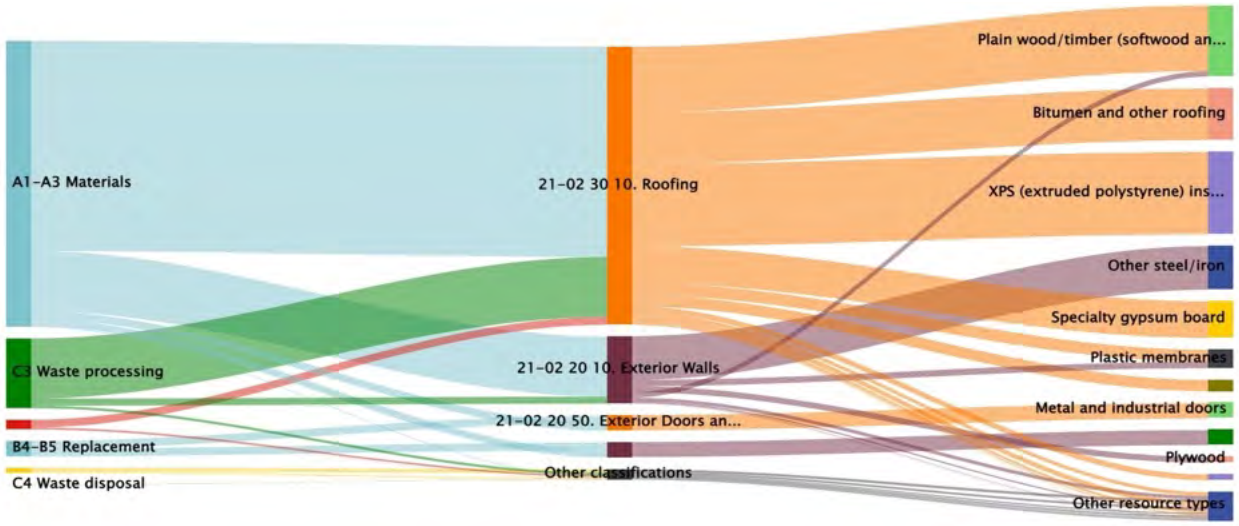


Figure 19 Life Cycle Impacts by Stage (%)

Embodied Carbon was modeled for the Burlington Seniors Centre NZER scenario in One Click LCA (Appendix K). Materials modeled were based on the most representative materials available to the Canadian market with Environmental Product Declarations (EPDs) available in the One Click LCA database. The analysis was limited to embodied carbon of assembly materials being added to the building including panel additions to above-grade walls, roofs, below-grade components, and windows and doors. HVAC and electrical components were excluded from the analysis.

Table 4 Total Global Warming Potential

gross floor area m^2	A1-A3 $KgCO2e/m^2$	A1-C4 KgCO2e/m2	Biogenic carbon KgCO2e/m2
1941	**18.06**	**46.07**	**20.5**

The results include a whole life cycle assessment of the building in six impact categories: Global Warming, Ozone Depletion, Acidification, Eutrophication, Formation of tropospheric ozone, Depletion of nonrenewable energy, and Biogenic carbon storage.

The major contributors to the GWP in this design are the metal roofing, EPS insulation, roofing membranes and windows. The A1-A3 Materials stage contributed 39% of the total carbon emissions associated with this building followed by C3 Waste processing at 34% as illustrated in Figure 19 & 20. The biogenic carbon of this building offsets 44.5% of the total A1-C4 carbon emissions. This storage is attributed to the wood products (68%) and cellulose insulation (32%) used in the assembly as shown in Figure 21.

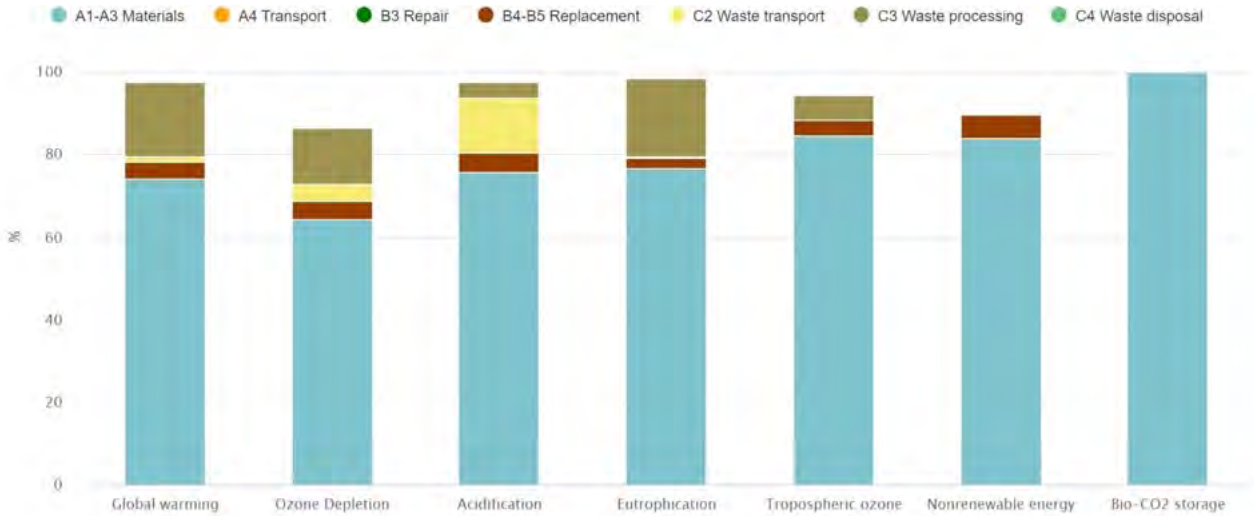


Figure 20 Global Warming by Stage and Material

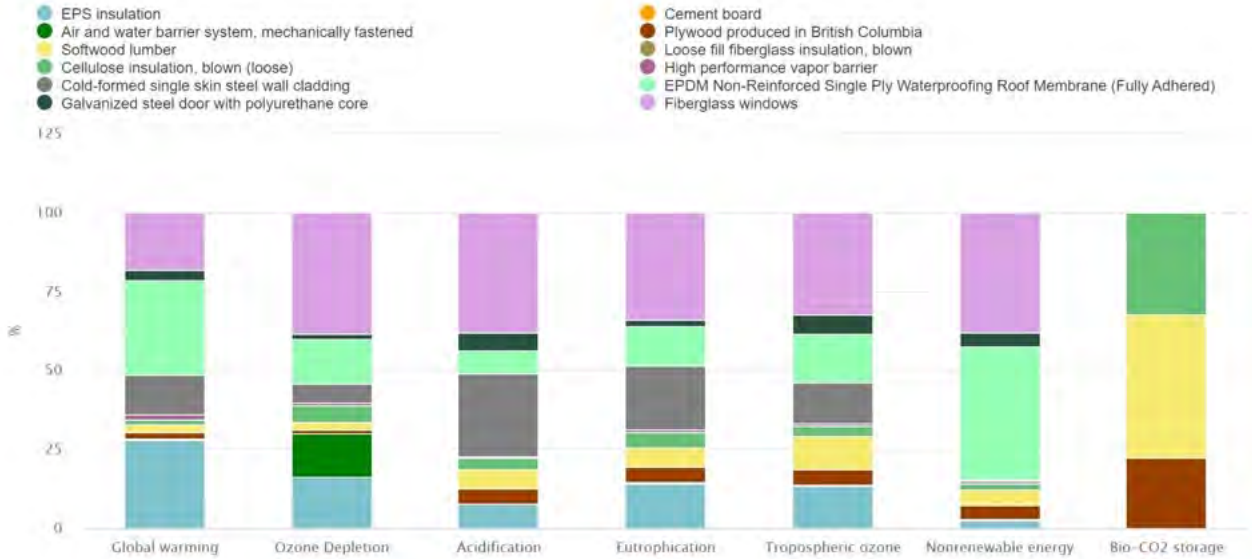


Figure 21 Life Cycle Cost by Material

Proposed Mechanical Systems

All scenarios:

- Rainwater drains and plumbing vents that penetrate the roof are to be insulated from ceiling to floor with 3” pipe insulation to prevent thermal bridging.

1. Minimum Upgrade Scenario
   - Heating and cooling will be with a combination of existing rooftop units, mini split units, and electric baseboard heaters. The existing CAV rooftop units will be retrofitted to become single zone VAV units with demand-controlled ventilation through the addition of a packaged solution that includes a variable frequency drive, CO_2 sensor and controller.
   - Domestic hot water will continue to be provided by a natural gas tankless water heater and a separate 80-gallon storage tank.
   - The existing rooftop units will continue to supply ventilation and existing kitchen MUA will remain.
   - All existing controls will remain, with the addition of the controls for the VFD units on the rooftop units and CO_2 sensors for demand-controlled ventilation.

2. NZER Scenarios:
   - Domestic hot water will be provided by an 80-gallon heat pump hot water heater.
   - Two ERVs will replace the existing rooftop units, one serving the auditorium and one for the rest of the building. They will be dual core type with approximately 90% heat recovery efficiency. Variable air volume (VAV) boxes along with CO_2 sensors would be installed to enable demand-controlled ventilation.
   - Main ventilation distribution duct runs will be replaced to accommodate new location of the ERVs on the roof.
   - The kitchen MUA and exhaust fan will be converted to VAV with a new high performance kitchen hood.
   - New VRF and ERVs will use the existing direct digital control system.

   a. ASHP Scenario
   - New air source variable refrigerant flow (VRF) system with two 8-ton units, installed on the roof to replace all existing heating and cooling equipment. The VRF system is sized to meet 100% of the peak cooling load, which meets 85% of the heating load.
   - An 12kW electric duct heater will serve the remaining 15% of the peak heating load.

   b. GSHP Scenario
   - New water source VRF system with two 8-ton ground/water condensing units to replace all existing heating and cooling equipment.
   - 7 kW electric duct heater to serve the remaining peak heating load.

Proposed Electrical Systems

1. Minimum Upgrade Scenario
    - All existing fluorescent lighting upgraded to LED using LED lighting retrofit kits.
    - Existing manual lighting controls remain.
    - No changes to the electrical distribution system or the building service.
2. NZER Scenarios
    - All existing fluorescent fixtures will be replaced with equivalent LED fixtures.
    - The lighting control system will be updated to include automatic lighting control.
    - New Power Distribution System
    - New Electrical Service
3. Net Zero Energy Scenario
    - Changes noted in the NZER scenarios above.
    - 220 kW (DC) solar pv array

Ontario Net Metering Program

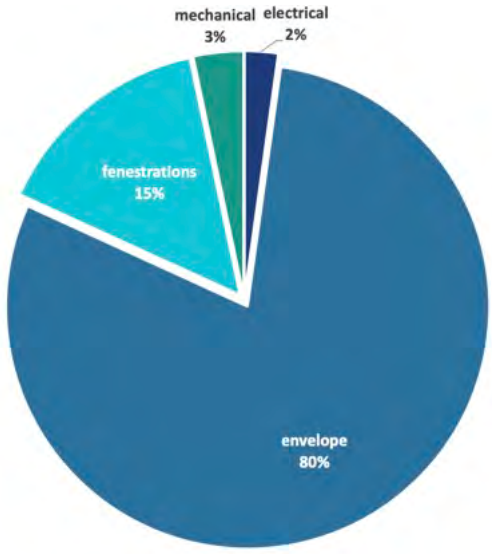
In Ontario, there is a 1MW limit on commercial net metered solar systems which is well over the amount of solar being proposed. In a net metering agreement, 100% of the excess energy generated from the solar array is put back on the utility grid and the consumers account is credited for the amount generated. This credit is applied against the amount of energy consumed to reduce the consumers power bill. With a net zero solar installation, the consumers bill would average zero dollars over the course of a year. Since 100% of the excess energy generated is configured to go back onto the grid, the solar array will be shut off in the event of a grid outage.

Construction Costs

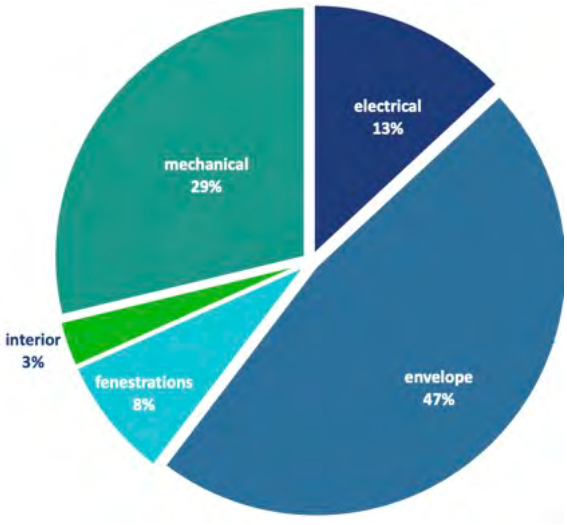
Class D – Feasibility Cost Estimates (Appendix M) were obtained for the Minimum Upgrade, the two Net Zero Energy Ready scenarios and Net Zero Energy retrofit scenarios. The costs include all materials, labour, equipment, overheads, general conditions, plus markups and contractor's profit for the retrofit options. Pricing reflects competitive bids for every element of the work for a project of this type procured under an open market stipulated lump sum bid contract in Debert, Nova Scotia.

A Class D estimate is an indicative estimate of the final project costs and is expected to be within ±25% of actual costs.

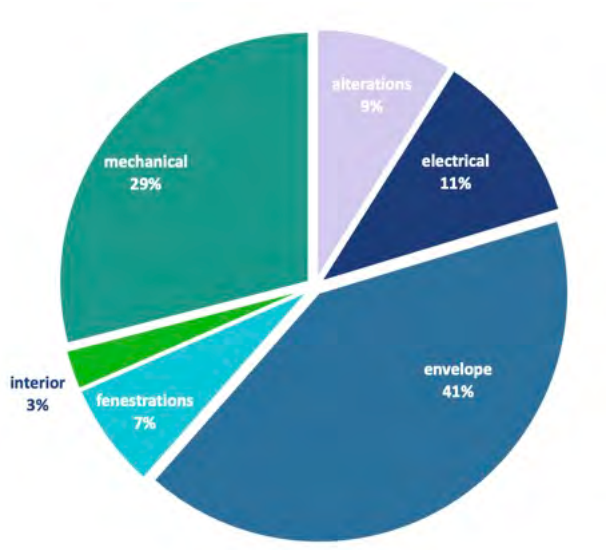
Minimum Upgrade	
Envelope	2,380,755
Fenestration	$444,565
Mechanical	$99,504
Electrical	$66,176
total	**$2,991,000**



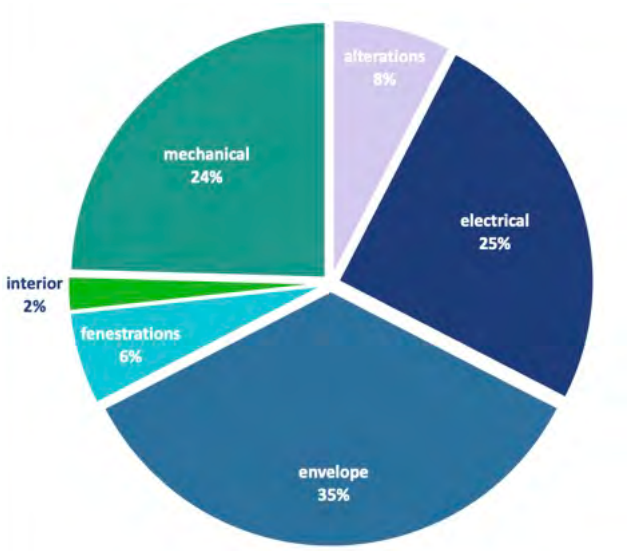
Net Zero Energy Ready ASHP	
Envelope	$2,643,505
Fenestration	$444,565
Interiors	$165,443
Mechanical	$1,608,597
Electrical	$730,892
total	**$5,593,002**



NZER GSHP	
Envelope	$2,643,239
Fenestration	$444,520
Interiors	$165,426
Mechanical	$1,860,996
Electrical	$730,819
Alterations	$574,003
total	**$6,419,003**



Net Zero Energy - GSHP	
Envelope	$2,643,479
Fenestration	$444,560
Interiors	$165,441
Mechanical	$1,861,165
Electrical	$1,894,302
Alterations	$574,055
total	**$7,583,002**



Total Cost of Building Ownership

Total Cost of Building Ownership (TCBO) analysis was conducted using the Sustainable Energy Efficient Facility Asset Renewal (SEEFAR)-Valuation© program. Calculations include costs for utilities, insurance, carbon tax, maintenance, maintenance capital (replacing major components as they age out), interest, and escalation of these costs over time. TCBO analysis typically includes property taxes, however the building is not subject to property tax. The input parameters for the SEEFAR-Valuation© are given in Appendix N.

The following tables present a comparative analysis of the existing **base case** TCBO and each of the retrofit scenarios explored by the design team. The base case TCBO was evaluated based on the current condition of the building and the maintenance and renewal that would be required for the next 60 years for all components of the building, including interior elements. The TCBO for each retrofit scenario was modeled based on the design details, modeled energy performance and construction cost estimates for the retrofit scenarios outlined in this report.

Table 5 TCBO Summary

	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
GHG emissions (kg) (60 Years)	5,810,144	1,869,799	325,130	315,764	0
EUI (kWh/m2/year)	435.4	217.0	113.4	110.1	0.0
TCBO at 60 years	**$34,646,000**	**$30,430,000**	**$30,182,000**	**$28,977,000**	**$24,430,000**
TCBO Savings at 60 years	$0	$4,216,000	$4,464,000	$5,669,000	$10,216,000
% diff. from Base Case	-	12%	13%	16%	29%

Key TCBO Results:

- The Burlington Seniors Centre is 43 years old and could last an additional 60 years if well-maintained. The TCBO model shows that it will cost over $30M to continue operations of the existing building for the next 60 years if the building does not undergo upgrades that improve thermal performance and reduce energy consumption.
- The base case TCBO is about five times the building's estimated Cost Replacement Value (CRV) of $7.2M.
- The Minimum Upgrade uses 50% less energy than the base case and saves 12% in TCBO.
- The NZER options use 75% less energy but save only 13-16% in TCBO.
- The lowest TCBO for the Burlington Seniors Centre is the NZE retrofit with a 29% reduction in lifetime operating costs and a savings of $10.2 M.

Table 6 Operating Cost Summary	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
Utilities (including carbon tax)					
Cost	$ 16,927,000	$ 10,416,000	$ 6,735,000	$ 6,547,000	$ 198,000
Diff. from Base Case	$ -	$ (6,511,000)	$ (10,192,000)	$ (10,380,000)	$ (16,729,000)
% diff from Base Case	0%	-38%	-60%	-61%	-99%
Energy Cost ($/ft2)	$ 822.96	$ 506.41	$ 327.44	$ 318.30	$ 9.63
					Maintenance
Cost	$ 285,000	$ 378,000	$ 390,000	$ 372,000	$ 1,097,000
Diff. from Base Case	$ -	$ 93,000	$ 105,000	$ 87,000	$ 812,000
% diff from Base Case	0%	33%	37%	31%	285%
Cost ($/ft2)	$ 13.86	$ 18.38	$ 18.96	$ 18.09	$ 53.33
					Insurance & Taxes
Costs	$ 518,000	$ 518,000	$ 518,000	$ 518,000	$ 518,000
Diff. from Base Case	$ -	$ -	$ -	$ -	$ -
% diff from Base Case	0%	0%	0%	0%	0%
					First Year Annual Maintenance
Cost	$ 2,450	$ 3,250	$ 3,350	$ 3,200	$ 9,428
Diff. from Base Case	$ -	$ 800	$ 900	$ 750	$ 6,978
% diff from Base Case	0%	33%	37%	31%	285%
Cost ($/ft2)	$ 0.12	$ 0.16	$ 0.16	$ 0.16	$ 0.46

The 60-year utility costs for the Base Case are two times the CRV of the building.

- The NZR options reduce the 60-year utility costs by over 60%.
- A NZE retrofit reduces the energy costs by 99%. The NZE option is still $198K because it contains water charges.
- The maintenance costs for the Minimum Upgrade and NZER options are all around $100K more than the Base Case. The NZE option is $1M because of the added maintenance costs of the solar panels ($5400 per year). This cost is more than offset by the $16M in energy savings over the life of the building.
- Insurance costs are the same for all options.
- Burlington does not pay property tax on the building.

Parameters:

- The analysis start year is 2024. Utility, construction, and maintenance costs have been escalated to 2024. Construction costs have been escalated by 20% for 2022-23, and by 10% from 2023-24, or 32% over the two years.
- Carbon tax has been applied to electricity.

Table 7 Capital Cost Summary					
	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
Initial Retrofit / HPB CostYear 1					
Initial Cost	$ 718,000	$ 3,630,000	$ 6,538,000	$ 7,418,000	$ 8,496,000
Diff. from Base Case	$ -	$ 2,912,000	$ 5,820,000	$ 6,700,000	$ 7,778,000
% diff from Base Case	0%	406%	811%	933%	1083%
Cost ($/ft2)	$ 35	$ 176	$ 318	$ 361	$ 413
Maintenance Capital Costs 60 Years					
Cost	$ 16,197,000	$ 15,488,000	$ 16,002,000	$ 14,121,000	$ 14,121,000
Diff. from Base Case	$ -	$ (709,000)	$ (195,000)	$ (2,076,000)	$ (2,076,000)
% diff from Base Case	0%	-4%	-1%	-13%	-13%
Cost ($/ft2)	$ 787	$ 753	$ 778	$ 687	$ 687
Retrofit / HPB + Maintenance Capital Costs 60 Years					
Total Costs	$ (16,915,000)	$ (19,118,000)	$ (22,540,000)	$ (21,539,000)	$ (22,617,000)
Diff. from Base Case	$ -	$ (2,203,000)	$ (5,625,000)	$ (4,624,000)	$ (5,702,000)
% diff from Base Case	0%	-13%	-33%	-27%	-34%

The Capital Cost Summary compares the first-year capital investment in maintaining the existing building with the construction costs for the retrofit scenarios. The capital costs for the retrofits have been escalated to 2024 values from the construction cost estimate. The retrofit costs are high because of the extensive building enclosure upgrades and new mechanical systems and solar PV.

Maintenance capital is the cost of replacing major building components as they wear or age out. For example, a boiler needs to be replaced every 25 years. The retrofits have reduced the maintenance capital costs because more durable and long-lasting materials were specified.

		Table 8 Annual Energy Consumption				
	Wpkw	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
Water	m3	300.00	300.00	300.00	300.00	300.00
Sewer Discharge	m3	-	-	-	-	-
Electric	kWh	354,452.86	284,017.00	216,753.00	210,509.00	210,509.00
Gas	m3	46,245.00	12,649.00	-	-	-
Heating Oil	Litres	-	-	-	-	-
GHG emissions	kg CO2 eq	96,835.73	31,163.31	5,418.83	5,262.73	-
Solar PV generated	kWh	-	-	-	-	210,509.00
Total	ekWh	832,317.86	414,723.33	216,753.00	210,509.00	-
Total	GJ	2,996.34	1,493.00	780.31	757.83	-
EUI	kWh/m2/yr	**435.41**	**216.96**	**113.39**	**110.12**	-

Key Results:

- Electricity consumption decreases in all retrofit scenarios.
- Total annual energy consumption decreases in the retrofit scenarios, and the Net Zero Energy scenarios have zero consumption.
- GHG emissions and EUI are reduced across all retrofit scenarios.
- The Minimum Upgrade reduces GHGs by 67% and EUI by 50%. This scenario maintains existing fossil fuel-based mechanicals which must be removed by 2040.
- The NZR options reduce GHGs by 95% and EUI by 75%.
- The NZE retrofit reduces GHGs and EUI by 100%.
- 96,836 kgCO_2e are prevented annually in the NZE retrofit.

Notes

- Natural gas mechanicals are included in the base case and minimum upgrade scenarios. Gas use must be eliminated by 2050.
- The solar photovoltaic array is sized to match the energy consumption for the GSHP option. The roof has more capacity for solar and could be a Net Positive building.
- Water consumption is based on pre-pandemic usage. This study did not consider plumbing upgrades related to water conservation efforts.

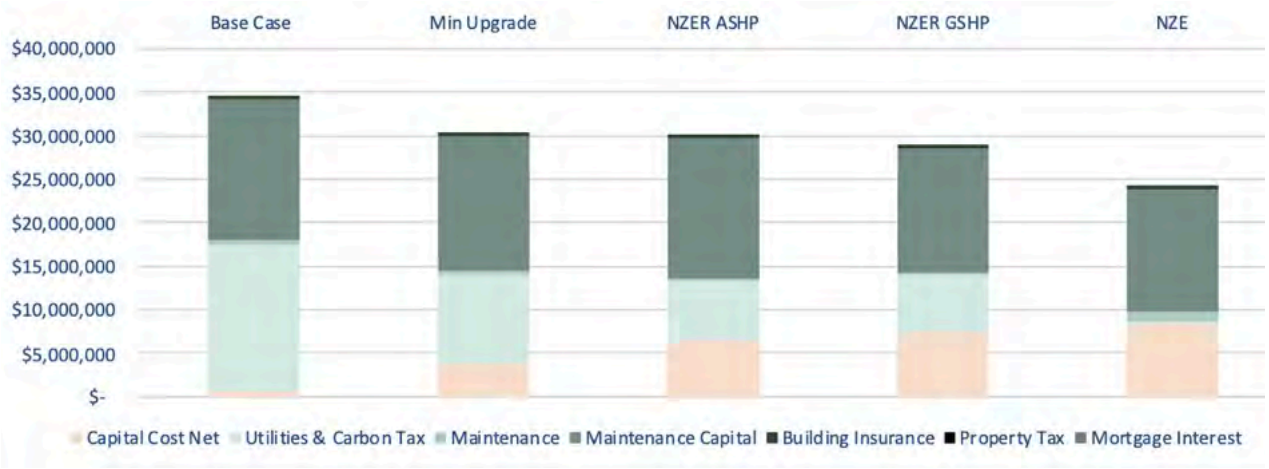


Figure 20 TCBO Comparison

Cumulative TCBO

Figures 21 and 22 compare the 60-year TCBO of the various retrofit scenarios.

The existing building has the lowest TCBO for the first 30 years, however the Net Zero Energy scenario has the lowest costs for the life of the building, a 29% reduction over the existing base case. Operational savings in the NZE Scenario exceed the retrofit costs by 34 years post-retrofit.

A Net Zero Energy retrofit achieves 100% GHG reductions and costs 29% less to operate than the existing building. With a 60-year savings of $10.2 M, the Net Zero Energy retrofit is the best investment for this building.

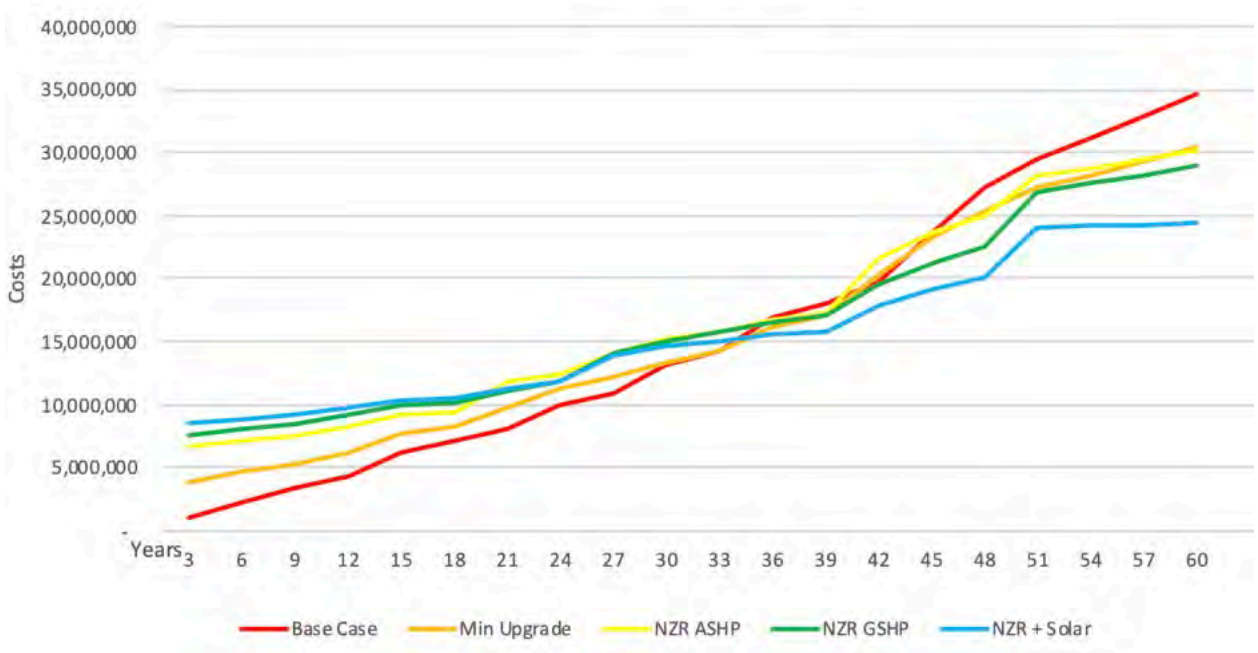


Figure 21 Cumulative TCBO

Discussion

The results of this project did not support the hypothesis, that substantial TCBO savings for municipal buildings could be achieved through Net Zero Energy retrofits by prioritizing high performance building enclosures, electrification of all systems and adding solar PV.

Burlington Seniors Centre uses 40% more energy than the average community centre in Canada[7] (excluding high EUI uses such as pools, ice rinks). It can achieve 100% GHG and EUI reductions and prevent nearly 100,000 $kgCO^2e$ from being emitted annually. It can't achieve that level of performance and expect a twenty-year return on investment; it will take 30 years before the savings from the retrofit cost less than the business-as-usual scenario.

Yet municipalities can't simply carry on with business as usual because our communities must be decarbonized. Return on investment can't be the driver of decisions if we are going to meet our net-zero goals. Making a financial case for electrification of buildings with natural gas-based HVAC is not easy, but this project will save the City of Burlington 29% in lifetime operating costs.

During this project the ReCover team met with several prefabricated panel manufacturers working in southern Ontario. These companies are keen to apply their skills to the retrofit problem. The first panelized retrofits are going to be challenging and costs will be high. We still need to start and to accept that the costs will be high until we get faster and more experienced. The industry is ready to start.

Burlington Seniors Centre is a promising demonstration project. Its geometry lends itself to panelization and by removing the existing brick and making use of the existing brick ledge the structural system is more straightforward than some of the other buildings in the study.

The Burlington Seniors Centre has undergone several incremental retrofits which were not completely effective at addressing concerns with comfort. A Net-Zero Energy retrofit will mean no more incremental retrofits will be necessary between now and 2050.

With the large number of buildings requiring retrofits in the coming decades, plans must prioritize completing comprehensive retrofits to every building only once on the path to net-zero.

[7] Energy Star (2021) Technical Reference. Canadian Energy Use Intensity by Property Type, https://portfoliomanager.energystar.gov/pdf/reference/Canadian%20National%20Median%20Table.pdf

Conclusions

This study of Panelized Deep Retrofits of Municipal Buildings was undertaken to develop deep retrofit strategies to support municipal decarbonization efforts by adapting the Energiesprong approach to the Canadian context.

The project goals were to develop deep retrofit scenarios that achieve 50% or more EUI savings and a scenario that can achieve Net Zero Energy (NZE) with the addition of solar PV. The solutions needed to minimize occupant disruption and embodied carbon. The recommended retrofit pathway would be the option with the lowest Total Cost of Building Ownership. Finally, the recommended solution should demonstrate a calculated payback of 20 years or better.

The technical details of the retrofit scenarios were straightforward. The economic targets were challenging and in the case of the 20-year payback, not one of the six proposed retrofits can achieve it.

The ReCover Initiative has studied the potential for prefabricated panelized deep retrofits in lo-rise multi-unit dwellings in two previous case studies[8]. These studies found the lowest TCBO over the anticipated life of the building was achieved through Net Zero Energy retrofits where the targets were met with an Energy Use Intensity (EUI) reduction of at least 75% before adding solar PV. This was not the result in the Panelized Retrofits to Municipal Buildings study.

While the results of this project were not expected, they do serve the objectives to de-risk investment in deep retrofits in Canada, to provide evidence on the effectiveness and scalability of a panelized deep retrofit approach and to build confidence and experience in deep retrofits among Canadian municipalities and industry stakeholders.

This study shows that the technical challenges are secondary to the overwhelming barrier of cost. It also showed that if investment in deep retrofits doesn't start now, municipalities will pay exponentially more down the road.

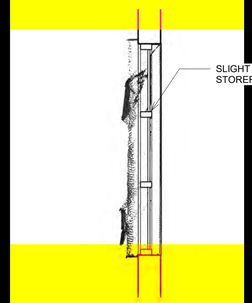
Deep GHG reductions are very achievable in municipal buildings. A Net Zero Energy retrofit to the Burlington Seniors Centre can prevent nearly 100,000 $kgC0_2e$ per year and save more than $10M for the City of Burlington. It will also halt decades of comfort issues for the building users and make the building more resilient, both physically and economically, in the decades to come.

[8] ReCover Initiative (2020) *ReCover Phase One Case Study Report* and ReCover Initiative (2022) *Scarlettwood Court Deep Retrofit Case Study Repor*t, https://www.recoverinitiative.ca/about-us/our-results/report-request

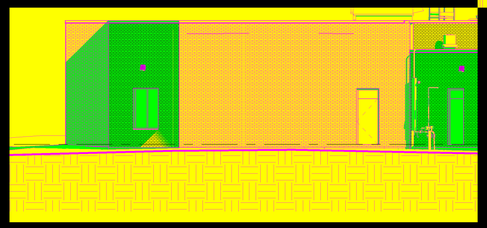
Appendix A

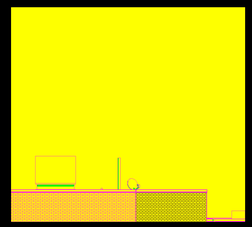
Pre-retrofit Drawings

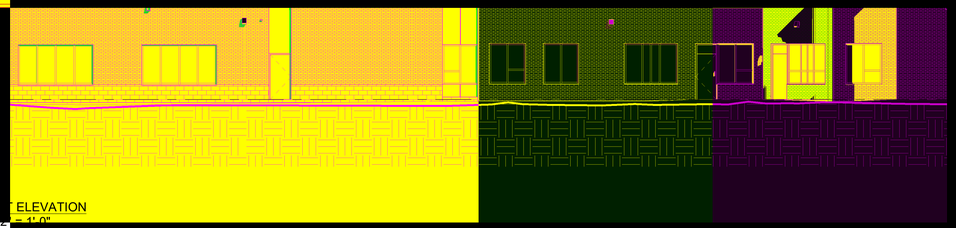
- **Existing Drawings**
- **LiDAR Drawings**



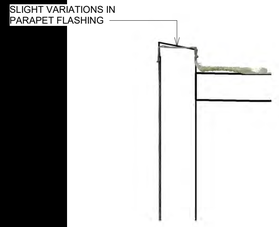
7 CALLOUT 1
3/8" = 1'-0"



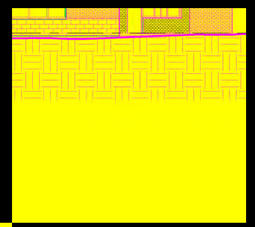


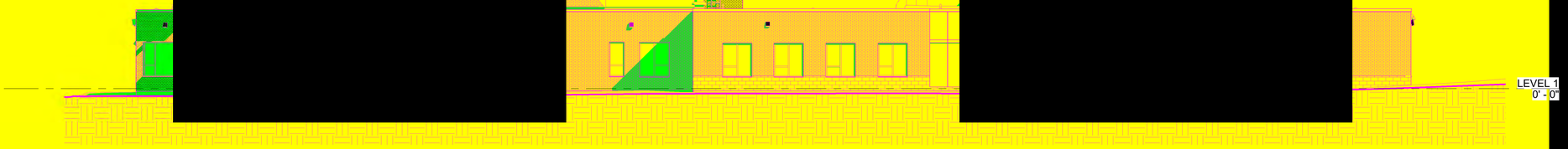


ELEVATION
= 1'-0"



5 SECTION 1
3/8" = 1'-0"





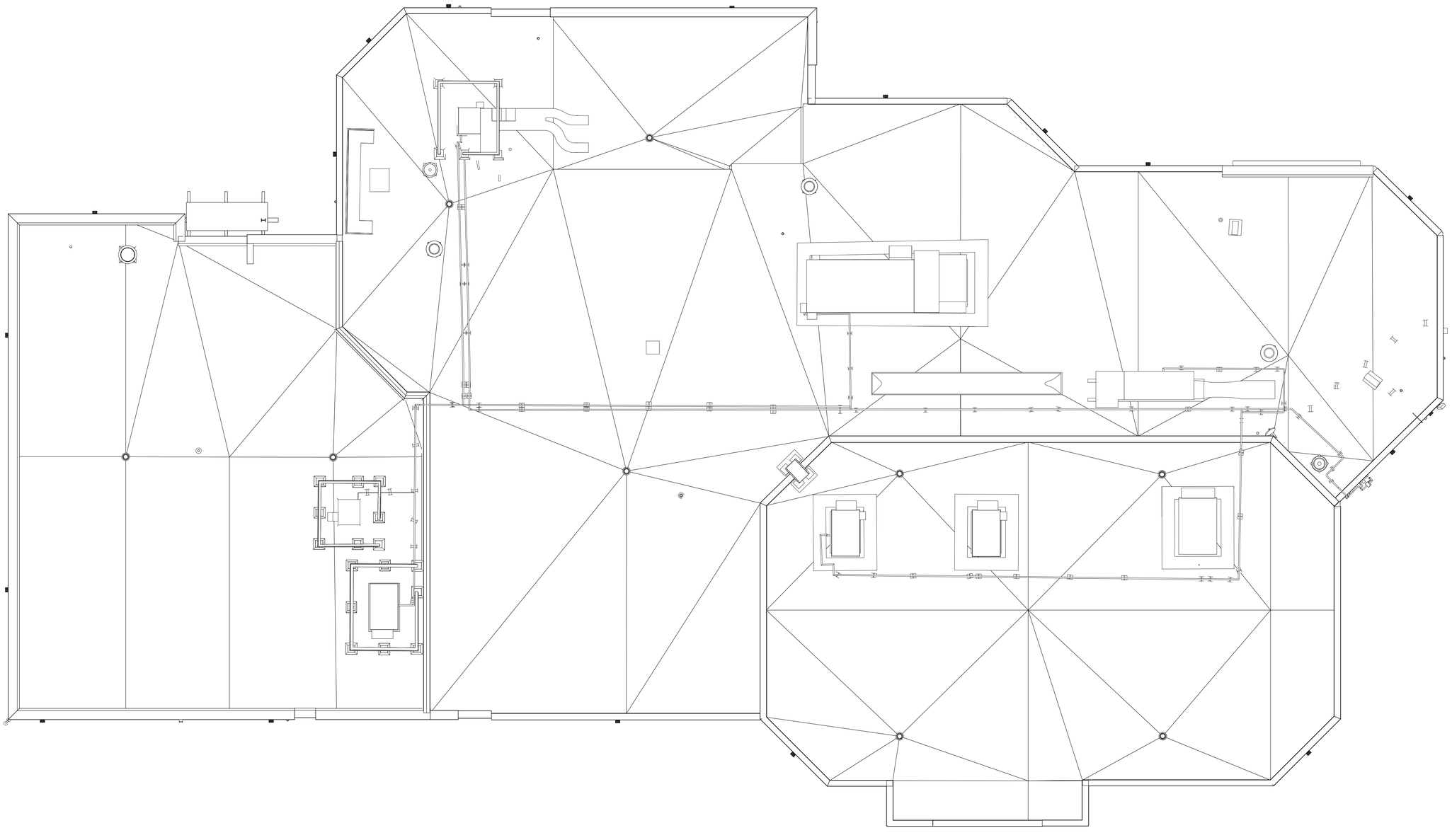
4 WEST ELEVATION
3/32" = 1'-0"

SMARTER SPACES

Smarter Spaces Inc. || smarterspaces.ca

2285 NEW ST - EXISTING CONDITIONS

A101



1 ROOF PLAN
1/8" = 1'-0"

SMARTER SPACES

Smarter Spaces Inc. || smarterspaces.ca

2285 NEW ST - EXISTING CONDITIONS

2285 NEW ST, BURLINGTON, ON

PROJECT NUMBER:	310-1626
FIELD WORK:	GH
DRAWN:	KM
AUDIT:	GH
SUBMISSION:	2022-07-26

ROOF PLAN

SCALE: 1/8" = 1'-0"

A102

Appendix B

Facility Condition Assessment

campus	name	ADDRESS1	name2	uniformat	description	LIFETIME	yearInstalled	RENEWALFY	renewalcost
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roof Drainage - Gravity - Average	D2040-Rain Water Drainage	Rain water drainage includes interior piping, roof drains and 4-inch discharge piping by gravity flow to a municipal main.	75	2007	2082	$55,129.89
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Fire Alarm System - Panel Only	D5037-Fire Alarm Systems	The fire panel at this building is Manufacturer: Notifier Inspection Date: 04/27/2017 IDC Style: Model Number: NFS-320C Install Date: 05/01/2009 SLC Style: Software Version: 12.003 Version Date: 05/01/2009 NAC Style: Y Location: 1st Electrical Current Protection: Fuse Auto Evac Time:	20	2009	2029	$15,633.21
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Main Electrical Service - Transformers	D5010-Electrical Service and Distribution	There is one step down transformer. It reduces power from 600V to 208V and rated at 45kVA.	50	2007	2057	$15,487.93
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exhaust System - Restroom w/Roof Fan Qty 4	D3042-Exhaust Ventilation Systems	HVAC ventilation system includes roof-mounted restroom exhaust fans with ducting. Four original exhaust fan units remain. Two of the original six were replaced when the building was expanded in 2006/07. Powerair X-hauster units - Mod. L01205 (1/6 HP)	20	2006	2026	$4,430.42
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Sanitary Waste - Gravity Disch	D2030-Sanitary Waste	The building includes an average sanitary waste system, of cast iron, copper and plastic piping, with gravity discharge to the municipal system.	50	1979	2033	$73,456.20
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Domestic Water Piping Dist Complete	D2023-Domestic Water Supply Equipment	The building domestic water system includes a 2 inch main line, with rough ins included. The piping is primarily copper. This includes the piping, control and shut off valves.	50	1979	2033	$48,891.40
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	RTU #1 - Port Nelson/Wellington Room	D3050-Terminal and Package Units	Trane RTU-1 M/N: YSC072AWRAZJC100AIAOA600 S/N: 633101377L Asset Details: 6 Tons, 575v, Heat Input 150000/Output 120000 BTU Notes: Serves the Port Nelson and Wellington Multipurpose rooms in the additional section of the building Note: RS Means line items do not exactly match the size of the units in the field. Quantities have been adjusted for budgetary purposes.	20	2007	2027	$23,632.28
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Eng Air Multizone Unit with 7 VAV box zones	D3050-Terminal and Package Units	The HVAC system includes 1 packaged rooftop units with gas heat and 40 tons of cooling. This is for the Engineer Air unit. The unit serves various sections of the facility which in 2017 has had an improved VAV box and related controls added to each zone throughout facility. This will create better air flow and balancing around site in a more energy efficient manner Multi-Zone Unit - Engineered Air Mod. FWB403/DJE-100-MO 700,000 BTU input. This unit services Dining Room, Boutique Room with Reheat, Billiard Room, Arts and Crafts Room, Games, Admin offices, Reception areas through VAV boxes. Tom P - 2017 Modifications made to duct work and rebuilding motors to improve performance and energy efficiency. Tom suggests 10 yr life extension as a result Note: RS Means line items do not exactly match the size of the units in the field. Quantities have been adjusted for budgetary purposes.	10	2017	2027	$260,842.91
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Main Electrical Service - 500A/480Y/277V	D5010-Electrical Service and Distribution	The building has a 500A 600V main electric service and disconnect that is a safety switch. On the main are the 2 transformers, building supply fan 1,2,3,4 and RTU1	45	1979	2024	$31,252.62
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Branch Wiring - Equipment & Devices	D5021-Branch Wiring Devices	Branch wiring includes outlets, switches, and wiring to all end use devices.	50	2007	2057	$71,761.18
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Distribution Equipment - Panelboards	D5010-Electrical Service and Distribution	There are four panelboards. All are rated at 120/208V at 225 A and feed outlets throughout the facility. There is one main distribution panel board rated at 600A at 120/208V. 2 located in the Maintenance Electrical Room and other 2 in storage room new section with battery packs.	45	1979	2024	$46,419.55
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Tankless Water Heater - Gas Qty 1	D2022-Hot Water Service	Natural gas tankless water heater with supporting storage tank(separate system). Original install 2011 and replaced in 2021 Navien Mod. NP-240A NG	10	2021	2031	$5,593.35

Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Natural Gas Supply for Bldg - 1 1/2" Feed	D3012-Gas Supply System	The building includes a natural gas supply and distribution system. The gas main is 1 1/2" in size and is distributed through black pipe to all devices.	50	2007	2057	$25,131.05
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	RTU 4 - Auditorium A	D3050-Terminal and Package Units	Trane RTU-4 M/N: YCD180BWLAHB S/N: 435101868D Details: 15 tons, Input 250000/Output 203000, 575v Notes: Serves the North side of auditorium, unit is located on rooftop on north end of raised section Note: RS Means line items do not exactly match the size of the units in the field. Quantities have been adjusted for budgetary purposes.	20	2007	2027	$31,981.88
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Drinking Fountains - 2010	D2018-Drinking Fountains and Coolers	Stainless steel water fountains installed in 2010. Replaced original porcelain wall mounted units in original section of the building.	20	2010	2030	$5,380.10
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exhaust System - RTU - Commercial Kitchen	D3065-Hoods and Exhaust Systems	The ventilation system includes a kitchen exhaust system, with welded duct and insulation. Make: Centri Master Model: PNU12ORG Serial No: NXA312007	20	2007	2027	$7,711.09
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Kitchen Hood Suppression	D4095-Hood and Duct Fire Protection	System includes a dry chemical fire suppression system for a commercial kitchen. Fire suppression includes fusible links, manual pull stations, 3 gallon tanks, nozzles, and control panels. Hood not included. Range Guard Mod. RG-2.5G	20	2001	2021	$10,142.08
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Lighting Fixtures - 2x4 Interior Space Lighting LED	D5022-Lighting Equipment	Lighting consists of recessed, surface mount, track, and specialty fixtures. Interior lighting is mainly comprised on 2x2 and 2X4 recessed fluorescent units with parabolic or acrylic lenses and led lighting There are 4 track light(3 bulb) units in Lounge/Cafeteria area also.	30	2007	2037	$50,168.25
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Main Electrical Service - Transformers - 1979	D5010-Electrical Service and Distribution	There is one step down transformer. It reduces power from 600V to 208V and rated at 150kVA.	45	1979	2024	$24,135.14
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Foundation Wall and Footings - No Basement 2007	A10-Foundations	At the newer portion of the building, the building's substructure includes cast in place concrete foundations, including strip footings or grade beams, and foundation walls of varying height. System includes damp proofing and underdrains.	75	2007	2082	$7,483.44
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Foundation Wall and Footings - No Basement 1979	A10-Foundations	At the original portion of the building, the building's substructure includes cast in place concrete foundations, including strip footings or grade beams, and foundation walls of varying height. System includes damp proofing and underdrains.	75	1979	2054	$11,011.24
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Structural Slab on Grade - Non-Industrial 1979	A1030-Slab on Grade	At the original portion of the building, the building's substructure includes a non-industrial type structural slab on grade.	75	1979	2054	$6,754.35
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	GWB Drywall Walls - Standard	C1010-Partitions	At the original portion of the building, interior walls include standard GWB partitions, taped and finished. See applied finish costs elsewhere.	50	1979	2033	$18,505.79
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Skylights - Dome Type	B3021-Glazed Roof Openings	Roof openings include a strip of small conjoined skylights, plastic dome type, with insulated curbs and presumed double glazing. Presumed original. with Roller shades for light level controls	30	2019	2049	$6,206.08
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Swinging Aluminum and Glass Doors Qty 2	C1020-Interior Doors	At the entranceway between the original and new portion of the building, the exterior doors include swinging glazed aluminum storefront-type doors, with hardware including closer and panic bar (where applicable). Quantities include inner vestibule doors of similar description.	30	2007	2037	$14,267.63
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Swinging Hollow Metal Doors - Qty 11	C1020-Interior Doors	At corridor and fire separations in the original portion of the building, interior doors include painted steel doors in painted steel frames, with hinges, lockset and closer. These doors separate the large auditorium, general purpose rooms, and kitchen from adjacent spaces. These doors are aged, lack fire ratings, and do not have appropriate or latching hardware in violation of OBC section 3.8.3.3. These doors should be replaced with new assemblies bearing the appropriate fire ratings with Barrier-Free and otherwise code compliant hardware.	40	2013	2053	$34,866.29
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Ceiling Tile System - Standard - 2007 - New Section Multipurpose Rm	C3030-Ceiling Finishes	In the addition portion of the building, at Multi-Purpose Room, ceiling finishes include suspended ACT ceiling system of 2'x2' or 2'x4' lay-in ACT tiles in grids.	25	2007	2032	$19,447.79

Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Structural Slab on Grade - Non-Industrial 2007	A1030-Slab on Grade	At the addition portion of the building, the building's substructure includes a non-industrial type structural slab on grade.	75	2007	2082	$3,019.29
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Ceramic Tile - washrooms (4)	C3010-Wall Finishes	Interior wall finishes include thin set ceramic tile, located at washrooms.	30	2007	2037	$16,272.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	CMU Block Walls 2007	C1010-Partitions	Throughout the older and newer portion of the building, interior partitions are composed of painted brick,concrete blocks. See applied finish costs elsewhere.	60	2007	2067	$79,913.89
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Commerical (Resturant) Kitchen Casework - Average	E1093-Food Service Equipment	At the Kitchen, the building includes average stainless steel casework including wall and undercounter cabinets and countertops, without appliances.	40	2016	2056	$36,638.44
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Brick Cavity Walls - CMU Backup 1979	B2010-Exterior Walls	At the original portion of the building, the exterior wall construction is brick cavity walls with CMU Backup.	75	1979	2054	$10,554.38
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Carpeting - Billiards Area	C3020-Floor Finishes	Carpeting in billiards area replaced during office administration renovation	12	2021	2033	$8,104.69
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Ceramic Tile - New Section Main Coordior and 4 Washrooms	C3020-Floor Finishes	Floor finishes include ceramic tile, primarily 12"x12" in size, located at all restrooms and the main corridor/entrance vestibule in new addition.	30	2007	2037	$66,076.76
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	CMU Block Walls 1979	C1010-Partitions	At the original portion of the building, interior walls include partitions composed of concrete block or other unit masonry (brick), painted. See applied finish costs elsewhere.	62	1979	2041	$118,053.55
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exterior Door HM 3x7 - 1979 - Qty 7	B2030-Exterior Doors	Doors at utility / service / emergency exits in the original portion of the building are hollow metal doors in metal frames without glass, including hardware. Doors from Kitchen and Meeting / Program Room are newer (see other systems).	30	1979	2023	$10,220.66
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Restroom - Complete	C1030-Fittings	Complete gang restroom including accessories, wall, floor, and ceiling finishes, lighting, exhaust and outlets. Fire alarm devices are not included. See plumbing fixture costs elsewhere. 1979 Toilets floor mounted and 2007 toilets are wall hung units	30	2007	2037	$186,291.80
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	GWB Finished Plaster Ceilings - 1979 Section	C3030-Ceiling Finishes	In the original building, at main corridor / common area, kitchen, Lounge, etc., ceiling finishes include GWB ceiling system, taped or plastered with smooth or textured finish, but not painted. GWB ceiling is presumably mounted on metal or wood furring or suspended. See paint or other applied finish costs elsewhere.	40	1979	2041	$54,625.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Single-Story - Steel 1979	B10-Superstructure	The superstructure at the original portion of the building is steel frame, steel roof deck on steel joists, beams, columns, and/or bearing walls.	75	1979	2054	$11,492.03
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Single-Story - Steel 2007	B10-Superstructure	The superstructure at the addition to the building is steel frame, steel roof deck on steel joists, beams, columns, and/or bearing walls.	75	2007	2082	$3,232.81
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Brick Cavity Walls - CMU Backup 2007	B2010-Exterior Walls	At the addition portion of the building, the exterior wall construction is brick cavity walls with CMU Backup.	75	2007	2082	$9,303.75
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Door Assembly - New Section - Sliding - Interior and Exterior Doors	B2031-Glazed Doors and Entrances	At the main entrance at the addition, the exterior doors include sliding glazed aluminum storefront type panels with glazed side panels, aluminum frame, hardware, including motor and sensors. Quantities include inner vestibule doors of similar description.	25	2007	2032	$28,076.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exterior Door HM 3x7 - 2007 - Qty 3	B2030-Exterior Doors	Doors at utility / service / emergency exits in the original portion of the building are hollow metal doors in metal frames without glass, including hardware. Doors from Kitchen and Meeting / Program Room are in the original portion of the building but are newer and included here.	30	2007	2037	$4,380.28
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roof Hatch w interior access ladder and access hatch roof top protection system - Qty 1	B3022-Roof Hatches	Roof openings include one roof hatch with insulated curb, providing access to roof level. The GRASP Hatch Guard is the perfect solution to the problem of an open hatch being viewed as an open pit/fall hazard. It acts as both a railing system around the open hatch, as well as provides hand grabs / ladder extensions for a worker as they ascend/decent the access ladder. Once again, our product is non-roof penetrating to minimize any roofing issues. Option 1 ? Approx. 24 l.f. of Modu-Guard Railing, Hot Dipped Galvanized $4, 125.00 (plus HST	40	2019	2059	$14,193.28

Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Swinging Wood Doors 2007 - Qty 13	C1020-Interior Doors	Throughout the addition portion of the building, interior doors are primarily solid core laminated wood doors in painted steel frames, with hinges, lockset and closer. Doors are equipped with lever-type hardware, and some doors are equipped with vision panels.	40	2007	2047	$25,949.63
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Swinging Wood Doors 1979 - Qty 10	C1020-Interior Doors	Interior doors include solid core painted or laminated wood doors in painted steel frames, with hinges, lockset and closer. Hardware varies.	40	1979	2023	$19,961.25
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Vinyl Sheet Floor - Multipurpose rooms (New Secton)	C3020-Floor Finishes	At Multi-Purpose room in the addition, floor finishes include faux-wood vinyl sheet goods flooring and related base.	20	2007	2027	$28,061.09
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Wood Slat Board - part of ceiling finish near main entrance - replacement with different substratrate and strucutre	C3030-Ceiling Finishes	Interior ceiling finishes include wood boards, stained, at main entrance and adjacent reception in the original building.	42	1979	2021	$10,261.70
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Ceiling Tile System - Enitre Site in Storage Rms. Offices Original Section of Site	C3030-Ceiling Finishes	In the original portion of the building, everywhere except main corridor / common area, Lounge, washrooms, Kitchen, ceiling finishes include suspended ACT ceiling system of 2'x2' or 2'x4' lay-in ACT tiles in grids.	25	1979	2031	$54,065.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Folding Partition Wall 1 - OS - Indian Wells / Freeman Rooms	C1013-Retractable Partitions	Folding Partition separation between Indian Wells and Freeman Rooms 24 x 9 ft	20	2007	2027	$16,183.01
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roof - Section 1.0 and 2.1 - SBS Modified Bitumen Roof - East Side 2011 Portion of Building	B30-Roofing	Roof inspections performed by Dycon Roofing Consultants Inc from Jan 30 2017. Sections 1.0 and 2.1 are SBS Modified Bitumen systems, which were replaced in 2011 by an unknown contractor. They appear to be in Very Good Condition and may provide reliable waterproofing for the next 10+ years. Total Area = 17238 sq ft	20	2011	2031	$343,629.19
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Custodial/Utility Sinks - Janitor Closet / Maintenence Room	D2014-Sinks	The plumbing fixtures include floor mounted custodial/utility sinks. Includes rough-in and faucet. Located in Janitorial Closet and Maintenance Room.	30	2011	2041	$12,928.75
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Emergency Eye Wash Stations - 2007	D2010-Plumbing Fixtures	Bradley eyewash stations installed during building expansion in 2007. Located in the Janitorial & Mechanical Rooms.	20	2007	2027	$2,189.33
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exhaust System - RTU - Kiln Room	D3064-Exhaust and Ventilating Systems	Roof-mounted exhaust fan with ducting located above Kiln Room, off the Arts & Crafts Room. Installed in May 2011. Make: Soler & Palau Canada Model: DB12QH1S Fan RPM: 1600 Motor HP: 1/2 Motor RPM: 1800 Motor Voltage: 115V	20	2011	2027	$2,754.65
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exhaust System - RTU - 2007 Expansion	D3064-Exhaust and Ventilating Systems	Roof-mounted exhaust fan with ducting located above facility expansion area. Installed in 2007. Make: Greenhack Model: 6-150-C-X Serial No: 10646985 0610	20	2007	2027	$1,686.45
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Hot Water Storage Tank - 80 Gallon	D2022-Hot Water Service	80 gallon capacity hot water storage tank installed in 2011 along with tankless water heater. Laars Mod. A0073100	13	2011	2022	$3,514.31
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roof - Section 2.2 - Built-Up Roof - Original Building Roof - West Side of Site	B30-Roofing	Roof inspections performed by Dycon Roofing Consultants Inc. Information imported by VFA on Jan 30, 2017. Roof Section 2.2 is a Built-up Roof (BUR) system, which is original to the construction of the addition performed in 2007. It appears to be in Good Condition and may provide reliable waterproofing for the next 6 to 9 years from 2017 Dycon Roof Condition Report. 4,663 sq ft Total Area = 4,747 sq ft	17	2007	2024	$91,028.96
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	RTU #2 CM07 that utlizes VAV boxes - Entrance Hall Way, Boardroom, Restroom Areas (New Section)	D3050-Terminal and Package Units	Trane RTU-2 M/N: 2YCC3024A1064AA S/N: 6332WGF9H Asset Details: 2 Tons, 208/230, Heating Input 64,000/ Output 51,500 BTU Notes: Serves the Entrance Hallway, Boardroom, Restrooms new section areas. Note: RS Means line items do not exactly match the size of the units in the field. Quantities have been adjusted for budgetary purposes.	20	2007	2027	$9,846.78
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	RTU #3 - Freeman Indian Point Room	D3050-Terminal and Package Units	Trane RTU-3 M/N: 2YCC3030A1075AA S/N: 6331MGH9H Asset Details: 2.5 Tons, 208/230V, Heat Input: 75,000/ Output 60,500 BTU Notes: This unit serves the Freeman Indian Point Room. Note: RS Means line items do not exactly match the size of the units in the field. Quantities have been adjusted for budgetary purposes.	20	2007	2027	$9,846.78

Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	RTU 5 - Auditorium B	D3050-Terminal and Package Units	Trane RTU-5 M/N: YSC120AWRHAOBVR S/N: 435100222L Details: 10 Ton, Heating Input 250000/Output 200000 BTU, 575V Notes: This unit serves the middle section of the auditorium and is located on the raised section of the rooftop Note: RS Means line items do not exactly match the size of the units in the field. Quantities have been adjusted for budgetary purposes.	20	2007	2027	$25,640.45
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	RTU 6 - Auditorium Stage	D3050-Terminal and Package Units	Trane RTU-6 M/N: Y32120AWPHOBVR S/N: 435100707L Details: 10 Ton, Input 250000/Output 200000 BTU, 575V Notes: This unit serves the staged section of the auditorium, and is located on the raised section of the buildings rooftop Note: RS Means line items do not exactly match the size of the units in the field. Quantities have been adjusted for budgetary purposes.	20	2007	2027	$25,640.45
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roof - Section 3.0 - Metal Roof Canopy - Front Entrances	B30-Roofing	Roof inspections performed by Dycon Roofing Consultants Inc. Information imported by VFA on Jan 30, 2017. Roof Section 3.0 in Dycon Report. Refers to the 84 sq ft small steel entrance canopy along the east side of the building	40	2007	2047	$20,767.60
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Building Automation System (BAS) - Software upgrade and System component renewals as needed	D3068-Building Automation Systems		10	2010	2020	$29,010.88
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exterior Lighting - Wall Pack LED 50 W	D5022-Lighting Equipment	The building includes LED exterior wall-pack fixtures.	30	2015	2045	$11,550.79
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Rubber Flooring - Pulastic 5+2 - Auditorium	C3020-Floor Finishes	The Auditorium floor is finished with Pulastic 5+2 type of flooring including 3 - 2" sockets, aluminum thresholds, 4" Johnsonite base for badminton net pole. Colour: #504 Stone Gray	20	2013	2033	$102,930.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Rubber Flooring - Pulastic 4+2 - Kitchen	C3020-Floor Finishes	The Kitchen floor is finished with Pulastic 4+2 type of flooring including vent cove base. Colour: #504 Stone Gray	20	2013	2033	$10,505.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Vinyl Composite Tile - Community Rooms x 9	C3020-Floor Finishes	At Janitor Room, Board Room, Program, Computer Room, Indian Point Room, Freeman Room, Games Room and Arts & Crafts Room floor finishes include areas of standard VCT flooring and related base.	20	2007	2027	$13,841.40
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Ceramic (Quarry Style) Tile - Original Main Cooridor and office kitchenette	C3020-Floor Finishes	The older building corridors and kitchen storage room still has the original quarry tile floor finish. The staff kitchen also has the orignal 2" x 2" quarry tile.	45	1979	2024	$49,140.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Painted / Sealed Concrete	C3020-Floor Finishes	The floor finish of Kiln, Mechanical and Electrical Room flooring is made up of sealed concrete.	40	1979	2040	$10,412.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Windows 8' Wide Aluminum Framed	B2020-Exterior Windows	Windows included in this system are two 8' wide located at dinning room and one 6' wide located behind the stage in auditorium. The windows are double glazed, insulated, aluminum frame with awning style small openning.	30	2011	2041	$17,263.93
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Aluminum Framed Windows 4' Wide	B2020-Exterior Windows	This system includes six 4' wide windows out of which four are located at Indian Point Room and Freeman Room, one located at Board Room and one located at Auditorium on the badminton court side. The windows are double glazed, insulated, aluminum frame.	30	2011	2041	$7,398.83
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Windows 6' Wide- Alumium Framed	B2020-Exterior Windows	This system includes four 6' wide doubly glazed, insulated, aluminum windows out of which two are located at badminton court side of the Auditorium, one at Games Room and one at General Purpose and Boutique.	30	2011	2041	$56,215.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Back Flow Preventers - DCVA- 2"	D2023-Domestic Water Supply Equipment	The building has back flow preventer installed on the water main. Type - DCVA - Watts 007MI QT D.C. 2" -Serial # A07079	35	2006	2041	$4,258.94
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	HVAC Ductwork	D3040-Distribution Systems	The building addition includes duct work distribution. Note: RS Means line items do not exactly match the size of the units in the field. Quantities have been adjusted for budgetary purposes.	40	2007	2047	$48,110.11

Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Security System - CCTV System - Entire System	D5038-Security and Detection Systems	A CCTV system is installed to monitor the facility with cameras mounted at multiple strategic locations. The system includes main control, stationary and motorized cameras, UPS, wiring and conduit. System includes: DVR/NVR: 16ch 1TB DVR Camera Type: 1x PTZ, 8x Outside Dome, 1x Vandal Dome Power Supply : 12V DC Monitor: Y UPS: 1 unit	10	2011	2043	$31,284.64
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Security System - Intrusion Alarm System	D5038-Security and Detection Systems	The building includes a typical intrusion alarm security system. The security system includes : Controller/Expanders/Wireless Communicator: 1x 8 zone controller, 3 x 8 zone expanders, 1x Wireless Communicator Keypads: 2 Doors: 8 Motions: 13	20	2011	2043	$5,609.39
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Hydro Transformer - BH - D204	G-Building Sitework	Burlington Hydro Transformer ID# D204 Installed 12-07-1978 Type - WYE - 3 Phase Pad Unit	40	1978	2018	$-
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Folding Partitions Unit 3 - OS Auditorium - Qty 2	C1013-Retractable Partitions	The Auditorium A and B Rooms of the building interior includes motorized folding partitions which sub-divide the auditorium. 2 units motorized 40x12	20	2014	2034	$66,708.59
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Folding Partition Wall 2 -OS - MultiPurpose and Boutique Rms	C1013-Retractable Partitions	Folding Partition separation between General Purpose and Boutique Rooms - 40x9 ft	20	2014	2034	$16,183.01
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Folding Partition Wall 4 - NS - Port Nelson / Wellington Rms	C1013-Retractable Partitions	Folding Partition separation between Port Nelson and Wellington Rooms 40 x 9 ft	20	2014	2034	$16,183.01
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Lighting Fixtures - 2x2 Interior Space Lighting LED	D5022-Lighting Equipment	Lighting consists of recessed, surface mount, track, and specialty fixtures. Interior lighting is mainly comprised on 2x2 and 2X4 recessed fluorescent units with parabolic or acrylic lenses and led lighting	30	2007	2037	$16,722.75
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Lighting Fixtures - Pot Lighting Common Areas Space Lighting LED	D5022-Lighting Equipment	Lighting consists of recessed pot lighting with retrofit to LED bulb in common space and lounge mostly.	30	2007	2037	$18,692.63
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Lighting Fixtures - Globe Lighting Billards Lighting LED	D5022-Lighting Equipment	Lighting consists of specialty fixtures with globe glass for dim billiards area lighting. .	40	1999	2039	$61,316.75
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Lighting Fixtures - 4ft Track Lighting in Lounge	D5022-Lighting Equipment	There are 4 track light(3 bulb) units in Lounge/Cafeteria area also.	30	2007	2037	$1,461.40
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exterior Lighting - LED Pole mounted 20 ft lighting	D5022-Lighting Equipment	6 Parking lot led lighting supplied by King Luminaire metal panted posts with nautical look and these 6 serve the Seniors central front parking area	20	2015	2035	$92,664.75
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roll Up Security Door - 8 x 4	C1026-Interior Hatches and Access Doors	Coiling Security doors 8' L x 4' H manually operated in Kitchen Areas. Cookson Rolling Doors	40	2007	2047	$10,721.95
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Workstation Furniture including Chair	E1018-Office Equipment	Average workstation unit which includes on average filing, work surfaces, wall panels, chair, electrical and data connections and carpet tile flooring	15	2007	2043	$75,676.21
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Kitchen Equipment - All equipment	E2010-Fixed Furnishings	The equipment in the main kitchen space at the Burlington Seniors Centre includes the following: 2 - Stainless Steel preparation table 1 - Countertop dishwasher 1 - Set Stainless Steel countertop and metal cabinetry estimated 10 ft long where dishwasher is situated 1 - gas oven with 6 burners 1 - griddle 1 - spring air system exhaust system with 4 sprinkler heads 1 - Stainless steel with cabinetry below by main counter est 15 ft length 1 - Countertop toaster 1- Microwave 1 - Commercial Fridge	30	2000	2030	$36,308.03
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Flag Pole	G2048-Flagpoles	Metal flagpole with Canadian Flag	30	2007	2037	$4,634.78
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roller Window Shades	E2013-Blinds and Other Window Treatment	Roller Shade window treatments	20	2010	2030	$33,581.25
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exterior Metal Furniture	E2010-Fixed Furnishings	1 Rain shelter, 1 bench and 1 bike rack of all cold rolled galvanized metal tube product.	25	2007	2032	$10,793.88
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Metal Panel Features	B2010-Exterior Walls	At the addition portion of the building, the exterior wall construction is brick cavity walls with CMU Backup.	60	2007	2067	$8,725.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Exterior Lighting Controls Panels	D5022-Lighting Equipment	Exterior Lighting control panels with relays and connections to BAS also.	40	2007	2047	$15,000.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Red Sound Accoustical Panels- Auditorium and behind Reception	C3010-Wall Finishes		30	2007	2037	$16,937.50
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roof Top Ladders Qty 1	B1029-Other Roof Systems	Roof openings include one roof hatch with insulated curb, providing access to roof level.	30	2019	2049	$7,872.53

Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Make Up Air 1 - Kitchen	D3050-Terminal and Package Units	MAU - 1 installed over kitchen area. Engineered Air Unit Model no:FWE52/HE20/O Contains see attached details from Tom P (PM) for more details: 2 Compressors 1 Condensor Fan 1 Supply Air Fan	20	2017	2037	$59,825.47
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Emergency Light Units	D5092-Emergency Light and Power Systems	Emergency Light, Combination Beghelli 5 Emergency Light, Combination Lumacell 6v36w 1 Emergency Light, Power Unit Beghelli RG24S2720 1 Emergency Light, Power Unit Flag Fire 2 Emergency Light, Power Unit Lumacell 2	20	2007	2027	$9,749.25
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Fire Alarm - Devices Only	D5037-Fire Alarm Systems	The building has an addressable fire alarm system that includes the head end/main control panel, pull stations, smoke detectors, and bells. Pull Station 10 Horn/Strobe 1 Heat Detector 19 Smoke Detector 2	20	2000	2043	$13,077.09
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Security System - CCTV System - DVR only	D5038-Security and Detection Systems	A CCTV system is installed to monitor the facility with cameras mounted at multiple strategic locations. The system includes main control, stationary and motorized cameras, UPS, wiring and conduit. Per a Capital Budget meeting with R Lawrence and D Gauley these units are to be set at 7 year renewals at a budget of 10 k System includes: DVR/NVR: 16ch 1TB DVR	7	2018	2025	$8,756.65
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Illuminated Wall Mounted Building Sign	G2044-Signage	This consist of an illuminated and non illuminated signs at the entrance. Price is based on reused of exisiting illumination of signage. 30 x 20 sign.	30	2018	2048	$7,229.58
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Roof - Section 4 - Shingled Roof - Shed/Garbage Building Roof	B30-Roofing	Roof Section 4.0 is a Shingled Roof system, which is original to the construction of the Shed/Garbage Building. Replaced by Dave Currie in 2018 and not captured in 2017 Roof Assessment Total Area = Estimated 400 sq ft	20	2018	2038	$7,539.84
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Non Illuminated Building Wall Mounted sign	G2044-Signage	This consist of an illuminated and non illuminated signs at the entrance. Price is based on reused of exisiting illumination of signage.	30	2010	2040	$2,891.84
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Wayfinding Interior Signage	E2010-Fixed Furnishings	Interior building wayfinding signage for client and user directional assistance when on site. Usually posted on each room and space. Including common area directional assistance signage./	20	2010	2030	$3,614.75
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Mondo Sport Rubber Floor - Dining Room (Lounge and Card Room)	C3020-Floor Finishes	In Lounge and Card Room floor finishes include faux-wood vinyl sheet goods flooring and related base. pricing also included removal of existing carpeting, repairs to subflooring and minor prep.	20	2018	2038	$16,122.67
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Carpeting - Administrative/Customer Reception Area	C3020-Floor Finishes	At office and administration areas finish of carpet tile by BAVCO construction and baseboards.	12	2006	2020	$11,637.50
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Automatic Door Operators - Washrooms - Qty 4,Gymansium 1	C1020-Interior Doors	Pricing is from 2018 renewal about 2000 per unit per Chris Jarvis from work at Burlington Seniors centre. Beleved Group 87 installation.	15	2018	2033	$14,036.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Automatic Door Operators - Qty 5 - Gymnasium, Washrooms	C1020-Interior Doors	Pricing is from 2018 renewal about 2200 per unit per Chris Jarvis from work in the 4 restrooms and gymnasium door.	15	2018	2033	$14,036.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Painting - Complete Repaint of Entire Interior Areas (not including Gym/Aud portion of site)	C30-Interior Finishes	Funding for the repaint of the entire interior area of site including all preparation, covering, doors, trims etc on a 10 year cycle. This would funding outside of the operational dollars used for touch ups throughout sites annually. Budgets estimates from average cost to paint Community Centres, Arenas and other public site as provided by Northern Painters - Mike Connor - 2018.	10	2010	2029	$23,232.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Painting - Complete Repaint of Entire Auditrorium and Gymasium Ceilings, Walls and Misc Areas	C30-Interior Finishes	Funding for the repaint of the interior area of auditorium/gymnasium including walls, ceilings etc of Gymnasium site including all preparation, covering, doors, trims etc on a 10 year cycle. This would be best scheduled as per Parks and Recreation seasonal shutdowns and year is estimated of last completion taken from Oct 2018 meeting with Parks and Recreation Supervisors	10	2010	2025	$12,724.04

Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Door Assembly - Sliding - Original Section Interior and Exterior Sliders	B2031-Glazed Doors and Entrances	At the main entrance at the addition, the exterior doors include sliding glazed aluminum storefront type panels with glazed side panels, aluminum frame, hardware, including motor and sensors. Quantities include inner vestibule doors of similar description.	25	2007	2032	$28,076.00
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Acoustical Baffling - Billard Area	C3010-Wall Finishes	The installation of the following by the Quiet Room.ca in 2021- see attached invoice from C Jarvis TQR Acoustical panels	20	2001	2021	$8,045.17
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Lighting Fixtures - Interior -18- 2x2 Flat Panel LED - Indian Point and Freeman Room	D5022-Lighting Equipment	Interior lighting consists of 2x2 Sylvania LEDVANCE Edge Lit Panel LED lighting 4000k, 32W,Dimmable White 120-277V	30	2019	2049	$4,876.44
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Ceiling Tile System - Port Nelson and Wellington Room Original Section of Site	C3030-Ceiling Finishes	In the original portion of the building, everywhere except main corridor / common area, Lounge, washrooms, Kitchen, ceiling finishes include suspended ACT ceiling system of 2'x2' or 2'x4' lay-in ACT tiles in grids.	25	2019	2044	$8,128.12
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Acoustical Baffling - Lounge Area	C3010-Wall Finishes	The installation of the following by the Quiet Room.ca in 2019 - see attached invoice from C Jarvis Celing 1-2x10 1-3x10 1-3x8 1-4x8, 2-4x10, 1-4x12all TQR Acoustical panels Wall - 2 - 2x8 TQR Acoustical panels	20	2019	2039	$6,895.86
Parks & Recreation	Burlington Seniors' Centre (DD 2040)	2285 New St.	Kitchenette - Port Nelson and Wellington Rm and - Qty 2	E2012-Fixed Casework	There are 2 kitchenette units. These include countertop, base cabinets, sink and faucet. The units are located in the following rooms: -Wellington Room -Port Nelson Room	20	2019	2039	$12,108.36

Appendix C

Structural Outline Specification

BURLINGTON SENIORS CENTRE RECREATIONAL BUILDING

Building Use and Occupancy

The Burlington Seniors Centre is a single-storey community recreation building located at 2285 New Street in Burlington, Ontario. The structure is owned and operated by the City of Burlington. It is our understanding that the existing building consists of an original structure, designed in 1978, and a single-storey addition at the northwest side of the building, designed in 2005. An aerial view of the building noting the different building sections is shown in Figure 1.

Figure 1: Burlington Seniors Centre roof areas.

As the building's primary use is a community recreation centre, the structure is categorized as a High Importance building as per Sentence 4.1.2.1.(3) in the 2015 edition of the National Building Code of Canada (NBCC). A High Importance building is defined as:

> "Buildings that are likely to be used as post-disaster shelters, including buildings whose primary use is:
> - As an elementary, middle, or secondary school
> - As a community centre
>
> Manufacturing and storage facilities containing toxic, explosive, or other hazardous substances in sufficient quantities to be dangerous to the public if released."

High Importance structures are subject to higher environmental loading, including snow, wind, and seismic loads, than a normal importance building. It is conceivable that a municipally owned community building with large open spaces would be used for a public shelter in post-disaster conditions.

Structural Analysis

Foundation System & Above Grade Walls

The foundation of the original structure and expansion consists of 8" and 12" concrete masonry unit (CMU) block walls on cast-in-place concrete strip footings. All exterior footings are 24x12" and are reinforced with two (2) #4 bars longitudinally, with #3 bars at 12" transverse bars.

Above grade structural walls also consist of 8" and 12" CMU block walls. Based on available design information, all wall corners are reinforced with one #6 reinforcing bar in a grout-filled cell in the original 1978 building structure. There is a table on the original structural design drawings with multiple options for distributed seismic reinforcement throughout the masonry walls, in addition to a note that reinforcement may not be required is the Structural Engineer can demonstrate that the masonry can resist seismic forces without reinforcement. There are no clear details available to suggest what reinforcing, if any, is present in the structural masonry. Accordingly, select invasive investigations may be necessary to locate grout/reinforcing in the CMU voids.

Based on a preliminary assessment, there is additional capacity in the masonry walls to accommodate additional vertical load based on a uniform distributed load analysis. However, this capacity is dependant on the connection of both the wall panels and roof panels. Exterior walls are subject to combined axial and lateral load, and the magnitude/concentration of these loads is dependent on how the load is distributed from the panels to the walls. If load is concentrated in specific areas, additional reinforcing and grout may be required in the CMU voids.

Roof Structure

The roof structure generally consists of a system of pre-engineered open web steel joists (OWSJs) bearing on CMU walls. There are also select structural steel beams supporting the OWSJs. There are design dead loads on the original 1978 structural drawings that specify the following roof loads:

- Dead: 25 psf / **1.20 kPa**
- Snow: 40 psf / **1.92 kPa** + additional snow drifting at walls / RTUs.

Additionally, there is a roof area load of **2.04 kPa** (plus additional snow drifting values) specified on drawing S3 – Roof Framing Plan in the 2005 structural drawings for the building expansion. It is indicated in the General notes that design live loads are indicated on the drawings. Accordingly, it has been assumed that the 2.04 kPa is the unfactored design snow load, excluding dead load from the roof assembly.

It is not possible to deem the trusses satisfactory based on past performance as per NBCC Structural Commentary L since it cannot be argued that loading would not increase as a result of the retrofit. Accordingly, the building upgrade must be assessed under the design loading of the current edition of the National Building Code of Canada. Notably, the *unfactored* design snow load for a high-importance, flat roof structure in Burlington, ON is **1.47 kPa**. Based on the assumptions detailed above, the maximum *factored* gravity load for the roof members, excluding snow drifting, is **3.71 kPa**. Based on this initial assessment, there may be some reserve capacity in the joists based solely on design loading.

It is crucial to note that further inspection of the joists and review of available shop drawings is recommended in order to verify these assumptions and accurately quantify the design loading on each joist. It is also important to note that at the time of the design of the original building, design codes and standards in Canada were shifting from an Allowable Stress Design (ASD) approach to a Limit States Design (LSD) approach. Prior to the introduction of LSD design, design loads were not factored. Instead, a code-prescribed safety factor was

employed in design. Accordingly, it is difficult to directly compare the "design" load values from the original drawings to modern code requirements.

Although it is possible to evaluate individual members within the truss (if site measurements are taken), it is difficult, if not impossible, to document the capacity of existing welds at all panels points. These trusses are typically optimized based on design loads and as such, rarely have additional (reserve) capacity to accommodate future increases in load. It should be noted that OWSJ evaluation/rehabilitation is recommended to be undertaken by the joist manufacturer only as each OWSJ is a proprietary fabricated truss.

Summary and Recommendations

Overall, based on photos provided to DesignPoint and a preliminary assessment of the existing building, the existing structural system appears to be performing to a satisfactory level with no signs of structural fatigue or failure. A thorough "arms length" structural inspection is recommended to confirm these findings and identify any signs of fatigue or failure, especially at openings in the existing masonry walls.

Based on a preliminary review of available information, the CMU walls are adequate to support the existing gravity and lateral loads, so long as the main structural walls have not been modified in the decades since construction (i.e. cutting holes in masonry for new openings). The installation of wall panels will not increase the overall magnitude of the lateral load, but the distribution of out-of-plane lateral forces (i.e. wind) to the walls will be modified based on the proposed panel connection details. It is understood that the walls will be panelized with a two-course high system consisting of 10'-0" tall base panels, requiring a connection to the CMU wall between the existing floor slab and roof diaphragm to avoid a hinge point where the panels are joined. Accordingly, where the exterior walls would have initially been designed for a unform area wind load, the installation of the panels will transform this area load to a linear load at the joint between the bottom and top course of panels.

The proposed panels will distribute wind load to the existing foundation and roof diaphragm, as well as to the panel connection point at 10' above the panel base. Based on a review of original architectural drawings, the underside of the roof deck height typically varies between 13' and 17'. As a result of the panel installation, half of the exterior wind loading will be distributed directly to the roof and foundation, with the other half concentrated at the panel to wall connections. This modification will reduce the overall out-of-plane wind load seen by the CMU walls. A schematic of this loading change is illustrated in Figure 2.

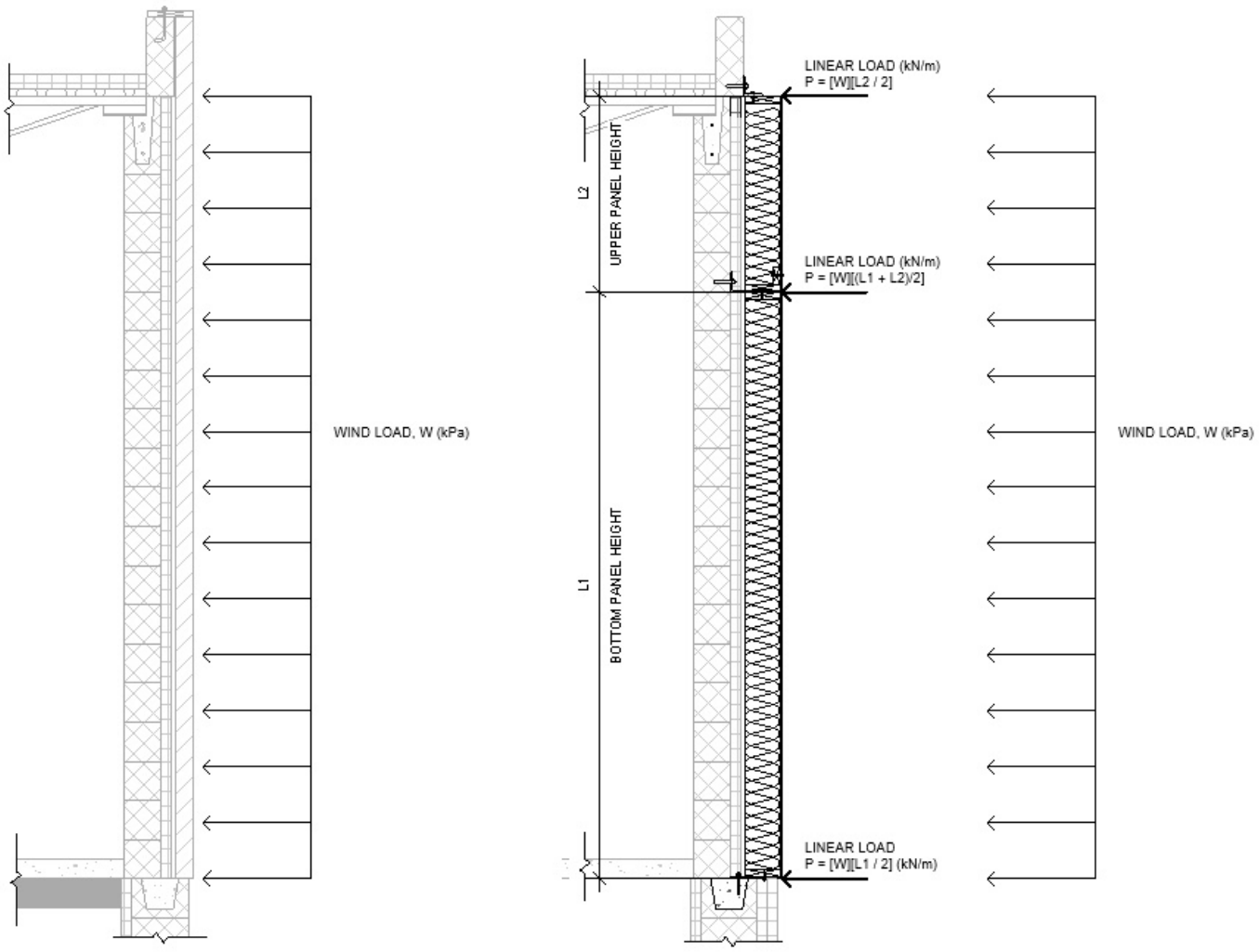


Figure 2: Wind load path with and without panels.

As this constitutes a change in load path, the existing CMU walls must be analyzed as per current NBCC loading requirements to confirm their adequacy. As per NBCC 2015 Appendix L, satisfactory past performance cannot be relied on when the load path in a structure is modified. A detailed investigation may be required to confirm the presence of reinforcing bars and grout in the exterior walls to facilitate this analysis.

It is understood that the existing 4" brick veneer will be removed, allowing the proposed wall panels to sit on the existing brick ledge on the foundation wall. A proposed panel to foundation connection is shown in Figure 3. This connection is designed to transfer out-of-plane bending forces only. In-plane wall bending (i.e. shear wall action) will be resisted by the existing CMU walls. Gravity load from the roof will not be transferred to the panels.

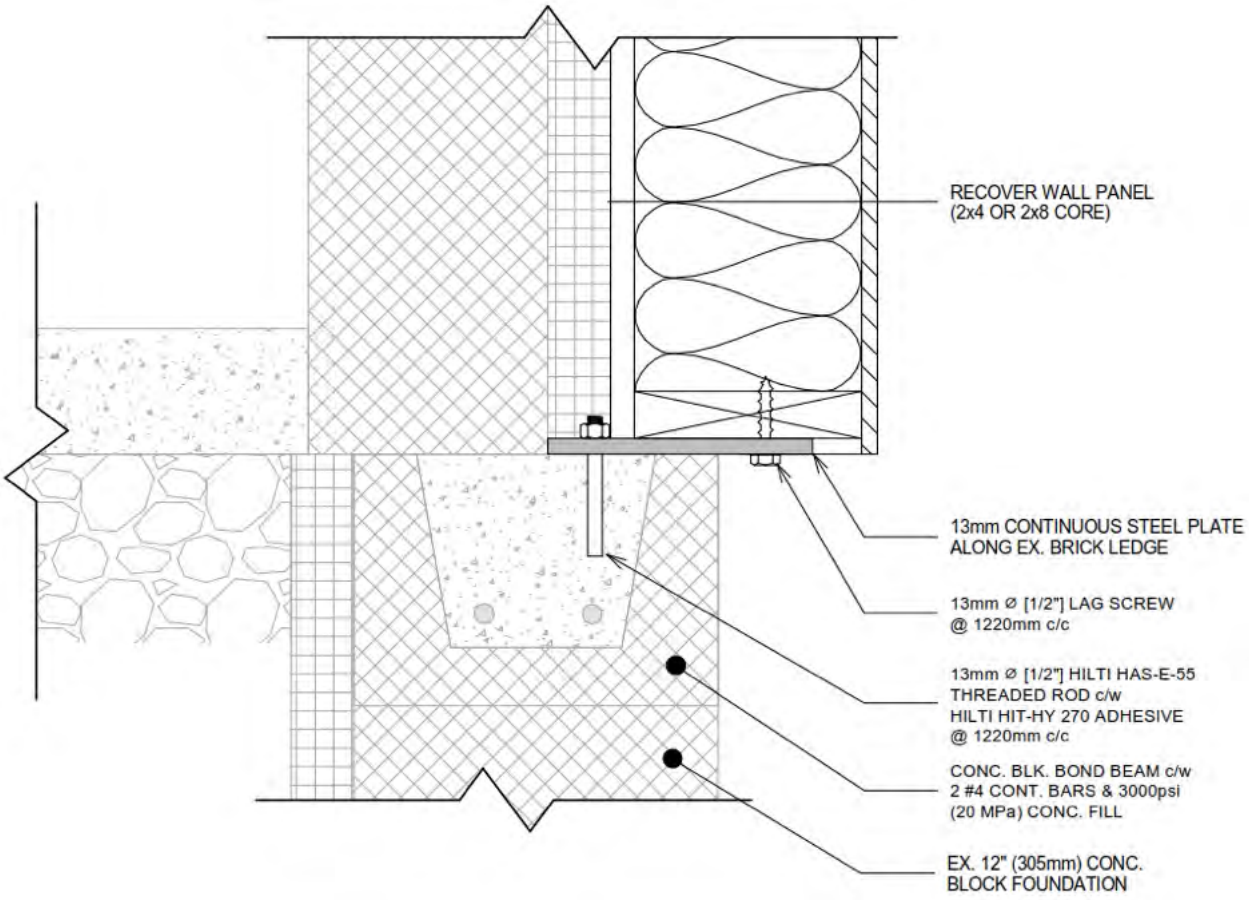


Figure 3: Panel connection at wall base.

Based on original design drawings, the top of the exterior walls consists of a 6" CMU parapet constructed on top of the primary 8" CMU wall structure. We have proposed 102mm long pieces of structural steel angle be installed to fasten the top plate of the wall panels to the existing structure at the roof diaphragm with field-installed masonry anchors and lag screws fastened to the parapet wall and panel top plate, respectively. A proposed wall panel to roof connection detail is shown in Figure 4.

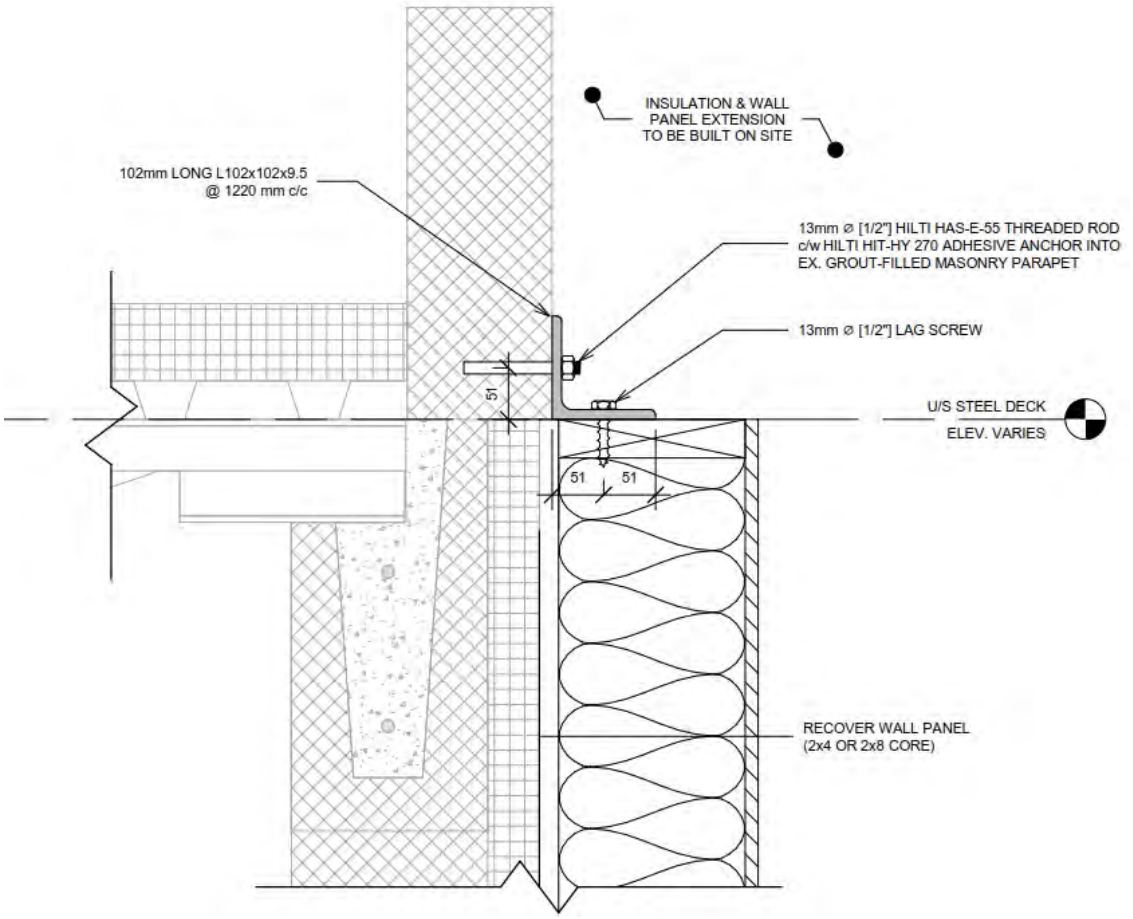


Figure 4: Panel connection at existing roof diaphragm.

Prior to proceeding with any installation of roof insulation, we recommend an inspection of the existing roof structure to identify joist tags or other identifying information on the roof OWSJs. Original manufacturer's design drawings, especially for the newer portion of the building, may be available for review. As discussed, without design information, it is very difficult to accurately quantify the strength of joists as member cross sections are often non-standard, proprietary shapes unique to each manufacturer. Moreover, without design information, it is difficult to quantify the strength of the welded connections without a costly and detailed joist inspection. It is not possible to deem the roof structure satisfactory based on past performance as per NBCC Structural Commentary L if additional roof insulation is added since it cannot be argued that loading would not increase as a result of the retrofit. Increasing insulation would potentially decrease snowmelt and increase the snow load on the roof compared to the snow load that it has satisfactorily resisted in the past.

Appendix D

Mechanical Outline Specification

PURPOSE

The purpose of this Design Summary is to document the mechanical systems for the energy retrofit of the Burlington Seniors' Centre. The building is located at 2285 New St in Burlington, Ontario. The intent is to summarize the existing features and for the Plumbing and HVAC disciplines.

The building was built in 1979 and had a renovation and expansion in 2005. The building is used primarily for recreation services such as meetings, art classes, and workshops. There are offices located on the southeast side of the building as well as an auditorium on the northwest side.

SITE SERVICES

Existing sanitary system includes cast iron, copper, and plastic piping, with gravity discharge to the municipal system. Water service is provided by the municipal system. The water main has both a meter and backflow preventer installed.

PLUMBING SERVICES

Rainwater:
Rainwater drainage includes interior piping roof drains, and four-inch discharge, gravity flow piping to the municipal line.

Domestic Water Service:
The existing hot water service includes a natural gas tankless water heater with a separate 80-gallon storage tank. The system includes a two-inch main line with rough ins included. Piping, controls, and shut off valves are primarily copper.

Figure 1 Natural Gas Tankless Water Heater

Figure 2 Storage Tankr

Natural Gas Supply:
The gas main is distributed through steel piping, the building has a natural gas meter, as shown in the figure below.

Figure 3 Natural Gas Meter

Plumbing Fixtures:
In the janitorial closet and maintenance room, a floor mounted custodial/utility sink has been installed. Installation includes sink, rough-in, and faucet. Bradley eyewash stations were also installed in these rooms.

Restrooms include a combination of 1979 floor mounted and 2007 wall hung toilets. There are two kitchenette units in the Wellington Room and Port Nelson Room. Units include countertop, base cabinets, sink, and faucet.

Stainless steel water fountains are installed throughout the building.

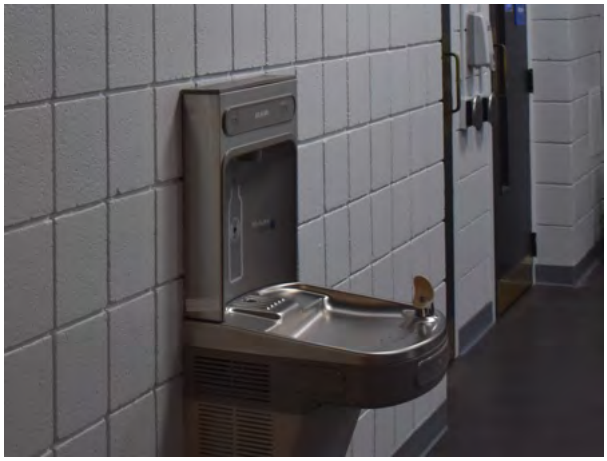


Figure 4 Typical Water Fountain in Facility

HVAC SYSTEM

Heating and Cooling:
Space heating and cooling is provided by a combination of Constant Air Volume (CAV), Variable Air Volume (VAV) and Variable Volume and Temperature (VVT) rooftop air handling units complete with natural gas burners. Details of each rooftop unit and corresponding distribution system is included below. A summary of all HVAC equipment has also been provided following details of each unit.

Unit ID:	Multizone Packaged RTU
Manufacturer:	Engineered Air
Model Number:	FWE52/HE20/O
Distribution:	VAV boxes are installed for each zone. The system serves seven zones: dining room, boutique room, billiard room, arts and crafts room, games room, admin offices, and reception areas.

Figure 5 Multizone Packaged RTU

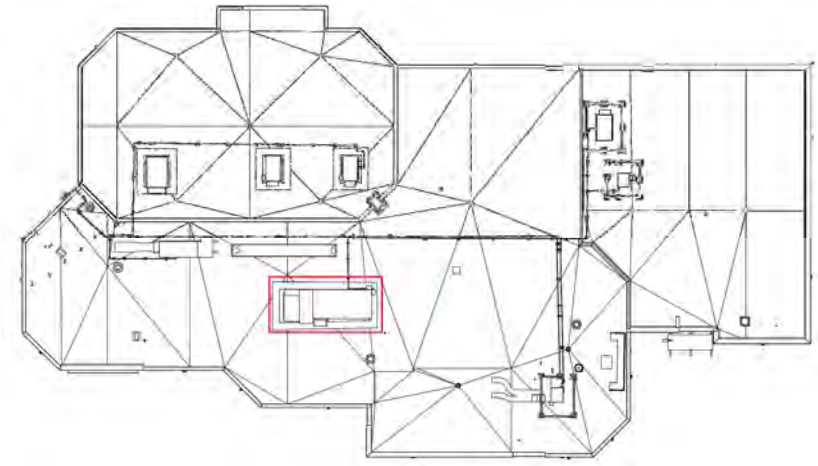


Figure 6 Location of Multizone Packaged RTU

Due to occupant comfort complaints, electric heaters have also been added in the offices and games room. The boutique room has electric reheat for hot yoga programs.

Figure 7 Electric Heater in Games Room

Unit ID: RTU-1
Manufacturer: Trane
Model Number: YSC072AWRAZJC100AIAOA600
Distribution: CAV system serves the Port Nelson and Wellington Multipurpose rooms

Figure 8 RTU-1

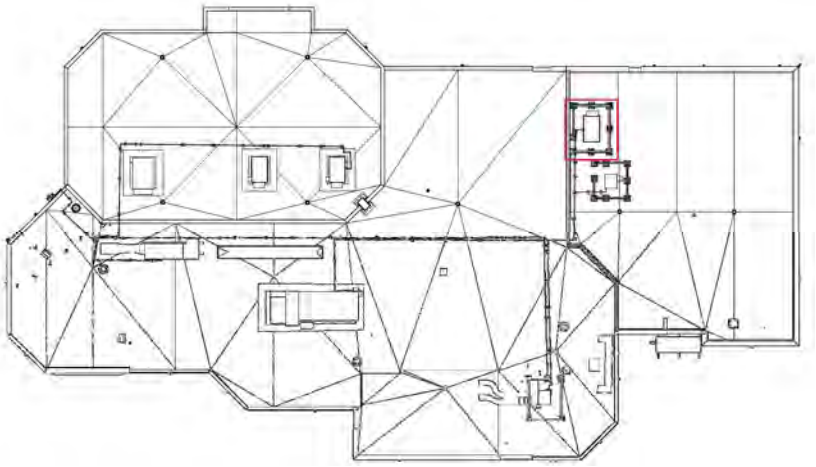


Figure 9 Location of RTU-1

Unit ID: RTU-2
Manufacturer: Trane
Model Number: 2YCC3024A1064AA
Distribution: VVT system serves the Freeman Indian Point Room

Figure 10 RTU-2

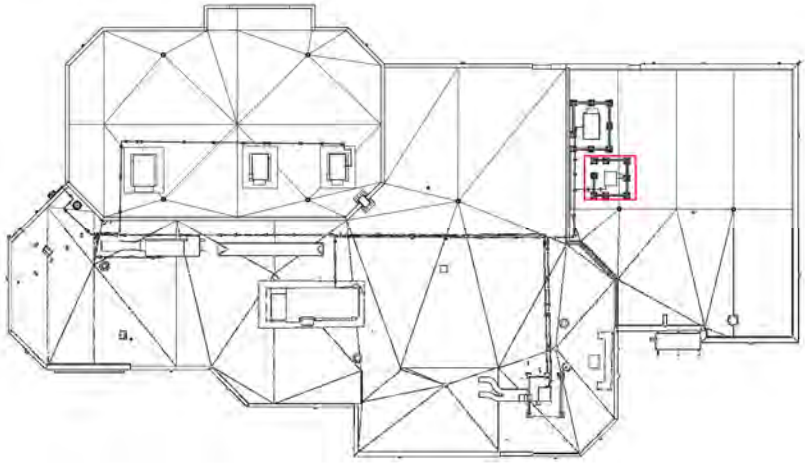


Figure 11 Location of RTU-2

Unit ID: RTU-3
Manufacturer: Trane
Model Number: 2YCC3024A1064AA
Distribution: CAV system serves the entrance hallway, boardroom, and restrooms

Figure 12 RTU-3

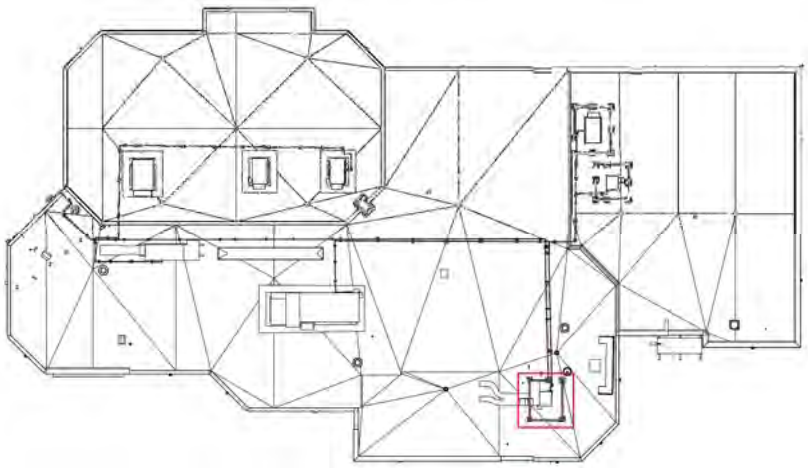


Figure 13 Location of RTU-3

Unit ID: RTU-4
Manufacturer: Trane
Model Number: YCD180BWLAHB
Distribution: CAV system serves auditorium A

Figure 14 RTU-4

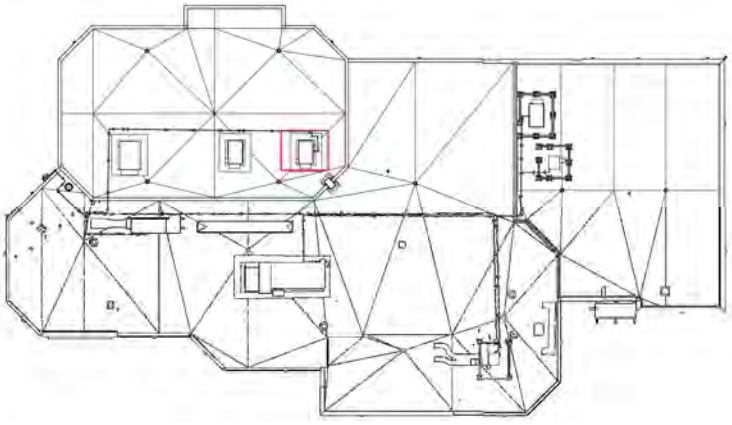


Figure 15 Location of RTU-4

Unit ID: RTU-5
Manufacturer: Trane
Model Number: YSC120AWRHAOBVR
Distribution: CAV system serves auditorium B

Figure 16 RTU-5 (foreground)

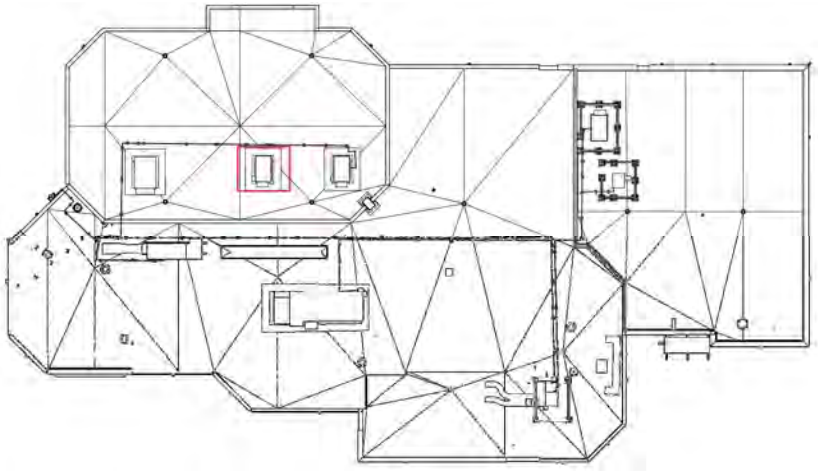


Figure 17 Location of RTU-5

Unit ID:	RTU-6
Manufacturer:	Trane
Model Number:	Y32120AWPHOBVR
Distribution:	CAV system serves auditorium stage

Figure 18 RTU-6 (background)

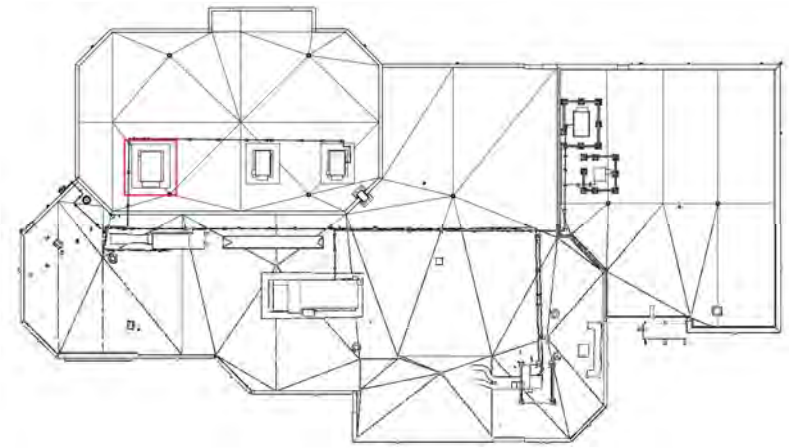


Figure 19 Location of RTU-6

Two small storage rooms have supplemental cooling provided by mini split heat pumps. These units were recently installed due to the heat gain of commercial fridges and freezers in the storage rooms. Location and model have been included in the figures below.

Figure 20 Mini split indoor unit

Figure 21 Mini split indoor unit

Figure 22 Mini split outdoor unit

Figure 23 Mini split outdoor unit

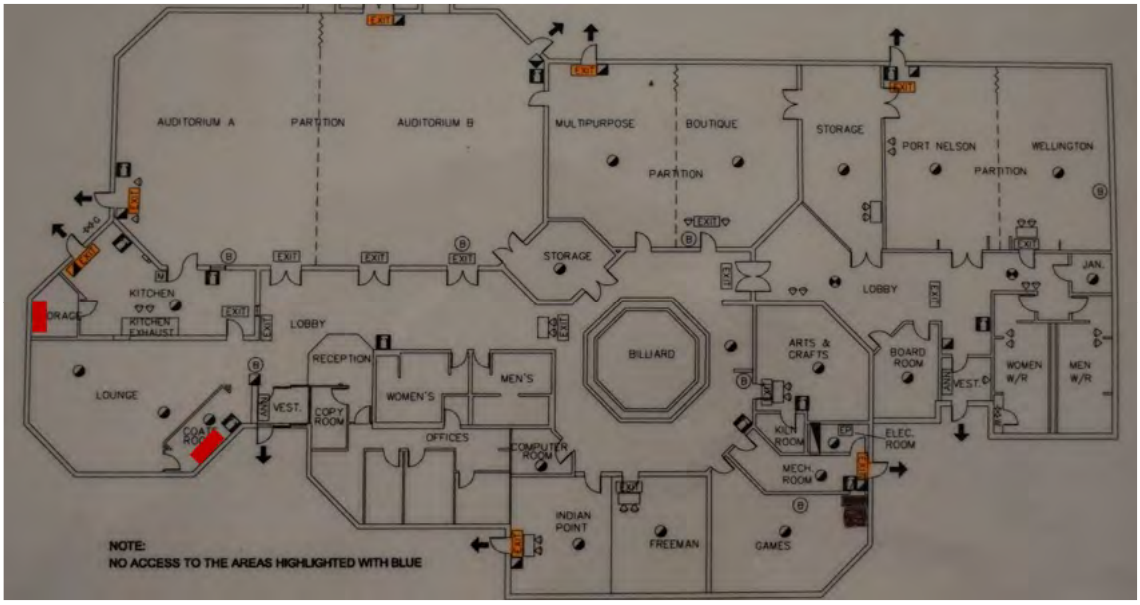


Figure 24 Mini split indoor unit location

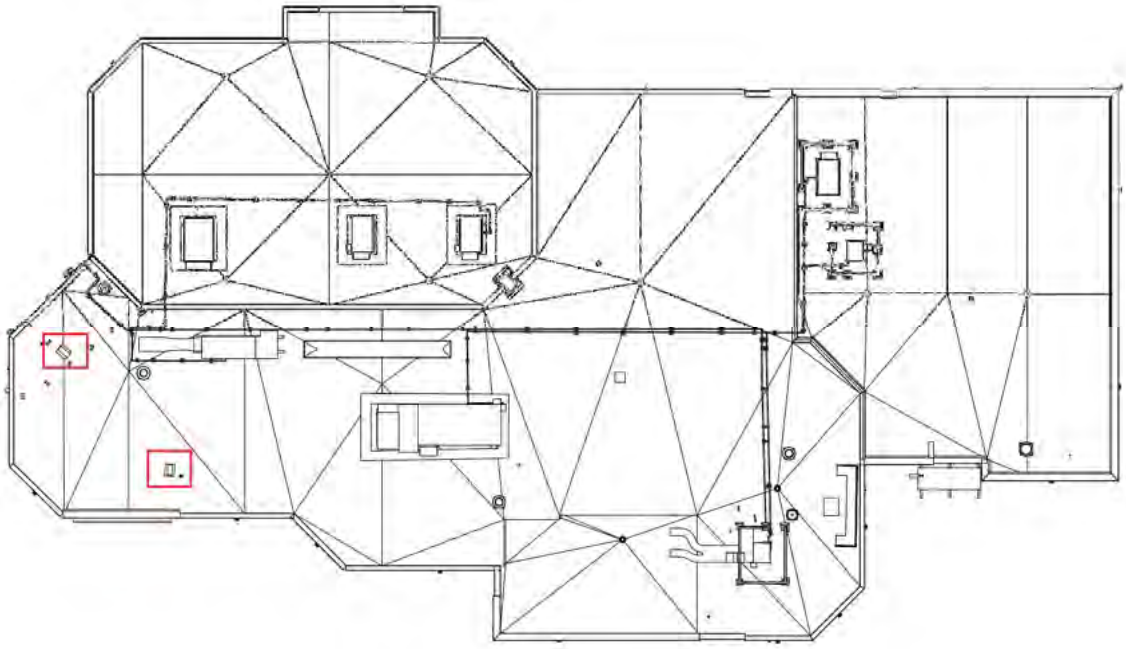


Figure 25 Minisplit outdoor unit location

Ventilation:

Outdoor air is provided by the rooftop units. There are four exhaust fans that serve the kitchen, two-bathroom facilities, and kiln room. A make-up air unit has also been installed in the kitchen.

Figure 26 Kitchen Make-Up Air Unit and Exhaust Fan

Figure 27 Kiln and Washroom Exhaust

Equipment Schedule:

Zone	Unit	Occupied		Unoccupied	
		Heat (°C)	Cool (°C)	Heat (°C)	Cool (°C)
Dining Room	Multizone	19.5	21.5	19	28
Admin	Multizone	19	21	18	24
Reception Corridor	Multizone	19	21	17	23
Billiard Room	Multizone	20	22	18	24
Boutique Room	Multizone	19	21	17	26
Arts and Crafts Room	Multizone	18.5	20.5	18	26
Games Room	Multizone	19.5	21.5	16	23
Freeman/Indian Point Room	RTU-2	17	19	16	24
Entrance Hall	RTU-3	19	21	18	26
Board Room	RTU-3	19	21	17	24
Port Nelson/Wellington Room	RTU-1	19	21	16	24
Auditorium A	RTU-4	19	21	17	25
Auditorium B	RTU-5	19	21	17	25
Auditorium Stage	RTU-6	19	21	17	25

HVAC Equipment Summary Table:

System ID	System Type	Total Airflow (cfm)	Outdoor Airflow (cfm)	Heating Capacity (MBH)	Heating Source	Cooling Capacity (tons)	Motor HP	Year	Notes
MZ	VAV	13,000	10,500	574	Natural Gas	40	15	2001	VAV controls installed in 2017
RTU-1	CAV	2,660	700	122	Natural Gas	6	2.00	2007	Multipurpose Rms
RTU-2	VVT	960	212	60	Natural Gas	2.5	0.30	2007	Freeman Rm
RTU-3	CAV	850	212	42	Natural Gas	2.0	0.25	2007	Entrance and board rm
RTU-4	CAV	6,000	-	203	Natural Gas	15	5.0	2007	Auditorium A
RTU-5	CAV	4,000	-	200	Natural Gas	10	3.00	2007	Auditorium B
RTU-6	CAV	4,000	-	200	Natural Gas	10	3.00	2007	Auditorium Stage
MUA	CAV	2,000	2000	195	Natural Gas	12	2.00	2017	Kitchen
EF-1	CAV	905	-	-	-	-	1.5	2006	Addition Wash
EF-2	CAV	-	-	-	-	-	0.75	2019	Kitchen
EF-3	CAV	-	-	-	-	-	0.5	2011	Kiln Rm
EF-4	CAV	-	-	-	-	-	0.15	2006	Lobby Wash

COMMENTS

Apart from the multi-zone VAV system, the majority of HVAC units are nearing the end of their 20-year lifetime and will need to be replaced.

There is no record of updates to the ductwork in the original building. As ductwork typically has a service life of 30-40 years, the efficiency of the original facility's distribution system is likely to be lower than industry norm.

Currently, two mini-split units have been installed in storage areas containing commercial fridge/freezers. The need for these units is due to the central system not designed to accommodate the added heating load of the equipment. For future designs, it is recommended that the design professional discuss current and future building use with the building owner to optimize equipment installation.

PROPOSED SYSTEMS

Systems have been proposed as per the minimally acceptable, net zero ready, and net zero scenarios. The details of each system are provided below. For the purpose of this study, it has been assumed that the occupancy schedules and space usage are consistent with existing conditions.

The minimally acceptable and net zero ready scenarios reduce the energy consumption by 50% and 80% respectively when compared to the existing building. The new HVAC and plumbing systems in the minimal acceptable scenario will meet the requirements of the 2020 National Energy Code for Buildings (NECB).

In all scenarios, it is recommended that insulation be increased or added to internal rainwater leaders and plumbing vents to prevent condensation and thermal bridging. Typically, insulation to prevent condensation on rainwater leaders is a minimum of 1/2" (~R-3) and plumbing vents are normally uninsulated; however, it is recommended that the insulation be added or increased to 3" (~R-20) to prevent thermal bridging. The insulation should be run down to the slab which may require access inside walls. To fully minimize thermal bridging, roof drain retrofits should be prioritized to be external of the enclosure.

1. Minimum Acceptable Scenario

Heating and Cooling

Heating and cooling will be provided by a combination of the existing rooftop units, existing mini split units, and electric baseboard heaters. The existing constant air volume (CAV) rooftop units will be retrofitted to become single zone VAV units with demand-controlled ventilation through the addition of a packaged solution (e.g. Prostar Catalyst) that includes a variable frequency drive, CO_2 sensor and controller. This should help address a potential issue with over ventilation of the building due to the existing control sequences. Doing so will reduce fan energy use along with heating and cooling energy use. As well, these packaged solutions come fully equipped with a control system architecture that can be fully integrated into existing building automation systems. As this scenario does not reduce the heating loads sufficiently to use a lower temperature air supply system (heat pumps), the use of the existing high temperature rooftop units avoids the replacement of the existing ductwork. The Kitchen MUA unit will remain as is.

Domestic hot water would continue to be served by a natural gas tankless water heater and a separate 80-gallon storage tank.

Ventilation

The existing rooftop units will continue to supply ventilation for the minimum acceptable scenario.

Controls

All existing building controls will remain with the addition of the packaged VFD units on the CAV rooftop units. The CAV rooftop unit retrofit would also include the installation of CO_2 sensors (for demand-controlled ventilation).

Equipment List

- (6) Packaged rooftop VFD conversion kits including VFD, CO_2 and air temperature sensors.

2. Net Zero Carbon Energy Ready Scenario

The net zero carbon energy ready system includes full electrification of the HVAC and DHW systems. Two variable refrigerant flow (VRF) options have been proposed: air source and ground source.

a. Air Source VRF Option

Heating and Cooling

The natural gas rooftop units, mini split units, and baseboard heaters will be replaced with a VRF system to heat and cool the entire building.

The VRF system has been sized such that it meets 100% of the peak cooling load. Consequently, the system has been sized for heating such that it meets 85% of the heating load at 0°F. The unit's compressors will allow over speeding and flash injection for cold climate operation. Electric duct heaters would be installed in the ductwork to serve the remaining 15% of the peak load. As peak demands rarely occur throughout the year, it is much more economical for the electric heaters to provide heating during peak demand periods as reducing the heat pump capacity to 85% of peak load typically results in the electric heaters providing less than 10% of annual heating. The VRF condensing unit would be mounted on the rooftop.

The VRF system would include refrigerant piping from the condensing units to a branch controller which will then distribute the piping to fan coils units. The fan coils would then tie into the existing ductwork and air would be distributed to each zone. Each fan coil would be hooked up to a thermostat, thus having one fan coil per zone.

Domestic water would be provided by a packaged heat pump water heater (HPWH). The HPWH has been sized according to existing tank capacity, refer to Figure 27.

Figure 28 Air Source Cold Climate VRF Heat Pump

Figure 29 Packaged Heat Pump Water Heater

Ventilation

The existing rooftop units would be removed and two ERVs would be installed. One ERV would serve the auditorium and the other would serve the rest of the building. ERVs would be dual core type with approximately 90% heat recovery efficiency similar to Tempeff Dualcore, refer to Figure 30 below. Outdoor air and exhaust air ductwork will be insulated between the building envelope and ERV. Both ERVs would be located on the roof. Variable air volume (VAV) boxes along with CO_2 sensors would be installed to enable demand-controlled ventilation.

Because the ventilation system is being decoupled from the heating and cooling system, the ventilation distribution system will need to be altered. As zones will remain unchanged, the zone (room) level ductwork will remain. However, the main duct runs will need to be removed and reinstalled to better accommodate the location of the two ERVs.

As previously mentioned, ERV ducting will consist of new main duct runs which tie into the zone distribution systems. Each zone will be equipped with a VAV box controlled by an occupancy of CO_2 sensor to optimize the required ventilation for the zone. ERV ducting will be galvanized steel.

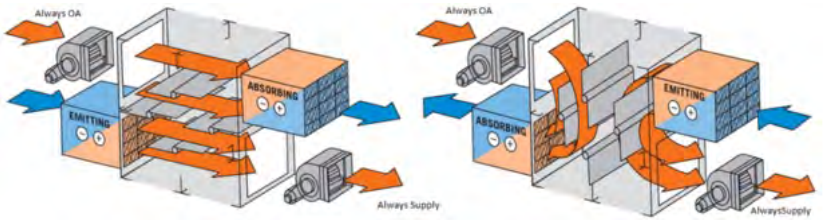


Figure 30 Tempeff Dual Core ERV

The kitchen MUA unit and exhaust fan system is currently constant volume, these can be converted to variable air volume to enable fan and heating savings along with a new high performance (lower airflow) kitchen hood.

Controls

The new VRF equipment and ERVs would tie into the building's existing direct digital control system.

System Overview

A list of required equipment and system schematic have been included below.

Equipment List

- (2) Nominal 8-ton air source VRF outdoor condensing units with branch control boxes
- (1) 12 kW Electric duct heater
- Fan Coils
    - (5) 1.5-ton fan coils
    - (10) 1.25-ton fan coils
    - (4) 0.75-ton fan coils
- (16) VAV boxes
- (1) 425 L/s (900 cfm) ERV with ECM motors and dual cores
- (1) 700 L/s ERV (1500 cfm) with ECM motors and dual cores
- (1) 566 L/s (1200cfm) Kitchen Makeup Air (MUA) unit with 30kW electric heater and VFD
- (1) 566 L/s (1200cfm) Kitchen exhaust fan with VFD
- (1) 1.8m (6ft) high performance kitchen exhaust hood
- (4) 80 gallon packaged heat pump water heater

System Schematic

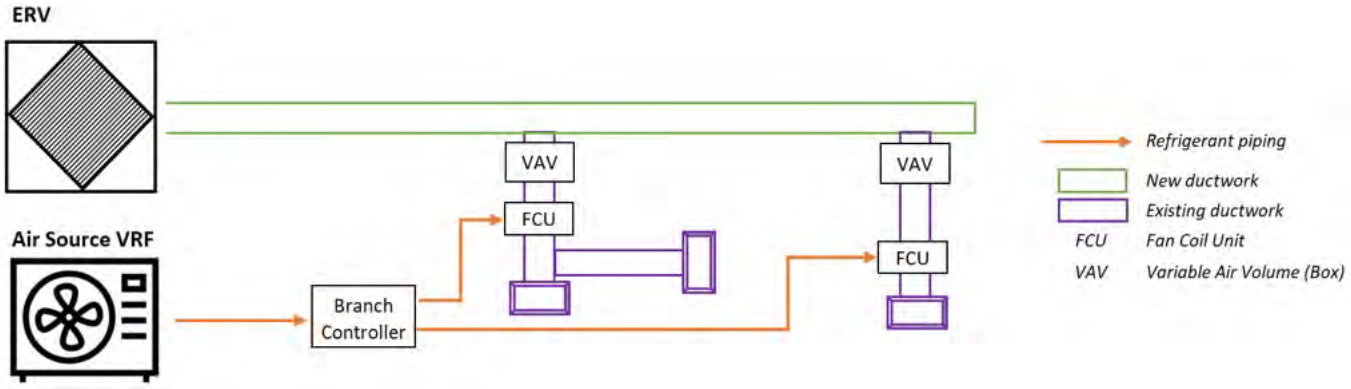


Figure 31 ASHP System Schematic

a. Ground Source Heat Pump (GSHP) Option

This option is the equivalent to the air source VRF scenario except heating and cooling would be generated by a water source VRF system. A series of water cooled VRF units will be connected to closed-loop vertical borehole ground heat exchangers. The vertical loop heat exchanger system will consist of long lengths of 1-1/4" diameter HDPE or PEX tubing placed in boreholes drilled to a depth of approximately 150m below the surface level and filled with thermally enhanced grout. Length of pipe, diameter of pipe, and the spacing of wells will depend on the final building heating and cooling loads during detailed design. An estimated 5 boreholes will be required for the building.[1] As the ground source VRF unit does not decrease capacity with reduced outdoor air temperatures, the unit has been sized for 100% cooling and 90% heating.

Accessories to the GSHP piping system would include glycol fill tank, expansion tank, air venting, circulation pumps and isolation valves. Each water-cooled unit will have a circulation pump on the evaporator and condenser side and be controlled when the compressor is engaged.

The boreholes would most likely be located under the parking lot on the northeast side of the property, refer to Figure 32. However, further analysis must be conducted to confirm the system design.

Figure 32 Proposed Borehole Location

[1] *Assumes 150m boreholes with capacity of 160 m per kW (150 ft per ton)*

The indoor water-cooled VRF units would require a minimum 500 ft^2 mechanical room on the northeast side. As the building does not have a dedicated mechanical room, it is recommended that the north facing washrooms be extended, see Figure 33 below.

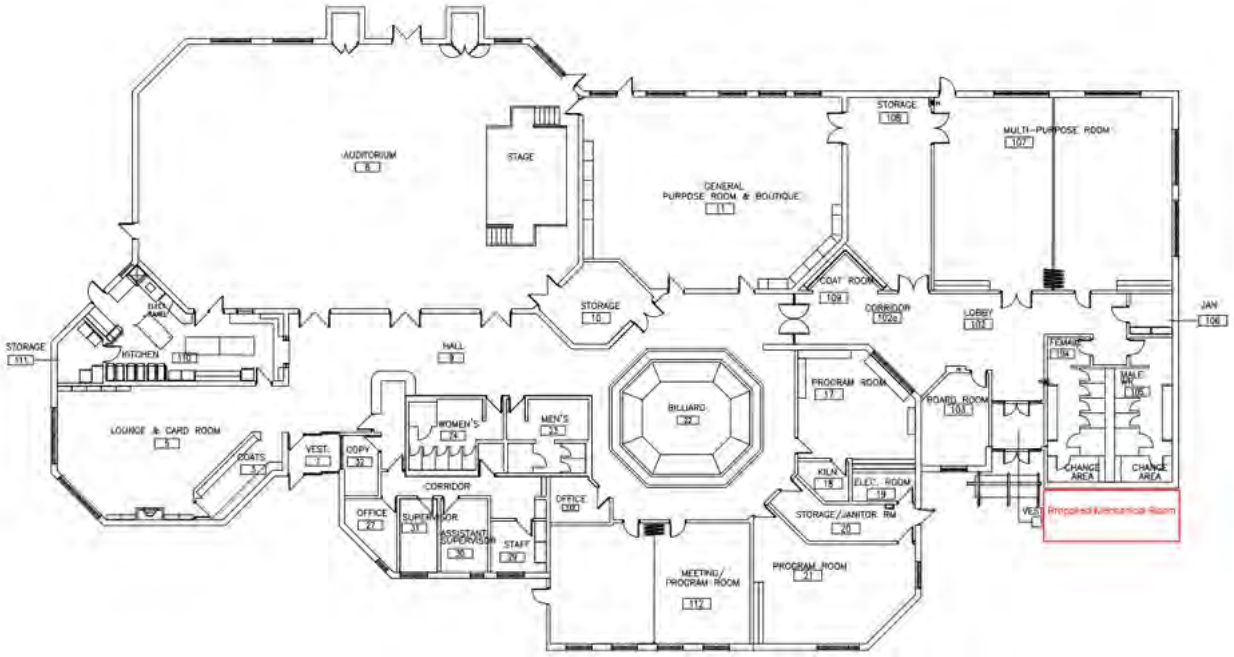


Figure 33 Proposed Mechanical Room Location

The ground source VRF option would utilize the same distribution system outlined in the air source option.

Domestic water would be provided by a packaged heat pump water heater (HPWH). The HPWH has been sized according to existing tank capacity.

Ventilation

The ventilation system will be equivalent to the air source system. Two ERVs will be installed, one dedicated to the auditorium and one for the rest of the building. The required alterations to the distribution system are consistent with the air source option.

The kitchen MUA unit and exhaust fan system is currently constant volume, these can be converted to variable air volume to enable fan and heating savings along with a new high performance (lower airflow) kitchen hood.

Controls

The new VRF equipment, circulation pumps and ERVs would tie into the building's existing direct digital control system.

System Overview

A list of required equipment and system schematic have been included below.

Equipment List

- (2) Nominal 8 ton ground/water source VRF condensing units with branch controllers
- (1) 7 kW Electric Duct Heater
- Ground Source Circulation Pumps (includes standby pumps)
  - (2) Ground loop circulation pumps, approximately 50 gpm each with VFD
- Fan Coils
  - (5) 1.5-ton fan coils
  - (10) 1.25-ton fan coils
  - (4) 0.75-ton fan coils
- (16) VAV boxes
- (1) 425 L/s (900 cfm) ERV with ECM motors and dual cores
- (1) 700 L/s ERV (1500 cfm) with ECM motors and dual cores
- (1) 566 L/s (1200cfm) Kitchen Makeup Air (MUA) unit with 30kW electric heater and VFD
- (1) 566 L/s (1200cfm) Kitchen exhaust fan with VFD
- (1) 1.8m (6ft) high performance kitchen exhaust hood
- (4) 80 gallon packaged heat pump water heater

System Schematic

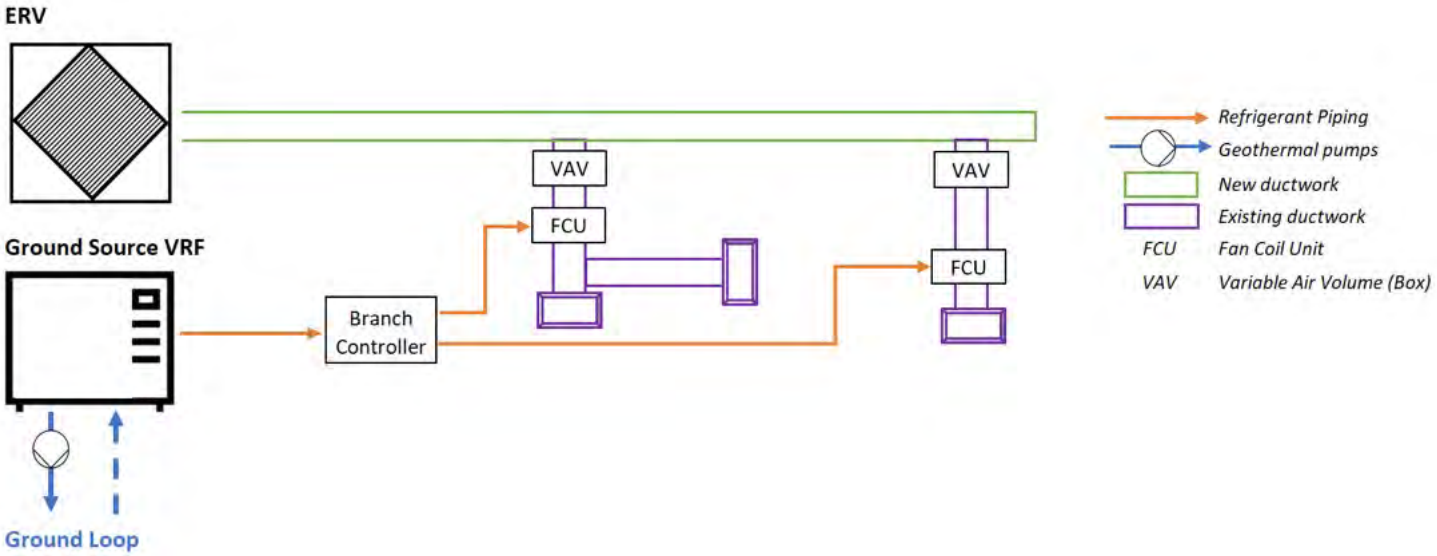


Figure 34 Ground Source VRF System Schematic

3. Net Zero Scenario

The net zero scenario is identical to the net zero ready scenario with the addition of a PV system.

Scenario System Summary

Item	Existing Building	Minimum Acceptable	ASHP Net Zero Energy[1]	GSHP Net Zero Energy [1]
Effective Wall R-value	R-7	R-15	R-25	R-25
Effective Roof R-value	R-21	R-25	R-60	R-60
Air Tightness (L/s·m^2 at 75Pa)	3.0 L/s·m2	0.5 L/s·m2	0.5 L/s·m2	0.5 L/s·m2
Central Heating Equipment	Natural gas rooftop units	Natural gas rooftop units	Air source VRF	Ground source VRF
Heating System	Combination ducted VAV/CAV and electric baseboards	Ducted VAV AHUs and electric baseboards	Ducted fan coil units	Ducted fan coil units
Cooling System	Combination ducted VAV/CAV and mini split units in storage rooms	Combination ducted VAV AHUs and mini split units in storage rooms	Ducted fan coil units	Ducted fan coil units
DHW Equipment	Natural gas tankless water heater and storage tank	Natural gas tankless water heater and storage tank	HP Water Heater	HP Water Heater
Ventilation Equipment	Combination ducted CAV/VAV natural gas rooftop units	Ducted VAV natural gas rooftop units	90% SRE ERVs with VAV boxes in zones	90% SRE ERVs with VAV boxes in zones
Renewables	-	-	TBD	TBD

[1] *Net Zero Energy Ready systems are identical with exclusion of renewables*

Appendix E

Electrical Outline Specification

PURPOSE

The purpose of this Design Summary is to document the mechanical systems for the energy retrofit of the Burlington Seniors' Centre. The building is located at 2285 New St in Burlington, Ontario. The intent is to summarize the existing features and for the Plumbing and HVAC disciplines.

The building was built in 1979 and had a renovation and expansion in 2005. The building is used primarily for recreation services such as meetings, art classes, and workshops. There are offices located on the southeast side of the building as well as an auditorium on the northwest side.

EXISTING SYSTEMS

Site Services

Existing incoming power service consists of two, 4" PVC conduits on the primary side servicing the existing pad mount transformer on site. The size of the pad mount transformer is unknown. The existing main incoming secondary service is sized at 400A, 600V, 3P and consists of two 4" PVC conduits. The secondary service feeders consist of 4#500MCM RW90, which are rated for 433A when run underground in conduit. All feeders are run in one 4" PVC conduit, the other conduit is a spare. The secondary service entrance enters the building in the main electrical room and terminates onto the main service entrance rated main breaker. The building's main disconnect is a 400A, 80% rated loose main breaker.

This information was obtained from the single line diagram in the drawing package provided to the team. Note the drawing package appears to be the original as-builts for the building and changes may have been made to the existing electrical systems since.

No photos of the buildings existing PMT are available. The size or the likelihood that the utility will need to replace it based on the various scenarios is unknown. Additionally, no photos of the service entrance rated building disconnect are available so the condition of the equipment is unknown.

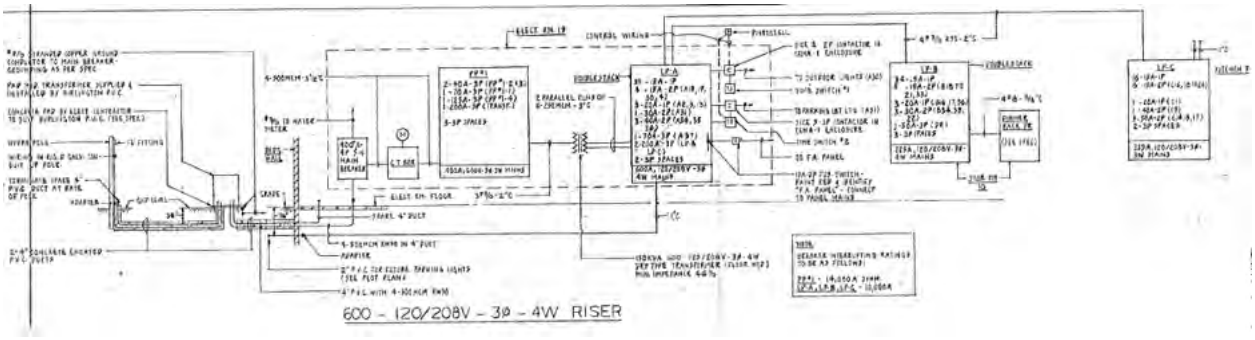


Figure 1: Existing SLD

Electrical Power Distribution Services

Main Distribution Equipment
The existing main distribution is original to the building and consists of a main disconnect, a main 600V panelboard and multiple branch circuit panelboards throughout the building. Based on the photos provided, the main distribution equipment appears to be in okay condition. No maintenance logs are available to determine if any work has been completed done throughout the years.

The main building disconnect is a 80% rated 400A fused disconnect switch. All other disconnects for panels, motors etc. are also fusible disconnects. Visually the disconnects appear to be in okay condition. No complete photos of the main electrical room are available so we are unsure of how much room remains for future additions and expansion of the electrical distribution system. Based on the original as-built drawings, the electrical room was constructed without room for future expansion in mind.

Figure 2: Panel PP#1

Existing Branch Circuit Panelboards
Several 120-208V branch circuit panelboards exist throughout the building servicing various areas. All panelboards appear to be original to the building and range from okay to good condition. No mini breakers are present in the existing panelboards. There is limited breaker space available for additional equipment. Depending on the scope of electrical changes, additional distribution may need to be added. Some panels appear to have breakers installed that are no longer in use, which could be removed to allow room for new distribution and branch circuits.

No logging data on power demand of the existing panelboards is available , more information would be needed to determine if the panels have adequate capacity to allow for additional load in the future. This could either be a calculated estimation, or the panels could be logged with a power meter to determine demand load.

Although there is a single line diagram that details the electrical distribution and wiring throughout the building. The drawings appear to be original to the building and likely does not capture changes made over the years.

Figure 3: Panel LP-A

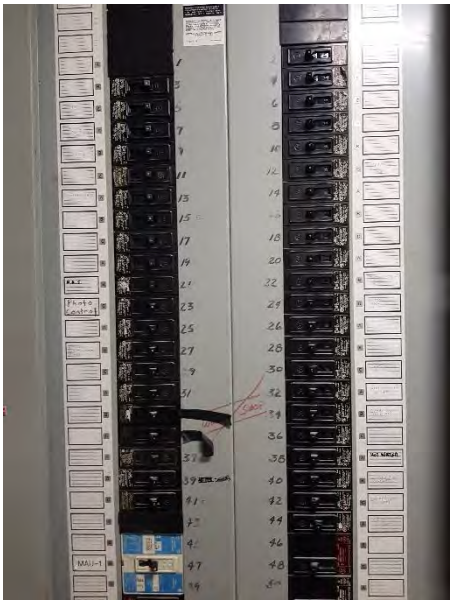


Figure 4: LP-A Circuits

Referencing table A-8.4.3.2.2, Division B of the 2017 National Energy Code the basic plug load for each section of the building is as follows.

Occupancy Type	Demand Load	Area
Multipurpose Room	5 W/m^2	175 m^2
Office	7.5 W/m^2	200 m^2
Lobby/Corridor	1 W/m^2	120 m^2
Washrooms	1 W/m^2	130 m^2
Auditorium	2.5 W/m^2	420 m^2
Recreation	1.5 W/m^2	750 m^2
Kitchen	10 W/m^2	65 m^2

Emergency Power Distribution

No emergency power distribution was present on site. Emergency lighting, exit signage and the building fire alarm panel are battery operated.

Electric Baseboard Heating
Electric baseboard heaters are located throughout the building to support the main heating system which consists of several rooftop units and mini-split units. The baseboard heaters do not appear to be original to the building. The heaters are in good condition and well within their life expectancy.

Figure 5: Electric Heater in Games Room

Lighting and Lighting Control System

Interior Lighting
Throughout the building, the majority of the fixtures are either rectangular or linear fluorescent fixtures with T8 lamps. The fixtures appear to be well-maintained and in okay to good condition depending on the area of the building. Most of the existing fluorescent lighting appears to be within its reasonable life expectancy. The estimated LPD for the areas with fluorescent lighting is 15W/m^2. The overall estimated LPD for the entire building is 13W/m^2.

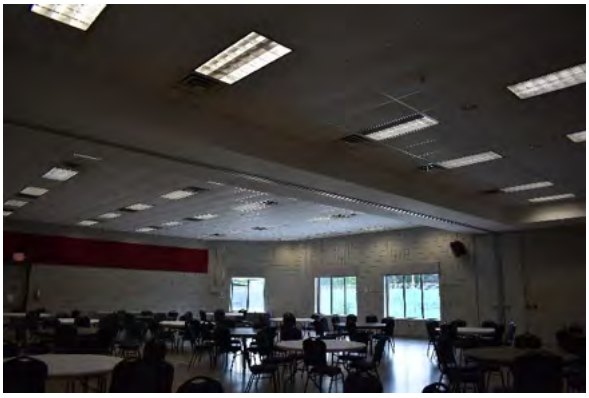


Figure 6: Interior Lighting

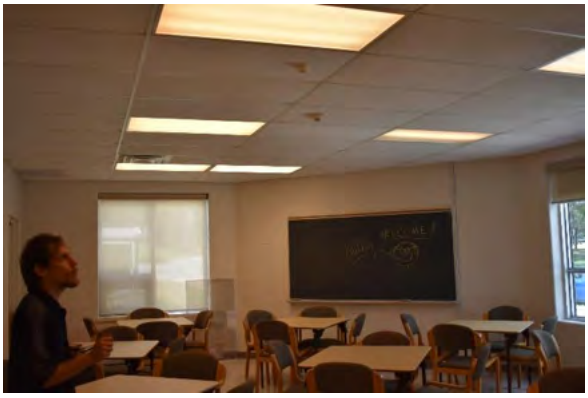


Figure 7: Interior Lighting

The office area of the building appears to have been retrofit recently with new LED flat panel fixtures. The fixtures are new and in extremely good condition. The estimated LPD for the office area is 7W/m^2.

Figure 8: Office Lighting

Exterior Lighting

The existing exterior lighting has been retrofit to LED. Several LED wall-packs exist around the perimeter of the building which are controlled by a timeclock. The wall-packs appear to be in good condition.

Figure 9: Office Lighting

PROPOSED SYSTEMS

Systems have been proposed as per the minimum acceptable, net zero ready and net zero scenarios. The details of each system are provided below. For the purpose of this study, it has been assumed that the occupancy schedules and space usage are consistent with existing conditions.

In all scenarios, it is recommended that at a minimum, existing lighting be upgraded to LED using LED lighting retrofit kits. These kits a relatively inexpensive and will help dramatically reduce energy consumption from lighting.

1. Minimum Acceptable Scenario

Lighting

In the minimum acceptable scenario, all existing fluorescent lighting throughout the building should be upgraded to LED using LED lighting retrofit kits. These kits come complete with LED replacement lamps and ballasts so the existing fixtures throughout the building can be internally re-wired to work with LED lamps. This will allow the existing building lighting to remain in the same areas and will reduce maintenance. New LED retrofit kits and bulbs will be provided on an as needed basis depending on the type of fixture.

Figure 10

Figure 11

Lighting Control

The minimum acceptable scenario does not change any of the existing lighting controls. Controls will remain manual on/off with no automatic control.

Power Distribution

The minimum acceptable scenario has no changes to the electrical distribution system due to the lack of electrification of mechanical equipment. The existing building service will remain as-is. Six VAV boxes will have to be disconnected and re-connected to allow for the installation of 6 new VFD retrofit kits.

No photovoltaics will be added or accounted for as part of the minimum acceptable scenario.

2. Net Zero Ready Scenario

The net zero scenario systems include full electrification of the HVAC and DHW systems. Two options have been proposed: air source VRFs and ground source VRFs. The net-zero ready scenario will upgrade the existing electrical distribution to accommodate a future solar array capable of producing as much energy as the building would use over the course of a year. In this scenario, the solar array will not yet be installed.

Lighting

In the net zero ready scenario, existing fluorescent fixtures will be replaced with equivalent LED fixtures. This upgrade will also act as a lifecycle upgrade to the aging existing light fixtures. Additional light fixtures will be provided in areas where existing lighting is lacking. Light fixtures will

be replaced like-for-like matching colour temperature and lumen output. In this scenario, the building lighting power density will reduce to an estimated 7W/m^2. See replacement fixture schedule below:

Existing Fixture	Existing Wattage (total lamps)	Example Replacement Fixture Product Number	Replacement Fixture Wattage
Recessed 2x4	160W (4 lamps)	Lithonia: BLT 40L ADP EZ1 LP835	32W
Utility Room Linears	80W (2 lamps)	Lithonia: CSS L48 4000LM MVOLT 40K	35W
Linear Highbays	160W (2 lamp)	Lithonia: MSL 4000LM SBL MVOLT 35K	29W

Additional light fixture alternatives and replacement bulbs will be provided as needed so all lighting is LED. Office lighting and exterior lighting to remain as-is (existing LED).

Lighting Control System

The lighting control system will be updated throughout the building to include automatic lighting control. This upgrade will help reduce unnecessary energy waste by automatically controlling the lighting to only be used while spaces are occupied. Automatic control will be provided in all areas of the building accordance with the national energy code. Daylight sensors will be provided in all areas with natural light and vacancy sensors will be provided in all areas as required by the National energy Code. All new lighting control will be low voltage 0-10V or wireless. Areas with existing occupancy sensors will have the sensors re-programed to operate in vacancy mode.

Electrical Power Distribution System

In the net zero ready scenario, a significant amount of mechanical equipment will be electrified, increasing the load on the distribution system. Using the billing information from the past year 2021, we can determine that a service upgrade will not be necessary for the noted changes to the mechanical and PV systems however, replacing the existing service distribution is strongly recommended as a lifecycle upgrade due to the age and condition of the equipment. The building demand load in 2021 is consistently below 120kW where the current building service size is approximately 415kW. This assumes that the building was being used under normal operation in 2021.

The net zero ready scenario should account for a PV installation when considering upgrading the buildings service size. The current energy model predicts 220kW (DC) of PV will be required to achieve a net-zero building. Up to 200kW (AC) of solar could be installed without a service upgrade, however more room would be required to allow for new infrastructure to support the solar array, including a new transformer and panelboard. In order to install more than 100kW (AC) of solar, the main service entrance rated disconnect would need to be reduced in size to 300A (400A existing) to reduce the potential for overloading the main panels bus.

In order to achieve net-zero, an inverter size of 130kW (AC) is required. Using a DC:AC ratio of 1.7, this would result in 220kW (DC) of solar panels installed on the roof. Although the existing system could handle this load, a new service entrance is recommended to replace the aging existing infrastructure. A new 400A main panelboard complete with a 300A main breaker would be installed

to replace the existing 400A panelboard and loose 400A main breaker. Assuming the existing service wires are in good condition and sized as noted on the original drawings, they could be re-used to accommodate the new distribution equipment. Existing branch circuit panelboards downstream of the service entrance will be re-fed to be serviced by the new main panelboard.

New electrical distribution will be added off the new main panelboard to allow for connection to mechanical equipment. A new 3P, 208Vpanelboard and transformer will be added to service all VRFs, FCUs, duct heaters, ERVs, water heaters etc. This new distribution could be added in the proposed new mechanical room.

Air Source VRF Option

Net-Zero Ready (ASHP)	Qty	kW	Total Load (kw)
Nomial 8ton air source VRF	2	13	26
12kW Duct Heater	1	12	12
5-Ton FCU	2	0.75	1.5
4-Ton FCU	7	0.665	4.655
2-Ton FCU	4	0.25	1
425 L/s ERV	1	1	1
700 L/s ERV	1	2	2
566 L/s MUA w/ 30kW Electric Heater	1	35	35
566 L/s Exhaust fan	1	1	1
80 Gallon Heat Pump Water Heater	4	5	20
Total Added Load			104

Air Source VRF with Ground Circ Pumps Option

Net-Zero Ready (ASHP)	Qty	kW	Total Load (kw)
Nomial 8ton air source VRF	2	8.3	17
7kW Duct Heater	1	7	7
Ground Source Circ Pumps	2	5	10
5-Ton FCU	2	0.75	2
4-Ton FCU	7	0.665	5
2-Ton FCU	4	0.25	1
425 L/s ERV	1	1	1
700 L/s ERV	2	2	4
566 L/s MUA w/ 30kW Electric Heater	1	35	35
566 L/s Exhaust fan	1	1	1
80 Gallon Heat Pump Water Heater	4	5	20
Total Added Load			102

A letter would be sent to the utility (Burlington Hydro) to inform them of added load onto the buildings existing electrical service. A new padmount transformer may be provided by the utility if

they feel it is necessary to account for the added load. The letter will include an updated load calculation showing what the existing load is on the building (obtained from the year-old demand load study) and what the new load will be. The cost of replacement of the existing pad mount transformer is covered by the utility if it is required.

3. Net Zero Scenario

The net zero scenario is identical to the net zero ready scenario with the addition of the net-zero PV system. Since the PV system is already account for in the net-zero ready scenario, there is no additional changes needed to the electrical distribution system above and beyond the net-zero ready scenario.

In Ontario, there is a 1MW on commercial net metered solar systems which is well over the amount of solar being proposed. In a net metering agreement, 100% of the excess energy generated from the solar array is put back on the utility grid and the consumers account is credited for the amount generated. This credit is applied against the amount of energy consumed to reduce the consumers power bill. With a net zero solar installation, the consumers bill would average zero dollars over the course of a year. Since 100% of the excess energy generated is configured to go back onto the grid, the solar array will be shut off in the event of a grid outage.

Air Source Heat Pump (ASHP) Option

Required PV Array Size (AC)	PV Array Size (DC) DC:AC Ratio of 1.7:1	Introduced Demand Load (Mechanical)	Total New Demand Load	New Panelboard Size	Main Breaker Size	Service Entrance Upgrade Recommended
130kW	220kW	104kW (100A)	206kW (198A)	400A	300A (80% rated)	Yes

Ground Source Heat Pump (GSHP) Option

Required PV Array Size (AC)	PV Array Size (DC) DC:AC Ratio of 1.7:1	Introduced Demand Load (Mechanical)	Total New Demand Load	New Panelboard Size	New Main Breaker Size	Service Entrance Upgrade Recommended
130kW	220kW	102kW (98A)	204kW (196A)	400A	300A (80% rated)	Yes

Note a DC:AC ratio of 1.7:1 is used as recommended ratio of array size to inverter size. Final Ratio to be confirmed by system designer. Replacement of the main switchgear is recommended in all scenarios.

Appendix F

Pre-retrofit Utility Records

Burlington
Energy Use As Reported by Client

Summarized by Monthly Consumption

As calculated by RDH

Electrical Consumption (kWh)

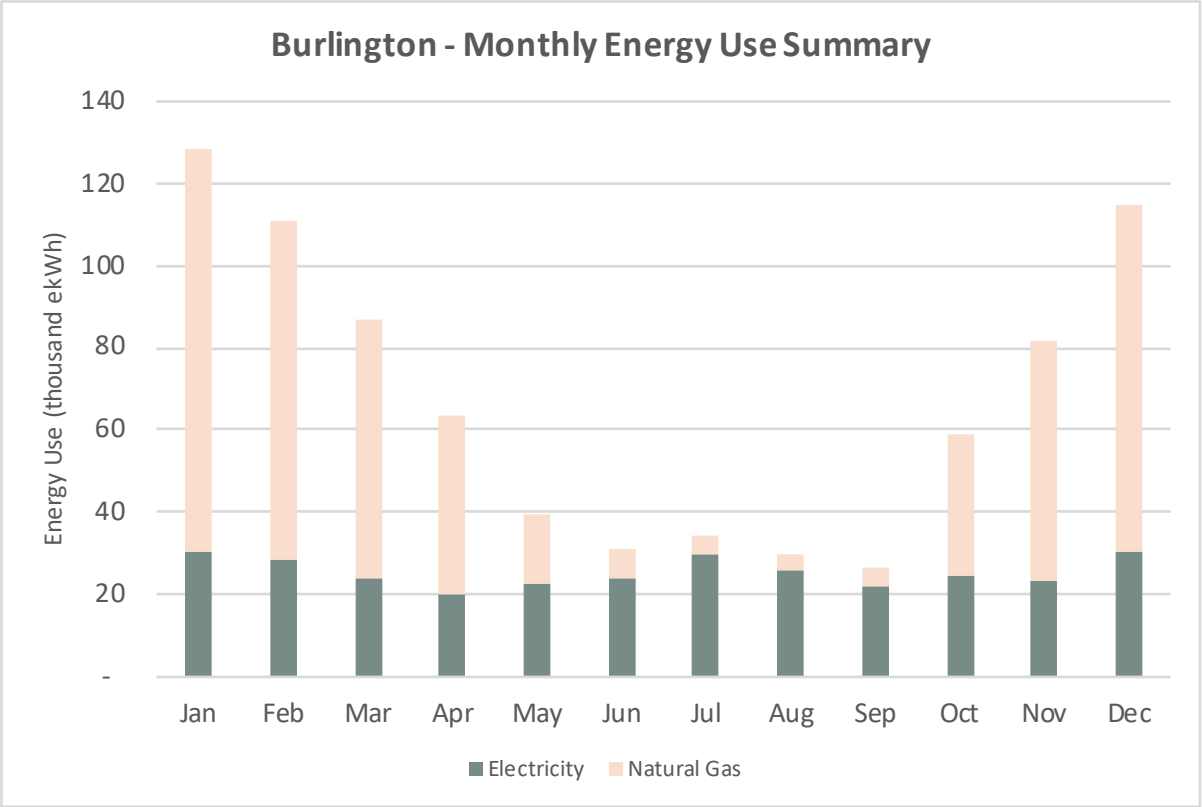
	2018	2019	2020	2021	Average	
Jan	32,400	36,480	30,720	21,360	30,240	Jan
Feb	32,880	32,160	29,760	20,160	28,740	Feb
Mar	31,680	27,600	18,000	19,440	24,180	Mar
Apr	27,840	27,360	14,400	10,560	20,040	Apr
May	36,000	30,960	11,040	12,000	22,500	May
Jun	33,600	28,800	17,760	16,560	24,180	Jun
Jul	38,880	35,040	26,400	18,240	29,640	Jul
Aug	34,560	27,600	22,320	18,960	25,860	Aug
Sep	27,360	25,680	18,720	15,840	21,900	Sep
Oct	33,120	31,440	17,760	16,560	24,720	Oct
Nov	26,400	24,480	19,440	22,320	23,160	Nov
Dec	35,760	36,000	25,440	24,720	30,480	Dec

Natural Gas (M^3)

	2018	2019	2020	2021	Avg. (M^3)	ekWh	
Jan	7,425	10,773	8,424	10,459	9,270	98,053	Jan
Feb	6,820	7,597	7,708	8,838	7,741	81,874	Feb
Mar	5,513	6,096	4,569	7,600	5,944	62,873	Mar
Apr	4,589	4,144	1,535*	3,616	4,116	43,535	Apr
May	1,204	2,152	550*	1,561	1,639	17,336	May
Jun	1,119	497	150*	394	670	7,084	Jun
Jul	859	171	150*	369	466	4,933	Jul
Aug	505	223	200*	358	362	3,828	Aug
Sep	805	357	297	324	446	4,713	Sep
Oct	4,101	3,533	3,627	1,810	3,268	34,563	Oct
Nov	6,178	6,250	3,707	6,022	5,539	58,589	Nov
Dec	8,207	7,440	7,871	8,331	7,962	84,216	Dec

* Due to covid restrictions, these months had to be interpoltated based off of one bill received in August. The interpolated months represent reduced consumption based on the facility being locked down.

ekWh converstion factor used	10.577

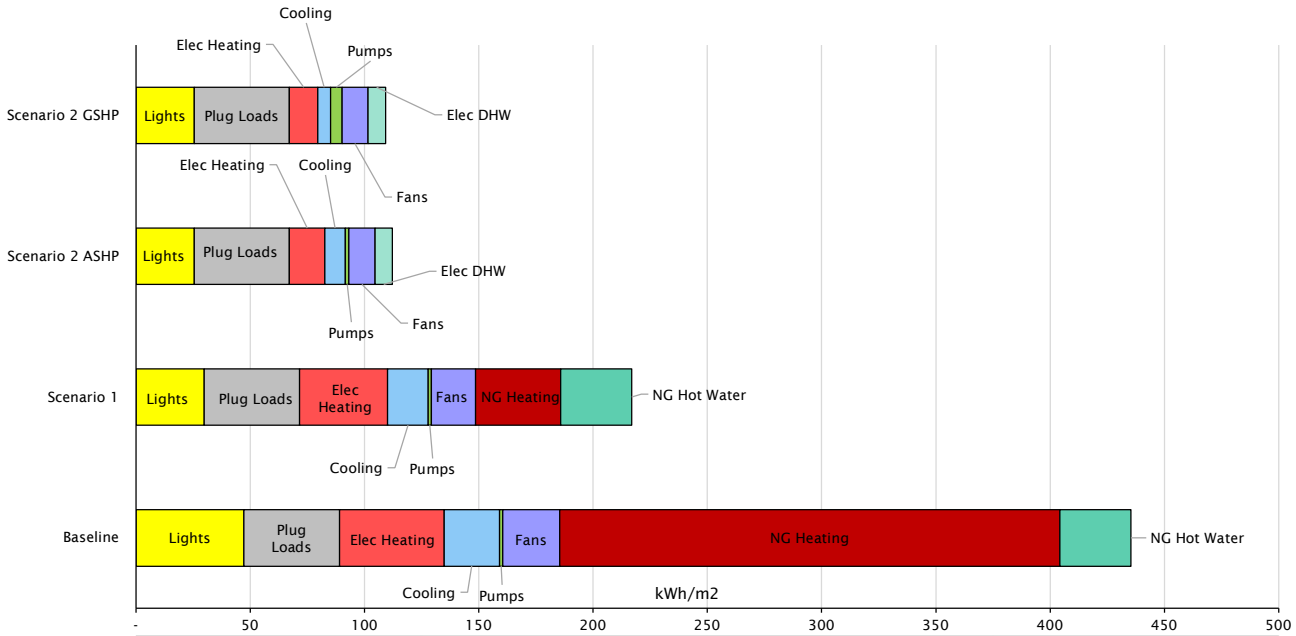

Burlington - Monthly Energy Use Summary
Energy Use (thousand ekWh)
140
120
100
80
60
40
20
-
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Electricity
Natural Gas

Appendix G

Energy Model Reports

Burlington

Total Energy Use Intensity TEUI (kWh/m²/yr):

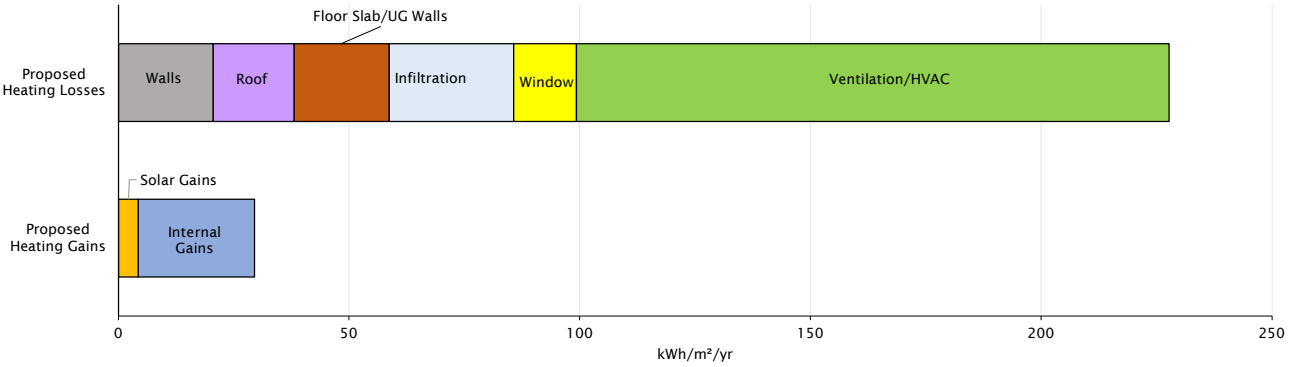


	Baseline	Scenario 1	Scenario 2 ASHP	Scenario 2 GSHP
Lights	47.29	29.89	25.44	25.44
Plug Loads	41.74	41.74	41.74	41.74
Elec Heating	45.84	38.52	15.40	12.39
Cooling	24.20	17.68	9.06	5.57
Pumps	1.44	1.44	1.46	4.97
Fans	24.93	19.30	11.47	11.45
Elec DHW	-	-	7.61	7.61
NG Heating	218.84	37.28	-	-
NG Hot Water	31.14	31.11	-	-

Note: The values presented above represent the relative proportion of each component of total energy use.

	TEUI		Total kWh	
Baseline	435.4	kWh/m²/yr	832320	kWh/yr
Scenario 1	217.0	kWh/m²/yr	414721	kWh/yr
Scenario 2 ASHP	113.4	kWh/m²/yr	216753	kWh/yr
Scenario 2 GSHP	110.1	kWh/m²/yr	210509	kWh/yr

Baseline Thermal Energy Demand Intensity TEDI (kWh/m²/yr)



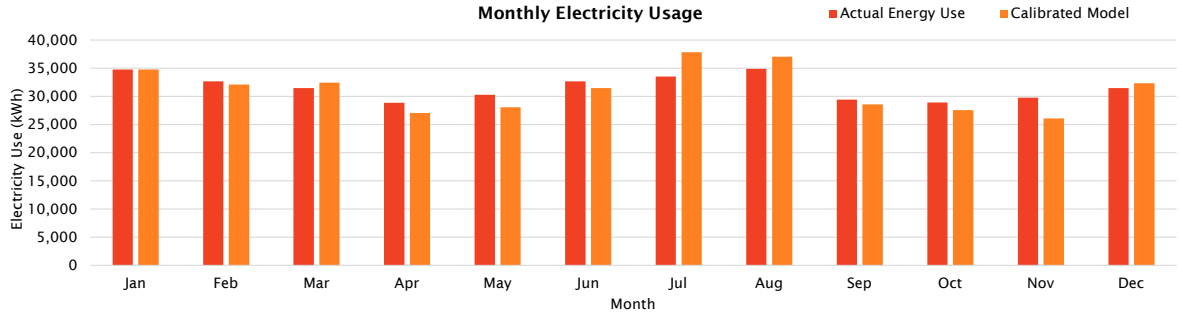
Note: The values presented above, represent the relative proportion of each component of the thermal energy demand intensity. These values include adjustments that account for internal gains from lights/plug loads/solar

Burlington

Project #, Building Name:		26522, Burlington Seniors Centre
Calibrated Model Filename:		26522-Burlington-2022-10-31.inp
Weather File		CAN_ON_HAMILTON-RBG-CS_6153301_CWEC.BIN
Total Energy, kWh	8.73E+05	**List of Model Calibrations:**
Meter EUI, kWh/m2	478	-Significant change in electricity consumption after March 2020. Calibrated the model against 2018/2019 data only. -Electric baseboards have been modelled in each zone served by RTU-7, with capacities to limit underheating in those zones. The RTU-7 LAT is set to modulate 55F to 65F (limiting the heat provided at the RTU furnace). This was done to calibrate the
Model EUI, kWh/m2	463	electricitiy in the winter-time. Comments from the M&R mechanical report reference electric baseboards and space heaters in the rooms served by RTU-7. -Electricity in the Summer and early Fall is not calibrated. Assume this is related to occupancy/programming. Added electrical user loads in May - October to calibrate the model. -OA to RTU-7 modified to 35% per discussions with M&R, and based on the controls strategy.

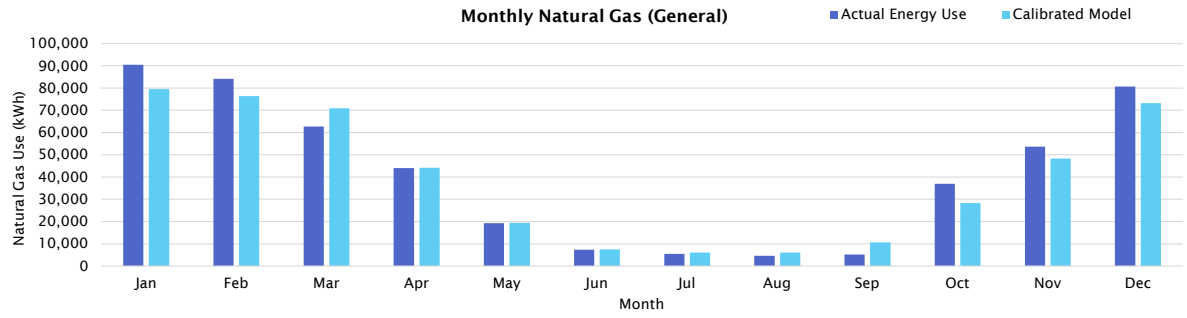
Monthly Electricity Usage (kWh)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Actual Energy Use	34,754	32,691	31,479	28,884	30,255	32,644	33,530	34,874	29,408	28,935	29,772	31,502	378,728
Calibrated Model	34,767	32,103	32,468	27,044	28,061	31,475	37,864	37,066	28,583	27,534	26,074	32,311	375,350
Difference	14	-589	990	-1,840	-2,194	-1,169	4,333	2,192	-825	-1,402	-3,698	809	-3,379
% Difference	0.0%	-1.8%	3.1%	-6.4%	-7.3%	-3.6%	12.9%	6.3%	-2.8%	-4.8%	-12.4%	2.6%	-0.9%



Monthly Natural Gas Usage (kWh)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Actual Energy Use	90,420	84,076	62,711	43,970	19,214	7,285	5,425	4,550	5,196	37,028	53,616	80,599	494,088
Calibrated Model	79,555	76,414	70,873	44,124	19,416	7,439	6,041	6,090	10,587	28,326	48,334	73,142	470,341
Difference	-10,865	-7,662	8,163	155	202	154	616	1,540	5,391	-8,702	-5,282	-7,457	-23,747
% Difference	-12.0%	-9.1%	13.0%	0.4%	1.1%	2.1%	11.4%	33.8%	103.8%	-23.5%	-9.9%	-9.3%	-4.8%



Burlington
Energy Model Input Summary

METHODOLOGY						
The following summary outlines the Proposed Design as presented in the drawings and narratives provided to RDH. Where these documents are not fully developed, assumptions were made based on previous experience. This information will be used to assess the energy savings of the current design to confirm the design is on track to achieve the targeted performance.						
Documents Referenced	Mechanical - Burlington Existing Outline Specification.pdf Burlington Seniors Center - VFA Asset Info.xlsx Site Photos Building Elevations					
ARCHITECTURAL						
Spaces	**Area**				**Units**	**System**
Total	**1911.56**	**Kw/cfm**	**design cfm**	**OA ratio**	m^2	
Multi-Purpose Room	174.9		960	0.22	m^2	RTU-1
Storage	59.21				m^2	RTU-1
RTU-1 Total	**234.11**				**m^2**	
Board Room	21.85				m^2	RTU-2
Washrooms	68.78				m^2	RTU-2
Lobby/Corridor/Janitor	116.98				m^2	RTU-2
RTU-2 Total	**207.61**				**m^2**	
Office	9.635				m^2	RTU-3
Meeting/Programs	92.265				m^2	RTU-3
RTU-3 Total	**101.9**				**m^2**	
Auditorium	417.98				m^2	RTU-4/5/6
RTU-4/5/6 Total	417.98				m^2	
Washrooms	56.51				m^2	RTU-7
Office	77.58				m^2	RTU-7
Recreation	750.47				m^2	RTU-7
RTU-7 Total	**884.56**				**m^2**	
Kitchen	65.4				m^2	MAU-1
MAU-1 Total	**65.4**				**m^2**	

Building Enclosure	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	**Notes**
Above Grade Exterior Walls (Brick) W1	R-6.87	R-15	R-25	R-25	IP	Older Walls: 4" Brick w/ 2" insulation (R3.5/in) over 8" conc blocks. 25% reduction of insulation effectiveness due to thermal bridging of stainless ties Comprises **130 m** of building walls
Above Grade Exterior Walls (Phenolic Panel) W2	R-12.75	R-15	R-25	R-25	IP	Expansion Walls: 3.5" Brick w/ 3" insulation (R5/in) over 7.5" conc blocks. 25% reduction of insulation effectiveness due to thermal bridging of stainless ties Comprises **87 m** of building walls
Roof	R-20.8	R-25	R-60	R-60	IP	Average of old and expansion roof R-values with rigid, tapered insulation. Assumed 4-inches of rigid over entire roof.
Glazing	U-0.6 SHGC-0.37 VT-0.43	U-0.18 SHGC-0.32	U-0.18 SHGC-0.32	U-0.18 SHGC-0.32	IP	Aluminum-framed double glazed storefront windows non-thermally broken. Assuming low-e coated glass.
Doors	Assume U-0.2?	Assume U-0.2	Assume U-0.2	Assume U-0.2	IP	
Fenestration	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Elevation**	
Window to Wall Ratio	5.90%	5.90%	5.90%	5.90%	North	Building Elevations
	9.60%	9.60%	9.60%	9.60%	South	Building Elevations
	13.00%	13.00%	13.00%	13.00%	East	Building Elevations
	11.70%	11.70%	11.70%	11.70%	West	Building Elevations
	11%	**11%**	**11%**	**11%**	**Overall**	Building Elevations
Infiltration Rate	3.0 L/s/m² exterior vertical enclosure and roof area @ 75Pa (Modelled as 0.52 L/s/m² @ 5Pa, assumed operating pressure)	75% Reduction to 0.5L/s/m² exterior enclosure area	75% Reduction to 0.5L/s/m² exterior enclosure area	75% Reduction to 0.5L/s/m² exterior enclosure area	L/s/m2	Based on ASHRAE Fundamentals, Leaky Building (2009); infiltration rate per m^2 of exterior envelope. Assumed for now.

MECHANICAL- Airside						
RTU - 1	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Zones Served	South East Storage/Multipurpose	South East Storage/Multipurpose	Entire building	South East Storage/Multipurpose		
System Type	Forced Air, Constant Volume Furnace with Cooling Unit	Forced Air VAV Furnace with Cooling Unit	Air Source VRF providing refrigerant to FCUs. Outdoor unit can operate down to -22F, but at 0F it's capacity can only provide 85% of the peak building load so electric duct heaters supplement.	Ground Source VRF providing refrigerant to FCUs. Sized to meeting 100% of the peak building cooling load and 90% of the heating (electric duct heaters supplement). Ground loop circulation pumps to be xxx HP and have VFDs.		
Design Air Flow	2,660	Max = 2660 Min = 1064	Assume 350 cfm/ton FCUs cycle on/off to meeting heating & cooling demands	Assume 350 cfm/ton FCUs cycle on/off to meeting heating & cooling demands	cfm	Mechanical - Burlington Existing Outline Specification.pdf
Outdoor air volume	700	varies based on CO2 control	2 ERVs provide ventilation directly into spaces Auditorium ERV = 1500 Rest of building ERV = 900 cfm	2 ERVs provide ventilation directly into spaces Auditorium ERV = 1500 Rest of building ERV = 900 cfm	cfm	Mechanical - Burlington Existing Outline Specification.pdf
Outdoor air control		DCV	VAV boxes with DCV	VAV boxes with DCV		
Heating Capacity	120,000	120,000	ASHP = 2x99,000 @ 0F (Nominal @ 47F = 108,000) Electric duct heaters = 12 kW	HP = 108,000 Electric duct heaters = 7 kW	BTU	Burlington Seniors Center - VFA Asset Info.xlsx
Heating Efficiency	80%	80%	ASHP: COP = 3.83 @ 47F	COP = 6.6		Burlington Seniors Center - VFA Asset Info.xlsx
Cooling Capacity	6.0	6.0	ASHP = 2x8 tons FCU total = 13 tons	HP = 2x8 FCU total = 13 ton	Tons	Burlington Seniors Center - VFA Asset Info.xlsx
Cooling Efficiency			EER = 12.4	EER = 22.5		
Reheat						
Motor HP	2.00	2.00	FCU = 0.25 W/CFM	FCU = 0.25 W/CFM	HP	Mechanical - Burlington Existing Outline Specification.pdf
AHU Supply Fan	CV	VAV				
AHU Return Fan						
Economizer	None	Yes	None	None		
Energy recovery	None	None	Ventilation provided by balanced Dual Core unit: Effectiveness: Sensible = 90%, Latent = 70% Total fan power = 1 W/cfm	Ventilation provided by balanced Dual Core unit: Effectiveness: Sensible = 90%, Latent = 70% Total fan power = 1 W/cfm	Effectiveness	
RTU - 2	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Zones Served	Washroom, Boardroom, Lobby	Washroom, Boardroom, Lobby	see above	see above		
System Type	Variable Volume and temperature (VVT)	Variable Volume and temperature (VVT)				
Design Air Flow	960 (50% min flow)	max = 960 min = 384			cfm	Mechanical - Burlington Existing Outline Specification.pdf
Outdoor air volume	212	varies based on CO2 control	7,774		cfm	Mechanical - Burlington Existing Outline Specification.pdf
Outdoor air control		DCV	4,550			
Heat Input	64,000	64,000	12,324		BTU	Burlington Seniors Center - VFA Asset Info.xlsx
Heat Output	51,500/60,000	fan curves			BTU	Burlington Seniors Center - VFA Asset Info.xlsx / Mechanical - Burlington Existing Outline Specification.pdf
Cooling	2.0	2.0			tons	Burlington Seniors Center - VFA Asset Info.xlsx
Cooling Efficiency	9.0	9.0			EER	RDH assumption
Reheat						
Motor HP	0.30	0.30			HP	Mechanical - Burlington Existing Outline Specification.pdf
Economizer	None	Yes				
Energy recovery	None	None			Effectiveness	

RTU - 3	Burlington Seniors Center	Scenario 1: Min Acceptable 50% Reduction	Scenario 2: ASHP Net Zero Ready	Scenario 2: Net Zero Ready GSHP	Units	Notes
Zones Served	West Office/Meeting Rooms	West Office/Meeting Rooms	see above	see above		
System Type	Constant Volume Forced Air Furnace	VAV Forced Air Furnace				
Design Air Flow	850	850 Min = 340			cfm	Mechanical - Burlington Existing Outline Specification.pdf
Outdoor air volume	212	varies based on CO2 control			cfm	Mechanical - Burlington Existing Outline Specification.pdf
Outdoor air control		DCV				
Heat Input	75,000	75,000			BTU	Burlington Seniors Center - VFA Asset Info.xlsx
Heat Output	60,500/42,000	60,500/42,000			BTU	Burlington Seniors Center - VFA Asset Info.xlsx / Mechanical - Burlington Existing Outline Specification.pdf
Cooling	2.5	2.5			tons	Burlington Seniors Center - VFA Asset Info.xlsx
Cooling Efficiency	9.0	9.0			EER	RDH assumption
Reheat	None	None				
Economizer	None	Yes				Site Photos
Energy recovery	None	None			Effectiveness	Site Photos
Zone Heating / Cooling	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Heating	Linear Diffusers + Ceiling Diffusers	Linear Diffusers + Ceiling Diffusers				
Cooling						
Supplementary heating	None	None				
RTU - 4/5/6	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	**Notes**
Zones Served	Auditorium	Auditorium	see above	see above		
System Type	Forced Air Furnace	Forced Air Furnace				
Design Air Flow	6000 (RTU 4) 4000 (RTU 5/6) Min flow 50%	6000 (RTU 4) 4000 (RTU 5/6) Min flow 40%			cfm	Mechanical - Burlington Existing Outline Specification.pdf
Outdoor air volume	15%	varies based on CO2 control			%	per M&R
Outdoor air control		DCV				
Heat Input	250,000 (All)	250,000 (All)			BTU	Burlington Seniors Center - VFA Asset Info.xlsx
Heat Output	203,000(RTU 4) 200,000 (RTU5/6)	203,000(RTU 4) 200,000 (RTU5/6)			BTU	Mechanical - Burlington Existing Outline Specification.pdf
Cooling	15 (RTU 4) 10 (RTU 5/6)	15 (RTU 4) 10 (RTU 5/6)			Tons	Mechanical - Burlington Existing Outline Specification.pdf
Cooling Efficiency	9.0	9.0			EER	RDH assumption
Reheat	None	None				
Motor HP	5 (RTU 4) 3 (RTU 5/6)	5 (RTU 4) 3 (RTU 5/6)			HP	Mechanical - Burlington Existing Outline Specification.pdf
Economizer	None	Yes				
Energy recovery	None	None			Effectiveness	
Zone Heating / Cooling	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Heating	Linear Diffusers + Ceiling Diffusers	Linear Diffusers + Ceiling Diffusers				
Cooling						
Supplementary heating	None	None				

RTU - 7	Burlington Seniors Center	Scenario 1: Min Acceptable 50% Reduction	Scenario 2: ASHP Net Zero Ready	Scenario 2: Net Zero Ready GSHP	Units	Notes
Zones Served	Dining, Billiard, Misc.	Dining, Billiard, Misc.	Dining, Billiard, Misc.	Dining, Billiard, Misc.		
System Type	Forced Air Furnace with VAV	Forced Air Furnace with VAV				
Design Air Flow	13000 (Min Flow 50%)	13000 (Min Flow 50%)	13000 (Min Flow 50%)	13000 (Min Flow 50%)	cfm	Mechanical - Burlington Existing Outline Specification.pdf
Outdoor air volume	4,550 (35% OA)	Demand Controlled Ventilation	Demand Controlled Ventilation	Demand Controlled Ventilation	cfm	Mechanical - Burlington Existing Outline Specification.pdf Modified per discussion w/ M&R 25% operational plus additional purge time Scenarios 1 and 2 include demand controlled ventilation
Outdoor air control						
Heat Input	700,000	700,000	700,000	700,000	BTU	Burlington Seniors Center - VFA Asset Info.xlsx
Heat Output	574,000	574,000	574,000	574,000	BTU	Mechanical - Burlington Existing Outline Specification.pdf
Cooling	40.0	40.0	40.0	40.0	Tons	Burlington Seniors Center - VFA Asset Info.xlsx
Cooling Efficiency	9.0	9.0	9.0	9.0	EER	RDH assumption
Reheat						
Motor HP	15.00	15.00	15.00	15.00	HP	Mechanical - Burlington Existing Outline Specification.pdf
Economizer	None	Yes	None	None		
Energy recovery	None	None	None	None	Effectiveness	
Zone Heating / Cooling	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Heating	Electric Baseboards	Electric Baseboards	Electric Baseboards	Electric Baseboards		
Cooling						
MAU Serving Kitchen	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
System Type	Make Up Air	VAV Make Up Air	VAV Make Up Air	VAV Make Up Air		
Design Air Flow	2,000	Max = 1200 Min = 360	Max = 1200 Min = 360	Max = 1200 Min = 360	cfm	Mechanical - Burlington Existing Outline Specification.pdf Scenario 2 modeled as 600 cfm continuous to approximate a lower run time at high speed
Outdoor air volume	2,000	100%	100%	100%	cfm	Mechanical - Burlington Existing Outline Specification.pdf
Heating Capacity	195,000	30kW electric heater	30kW electric heater	30kW electric heater	BTUH	Mechanical - Burlington Existing Outline Specification.pdf
Cooling	12.00	12.00	12.00	12.00	Tons	Mechanical - Burlington Existing Outline Specification.pdf
Cooling Efficiency	9.0	11.0	11.0	11.0	EER	RDH assumption
MAU Supply Fan	(1)10/10 6.5 FLA 2 HP 86.5% eff	0.6 bhp	0.6 bhp	0.6 bhp		Site Photos
Kitchen Exhaust (CP-KX-1)	2000 CFM 0.75 HP	1200 CFM 0.6 bhp	1200 CFM 0.6 bhp	1200 CFM 0.6 bhp	CFM	Per M&R
Fan control	VFD	VFD	VFD	VFD		
ERV Effectiveness	None	None	None	None		
Economizer	None	None	None	None		
Mini Split Kitchen Storage	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
System Type	Mini Split Unit for Kitchen Storage **Systems not included in model - controls and operation not known**	Mini Split Unit for Kitchen Storage **Systems not included in model - controls and operation not known**	Mini Split Unit for Kitchen Storage **Systems not included in model - controls and operation not known**	Mini Split Unit for Kitchen Storage **Systems not included in model - controls and operation not known**		Mechanical - Burlington Existing Outline Specification.pdf
Design Air Flow	259/215/191	259/215/191	259/215/191	259/215/191	cfm	Goodman MiniSplit MSG12 CRN1N/W
Outdoor air volume	0	0	0	0	cfm	
Heating Max	12,000	12,000	12,000	12,000	BTUH	Goodman MiniSplit MSG12 CRN1N/W
Heating Min					BTUH	
Cooling	12,000	12,000	12,000	12,000	BTUH	Goodman MiniSplit MSG12 CRN1N/W
Cooling Efficiency	13.5	13.5	13.5	13.5	SEER	Goodman MiniSplit MSG12 CRN1N/W
Fans						
Fan control						
Mini Split Lounge Storage	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
System Type	Mini Split Unit for Lounge Storage **Systems not included in model - controls and operation not known**	Mini Split Unit for Lounge Storage **Systems not included in model - controls and operation not known**	Mini Split Unit for Lounge Storage **Systems not included in model - controls and operation not known**	Mini Split Unit for Lounge Storage **Systems not included in model - controls and operation not known**		Mechanical - Burlington Existing Outline Specification.pdf
Design Air Flow	341/288/235/200	341/288/235/200	341/288/235/200	341/288/235/200	cfm	Arcoaire Minisplit DLCH612K1A
Outdoor air volume	0	0	0	0	cfm	Arcoaire Minisplit DLCH612K1A
Heating Max	12,000	12,000	12,000	12,000	BTUH	Arcoaire Minisplit DLCH612K1A
Heating Min	6,800	6,800	6,800	6,800	BTUH	Arcoaire Minisplit DLCH612K1A
Heating Efficiency	8.5	8.5	8.5	8.5	HSPF	Arcoaire Minisplit DLCH612K1A
Cooling	12000.00	12000.00	12000.00	12000.00		Arcoaire Minisplit DLCH612K1A
Cooling Efficiency	16.00	16.00	16.00	16.00	SEER	Arcoaire Minisplit DLCH612K1A
Fans						
Fan control						

Miscellaneous Ventilation Systems	Burlington Seniors Center	Scenario 1: Min Acceptable 50% Reduction	Scenario 2: ASHP Net Zero Ready	Scenario 2: Net Zero Ready GSHP	Units	
Kiln Room (EF-3)	1109-2399 CFM Motor HP: 1/2	1109-2399 CFM Motor HP: 1/2	1109-2399 CFM Motor HP: 1/2	1109-2399 CFM Motor HP: 1/2	cfm	Burlington Seniors Center - VFA Asset Info.xlsx Flow rate per M&R Use only once a week per RFI 16
Lobby Washroom Exhaust Fans (EF-4)	200 CFM 0.15 HP	200 CFM 0.15 HP	200 CFM 0.15 HP	200 CFM 0.15 HP	cfm	per M&R
Expansion Washroom Exhaust Fan (EF-1)	905 CFM 1.5 HP	905 CFM 1.5 HP	905 CFM 1.5 HP	905 CFM 1.5 HP	cfm	Mechanical - Burlington Existing Outline Specification.pdf

SPACE CONDITIONS

Space types	MNECB Schedule	MNECB Schedule	MNECB Schedule	MNECB Schedule	Total Occupancy	
Rec Centre (community room, fitness etc.)	C	C	C	C	per NECB	
Program Rooms	C	C	C	C		
Offices	A	A	A	A		
Rec Centre	C	C	C	C		
Activity Court	C	C	C	C		
Change rooms	C	C	C	C		
Space type	**Heating Setpoint/ Setback**	**Heating Setpoint/ Setback**	**Heating Setpoint/ Setback**	**Heating Setpoint/ Setback**	**Cooling Setpoint/ Setback**	
Thermostats	72	72	72	72	75 F/ 80 F	
DHW	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
Heating Source	Natural Gas tankless heater with separate storage tank (80 gal)	Natural Gas tankless heater with separate storage tank (80 gal)	Packaged HP Water Heater (ASHP)	Packaged HP Water Heater (ASHP)		Mechanical - Burlington Existing Outline Specification.pdf
Efficiency			COP = 3.5 (2.7 seasonal)	COP = 3.5 (2.7 seasonal)	Gallons	
DHW Tank Setpoint	140	140	140	140	F	per M&R
DHW Delivery Setpoint	140	140	140	140	F	per M&R
Toilets					gpm	
Lavatory Faucets					gpm	
Showers					gpm	
Load	0.3	0.3	0.3	0.3	gpm peak	DHW load reduced from NECB rates during calibration to match July NG Consumption

ELECTRICAL						
Lighting	**Burlington Seniors Center**	**Scenario 1: Min Acceptable 50% Reduction**	**Scenario 2: ASHP Net Zero Ready**	**Scenario 2: Net Zero Ready GSHP**	**Units**	
General	1.22	0.73	0.65	0.65	W/ft2	Per M&R (2022-11-10)
Occupancy Sensor Controls	None	None	Automatic control	Automatic control	Fixtures Controlled	
Daylight Sensor Controls	None	None	Daylight sensor in areas with natural light	Daylight sensor in areas with natural light		
Process Loads						
Load					**Units**	
Commercial Fridge/Freezer	Kitchen storage - 0.5kW Coat storage - 0.8kW	Kitchen storage - 0.5kW Coat storage - 0.8kW	Kitchen storage - 0.5kW Coat storage - 0.8kW	Kitchen storage - 0.5kW Coat storage - 0.8kW	KW	per M&R

Appendix H

Panel Schematics

- **Panel Schematics**
- **Panel Connection Details**

Roof Panel Schematics

Cellulose Inverted Roof - R18 - 2x4 - DensGlass

ReCover Initiative

ReCover

Version Date
February 27, 2023

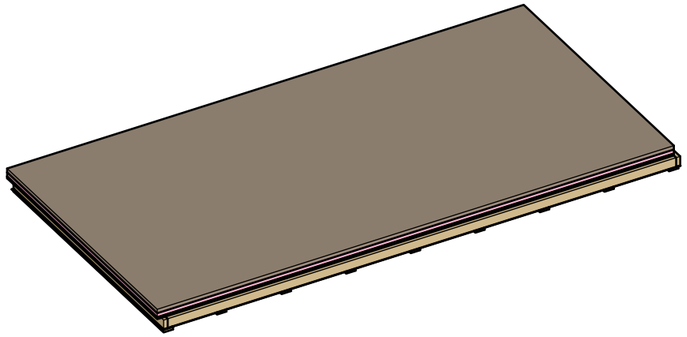
PROJECT
2x4 R18 Cellulose XPS
Inverted Roof Panel

Drawn By
Nick Rudnicki

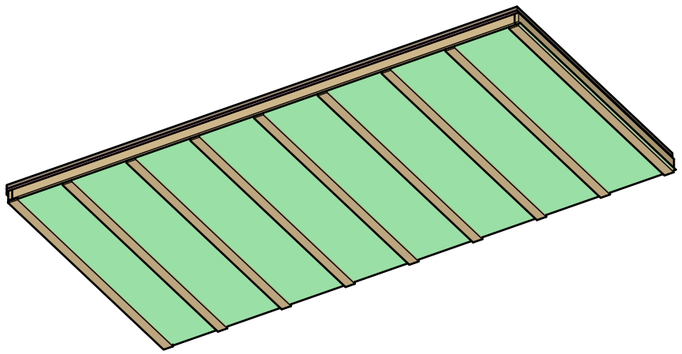
01

Installed and Finished Panel

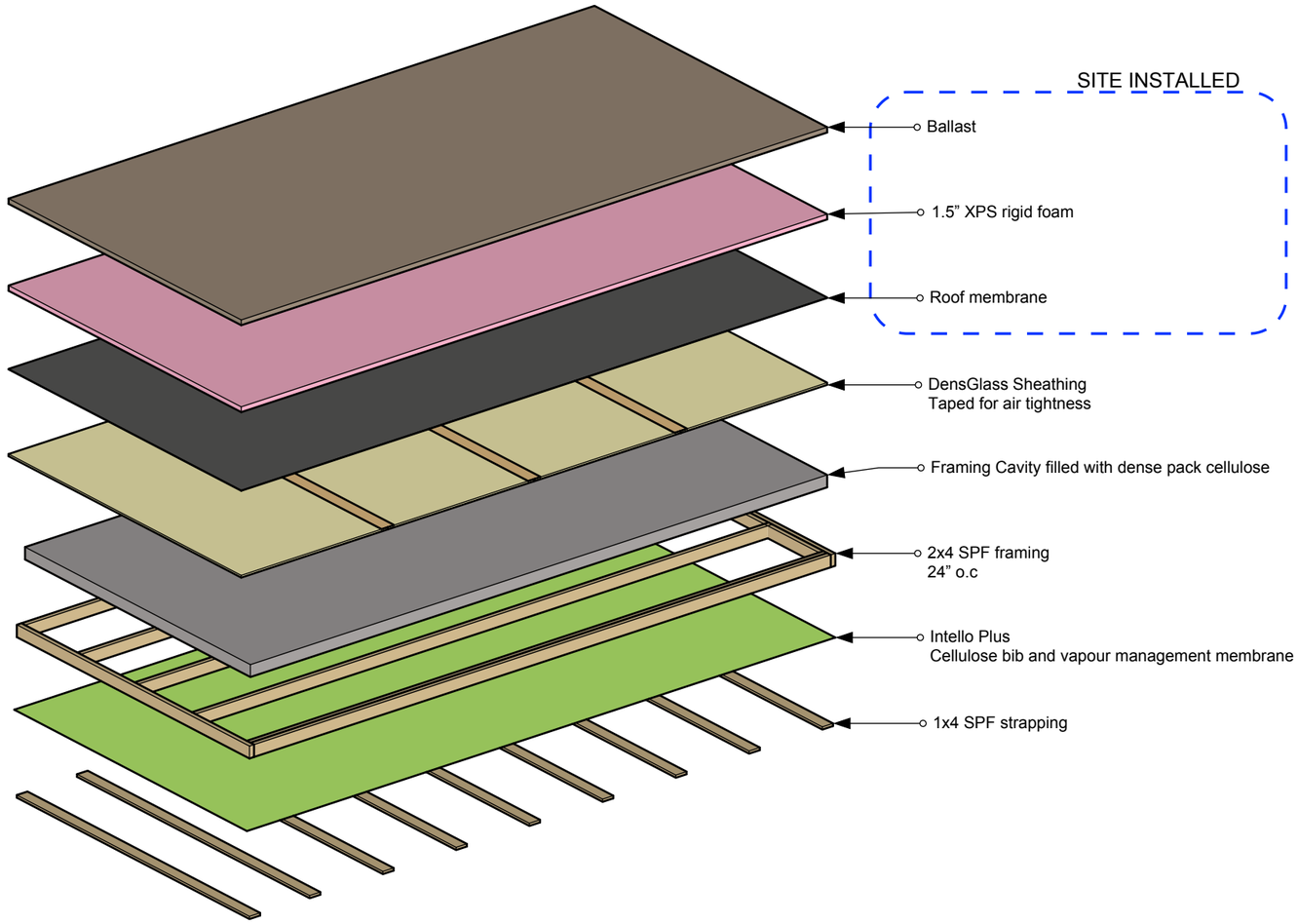
Overview of panel and site-installed XPS and roofing



Top View



Bottom View



Exploded View

ReCover

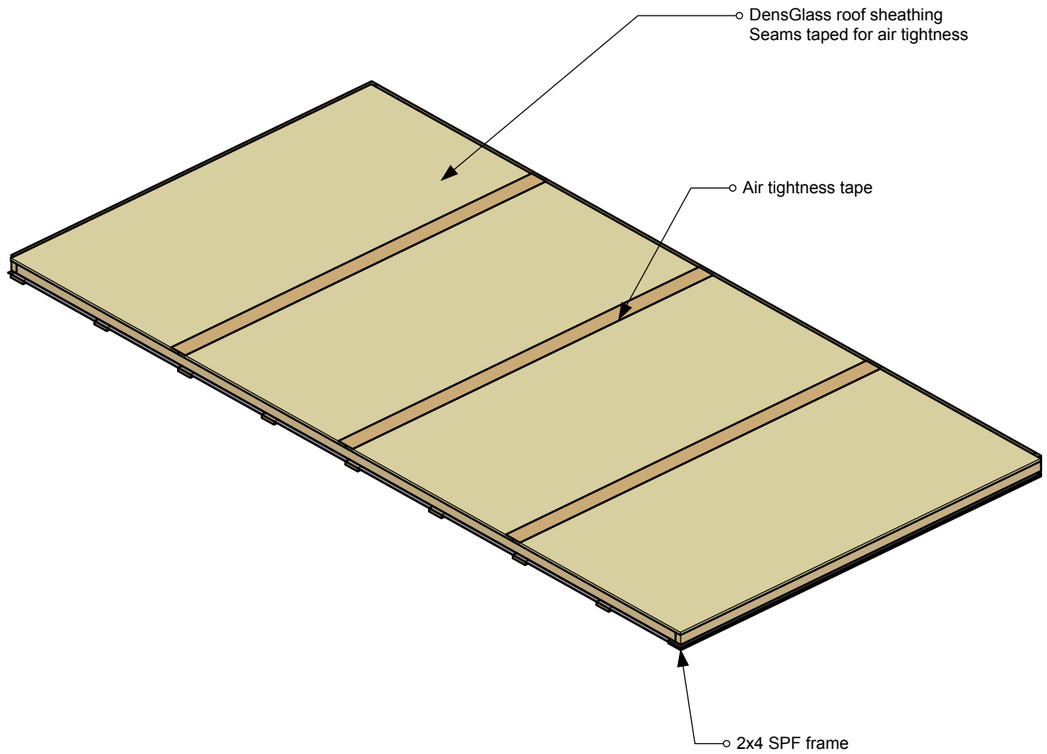
Version Date
February 27, 2023

PROJECT
2x4 R18 Cellulose XPS
Inverted Roof Panel

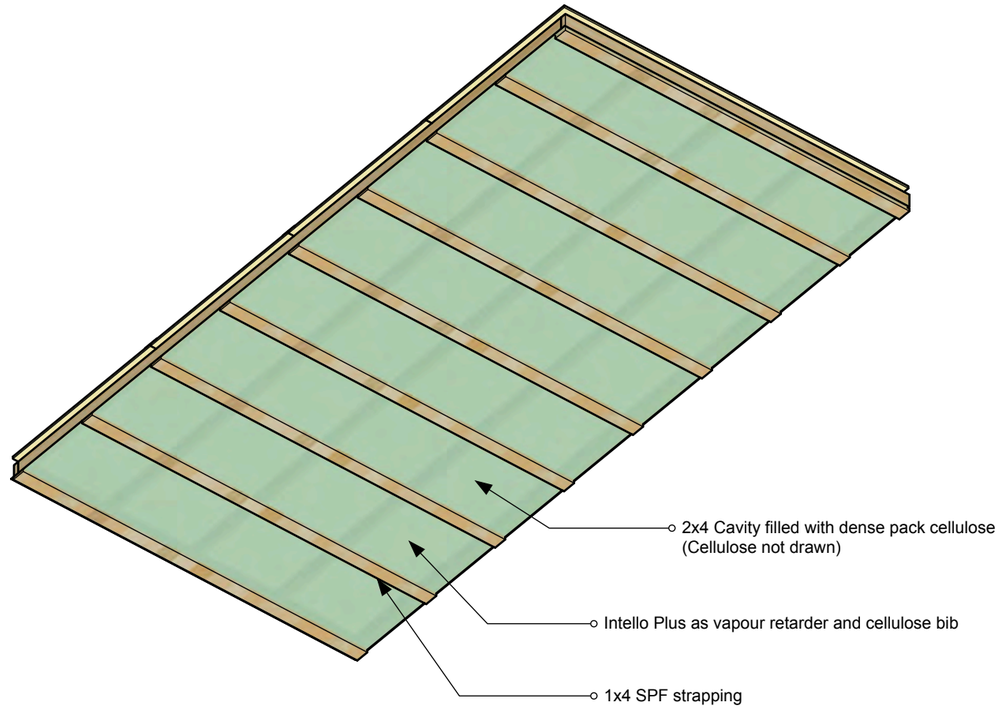
Drawn By
Nick Rudnicki

02

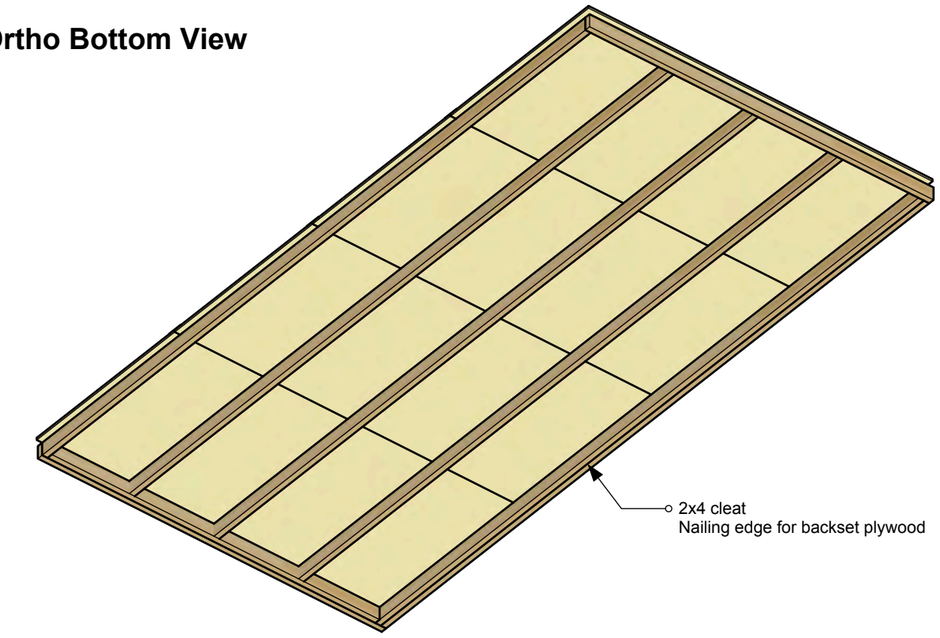
Just the Panel Overview



Top View



Ortho Bottom View



ReCover

Version Date
February 27, 2023

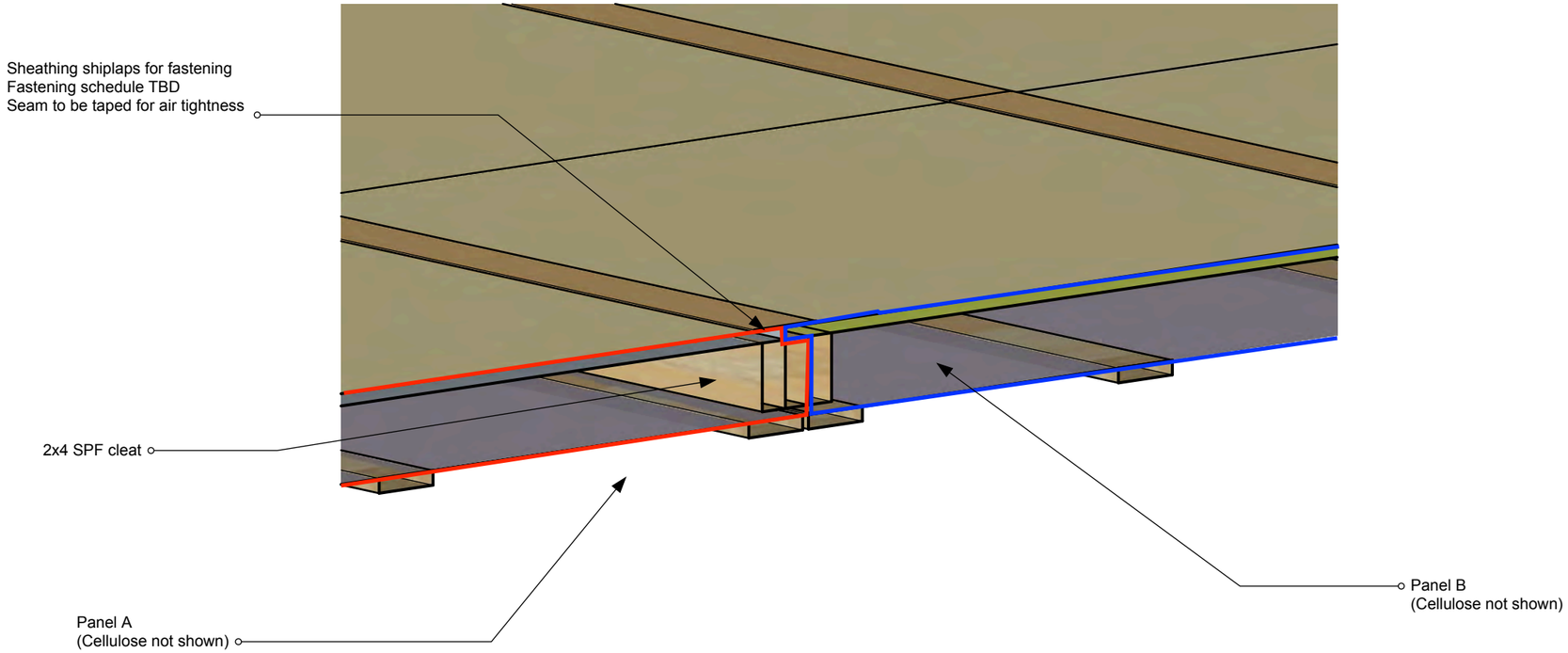
PROJECT
2x4 R18 Cellulose XPS
Inverted Roof Panel

Drawn By
Nick Rudnicki

03

Seam Joining Detail

How Panels Join Together on Site



ReCover

Version Date
February 27, 2023

PROJECT
2x4 R18 Cellulose XPS
Inverted Roof Panel

Drawn By
Nick Rudnicki

04

Roof Panel Schematics

Cellulose Inverted Roof - R38 - 2x8 - DensGlass

ReCover Initiative

ReCover

DRAWN BY
Nick Rudnicki

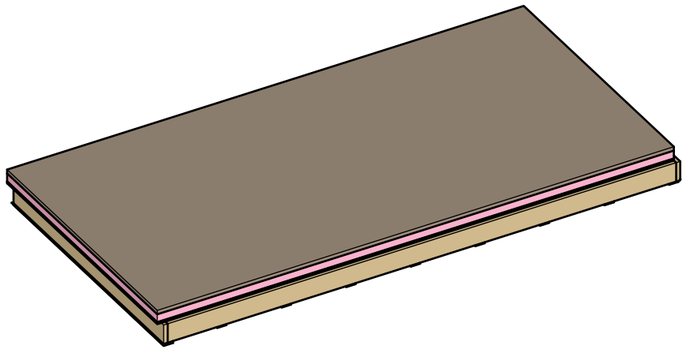
PROJECT
2x8 R38 Cellulose XPS
Inverted Roof Panel

Version Date
February 27, 2023

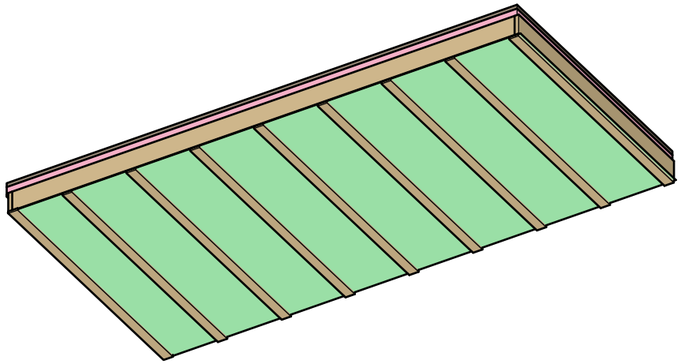
01

Installed and Finished Panel

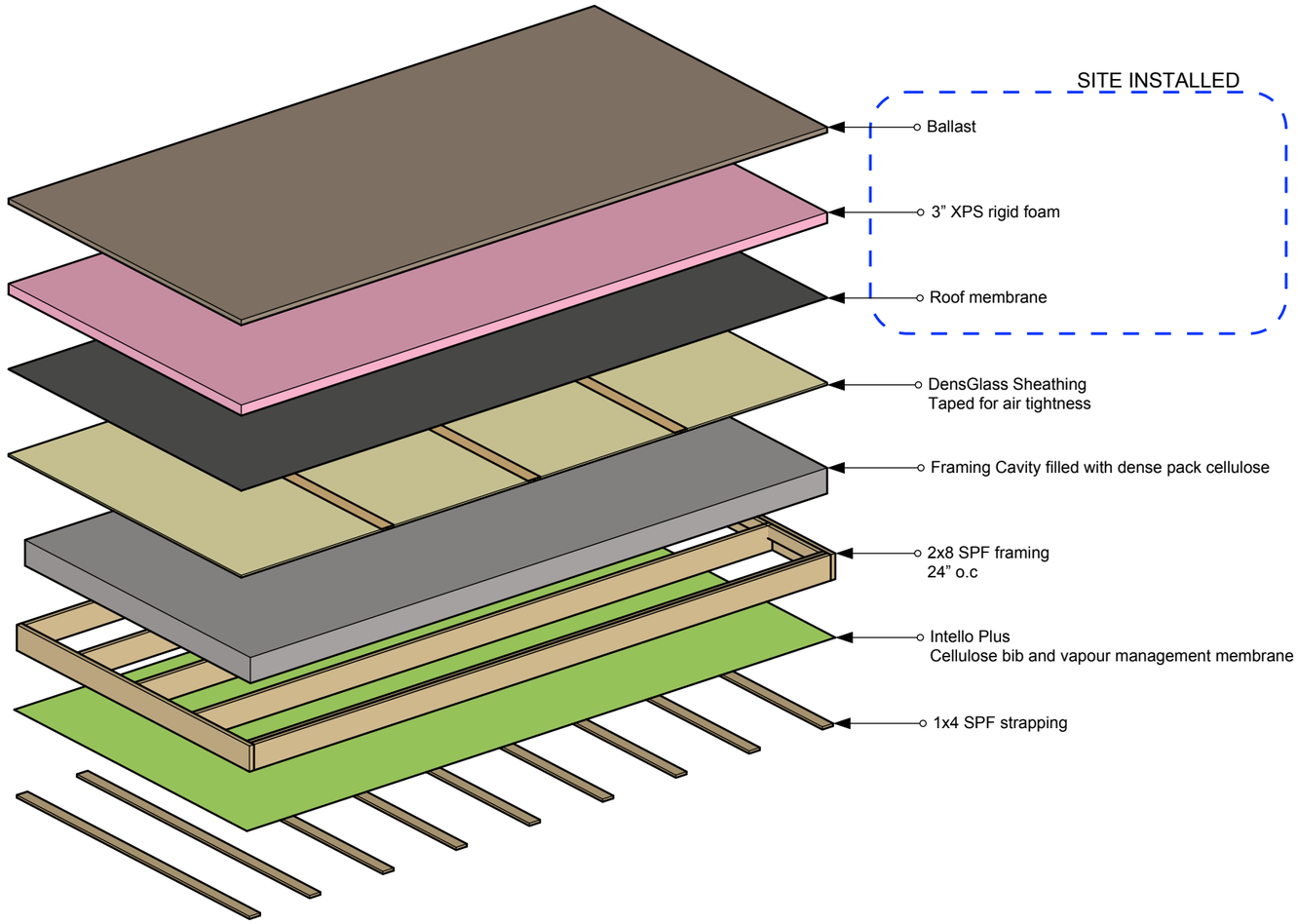
Overview of panel and site-installed XPS and roofing



Top View



Bottom View



Exploded View

ReCover

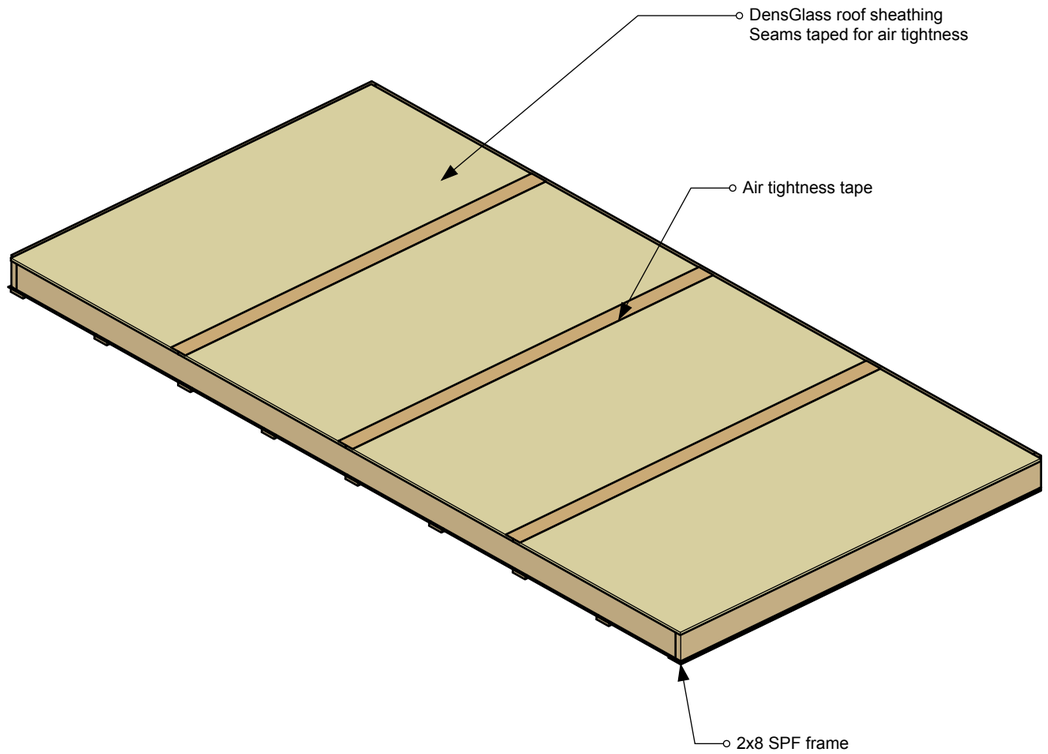
Version Date
February 27, 2023

PROJECT
2x8 R38 Cellulose XPS
Inverted Roof Panel

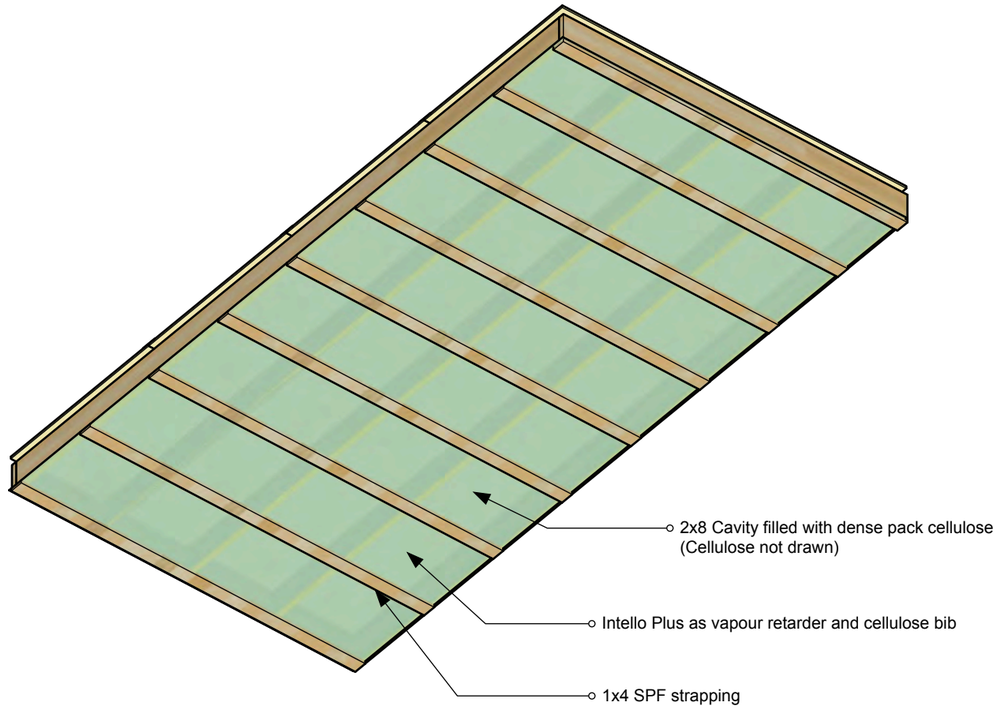
DRAWN BY
Nick Rudnicki

02

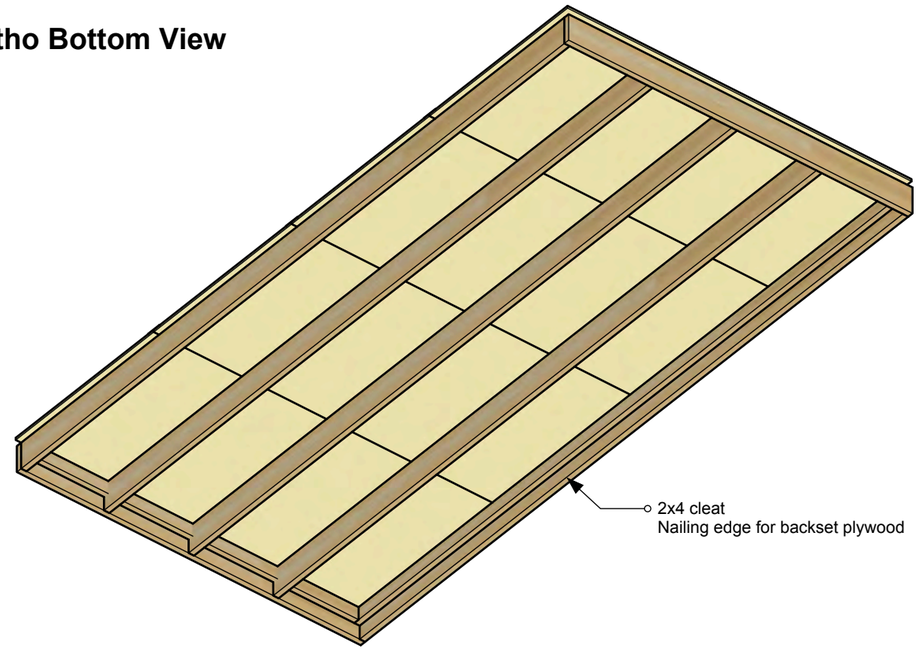
Just the Panel Overview



Top View



Ortho Bottom View



ReCover

Version Date
February 27, 2023

PROJECT
2x8 R38 Cellulose XPS Inverted Roof Panel

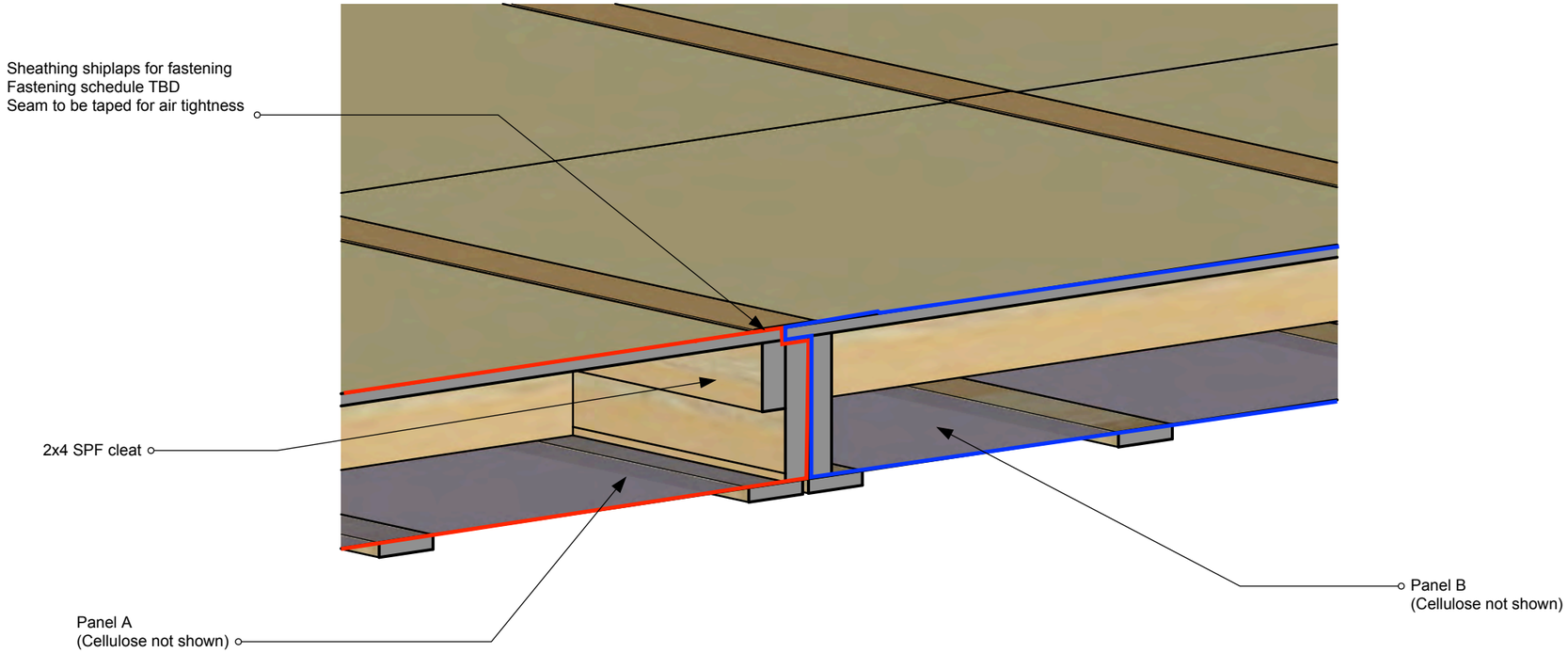
DESCRIPTION
Sheet Description

DRAWN BY
Nick Rudnicki

03

Seam Joining Detail

How Panels Join Together on Site



ReCover

Version Date
February 27, 2023

PROJECT
2x8 R38 Cellulose XPS Inverted Roof Panel

DESCRIPTION
Sheet Description

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04

Wall Panel Schematics

Cellulose - R11 - 2x4 - 1/2” Plywood

ReCover Initiative

ReCover

DRAWN BY
Nick Rudnicki

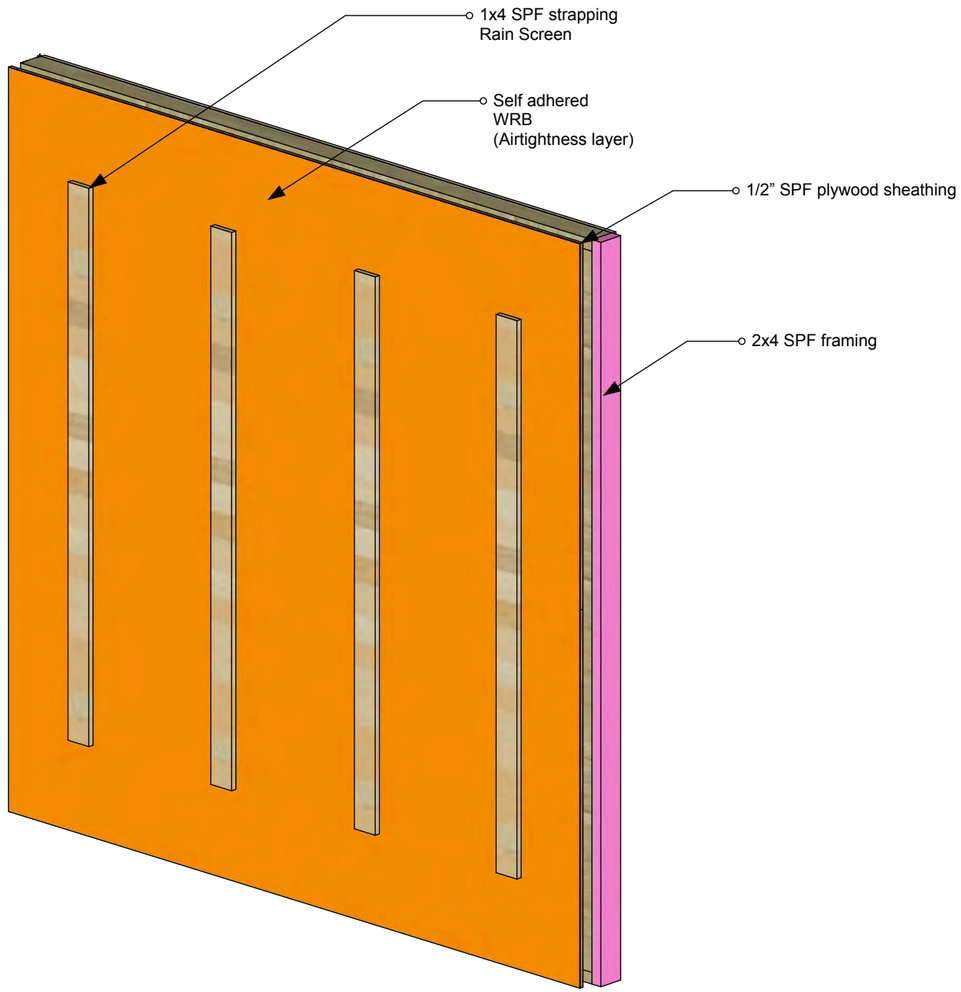
PROJECT
2x4 R11 Cellulose
Panel Schematics

Version Date
February 27, 2023

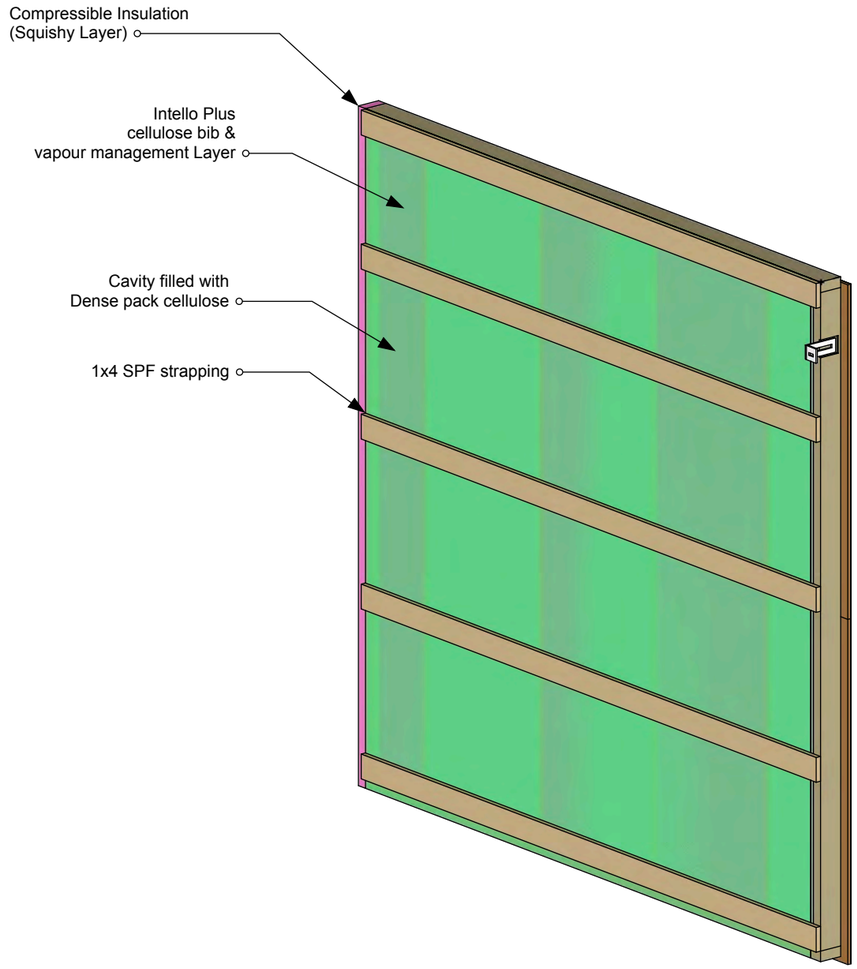
01

Panel - Overview

Panel schematic with all membranes in place



EXTERIOR VIEW



INTERIOR VIEW

ReCover

Version Date
February 27, 2023

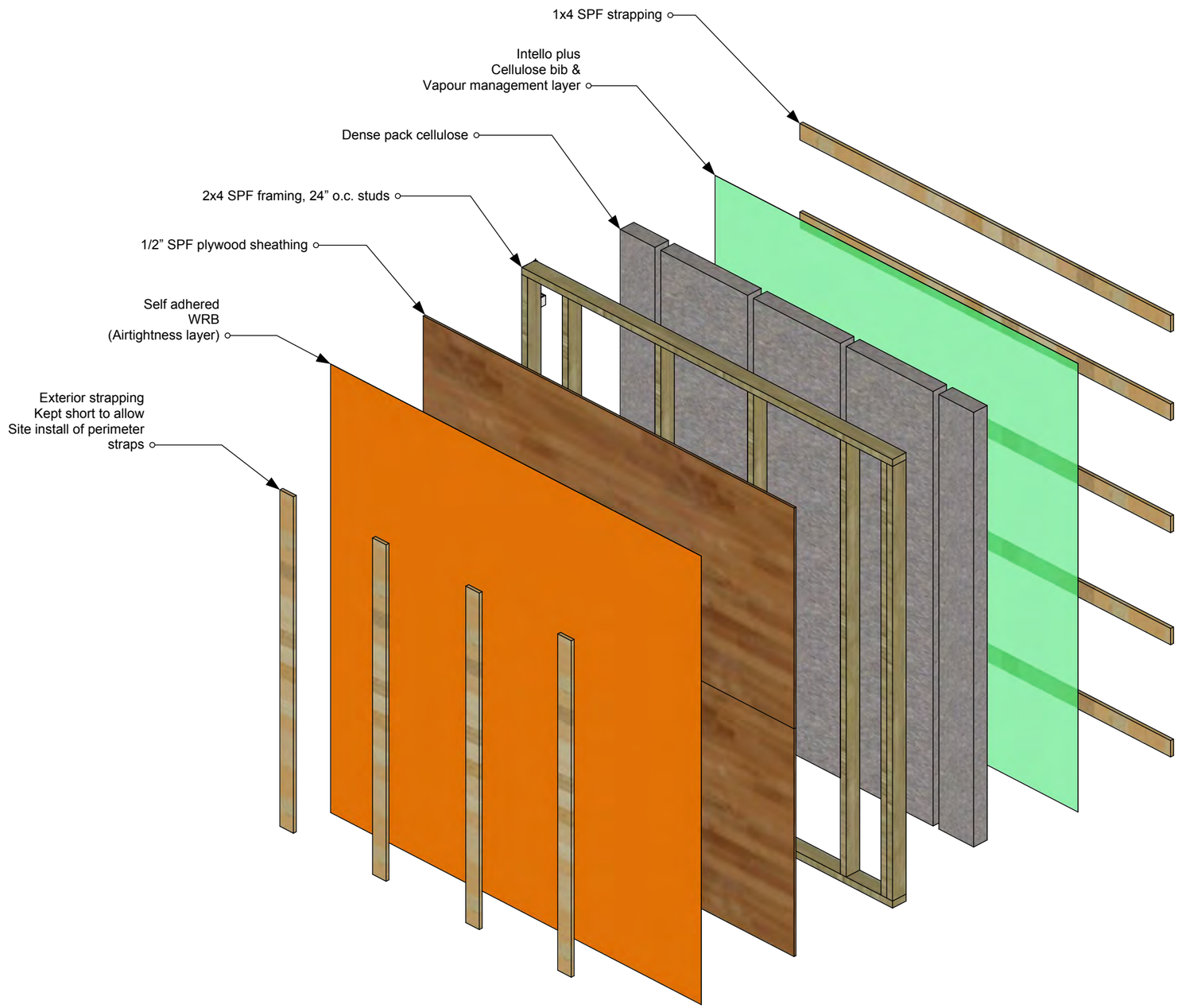
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

02

Panel - Exploded View

Panel schematic with all membranes in place



ReCover

Version Date
February 27, 2023

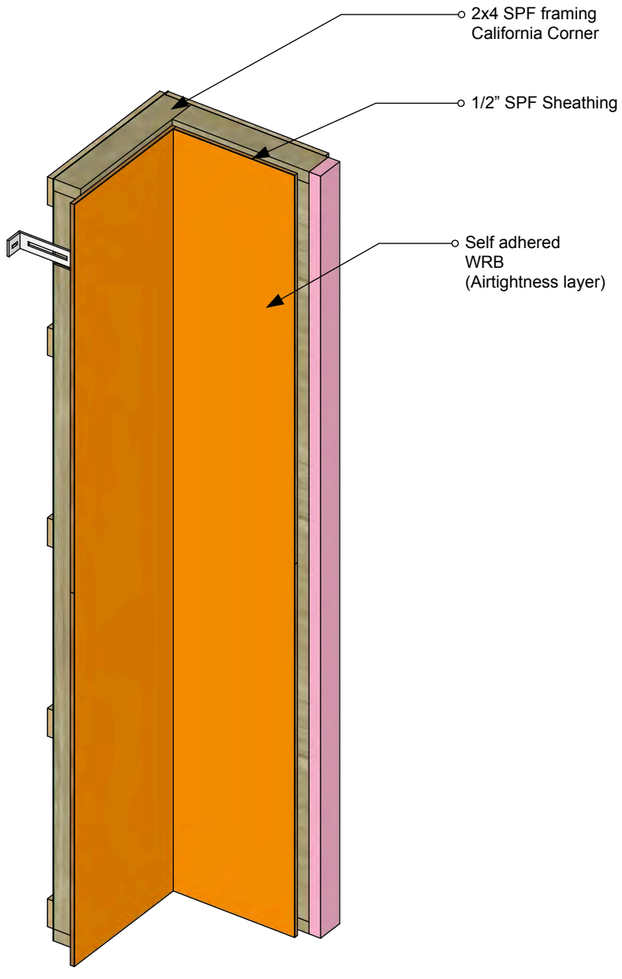
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

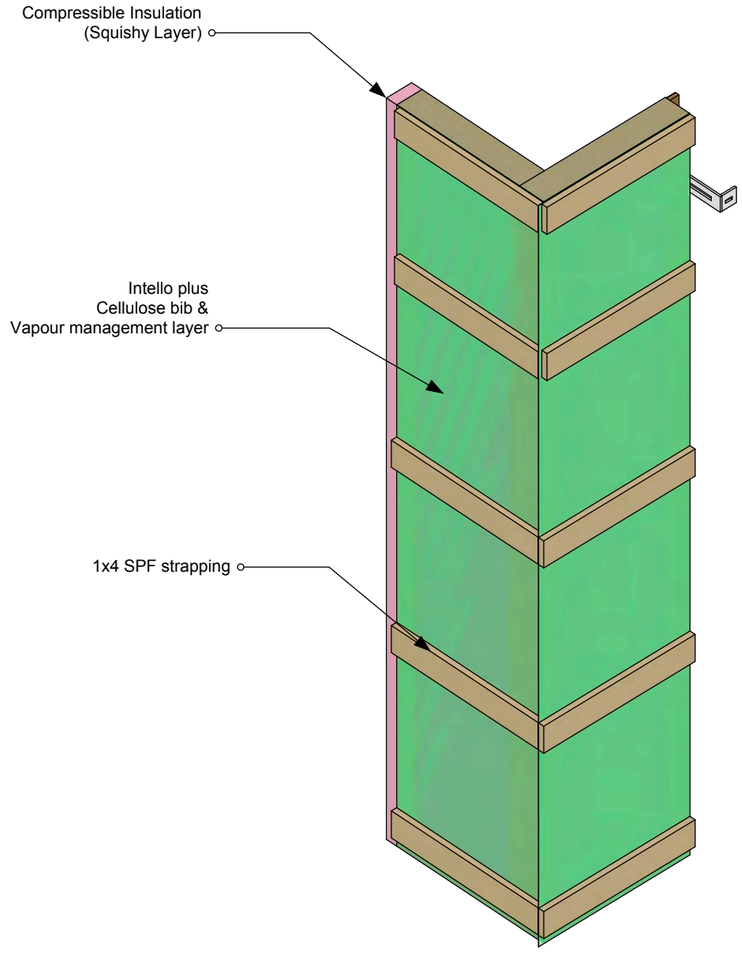
03

Panel - Inside Corner

Panel schematic with all membranes in place



EXTERIOR VIEW



INTERIOR VIEW

RSI projects

ReCc

Version Date
February 27, 2023

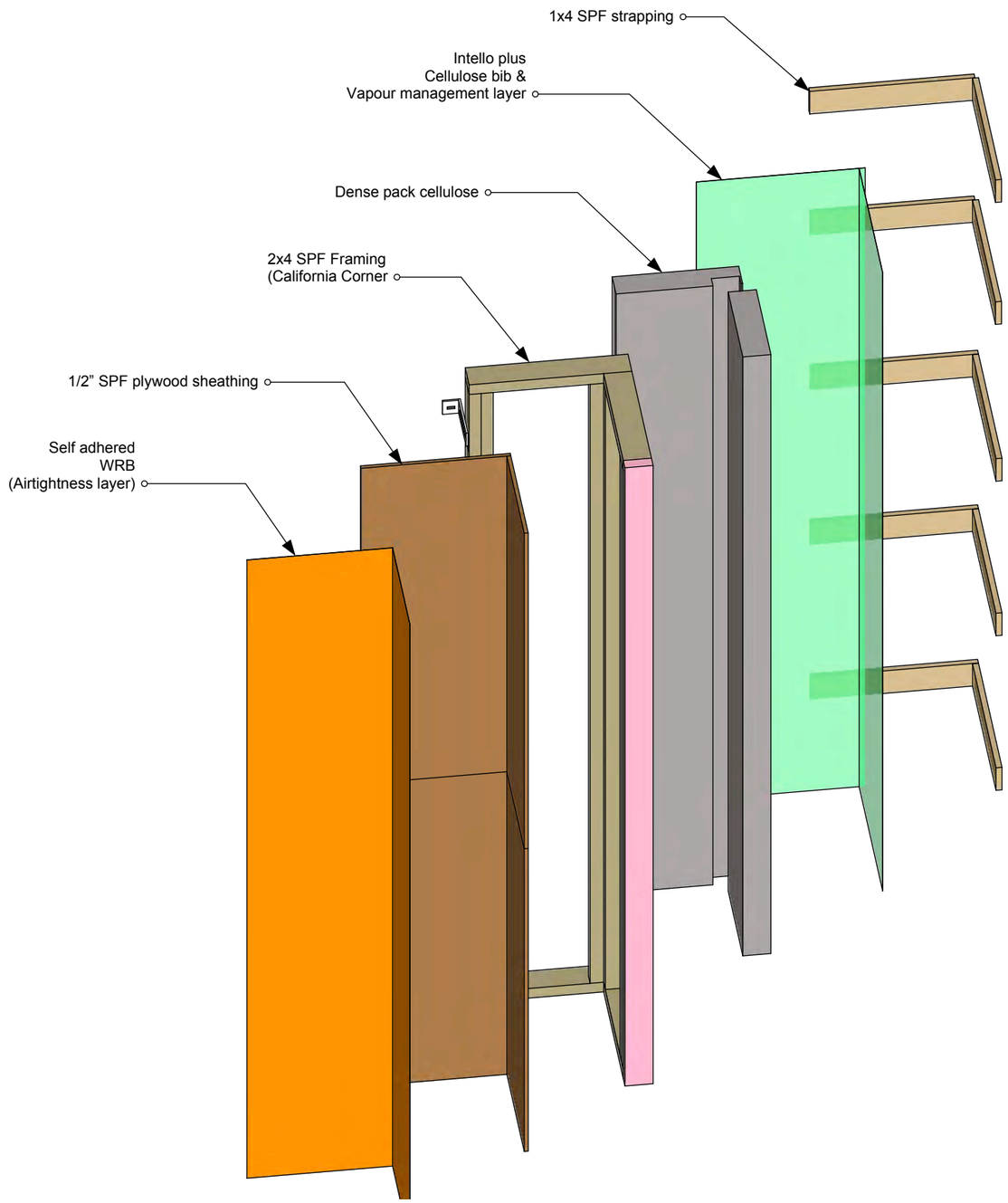
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

04

Panel - Inside Corner - Exploded

Panel schematic with all membranes in place



ReCover

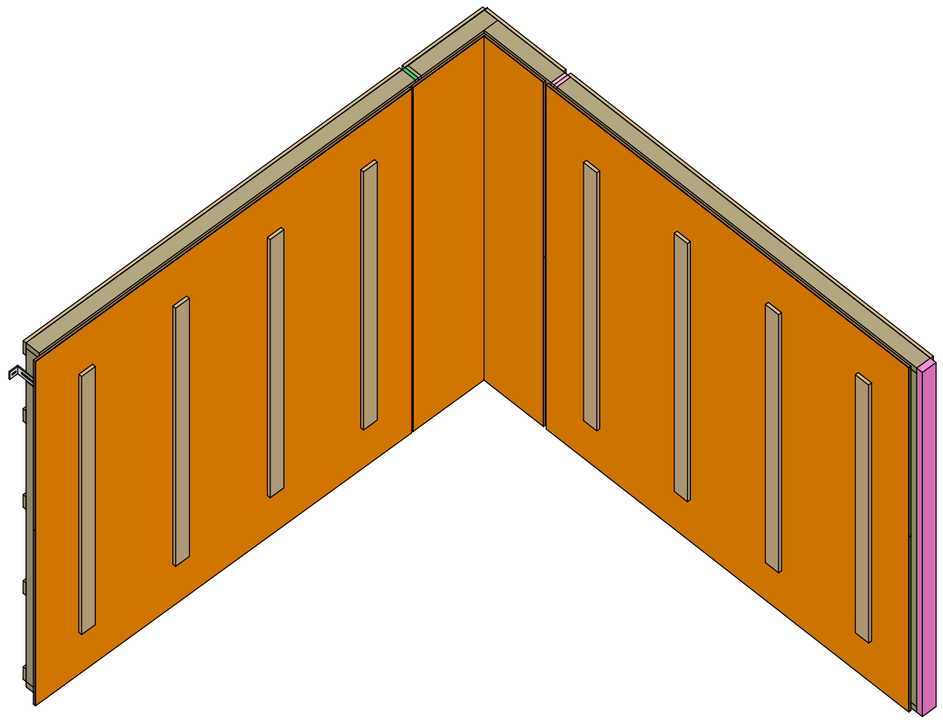
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

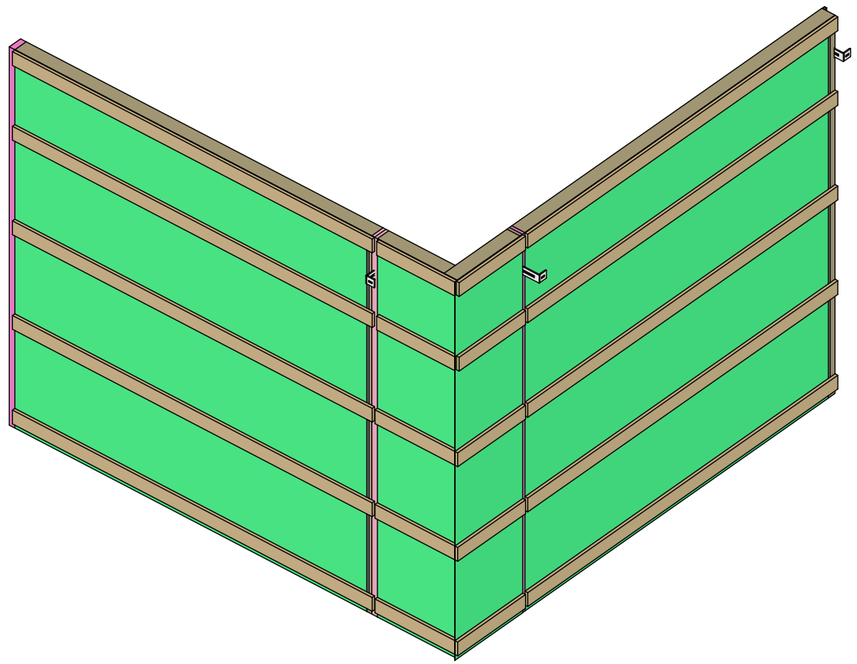
DRAWN BY
Nick Rudnicki

05

Inside Corner Installed



EXTERIOR VIEW



INTERIOR VIEW

ReCover

Version Date
February 27, 2023

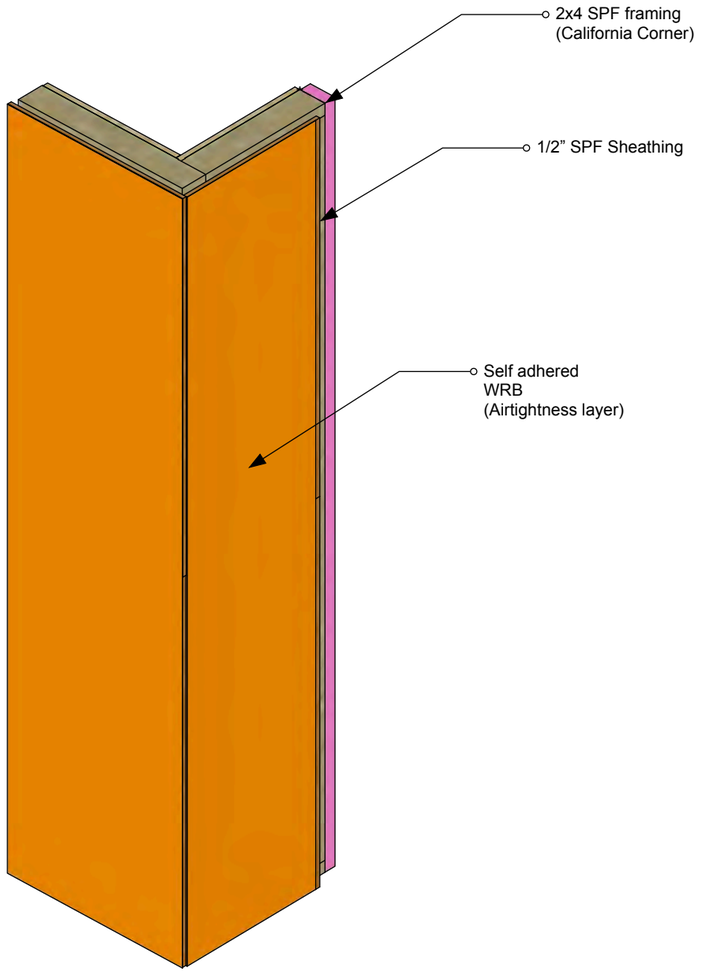
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

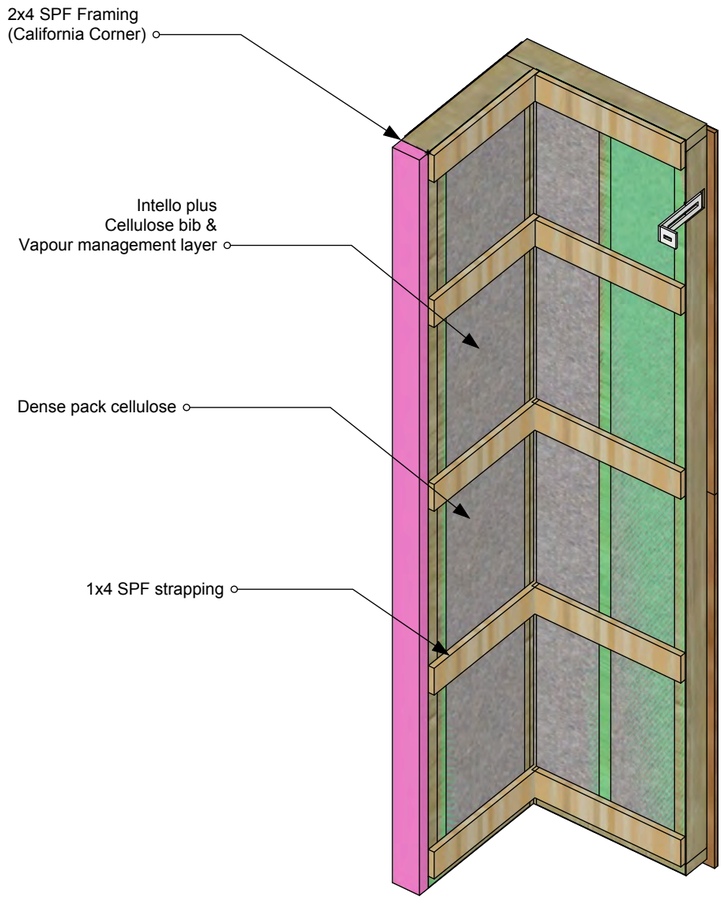
06

Panel - Outside Corner

Panel schematic with all membranes in place



EXTERIOR VIEW



INTERIOR VIEW

ReCover

Version Date
February 27, 2023

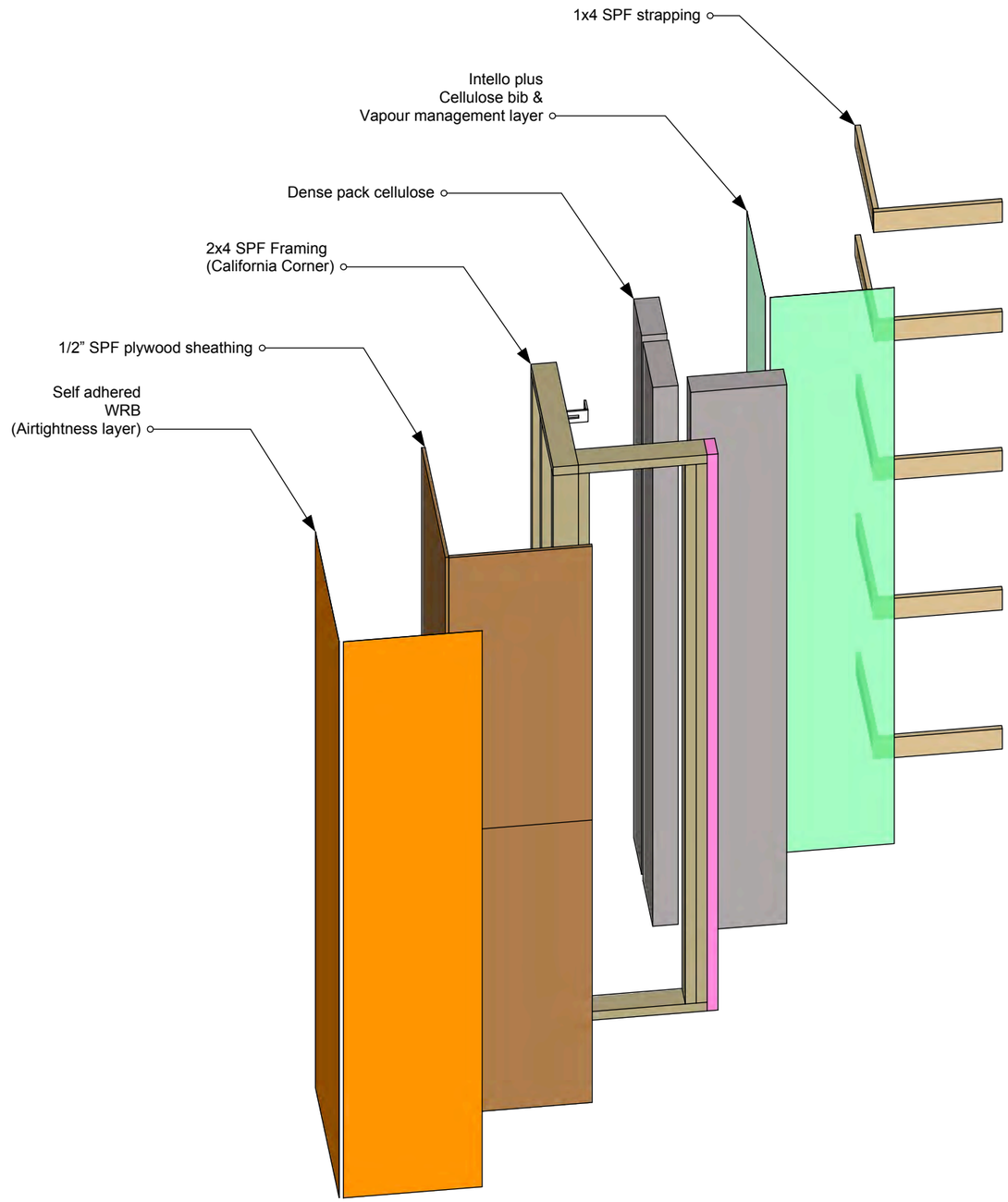
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

07

Panel - Outside Corner - Exploded

Panel schematic with all membranes in place



ReCover

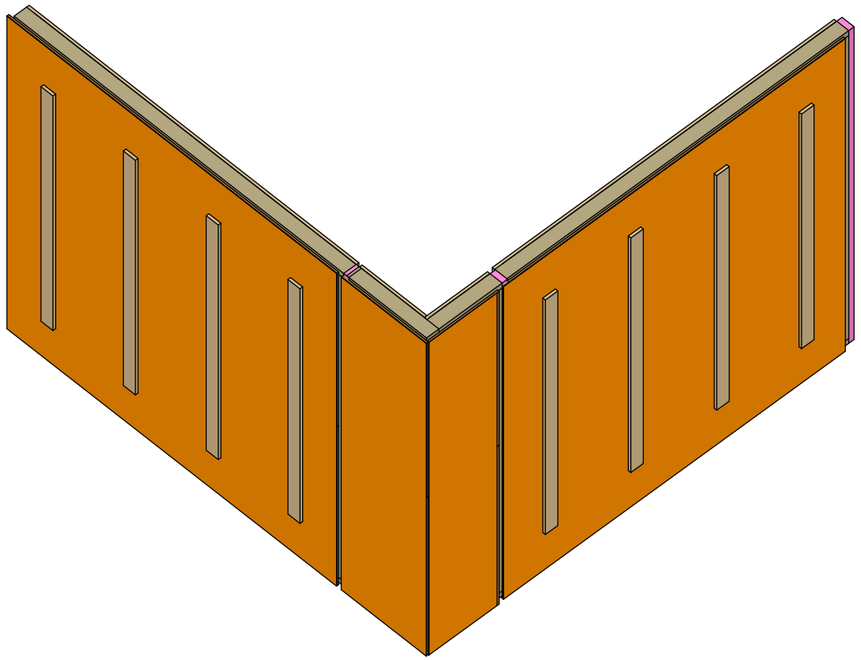
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

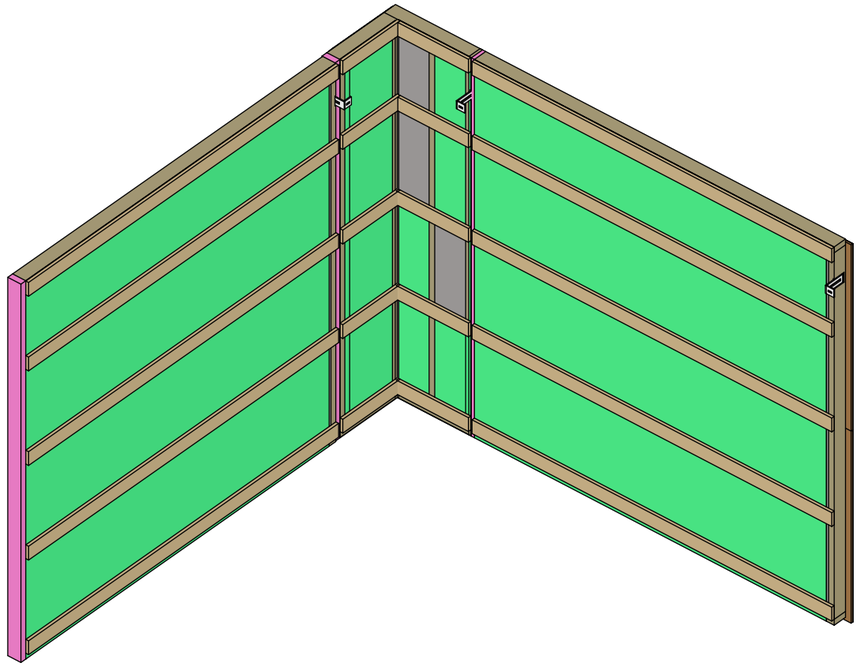
DRAWN BY
Nick Rudnicki

08

Outside Corner Installed



EXTERIOR VIEW



INTERIOR VIEW

ReCover

Version Date
February 27, 2023

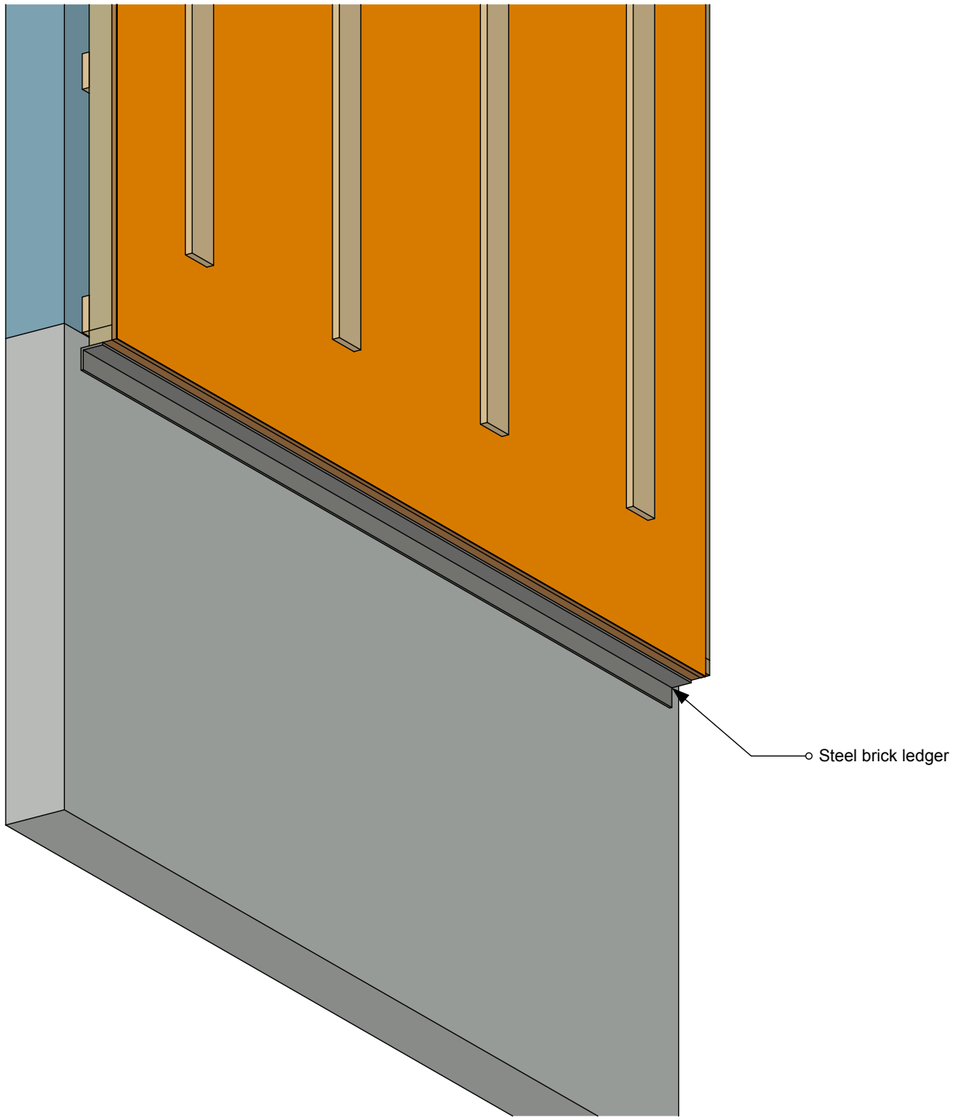
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

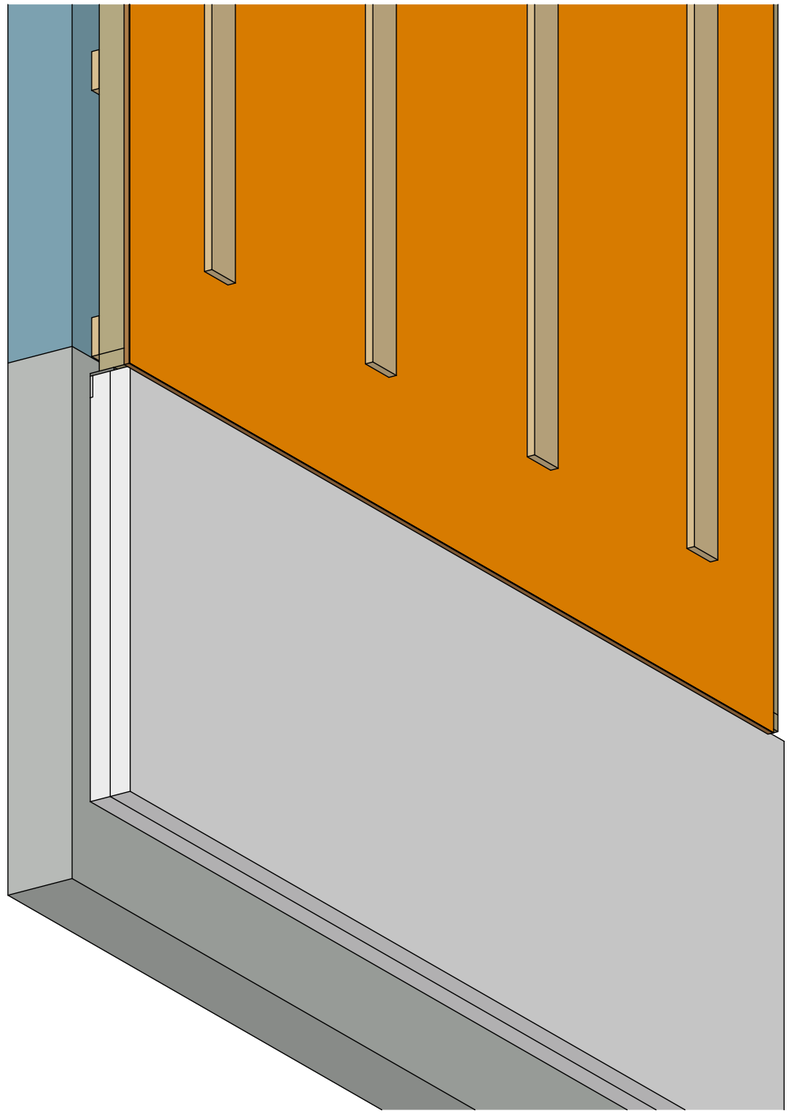
09

Foundation Attachment - Ledger

"Brick Ledger" style continuous ledger for panel support



BEFORE SITE INSULATION



AFTER SITE INSULATION

ReCover

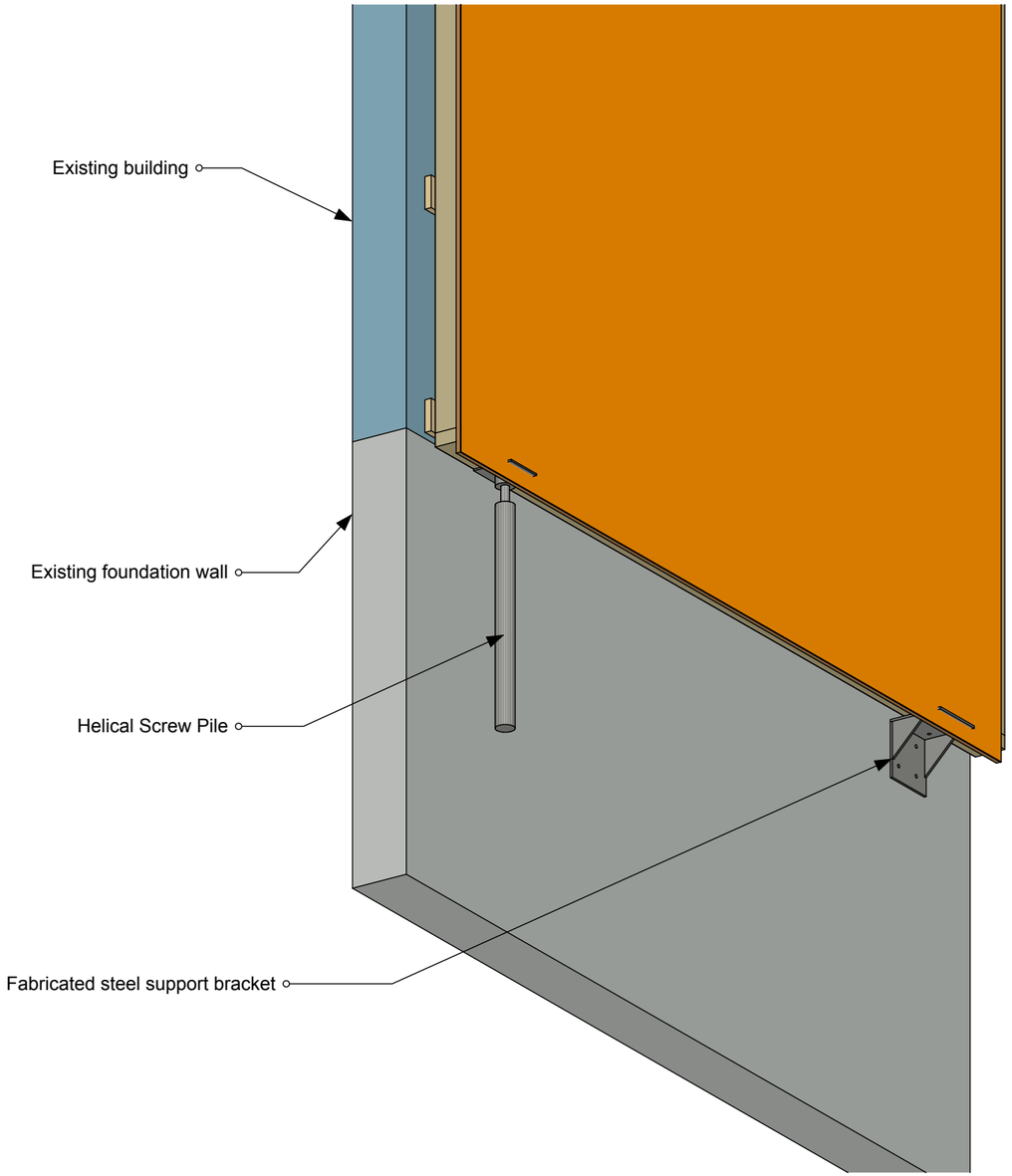
Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

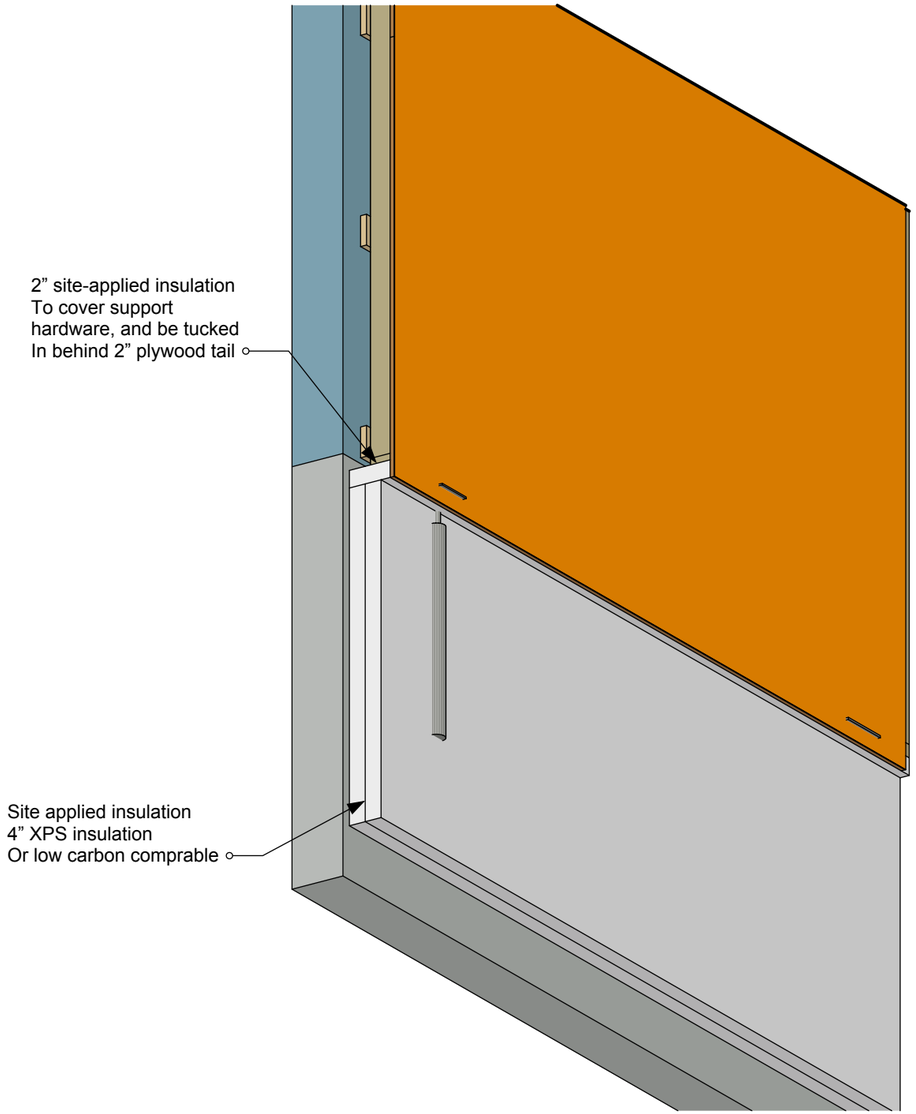
DRAWN BY
Nick Rudnicki

Foundation Attachment - Pile or Bracket

First options for attaching the panels to the foundation



BEFORE SITE INSULATION



AFTER SITE INSULATION

ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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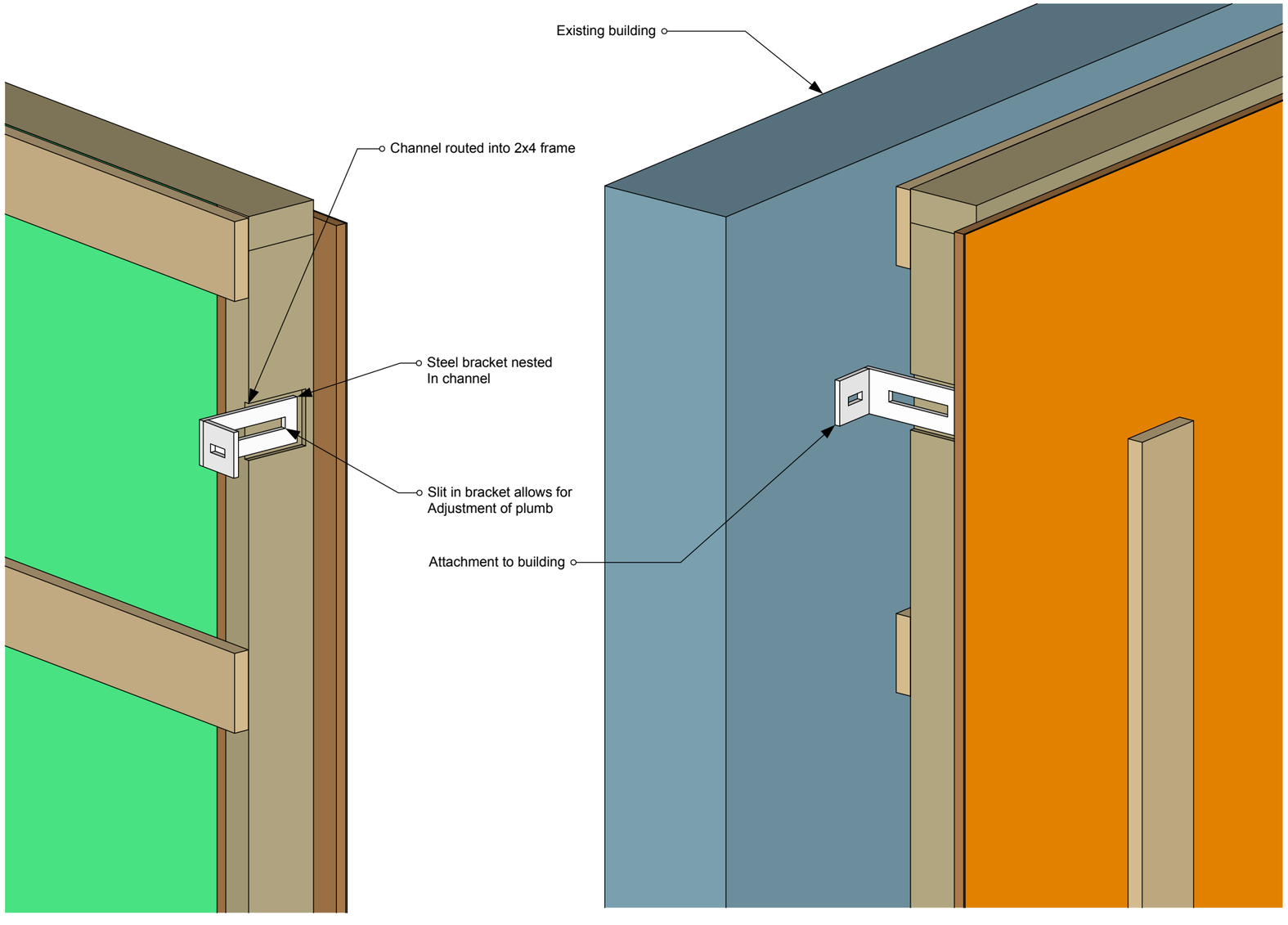
Attach to Existing

Bracket to attach individual panels to existing



INTERIOR VIEW

EXTERIOR VIEW

ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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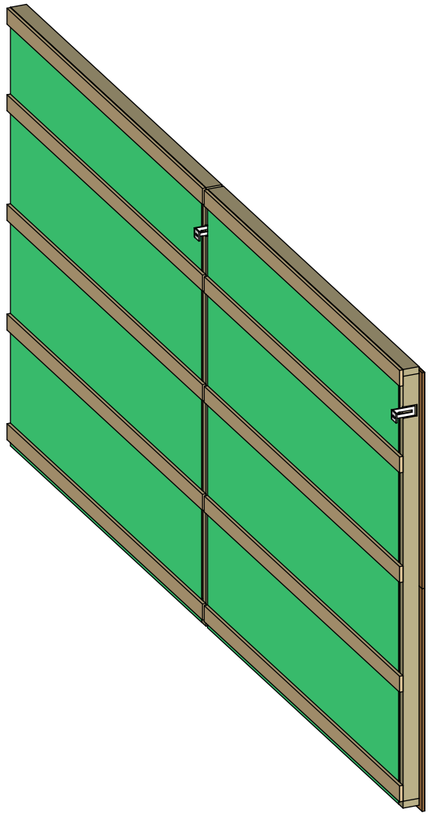
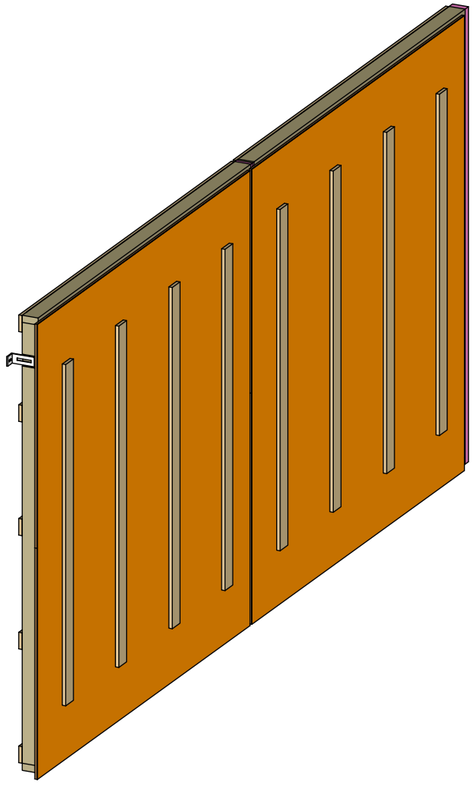
Nick Rudnicki

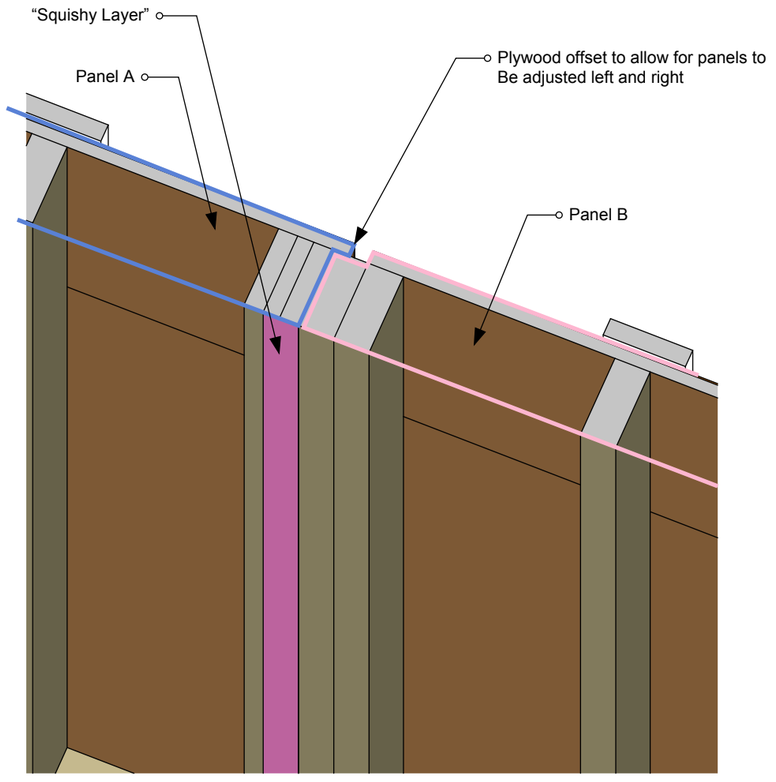
Vertical Wall Joins



INTERIOR VIEW



EXTERIOR VIEW



SECTION VIEW

ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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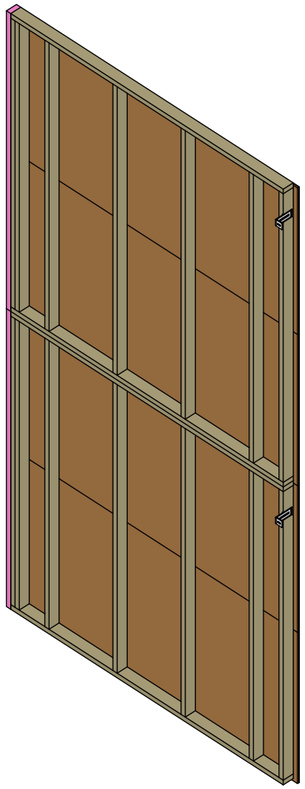
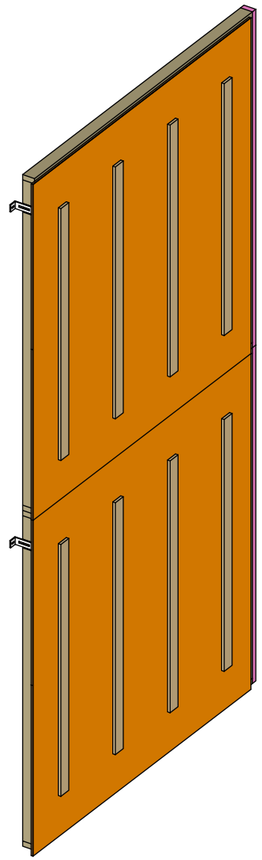
Nick Rudnicki

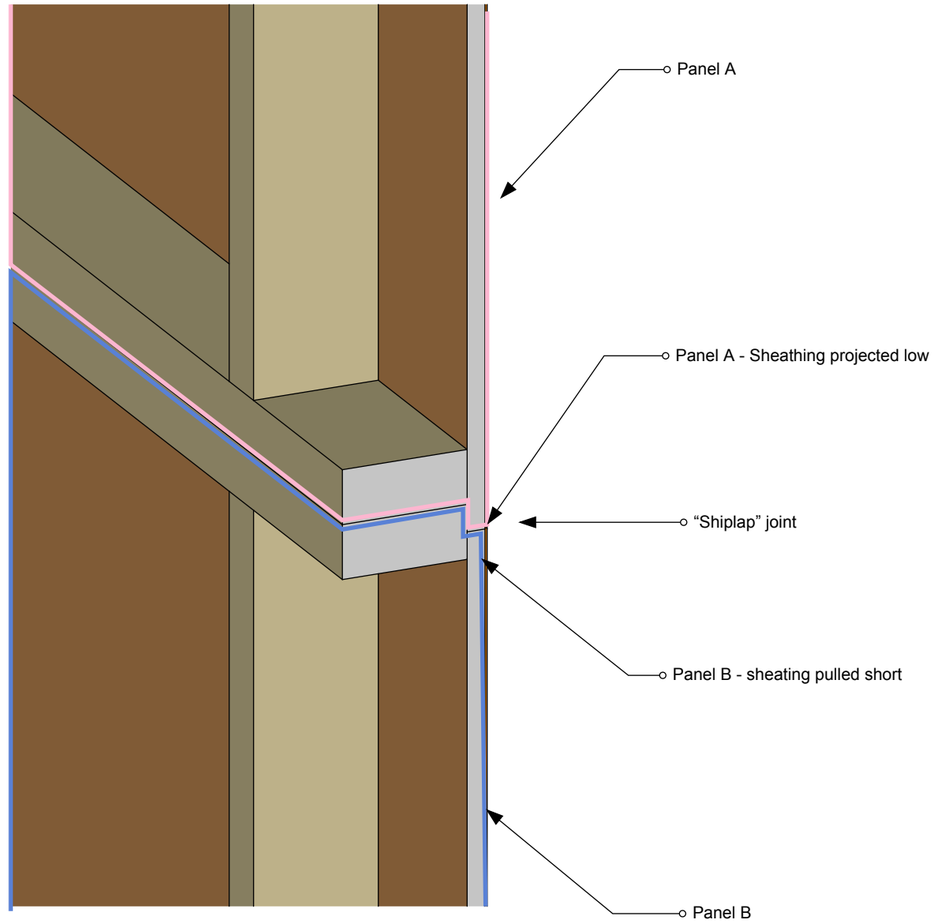
Horizontal Wall Joins



INTERIOR VIEW



EXTERIOR VIEW



SECTION VIEW

ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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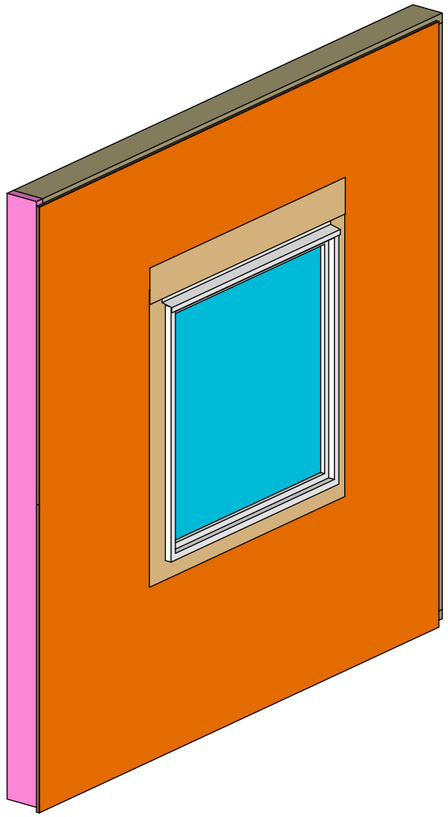
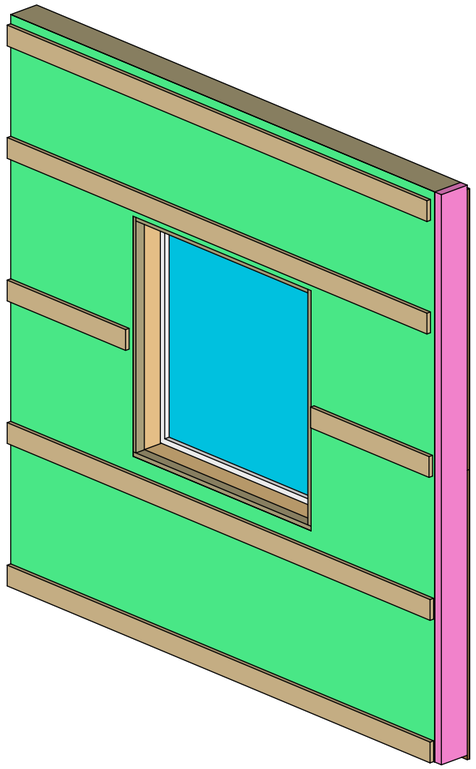
Window Panel

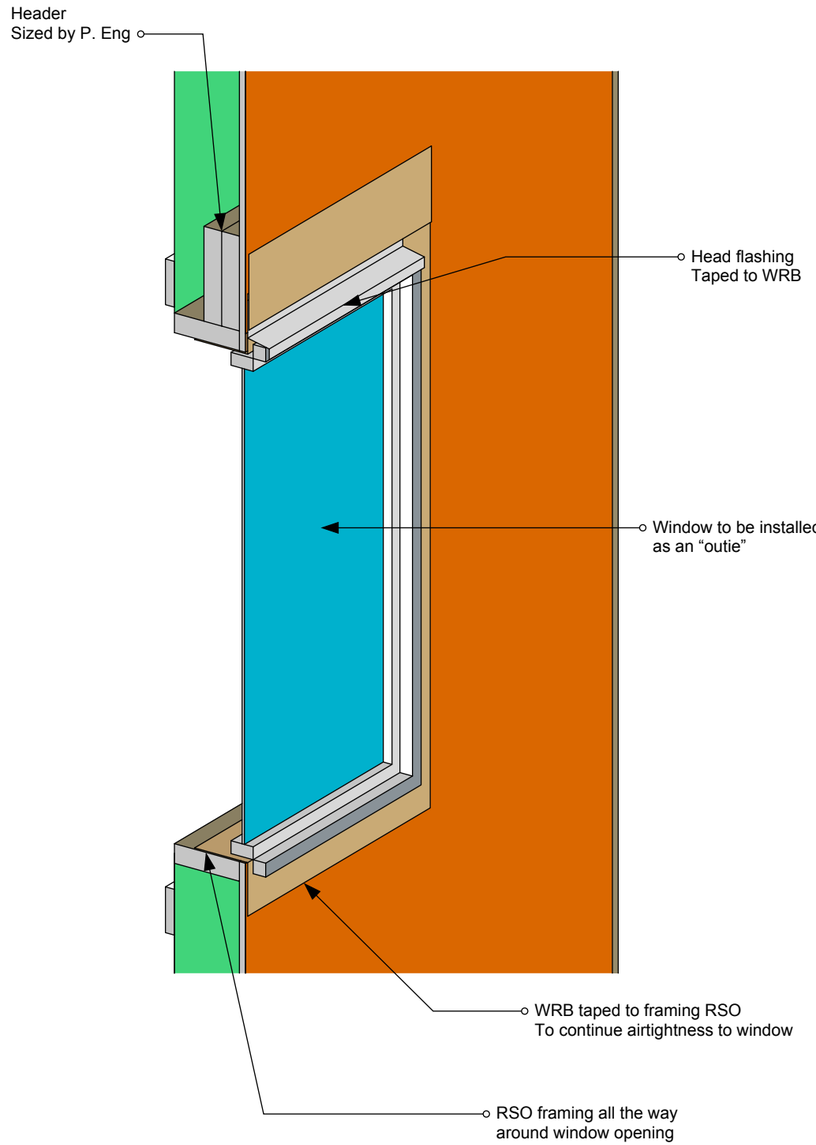


PANEL
EXTERIOR VIEW

Window installed in factory
Window installed as an “outie” to minimize how much window sill there is exposed to the rain



PANEL
EXTERIOR VIEW



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Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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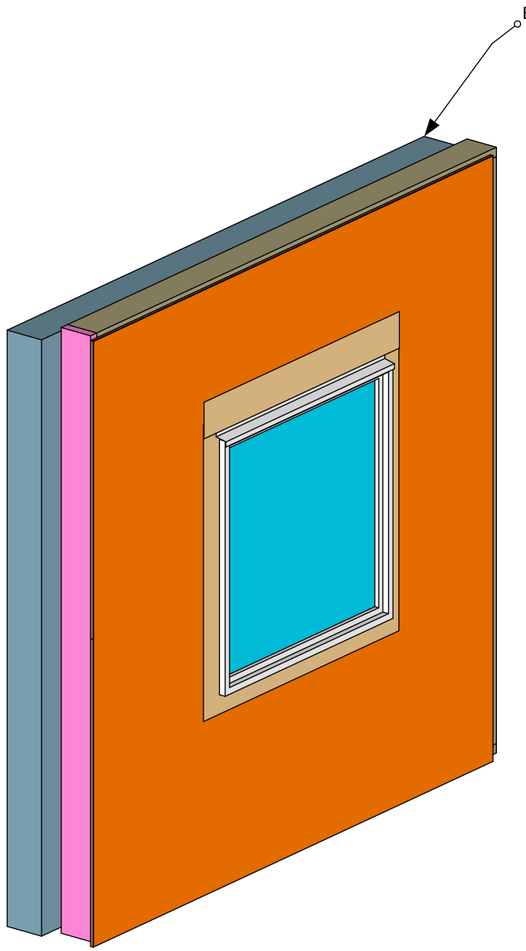
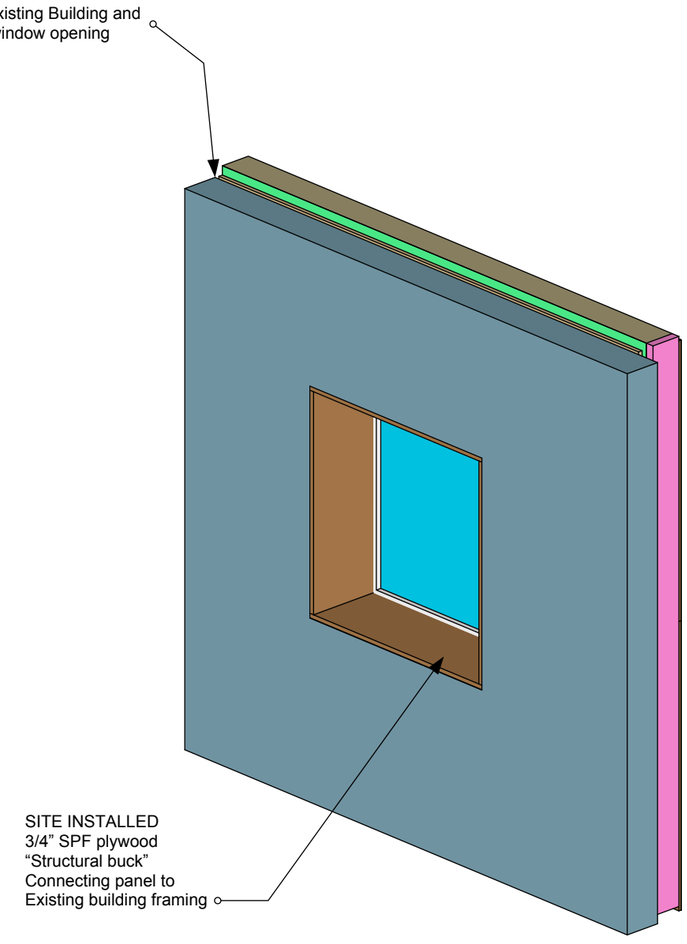
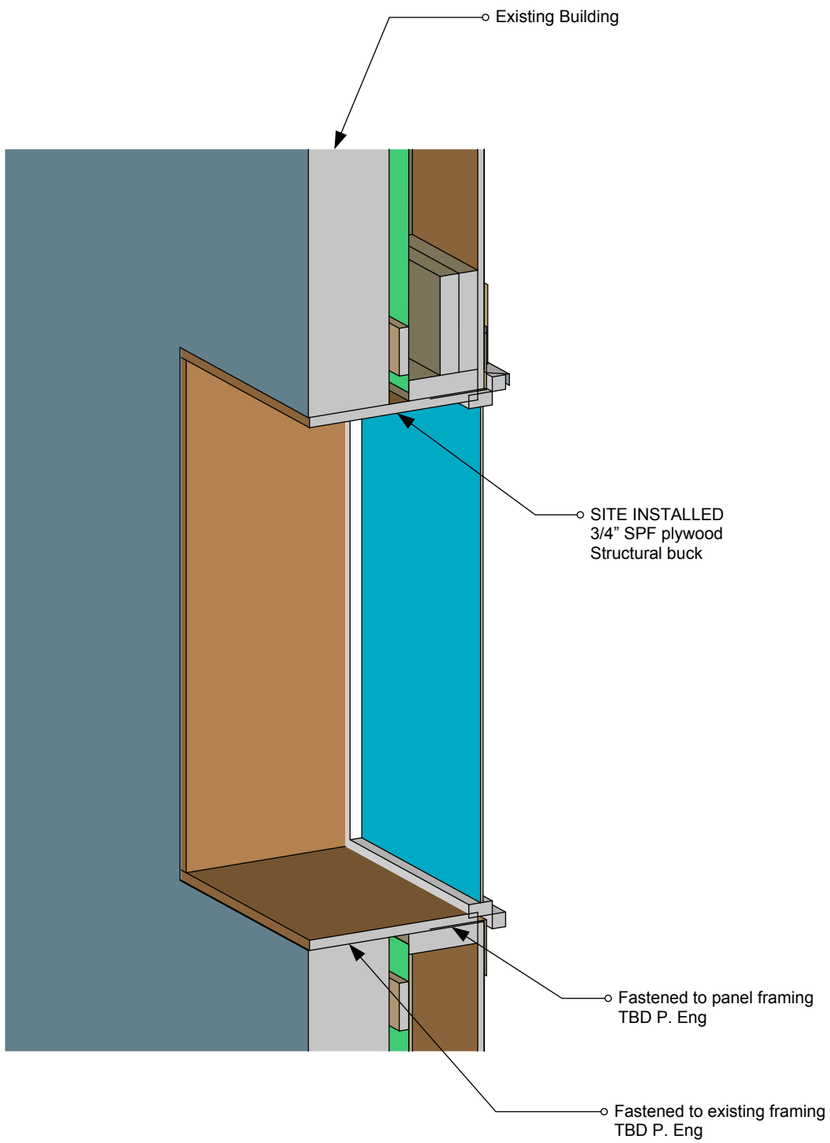
Window Penetration



EXTERIOR VIEW



INTERIOR VIEW



SECTION VIEW

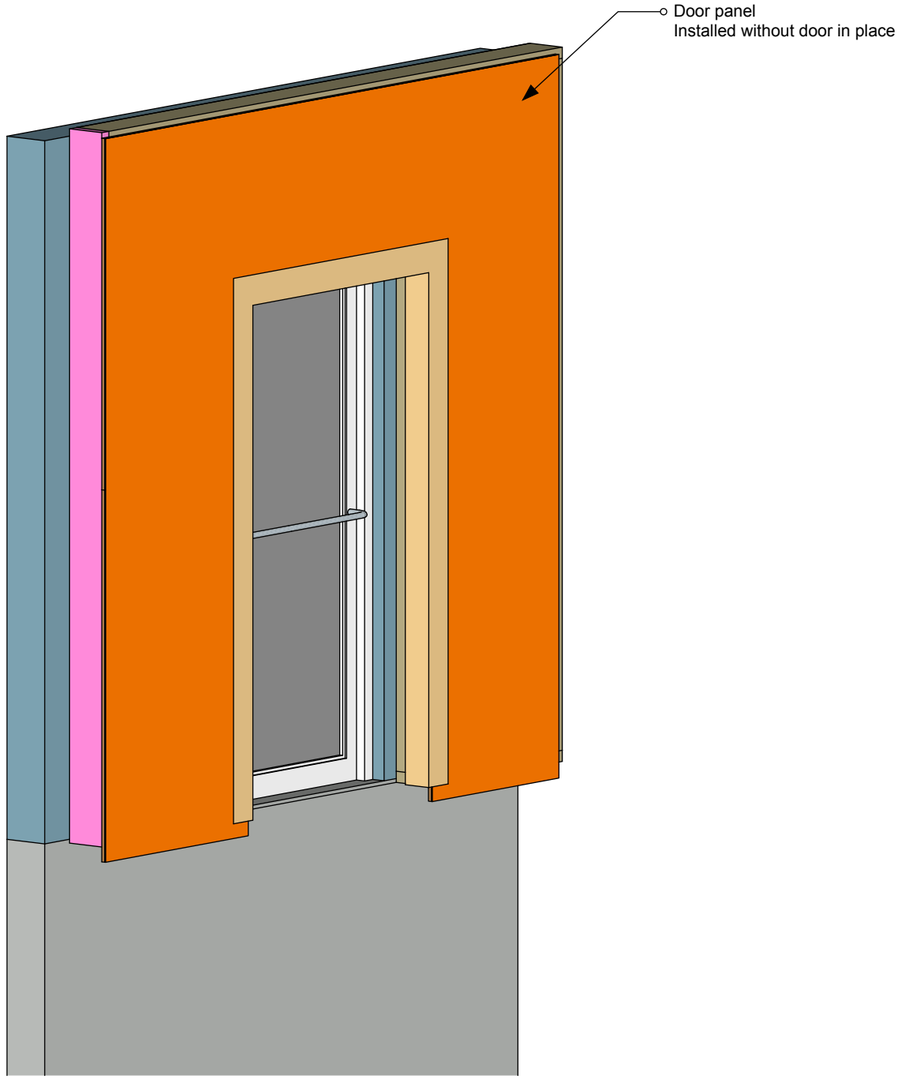
ReCover

Version Date
February 27, 2023

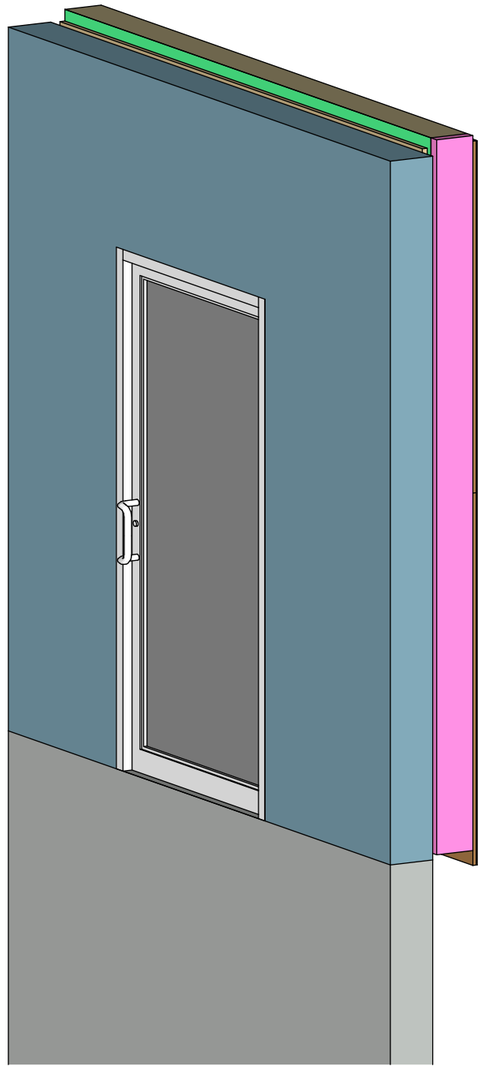
PROJECT
2x4 R11 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Door Penetration Panel



EXTERIOR VIEW



INTERIOR VIEW

ReCover

Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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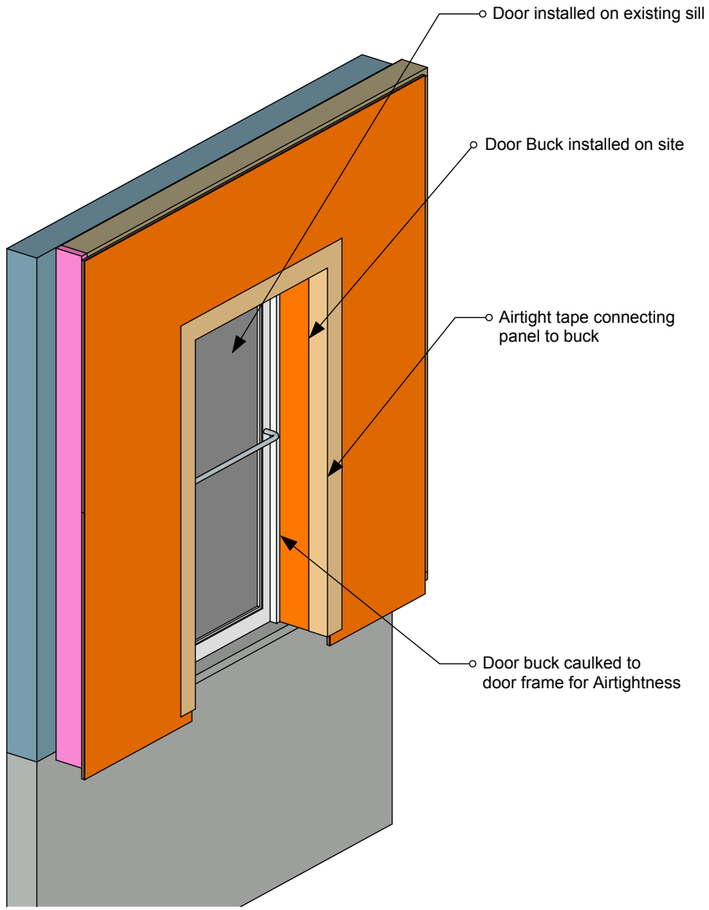
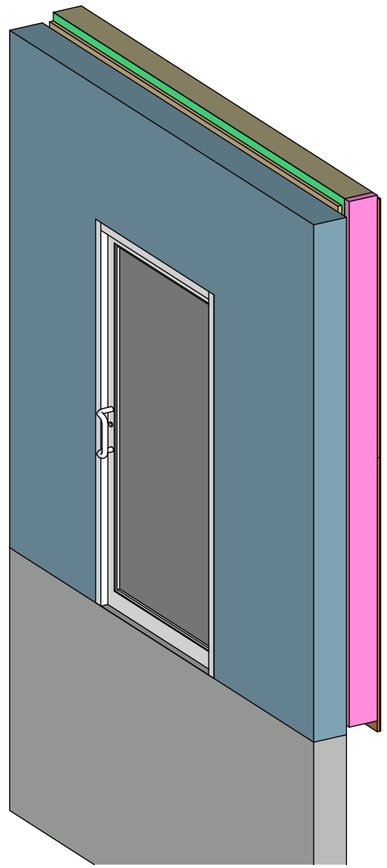
Nick Rudnicki

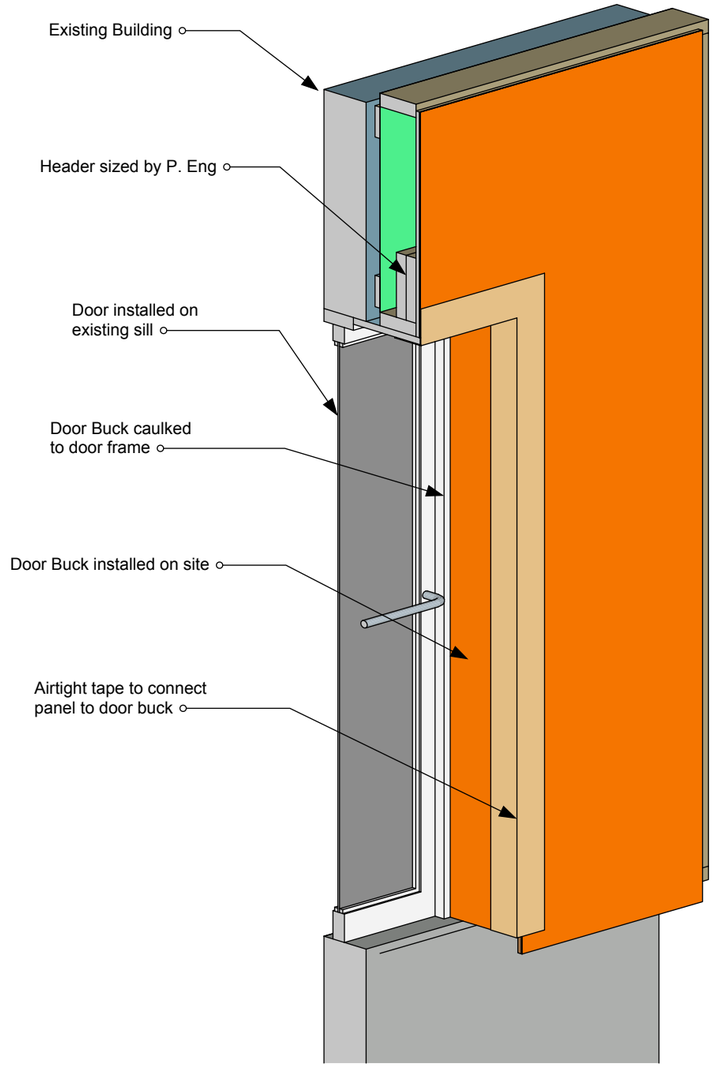
Door Penetration Panel Installed



EXTERIOR VIEW



INTERIOR VIEW



SECTION VIEW

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Version Date
February 27, 2023

PROJECT
2x4 R11 Cellulose
Panel Schematics

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Wall Panel Schematics

Cellulose - R21 - 2x8 - 1/2” Plywood

ReCover Initiative

ReCover

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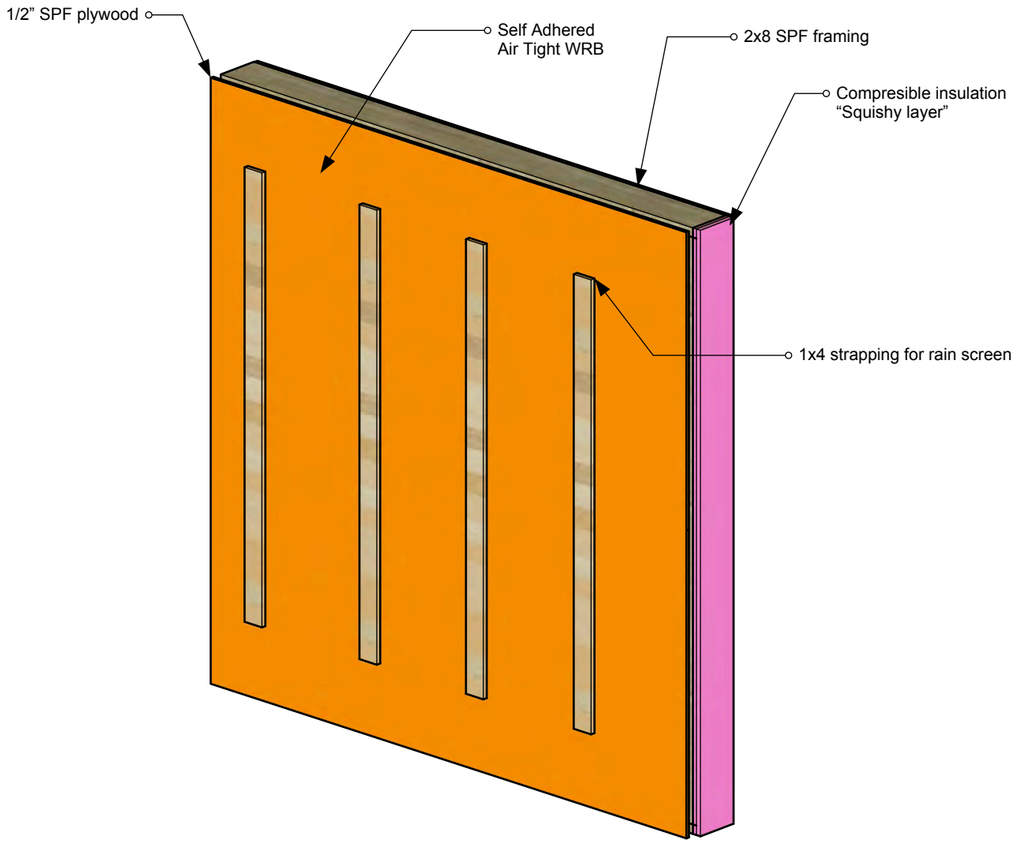
Nick Rudnicki

PROJECT
2x6 R21 Cellulose
Panel Schematics

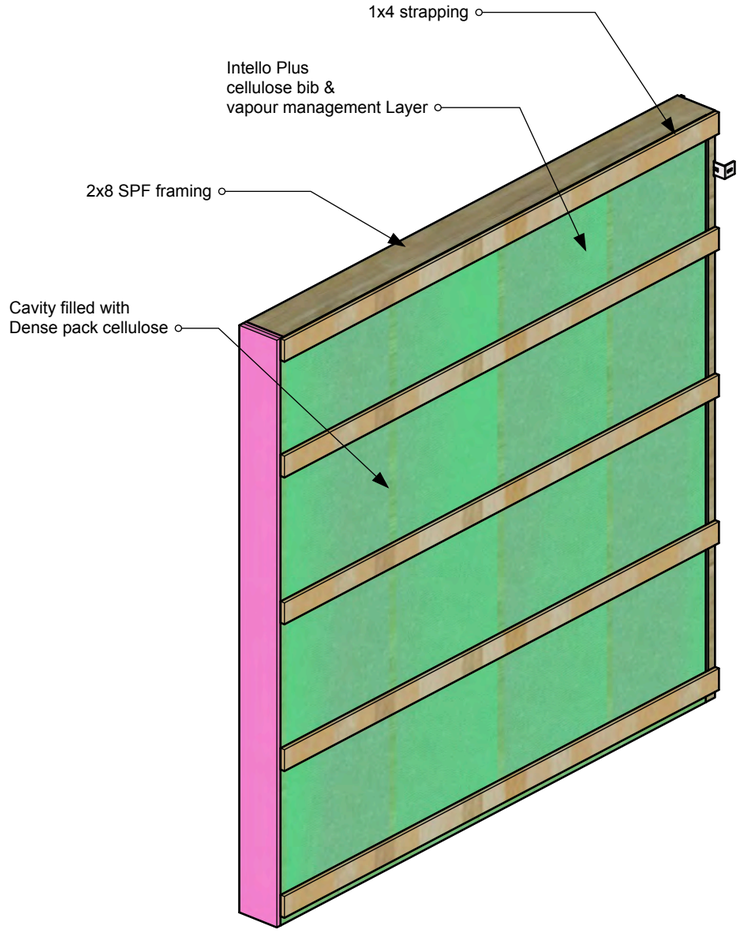
Version Date
February 27, 2023

01

Basic Panel - Overview



EXTERIOR VIEW



INTERIOR VIEW

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Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

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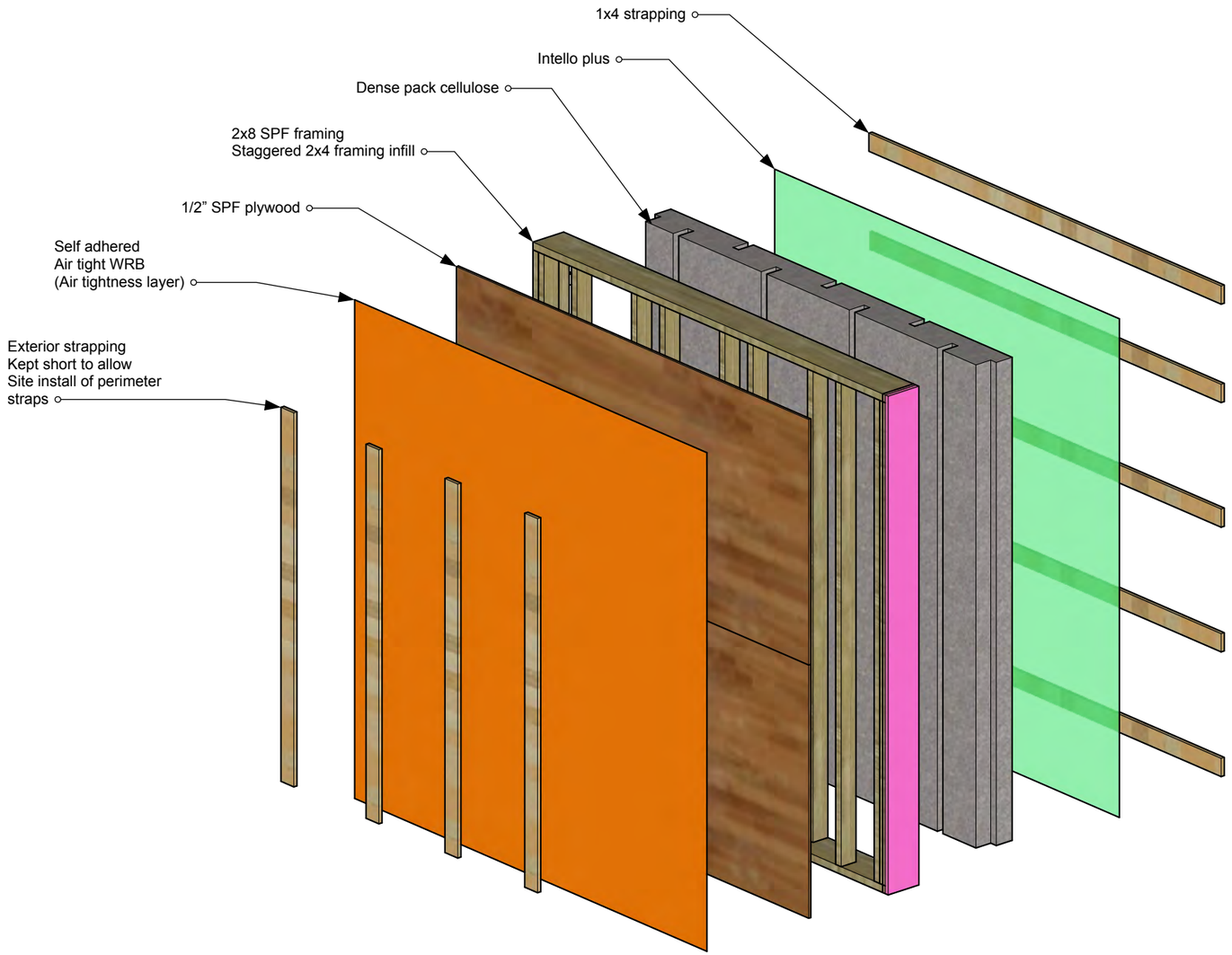
02

Basic Panel - Exploded View



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Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

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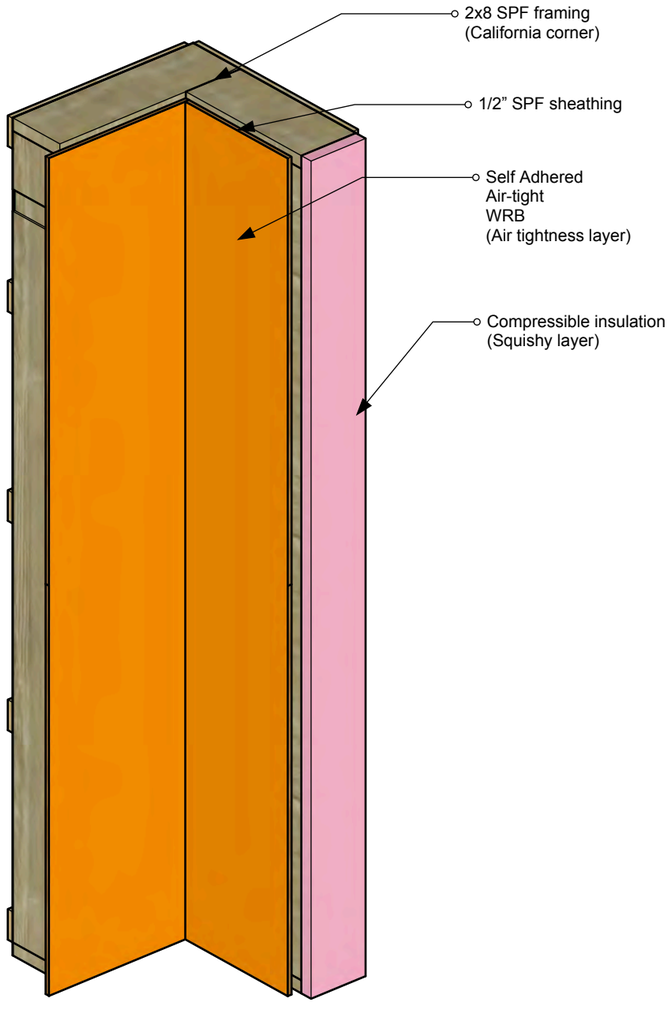
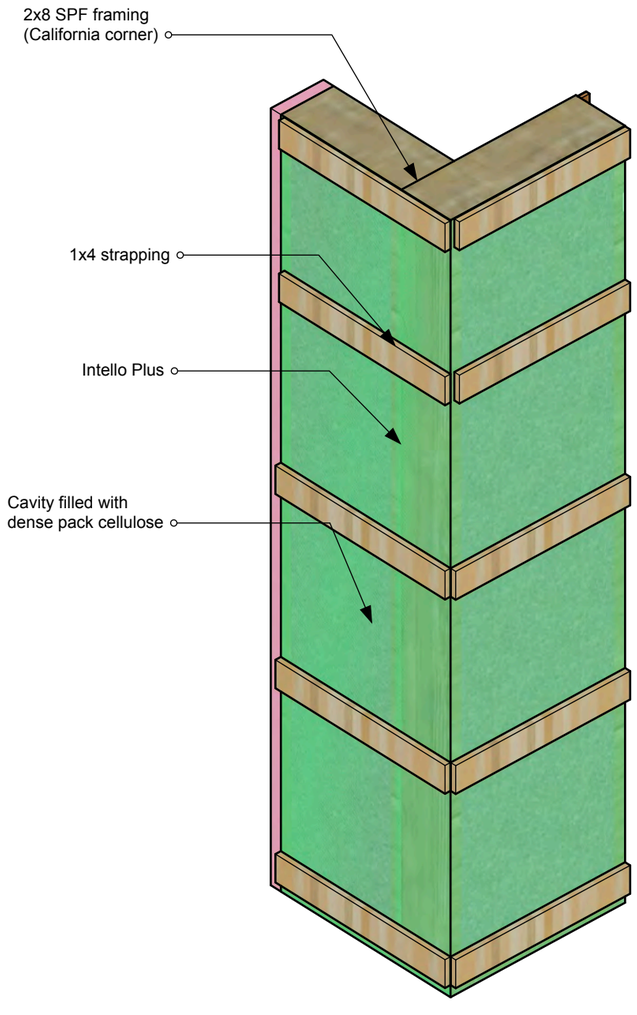
Nick Rudnicki

03

Inside Corner Panel - Overview



EXTERIOR VIEW



INTERIOR VIEW

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Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

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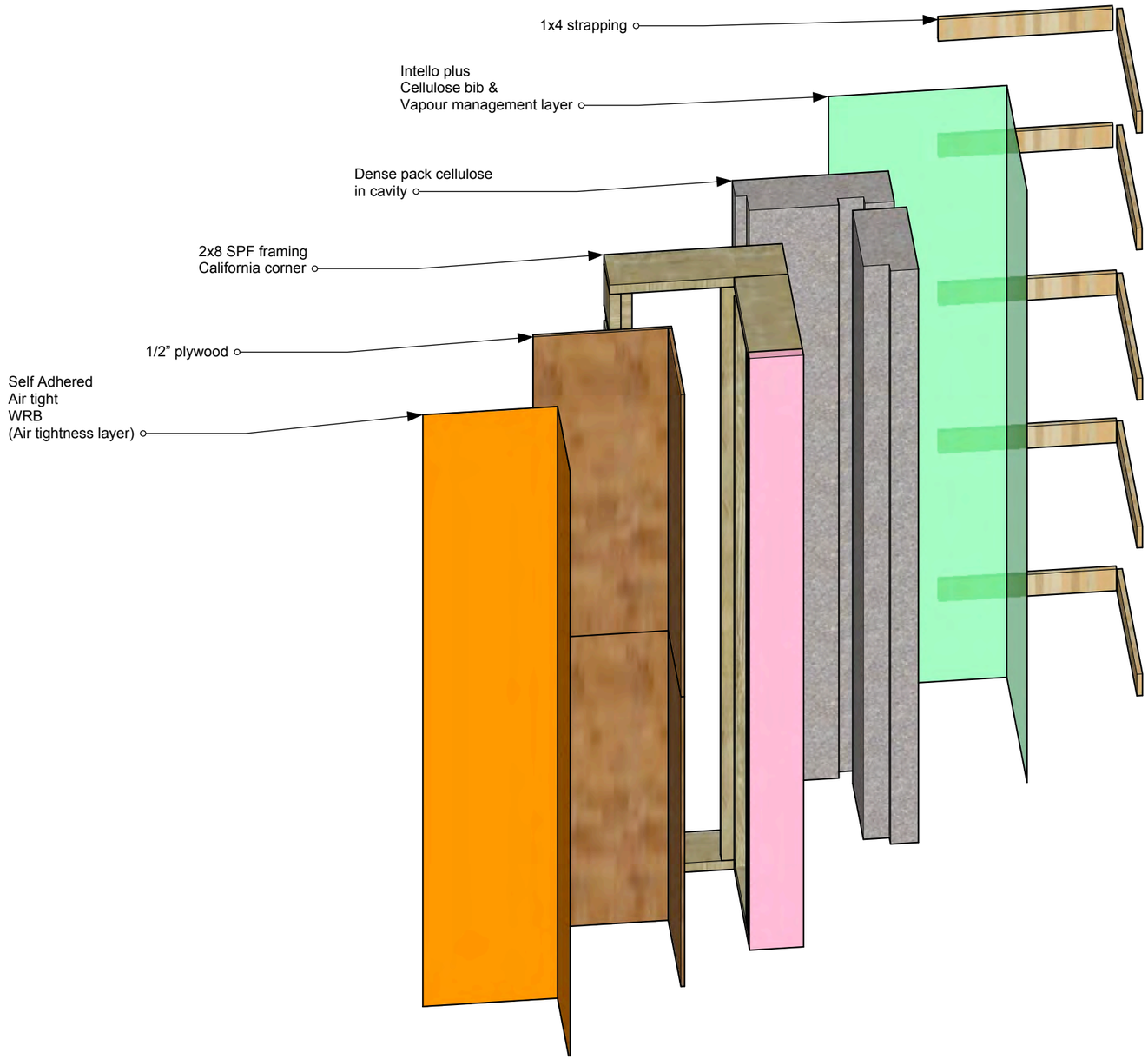
Nick Rudnicki

04

Inside Corner Panel - Exploded View



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Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

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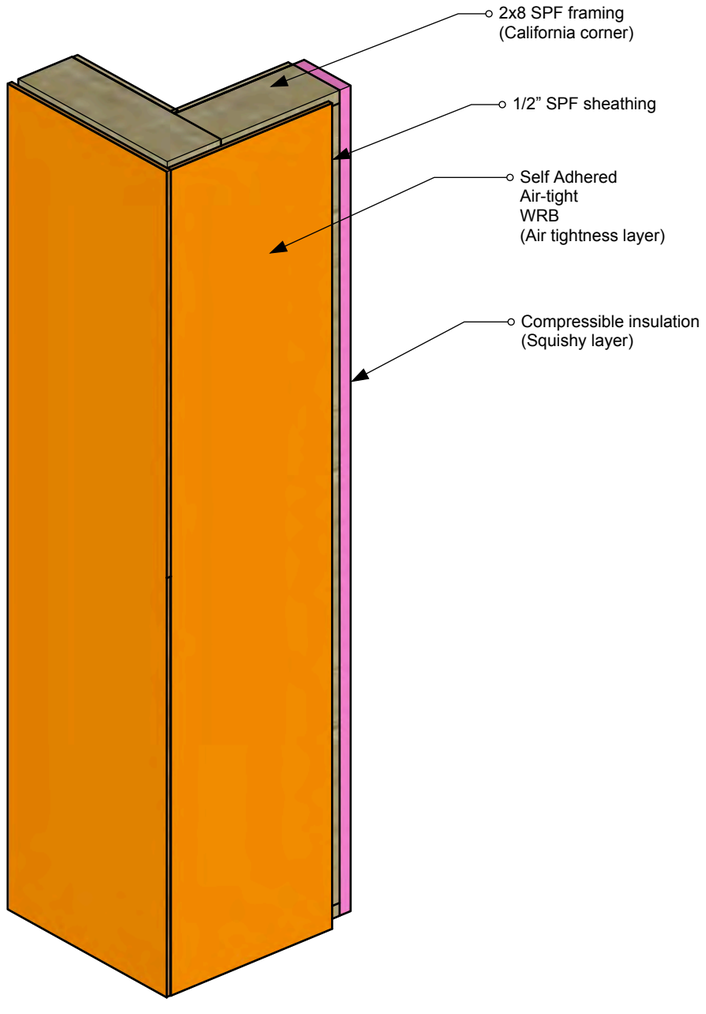
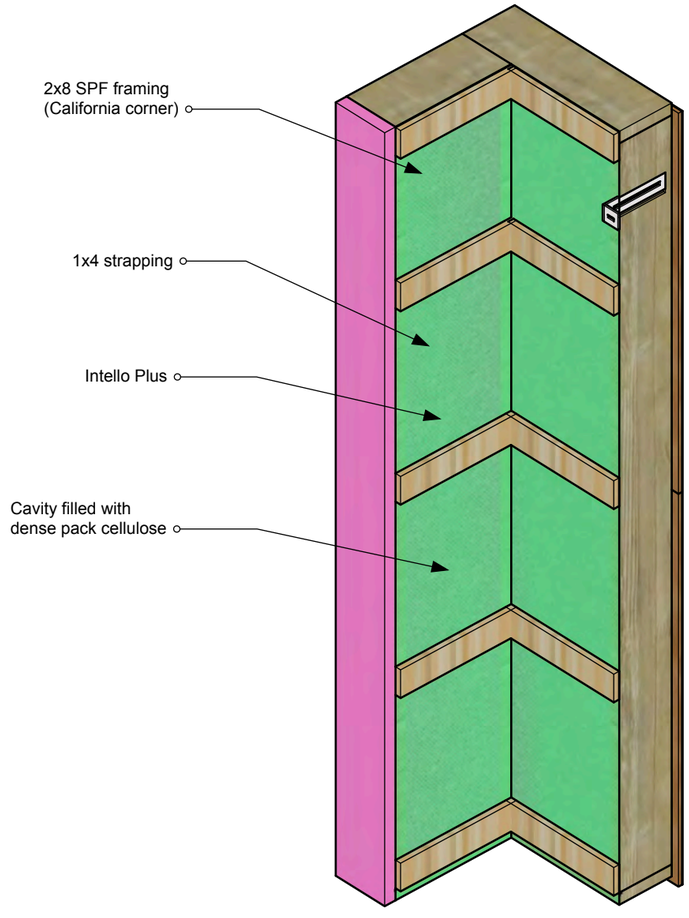
05

Outside Corner Panel - Overview



EXTERIOR VIEW



INTERIOR VIEW

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Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

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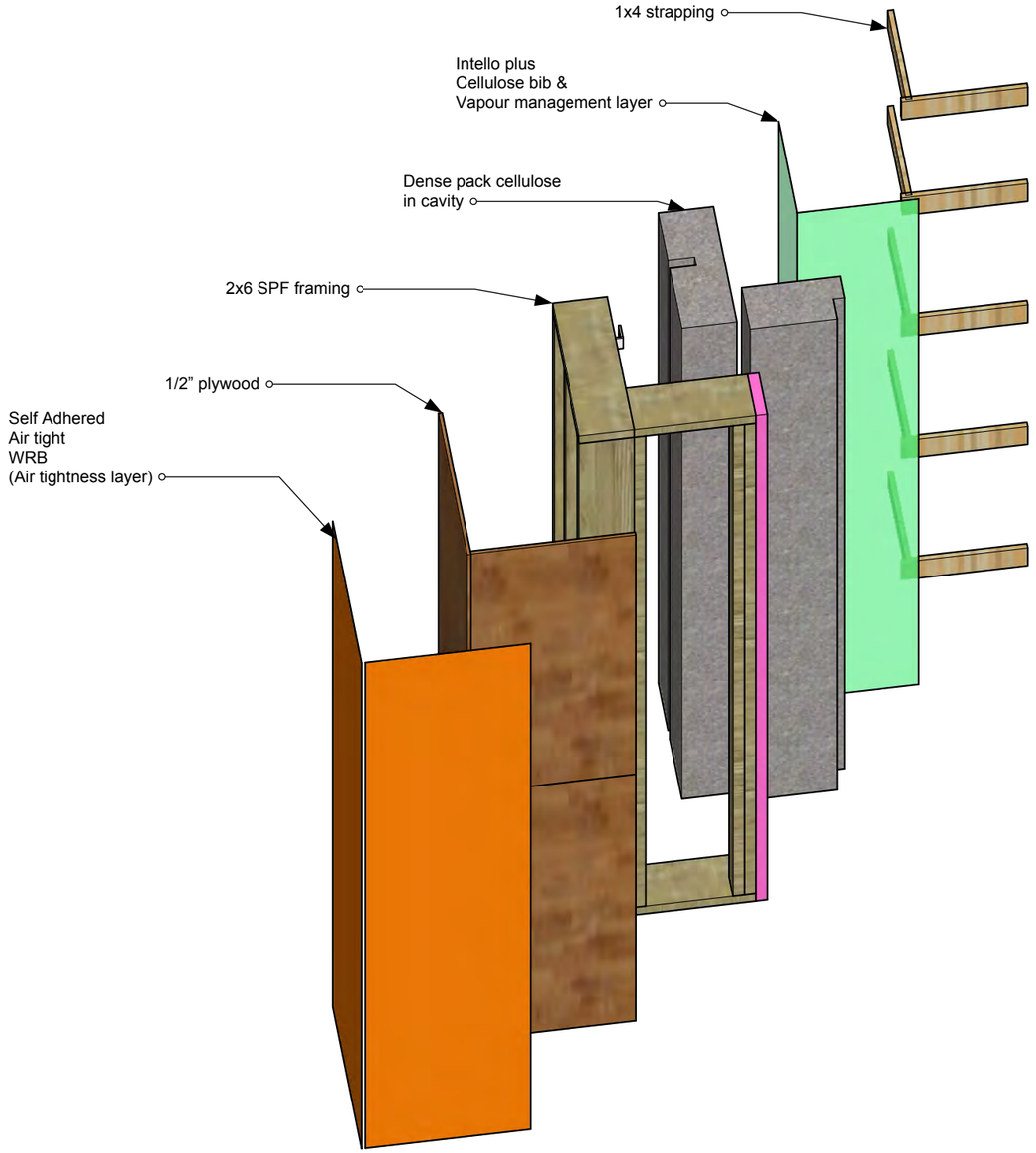
Nick Rudnicki

06

Outside Corner Panel - Exploded View



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Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

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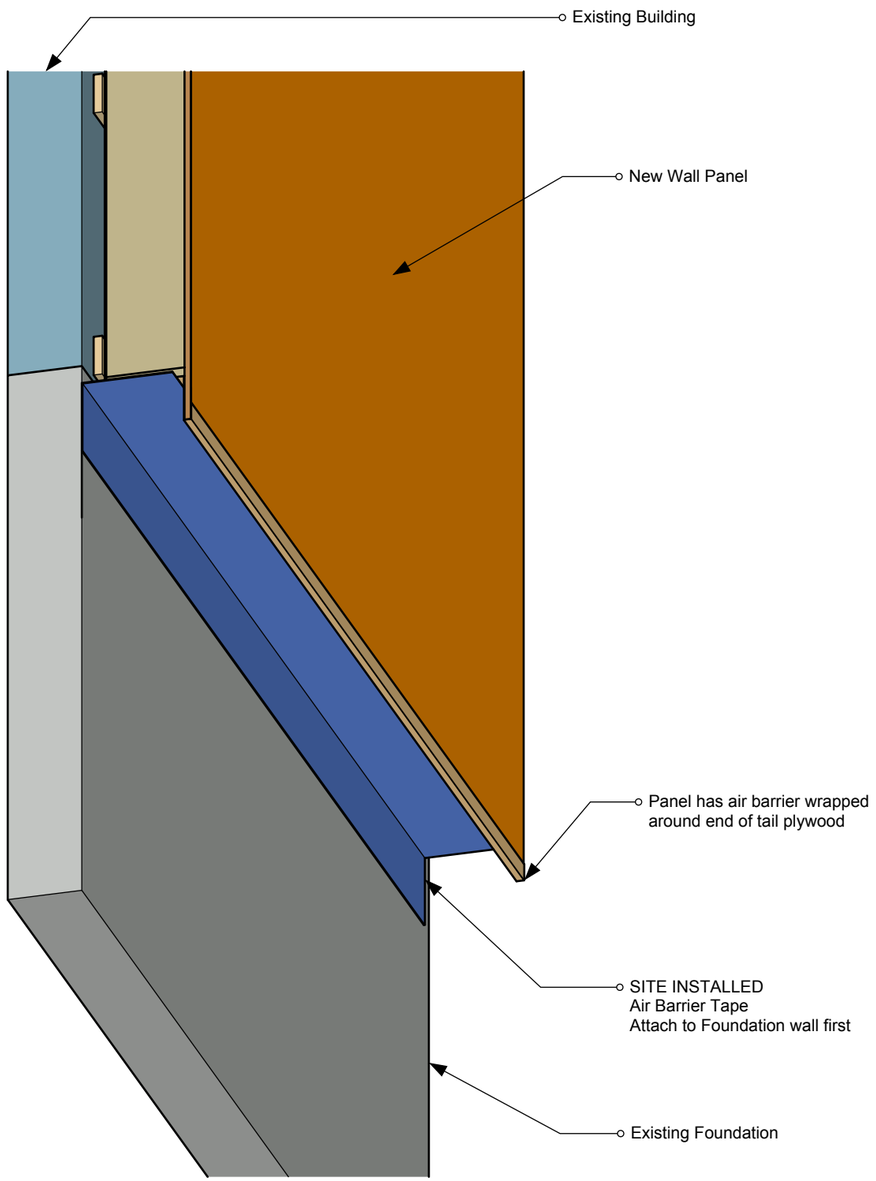
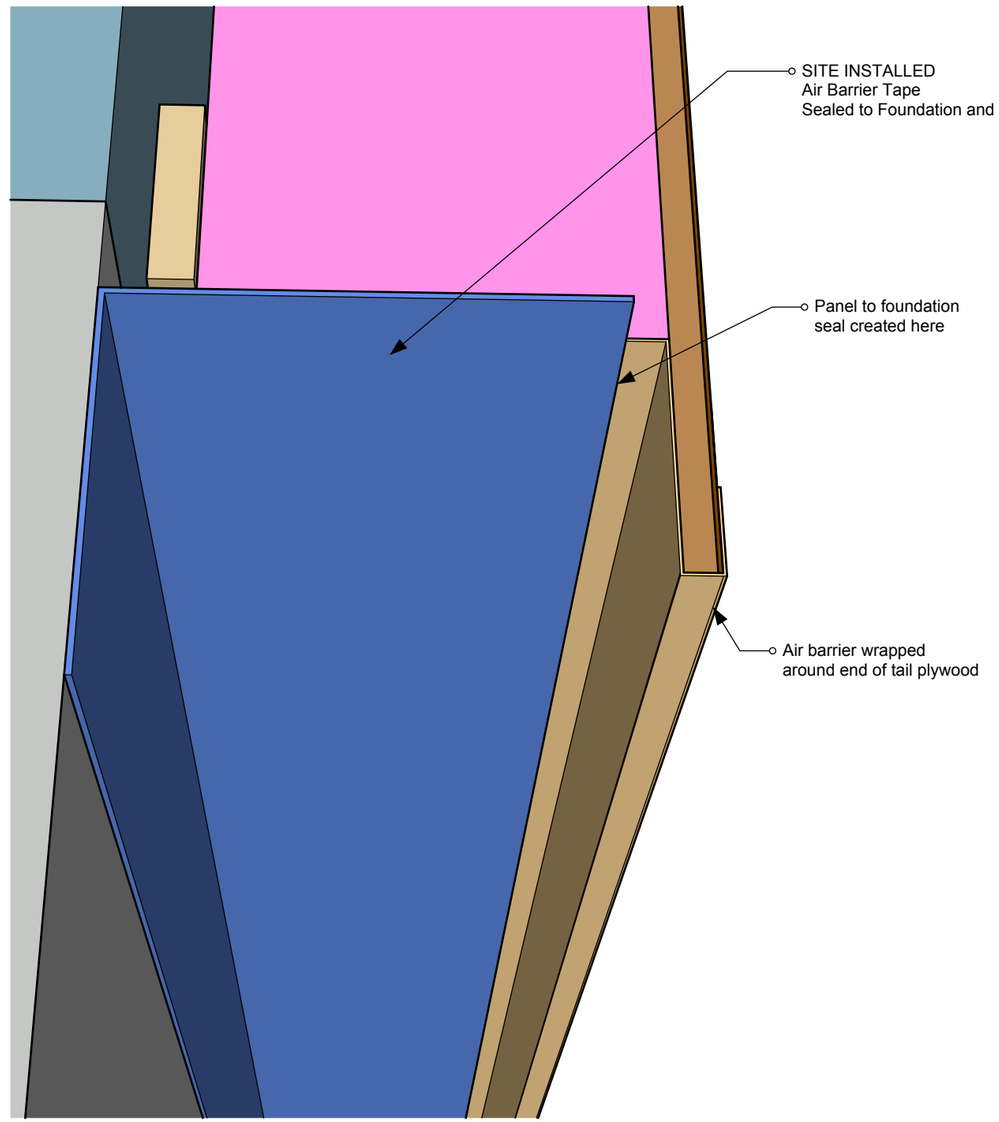
Foundation Attachment - Air Sealing





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Version Date
February 27, 2023

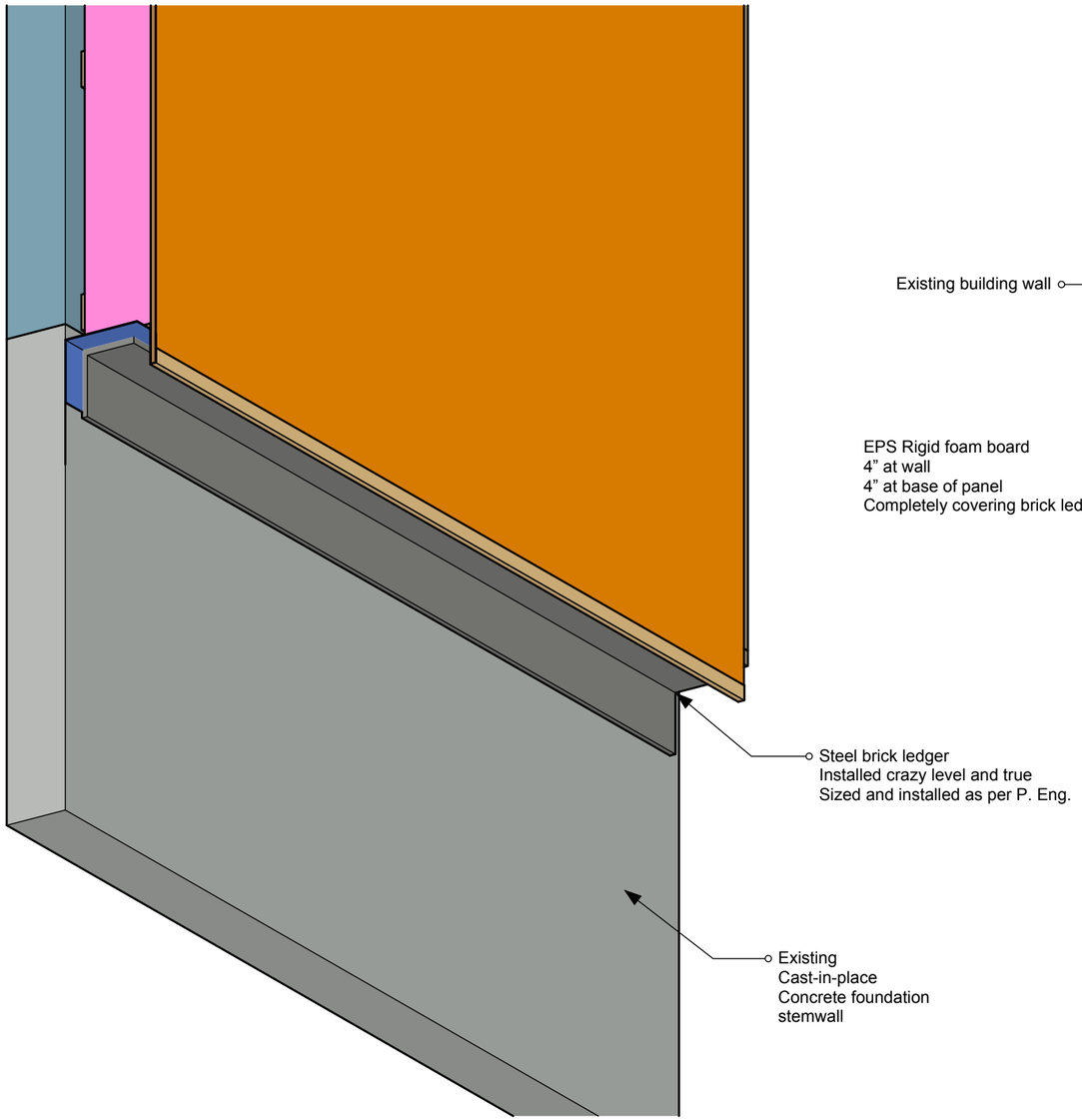
PROJECT
2x6 R21 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

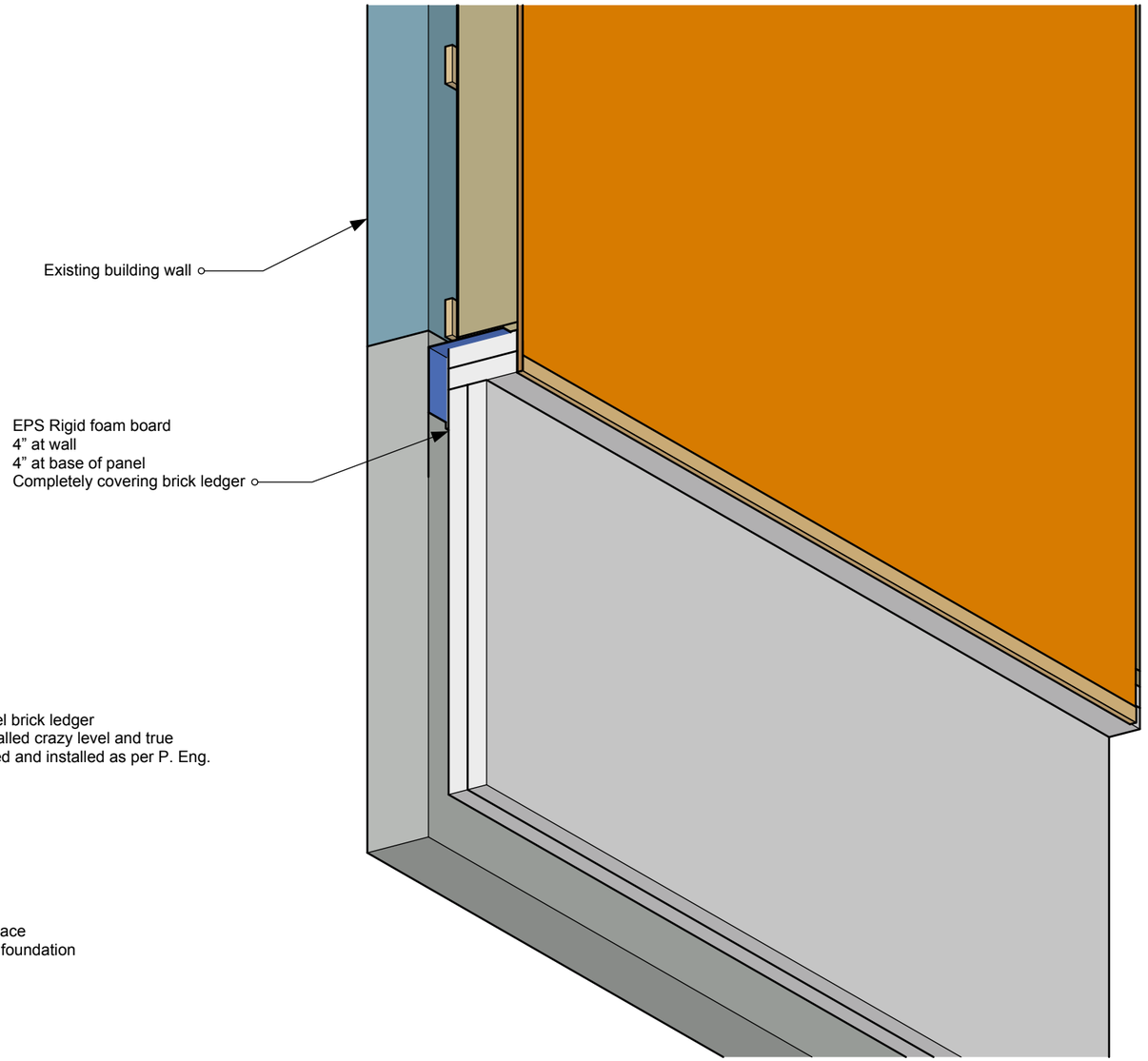
08

Foundation Attachment - Brick Ledger

"Brick Ledger" style continuous ledger for panel support



BEFORE SITE INSULATION



AFTER SITE INSULATION

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Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

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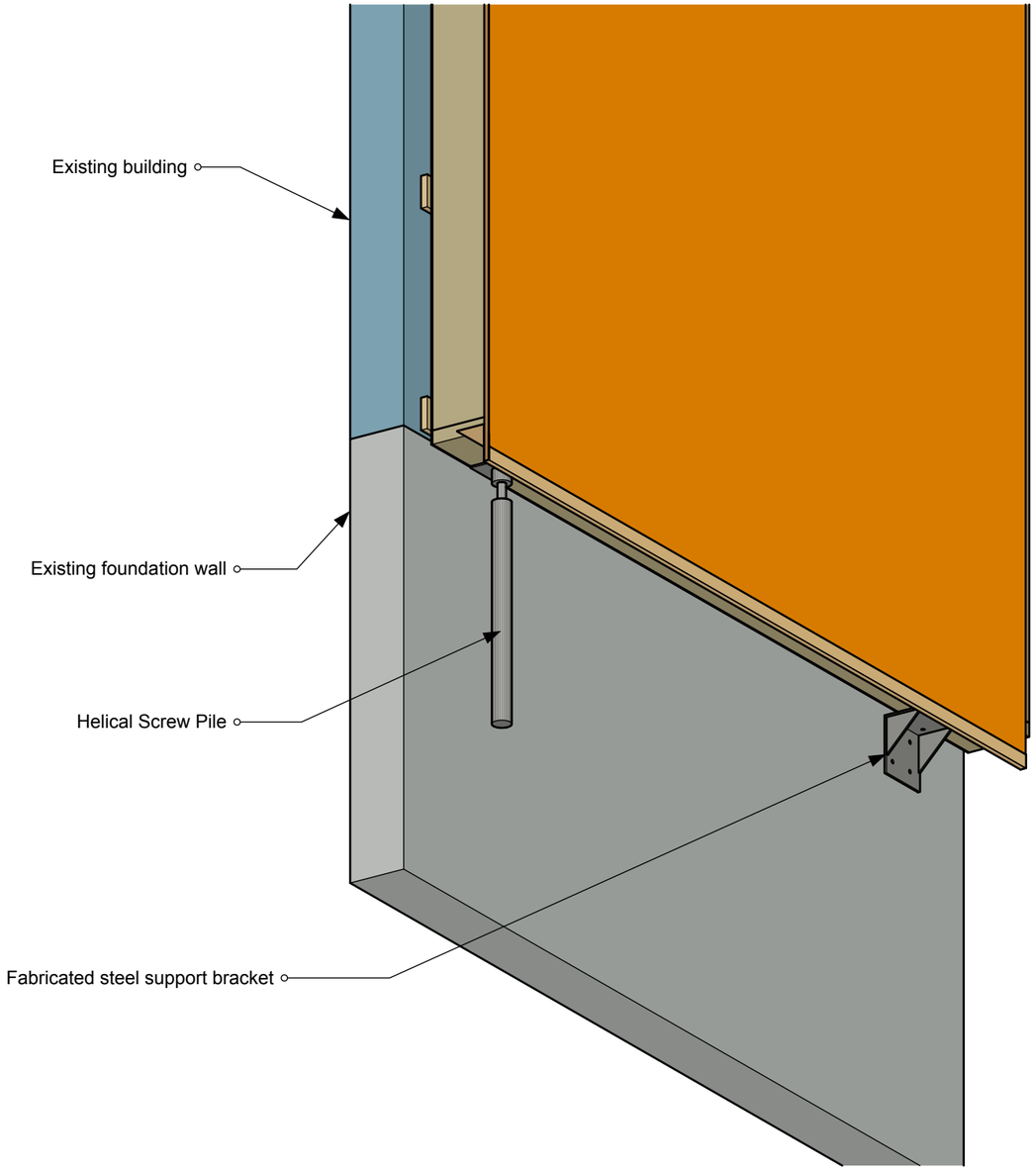
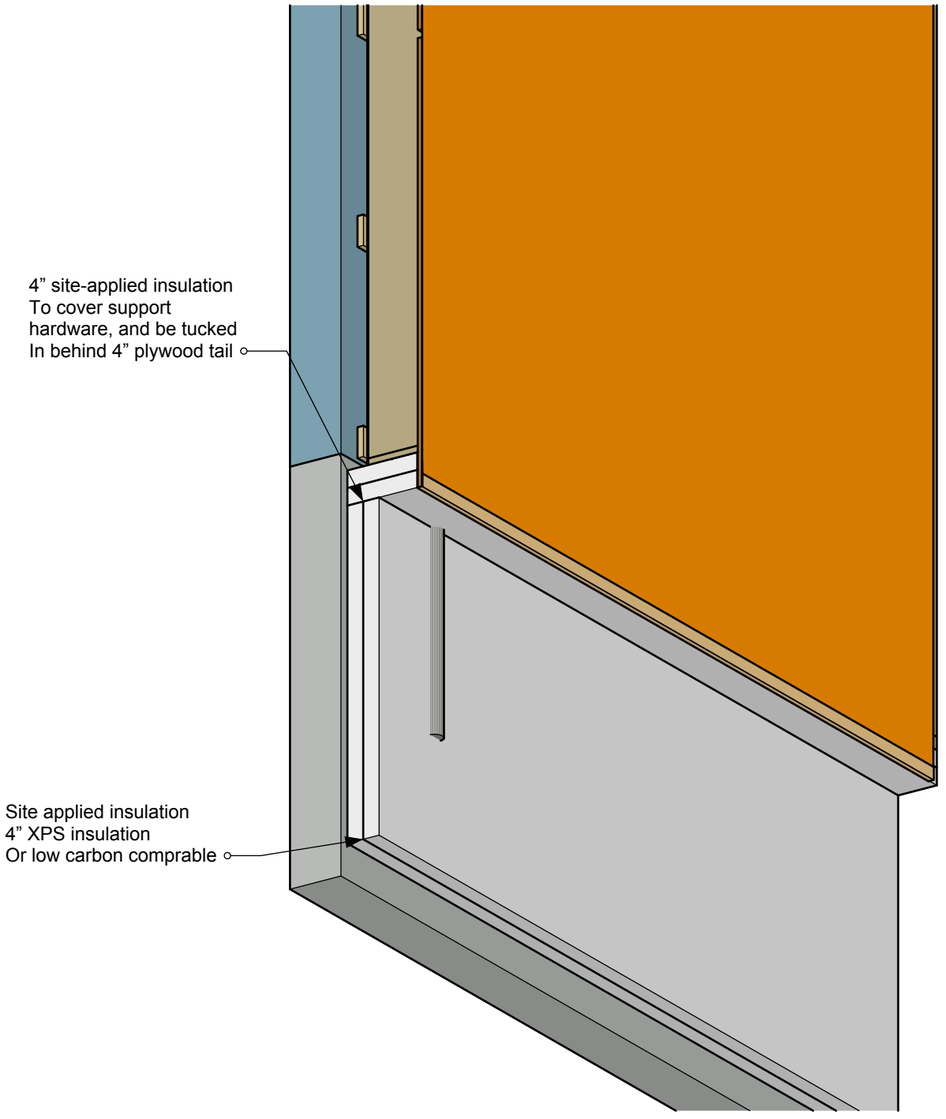
09

Alternate Foundation Attachment - Pile or Bracket

In case “brick ledger” cannot work



BEFORE SITE INSULATION



AFTER SITE INSULATION

ReCover

Version Date
February 27, 2023

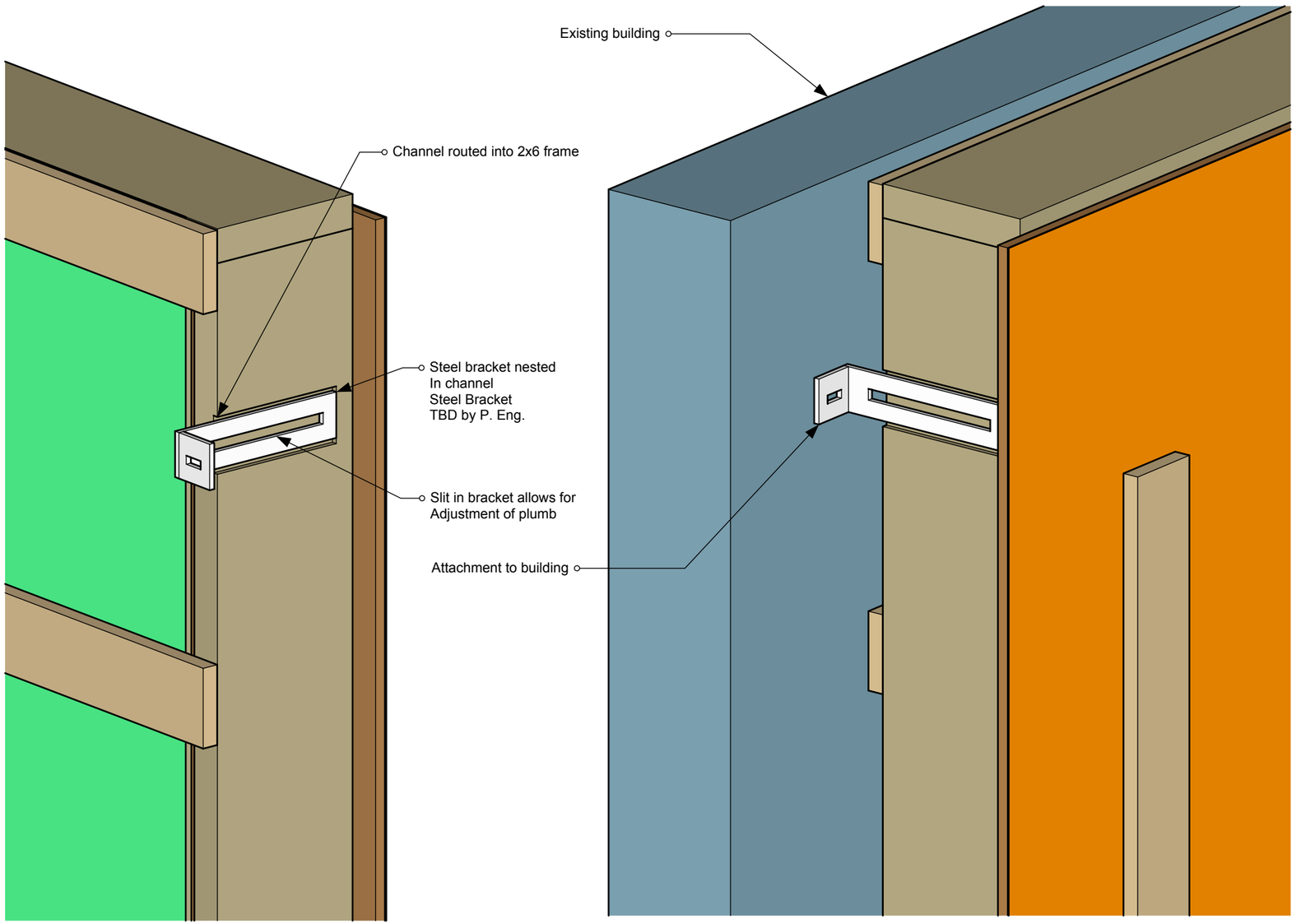
PROJECT
2x6 R21 Cellulose
Panel Schematics

DESCRIPTION
Sheet Description

DRAWN BY
Nick Rudnicki

Attach to Existing Building

Bracket to attach individual panels to existing



INTERIOR VIEW

EXTERIOR VIEW

ReCover

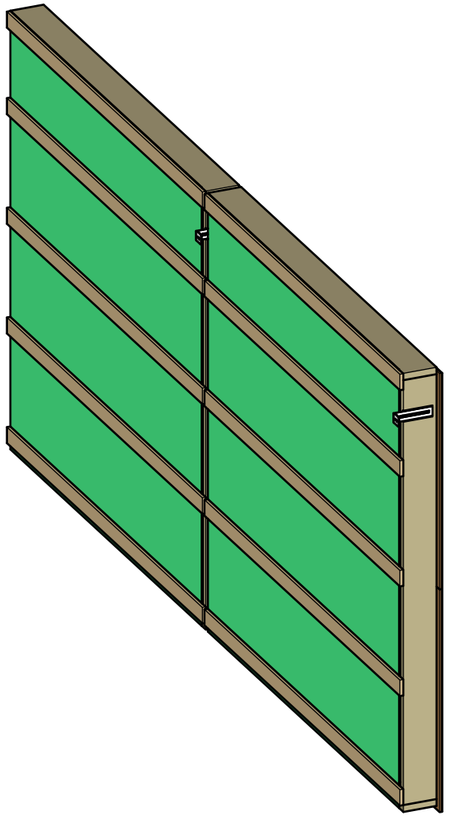
Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

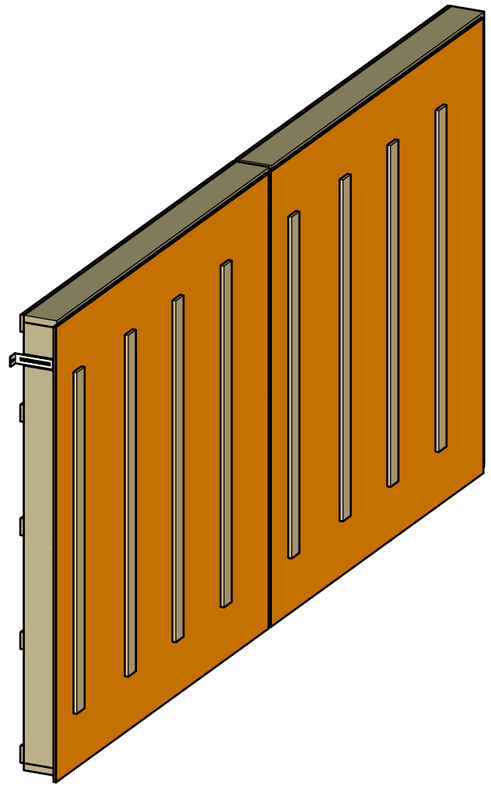
DESCRIPTION
Sheet Description

DRAWN BY
Nick Rudnicki

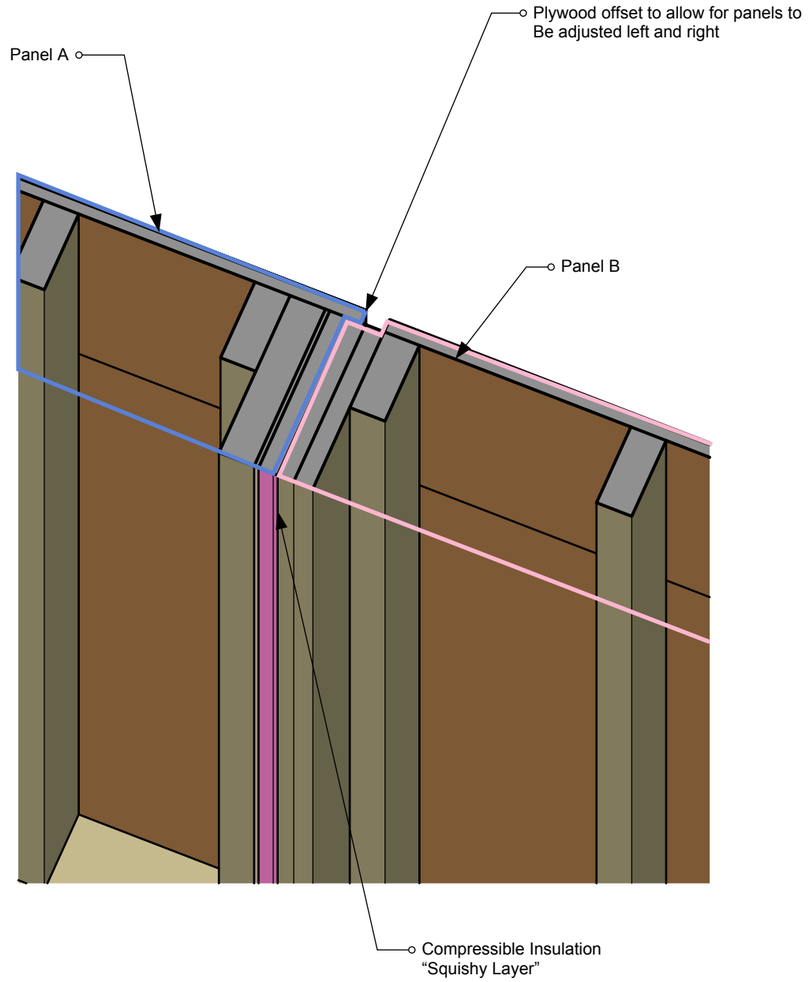
Vertical Wall Joints



INTERIOR VIEW



EXTERIOR VIEW



SECTION VIEW

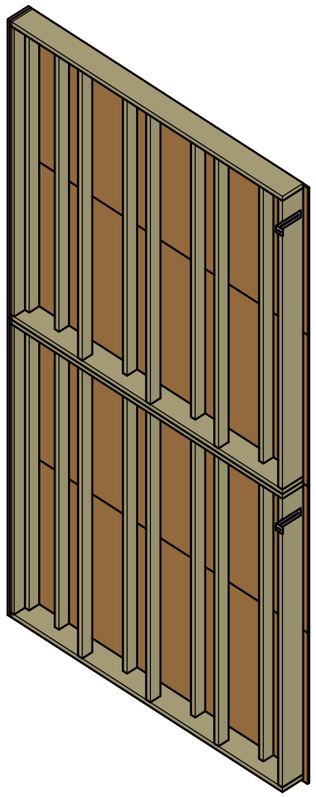
ReCover

Version Date
February 27, 2023

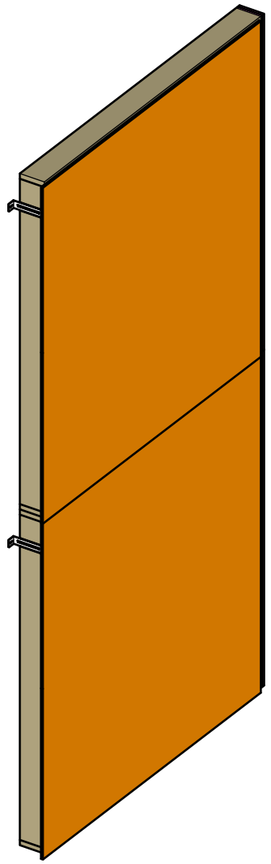
PROJECT
2x6 R21 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

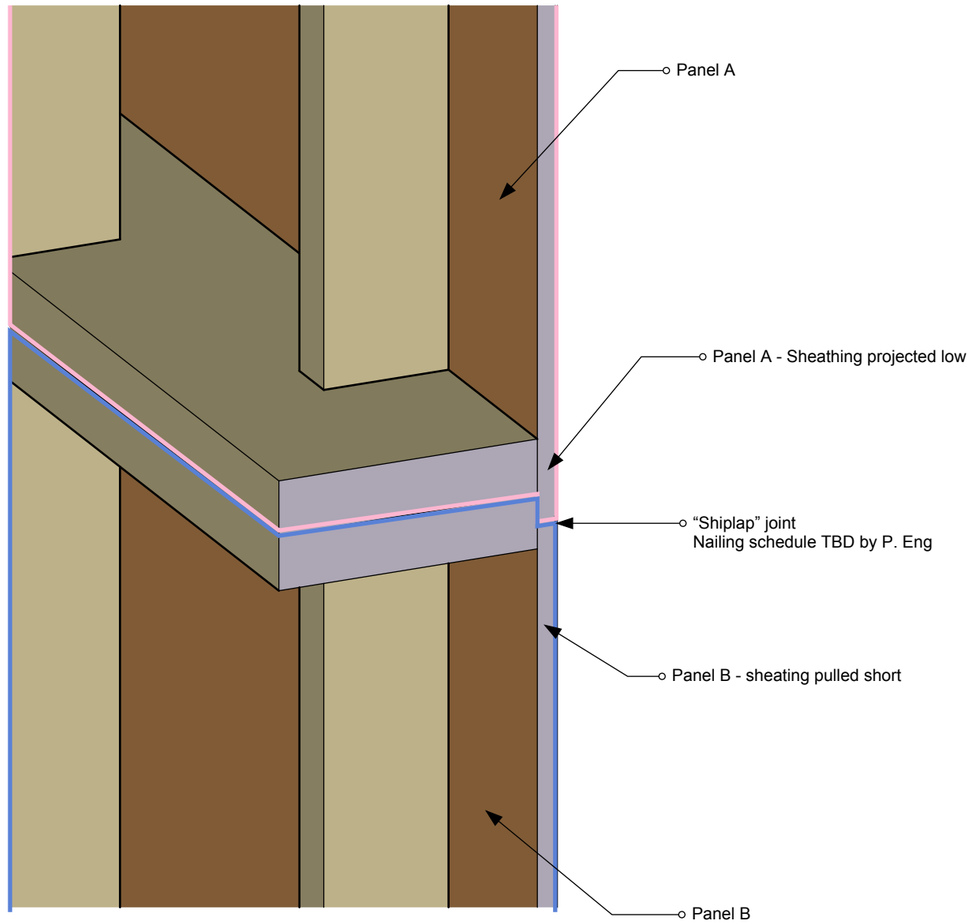
Horizontal Wall Joins



INTERIOR VIEW



EXTERIOR VIEW



SECTION VIEW

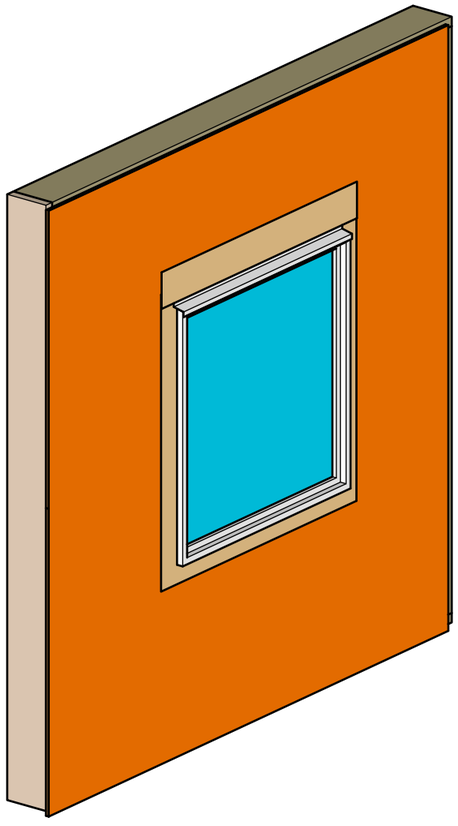
ReCover

Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

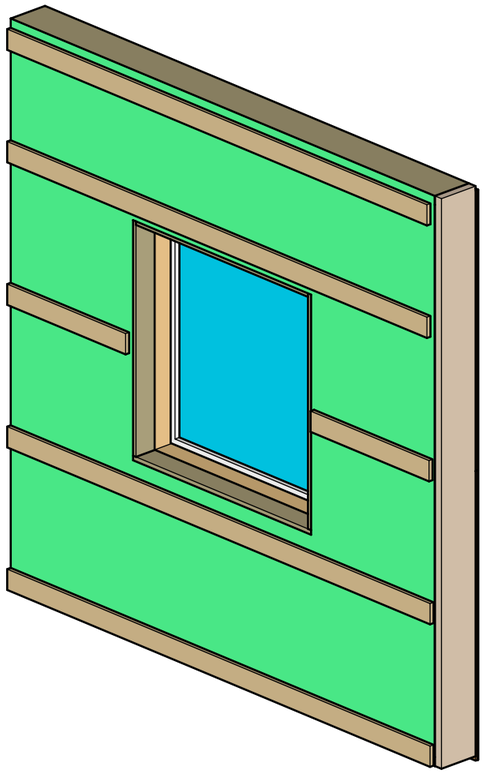
DRAWN BY
Nick Rudnicki

Window Panel

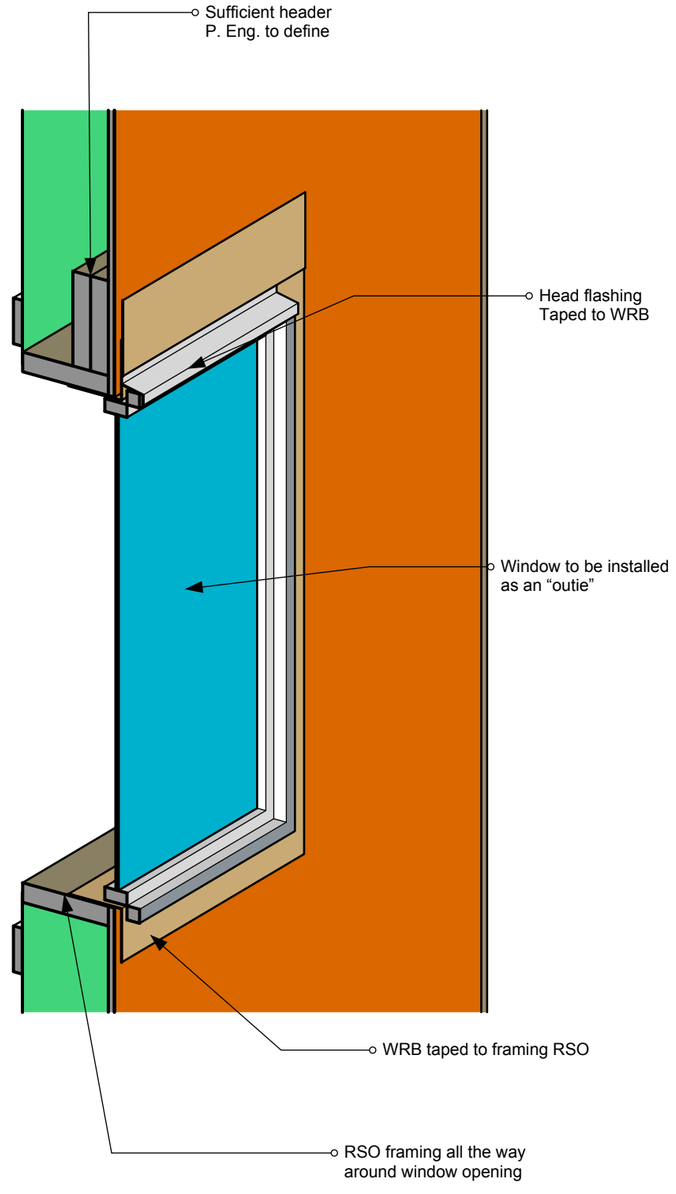


PANEL
EXTERIOR VIEW

Window installed in factory
Window installed as an “outie” to minimize how much window sill there is exposed to the rain



PANEL
EXTERIOR VIEW



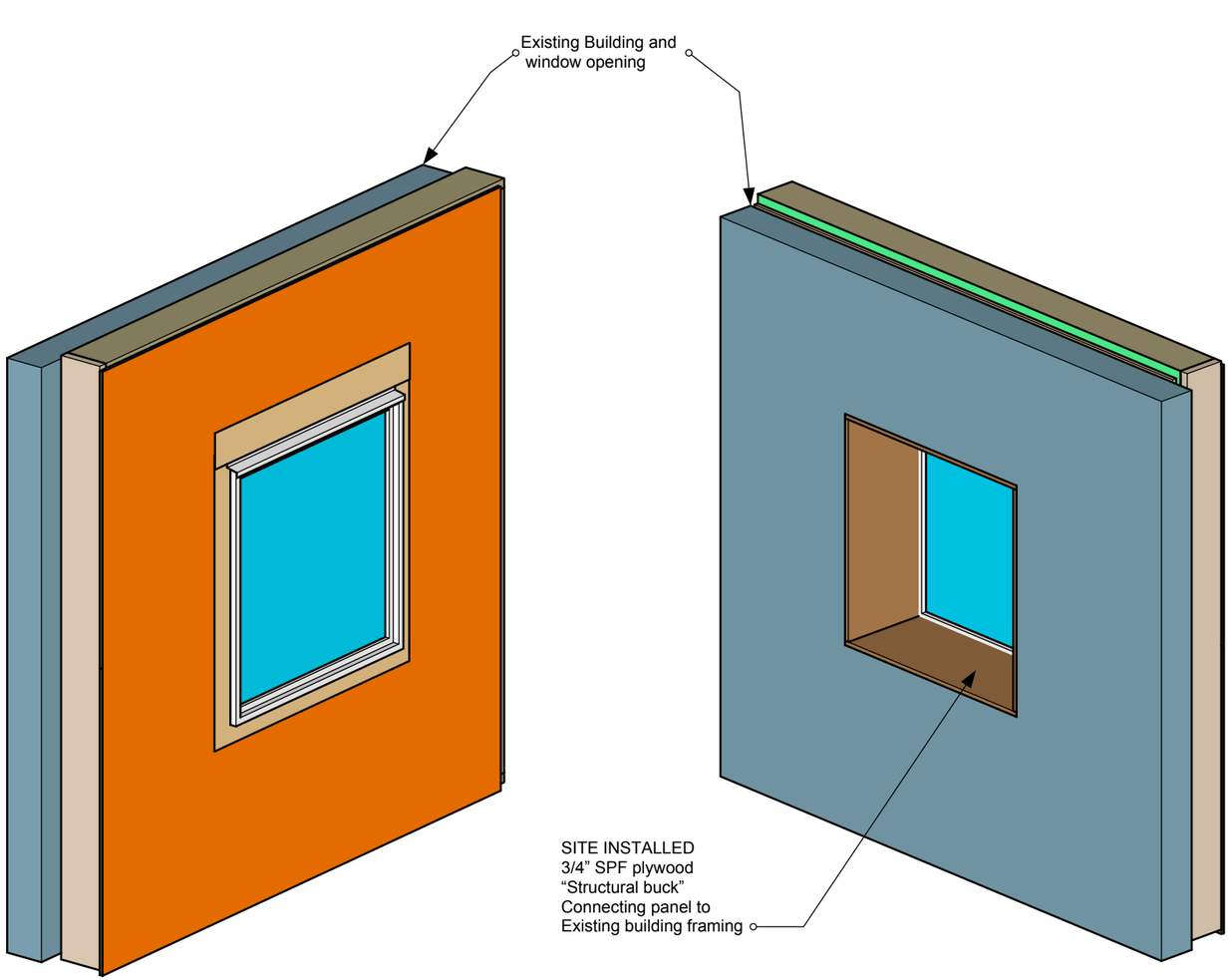
ReCover

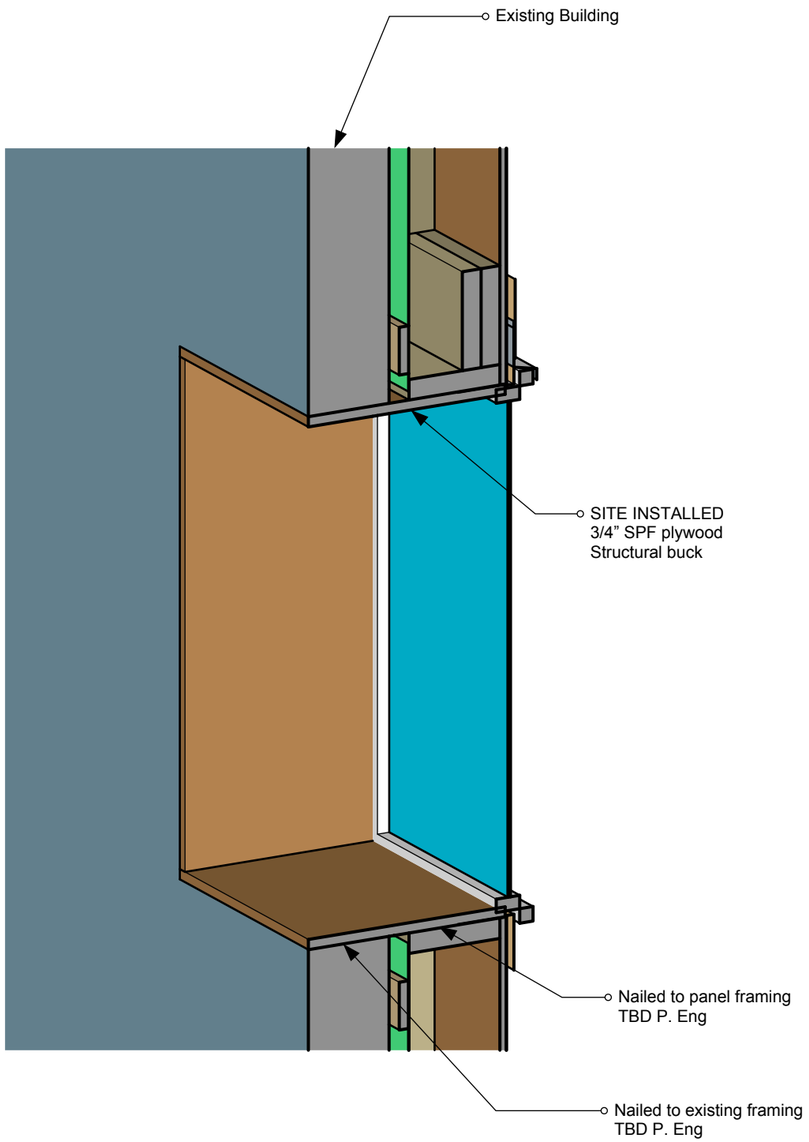
Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Window Panel Install





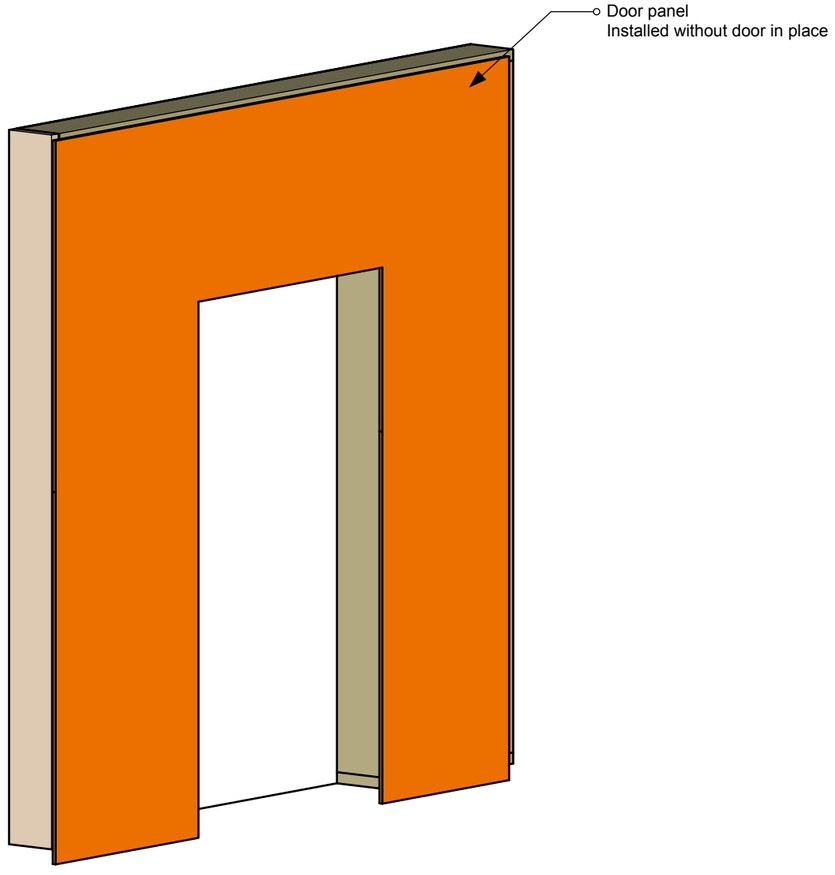
ReCover

Version Date
February 27, 2023

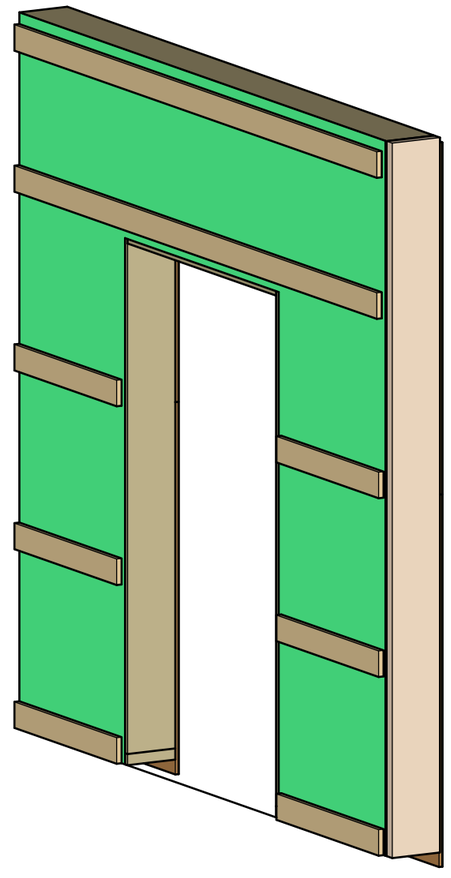
PROJECT
2x6 R21 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Door Penetration Panel



EXTERIOR VIEW



INTERIOR VIEW

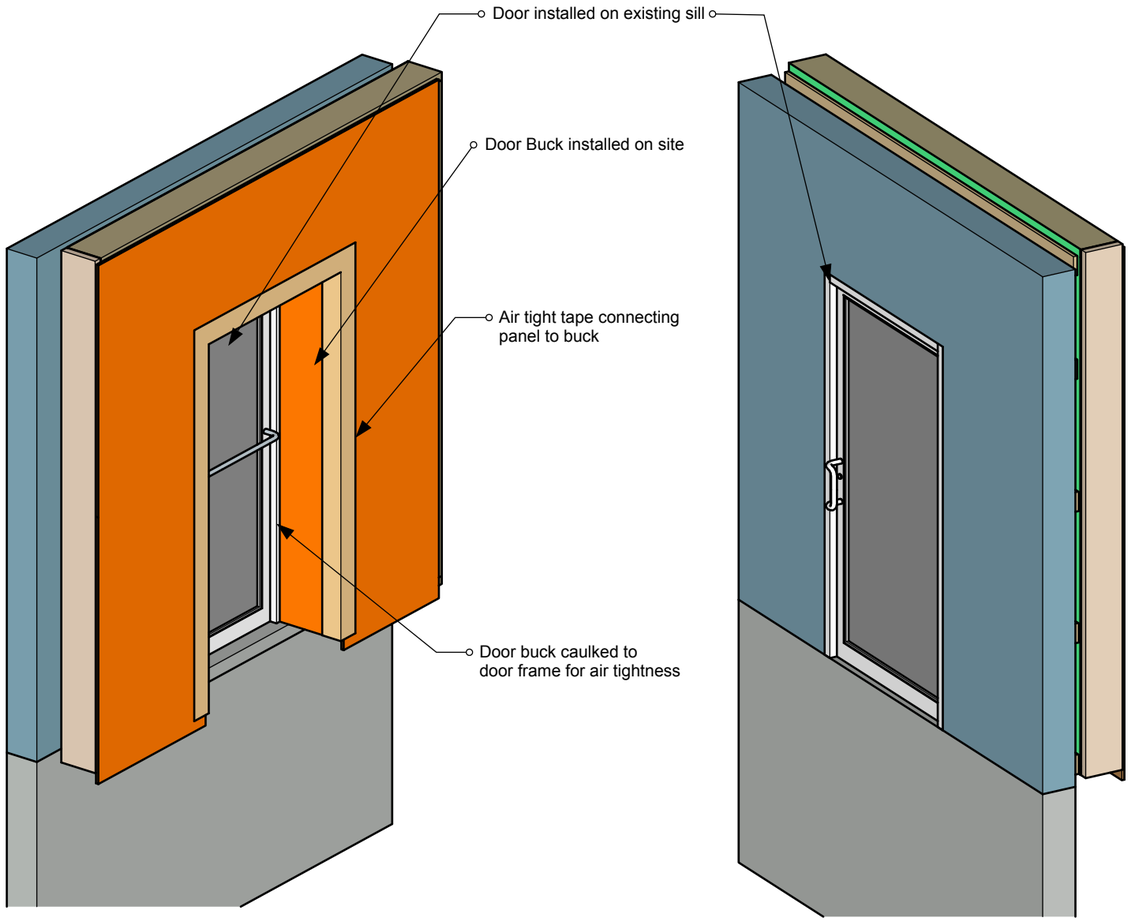
ReCover

Version Date
February 27, 2023

PROJECT
2x6 R21 Cellulose
Panel Schematics

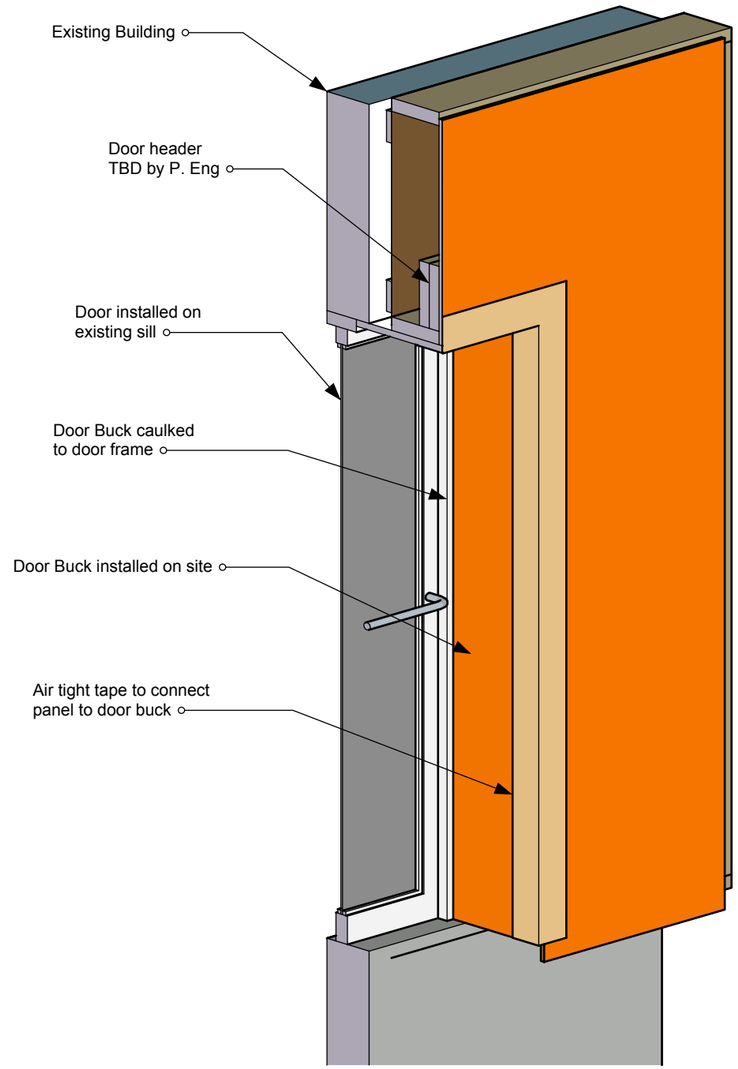
DRAWN BY
Nick Rudnicki

Door Penetration Panel Installed



EXTERIOR VIEW

INTERIOR VIEW



SECTION VIEW

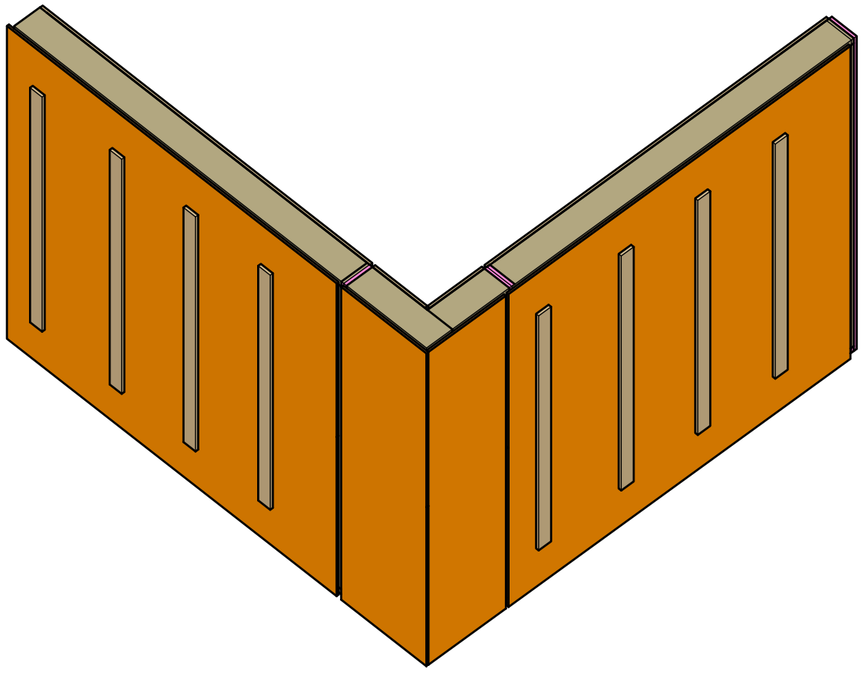
ReCover

Version Date
February 27, 2023

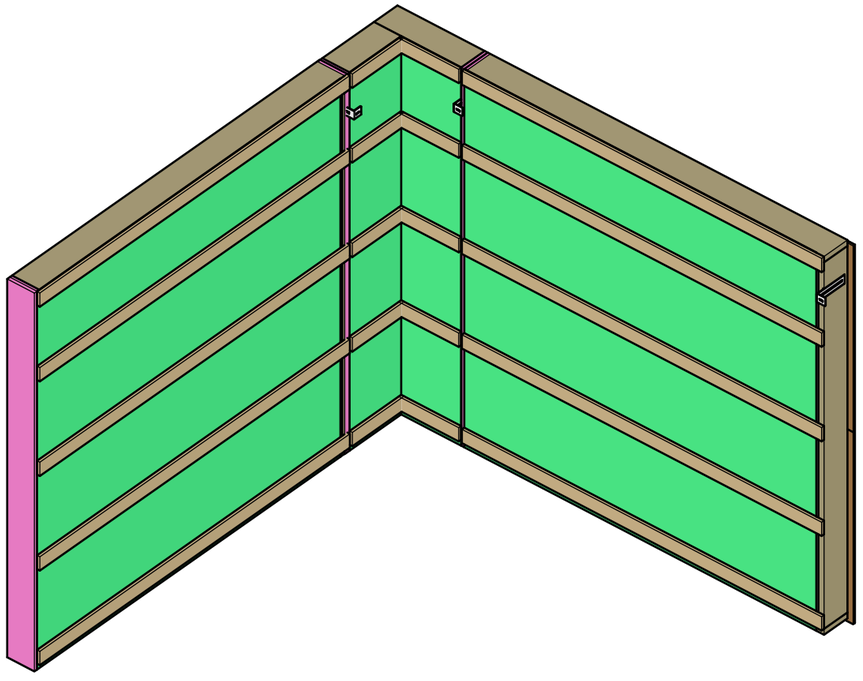
PROJECT
2x6 R21 Cellulose Panel Schematics

DRAWN BY
Nick Rudnicki

Outside Corner Installed



EXTERIOR VIEW



INTERIOR VIEW

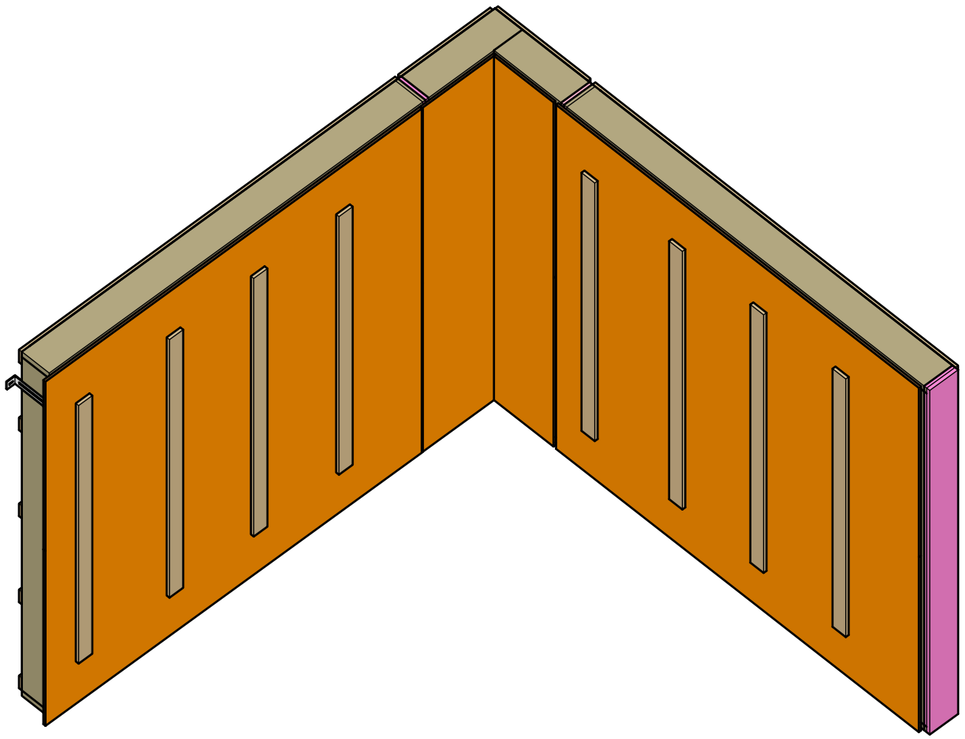
ReCover

Version Date
February 27, 2023

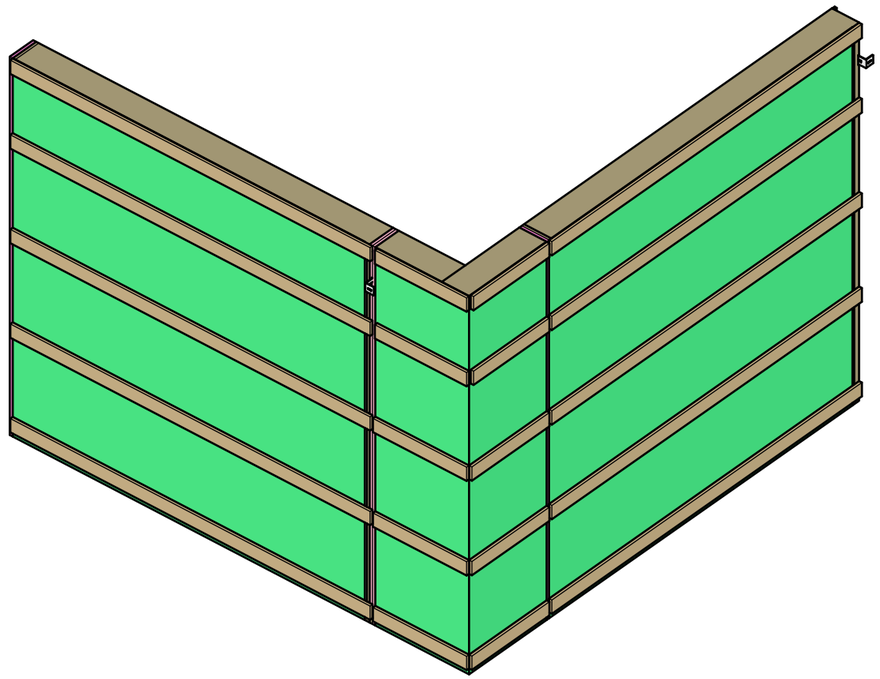
PROJECT
2x6 R21 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki

Inside Corner Installed



EXTERIOR VIEW



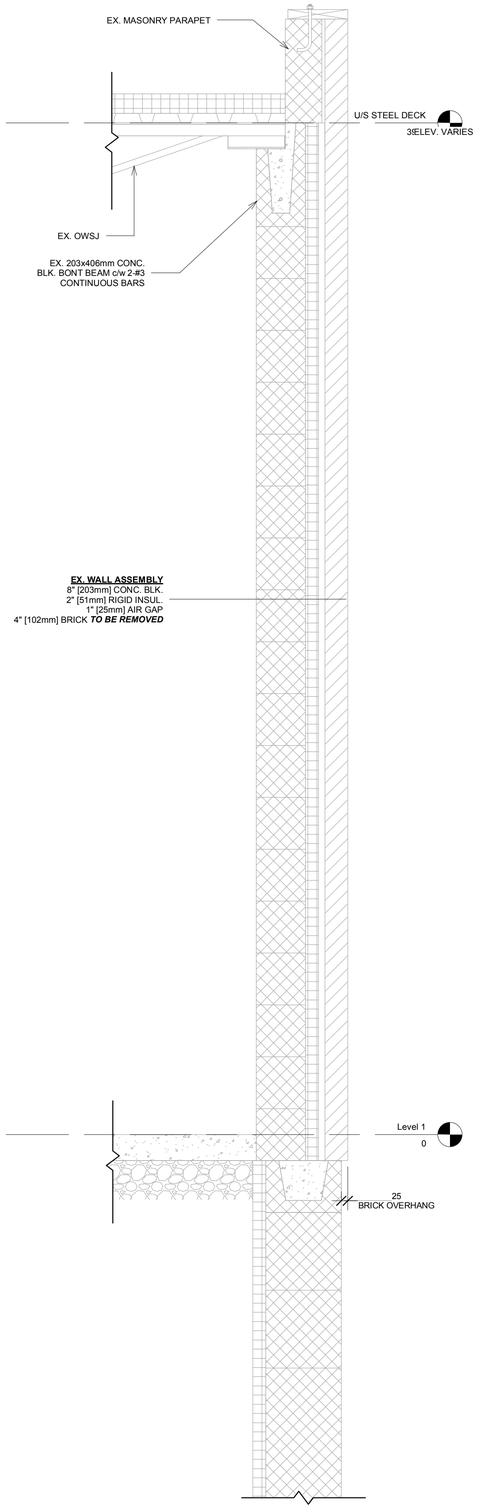
INTERIOR VIEW

ReCover

Version Date
February 27, 2023

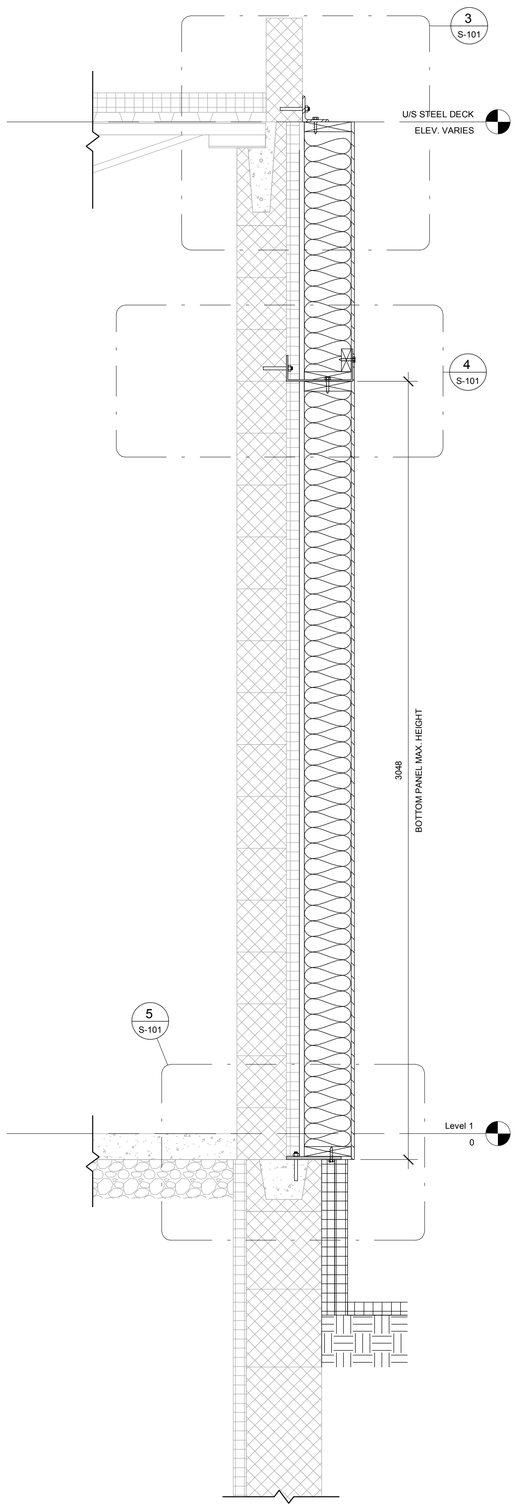
PROJECT
2x6 R21 Cellulose
Panel Schematics

DRAWN BY
Nick Rudnicki



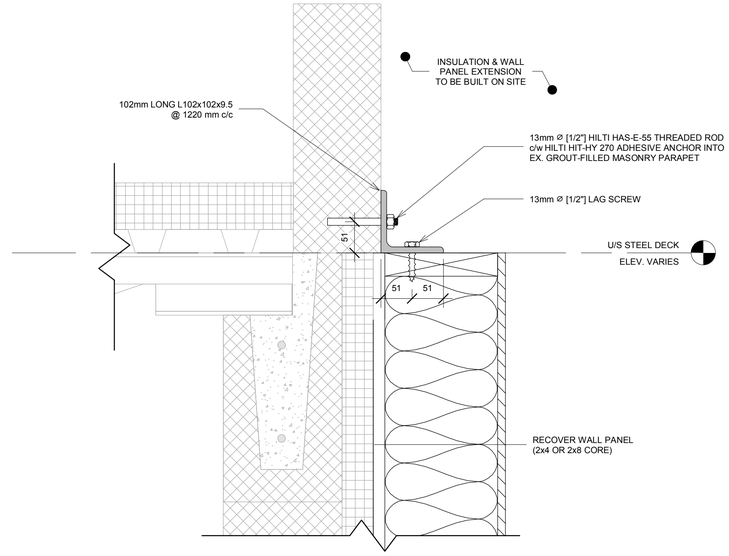
1 S-101 EXISTING WALL SECTION

1 : 12



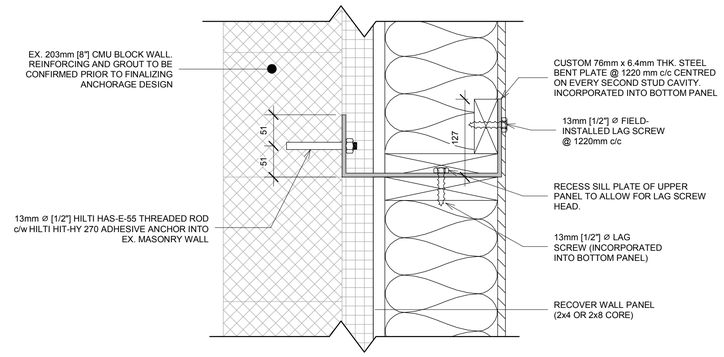
2 S-101 WALL WITH PANELS

1 : 12



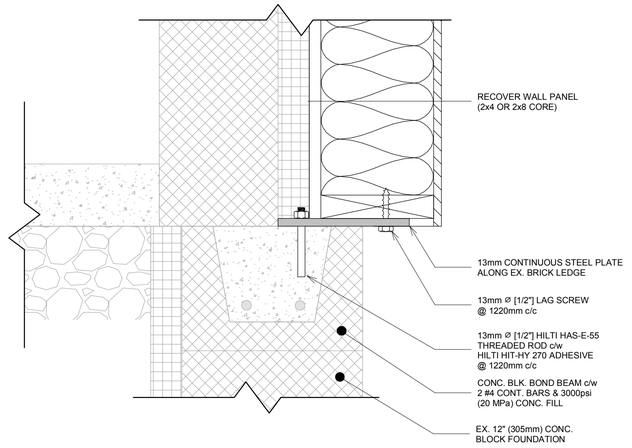
3 S-101 WALL PANEL AT ROOF

1 : 5



4 S-101 MID-HEIGHT WALL PANEL JOINT

1 : 5



5 S-101 WALL PANEL AT FOUNDATION

1 : 5

PRELIMINARY

ISSUE	DATE	DESCRIPTION
1	13-03-2023	ISSUED FOR REVIEW

CONSULTANT

DESIGNPOINT
engineering • surveying • solutions
902.832.5597
designpoint.ca

CLIENT

RECOVER INITIATIVE

PROJECT DESCRIPTION

BURLINGTON SENIORS CENTRE RECREATIONAL BUILDING

BURLINGTON, ONTARIO

SHEET DESCRIPTION

PANEL CONNECTION DETAILS

Drawn	Engineer	Project No.	Drawing No.
A. MCCRACKEN	E. TEASDALE	22-316	S-101
Scale: As indicated	Filename: 22-316_Burlington.rvt		1 of 1

Appendix I

Panel Layouts

Burlington Seniors Centre Panelized Retrofit

Construction Plan

City of Burlington

ReCover

CLIENT
City of Burlington

Version Date
March 8, 2023

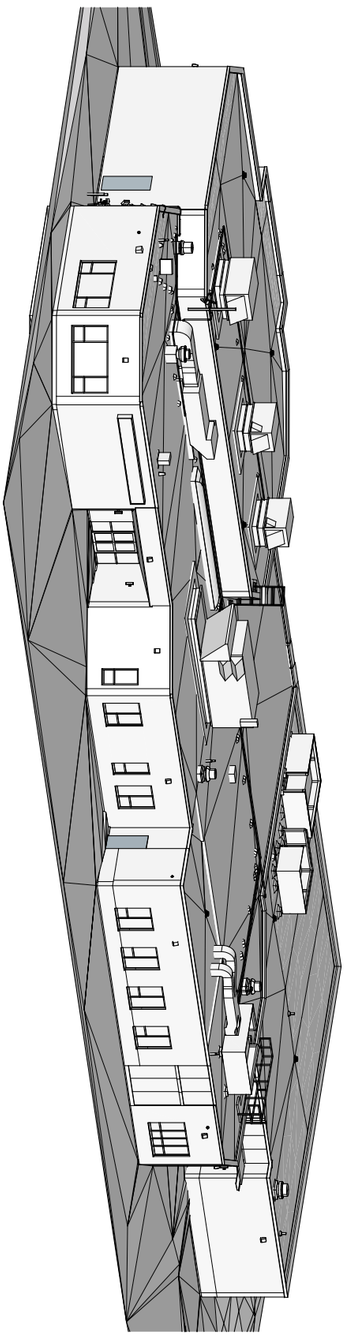
Project Address
2285 New St
Burlington
ON, L7R 1J4

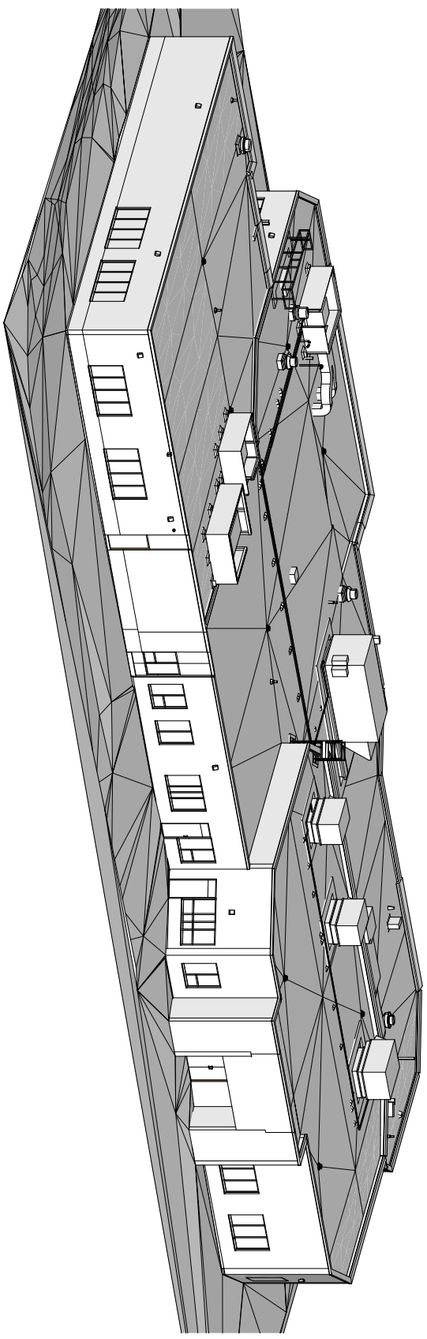
PROJECT
Burlington Seniors Centre
Panelized Retrofit

DRAWN BY
Nick Rudnicki

01

Existing Building





DRAWN BY
Nick Rudnicki

PROJECT
Burlington Seniors Centre
Panelized Retrofit

Project Address
2285 New St
Burlington
ON, L7R 1J4

Version Date
March 8, 2023

CLIENT
City of Burlington

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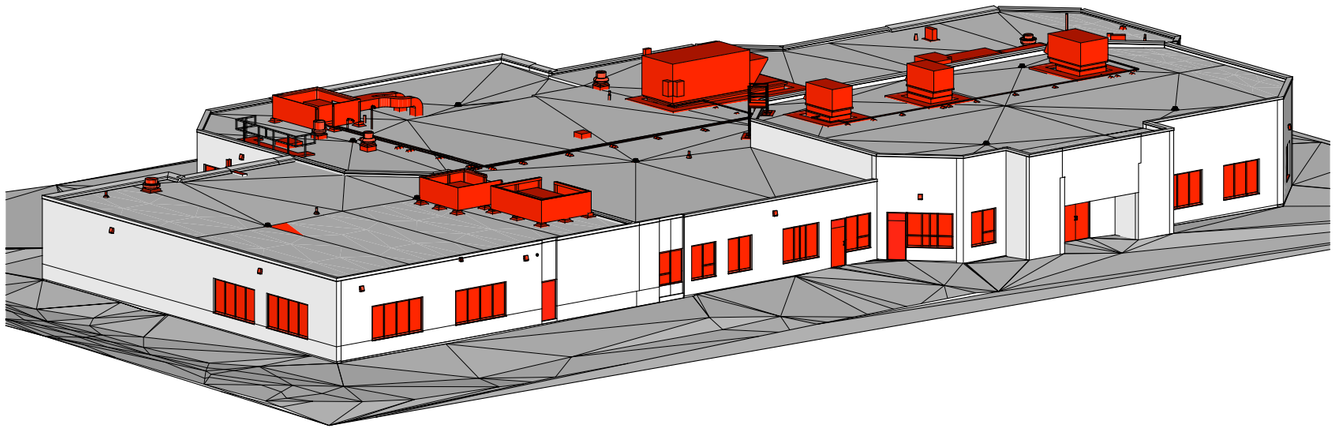
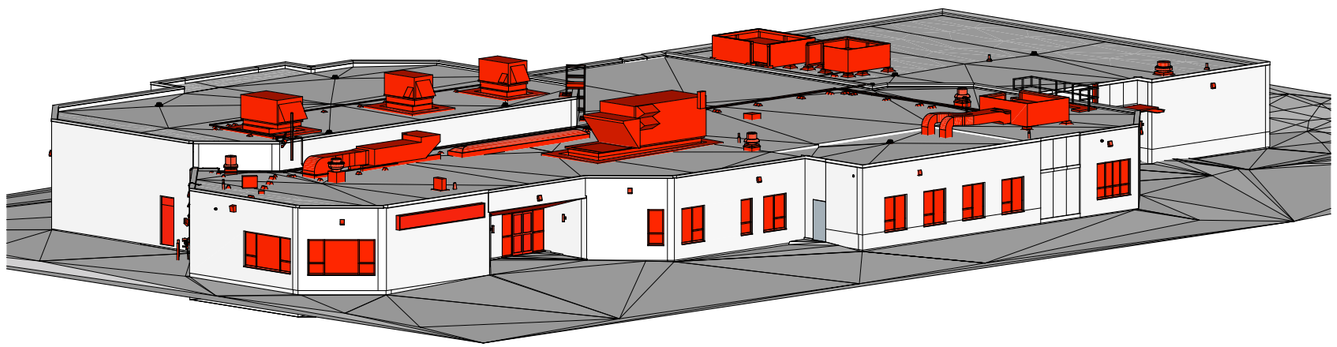
Demolition





Remove all windows and doors

Remove all roof top mechanical systems

ReCover

CLIENT
City of Burlington

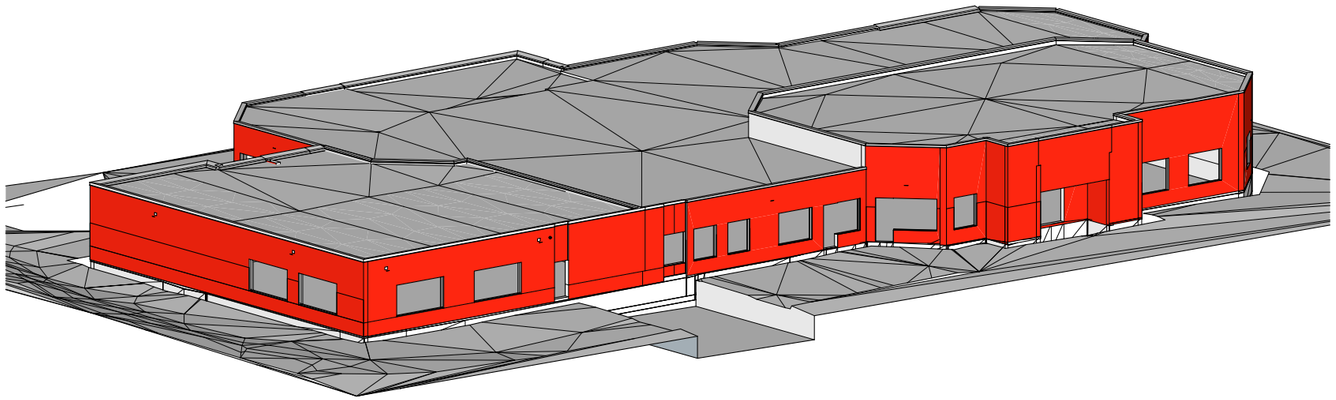
Version Date
March 8, 2023

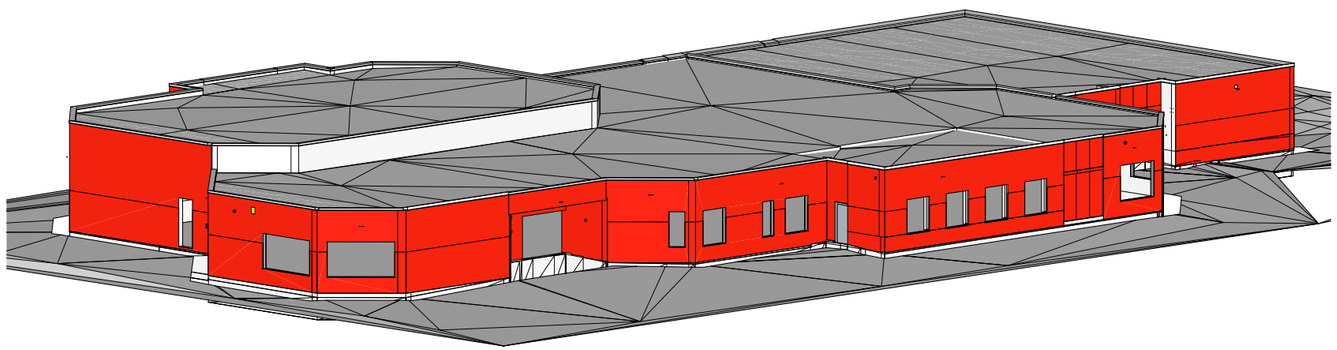
Project Address
2285 New St
Burlington
ON, L7R 1J4

PROJECT
Burlington Seniors
Centre
Panelized Retrofit

DRAWN BY
Nick Rudnicki

Brick Removal and Excavation





1. Excavate a trench around perimeter of building to facilitate foundation insulation.

2. Excavate out for footprint of mechanical room expansion.

3. Remove all brick from existing facade.

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CLIENT
City of Burlington

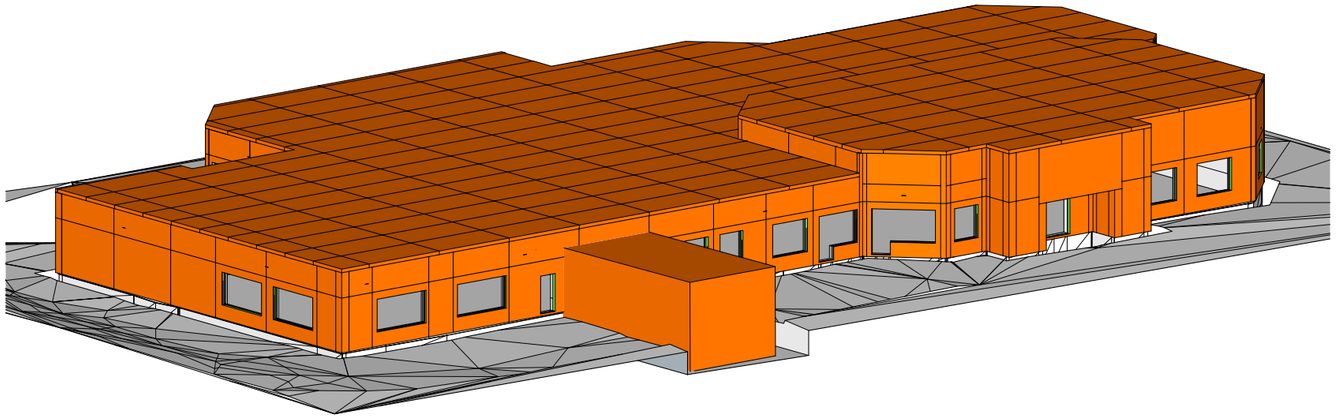
Version Date
March 8, 2023

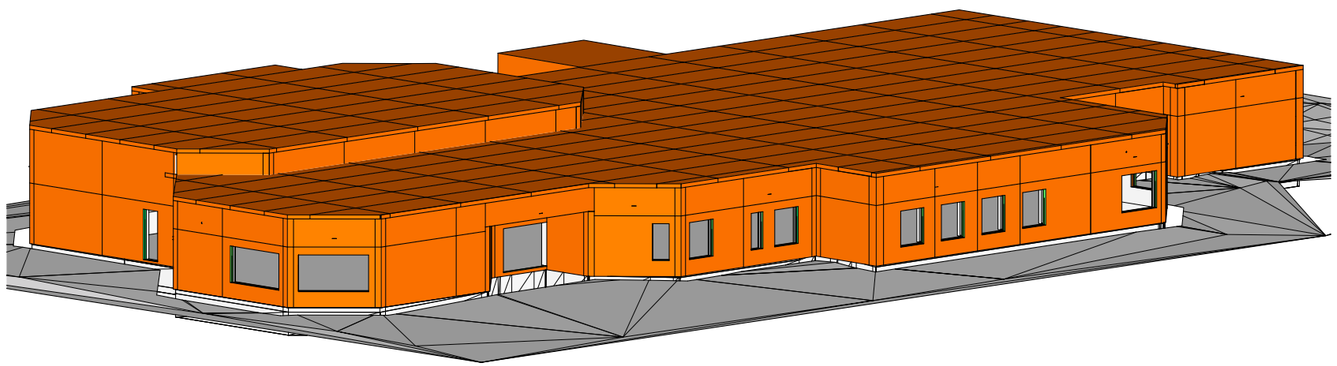
Project Address
2285 New St
Burlington
ON, L7R 1J4

PROJECT
Burlington Seniors Centre
Panelized Retrofit

DRAWN BY
Nick Rudnicki

Wall and Roof Panel Install





1. Build addition room

2. Install Wall panels, bearing on existing brick check of foundation wall.

3. Install roof panels.

ReCover

CLIENT
City of Burlington

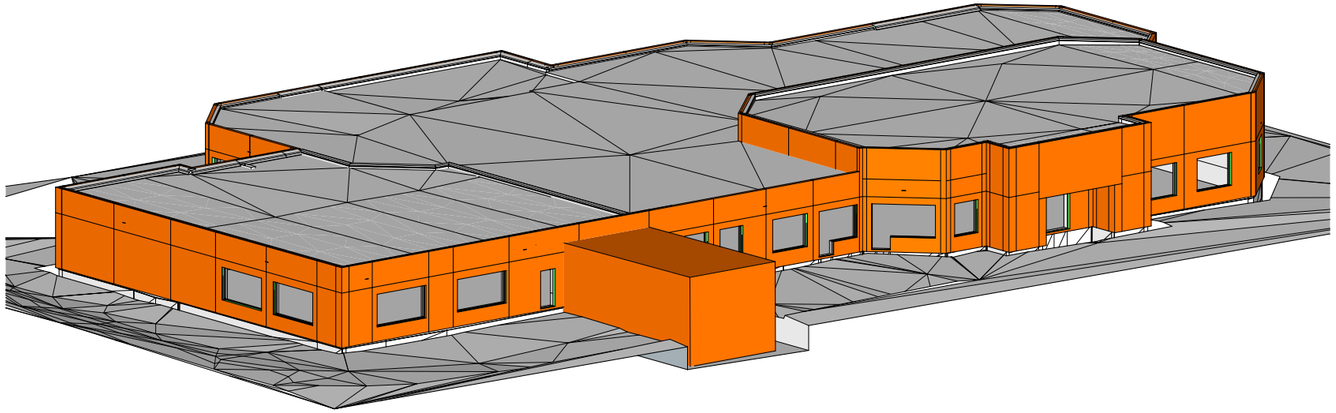
Version Date
March 8, 2023

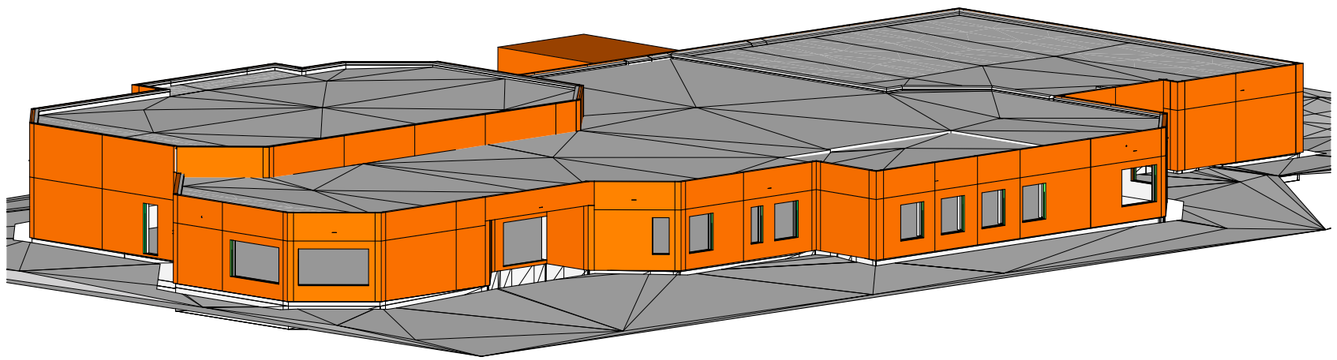
Project Address
2285 New St
Burlington
ON, L7R 1J4

PROJECT
Burlington Seniors Centre
Panelized Retrofit

DRAWN BY
Nick Rudnicki

Wall Panel Install





1. Build addition room

2. Install Wall panels, bearing on existing brick check of foundation wall.

ReCover

CLIENT
City of Burlington

Version Date
March 8, 2023

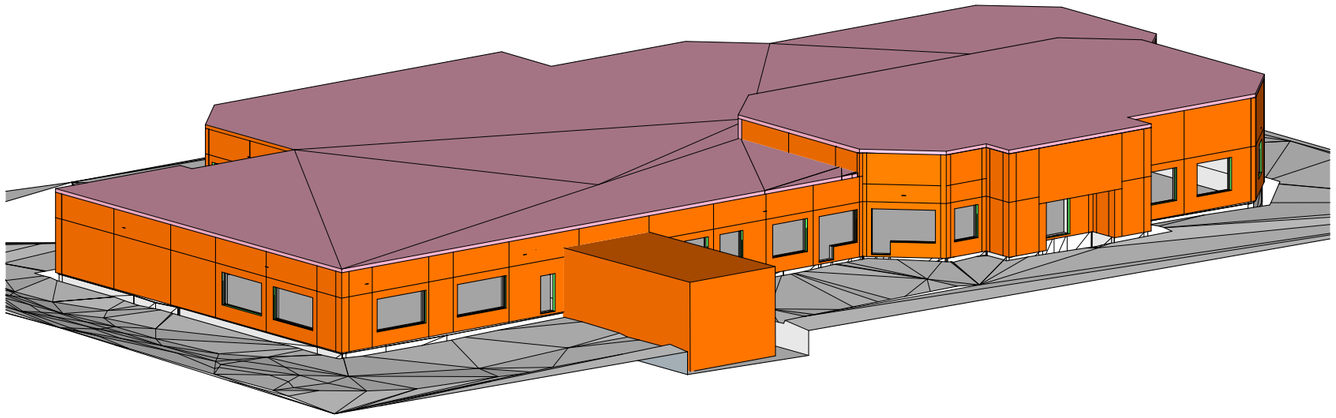
Project Address
2285 New St
Burlington
ON, L7R 1J4

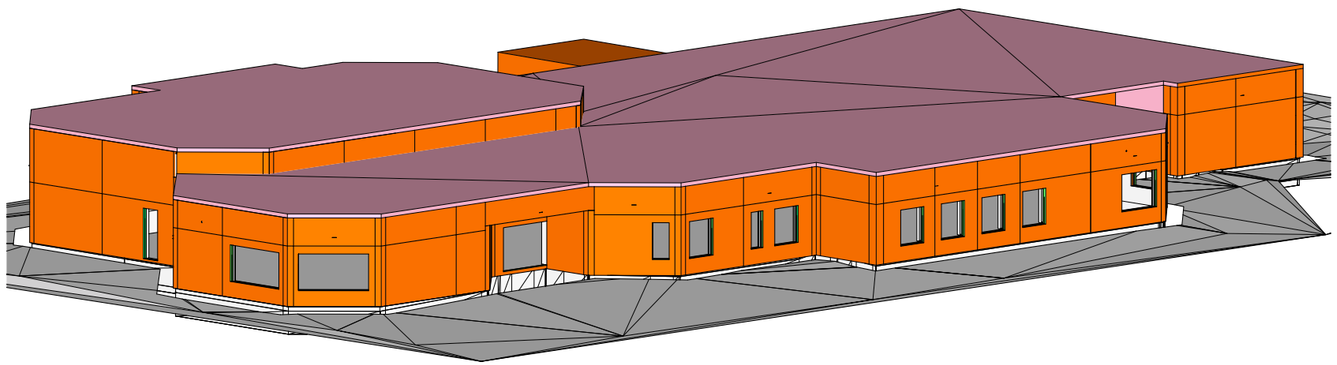
PROJECT
Burlington Seniors Centre
Panelized Retrofit

DRAWN BY
Nick Rudnicki

06

Roof Insulation





1. Install conventional XPS roof insulation

ReCover

CLIENT
City of Burlington

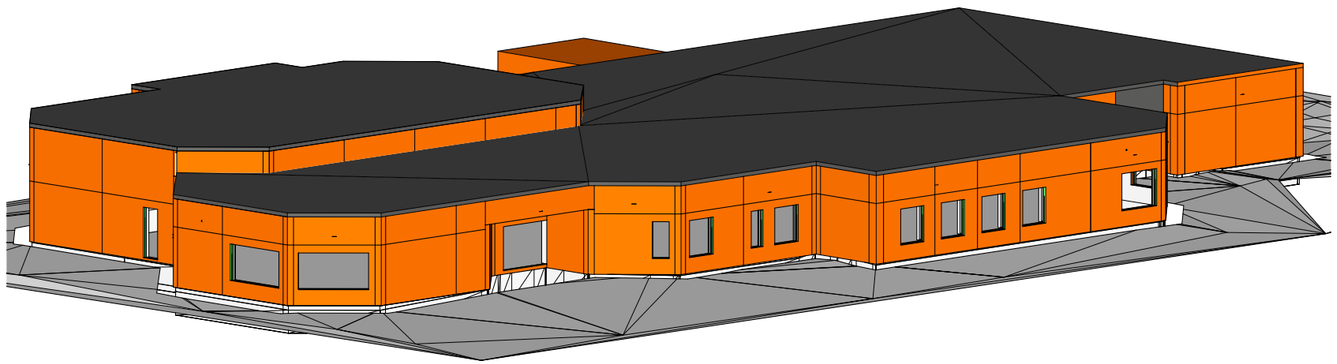
Version Date
March 8, 2023

Project Address
2285 New St
Burlington
ON, L7R 1J4

PROJECT
Burlington Seniors
Centre
Panelized Retrofit

DRAWN BY
Nick Rudnicki

Wall and Roof Panel Install



1. Install conventional roof membrane

ReCover

CLIENT
City of Burlington

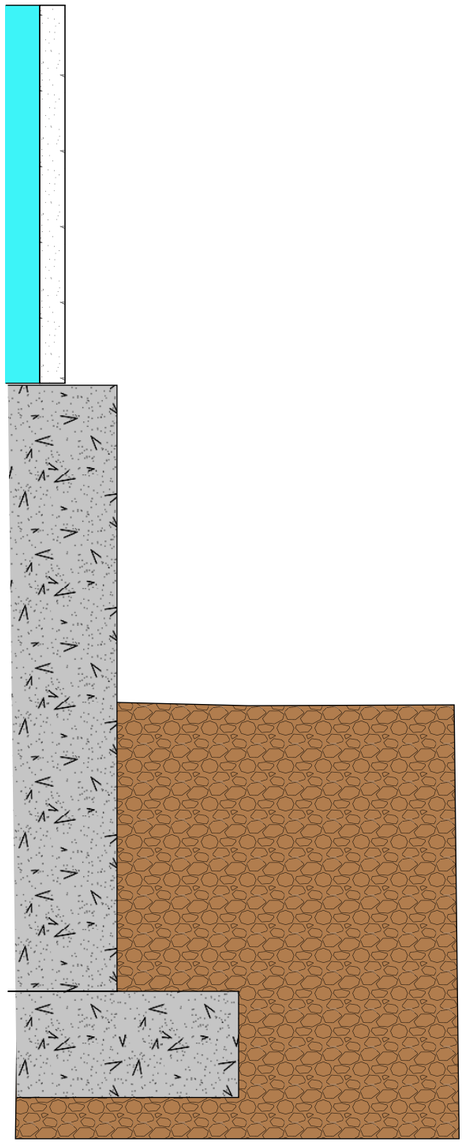
Version Date
March 8, 2023

Project Address
2285 New St
Burlington
ON, L7R 1J4

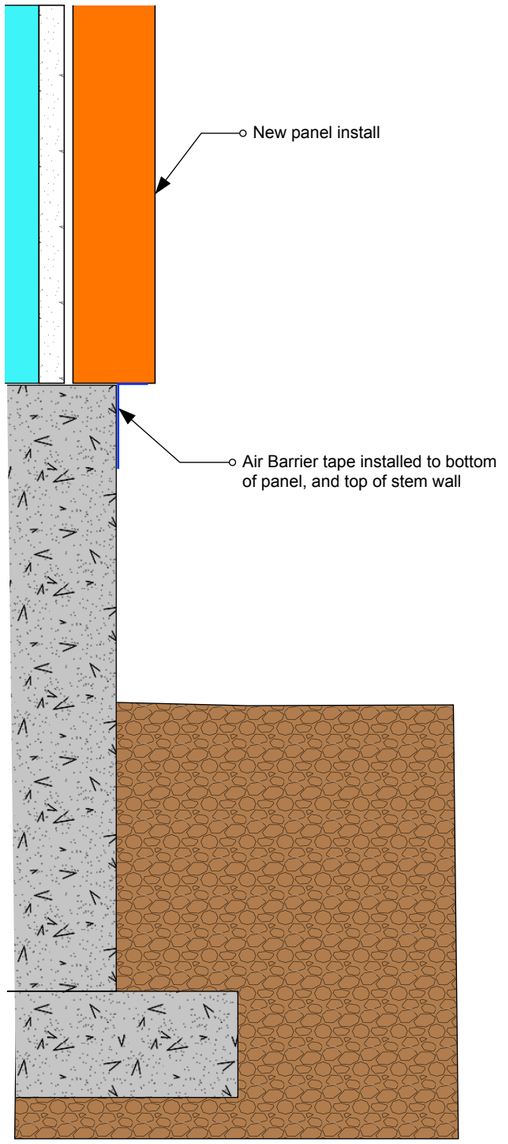
PROJECT
Burlington Seniors
Centre
Panelized Retrofit

DRAWN BY
Nick Rudnicki

Foundation Insulation and Panel Base

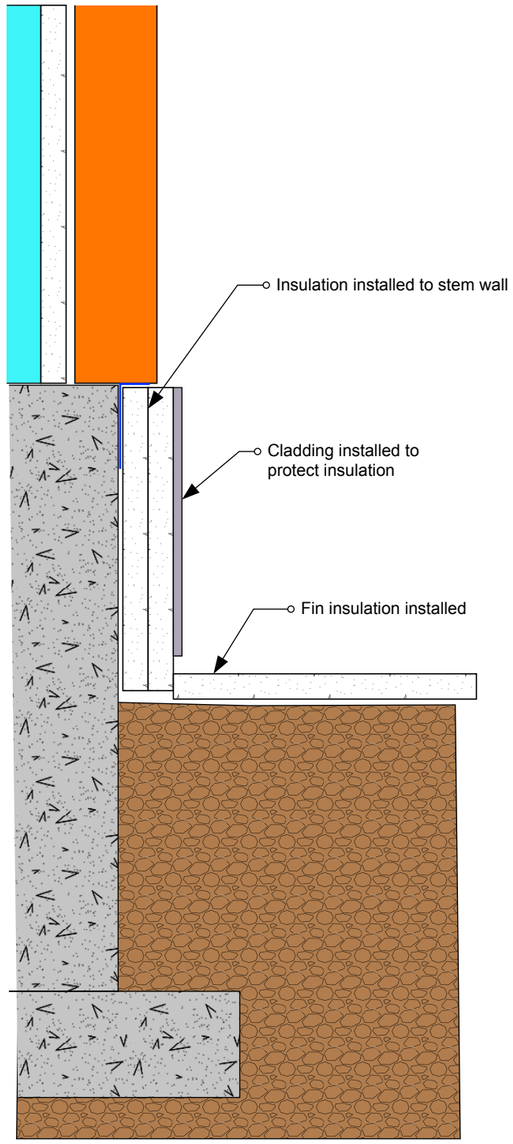


STEP 1
Excavate to reveal stem-wall



STEP 2
Install panel resting on top of brick-ledge

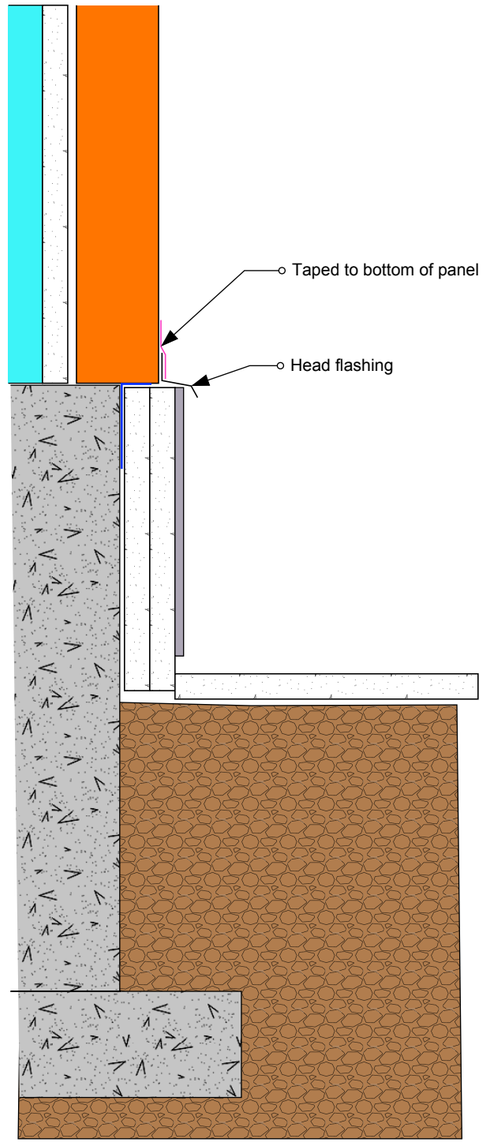
Install air-barrier to connect bottom of panel to stem wall.



STEP 3
Install stem wall insulation

Install fin insulation

Install insulation cladding



STEP 4
Install head flashing to top of exposed foundation insulation

Tape flashing to bottom of panel

ReCover

CLIENT
City of Burlington

Version Date
March 8, 2023

Project Address
2285 New St
Burlington
ON, L7R 1J4

PROJECT
Burlington Seniors Centre
Panelized Retrofit

DRAWN BY
Nick Rudnicki

09

Appendix J

Hygrothermal Report

- **Report**

RE: Preliminary WUFI® Pro Results – PRELIMINARY DRAFT, FOR FINAL REVIEW

Location: 2285 New Street, Burlington, Ontario

Date: 2023-03-01

The services of Stanley Francispillai, P. Eng. (Quebec, Nova Scotia), were retained by Habit Studio Incorporated for the ReCover Initiative: Panelized Deep Energy Retrofits of Municipal Buildings project. These services were limited to the presentation of results for the hygrothermal modelling of the post-retrofit above-grade wall and roof assemblies of six municipal buildings using the ReCover Initiative team's panel design. The present report serves as a summary of the WUFI® Pro results obtained for the Burlington Seniors' Centre located at 2285 New St. in Burlington, Ontario.

INTRODUCTION

It is understood that the Burlington Seniors' Centre, built in 1979, resides in the suburbs of Burlington north of the intersection between New St. and Drury Ln. The building in question is composed of two parts, namely the original centre (henceforth named the Existing Seniors' Centre) and the addition constructed in 2005 (henceforth the Building Expansion), both of which are fully attached to create one building. The centre's length runs South-East to North-West. The north-eastern side of the building faces the centre's parking lot, while the south-western side faces the community tennis courts (**Figure 1**).

Figure 1 – Plan view location and orientation of the Existing Seniors' Centre (shaded red) and the (existing) Building Expansion (shaded blue) of the Burlington Seniors' Centre, Burlington (Google, 2022)

SCOPE OF WORK

The scope of work for this project includes the presentation of results associated with the hygrothermal modelling of the post-retrofit exterior wall and roof assemblies of the Burlington Seniors' Centre over a 10-year period using the software WUFI® Pro. The simulation uses preliminary assumptions based on discussions made with the ReCover team, as well as the PHIUS+ protocol *Moisture Risk Analysis & Assessment using WUFI v1.1* (G. Wright, P. Ferreira, R. Richman, 2021).

The hygrothermal modelling includes all above-grade exterior walls and roof structures of the Existing Seniors' Centre and the Building Expansion. The retrofit designs used in the hygrothermal models were provided by the ReCover team.

It is of note that no design was conducted by Stanley Francispillai, P. Eng. Existing assemblies were obtained from available documents, and retrofit assemblies were defined by the ReCover team for simulation through WUFI® Pro. This report consists of the output of these simulations.

INPUTS & ASSUMPTIONS

Prior to completing the preliminary models in WUFI®, the inputs and assumptions guiding the simulations were chosen with the ReCover team. These inputs and assumptions were made based on information received from the City of Burlington, including photos, drawings, and reports (such as *25109_BSC_A101 Site Plan Record.dwg*, *25109_BSC_A502 WALL SECTIONS record.dwg, S5 Wall Sections.TIF*, and *2017 RCA Burlington Seniors' Centre.pdf*). The inputs and assumptions of the hygrothermal simulations are based solely on this information. Reference documents are included in **APPENDIX D**.

OUTDOOR CLIMATE: The outdoor climate was modelled using the closest location to the City of Burlington with data available to the author of this report – this was Toronto, Ontario. A specific Burlington climate file is not available in the WUFI® database.

INDOOR CLIMATE: The non-residential indoor climate was modelled using sinusoidal functions. The average indoor temperature and relative humidity setpoints of 21°C and 50% were used in these simulations as assumptions for regular occupancy. As it is unclear as to what future tenancy patterns and moisture loads will be present, the following assumptions were made regarding the indoor climate:

Table 1 – Setpoints and assumptions used in WUFI® for interior climate of building

Interior Setpoints	Average	Amplitude	Range	Date of Maximum Value
Temperature	21°C	1°C	20°C – 22°C	July 20th
Relative Humidity	50%	10%	40% – 60%	July 15th

Note: it is assumed that the temperature and relative humidity setpoints are applied to the entire buildings

ASSEMBLY MATERIALS: Based on the information obtained, the primary existing wall and roof assemblies shown in Table 2 and Table 3 were modelled for the Existing Seniors' Centre and the Building Expansion, respectively (detailed material properties are included in **APPENDIX A** and **APPENDIX B**). The retrofit assemblies proposed for the retrofit were based on the details provided by ReCover in an email from Nick Rudnicki received on 2022-12-07. However, final assemblies were also discussed and conveyed by the ReCover team via other emails, as well as phone and video calls.

It should also be noted that assumptions were made regarding certain assemblies. For instance, the build-up of the Building Expansion's existing roof assembly was estimated by the ReCover team based on the line-types of the DWG drawings provided. Other modelling assumptions are included in notes below the following tables as well as in this report's Appendices. **Assembly material choices and assumptions should be reviewed for agreement with existing and proposed conditions.**

Table 2 – Existing Seniors' Centre assemblies and material components used in WUFI® simulations

Assembly	Materials (Interior to Exterior)	Thickness, m (inch)
Wall	Concrete Brick	0.2 (8)
	Extruded Polystyrene Insulation	0.05 (2)
	~~Air Space~~ (*REMOVED*)	~~0.025 (1)~~
	~~Brick~~ (*REMOVED*)	~~0.1 (4)~~
	Air Space	0.02 (0.79)
	Cellulose Bib	0.001 (0.04)
	Dense-Pack Cellulose	0.140 (5.50)
	Plywood	0.013 (0.51)
	Weather Resistive Barrier (WRB)	0.001 (0.04)
	Air Space	0.01 (0.39)
	Metal Cladding*	0.001 (0.04)
Roof	Metal Deck (unpainted)**	0.0008 (0.03)
	Roof Membrane	0.001 (0.04)
	Extruded Polystyrene Insulation	0.075 (3)
	Roof Membrane	0.001 (0.04)
	Air Space	0.02 (0.79)
	Cellulose Bib	0.001 (0.04)
	Dense-Pack Cellulose	0.184 (7.24)
	Plywood/DensGlass* **	0.016 (0.63)
	Roof Membrane	0.001 (0.04)
	Extruded Polystyrene Insulation	0.064 (2.5)

*Metal Cladding modelled using **Roof Membrane V13** from WUFI® as per protocol

**The interior side of the roof assembly's Metal Deck was assumed to be unpainted

***DensGlass modelled using **DensElement™ Barrier System** from WUFI® but with decreased density and increased water vapour diffusion resistance as per the DensGlass specifications provided by ReCover

Table 3 – Building Expansion assemblies and material components used in WUFI® simulations

Assembly	Materials (Interior to Exterior)	Thickness, m (inch)
Wall	Concrete Brick	0.19 (7.5)
	Extruded Polystyrene Insulation	0.075 (3)
	~~Air Space~~ (*REMOVED*)	~~0.025 (1)~~
	~~Brick~~ (*REMOVED*)	~~0.09 (3.5)~~
	Air Space	0.02 (0.79)
	Cellulose Bib	0.001 (0.04)
	Dense-Pack Cellulose	0.140 (5.50)
	Plywood	0.013 (0.51)
	Weather Resistive Barrier (WRB)	0.001 (0.04)
	Air Space	0.01 (0.39)
	Metal Cladding*	0.001 (0.04)
Roof	Metal Deck (unpainted)**	0.0008 (0.03)
	Plywood	0.013 (0.51)
	Roof Membrane	0.001 (0.04)
	Extruded Polystyrene Insulation	0.1 (4)
	Plywood	0.013 (0.51)
	Roof Membrane	0.001 (0.04)
	Air Space	0.02 (0.79)
	Cellulose Bib	0.001 (0.04)
	Dense-Pack Cellulose	0.184 (7.24)
	Plywood/DensGlass* **	0.016 (0.63)
	Roof Membrane	0.001 (0.04)
	Extruded Polystyrene Insulation	0.064 (2.5)

*Metal Cladding modelled using **Roof Membrane V13** from WUFI® as per protocol

**The interior side of the roof assembly's Metal Deck was assumed to be unpainted

***DensGlass modelled using **DensElement™ Barrier System** from WUFI® but with decreased density and increased water vapour diffusion resistance as per the DensGlass specifications provided by ReCover

MOISTURE & AIR SOURCES: To determine how the retrofit walls perform under certain environmental stresses, a 1% driving rain moisture source was placed on the exterior face of the WRB in the form of a fictitious 1-mm layer of brick, as per the PHIUS+ protocol. Moreover, the new vented cladding was given a default ventilation rate of 25 air changes per hour (ACH) and was placed within the 10 mm "*Air layer 10mm; metallic*" material which is pre-defined by WUFI® for use adjacent to metal surfaces.

ORIENTATIONS: Given that the wall and roof assemblies differ between the Existing Seniors' Centre and the Building Expansion, both were simulated independently. In WUFI® Pro, the Existing Seniors' Centre wall assembly was simulated in the North-East, South-East, and South-West directions while that of the Building Expansion was simulated in the North-East, North-West, and South-West orientations; these walls were set to 90° inclinations from the horizontal.

RAIN LOAD: In terms of rain loading, the ASHRAE Standard 160 rain load calculation method was utilized. For the wall assemblies, the rain exposure factor was based on the building's height of less than 10-m, while the rain exposure category was assumed to be medium, as the building is located approximately 880-m from the western tip of Lake Ontario. The rain deposition factor was automatically defined based on the flat roof structures involved. These same assumptions were used for the roof assembly, with the only difference being the rain deposition factor requiring a higher value due to increased bulk water contact from rainwater runoff.

BOUNDARY CONDITIONS: For the post-retrofit condition simulated, it was assumed that the walls' proposed exterior metal cladding would be painted, while the interior side of the various walls were also simulated with painted finishes based on site-visit photographs. The interior side of the roof assemblies' metal deck was assumed to be unpainted for this preliminary analysis. The presence (or lack thereof) of these paints affects the surface transfer (sd) coefficients of the hygrothermal models – other sd-coefficients considered in the models are included in **APPENDIX B**. Finally, roof simulations were conducted considering shading from the presence of solar photovoltaic panels per ReCover's request.

INITIAL CONDITIONS: Finally, as per ASHRAE 160, initial material conditions were set to EMC80 (equilibrium moisture content at 80% relative humidity), while concrete-based materials were set to EMC90; for all materials, the starting temperature was set to 20°C. The simulations were defined to begin on October 1st, 2022, which is the default starting day for WUFI®, and continue for a period of 10-years.

Other inputs of the WUFI® simulations can be found in the software's auto-generated results report, included in **APPENDIX B**.

RESULTS

The PHIUS+ protocol's post-processing and evaluation procedure was sourced for describing the results of the hygrothermal simulations conducted.

EXISTING SENIORS' CENTRE: POST-RETROFIT WALL

The post-retrofit Existing Seniors' Centre wall assembly simulation did not demonstrate any numerical errors for all orientations and conditions tested – no convergence failures occurred, and the differences between balances of change in total water content and the sum of the moisture fluxes were very small.

As recommended by the protocol, the plywood layers were subdivided into three adjacent layers for near-surface condition assessment, with the outermost and innermost layers being 1/8-inch thick, respectively. The three plywood layers were focused upon for this feasibility report given their susceptibility to decay and mold. To estimate decay risk, the time periods during which the mass percentage of water content (MC) remains above 20% were observed.

In all orientations simulated, namely North-East, South-East, and South-West, at least one of the three plywood layers experiences spikes in MC above 20%. The occurrence and duration of these spikes vary from orientation to orientation. In general, the primary spike occurs in the first year, after which the MC decreases annually. In the South-East and South-West orientations, only the innermost 1/8-inch plywood layer experiences a period of MC above 20% in the first year alone – subsequent years' MC fall below the 20% threshold (see **Figure 2**). However, the output of the North-East post-retrofit wall assembly demonstrates significant MC levels above 20% in all plywood layers, namely in the outermost plywood layer. In this outer 1/8-inch layer, the 20% threshold is surpassed in the first year (approximately November 2022 to mid-April 2023), the second year (approximately November 2023 to late January 2024, mid-to-late March 2024, and beginning-to-mid April 2024), as well as subsequent years (approximately November to mid-January with secondary, less significant spikes in March and April) (see **Figure 3**). (Note: all orientations' plywood and cellulose MC graphs are available in **APPENDIX C**)

For mold-related durability, a VTT simulation was conducted using the WUFI® Pro plug-in which examines the mold growth index at the specified locations. The plywood layers and the outermost element of the cellulose layer were simulated using VTT. The plywood layers were defined with a sensitivity class of "Sensitive" (second-highest risk category) and a material class experiencing "Almost no decline". The cellulose layer was simulated in VTT as a proxy for the structural wood members (not modelled) located within the cellulose cavity. Based on discussions with ReCover, it was assumed that the chemical properties of the cellulose insulation may impart greater mold resistance to the cavity wood members – for this reason, a sensitivity class of "Medium resistant" was used to simulate the wood members within the cellulose cavity.

The mold growth index ranges from 0 to 6 and is coupled with a traffic light scheme in the WUFI® plug-in, ranging from green (uncritical) to yellow to red (inacceptable) – within the yellow range, there is potential risk for mold growth, however more information would be required about the specific material used to decide whether the risk is deemed acceptable or inacceptable. The plywood layers and outermost cellulose elements in all orientations simulated present acceptable VTT results according to WUFI®, with the green VTT light shown for each layer simulated (see **Figure 4**). In the North-East orientation, the mold growth index increases annually in the outermost plywood layer (dark blue line, **Figure 4**) – however, the index begins decreasing after 2026.

For these reasons, it is understood that the proposed post-retrofit wall assembly may manage moisture adequately based on the information available and the assumptions presented in this report. However, this is dependent on whether the plywood can be subject to certain periods of high moisture content, as well as all wood layers' mold resistance properties. This is especially applicable to the North-East orientation, as the outer 1/8-inch plywood layer demonstrates annual spikes in MC above 20%.

Per ReCover's request, the use of DensGlass (approximated using WUFI®'s pre-defined DensElement™ Barrier System material) as a sheathing substitution was also simulated in the North-East orientation. The outermost cellulose elements were simulated in VTT to obtain mold growth indices as proxies for the wood studs present – this resulted in the green VTT traffic light status due to the assumed mold resistance properties imparted from the cellulose insulation. This sheathing substitution may eliminate certain durability issues related to the biogenic nature of plywood – however, the use and suitability of such a sheathing should be explored further.

Therefore, a sheathing substitution from the originally defined plywood material may create a more suitable panelized retrofit strategy for this building in the North-East orientation in terms of mold and decay resistance based on the information available and the assumptions presented in this report – this should be explored further.

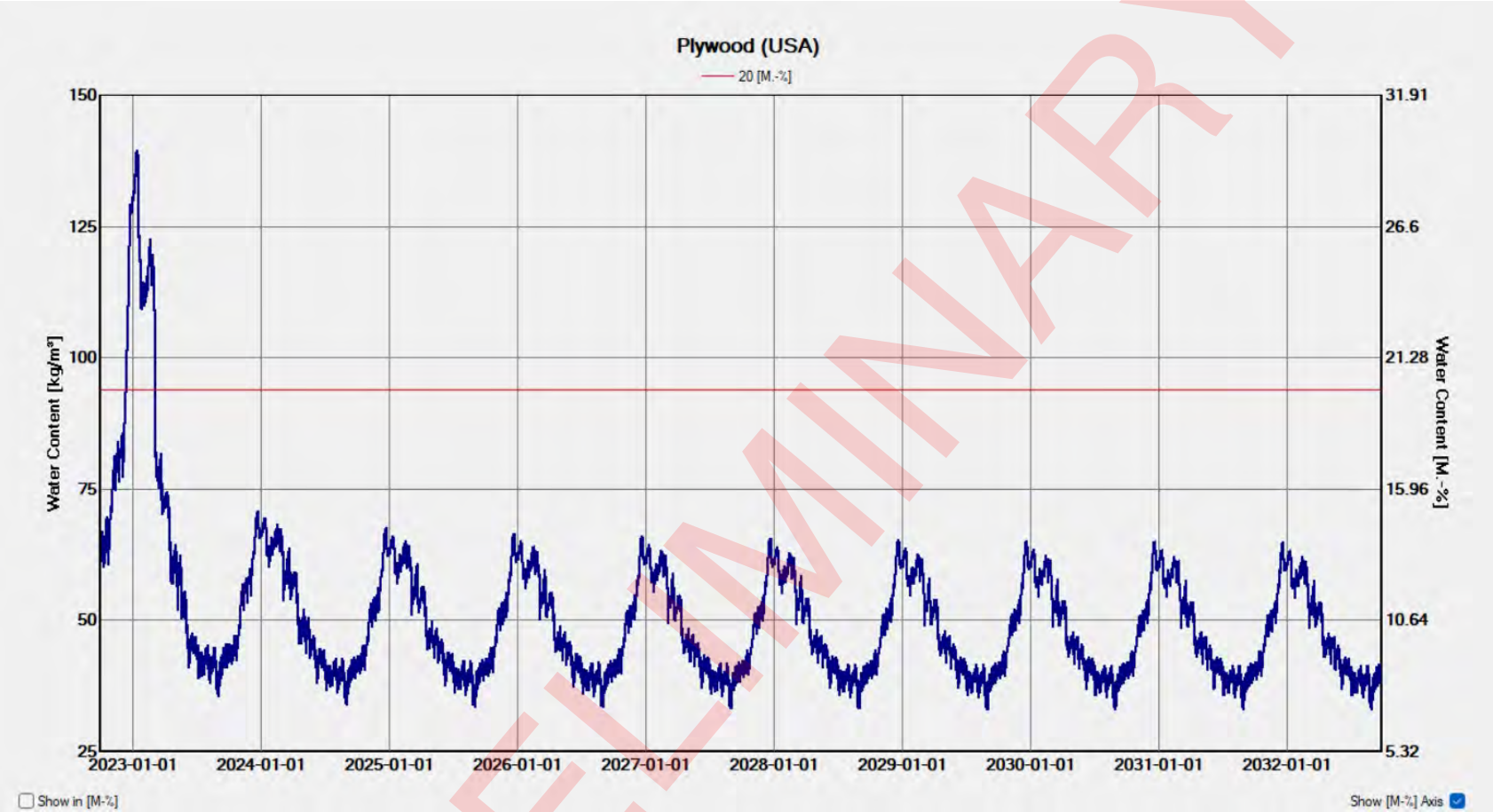


Figure 2 – WUFI® output for wall assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Existing Seniors' Centre South-East wall assembly's inner 1/8-inch plywood layer

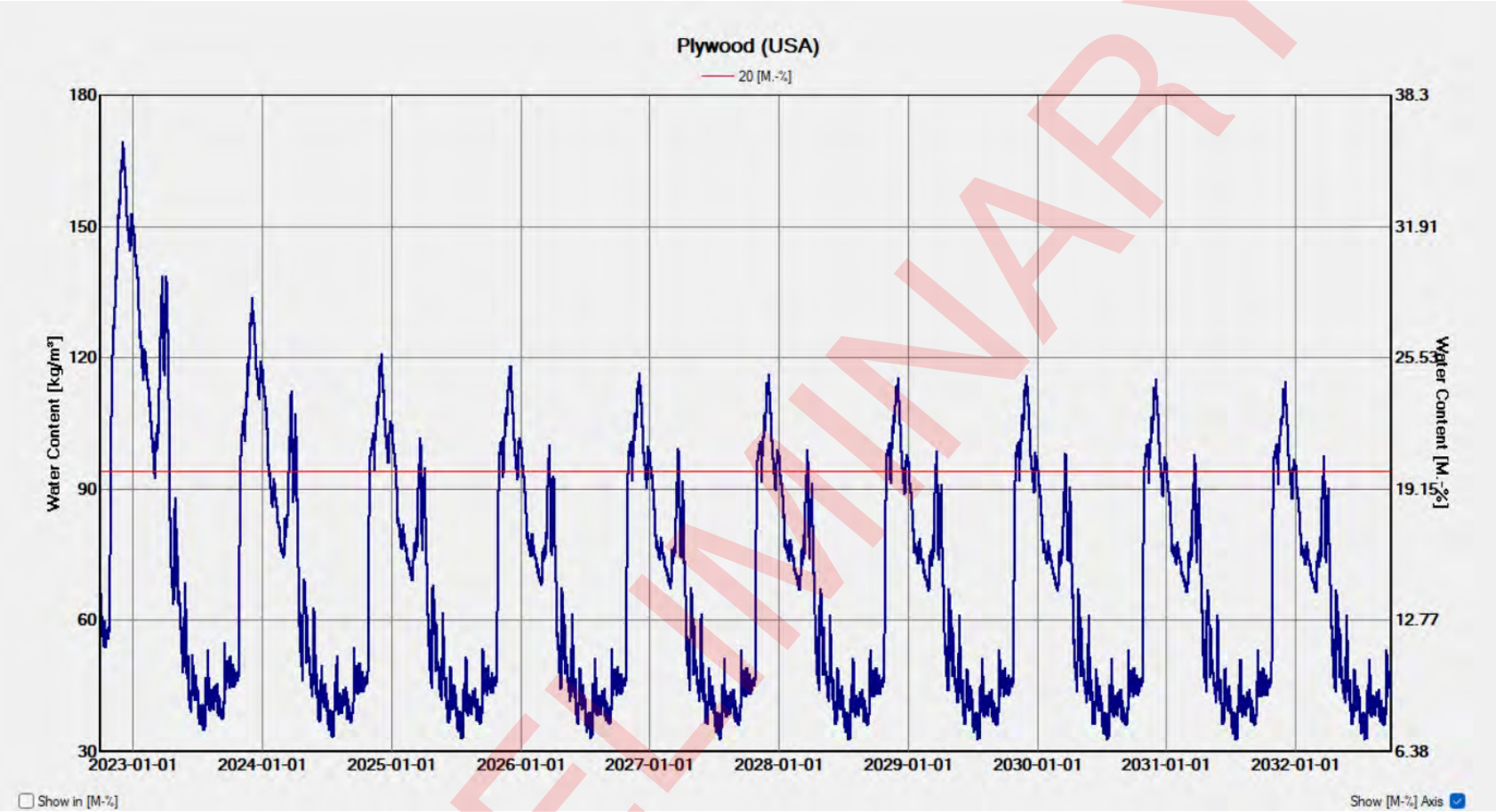


Figure 3 – WUFI® output for wall assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Existing Seniors' Centre North-East wall assembly's outer 1/8-inch plywood layer

Figure 4 – WUFI® output for wall assembly: VTT mold growth index simulation over 10-year period simulated for post-retrofit Existing Seniors' Centre North-East wall assembly's plywood and cellulose layers
(blue: outer plywood; green: center plywood; light blue: inner plywood;
red: outermost cellulose element; black: second outermost cellulose element)

EXISTING SENIORS' CENTRE: POST-RETROFIT ROOF

The post-retrofit Existing Seniors' Centre roof assembly simulation did not demonstrate any numerical errors for all orientations and conditions tested – no convergence failures occurred, and the differences between balances of change in total water content and the sum of the moisture fluxes were very small.

Again, as recommended by the protocol, the plywood layer was subdivided into three adjacent layers, with the outermost and innermost layers being 1/8-inch thick, respectively. Significant moisture content spikes above 20% were only observed in the innermost plywood layer for many years, occurring approximately mid-December to mid-March. The duration and amplitude of these spikes decrease annually but still rise above the 20% threshold in each year of the simulation (see **Figure 5**). Between 2022 and 2025, the outermost plywood layer experiences spikes that barely surpass 20% MC and are very short in duration (see **Figure 6**); the center plywood layer remains below 20% MC during the entire simulation period.

Unfortunately, all layers of plywood obtained the yellow VTT traffic light status per the WUFI® VTT models simulated (<2.5 outer, <2.2 center, <1.9 inner plywood). The outermost cellulose element was also simulated for mold growth index as wood studs are present – here, the VTT traffic light status was green due to the assumed mold resistance properties imparted from the cellulose insulation (see **Figure 8**).

For these reasons, it is understood that the proposed post-retrofit wall assembly may <u>not</u> manage moisture adequately based on the information available and the assumptions presented in this report. The plywood layer may be subject to periods of high moisture content above 20% which could lead to decay. Moreover, the plywood may be subject to mold growth as well.

Per ReCover's request, the use of DensGlass (approximated using WUFI®'s pre-defined DensElement™ Barrier System material) as a sheathing substitution was also simulated. The outermost cellulose elements were simulated in VTT to obtain mold growth indices as proxies for the wood studs present. Although the mold growth indices are higher than those in the cellulose layer of the plywood sheathing option, the VTT traffic light status of the cellulose elements was still green due to the assumed mold resistance properties imparted from the cellulose insulation (see **Figure 10**). This sheathing substitution may eliminate certain durability issues related to the biogenic nature of plywood – however, the use and suitability of such a sheathing should be explored further.

Therefore, a sheathing substitution from the originally defined plywood material may create a more suitable panelized retrofit strategy for this building in terms of mold and decay resistance based on the information available and the assumptions presented in this report – this should be explored further.

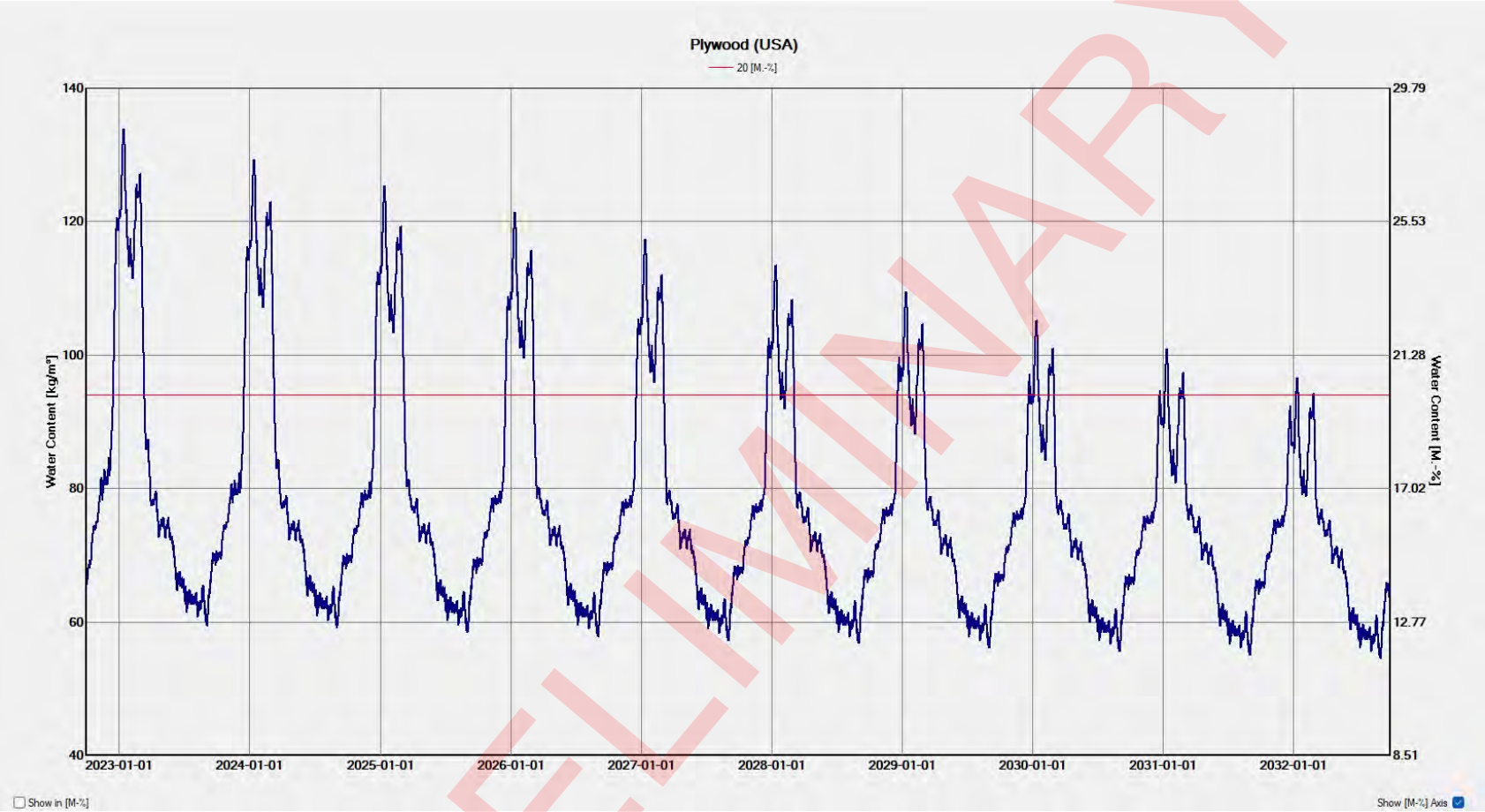


Figure 5 – WUFI® output for roof assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Existing Seniors' Centre roof assembly's inner 1/8-inch plywood layer (scenario with plywood panel sheathing)

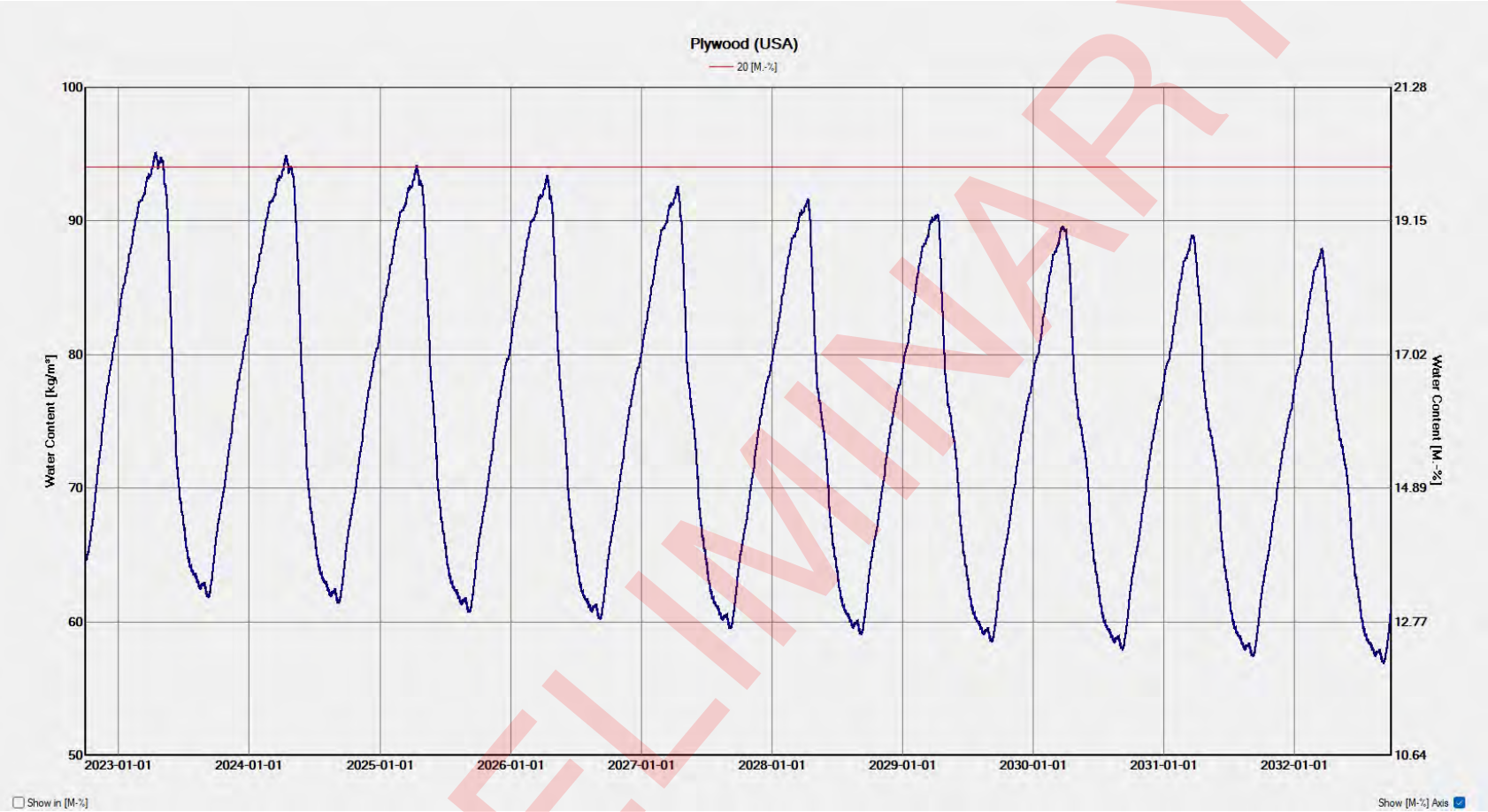


Figure 6 – WUFI® output for roof assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Existing Seniors' Centre roof assembly's outer 1/8-inch plywood layer (scenario with plywood panel sheathing)

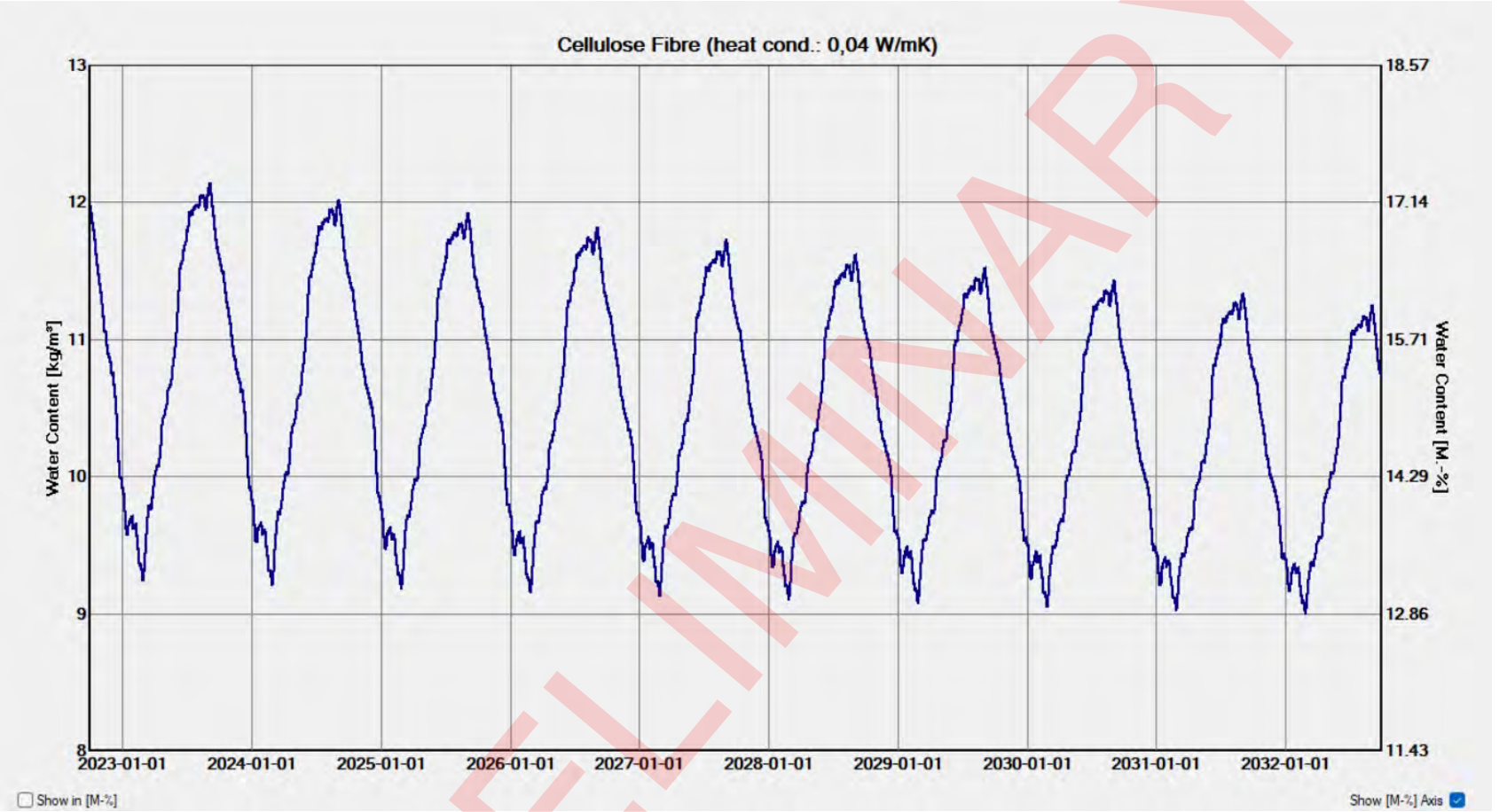


Figure 7 – WUFI® output for roof assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Existing Seniors' Centre roof assembly's cellulose layer (scenario with plywood panel sheathing)

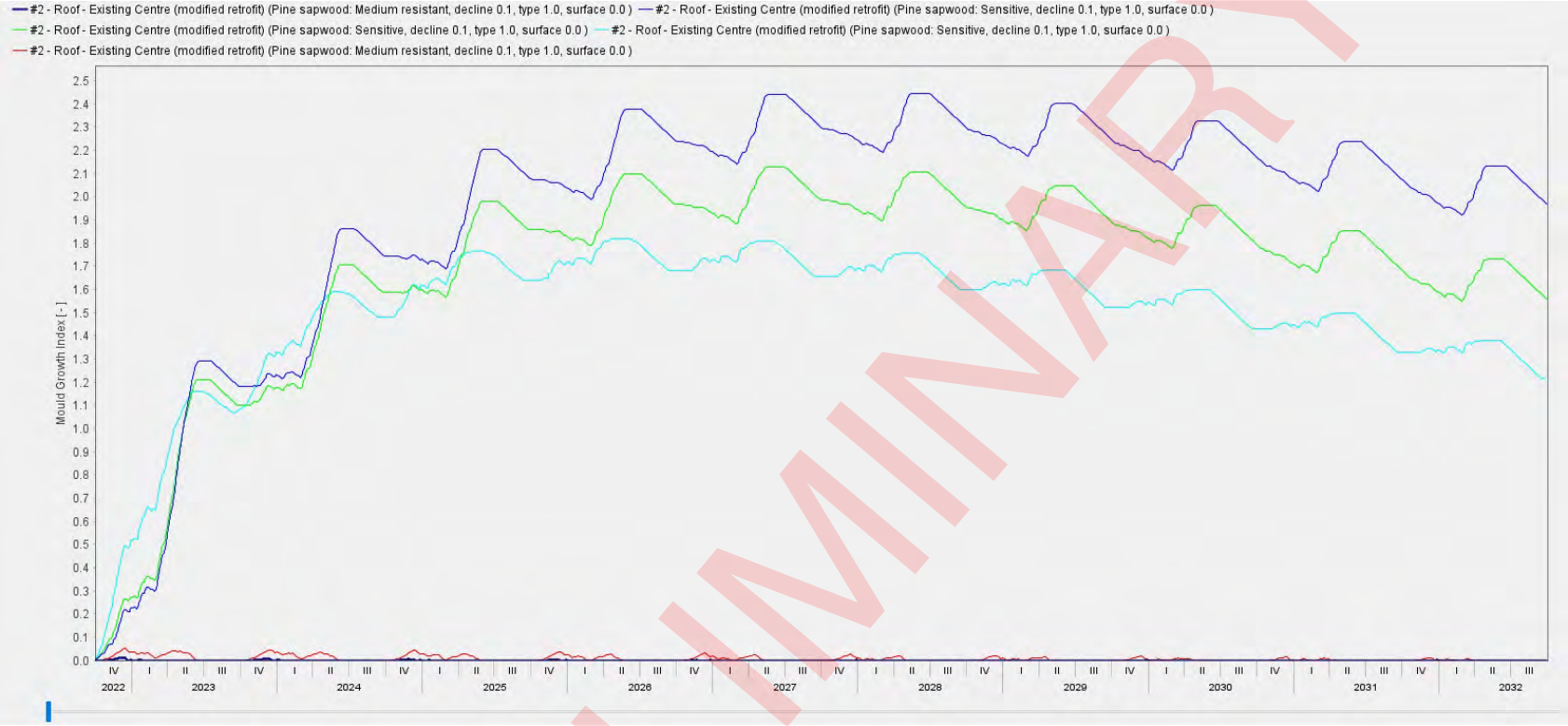


Figure 8 – WUFI® output for roof assembly: VTT mold growth index simulation over 10-year period simulated for post-retrofit Existing Seniors' Centre roof assembly's plywood and cellulose layers (scenario with plywood panel sheathing)
(blue: outer plywood; green: center plywood; light blue: inner plywood; red: outermost cellulose element; black: other cellulose element)

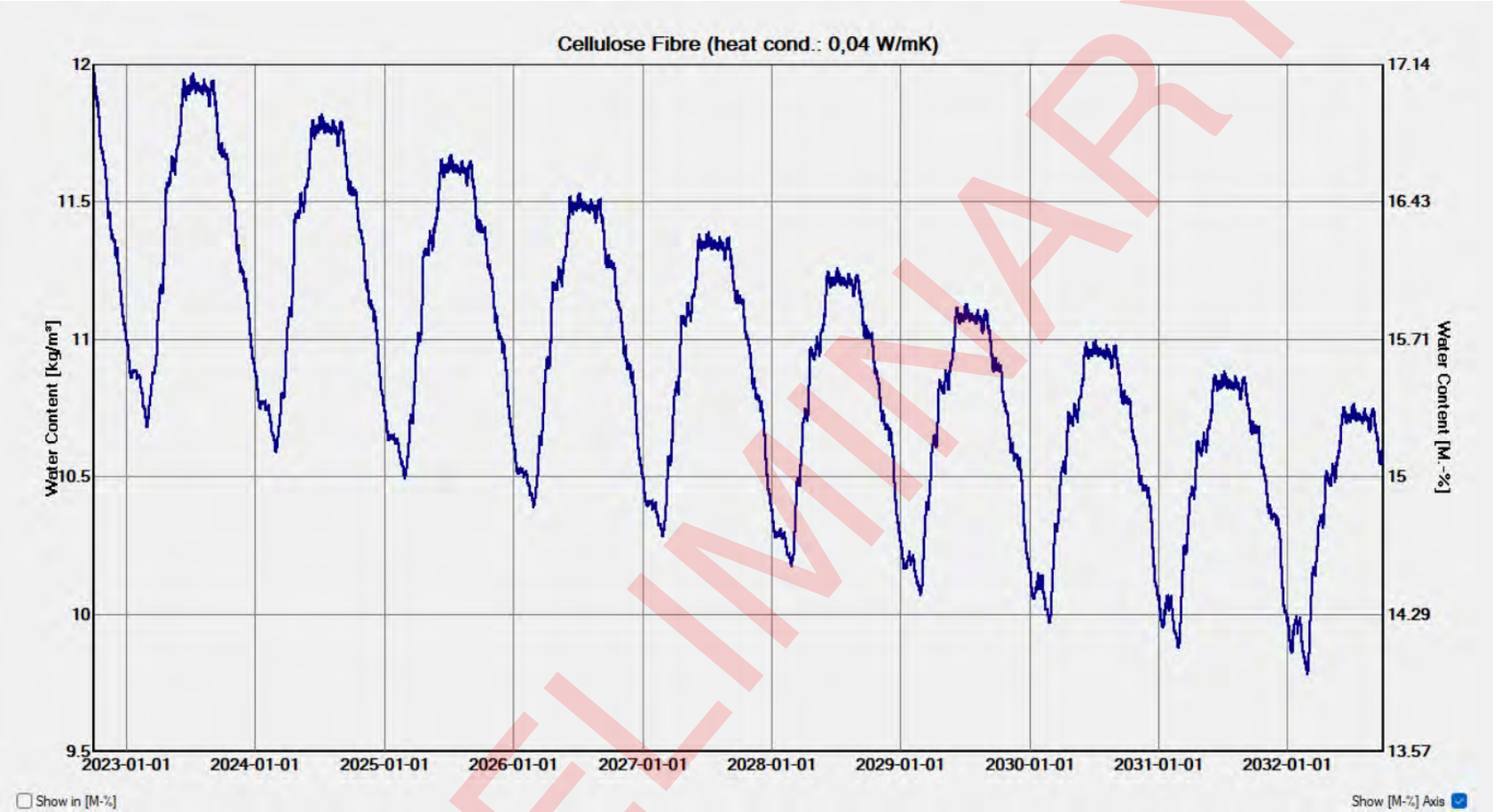


Figure 9 – WUFI® output for roof assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Existing Seniors' Centre roof assembly's cellulose layer (scenario with DensGlass panel sheathing)

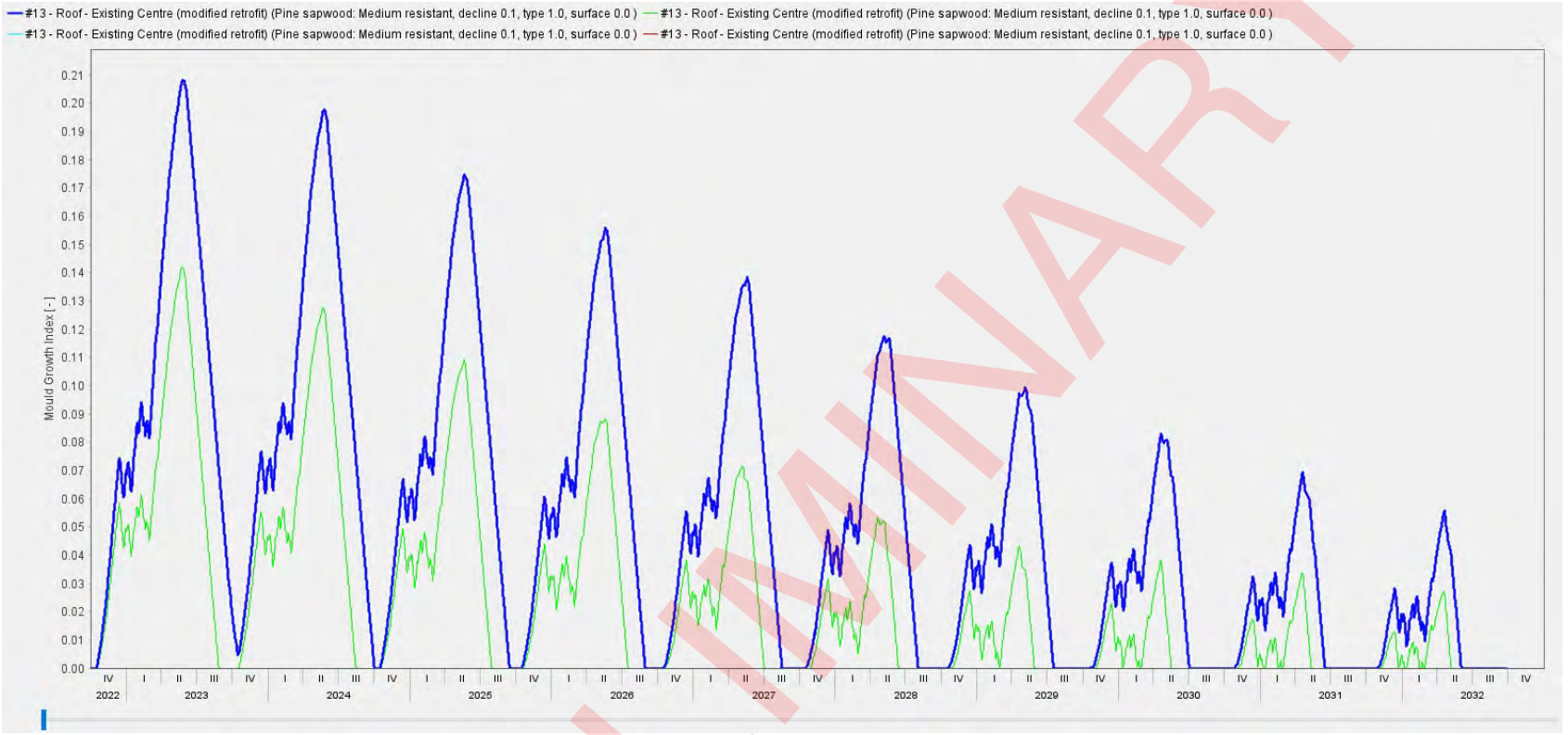


Figure 10 – WUFI® output for roof assembly: VTT mold growth index simulation over 10-year period simulated for post-retrofit Existing Seniors' Centre roof assembly's plywood and cellulose layers (scenario with DensGlass panel sheathing)
(blue: outermost cellulose element; green: second outermost cellulose element;
light blue: second innermost cellulose element; red: outermost cellulose element)

BUILDING EXPANSION: POST-RETROFIT WALL

The post-retrofit Building Expansion's wall assembly simulation did not demonstrate any numerical errors for all orientations and conditions tested – no convergence failures occurred, and the differences between balances of change in total water content and the sum of the moisture fluxes were very small.

Again, as recommended by the protocol, the plywood layer was subdivided into three adjacent layers, with the outermost and innermost layers being 1/8-inch thick, respectively. In the North-East and North-West orientations simulated, at least one of the three plywood layers experiences spikes in MC above 20%. The occurrence and duration of these spikes vary from orientation to orientation. As in the Existing Seniors' Centre, the output of the North-East post-retrofit wall assembly for the Expansion building demonstrates significant MC levels above 20% in all plywood layers but namely in the outermost section. This 1/8-inch layer experiences MC levels surpassing 20% in the first year (November 2022 to mid-April 2023), the second year (approximately November 2023 to late January 2024, mid-to-late March 2024, and beginning-to-mid April 2024), as well as in subsequent years (approximately November to mid-January with secondary spikes in mid-to-late March) (see **Figure 11**). While the North-West orientation only experiences a first-year spike in MC above 20% in its innermost 1/8-inch plywood layer (see **Figure 12**), no plywood layers in the South-West orientation experience MC spikes surpassing 20%.

For mold-related durability, a VTT simulation was again conducted to simulate the mold growth index at the specified locations within the plywood layers and the outermost element of the cellulose layer. Using the same assumptions as per the Existing Senior's Centre wall assemblies' simulations, the results of the roof assembly VTT simulation indicate a green VTT traffic light in all locations simulated (see **Figure 13**). In the North-East orientation, the mold growth index increases annually in the outermost plywood layer (dark blue line, **Figure 13**) – however, the index begins decreasing after 2025.

For these reasons, it is understood that the proposed post-retrofit wall assembly may manage moisture adequately based on the information available and the assumptions presented in this report. However, this is dependent on whether the plywood can be subject to certain periods of high moisture content, as well as all wood layers' mold resistance properties. This is especially applicable to the North-East orientation, as the outer 1/8-inch plywood layer demonstrates annual spikes in MC above 20%.

Once again, per ReCover's request, the use of DensGlass (approximated using WUFI®'s pre-defined DensElement™ Barrier System material) as a sheathing substitution was also simulated in the North-East orientation. The outermost cellulose elements were simulated in VTT to obtain mold growth indices as proxies for the wood studs present – this resulted in the green VTT traffic light status due to the assumed mold resistance properties imparted from the cellulose insulation. This sheathing substitution may eliminate certain durability issues related to the

biogenic nature of plywood – however, the use and suitability of such a sheathing should be explored further.

Therefore, a sheathing substitution from the originally defined plywood material may create a more suitable panelized retrofit strategy for this building in the North-East orientation in terms of mold and decay resistance based on the information available and the assumptions presented in this report – this should be explored further.

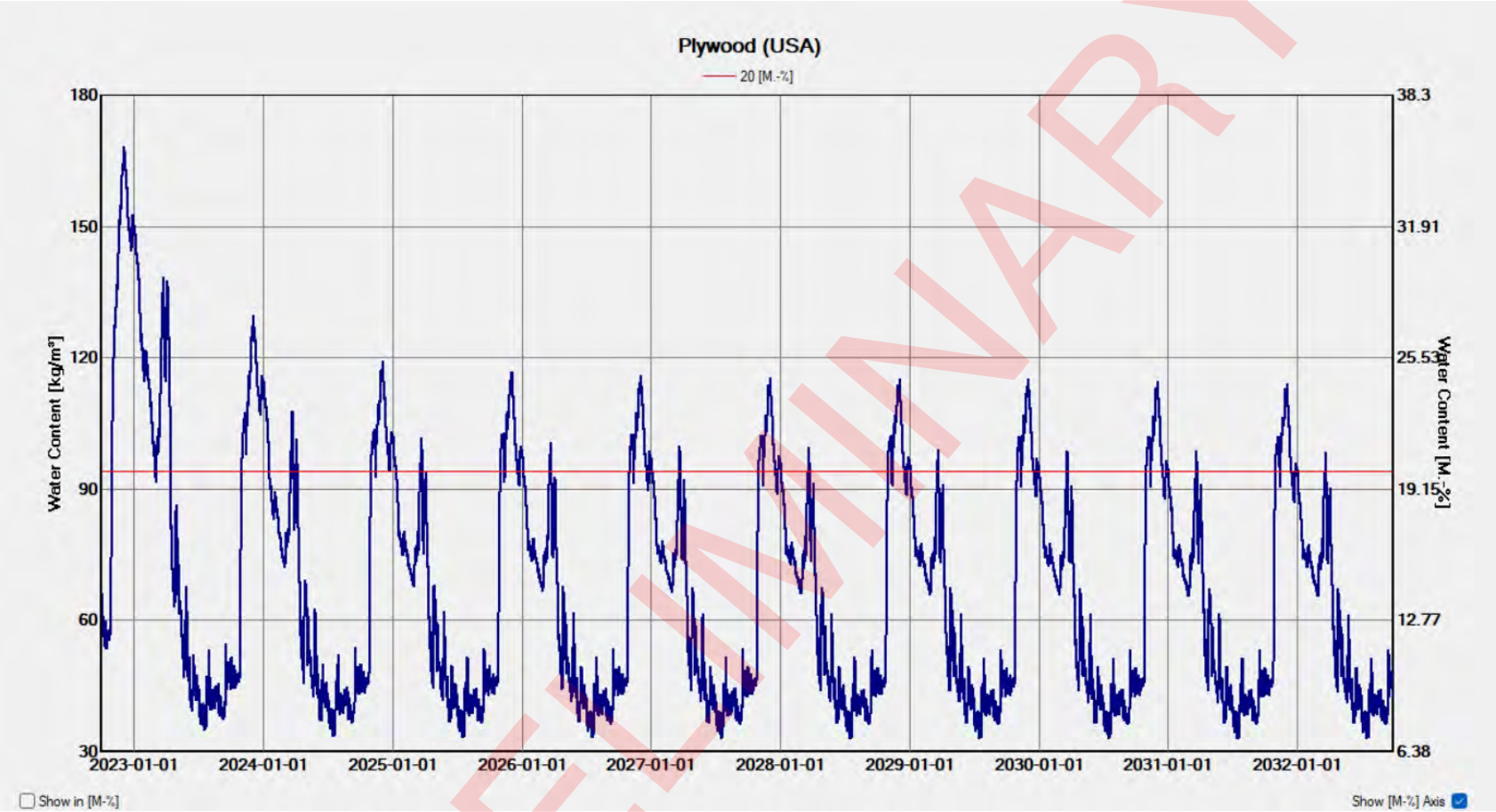


Figure 11 – WUFI® output for wall assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Expansion Centre North-East wall assembly's outer 1/8-inch plywood layer

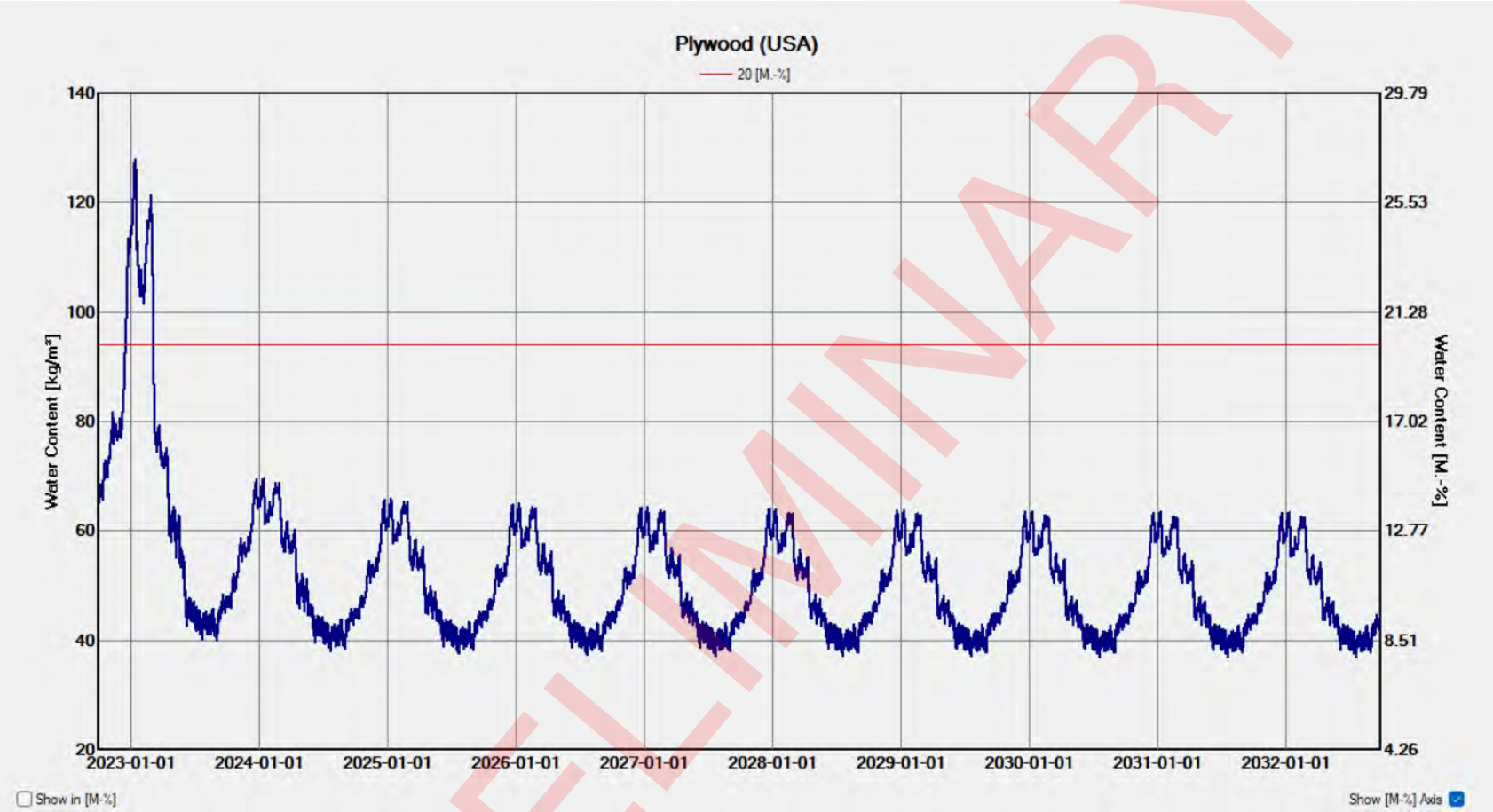


Figure 12 – WUFI® output for wall assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Expansion Centre North-West wall assembly's inner 1/8-inch plywood layer

Figure 13 – WUFI® output for wall assembly: VTT mold growth index simulation over 10-year period simulated for post-retrofit Expansion Centre North-East wall assembly's plywood and cellulose layers
(blue: outer plywood; green: center plywood; light blue: inner plywood;
red: outermost cellulose element; black: second outermost cellulose element)

BUILDING EXPANSION: POST-RETROFIT ROOF

The post-retrofit Building Expansion's roof assembly simulation did not demonstrate any numerical errors for all orientations and conditions tested – no convergence failures occurred, and the differences between balances of change in total water content and the sum of the moisture fluxes were very small.

Again, as recommended by the protocol, the three plywood layers were subdivided into three adjacent layers, with the outermost and innermost layers of each plywood being 1/8-inch thick, respectively. Significant moisture content spikes above 20% were only observed in the innermost plywood layer of the retrofit panel (i.e., the new plywood material) and occur approximately between mid-December to mid-March. Although the duration and amplitude of these spikes decrease annually, the 20% threshold is surpassed each year of the simulation (see **Figure 14**). The new (panel) outermost and center plywood layers remain below 20% MC during the entire simulation period – this is also the case for the existing plywood layers.

Unfortunately, all layers of the new plywood material obtained the yellow VTT traffic light status per the WUFI® VTT models simulated (<2.4 outer, <2.1 center, <1.8 inner plywood). The outermost cellulose element was also simulated for mold growth index as wood studs are present – here, the VTT traffic light status was green due to the assumed mold resistance properties imparted from the cellulose insulation (see **Figure 16**).

For these reasons, it is understood that the proposed post-retrofit wall assembly may <u>not</u> manage moisture adequately based on the information available and the assumptions presented in this report. The plywood layer may be subject to periods of high moisture content above 20% which could lead to decay. Moreover, the plywood may be subject to mold growth as well.

Again, per ReCover's request, the use of DensGlass (approximated using WUFI®'s pre-defined DensElement™ Barrier System material) as a sheathing substitution was also simulated for the post-retrofit roof assembly. The outermost cellulose elements were simulated in VTT to obtain mold growth indices as proxies for the wood studs present. Although the mold growth indices are higher than those in the cellulose layer of the plywood sheathing option, the VTT traffic light status of the cellulose elements was still green due to the assumed mold resistance properties imparted from the cellulose insulation (see **Figure 18**). This sheathing substitution may eliminate certain durability issues related to the biogenic nature of plywood – however, the use and suitability of such a sheathing should be explored further.

It should be noted that a sheathing substitution from the originally defined plywood material may create a more suitable panelized retrofit strategy for this building in terms of mold and decay resistance based on the information available and the assumptions presented in this report – this should be explored further.

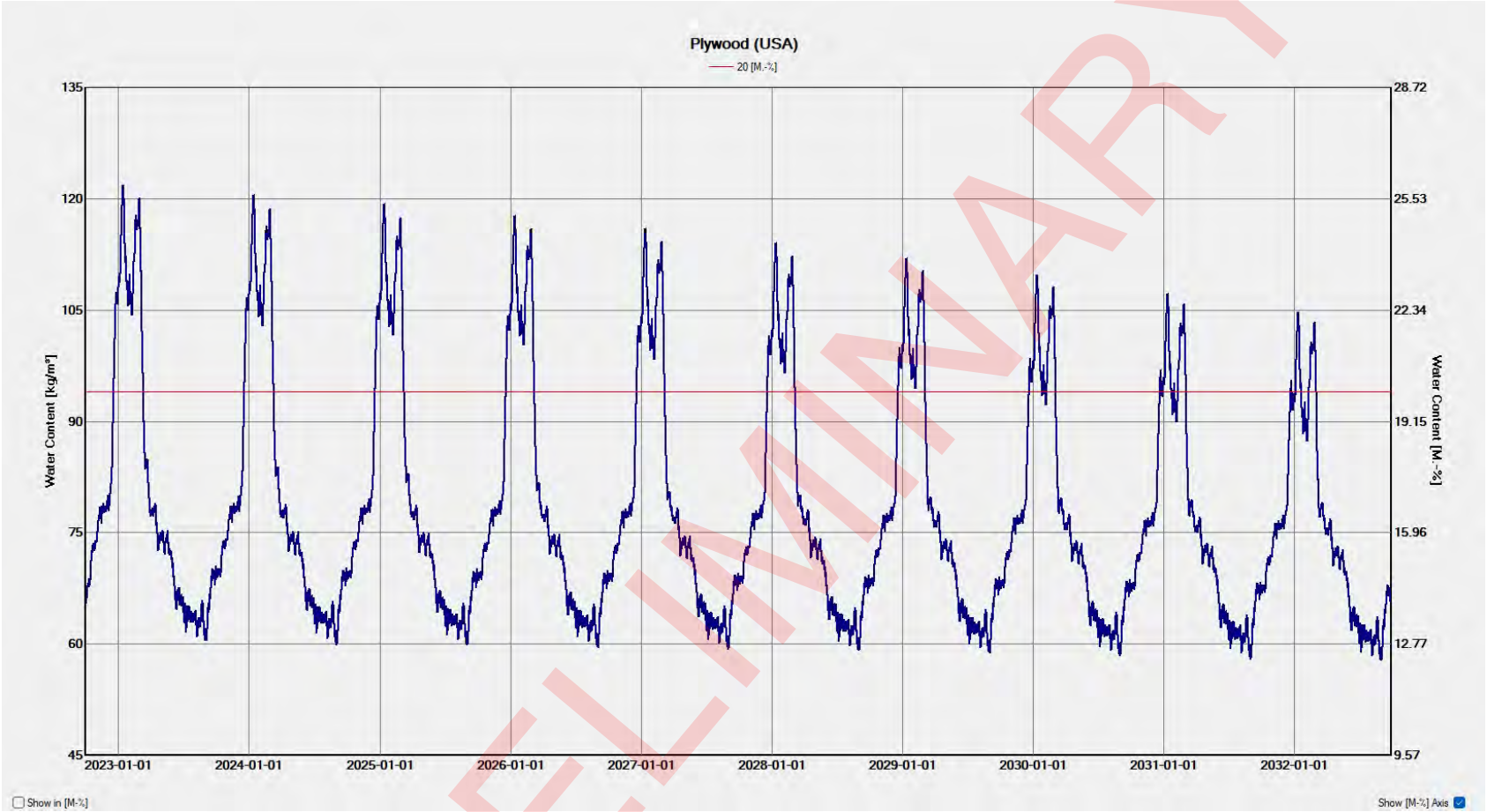


Figure 14 – WUFI® output for roof assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Expansion Centre roof assembly's new inner 1/8-inch plywood layer (scenario with plywood panel sheathing)

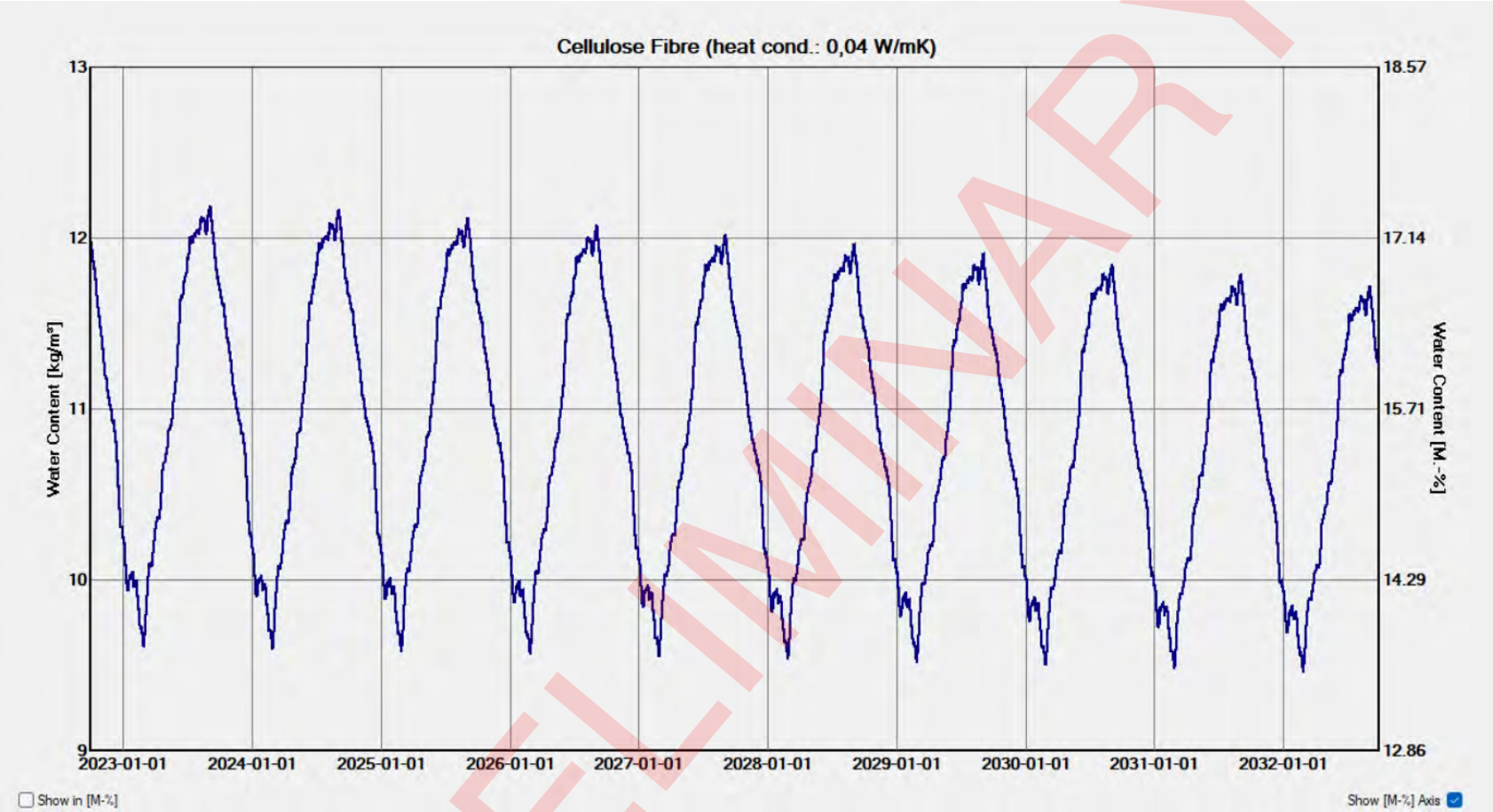


Figure 15 – WUFI® output for roof assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Expansion Centre roof assembly's cellulose layer (scenario with plywood panel sheathing)

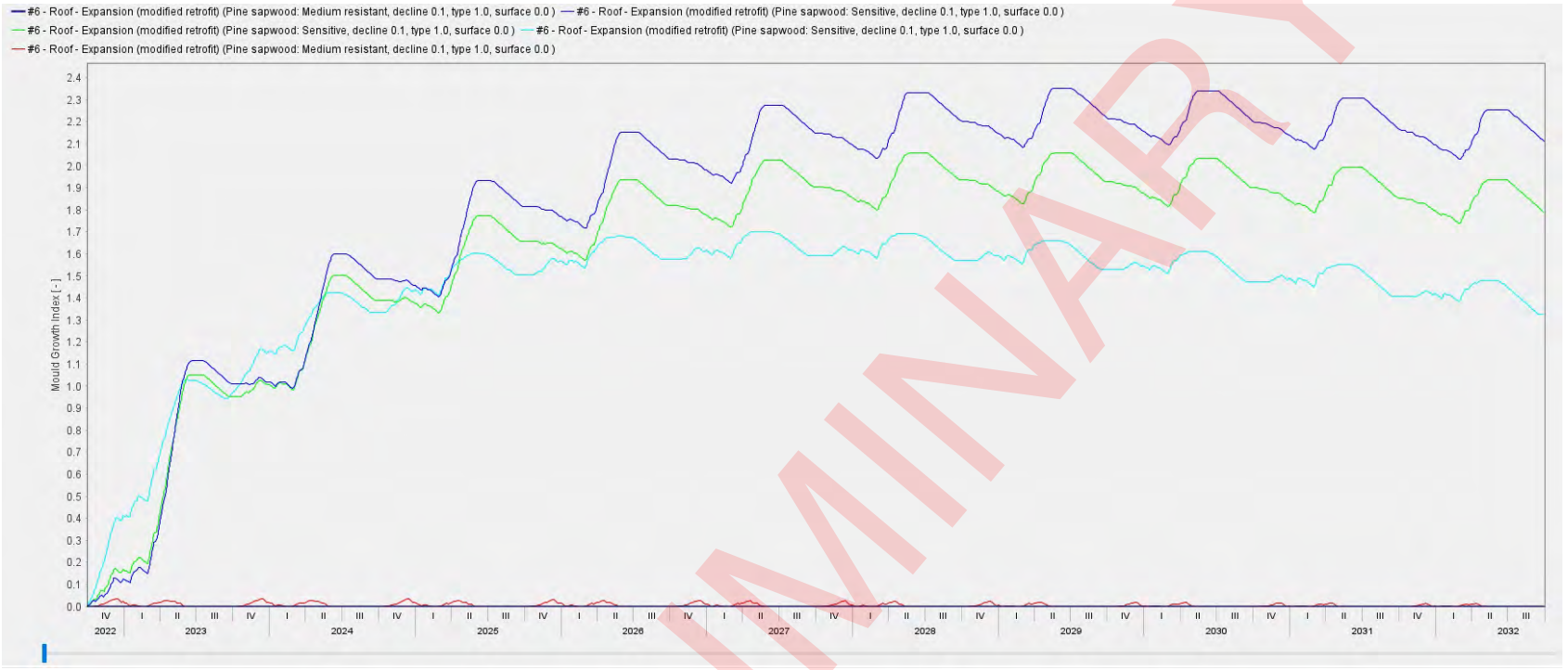


Figure 16 – WUFI® output for roof assembly: VTT mold growth index simulation over 10-year period simulated for post-retrofit Expansion Centre roof assembly's new plywood and cellulose layers (scenario with plywood panel sheathing)
(blue: outermost new plywood; green: center new plywood; light blue: innermost new plywood;
red: outermost cellulose element; black: other cellulose element)

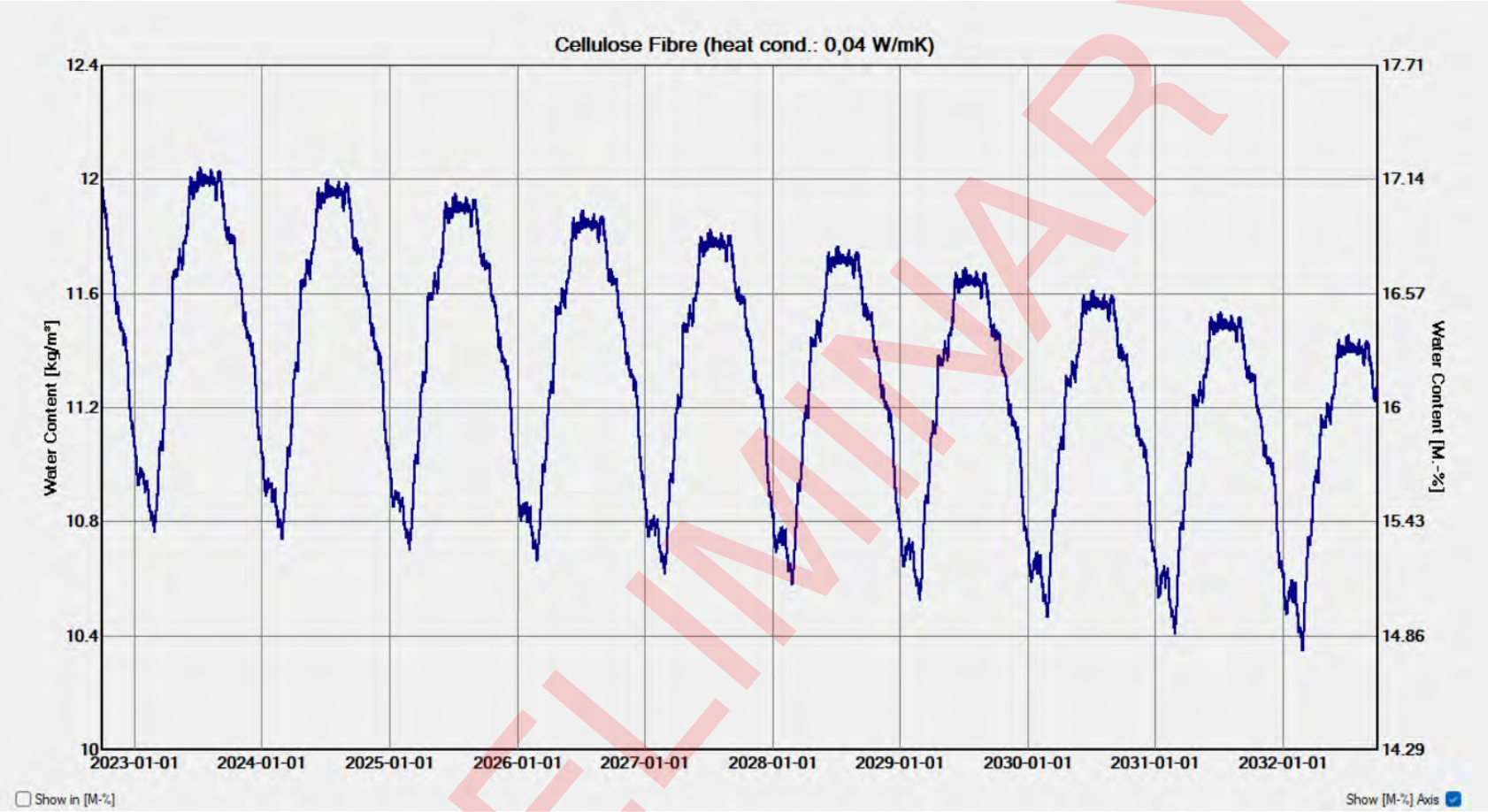


Figure 17 – WUFI® output for roof assembly: water content (kg/m³, %) over 10-year period simulated for post-retrofit Expansion Centre roof assembly's cellulose layer (scenario with DensGlass panel sheathing)

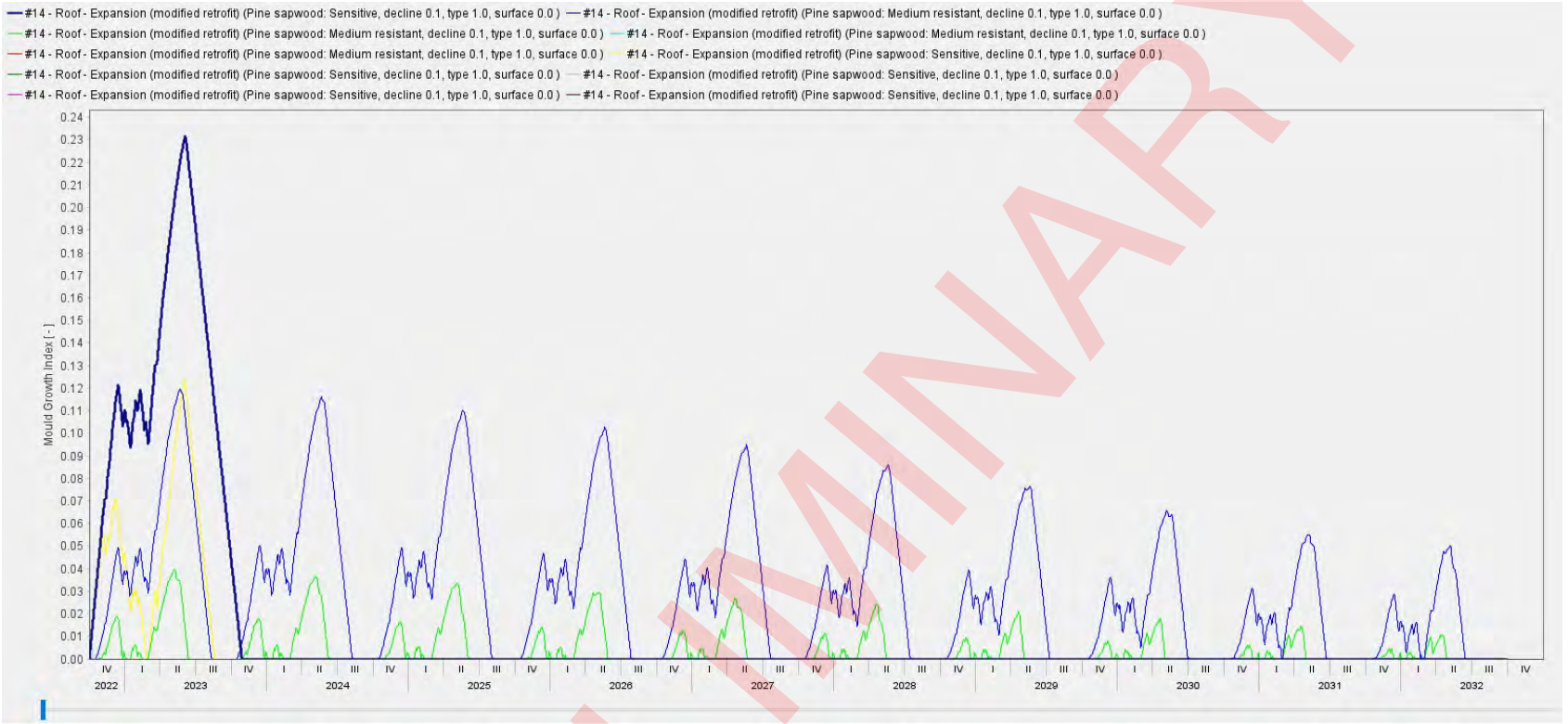


Figure 18 – WUFI® output for roof assembly: VTT mold growth index simulation over 10-year period simulated for post-retrofit Expansion Centre roof assembly's plywood and cellulose layers (scenario with DensGlass panel sheathing)
(blue: outermost cellulose element; green: second outermost cellulose element;
light blue: second innermost cellulose element; red: outermost cellulose element;
black: outermost existing plywood, outer layer; yellow: outermost existing plywood, center layer; green: outermost existing plywood, inner layer;
grey: innermost plywood, outer layer; pink: innermost plywood, center layer; brown: innermost plywood, inner layer)

LIMITATIONS OF STUDY

The results presented in this report are subject to certain limitations, including the following:

- Wall and roof assembly materials and thicknesses were assumed based on information obtained from the City of Burlington and the ReCover team, as well as available predefined WUFI® materials;
- The venting behind the wall (25-ACH) metal cladding system was estimated for this preliminary draft report based on the PHIUS+ protocol;
- All material properties, including but not limited to thermal conductivity and permeability, were assumed based on WUFI® Pro default values as well as the ReCover team's approximations. The specific vulnerability of the existing and proposed materials such as cellulose to mold growth is approximated, and should be validated with specialists;
- Damage functions indicated in the report were the only ones studied – rot/decay of the wood elements (excluding sheathing), corrosion of any metal elements, bulk water leaks, and any other damage functions were not simulated due to limitations of the one-dimensional WUFI® Pro software, information available, and scope of work;
- The suitability of materials proposed by ReCover in the panel designs (e.g., cellulose insulation, DensElement/DensGlass sheathing, etc.) should be validated with specialists;
- Mold growth index simulation using VTT requires estimation of the properties of each material layer simulated. The assumptions used in this feasibility study should be validated with specialists in this field. The mold growth risks involved could be higher if the materials specified for the project are more vulnerable to mold growth than the approximated materials modelled in WUFI®;
- VTT results can vary from one element to another within a given material layer – the results presented in this report are dependent on the elements chosen for simulation;
- All interfaces, connections, and details (e.g., interface between wall and roof assemblies, interface between panel sheathing and studs, etc.) in both parts of the building (Existing Seniors' Centre and Building Expansion) were not modelled in WUFI® Pro and should be validated by others;
- The climate file used for the simulations approximates the weather experienced by the building under simulation, and cannot adequately model the micro-climate experienced by the building in its specific location;
- This report assumes that any issues with the existing envelope will be addressed prior to conducting the retrofit, including but not limited to cracking of the masonry, unsealed penetrations, etc.;
- WUFI® Pro is a one-dimensional software that cannot quantify all real-world hygrothermal phenomena. For instance, WUFI® 2-D could better approximate a complex two-dimensional phenomenon that WUFI® Pro could not – certain software is therefore better served in certain situations;

- WUFI® Pro is a software and is limited by the quality of data inputted into each case simulated – given the nature of the preliminary study in question, the information available for the assemblies' components, the unknown properties of each material, and the approximated indoor/outdoor conditions, great care must be taken when using the WUFI® Pro results presented in this feasibility report.

If the ReCover team's retrofit design should move forward to construction, it is imperative that a more thorough investigation of the wall and roof assemblies in question be conducted so that more accurate predictions of the assemblies' hygrothermal performance can be made. Further information of the building is necessary, including but not limited to validation of the wall and roof assemblies, determination of material thicknesses and properties, etc. Therefore, the results of the WUFI® Pro models presented in this report can only be used as a first step towards understanding the post-retrofit hygrothermal performance of the wall and roof assemblies in question. **This preliminary feasibility report cannot be used for construction purposes.** Once further investigation of the actual conditions is completed (e.g., wall and roof openings) and the design of the panels are reviewed and approved by the appropriate parties, hygrothermal models will need to be simulated with the validated inputs, a specific location-based climate file, etc. This will create a more accurate WUFI® model of the building envelope in question and allow for a better understanding of the assemblies' hygrothermal performance post-retrofit.

It is hoped that this report is to your satisfaction. If you have any questions, please do not hesitate to contact Stanley Francispillai.

Stanley Francispillai, P. Eng. (QC, NS)
WUFI® Pro Software Modeller
(438) 872-5524

Assembly Notes

Project: Burlington (Existing Seniors' Centre) NRCan Pilot Project
Case: North-East, South-East, South-West walls
Reference Files: *"Burlington - Existing Building Assemblies (2022-08-29).pdf"* (Google Drive)
"WuFi inputs for Burlington and Halifax" (2022-12-12 email, Nick Rudnicki)
Phone & video calls with ReCover Team

Assembly (Exterior to Interior)	**Modelled Material (WUFI)**	**Alterations (If Applicable)**	**Supporting Docs. (If Applicable)**
Metal cladding	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol
3/4" air gap	Air Layer 10 mm; metallic (Generic Materials)	Specific air layer behind metallic surfaces	PHIUS+ protocol
High Perm WRB (Assume PERM 50, Tech specs available)	Spun Bonded Polyolefin Membrane (SBP) (North America Database)	-	Assumption
1/2" SPF Plywood	Plywood (USA) (N.A. Database)	Split into three layers, 1/8" inner and outer	PHIUS+ protocol
5.5" of dense pack cellulose	Cellulose Fibre (heat cond.: 0,04 W/mK) (Fraunhofer Database)	-	Past ReCover project assumption
Cellulose Bib Super high PERM	INTELLO PLUS (ETA) (N.A. Database)	-	ReCover Team
1/2" air gap (from 1x4 SPF strapping)	Air Layer 20 mm; without additional moisture capacity (Generic Materials)	-	For strapping + existing wall abnormalities
~~*4" Face Brick*~~	~~Red Matt Clay Brick~~	~~-~~	Removed per ReCover's request
~~*1" Air Space*~~	~~Air Layer 25 mm; without additional moisture capacity (Generic Materials)~~	-	Removed per ReCover's request
2" Wall Insul'n	Extruded Polystyrene Insulation (N.A. Database)	-	Assumption
8" Scored Conc. Blk.	Concrete Brick (N.A. Database)	-	

Assembly Notes			
Project:	Burlington (Existing Seniors' Centre) NRCan Pilot Project		
Case:	Roof		
Reference File:	*"Burlington - Existing Building Assemblies (2022-08-29).pdf"* (Google Drive) *"WuFi inputs for Burlington and Halifax"* (2022-12-12 email, Nick Rudnicki) *Phone & video calls with ReCover Team*		
Assembly (Exterior to Interior)	**Modelled Material (WUFI)**	**Alterations (If Applicable)**	**Supporting Docs. (If Applicable)**
2.5" Extruded Polystyrene Insulation	Extruded Polystyrene Insulation (North America Database)	-	ReCover Team
Roof Membrane	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol ReCover Team
5/8" plywood	Plywood (USA) (N.A. Database)	Split into three layers, 1/8" inner and outer	PHIUS+ protocol
7.25" I-Joist Cavity Filled with dense pack cellulose	Cellulose Fibre (heat cond.: 0,04 W/mK) (Fraunhofer Database)	-	Past ReCover project assumption
Cellulose Bib Super high PERM	INTELLO PLUS (ETA) (N.A. Database)	-	ReCover Team
1/2" air gap (from 1x4 SPF strapping)	Air Layer 20 mm; without additional moisture capacity (Generic Materials)	-	For strapping + existing roof abnormalities
4 Ply F&G Roofing	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol ReCover Team
3" Roof insulation	Extruded Polystyrene Insulation (N.A. Database)	-	Assumption
Vapour Barrier	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol ReCover Team
1/16 Steel Deck	Metal Deck, unperforated (N.A. Database)	-	

Assembly Notes			
Project:	Burlington (Expansion Centre) NRCan Pilot Project		
Case:	North-East, North-West, South-West walls		
Reference Files:	*"Burlington - Existing Building Assemblies (2022-08-29).pdf"* (Google Drive) *"WuFi inputs for Burlington and Halifax"* (2022-12-12 email, Nick Rudnicki) *Phone & video calls with ReCover Team*		
Assembly (Exterior to Interior)	**Modelled Material (WUFI)**	**Alterations (If Applicable)**	**Supporting Docs. (If Applicable)**
Metal cladding	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol
3/4" air gap	Air Layer 10 mm; metallic (Generic Materials)	Specific air layer behind metallic surfaces	PHIUS+ protocol
High Perm WRB (Assume PERM 50, Tech specs available)	Spun Bonded Polyolefin Membrane (SBP) (North America Database)	-	Assumption
1/2" SPF Plywood	Plywood (USA) (N.A. Database)	Split into three layers, 1/8" inner and outer	PHIUS+ protocol
5.5" of dense pack cellulose	Cellulose Fibre (heat cond.: 0,04 W/mK) (Fraunhofer Database)	-	Past ReCover project assumption
Cellulose Bib Super high PERM	INTELLO PLUS (ETA) (N.A. Database)	-	ReCover Team
1/2" air gap (from 1x4 SPF strapping)	Air Layer 20 mm; without additional moisture capacity (Generic Materials)	-	For strapping + existing wall abnormalities
~~*3.5" Brick*~~	~~Red Matt Clay Brick~~	-	Removed per ReCover's request
~~*1" Air Space*~~	~~Air Layer 25 mm; without additional moisture capacity (Generic Materials)~~	-	Removed per ReCover's request
3" Rigid insulation	Extruded Polystyrene Insulation (N.A. Database)	-	Assumption
7.5" Concrete block	Concrete Brick (N.A. Database)	-	

Assembly Notes

Project: Burlington (Expansion Centre) NRCan Pilot Project
Case: Roof
Reference File: *"Burlington - Existing Building Assemblies (2022-08-29).pdf"* (Google Drive)
"WuFi inputs for Burlington and Halifax" (2022-12-12 email, Nick Rudnicki)
Phone & video calls with ReCover Team

Assembly (Exterior to Interior)	**Modelled Material (WUFI)**	**Alterations (If Applicable)**	**Supporting Docs. (If Applicable)**
2.5" Extruded Polystyrene Insulation	Extruded Polystyrene Insulation (North America Database)	-	ReCover Team
Roof Membrane	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol ReCover Team
5/8" plywood	Plywood (USA) (N.A. Database)	Split into three layers, 1/8" inner and outer	PHIUS+ protocol
7.25" I-Joist Cavity Filled with dense pack cellulose	Cellulose Fibre (heat cond.: 0,04 W/mK) (Fraunhofer Database)	-	Past ReCover project assumption
Cellulose Bib Super high PERM	INTELLO PLUS (ETA) (N.A. Database)	-	ReCover Team
1/2" air gap (from 1x4 SPF strapping)	Air Layer 20 mm; without additional moisture capacity (Generic Materials)	-	For strapping + existing roof abnormalities
Vapor Barrier	Roof Membrane V13 (Generic Materials)	Assumed presence based on CAD file shown in *Burlington - Existing Building Assemblies (2022-08-29).pdf*	PHIUS+ protocol ReCover Team
1/4" Wood sheathing	Plywood (USA) (N.A. Database)	Made 1/2" instead of 1/4" Split into three layers, 1/8" inner and outer	Assumption
4" Rigid insulation	Extruded Polystyrene Insulation (N.A. Database)	-	Assumption
Vapor Barrier	Roof Membrane V13 (Generic Materials)	-	PHIUS+ protocol ReCover Team
1/2" Wood sheathing	Plywood (USA) (N.A. Database)	Split into three layers, 1/8" inner and outer	
1-3/8" Metal deck (0.05" thick)	Metal Deck, unperforated (N.A. Database)	-	

Project Data

Project Name	ReCover Panelized Retrofit Feasibility Studies
Project Number	L-22-0001
Client	Habit Studio Inc.
Contact Person	Lorrie Rand
City/Zip	Halifax
Street	6437 Cork Street, Unit 4
Phone	902-791-0558
Fax	
e-mail	lorrie@habitstudio.ca
Responsible	Stanley Francispillai, P. Eng. (QC, NS)
Remarks	Hygrothermal modelling for Burlington (Ontario) building post-retrofit
Date	2023-01-02

Appendix K

Embodied Carbon

NRCan | Recover FEED Studies

Burlington Building Retrofit Embodied Carbon Assessment

Fatma Osman, BA, Toronto Metropolitan University

INTRODUCTION

This report presents an embodied carbon analysis of the Burlington retrofit project proposed by the Recover Initiative as part of the NRCan FEED studies. Understanding the embodied carbon in the construction industry can help reduce the overall carbon footprint of buildings, which is one of the main goals the Recover initiative works to achieve. This report emphasizes the importance of embodied carbon analysis and the environmental impacts attributed to material selection.

SCOPE OF WORK

The scope of work includes conducting an embodied carbon analysis of the retrofit project; all materials that are proposed to be added to the existing building. This analysis is limited to embodied carbon of assembly materials and does not include other systems, such as the HVAC systems. Specifically, the analysis looks at additions to above-grade walls, roofs, below-grade components, and windows and doors. The results include a whole life cycle assessment of the building in six impact categories: Global Warming, Ozone Depletion, Acidification, Eutrophication, Formation of tropospheric ozone, Depletion of nonrenewable energy, and Biogenic carbon storage.

INPUTS AND ASSUMPTIONS

- The materials used in the analysis were chosen based on the most representative materials available to the Canadian market that has Environmental Product Declarations (EPDs) available in the One Click LCA software database.
- Materials were chosen based on their environmental performance; averages were prioritized (unless low-carbon materials were specified by the Recover design team).
- The service life used in the analysis is 60 years as per LEED v4 minimum requirement for whole building LCAs.
- Materials within assembly panels were assumed to have a 60 years service life as the building; all other materials were left to default service lives as per the One Click software.

THIS REPORT CONTAINS

- Summary of Results.
- Summary of Global Warming Potential (GWP) per building floor area.
- Graphs that summarize the detailed tables.
- Detailed data on assembly materials and specific products used in the assessment (in Appendix).
- Detailed data on embodied carbon of the different life stages of the buildings in the form of tables (in Appendix).

Burlington Retrofit Project LCA results summary

Table 1: Total Global Warming Potential

Burlington building gross floor area m2	A1-A3 KgCO2e/m2	A1-C4 KgCO2e/m2	Biogenic carbon KgCO2e/m2
1941	18.06	46.07	20.5

The major contributors to the GWP in this design are the metal roofing, EPS insulation, roofing membranes and windows. The A1-A3 Materials stage contributed 39% of the total carbon emissions associated with this building followed by C3 Waste processing at 34% as illustrated in Figure 1 & 2. The biogenic carbon of this building offsets 44.5% of the total A1-C4 carbon emissions. This storage is attributed to the wood products (68%) and cellulose insulation (32%) used in the assembly as shown in Figure 3. The results graphs below show the breakdowns of life cycle stages and impact categories associated with the building materials.

Results Graphs

Burlington Retrofit Global Warming by Stage and Material

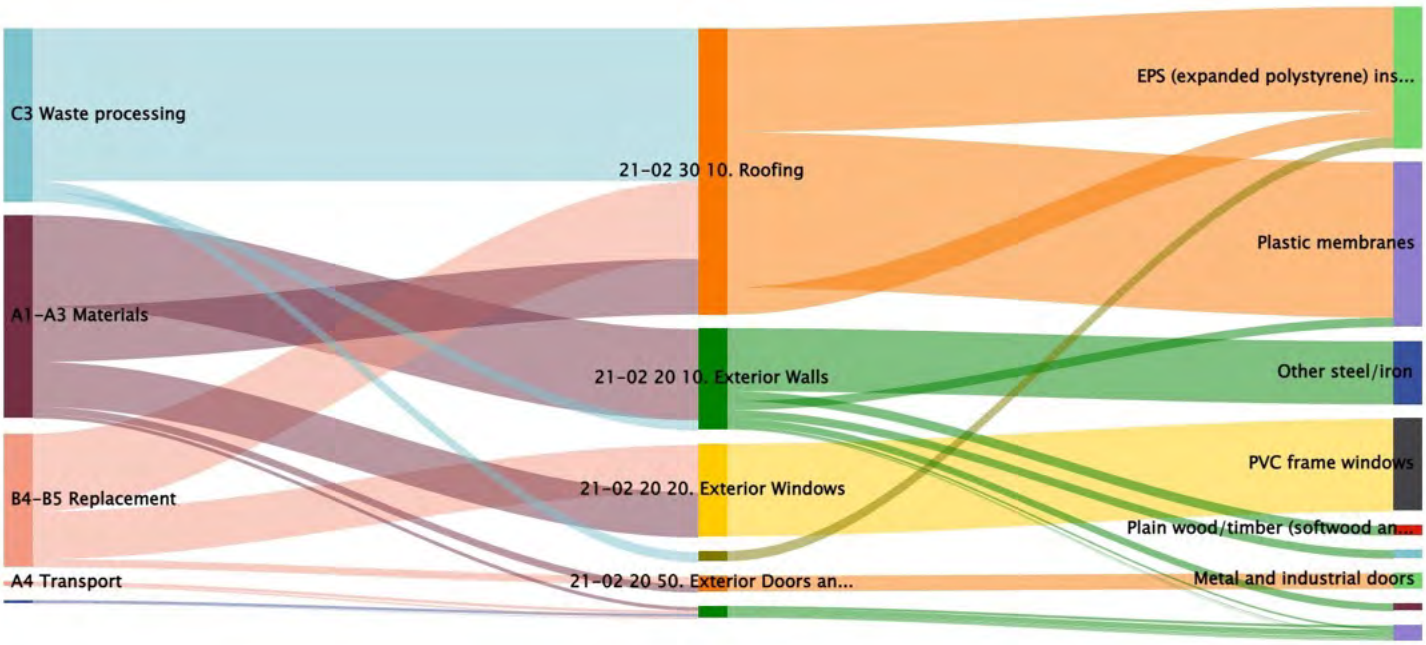


Figure 1: Burlington retrofit design breakdown of the life cycle stages and the associated materials

Burlington Retrofit Life-Cycle Impacts by Stage (%)

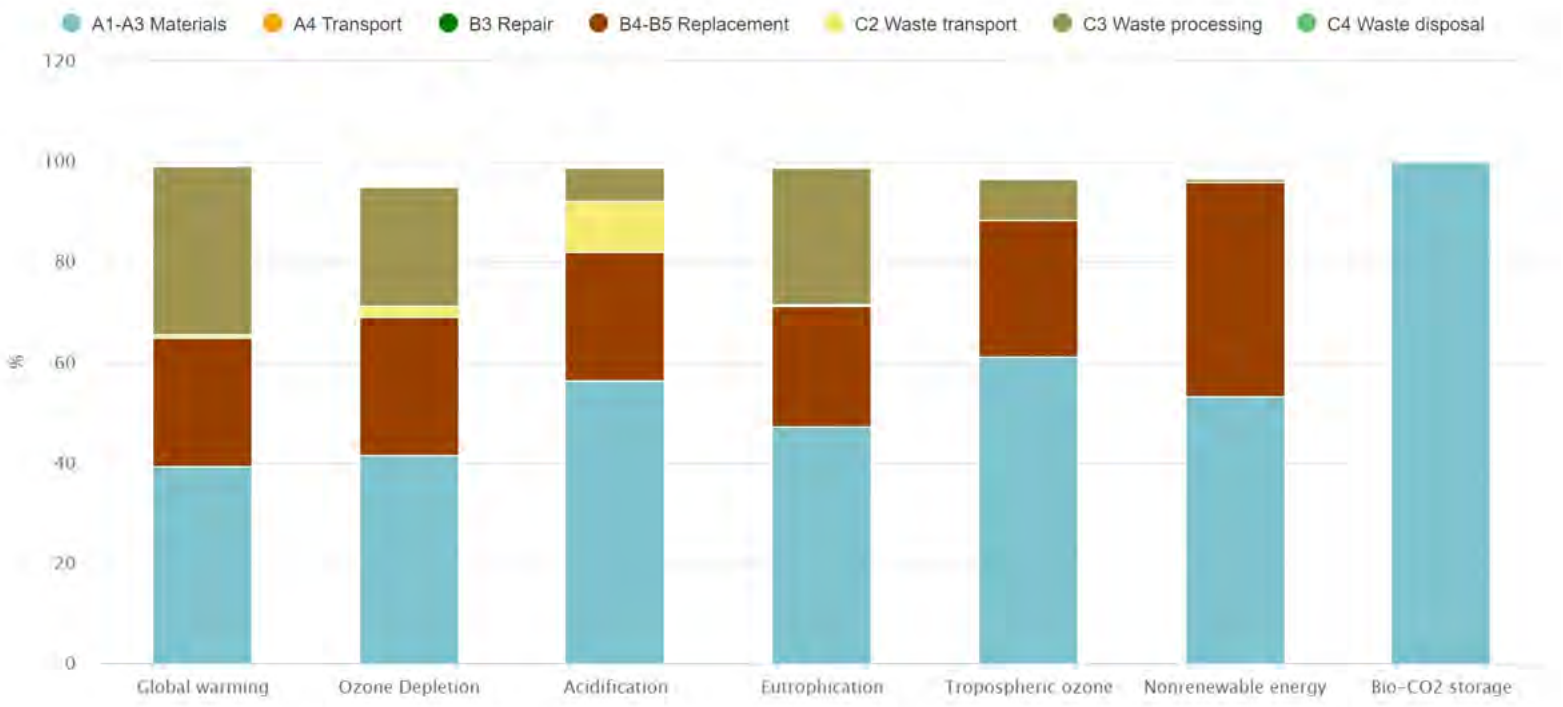


Figure 2: Burlington retrofit design breakdown of the life cycle impact categories and the associated life cycle stages

Burlington retrofit Life-Cycle Impacts by Material (%)

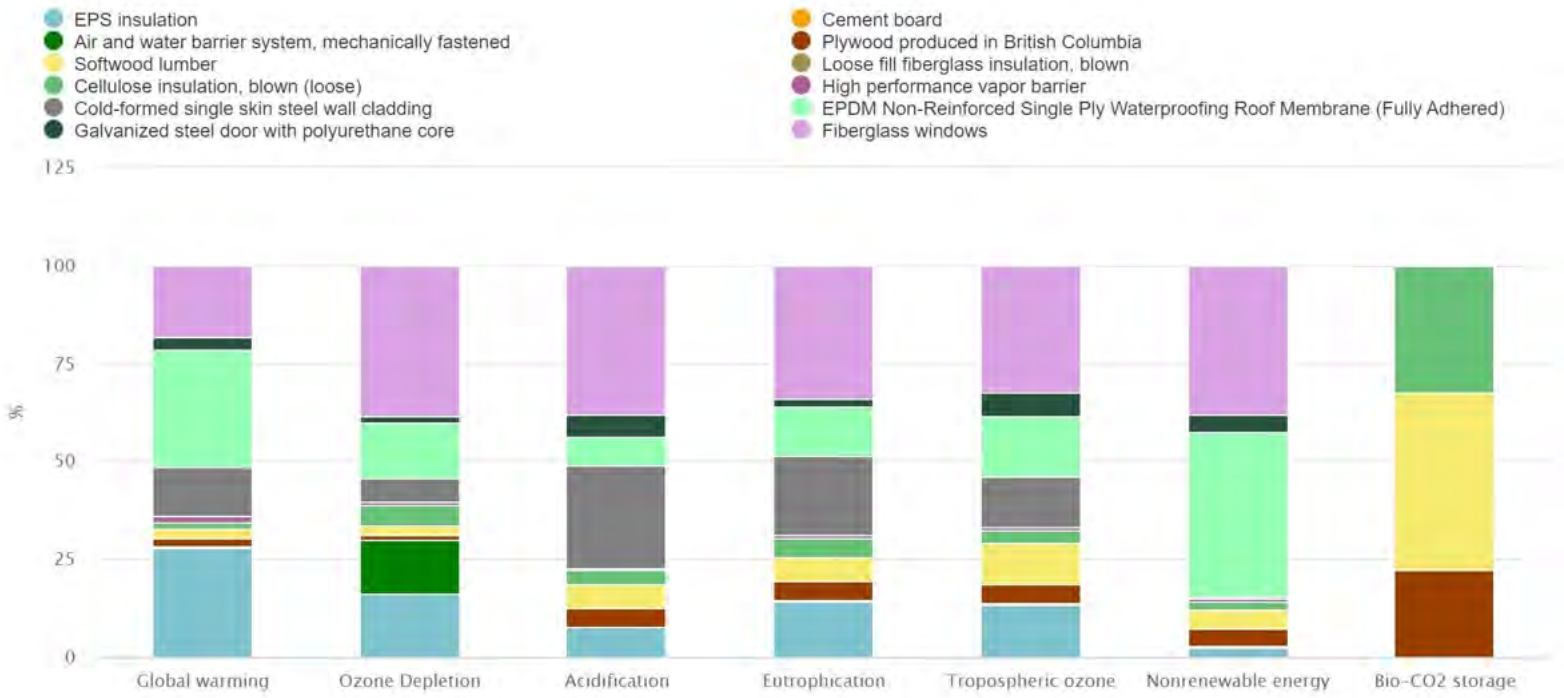


Figure 3: Burlington retrofit design breakdown of the life cycle impact categories and the associated materials

Appendix

Proposed Retrofit Assemblies and Environmental Impact calculations

Burlington

Wall Panel Assembly (R21)

Material (ReCover specification)	Description (from EPD)	Thickness (mm)	Volume of material (m3)	Carbon emissions (A1-A3) (KgCO2E)	% of total
Self Adhered WRB	Air and water barrier system, mechanically fastened, 0.0225 lbs/ft2, 0.11 kg/m2, Tyvek (DuPont)		*	77.3	0.5%
1/2" SPF plywood sheathing	Plywood produced in British Columbia, 477.33 kg/m3 (Forestry Innovation Investment)	13	11.211306	1476.3	9.0%
2x6 SPF framing	Softwood lumber, 405 kg/m3 (Canadian Wood Council)		19.75921175	1462.6	8.9%
Compressible insulation	Loose fill fiberglass insulation, blown, Rsi=1 m2K/W, 19.84 mm, 0.46 kg/m2, 23.2 kg/m3, (Johns Manville)	21	1.043761711	29.0	0.2%
Exterior strapping (#3)	Softwood lumber, 405 kg/m3 (Canadian Wood Council)		1.226228344	90.8	0.6%
Dense pack cellulose (5.5")	Cellulose insulation, blown (loose), L = 0.039 W/mK, R = 2.56 m2K/W (15 ft2°Fh/BTU), 50 kg/m3 (3.12lbs/ft3), (applicable for densities: 40-90 kg/m3 (2.5-5.62 lbs/ft3)),	191	148.4103782	1303.3	8.0%
Intello plus	High performance vapor barrier, 0.021 in (0.5 mm), 0.76 kg/m2, Florprufe® 120 (GCP Applied Technologies)		*	270.3	1.6%
1x4 strapping	Softwood lumber, 405 kg/m3 (Canadian Wood Council)		2.043713907	151.3	0.9%
Metal siding (cladding)	**Cold-formed single skin steel wall cladding, 0.36-1.27 mm, 4.17 kg/m2 (Metal Building Manufacturers Association)**		*****	**10884.7**	**66.4%**
4" EPS wall insulation	EPS insulation (generic)	101.6	40	463.2	2.8%
2" thick below grade fin		50.8			
Cement board	Cement board, 1/2 in (12.7 mm), 11.8 kg/m2, PLUS (PermaBASE Building Products)	6.35	0.4191	181.9	1.1%
Total				**16390.5**	100.0%
* Software calculates the impact based on the area provided			**Per m2**	**8.4**	**kg CO2/m2**

Roof Panel Assembly (R38)

Material (ReCover specification)	Description (from EPD)	Thickness (mm)	Volume of material (m3)	Carbon emissions (A1-A3) (KgCO2E)	% of total
8" low carbon EPS	EPS insulation (generic)	200	401.9	4,653.67	48.6%
Roofing Membrane	**EPDM Non-Reinforced Single Ply Waterproofing Roof Membrane (Fully Adhered), 60 mils: 2.07 kg/m2 (Single Ply Roofing Industry)**		*	**4,930.26**	**51.4%**
Total				**9,583.93**	100.0%
* Software calculates the impact based on the area provided			**Per m2**	**4.9**	**kg CO2/m2**

Windows and Doors

Material (ReCover specification)	Description (from EPD)	Thickness (mm)	Volume of material (m3)	Carbon emissions (A1-A3) (KgCO2E)	% of total
Insulated core steel doors	Galvanized steel door with polyurethane core, 44.5 mm (1.75 inch), 42.5 kg/unit, 490 kg/m3 (DE LA FONTAINE)	*	*	1,332.00	14.7%
High performance triple pane windows	Fiberglass windows, 1.5m x 1.3 m, 40 mm frame thickness, 1.42 m2 glazing area, 60.50 kg/m2, 300 Series Tilt and Turn, 300 Series Fixed, 325 Series Awning/Casement, 325 Series Fixed, 400 Series (Inline)	*	*	7,741.08	85.3%
Total				**9,073.08**	100.0%
* Quantity is calculated in software based on area and/or number of units			**Per m2**	**4.0**	**kg CO2/m2**

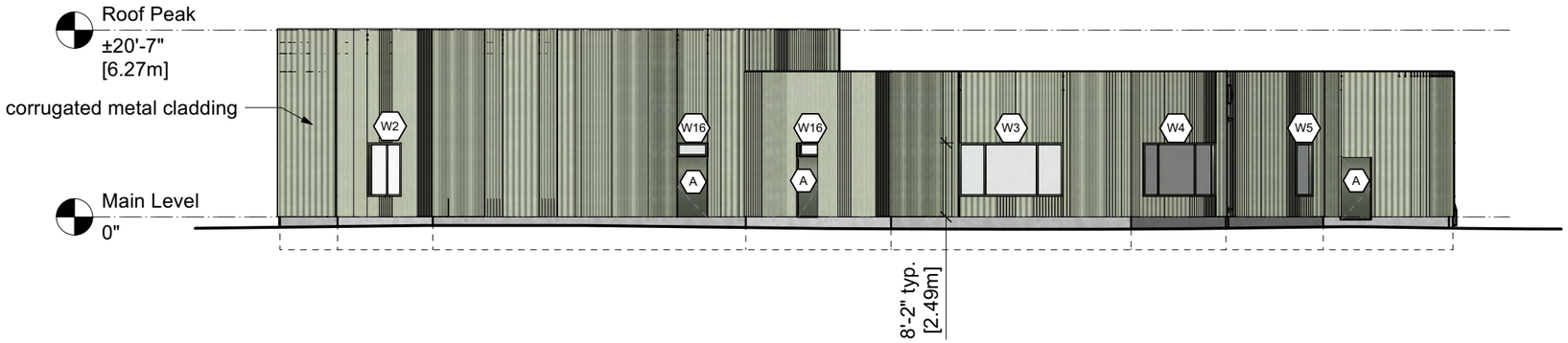
Environmental Emissions

Burlington Project		**A1 to C4**	**A1-A3**	**A4-A5**	**B1-B5**	**C1-C4**	**A1-A3**
Result category	**Units**	**Total**	**Construction Materials**	**Transportation to site & construction**	**Material replacement & refurbishment**	**Deconstruction**	**A1-A3 % of total**
Global warming	kg CO2e	89,418.43	35047.46	829.13	23039.09	30502.75	39.2%
Ozone Depletion	kg CFC11e	0.00	0.0019	0.00022	0.0012	0.0012	42.0%

Acidification	kg SO_2e	364.35	205.21	4.72	93.3	61.12	56.3%
Eutrophication	kg Ne	63.38	29.82	0.66	15.42	17.48	47.0%
Formation of tropospheric ozone	kg O3e	4,218.83	2583.9	133.94	1144.17	356.82	61.2%
Depletion of nonrenewable energy	MJ	718,666.13	382744.7	23575.7	305877	6468.73	53.3%
Biogenic carbon storage	kg CO2e	39,735.40	39735.4	0	0	0	100.00%

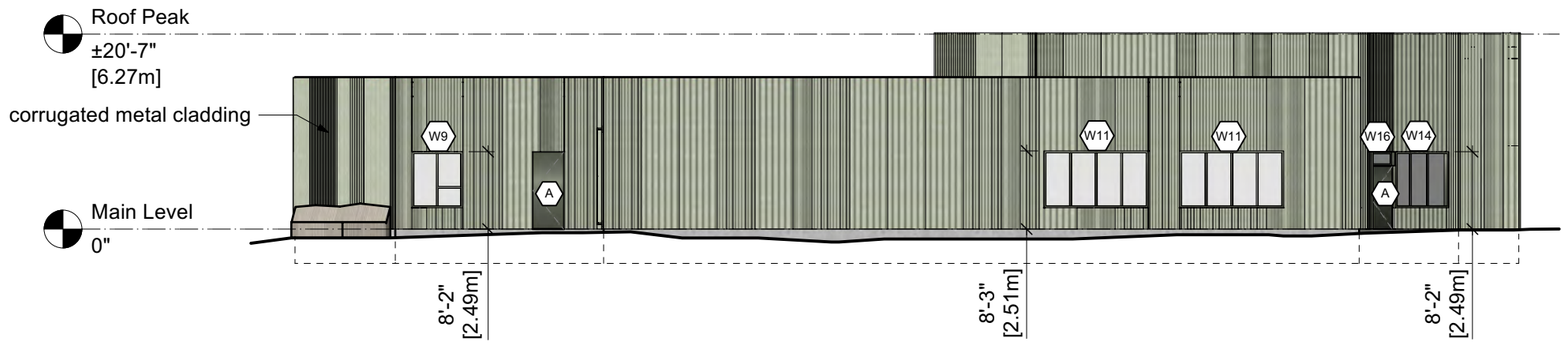
Appendix L

Architectural Elevation Drawings



1 North Elevation

1/16" = 1'-0"



2 South Elevation

1/16" = 1'-0"

0 6 12 18 24 30FT

graphic scale:

north arrow:

habit studio

6437 Cork St, Halifax, NS
email: lorrie@habitstudio.ca | tel: 902.448.6873

Burlington Seniors Centre

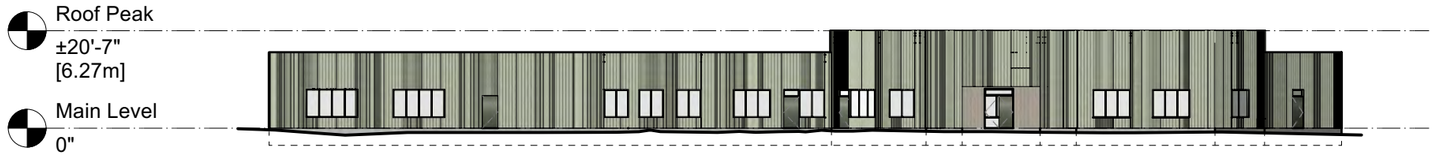
2285 New st, Burlington, ON

ReCover Initiative Panelized Deep Retrofit Study

Burlington_CURRENT.vwx

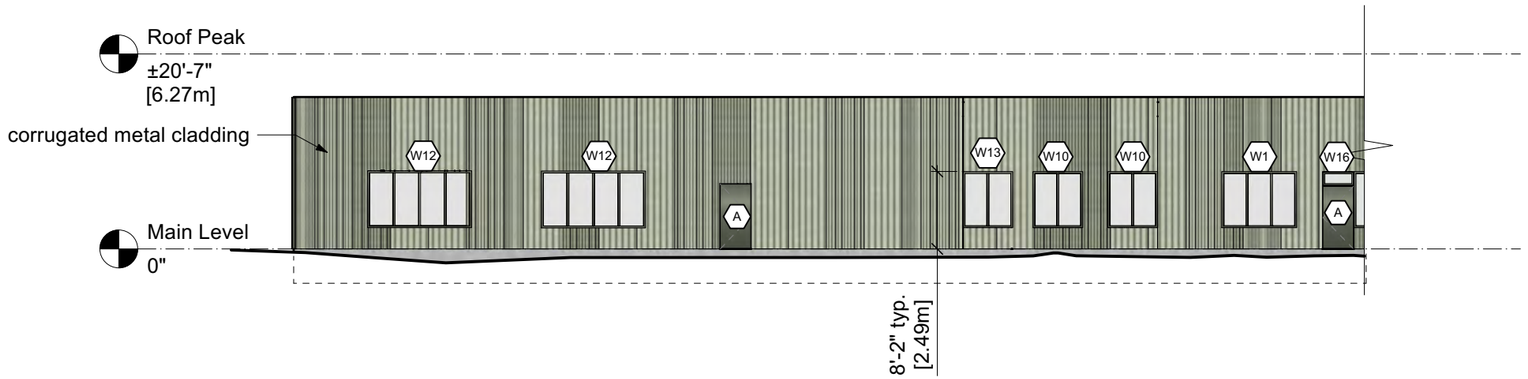
drawing title: Proposed North & South Elevation

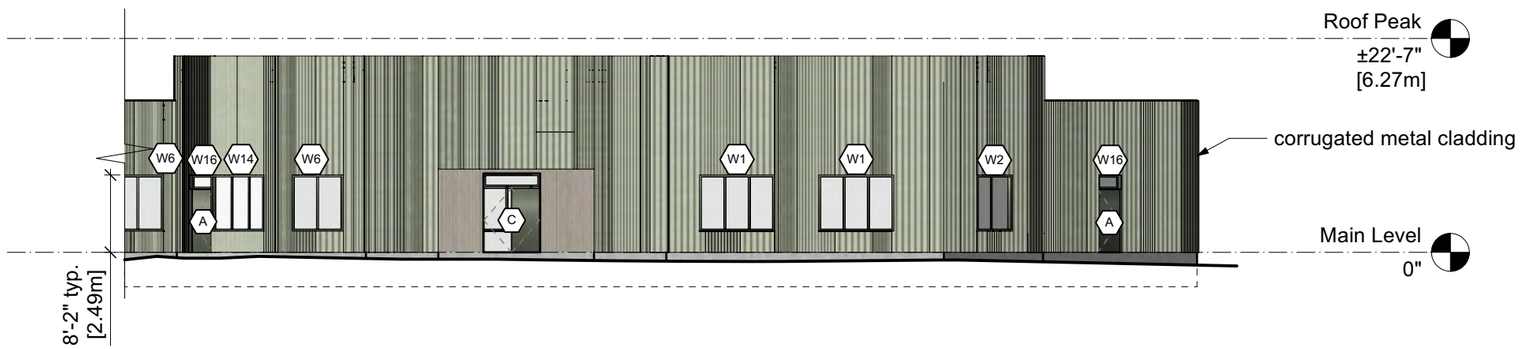
phase:		sheet size:
concept		17x11
drawn by: IG	checked by: LR	drawing number: A1
date: 2023-03-06	scale: as noted	



3 East Elevation

1/32" = 1'-0"





4 Enlarged East Elevation

1/16" = 1'-0"

0 6 12 18 24 30FT

graphic scale: north arrow:

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6437 Cork St, Halifax, NS
email: lorrie@habitstudio.ca | tel: 902.448.6873

Burlington Seniors Centre

2285 New st, Burlington, ON

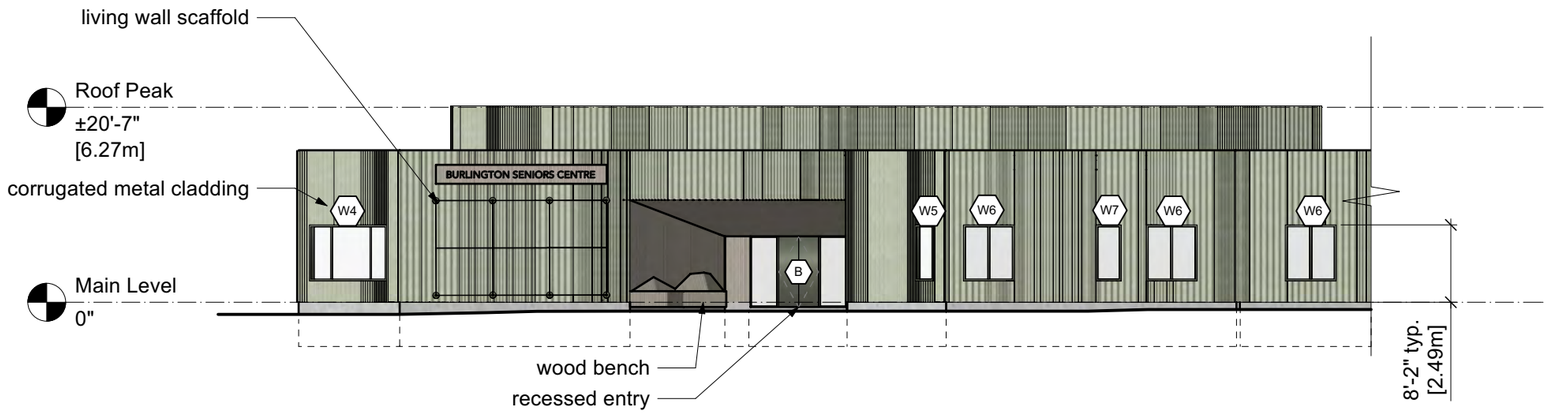
ReCover Initiative Panelized Deep Retrofit Study

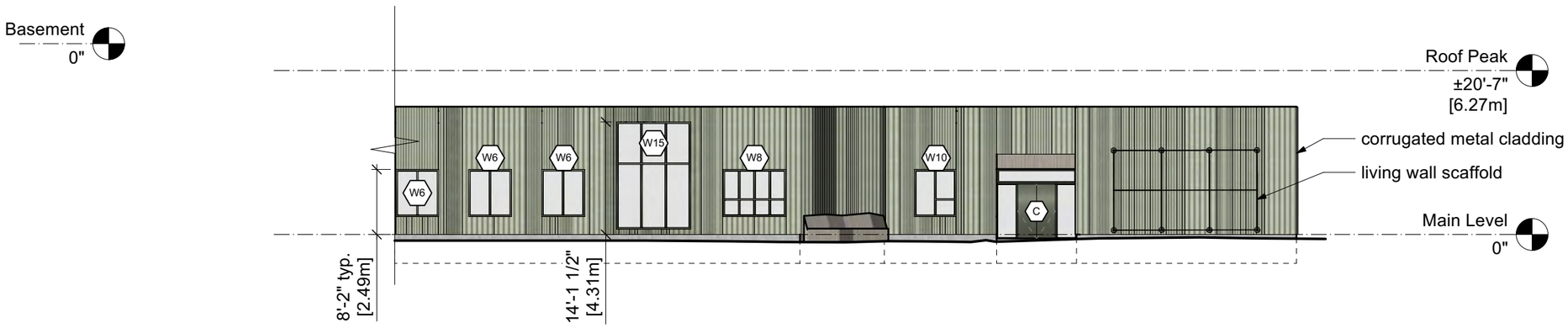
Burlington_CURRENT.vwx

drawing title: Proposed East Elevation		
phase: concept		sheet size: 17x11
drawn by: IG	checked by: LR	drawing number: A2
date: 2023-03-06	scale: as noted	

5 West Elevation

1/32" = 1'-0"





6 Enlarged West Elevation

1/16" = 1'-0"

0 6 12 18 24 30FT

graphic scale:

north arrow:

habit studio

6437 Cork St, Halifax, NS
email: lorrie@habitstudio.ca | tel: 902.448.6873

Burlington Seniors Centre

2285 New st, Burlington, ON

ReCover Initiative Panelized Deep Retrofit Study

Burlington_CURRENT.vwx

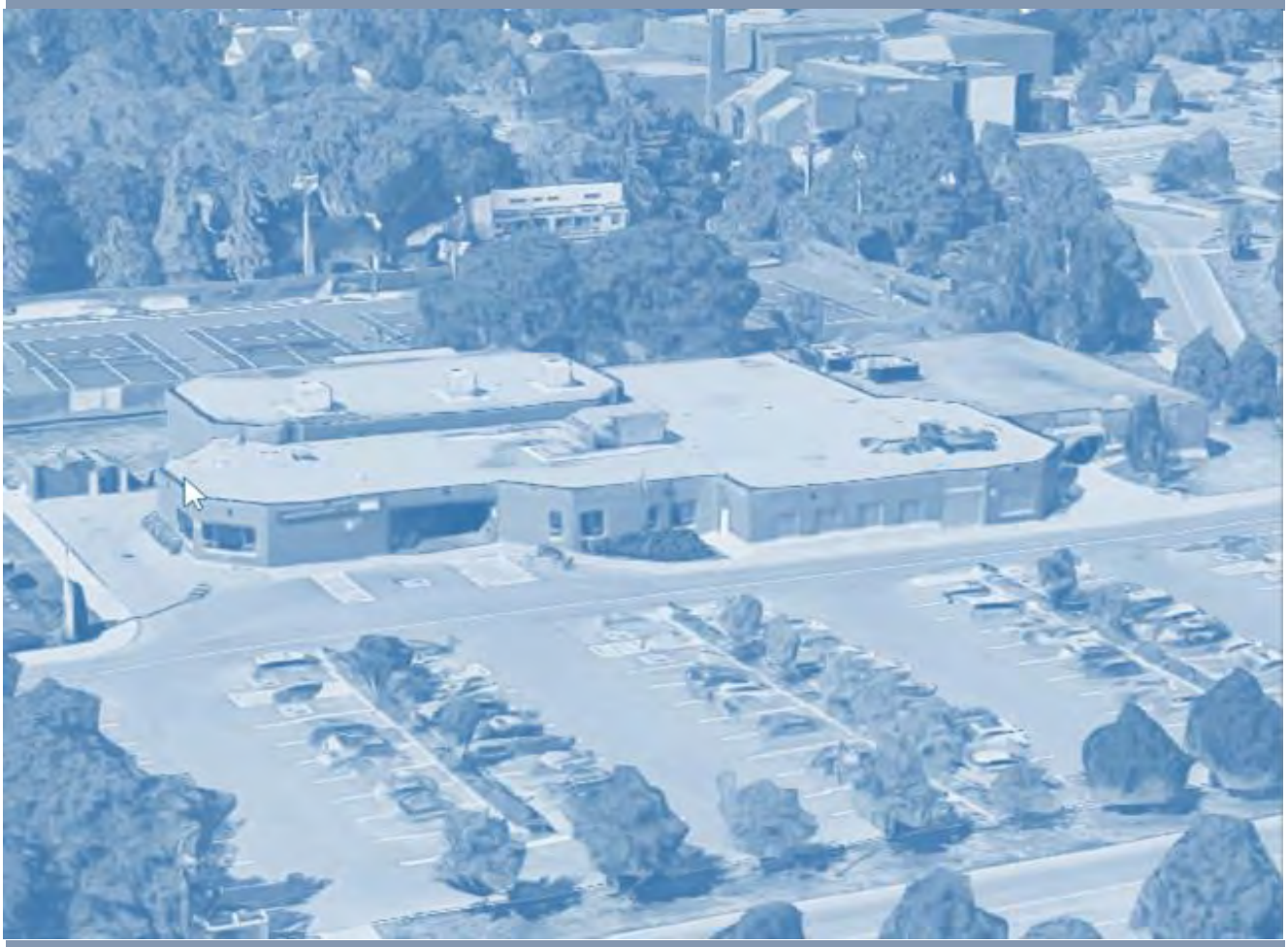
drawing title: Proposed West Elevation		
phase: concept		sheet size: 17x11
drawn by: IG	checked by: LR	drawing number: A3
date: 2023-03-06	scale: as noted	

Appendix M

Cost Estimate

Retrofit 2285 New Street

Burlington, Ontario



ELEMENTAL COST PLAN
CLASS D - FEASIBILITY ESTIMATE
JULY 20, 2023

163 Village Road, Herring Cove, Nova Scotia, Canada, B3V 1H2
www.qsolv.ca

Preamble

INTRODUCTION

The Class D - Feasibility Estimate enclosed represents the construction costs for the proposed energy retrofit options to the existing multi-purpose facility located at 2285 New Street in Burlington, Ontario as design by RSI Projects Inc.

Four scenario cost options are presented in this report as follows:

Scenario One Code Minimum generally includes the replacement of the brick facade with new metal siding on prefab insulated panels, replacement of windows and doors, roof replacement, upgrade of existing RTUs, and upgrade lighting with LED retrofit kits.

Scenario Two Net Zero Ready - ASHP generally includes the replacement of the brick facade with metal siding on prefab insulated panels, insulation on foundation walls, replacement of windows and doors, replacment of roof with additional insulation, change HVAC to a VRF air source heat pump system, replacment of lighting with LED fixtures, and add heat pump hot water heaters.

Scenario Three Net Zero Ready - GSHP generally includes the replacement of the brick facade with metal siding on prefab insulated panels, insulation on foundation walls, replacement of windows and doors, replacement of roof with additional insulation, change HVAC to a VRF ground source heat pump system, small building addition to house new mechanical equipment, replacement of lighting with LED fixtures, and add heat pump hot water heaters.

Scenario Four Net Zero generally includes all scope items from Scenario Three plus adds photovoltaics.

APPROACH

The construction costs for this report include all materials, labour, equipment, overheads, general conditions, plus markups and contractor's profit, for the retrofit options as presented in the project documents.

Preamble

APPROACH

The estimated **Construction Value** per Scenario is as follows:

Scenario One Minimum Code	$2,991,000.00
Scenario Two Net Zero Ready - ASHP	$5,593,000.00
Scenario Three Net Zero Ready - GSHP	$6,419,000.00
Scenario Four Net Zero	$7,583,000.00

Quantities were measured based on the Canadian Institute of Quantity Surveyors (CIQS) standards for Method of Measurement and presented in elemental format.

Pricing reflects competitive bids for every element of the work for a project of this type procured under an open market stipulated lump sum bid contract in Burlington, Ontario. Unit costs are developed and expressed as typical sub-contractor pricing and are inclusive of subcontractor's overheads and profits.

This estimate is an indication of the probable construction costs and is intended to represent fair market value of the construction costs. This estimate should not be considered a prediction of the lowest bid.

SPACE MEASUREMENT

The Gross Floor Area (GFA) was measured at 21,615 square feet (sf) based on the Canadian Institute of Quantity Surveyors (CIQS) Method of Measurement and the International Construction Measurement Standards (ICMS).

COST BASE

All costs are expressed in third quarter 2023 Canadian dollars (3Q2023).

All costs are shown exclusive of the 13% Harmonized Sales Tax (HST).

Preamble

ESCALATION

An Escalation Allowance is excluded from this report as no project schedule was provided.

Ontario is experiencing significant construction escalation currently with no signs of easing moving forward. It is recommended the Owner carry a Construction Escalation allowance of 10% per annum to the mid point of construction and should be monitored and reviewed continuously during the remaining design phase.

CONTINGENCIES

A Design Development Contingency Allowance of 10% is included in this report to allow for scope and budget adjustments during the remaining design phase.

A Construction Contingency Allowance of 10% is included in this report to allow for scope changes and possible change orders during the construction phase.

EXCLUSIONS

The following have been excluded from this cost report:

Premium for single source materials or equipment unless noted otherwise
Third party commissioning
Professional and design fees
Project management fees
Interim financing
Legal fees and surveys
Owners risk allowance
Moving costs or swing space
Furniture and equipment unless noted otherwise
Hazardous materials abatement
Rock excavation
Accelerated schedule premiums
Shift premiums or after-hours work

Preamble

EXCLUSIONS

Cash allowances
Testing and inspections
Cost premiums due to new tariffs placed on material and equipment
Cost premiums due to changes in COVID-19 protocols
Allowances for rebates

DOCUMENTATION

This Class D estimate is based on the following documentation:

Drawings/Specifications/Reports	Dated:
A101	July 26, 2022
A102	July 26, 2022
Mechanical Outline Specification	March 10, 2023
Electrical Outline Specification	February 24, 2023
Foundation Attachment Detail	March 8, 2023
Retrofit Scenarios Details	No Date
Wall Panel Schematics	February 27, 2023

PROJECT COST SUMMARY

PROJECT: RETROFIT 2285 NEW STREET
LOCATION: BURLINGTON, ONTARIO
CLIENT:
DESIGNER: RSI PROJECTS

Class D Estimate

DATE: JULY 20, 2023
CLASS: D - FEASIBILITY
FILE 13441

	DESCRIPTION	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	NOTES
1	SCENARIO 1 CODE MINIMUM	21615	sf	$ 138.00	$ 2,991,000	
2	SCENARIO 2 NET ZERO READY, ASHP	21615	sf	$ 259.00	$ 5,593,000	
3	SCENARIO 3 NET ZERO READY, GSHP	21615	sf	$ 297.00	$ 6,419,000	
4	SCENARIO 4 NET ZERO	21615	sf	$ 351.00	$ 7,583,000	

ELEMENTAL COST SUMMARY

PROJECT: RETROFIT 2285 NEW STREET
LOCATION: BURLINGTON, ONTARIO
CLIENT:
DESIGNER: RSI PROJECTS

Scenario 1 Code Minimum

DATE: JULY 20, 2023
CLASS: D - FEASIBILITY
FILE 13441
GFA:sf 21615

GROSS FLOOR AREA 21615 sf

ELEMENT	RATIO TO GFA	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	RATE PER GFA	TOTAL AMOUNT	%
A SHELL						$ 85	$ 1,845,613	61.71
A1 SUBSTRUCTURE						$ -	$ -	0.00
A11 Foundations	1.000	21615	sf	$ -	$ -	$ -		0.00
A12 Basement Excavation	1.000	21615	sf	$ -	$ -	$ -		0.00
A2 STRUCTURE						$ -	$ -	0.00
A21 Lowest Floor Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A22 Upper Floor Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A23 Roof Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A3 EXTERIOR ENCLOSURE						$ 85	$ 1,845,613	61.71
A31 Walls Below Grade	1.000	21615	sf	$ -	$ -	$ -		0.00
A32 Walls Above Grade	0.574	12415	sf	$ 68.00	$ 844,248	$ 39		28.23
A33 Windows and Entrances	1.000	21615	sf	$ 13.44	$ 290,408	$ 13		9.71
A34 Roof Coverings	1.000	21615	sf	$ 31.85	$ 688,439	$ 32		23.02
A35 Projections	0.013	281	sf	$ -	$ 22,519	$ 1		0.75
B INTERIORS						$ -	$ -	0.00
B1 PARTITIONS AND DOORS						$ -	$ -	0.00
B11 Partitions	1.000	21615	sf	$ -	$ -	$ -		0.00
B12 Doors	1.000	21615	sf	$ -	$ -	$ -		0.00
B2 INTERIOR FINISHES						$ -	$ -	0.00
B21 Floor Finishes	1.000	21615	sf	$ -	$ -	$ -		0.00
B22 Ceiling Finishes	1.000	21615	sf	$ -	$ -	$ -		0.00
B23 Wall Finishes	1.000	21615	sf	$ -	$ -	$ -		0.00
B3 FITTINGS AND EQUIPMENT						$ -	$ -	0.00
B31 Fittings and Fixtures	1.000	21615	sf	$ -	$ -	$ -		0.00
B32 Equipment	1.000	21615	sf	$ -	$ -	$ -		0.00
B33 Conveying Systems	1.000	21615	sf	$ -	$ -	$ -		0.00
SERVICES						$ 5	$ 108,229	3.62
C1 MECHANICAL						$ 3	$ 65,000	2.17
C11 Plumbing and Drainage	1.000	21615	sf	$ -	$ -	$ -		0.00
C12 Fire Protection	1.000	21615	sf	$ -	$ -	$ -		0.00
C13 HVAC	1.000	21615	sf	$ 2.78	$ 60,000	$ 3		2.01
C14 Controls	1.000	21615	sf	$ 0.23	$ 5,000	$ 0		0.17
C2 ELECTRICAL						$ 2	$ 43,229	1.45
C21 Services and Distribution	1.000	21615	sf	$ -	$ -	$ -		0.00
C22 Lighting, Devices and Heating	1.000	21615	sf	$ 2.00	$ 43,229	$ 2		1.45
C23 Systems and Ancillaries	1.000	21615	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - LESS SITE						$ 90	$ 1,953,843	65.32
D SITE & ANCILLARY WORK						$ -	$ -	0.00
D1 SITEWORK						$ -	$ -	0.00
D11 Site Development	1.000	21615	sf	$ -	$ -	$ -		0.00
D12 Mechanical Site Services	1.000	21615	sf	$ -	$ -	$ -		0.00
D13 Electrical Site Services	1.000	21615	sf	$ -	$ -	$ -		0.00
D2 ANCILLARY WORK						$ -	$ -	0.00
D21 Demolition	1.000	21615	sf	$ -	$ -	$ -		0.00
D22 Alterations	1.000	21615	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - INCLUDING SITE						$ 90	$ 1,953,843	65.32
Z GENERAL REQUIREMENTS AND ALLOWANCES						$ 48	$ 1,036,807	34.66
Z1 GENERAL REQUIREMENTS AND FEES						$ 24	$ 517,768	17.31
Z11 General Requirements and Overheads		15%			$ 293,076	$ 14		9.80
Z12 Contractors Profit		10%			$ 224,692	$ 10		7.51
Z2 ALLOWANCES						$ 24	$ 519,038	17.35
Z21 Design Allowance		10%			$ 247,161	$ 11		8.26
Z22 Escalation Allowance TBD		0%			$ -	$ -		0.00
Z23 Construction Allowance		10%			$ 271,877	$ 13		9.09
TOTAL CONSTRUCTION COST (HST EXTRA)				$138 per sf			$ 2,991,000	100.00

Element	Quantities		Unit Rates	Sub-totals
EXTERIOR ENCLOSURE				
A32 Walls Above Grade				
▪ remove existing brick/block/metal panel façade	12415	sf	$ 5.00	$ 62,077
▪ supply and install prefab insulated wall panels	12415	sf	$ 25.00	$ 310,385
▪ supply and install prefinished metal siding	12415	sf	$ 38.00	$ 471,786
A32 Walls Above Grade Total	**12415**	**sf**	**$ 68.00**	**$ 844,248**
A33 Windows and Entrances				
▪ replace aluminum sliding double door entrances	2	no	$ 20,000.00	$ 40,000
▪ replace insulated metal single exits	7	no	$ 3,800.00	$ 26,600
▪ replace windows with high performance triple pane aluminum windows including interior patching	1210	sf	$ 185.00	$ 223,808
A33 Windows and Entrances Total	**21615**	**sf**	**$ 13.44**	**$ 290,408**
A34 Roof Coverings				
▪ remove existing roof finish	21615	sf	$ 2.00	$ 43,229
▪ new mod bit roof finish with 4" EPS insulation	21615	sf	$ 28.00	$ 605,209
▪ allowance for removing, reinstalling mechanical	1	sum	$ 40,000.00	$ 40,000
A34 Roof Coverings Total	**21615**	**sf**	**$ 31.85**	**$ 688,439**
A35 Projections				
▪ soffit replacement	281	sf	$ 80.00	$ 22,519
▪ canopies - no change	1	sum	$ -	$ -
A35 Projections Total	**281**	**sf**	**$ 80.00**	**$ 22,519**
MECHANICAL				
C13 Heating, Ventilation, Air Conditioning				
▪ upgrade CAV rooftop units with VFD, controllers	6	no	$ 10,000.00	$ 60,000
C13 Heating, Ventilation, Air Conditioning Total	**21615**	**sf**	**$ 2.78**	**$ 60,000**
C14 Controls				
▪ building automated controls - connect to existing system	1	sum	$ 5,000.00	$ 5,000
C14 Controls Total	**21615**	**sf**	**$ 0.23**	**$ 5,000**
ELECTRICAL				
C22 Lighting, Devices and Heating				
▪ install LED retrofit kits to all existing lights	21615	sf	$ 2.00	$ 43,229
C22 Lighting and Heating Total	**21615**	**sf**	**$ 2.00**	**$ 43,229**
GENERAL REQUIREMENTS AND FEES				
Z11 General Requirements and Overheads				
▪ contractor's overheads			15.00%	$ 293,076

Element	Quantities		Unit Rates		Sub-totals
Z11 General Requirements and Overheads Total	**21615**	**sf**	**$ 13.56**	**$**	**293,076**
Z12 Contractor's Profit					
▪ contractor's profit			10.00%	$	224,692
Z12 Contractor's Profit Total	**21615**	**sf**	**$ 10.40**	**$**	**224,692**
ALLOWANCES					
Z21 Design Allowance					
▪ design development contingency			10.00%	$	247,161
Z21 Design Allowance Total	**21615**	**sf**	**$ 11.43**	**$**	**247,161**
Z23 Construction Contingency					
▪ construction contingency			10.00%	$	271,877
Z23 Construction Contingency	**21615**	**sf**	**$ 12.58**	**$**	**271,877**

ELEMENTAL COST SUMMARY

PROJECT: RETROFIT 2285 NEW STREET
LOCATION: BURLINGTON, ONTARIO
CLIENT:
DESIGNER: RSI PROJECTS

Scenario 2 Net Zero Ready - ASHP

DATE: JULY 20, 2023
CLASS: D - FEASIBILITY
FILE 13441
GFA:sf 21615

GROSS FLOOR AREA 21615 sf

ELEMENT	RATIO TO GFA	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	RATE PER GFA	TOTAL AMOUNT	%
A SHELL						$ 93	$ 2,017,255	36.07
A1 SUBSTRUCTURE						$ -	$ -	0.00
A11 Foundations	1.000	21615	sf	$ -	$ -	$ -		0.00
A12 Basement Excavation	1.000	21615	sf	$ -	$ -	$ -		0.00
A2 STRUCTURE						$ -	$ -	0.00
A21 Lowest Floor Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A22 Upper Floor Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A23 Roof Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A3 EXTERIOR ENCLOSURE						$ 93	$ 2,017,255	36.07
A31 Walls Below Grade	0.069	1492	sf	$ 54.41	$ 81,183	$ 4		1.45
A32 Walls Above Grade	0.574	12415	sf	$ 68.00	$ 844,248	$ 39		15.09
A33 Windows and Entrances	0.069	1485	sf	$ 195.59	$ 290,408	$ 13		5.19
A34 Roof Coverings	1.000	21615	sf	$ 36.04	$ 778,897	$ 36		13.93
A35 Projections	0.013	281	sf	$ -	$ 22,519	$ 1		0.40
B INTERIORS						$ 5	$ 108,073	1.93
B1 PARTITIONS AND DOORS						$ -	$ -	0.00
B11 Partitions	1.000	21615	sf	$ -	$ -	$ -		0.00
B12 Doors	1.000	21615	sf	$ -	$ -	$ -		0.00
B2 INTERIOR FINISHES						$ 5	$ 108,073	1.93
B21 Floor Finishes	1.000	21615	sf	$ -	$ -	$ -		0.00
B22 Ceiling Finishes	1.000	21615	sf	$ 2.50	$ 54,037	$ 3		0.97
B23 Wall Finishes	1.000	21615	sf	$ 2.50	$ 54,037	$ 3		0.97
B3 FITTINGS AND EQUIPMENT						$ -	$ -	0.00
B31 Fittings and Fixtures	1.000	21615	sf	$ -	$ -	$ -		0.00
B32 Equipment	1.000	21615	sf	$ -	$ -	$ -		0.00
B33 Conveying Systems	1.000	21615	sf	$ -	$ -	$ -		0.00
SERVICES						$ 71	$ 1,528,251	27.32
C1 MECHANICAL						$ 49	$ 1,050,802	18.79
C11 Plumbing and Drainage	1.000	21615	sf	$ 1.67	$ 36,000	$ 2		0.64
C12 Fire Protection	1.000	21615	sf	$ -	$ -	$ -		0.00
C13 HVAC	1.000	21615	sf	$ 39.95	$ 863,500	$ 40		15.44
C14 Controls	1.000	21615	sf	$ 7.00	$ 151,302	$ 7		2.71
C2 ELECTRICAL						$ 22	$ 477,449	8.54
C21 Services and Distribution	1.000	21615	sf	$ 5.09	$ 110,000	$ 5		1.97
C22 Lighting, Devices and Heating	1.000	21615	sf	$ 17.00	$ 367,449	$ 17		6.57
C23 Systems and Ancillaries	1.000	21615	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - LESS SITE						$ 169	$ 3,653,579	65.32
D SITE & ANCILLARY WORK						$ -	$ -	0.00
D1 SITEWORK						$ -	$ -	0.00
D11 Site Development	1.000	21615	sf	$ -	$ -	$ -		0.00
D12 Mechanical Site Services	1.000	21615	sf	$ -	$ -	$ -		0.00
D13 Electrical Site Services	1.000	21615	sf	$ -	$ -	$ -		0.00
D2 ANCILLARY WORK						$ -	$ -	0.00
D21 Demolition	1.000	21615	sf	$ -	$ -	$ -		0.00
D22 Alterations	1.000	21615	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - INCLUDING SITE						$ 169	$ 3,653,579	65.32
Z GENERAL REQUIREMENTS AND ALLOWANCES						$ 90	$ 1,938,772	34.66
Z1 GENERAL REQUIREMENTS AND FEES						$ 45	$ 968,198	17.31
Z11 General Requirements and Overheads		15%			$ 548,037	$ 25		9.80
Z12 Contractors Profit		10%			$ 420,162	$ 19		7.51
Z2 ALLOWANCES						$ 45	$ 970,573	17.35
Z21 Design Allowance		10%			$ 462,178	$ 21		8.26
Z22 Escalation Allowance TBD		0%			$ -	$ -		0.00
Z23 Construction Allowance		10%			$ 508,395	$ 24		9.09
TOTAL CONSTRUCTION COST (HST EXTRA)				$259 per sf			$ 5,593,000	100.00

Element	Quantities		Unit Rates	Sub-totals
EXTERIOR ENCLOSURE				
A31 Walls Below Grade				
▪ remove concrete sidewalk and dispose	1404	sf	$ 3.00	$ 4,212
▪ remove asphalt paving and dispose	327	sf	$ 3.00	$ 982
▪ excavate to 2 feet below grade	165	cyd	$ 40.00	$ 6,616
▪ new 2" EPS fin insulation	1490	sf	$ 3.50	$ 5,215
▪ backfill to subgrade	165	cyd	$ 50.00	$ 8,270
▪ reinstate concrete sidewalks	1404	sf	$ 18.00	$ 25,269
▪ reinstate asphalt paving	327	sf	$ 15.00	$ 4,911
▪ reinstate landscaping	1561	sf	$ 5.00	$ 7,805
▪ new 4" EPS insulation to foundation walls	1492	sf	$ 7.00	$ 10,444
▪ cement board	1492	sf	$ 5.00	$ 7,460
A31 Walls Below Grade Total	**1492**	**sf**	**$ 54.41**	**$ 81,183**
A32 Walls Above Grade				
▪ remove existing brick/block/metal panel façade	12415	sf	$ 5.00	$ 62,077
▪ supply and install prefab insulated wall panels	12415	sf	$ 25.00	$ 310,385
▪ supply and install prefinished metal siding	12415	sf	$ 38.00	$ 471,786
A32 Walls Above Grade Total	**12415**	**sf**	**$ 68.00**	**$ 844,248**
A33 Windows and Entrances				
▪ replace aluminum sliding double door entrances	2	no	$ 20,000.00	$ 40,000
▪ replace insulated metal single exits	7	no	$ 3,800.00	$ 26,600
▪ replace windows with high performance triple pane aluminum windows including interior patching	1210	sf	$ 185.00	$ 223,808
A33 Windows and Entrances Total	**1485**	**sf**	**$ 195.59**	**$ 290,408**
A34 Roof Coverings				
▪ remove existing roof finish	21615	sf	$ 2.00	$ 43,229
▪ new mod bit roof finish with 8" EPS insulation	21615	sf	$ 32.00	$ 691,668
▪ allowance for removing, reinstalling mechanical	1	sum	$ 10,000.00	$ 10,000
▪ allowance to increase parapet height	680	lf	$ 50.00	$ 34,000
A34 Roof Coverings Total	**21615**	**sf**	**$ 36.04**	**$ 778,897**
A35 Projections				
▪ soffit replacement	281	sf	$ 80.00	$ 22,519
▪ canopies - no change	1	sum	$ -	$ -
A35 Projections Total	**281**	**sf**	**$ 80.00**	**$ 22,519**
FINISHES				
B22 Ceiling Finishes				
▪ cut and patch ceilings for new mechanical/electrical	21615	sf	$ 2.50	$ 54,037
B22 Ceiling Finishes Total	**21615**	**sf**	**$ 2.50**	**$ 54,037**
B23 Wall Finishes				

Element	Quantities		Unit Rates	Sub-totals
▪ cut and patch walls for new mechanical/electrical	21615	sf	$ 2.50	$ 54,037
B23 Wall Finishes Total	**21615**	**sf**	**$ 2.50**	**$ 54,037**
MECHANICAL				
C11 Plumbing and Drainage				
▪ new 80gal HP hot water tanks	4	no	$ 4,000.00	$ 16,000
▪ add insulation to internal RWLs and vent piping	1	sum	$ 20,000.00	$ 20,000
C11 Plumbing and Drainage Total	**21615**	**sf**	**$ 1.67**	**$ 36,000**
C13 Heating, Ventilation, Air Conditioning				
▪ VRF ASHP condensing units - 8 tons	2	no	$ 45,000.00	$ 90,000
▪ VRF fancoils	19	no	$ 8,500.00	$ 161,500
▪ refrigerant piping, branch controllers	2000	lf	$ 100.00	$ 200,000
▪ VAVs	16	no	$ 3,000.00	$ 48,000
▪ ERV 1500cfm	1	no	$ 60,000.00	$ 60,000
▪ ERV 900cfm	1	no	$ 28,000.00	$ 28,000
▪ new ERV ductwork, EDH	12000	lbs	$ 18.00	$ 216,000
▪ replace kitchen MAU 1200 cfm with electric heater	1	sum	$ 35,000.00	$ 35,000
▪ replace kitchen hood and exhaust system	1	sum	$ 25,000.00	$ 25,000
C13 Heating, Ventilation, Air Conditioning Total	**21615**	**sf**	**$ 39.95**	**$ 863,500**
C14 Controls				
▪ building automated controls - connect to existing system	21615	sf	$ 7.00	$ 151,302
C14 Controls Total	**21615**	**sf**	**$ 7.00**	**$ 151,302**
ELECTRICAL				
C21 Services and Distribution				
▪ replace main entrance, 400A switchgear	1	sum	$ 25,000.00	$ 25,000
▪ new feeders	1	sum	$ 50,000.00	$ 50,000
▪ new panel, transformer for HVAC	1	sum	$ 20,000.00	$ 20,000
▪ new disconnects, mechanical connections	1	sum	$ 15,000.00	$ 15,000
C21 Services and Distribution Total	**21615**	**sf**	**$ 5.09**	**$ 110,000**
GENERAL REQUIREMENTS AND FEES				
Z11 General Requirements and Overheads				
▪ contractor's overheads			15.00%	$ 548,037
Z11 General Requirements and Overheads Total	**21615**	**sf**	**$ 25.35**	**$ 548,037**
Z12 Contractor's Profit				
▪ contractor's profit			10.00%	$ 420,162
Z12 Contractor's Profit Total	**21615**	**sf**	**$ 19.44**	**$ 420,162**
ALLOWANCES				
Z21 Design Allowance				

Element	Quantities		Unit Rates		Sub-totals
▪ design development contingency			10.00%	$	462,178
Z21 Design Allowance Total	**21615**	**sf**	**$ 21.38**	**$**	**462,178**
Z23 Construction Contingency					
▪ construction contingency			10.00%	$	508,395
Z23 Construction Contingency	**21615**	**sf**	**$ 23.52**	**$**	**508,395**

ELEMENTAL COST SUMMARY

PROJECT: RETROFIT 2285 NEW STREET
LOCATION: BURLINGTON, ONTARIO
CLIENT:
DESIGNER: RSI PROJECTS

Scenario 3 Net Zero Ready - GSHP

DATE: JULY 20, 2023
CLASS: D - FEASIBILITY
FILE 13441
GFA:sf 21615

GROSS FLOOR AREA 21615 sf

ELEMENT	RATIO TO GFA	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	RATE PER GFA	TOTAL AMOUNT	%
A SHELL						$ 93	$ 2,017,255	31.43
A1 SUBSTRUCTURE						$ -	$ -	0.00
A11 Foundations	1.000	21615	sf	$ -	$ -	$ -		0.00
A12 Basement Excavation	1.000	21615	sf	$ -	$ -	$ -		0.00
A2 STRUCTURE						$ -	$ -	0.00
A21 Lowest Floor Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A22 Upper Floor Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A23 Roof Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A3 EXTERIOR ENCLOSURE						$ 93	$ 2,017,255	31.43
A31 Walls Below Grade	0.069	1492	sf	$ 54.41	$ 81,183	$ 4		1.26
A32 Walls Above Grade	0.574	12415	sf	$ 68.00	$ 844,248	$ 39		13.15
A33 Windows and Entrances	0.069	1485	sf	$ 195.59	$ 290,408	$ 13		4.52
A34 Roof Coverings	1.000	21615	sf	$ 36.04	$ 778,897	$ 36		12.13
A35 Projections	0.013	281	sf	$ -	$ 22,519	$ 1		0.35
B INTERIORS						$ 5	$ 108,073	1.68
B1 PARTITIONS AND DOORS						$ -	$ -	0.00
B11 Partitions	1.000	21615	sf	$ -	$ -	$ -		0.00
B12 Doors	1.000	21615	sf	$ -	$ -	$ -		0.00
B2 INTERIOR FINISHES						$ 5	$ 108,073	1.68
B21 Floor Finishes	1.000	21615	sf	$ -	$ -	$ -		0.00
B22 Ceiling Finishes	1.000	21615	sf	$ 2.50	$ 54,037	$ 3		0.84
B23 Wall Finishes	1.000	21615	sf	$ 2.50	$ 54,037	$ 3		0.84
B3 FITTINGS AND EQUIPMENT						$ -	$ -	0.00
B31 Fittings and Fixtures	1.000	21615	sf	$ -	$ -	$ -		0.00
B32 Equipment	1.000	21615	sf	$ -	$ -	$ -		0.00
B33 Conveying Systems	1.000	21615	sf	$ -	$ -	$ -		0.00
SERVICES						$ 78	$ 1,693,251	26.38
C1 MECHANICAL						$ 56	$ 1,215,802	18.94
C11 Plumbing and Drainage	1.000	21615	sf	$ 1.67	$ 36,000	$ 2		0.56
C12 Fire Protection	1.000	21615	sf	$ -	$ -	$ -		0.00
C13 HVAC	1.000	21615	sf	$ 47.58	$ 1,028,500	$ 48		16.02
C14 Controls	1.000	21615	sf	$ 7.00	$ 151,302	$ 7		2.36
C2 ELECTRICAL						$ 22	$ 477,449	7.44
C21 Services and Distribution	1.000	21615	sf	$ 5.09	$ 110,000	$ 5		1.71
C22 Lighting, Devices and Heating	1.000	21615	sf	$ 17.00	$ 367,449	$ 17		5.72
C23 Systems and Ancillaries	1.000	21615	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - LESS SITE						$ 177	$ 3,818,579	59.49
D SITE & ANCILLARY WORK						$ 17	$ 375,000	5.84
D1 SITEWORK						$ -	$ -	0.00
D11 Site Development	1.000	21615	sf	$ -	$ -	$ -		0.00
D12 Mechanical Site Services	1.000	21615	sf	$ -	$ -	$ -		0.00
D13 Electrical Site Services	1.000	21615	sf	$ -	$ -	$ -		0.00
D2 ANCILLARY WORK						$ 17	$ 375,000	5.84
D21 Demolition	1.000	21615	sf	$ -	$ -	$ -		0.00
D22 Alterations	1.000	21615	sf	$ 17.35	$ 375,000	$ 17		5.84
NET BUILDING SUBTOTAL - INCLUDING SITE						$ 194	$ 4,193,579	65.33
Z GENERAL REQUIREMENTS AND ALLOWANCES						$ 103	$ 2,225,323	34.67
Z1 GENERAL REQUIREMENTS AND FEES						$ 51	$ 1,111,298	17.31
Z11 General Requirements and Overheads		15%			$ 629,037	$ 29		9.80
Z12 Contractors Profit		10%			$ 482,262	$ 22		7.51
Z2 ALLOWANCES						$ 52	$ 1,114,024	17.36
Z21 Design Allowance		10%			$ 530,488	$ 25		8.26
Z22 Escalation Allowance TBD		0%			$ -	$ -		0.00
Z23 Construction Allowance		10%			$ 583,536	$ 27		9.09
TOTAL CONSTRUCTION COST (HST EXTRA)				$297 per sf			$ 6,419,000	100.00

Element	Quantities		Unit Rates	Sub-totals
EXTERIOR ENCLOSURE				
A31 Walls Below Grade				
▪ remove concrete sidewalk and dispose	1404	sf	$ 3.00	$ 4,212
▪ remove asphalt paving and dispose	327	sf	$ 3.00	$ 982
▪ excavate to 2 feet below grade	165	cyd	$ 40.00	$ 6,616
▪ new 2" EPS fin insulation	1490	sf	$ 3.50	$ 5,215
▪ backfill to subgrade	165	cyd	$ 50.00	$ 8,270
▪ reinstate concrete sidewalks	1404	sf	$ 18.00	$ 25,269
▪ reinstate asphalt paving	327	sf	$ 15.00	$ 4,911
▪ reinstate landscaping	1561	sf	$ 5.00	$ 7,805
▪ new 4" EPS insulation to foundation walls	1492	sf	$ 7.00	$ 10,444
▪ cement board	1492	sf	$ 5.00	$ 7,460
A31 Walls Below Grade Total	**1492**	**sf**	**$ 54.41**	**$ 81,183**
A32 Walls Above Grade				
▪ remove existing brick/block/metal panel façade	12415	sf	$ 5.00	$ 62,077
▪ supply and install prefab insulated wall panels	12415	sf	$ 25.00	$ 310,385
▪ supply and install prefinished metal siding	12415	sf	$ 38.00	$ 471,786
A32 Walls Above Grade Total	**12415**	**sf**	**$ 68.00**	**$ 844,248**
A33 Windows and Entrances				
▪ replace aluminum sliding double door entrances	2	no	$ 20,000.00	$ 40,000
▪ replace insulated metal single exits	7	no	$ 3,800.00	$ 26,600
▪ replace windows with high performance triple pane aluminum windows including interior patching	1210	sf	$ 185.00	$ 223,808
A33 Windows and Entrances Total	**1485**	**sf**	**$ 195.59**	**$ 290,408**
A34 Roof Coverings				
▪ remove existing roof finish	21615	sf	$ 2.00	$ 43,229
▪ new mod bit roof finish with 8" EPS insulation	21615	sf	$ 32.00	$ 691,668
▪ allowance for removing, reinstalling mechanical	1	sum	$ 10,000.00	$ 10,000
▪ allowance to increase parapet height	680	lf	$ 50.00	$ 34,000
A34 Roof Coverings Total	**21615**	**sf**	**$ 36.04**	**$ 778,897**
A35 Projections				
▪ soffit replacement	281	sf	$ 80.00	$ 22,519
▪ canopies - no change	1	sum	$ -	$ -
A35 Projections Total	**281**	**sf**	**$ 80.00**	**$ 22,519**
FINISHES				
B22 Ceiling Finishes				
▪ cut and patch ceilings for new mechanical/electrical	21615	sf	$ 2.50	$ 54,037
B22 Ceiling Finishes Total	**21615**	**sf**	**$ 2.50**	**$ 54,037**
B23 Wall Finishes				

Element	Quantities		Unit Rates	Sub-totals
▪ cut and patch walls for new mechanical/electrical	21615	sf	$ 2.50	$ 54,037
B23 Wall Finishes Total	**21615**	**sf**	**$ 2.50**	**$ 54,037**
MECHANICAL				
C11 Plumbing and Drainage				
▪ new 80gal HP hot water tanks	4	no	$ 4,000.00	$ 16,000
▪ add insulation to internal RWLs and vent piping	1	sum	$ 20,000.00	$ 20,000
C11 Plumbing and Drainage Total	**21615**	**sf**	**$ 1.67**	**$ 36,000**
C13 Heating, Ventilation, Air Conditioning				
▪ geothermal wells, testing	5	no	$ 18,000.00	$ 90,000
▪ gshp piping, trenching, backfill, reinstatement	1	sum	$ 45,000.00	$ 45,000
▪ gshp circulation pumps, interior piping, HX	1	sum	$ 50,000.00	$ 50,000
▪ VRF condensing units - 8 tons	2	no	$ 35,000.00	$ 70,000
▪ VRF fancoils	19	no	$ 8,500.00	$ 161,500
▪ refrigerant piping, branch controllers	2000	lf	$ 100.00	$ 200,000
▪ VAVs	16	no	$ 3,000.00	$ 48,000
▪ ERV 1500cfm	1	no	$ 60,000.00	$ 60,000
▪ ERV 900cfm	1	no	$ 28,000.00	$ 28,000
▪ new ERV ductwork, EDH	12000	lbs	$ 18.00	$ 216,000
▪ replace kitchen MAU 1200 cfm with electric heater	1	sum	$ 35,000.00	$ 35,000
▪ replace kitchen hood and exhaust system	1	sum	$ 25,000.00	$ 25,000
C13 Heating, Ventilation, Air Conditioning Total	**21615**	**sf**	**$ 47.58**	**$ 1,028,500**
C14 Controls				
▪ building automated controls - connect to existing system	21615	sf	$ 7.00	$ 151,302
C14 Controls Total	**21615**	**sf**	**$ 7.00**	**$ 151,302**
ELECTRICAL				
C21 Services and Distribution				
▪ replace main entrance, 400A switchgear	1	sum	$ 25,000.00	$ 25,000
▪ new feeders	1	sum	$ 50,000.00	$ 50,000
▪ new panel, transformer for HVAC	1	sum	$ 20,000.00	$ 20,000
▪ new disconnects, mechanical connections	1	sum	$ 15,000.00	$ 15,000
C21 Services and Distribution Total	**21615**	**sf**	**$ 5.09**	**$ 110,000**
ANCILLARY WORK				
D22 Alterations				
▪ building addition for new mechanical equipment	500	sf	$ 750.00	$ 375,000
D22 Alterations	**21615**	**sf**	**$ 17.35**	**$ 375,000**
GENERAL REQUIREMENTS AND FEES				
Z11 General Requirements and Overheads				
▪ contractor's overheads			15.00%	$ 629,037

Element	Quantities		Unit Rates	Sub-totals
Z11 General Requirements and Overheads Total	**21615**	**sf**	**$ 29.10**	**$ 629,037**
Z12 Contractor's Profit				
▪ contractor's profit			10.00%	$ 482,262
Z12 Contractor's Profit Total	**21615**	**sf**	**$ 22.31**	**$ 482,262**
ALLOWANCES				
Z21 Design Allowance				
▪ design development contingency			10.00%	$ 530,488
Z21 Design Allowance Total	**21615**	**sf**	**$ 24.54**	**$ 530,488**
Z23 Construction Contingency				
▪ construction contingency			10.00%	$ 583,536
Z23 Construction Contingency	**21615**	**sf**	**$ 27.00**	**$ 583,536**

ELEMENTAL COST SUMMARY

PROJECT: RETROFIT 2285 NEW STREET
LOCATION: BURLINGTON, ONTARIO
CLIENT:
DESIGNER: RSI PROJECTS

Scenario 4 Net Zero

DATE: JULY 20, 2023
CLASS: D - FEASIBILITY
FILE 13441
GFA:sf 21615

GROSS FLOOR AREA 21615 sf

ELEMENT	RATIO TO GFA	ELEMENTAL QUANTITY		ELEMENTAL UNIT RATE	ELEMENTAL AMOUNT	RATE PER GFA	TOTAL AMOUNT	%
A SHELL						$ 93	$ 2,017,255	26.60
A1 SUBSTRUCTURE						$ -	$ -	0.00
A11 Foundations	1.000	21615	sf	$ -	$ -	$ -		0.00
A12 Basement Excavation	1.000	21615	sf	$ -	$ -	$ -		0.00
A2 STRUCTURE						$ -	$ -	0.00
A21 Lowest Floor Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A22 Upper Floor Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A23 Roof Construction	1.000	21615	sf	$ -	$ -	$ -		0.00
A3 EXTERIOR ENCLOSURE						$ 93	$ 2,017,255	26.60
A31 Walls Below Grade	0.069	1492	sf	$ 54.41	$ 81,183	$ 4		1.07
A32 Walls Above Grade	0.574	12415	sf	$ 68.00	$ 844,248	$ 39		11.13
A33 Windows and Entrances	0.069	1485	sf	$ 195.59	$ 290,408	$ 13		3.83
A34 Roof Coverings	1.000	21615	sf	$ 36.04	$ 778,897	$ 36		10.27
A35 Projections	0.013	281	sf	$ -	$ 22,519	$ 1		0.30
B INTERIORS						$ 5	$ 108,073	1.43
B1 PARTITIONS AND DOORS						$ -	$ -	0.00
B11 Partitions	1.000	21615	sf	$ -	$ -	$ -		0.00
B12 Doors	1.000	21615	sf	$ -	$ -	$ -		0.00
B2 INTERIOR FINISHES						$ 5	$ 108,073	1.43
B21 Floor Finishes	1.000	21615	sf	$ -	$ -	$ -		0.00
B22 Ceiling Finishes	1.000	21615	sf	$ 2.50	$ 54,037	$ 3		0.71
B23 Wall Finishes	1.000	21615	sf	$ 2.50	$ 54,037	$ 3		0.71
B3 FITTINGS AND EQUIPMENT						$ -	$ -	0.00
B31 Fittings and Fixtures	1.000	21615	sf	$ -	$ -	$ -		0.00
B32 Equipment	1.000	21615	sf	$ -	$ -	$ -		0.00
B33 Conveying Systems	1.000	21615	sf	$ -	$ -	$ -		0.00
SERVICES						$ 113	$ 2,453,251	32.35
C1 MECHANICAL						$ 56	$ 1,215,802	16.03
C11 Plumbing and Drainage	1.000	21615	sf	$ 1.67	$ 36,000	$ 2		0.47
C12 Fire Protection	1.000	21615	sf	$ -	$ -	$ -		0.00
C13 HVAC	1.000	21615	sf	$ 47.58	$ 1,028,500	$ 48		13.56
C14 Controls	1.000	21615	sf	$ 7.00	$ 151,302	$ 7		2.00
C2 ELECTRICAL						$ 57	$ 1,237,449	16.32
C21 Services and Distribution	1.000	21615	sf	$ 40.25	$ 870,000	$ 40		11.47
C22 Lighting, Devices and Heating	1.000	21615	sf	$ 17.00	$ 367,449	$ 17		4.85
C23 Systems and Ancillaries	1.000	21615	sf	$ -	$ -	$ -		0.00
NET BUILDING SUBTOTAL - LESS SITE						$ 212	$ 4,578,579	60.38
D SITE & ANCILLARY WORK						$ 17	$ 375,000	4.95
D1 SITEWORK						$ -	$ -	0.00
D11 Site Development	1.000	21615	sf	$ -	$ -	$ -		0.00
D12 Mechanical Site Services	1.000	21615	sf	$ -	$ -	$ -		0.00
D13 Electrical Site Services	1.000	21615	sf	$ -	$ -	$ -		0.00
D2 ANCILLARY WORK						$ 17	$ 375,000	4.95
D21 Demolition	1.000	21615	sf	$ -	$ -	$ -		0.00
D22 Alterations	0.023	500	sf	$ 750.00	$ 375,000	$ 17		4.95
NET BUILDING SUBTOTAL - INCLUDING SITE						$ 229	$ 4,953,579	65.32
Z GENERAL REQUIREMENTS AND ALLOWANCES						$ 122	$ 2,628,617	34.66
Z1 GENERAL REQUIREMENTS AND FEES						$ 61	$ 1,312,698	17.31
Z11 General Requirements and Overheads		15%			$ 743,037	$ 34		9.80
Z12 Contractors Profit		10%			$ 569,662	$ 26		7.51
Z2 ALLOWANCES						$ 61	$ 1,315,918	17.35
Z21 Design Allowance		10%			$ 626,628	$ 29		8.26
Z22 Escalation Allowance TBD		0%			$ -	$ -		0.00
Z23 Construction Allowance		10%			$ 689,290	$ 32		9.09
TOTAL CONSTRUCTION COST (HST EXTRA)				$351 per sf			$ 7,583,000	100.00

Element	Quantities		Unit Rates	Sub-totals
EXTERIOR ENCLOSURE				
A31 Walls Below Grade				
▪ remove concrete sidewalk and dispose	1404	sf	$ 3.00	$ 4,212
▪ remove asphalt paving and dispose	327	sf	$ 3.00	$ 982
▪ excavate to 2 feet below grade	165	cyd	$ 40.00	$ 6,616
▪ new 2" EPS fin insulation	1490	sf	$ 3.50	$ 5,215
▪ backfill to subgrade	165	cyd	$ 50.00	$ 8,270
▪ reinstate concrete sidewalks	1404	sf	$ 18.00	$ 25,269
▪ reinstate asphalt paving	327	sf	$ 15.00	$ 4,911
▪ reinstate landscaping	1561	sf	$ 5.00	$ 7,805
▪ new 4" EPS insulation to foundation walls	1492	sf	$ 7.00	$ 10,444
▪ cement board	1492	sf	$ 5.00	$ 7,460
A31 Walls Below Grade Total	**1492**	**sf**	**$ 54.41**	**$ 81,183**
A32 Walls Above Grade				
▪ remove existing brick/block/metal panel façade	12415	sf	$ 5.00	$ 62,077
▪ supply and install prefab insulated wall panels	12415	sf	$ 25.00	$ 310,385
▪ supply and install prefinished metal siding	12415	sf	$ 38.00	$ 471,786
A32 Walls Above Grade Total	**12415**	**sf**	**$ 68.00**	**$ 844,248**
A33 Windows and Entrances				
▪ replace aluminum sliding double door entrances	2	no	$ 20,000.00	$ 40,000
▪ replace insulated metal single exits	7	no	$ 3,800.00	$ 26,600
▪ replace windows with high performance triple pane aluminum windows including interior patching	1210	sf	$ 185.00	$ 223,808
A33 Windows and Entrances Total	**1485**	**sf**	**$ 195.59**	**$ 290,408**
A34 Roof Coverings				
▪ remove existing roof finish	21615	sf	$ 2.00	$ 43,229
▪ new mod bit roof finish with 8" EPS insulation	21615	sf	$ 32.00	$ 691,668
▪ allowance for removing, reinstalling mechanical	1	sum	$ 10,000.00	$ 10,000
▪ allowance to increase parapet height	680	lf	$ 50.00	$ 34,000
A34 Roof Coverings Total	**21615**	**sf**	**$ 36.04**	**$ 778,897**
A35 Projections				
▪ soffit replacement	281	sf	$ 80.00	$ 22,519
▪ canopies - no change	1	sum	$ -	$ -
A35 Projections Total	**281**	**sf**	**$ 80.00**	**$ 22,519**
FINISHES				
B22 Ceiling Finishes				
▪ cut and patch ceilings for new mechanical/electrical	21615	sf	$ 2.50	$ 54,037
B22 Ceiling Finishes Total	**21615**	**sf**	**$ 2.50**	**$ 54,037**
B23 Wall Finishes				

Element	Quantities		Unit Rates	Sub-totals
▪ cut and patch walls for new mechanical/electrical	21615	sf	$ 2.50	$ 54,037
B23 Wall Finishes Total	**21615**	**sf**	**$ 2.50**	**$ 54,037**
MECHANICAL				
C11 Plumbing and Drainage				
▪ new 80gal HP hot water tanks	4	no	$ 4,000.00	$ 16,000
▪ add insulation to internal RWLs and vent piping	1	sum	$ 20,000.00	$ 20,000
C11 Plumbing and Drainage Total	**21615**	**sf**	**$ 1.67**	**$ 36,000**
C13 Heating, Ventilation, Air Conditioning				
▪ geothermal wells, testing	5	no	$ 18,000.00	$ 90,000
▪ gshp piping, trenching, backfill, reinstatement	1	sum	$ 45,000.00	$ 45,000
▪ gshp circulation pumps, interior piping, HX	1	sum	$ 50,000.00	$ 50,000
▪ VRF condensing units - 8 tons	2	no	$ 35,000.00	$ 70,000
▪ VRF fancoils	19	no	$ 8,500.00	$ 161,500
▪ refrigerant piping, branch controllers	2000	lf	$ 100.00	$ 200,000
▪ VAVs	16	no	$ 3,000.00	$ 48,000
▪ ERV 1500cfm	1	no	$ 60,000.00	$ 60,000
▪ ERV 900cfm	1	no	$ 28,000.00	$ 28,000
▪ new ERV ductwork, EDH	12000	lbs	$ 18.00	$ 216,000
▪ replace kitchen MAU 1200 cfm with electric heater	1	sum	$ 35,000.00	$ 35,000
▪ replace kitchen hood and exhaust system	1	sum	$ 25,000.00	$ 25,000
C13 Heating, Ventilation, Air Conditioning Total	**21615**	**sf**	**$ 47.58**	**$ 1,028,500**
C14 Controls				
▪ building automated controls - connect to existing system	21615	sf	$ 7.00	$ 151,302
C14 Controls Total	**21615**	**sf**	**$ 7.00**	**$ 151,302**
ELECTRICAL				
C21 Services and Distribution				
▪ replace main entrance, 400A switchgear	1	sum	$ 25,000.00	$ 25,000
▪ new feeders	1	sum	$ 50,000.00	$ 50,000
▪ new panel, transformer for HVAC	1	sum	$ 20,000.00	$ 20,000
▪ new disconnects, mechanical connections	1	sum	$ 15,000.00	$ 15,000
▪ photovoltaic system complete with racking, inverters	190	kW	$ 4,000.00	$ 760,000
C21 Services and Distribution Total	**21615**	**sf**	**$ 40.25**	**$ 870,000**
ANCILLARY WORK				
D22 Alterations				
▪ building addition for new mechanical equipment	500	sf	$ 750.00	$ 375,000
D22 Alterations	**500**	**sf**	**$ 750.00**	**$ 375,000**
GENERAL REQUIREMENTS AND FEES				
Z11 General Requirements and Overheads				
▪ contractor's overheads			15.00%	$ 743,037

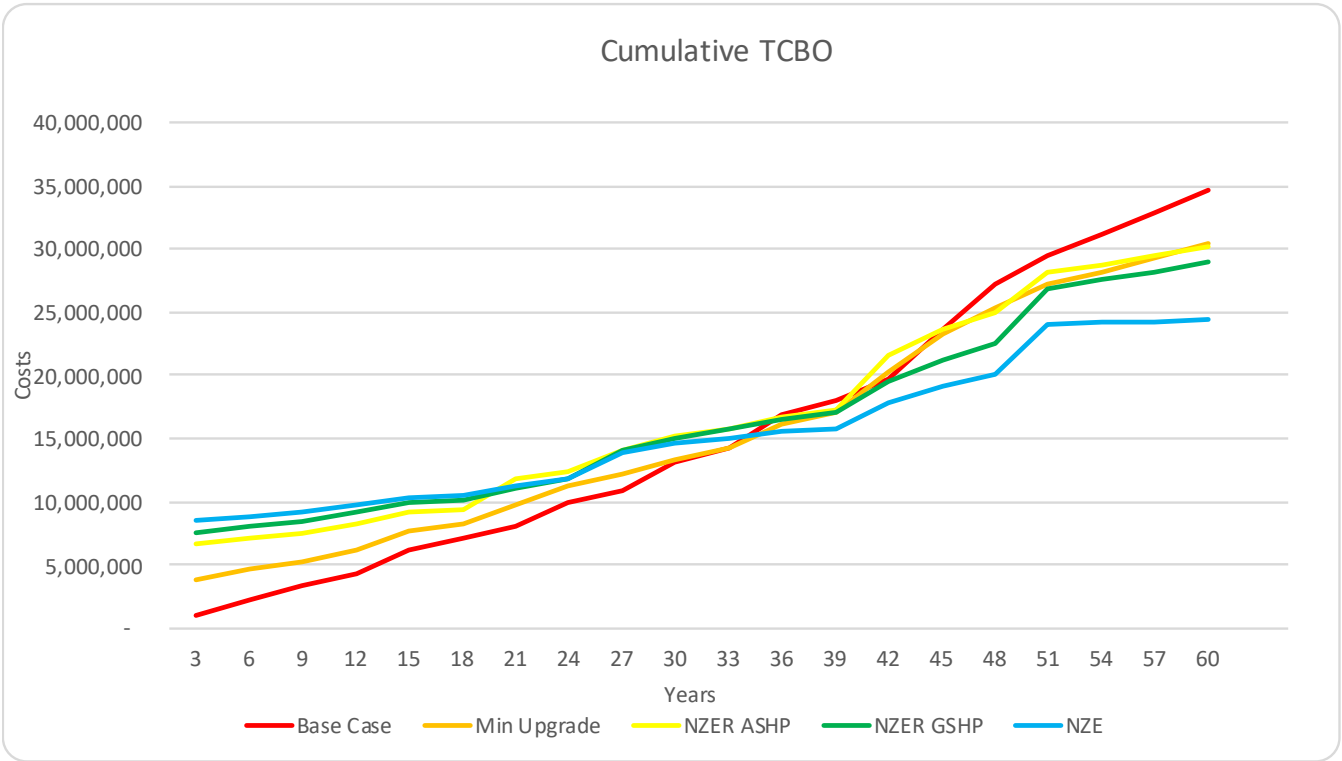
Element	Quantities		Unit Rates	Sub-totals
Z11 General Requirements and Overheads Total	**21615**	**sf**	**$ 34.38**	**$ 743,037**
Z12 Contractor's Profit				
▪ contractor's profit			10.00%	$ 569,662
Z12 Contractor's Profit Total	**21615**	**sf**	**$ 26.36**	**$ 569,662**
ALLOWANCES				
Z21 Design Allowance				
▪ design development contingency			10.00%	$ 626,628
Z21 Design Allowance Total	**21615**	**sf**	**$ 28.99**	**$ 626,628**
Z23 Construction Contingency				
▪ construction contingency			10.00%	$ 689,290
Z23 Construction Contingency	**21615**	**sf**	**$ 31.89**	**$ 689,290**

Appendix N

Total Cost of Building Ownership

ON Senior's Centre - Deep Retrofit

	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
GHG emissions (kg) (60 Years)	5,810,144	1,869,799	325,130	315,764	0
EUI (kWh/m2/year)	435.4	217.0	113.4	110.1	0.0
TCBO at 60 years	**$34,646,000**	**$30,430,000**	**$30,182,000**	**$28,977,000**	**$24,430,000**
TCBO Savings at 60 years	$0	$4,216,000	$4,464,000	$5,669,000	$10,216,000
60 Year TCBO savings compared to Base Case		**12%**	**13%**	**16%**	**29%**



Total Cost of Building Ownership (TCBO)

	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
GHG emissions (kg) (60 Years)	5,810,144	1,869,799	325,130	315,764	-
EUI (kWh/m2/year)	435	217	113	110	-
TCBO at 12 Years	$ 4,425,000	$ 6,177,000	$ 8,292,000	$ 9,154,000	$ 9,769,000
TCBO at 25 Years	$ 10,323,000	$ 11,684,000	$ 13,697,000	$ 13,824,000	$ 13,694,000
TCBO at 60 years	$ 34,646,000	$ 30,430,000	$ 30,182,000	$ 28,977,000	$ 24,430,000
TCBO Savings at 60 years		$ 4,216,000	$ 4,464,000	$ 5,669,000	$ 10,216,000
60 Year TCBO savings compared to Base Case		12%	13%	16%	29%
TCBO/Year/m2	$ 302	$ 265	$ 263	$ 253	$ 213
TCBO/Year/ft2	$ 28	$ 25	$ 24	$ 23	$ 20
60-Year TCBO/m2	$ 18,124	$ 15,919	$ 15,789	$ 15,159	$ 12,780
60-YearTCBO/ft2	$ 1,684	$ 1,479	$ 1,467	$ 1,409	$ 1,188
60 Year Energy Cost / m2	$ 7,141	$ 4,827	$ 3,330	$ 3,234	$ -

CAPITAL COST SUMMARY

	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
Initial Retrofit / HPB CostYear 1					
Initial Cost	$ 718,000	$ 3,630,000	$ 6,538,000	$ 7,418,000	$ 8,496,000
Difference from Base Case		$ 2,912,000	$ 5,820,000	$ 6,700,000	$ 7,778,000
% difference from Base Cost		$ 4	$ 8	$ 9	$ 11
Cost ($/ft2)	$ 35	$ 176	$ 318	$ 361	$ 413
Maintenance Capital Costs 60 Years					
Cost	$ 16,197,000	$ 15,488,000	$ 16,002,000	$ 14,121,000	$ 14,121,000
Difference from Base Case		$ (709,000)	$ (195,000)	$ (2,076,000)	$ (2,076,000)
% difference from Base Cost		$ (0)	$ (0)	$ (0)	$ (0)
Cost ($/ft2)	$ 787	$ 753	$ 778	$ 687	$ 687
Retrofit / HPB + Maintenance Capital Costs 60 Years					
Total Costs	$ 16,915,000	$ 19,118,000	$ 22,540,000	$ 21,539,000	$ 22,617,000
Difference from Base Case		$ 2,203,000	$ 5,625,000	$ 4,624,000	$ 5,702,000
% difference from Base Cost		13%	33%	27%	34%

OPERATING COST SUMMARY

	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
Utilities (including carbon tax)					
Cost	$ 16,927,000	$ 10,416,000	$ 6,735,000	$ 6,547,000	$ 198,000
Difference from Base Case		$ (6,511,000)	$ (10,192,000)	$ (10,380,000)	$ (16,729,000)
% difference from Base Case		-38%	-60%	-61%	-99%
Energy Cost ($/ft2)	$ 822.96	$ 506.41	$ 327.44	$ 318.30	$ 9.63
Maintenance					
Cost	$ 285,000	$ 378,000	$ 390,000	$ 372,000	$ 1,097,000
Difference from Base Case		$ 93,000	$ 105,000	$ 87,000	$ 812,000
% difference from Base Case		33%	37%	31%	285%
Maintenance Cost ($/ft2)	$ 13.86	$ 18.38	$ 18.96	$ 18.09	$ 53.33
Insurance & Taxes					
Costs	$ 518,000	$ 518,000	$ 518,000	$ 518,000	$ 518,000
Difference from Base Case		$ -	$ -	$ -	$ -
% difference from Base Case		0%	0%	0%	0%
First Year Annual Maintenance					
Cost	$ 2,450	$ 3,250	$ 3,350	$ 3,200	$ 9,428
Difference from Base Case		$ 800	$ 900	$ 750	$ 6,978
% difference from Base Case		33%	37%	31%	285%
First Year Maint. Cost ($/ft2)	$ 0.12	$ 0.16	$ 0.16	$ 0.16	$ 0.46

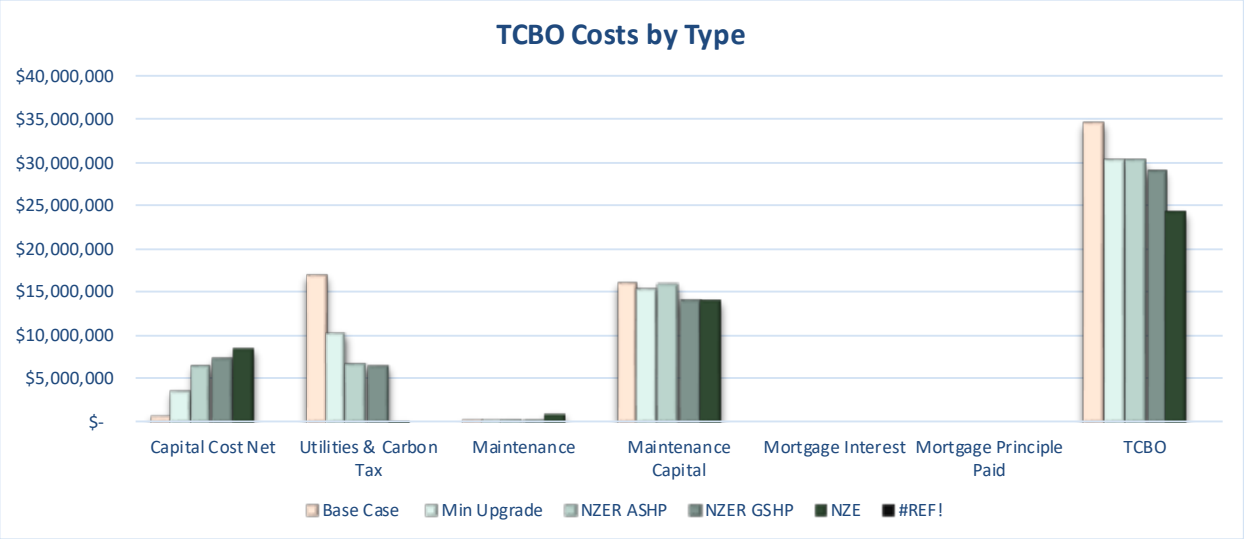
Annual Energy Consumption and GHG Emissions

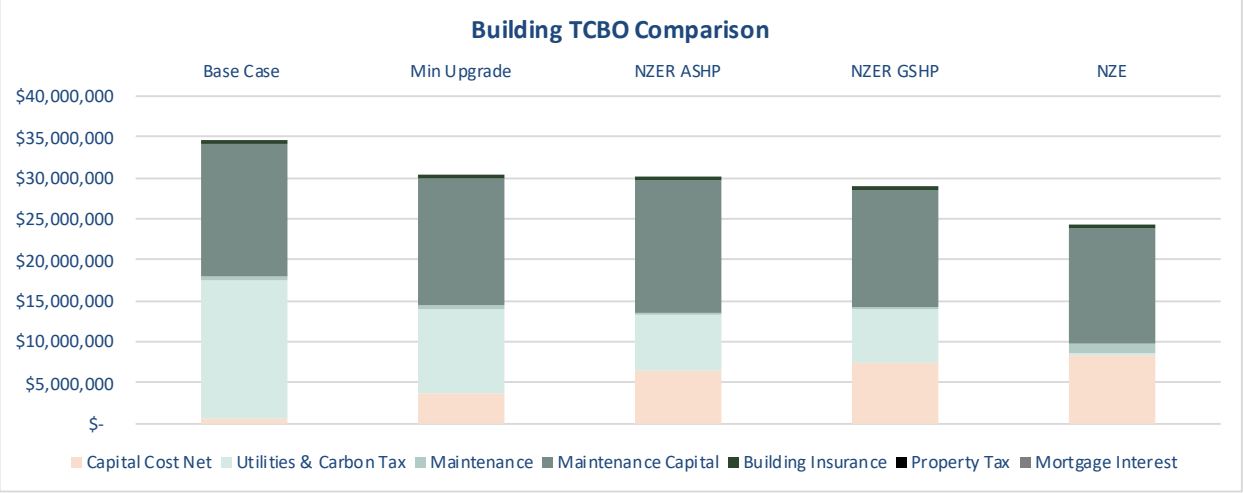
	Units	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
Annual Water Consumption	m3	300.00	300.00	300.00	300.00	300.00
Annual Sewer Discharge	m3	-	-	-	-	-
Annual Electric Consumption	kWh	354,452.86	284,017.00	216,753.00	210,509.00	210,509.00
Annual Gas Consumption	m3	46,245.00	12,649.00	-	-	-
Annual Heating Oil Consumption	Litres	-	-	-	-	-
GHG emissions	kg CO2 eq	96,835.73	31,163.31	5,418.83	5,262.73	-
Annual Solar PV generated	kWh	-	-	-	-	210,509.00
Total Annual Energy Consumption	ekWh	832,317.86	414,723.33	216,753.00	210,509.00	-
Total Annual Energy Consumption	GJ	2,996.34	1,493.00	780.31	757.83	-
EUI	kWh/m2/yr	435.41	216.96	113.39	110.12	-

60 Year Cost of Ownership Comparison

	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
Capital Cost	$ 718,330	$ 3,630,100	$ 6,537,753	$ 7,418,304	$ 8,495,882
Utility Subsidy	$ -	$ -	$ -	$ -	$ -
Capital Cost Net	$ 718,330	$ 3,630,100	$ 6,537,753	$ 7,418,304	$ 8,495,882
Utilities & Carbon Tax	$ 16,927,489	$ 10,415,918	$ 6,735,405	$ 6,547,082	$ 197,996
Maintenance	$ 285,015	$ 378,081	$ 389,714	$ 372,264	$ 1,096,783
Maintenance Capital	$ 16,196,806	$ 15,488,177	$ 16,001,543	$ 14,121,035	$ 14,121,035
Building Insurance	$ 517,924	$ 517,924	$ 517,924	$ 517,924	$ 517,924
Property Tax	$ -	$ -	$ -	$ -	$ -
Mortgage Interest	$ -	$ -	$ -	$ -	$ -
Mortgage Principle Paid	$ -	$ -	$ -	$ -	$ -
Mortgage Principal Received	$ -	$ -	$ -	$ -	$ -
TCBO	$ 34,645,565	$ 30,430,201	$ 30,182,340	$ 28,976,609	$ 24,429,619

	Cost as a Percentage of TCBO				
Capital Cost Net	2.1%	11.9%	21.7%	25.6%	34.8%
Utilities & Carbon Tax	48.9%	34.2%	22.3%	22.6%	0.8%
Maintenance	0.8%	1.2%	1.3%	1.3%	4.5%
Maintenance Capital	46.8%	50.9%	53.0%	48.7%	57.8%
Building Insurance	1.5%	1.7%	1.7%	1.8%	2.1%
Property Tax	0.0%	0.0%	0.0%	0.0%	0.0%
Mortgage Interest	0.0%	0.0%	0.0%	0.0%	0.0%
TCBO	100.0%	100.0%	100.0%	100.0%	100.0%





INPUTS : General

	Units	Base Case	Min Upgrade	NZER ASHP	NZER GSHP	NZE
Utility Costs						
Water						
unit water cost	$/m3	$ 2.75	$ 2.75	$ 2.75	$ 2.75	$ 2.75
annual water escalation rate	%	3.00%	3.00%	3.00%	3.00%	3.00%
include annual "Basic Charge Water" for active service, else 0	$/year	$ 389.00	$ 389.00	$ 389.00	$ 389.00	$ 389.00
"Basic Charge Water" escalation rate	%	3.00%	3.00%	3.00%	3.00%	3.00%
annual consumption	m3	300	300	300	300	300
refrofit reduction	%	0.00%				
Sewer						
unit sewer cost	$/m3					
annual sewer escalation rate	%	3.00%	3.00%	3.00%	3.00%	3.00%
include annual "Basic Charge Sewer" for active service, else 0	$/year					
"Basic Charge Sewer" escalation rate	%	3.00%	3.00%	3.00%	3.00%	3.00%
annual consumption	m3					
refrofit reduction	%	0.00%				
Electricity						
unit cost	$/kWh	$ 0.18	$ 0.18	$ 0.18	$ 0.18	$ 0.18
annual escalation rate	%	3.00%	3.00%	3.00%	3.00%	3.00%
include annual "Basic Charge" for active service, else 0	$/year					
"Basic Charge" escalation rate	%					
GHG emission factor	kg/kWh	0	0	0	0	0
Is Carbon Tax ADDED TO energy cost?	No = 0 or Yes = 1	1	1	1	1	1
annual consumption	kWh	354,453	284,017	216,753	210,509	210,509
refrofit reduction (only use this when TCPO calculation)	%	0.00%	0.00%	0.00%	0.00%	0.00%

Natural Gas							
unit cost	$/m3	$ 0.43	$ 0.43				
annual escalation rate	%	3.00%	3.00%	3.00%	3.00%	3.00%	
include annual "Basic Charge" for active service, else 0	$/year						
"Basic Charge" escalation rate	%						
GHG emission factor	kg/m3	2	2	2	2	2	
Is Carbon Tax ADDED TO energy cost?	No = 0 or Yes = 1	1	1				
annual consumption	m3	46,245	12,649				
refrofit reduction	%	0.00%					
No 2 Heating Oil							
unit cost	$/Litre						
annual escalation rate	%						
include annual "Basic Charge" for active service, else 0	$/year						
"Basic Charge" escalation rate	%						
GHG emission factor	kg/L	3	3	3	3	3	
Is Carbon Tax ADDED TO energy cost?	No = 0 or Yes = 1						
annual consumption	Litres						
refrofit reduction	%	0.00%					

GHG Emissions							
Carbon Tax escalation rate - after carbon tax finishes	%	4.00%	4.00%	4.00%	4.00%	4.00%	
Carbon Tax Year	**2020**	**2,030**	**2,040**	**2,050**	**2,060**	**2,070**	
GHG unit cost ($/tonne)	$ 30.00	$ 170.00	$ 251.64	$ 372.49	$ 551.38	$ 816.17	
Carbon Tax for Project Year	$ 80.00	$ 198.88	$ 294.38	$ 435.76	$ 645.03	$ 954.81	

Mortgage Financing of New Investment							
1st Year New Investment Capital Amount	$	No input here - See Value Tab Calculation					
Percent of 1st Year Capital Investment Financed with Mortgage	%						
Mortgage Financing of New Investment		No input here - See Value Tab Calculation					
Interest Rate	%						
Amortization in Years	#	25	25	25	25	25	
Start Date (yyyy-mm-dd)		2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	

Property Tax						
property tax lump sum OR	$					
property tax rate (% of building value) (e.g. .43%)	%					
property tax escalation rate	%	1.50%	1.50%	1.50%	1.50%	1.50%

Insurance							
property insurance annual cost lump sum OR	$	$ 4,541	$ 4,541	$ 4,541	$ 4,541	$ 4,541	
property insurance rate (% of building value) (e.g. .27%)	%						
property insurance escalation rate	%	2.00%	2.00%	2.00%	2.00%	2.00%	

Property Market Value Forecast by Decade:						
0-10 years	%	4.00%	4.00%	4.00%	4.00%	4.00%
11-20 years	%	4.00%	4.00%	4.00%	4.00%	4.00%
21-30 years	%	4.00%	4.00%	4.00%	4.00%	4.00%
31-40 years	%	4.00%	4.00%	4.00%	4.00%	4.00%
41-50 years	%	4.00%	4.00%	4.00%	4.00%	4.00%
51-60 years	%	4.00%	4.00%	4.00%	4.00%	4.00%

Market Value Inputs							
Project Type - Either Retrofit or New Build only	Input	Retrofit	Retrofit	Retrofit	Retrofit	Retrofit	
Current Building Value (normally existing building at current status (before new capital investment) or New Code Built Building). Include Comments on the source of Market Value Information.				Current Replacement Value: $ 351/ft2			
Market Value Base Case For Retrofits only (else Zero)	Input $	$ 7,226,560					
New Investment Project Cost - A thru F		No input here - See Value Tab Calculation					
New Investment over Current Market Value		No input here - See Value Tab Calculation					
Rate of Inclusion of New Investment for Mkt Val Calc.	Input %	75.0%	75.0%	75.0%	75.0%	75.0%	
Market Value Estimate Upon Completion of the Project		No input here - See Value Tab Calculation					
Net Present Value Rate (NPV) for Discounting Results		2.42%					
Annual Service Cost Escalation Rate		2.00%	2.00%	2.00%	2.00%	2.00%	
Annual Capital Cost Escalation Rate		2.00%	2.00%	2.00%	2.00%	2.00%	

Total Cost of Portfolio Ownership							
Is this a TCPO calculation	No = 0 or Yes = 1	-	-	-	-	-	
Year 1 Retrofit Capital Unit Cost	$/ft2	Base Case					
Year 1 Retrofit Capital Total Cost	$	See Value Tab					
Maintenance Capital Cost Reduction for Retrofit	%	0%					

Solar PV Array							
Array Unit Cost	$/kWdc					$	3,200
Array Size	kWdc		-	-	-		220
Total System Cost	$					$	704,000
System Annual Maintenance Cost (1)	$/kWdc/year					$	28.31
Total System Annual Maintenance Cost	$/year					$	6,228
Annual Solar Energy Output Degradation	%						0%
Unit cost of solar energy displacing utility energy	$/kWac	$ 0.1801	$ 0.1801	$ 0.1801	$ 0.1801	$	0.1801
Annual Solar Energy Produced, Displacing Utility Energy	kWh/year						210,509
Unit cost of solar energy generated back to the grid	$/kWhac						
Annual Solar Energy Generated Back to the Grid	kWh/year						

Input : Base Case

Line No.	Building Components Subject to M&R	Include in Option		Cost	Useful Life (years)	Current Age	Annual Service Cost	Annual Service Cost Escalation Rate	Annual Capital Cost Escalation Rate
	Units	0=no or 1=yes		$	Years	Years	$	2.00%	2.00%
1	Structural Slab on Grade - Non-Industrial 1979	0	$	6,754	75	44		2.00%	2.00%
1	Structural Slab on Grade - Non-Industrial 2007	0	$	3,019	75	16		2.00%	2.00%
2	Foundation Wall and Footings - No Basement 2007	0	$	7,483	75	16		2.00%	2.00%
3	Foundation Wall and Footings - No Basement 1979	0	$	11,011	75	44		2.00%	2.00%
4	Roof Top Ladders Qty 1	1	$	7,873	30	4		2.00%	2.00%
5	Single-Story - Steel 1979	0	$	11,492	75	44		2.00%	2.00%
6	Single-Story - Steel 2007	0	$	3,233	75	16		2.00%	2.00%
7	Brick Cavity Walls - CMU Backup 1979	0	$	10,554	75	44		2.00%	2.00%
8	Brick Cavity Walls - CMU Backup 2007	0	$	9,304	75	16		2.00%	2.00%
9	Metal Panel Features	1	$	8,725	60	16		2.00%	2.00%
10	Windows Aluminum Framed (all combined)	1	$	80,878	30	12		2.00%	2.00%
11	Exterior Door HM 3x7 - 1979 - Qty 7	1	$	10,221	30	30		2.00%	2.00%
12	Exterior Door HM 3x7 - 2007 - Qty 3	1	$	4,380	30	16		2.00%	2.00%
13	Door Assembly - Sliding - (all combined)	1	$	56,152	25	16		2.00%	2.00%
14	Skylights - Dome Type	1	$	6,206	30	4		2.00%	2.00%
15	Roof Hatch w interior access ladder and access hatch roof top protection system - Qty 1	1	$	14,193	40	4		2.00%	2.00%
16	Roof - Section 1.0 and 2.1 - SBS Modified Bitumen Roof - East Side 2011 Portion of Building	1	$	343,629	20	12	$ 1,000	2.00%	2.00%
17	Roof - Section 2.2 - Built-Up Roof - Original Building Roof - West Side of Site	1	$	91,029	17	16		2.00%	2.00%
18	Roof - Section 3.0 - Metal Roof Canopy - Front Entrances	1	$	20,768	40	16		2.00%	2.00%
19	Roof - Section 4 - Shingled Roof - Shed/Garbage Building Roof	1	$	7,540	20	5		2.00%	2.00%
20	GWB Drywall Walls - Standard	0	$	18,506	50	44		2.00%	2.00%
21	CMU Block Walls 2007	0	$	79,914	60	16		2.00%	2.00%
22	CMU Block Walls 1979	0	$	118,054	62	44		2.00%	2.00%
23	Folding Partition Wall 1 - OS - Indian Wells / Freeman Rooms	1	$	16,183	20	16		2.00%	2.00%
24	Folding Partitions (all combined)	1	$	99,075	20	9		2.00%	2.00%
25	Swinging Aluminum and Glass Doors Qty 2	1	$	14,268	30	16		2.00%	2.00%
26	Swinging Hollow Metal Doors - Qty 11	1	$	34,866	40	10		2.00%	2.00%
27	Swinging Wood Doors 2007 - Qty 13	1	$	25,950	40	16		2.00%	2.00%
28	Swinging Wood Doors 1979 - Qty 10	1	$	19,961	40	40		2.00%	2.00%
29	Automatic Door Operators - Washrooms - Qty 4,Gymansium 1	1	$	14,036	15	5		2.00%	2.00%
30	Automatic Door Operators - Qty 5 - Gymnasium, Washrooms	1	$	14,036	15	5		2.00%	2.00%
31	Roll Up Security Door - 8 x 4	1	$	10,722	40	16		2.00%	2.00%
32	Restroom - Complete	1	$	186,292	30	16		2.00%	2.00%
33	Ceramic Tile - washrooms (4)	1	$	16,272	30	16		2.00%	2.00%
34	Red Sound Accoustical Panels-Auditorium and behind Reception	1	$	16,938	30	16		2.00%	2.00%
35	Acoustical Baffling - Billard Area	1	$	8,045	20	20		2.00%	2.00%
36	Acoustical Baffling - Lounge Area	1	$	6,896	20	4		2.00%	2.00%
37	Carpeting - Billiards Area	1	$	8,105	12	2		2.00%	2.00%
38	Ceramic Tile - New Section Main Coordior and 4 Washrooms	1	$	66,077	30	16		2.00%	2.00%
39	Vinyl Sheet Floor - Multipurpose rooms (New Secton)	1	$	28,061	20	16		2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
BASE CASE	40	Rubber Flooring - Pulastic 5+2 - Auditorium & kitchen (all combined)	1	$ 113,435	20	10		2.00%	2.00%
	41	Vinyl Composite Tile - Community Rooms x 9	1	$ 13,841	20	16		2.00%	2.00%
	42	Ceramic (Quarry Style) Tile - Original Main Cooridor and office kitchenette	1	$ 49,140	45	44		2.00%	2.00%
	43	Painted / Sealed Concrete	1	$ 10,412	40	40		2.00%	2.00%
	44	Mondo Sport Rubber Floor - Dining Room (Lounge and Card Room)	1	$ 16,123	20	5		2.00%	2.00%
	45	Carpeting - Administrative/Customer Reception Area	1	$ 11,638	12	12		2.00%	2.00%
	46	Ceiling Tile System - Standard - 2007 - New Section Multipurpose Rm	1	$ 19,448	25	16		2.00%	2.00%
	47	GWB Finished Plaster Ceilings - 1979 Section	1	$ 54,625	40	40		2.00%	2.00%
	48	Wood Slat Board - part of ceiling finish near main entrance - replacement with different substratrate and strucutre	1	$ 10,262	42	42		2.00%	2.00%
	49	Ceiling Tile System - Enitre Site in Storage Rms. Offices Original Section of Site	1	$ 54,065	25	25		2.00%	2.00%
	50	Ceiling Tile System - Port Nelson and Wellington Room Original Section of Site	1	$ 8,128	25	4		2.00%	2.00%
	51	Painting - Complete Repaint of Entire Interior (all combined)	1	$ 35,956	10	10		2.00%	2.00%
	52	Emergency Eye Wash Stations - 2007	1	$ 2,189	20	16		2.00%	2.00%
	53	Custodial/Utility Sinks - Janitor Closet / Maintenence Room	1	$ 12,929	30	12		2.00%	2.00%
	54	Drinking Fountains - 2010	1	$ 5,380	20	13		2.00%	2.00%
	55	Tankless Water Heater - Gas Qty 1	1	$ 5,593	10	2	$ 100	2.00%	2.00%
	56	Hot Water Storage Tank - 80 Gallon	1	$ 3,514	13	12		2.00%	2.00%
	57	Domestic Water Piping Dist Complete	1	$ 48,891	50	44		2.00%	2.00%
	58	Back Flow Preventers - DCVA- 2"	1	$ 4,259	35	17	$ 50	2.00%	2.00%
	59	Sanitary Waste - Gravity Disch	1	$ 73,456	50	44		2.00%	2.00%
	60	Roof Drainage - Gravity - Average	1	$ 55,130	75	16		2.00%	2.00%
	61	Natural Gas Supply for Bldg - 1 1/2" Feed	1	$ 25,131	50	16		2.00%	2.00%
	62	HVAC Ductwork	1	$ 48,110	40	16		2.00%	2.00%
	63	Exhaust System - Restroom w/Roof Fan Qty 4	1	$ 4,430	20	17		2.00%	2.00%
	64	RTU #1 - Port Nelson/Wellington Room	1	$ 23,632	20	16	$ 200	2.00%	2.00%
	65	Eng Air Multizone Unit with 7 VAV box zones	1	$ 260,843	10	6	$ 300	2.00%	2.00%
	66	RTU 2,3,5,6 (all combined)	1	$ 102,956	20	16	$ 200	2.00%	2.00%
	67	Make Up Air 1 - Kitchen	1	$ 59,825	20	6		2.00%	2.00%
	68	Exhaust System - RTU - Kiln Room	1	$ 2,755	20	12		2.00%	2.00%
	69	Exhaust System - RTU - 2007 Expansion	1	$ 1,686	20	16		2.00%	2.00%
	70	Exhaust System - RTU - Commercial Kitchen	1	$ 7,711	20	16		2.00%	2.00%
	71	Building Automation System (BAS) - Software upgrade and System component renewals as needed	1	$ 29,011	10	10	$ 500	2.00%	2.00%
	72	Kitchen Hood Suppression	1	$ 10,142	20	20		2.00%	2.00%
	73	Main Electrical Service - Transformers	1	$ 15,488	50	16		2.00%	2.00%
	74	Main Electrical Service - 500A/480Y/277V	1	$ 31,253	45	44		2.00%	2.00%
	75	Distribution Equipment - Panelboards	1	$ 46,420	45	44		2.00%	2.00%
	76	Main Electrical Service - Transformers - 1979	1	$ 24,135	45	44		2.00%	2.00%
	77	Branch Wiring - Equipment & Devices	1	$ 71,761	50	16		2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes		Cost $	Useful Life (years) Years	Current Age Years		Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
78	Lighting Fixtures - 2x4 Interior Space Lighting LED	1	$	50,168	30	16			2.00%	2.00%
79	Exterior Lighting - Wall Pack LED 50 W	1	$	11,551	30	8			2.00%	2.00%
80	Lighting Fixtures - 2x2 Interior Space Lighting LED	1	$	16,723	30	16			2.00%	2.00%
81	Lighting Fixtures - Pot Lighting Common Areas Space Lighting LED	1	$	18,693	30	16			2.00%	2.00%
82	Lighting Fixtures - Globe Lighting Billards Lighting LED	1	$	61,317	40	24			2.00%	2.00%
83	Lighting Fixtures - 4ft Track Lighting in Lounge	1	$	1,461	30	16			2.00%	2.00%
84	Exterior Lighting Controls Panels	1	$	15,000	40	16			2.00%	2.00%
85	Lighting Fixtures - Interior -18- 2x2 Flat Panel LED - Indian Point and Freeman Room	1	$	4,876	30	4			2.00%	2.00%
86	Fire Alarm System - Panel Only	1	$	15,633	20	14			2.00%	2.00%
87	Fire Alarm - Devices Only	1	$	13,077	20	20			2.00%	2.00%
88	Security System - CCTV System - Entire System	1	$	31,285	10	10	$	100	2.00%	2.00%
89	Security System - Intrusion Alarm System	1	$	5,609	20	12			2.00%	2.00%
90	Security System - CCTV System - DVR only	1	$	8,757	7	5			2.00%	2.00%
91	Emergency Light Units	1	$	9,749	20	16			2.00%	2.00%
92	Commerical (Resturant) Kitchen Casework - Average	1	$	36,638	40	7			2.00%	2.00%
93	Kitchen Equipment - All equipment	1	$	36,308	30	23			2.00%	2.00%
94	Wayfinding Interior Signage	1	$	3,615	20	13			2.00%	2.00%
95	Kitchenette - Port Nelson and Wellington Rm and - Qty 2	1	$	12,108	20	4			2.00%	2.00%
96	Roller Window Shades	1	$	33,581	20	13			2.00%	2.00%
168		1							2.00%	2.00%
169	construction contingency for 2024 - 10%	1	$	-	61	0			2.00%	2.00%
170		1							2.00%	2.00%

Input : Min Upgrade

Line No.	Building Components Subject to M&R	Include in Option		Cost	Useful Life (years)	Current Age	Annual Service Cost	Annual Service Cost Escalation Rate	Annual Capital Cost Escalation Rate
	Units	0=no or 1=yes		$	Years	Years	$	2.00%	2.00%
1	Structural Slab on Grade - Non-	0	$	6,754	75	44		2.00%	2.00%
2	Structural Slab on Grade - Non-Industrial 2007	0	$	3,019	75	16		2.00%	2.00%
3	Foundation Wall and Footings - No Basement 2007	0	$	7,483	75	16		2.00%	2.00%
4	Foundation Wall and Footings - No Basement 1979	0	$	11,011	75	44		2.00%	2.00%
5	Roof Top Ladders Qty 1	1	$	7,873	30	4		2.00%	2.00%
6	Single-Story - Steel 1979	0	$	11,492	75	44		2.00%	2.00%
7	Single-Story - Steel 2007	0	$	3,233	75	16		2.00%	2.00%
8	Brick Cavity Walls - CMU Backup 1979	0	$	10,554	75	44		2.00%	2.00%
9	Brick Cavity Walls - CMU Backup 2007	0	$	9,304	75	16		2.00%	2.00%
10	Metal Panel Features	1	$	8,725	60	16		2.00%	2.00%
11	Windows Aluminum Framed (all combined)	1	$	80,878	30	12		2.00%	2.00%
12	Exterior Door HM 3x7 - 1979 - Qty 7	1	$	10,221	30	30		2.00%	2.00%
13	Exterior Door HM 3x7 - 2007 - Qty 3	1	$	4,380	30	16		2.00%	2.00%
14	Door Assembly - Sliding - (all combined)	1	$	56,152	25	16		2.00%	2.00%
15	Skylights - Dome Type	1	$	6,206	30	4		2.00%	2.00%
16	Roof Hatch w interior access ladder and access hatch roof top protection system - Qty 1	1	$	14,193	40	4		2.00%	2.00%
17	Roof - Section 1.0 and 2.1 - SBS Modified Bitumen Roof - East Side 2011 Portion of Building	0	$	343,629	20	12		2.00%	2.00%
18	Roof - Section 2.2 - Built-Up Roof - Original Building Roof - West Side of Site	0	$	91,029	17	16		2.00%	2.00%
19	Roof - Section 3.0 - Metal Roof Canopy - Front Entrances	1	$	20,768	40	16		2.00%	2.00%
20	Roof - Section 4 - Shingled Roof - Shed/Garbage Building Roof	0	$	7,540	20	5		2.00%	2.00%
21	GWB Drywall Walls - Standard	0	$	18,506	50	44		2.00%	2.00%
22	CMU Block Walls 2007	0	$	79,914	60	16		2.00%	2.00%
23	CMU Block Walls 1979	0	$	118,054	62	44		2.00%	2.00%
24	Folding Partition Wall 1 - OS - Indian Wells / Freeman Rooms	1	$	16,183	20	16		2.00%	2.00%
25	Folding Partitions (all combined)	1	$	99,075	20	9		2.00%	2.00%
26	Swinging Aluminum and Glass Doors Qty 2	1	$	14,268	30	16		2.00%	2.00%
27	Swinging Hollow Metal Doors - Qty 11	1	$	34,866	40	10		2.00%	2.00%
28	Swinging Wood Doors 2007 - Qty 13	1	$	25,950	40	16		2.00%	2.00%
29	Swinging Wood Doors 1979 - Qty 10	1	$	19,961	40	40		2.00%	2.00%
30	Automatic Door Operators - Washrooms - Qty 4,Gymansium 1	1	$	14,036	15	5		2.00%	2.00%
31	Automatic Door Operators - Qty 5 - Gymnasium, Washrooms	1	$	14,036	15	5		2.00%	2.00%
32	Roll Up Security Door - 8 x 4	1	$	10,722	40	16		2.00%	2.00%
33	Restroom - Complete	1	$	186,292	30	16		2.00%	2.00%
34	Ceramic Tile - washrooms (4)	1	$	16,272	30	16		2.00%	2.00%
35	Red Sound Accoustical Panels-Auditorium and behind Reception	1	$	16,938	30	16		2.00%	2.00%
36	Acoustical Baffling - Billard Area	1	$	8,045	20	20		2.00%	2.00%
37	Acoustical Baffling - Lounge Area	1	$	6,896	20	4		2.00%	2.00%
38	Carpeting - Billiards Area	1	$	8,105	12	2		2.00%	2.00%
39	Ceramic Tile - New Section Main	1	$	66,077	30	16		2.00%	2.00%
40	Vinyl Sheet Floor - Multipurpose rooms (New Secton)	1	$	28,061	20	16		2.00%	2.00%
41	Rubber Flooring - Pulastic 5+2 - Auditorium & kitchen (all combined)	1	$	113,435	20	10		2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
BASE CASE	42	Vinyl Composite Tile - Community	1	$ 13,841	20	16		2.00%	2.00%
	43	Ceramic (Quarry Style) Tile - Original Main Cooridor and office kitchenette	1	$ 49,140	45	44		2.00%	2.00%
	44	Painted / Sealed Concrete	1	$ 10,412	40	40		2.00%	2.00%
	45	Mondo Sport Rubber Floor - Dining Room (Lounge and Card Room)	1	$ 16,123	20	5		2.00%	2.00%
	46	Carpeting - Administrative/Customer Reception Area	1	$ 11,638	12	12		2.00%	2.00%
	47	Ceiling Tile System - Standard - 2007 - New Section Multipurpose Rm	1	$ 19,448	25	16		2.00%	2.00%
	48	GWB Finished Plaster Ceilings - 1979 Section	1	$ 54,625	40	40		2.00%	2.00%
	49	Wood Slat Board - part of ceiling finish near main entrance - replacement with different substratrate and strucutre	1	$ 10,262	42	42		2.00%	2.00%
	50	Ceiling Tile System - Enitre Site in Storage Rms. Offices Original Section of Site	1	$ 54,065	25	25		2.00%	2.00%
	51	Ceiling Tile System - Port Nelson and Wellington Room Original Section of Site	1	$ 8,128	25	4		2.00%	2.00%
	52	Painting - Complete Repaint of Entire Interior (all combined)	1	$ 35,956	10	10		2.00%	2.00%
	53	Emergency Eye Wash Stations - 2007	1	$ 2,189	20	16		2.00%	2.00%
	54	Custodial/Utility Sinks - Janitor Closet / Maintenence Room	1	$ 12,929	30	12		2.00%	2.00%
	55	Drinking Fountains - 2010	1	$ 5,380	20	13		2.00%	2.00%
	56	Tankless Water Heater - Gas Qty 1	1	$ 5,593	10	2		2.00%	2.00%
	57	Hot Water Storage Tank - 80 Gallon	1	$ 3,514	13	12		2.00%	2.00%
	58	Domestic Water Piping Dist Complete	1	$ 48,891	50	44		2.00%	2.00%
	59	Back Flow Preventers - DCVA- 2"	1	$ 4,259	35	17	$ 50	2.00%	2.00%
	60	Sanitary Waste - Gravity Disch	1	$ 73,456	50	44		2.00%	2.00%
	61	Roof Drainage - Gravity - Average	1	$ 55,130	75	16		2.00%	2.00%
	62	Natural Gas Supply for Bldg - 1 1/2" Feed	1	$ 25,131	50	16		2.00%	2.00%
	63	HVAC Ductwork	1	$ 48,110	40	16		2.00%	2.00%
	64	Exhaust System - Restroom w/Roof Fan Qty 4	1	$ 4,430	20	17		2.00%	2.00%
	65	RTU #1 - Port Nelson/Wellington Room	1	$ 23,632	20	16	$ 200	2.00%	2.00%
	66	Eng Air Multizone Unit with 7 VAV box zones	1	$ 260,843	10	6	$ 300	2.00%	2.00%
	67	RTU 2,3,5,6 (all combined)	0	$ 102,956	20	16	$ 200	2.00%	2.00%
	68	Make Up Air 1 - Kitchen	1	$ 59,825	20	6		2.00%	2.00%
	69	Exhaust System - RTU - Kiln Room	1	$ 2,755	20	12		2.00%	2.00%
	70	Exhaust System - RTU - 2007 Expansion	1	$ 1,686	20	16		2.00%	2.00%
	71	Exhaust System - RTU - Commercial Kitchen	1	$ 7,711	20	16		2.00%	2.00%
	72	Building Automation System (BAS) - Software upgrade and System component renewals as needed	1	$ 29,011	10	10	$ 500	2.00%	2.00%
	73	Kitchen Hood Suppression	1	$ 10,142	20	20		2.00%	2.00%
	74	Main Electrical Service - Transformers	1	$ 15,488	50	16		2.00%	2.00%
	75	Main Electrical Service - 500A/480Y/277V	1	$ 31,253	45	44		2.00%	2.00%
	76	Distribution Equipment - Panelboards	1	$ 46,420	45	44		2.00%	2.00%
	77	Main Electrical Service - Transformers - 1979	1	$ 24,135	45	44		2.00%	2.00%
	78	Branch Wiring - Equipment & Devices	1	$ 71,761	50	16		2.00%	2.00%
	79	Lighting Fixtures - 2x4 Interior Space Lighting LED	0	$ 50,168	30	16		2.00%	2.00%
	80	Exterior Lighting - Wall Pack LED 50 W	0	$ 11,551	30	8		2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
	81	Lighting Fixtures - 2x2 Interior Space Lighting LED	0	$ 16,723	30	16		2.00%	2.00%
	82	Lighting Fixtures - Pot Lighting Common Areas Space Lighting LED	0	$ 18,693	30	16		2.00%	2.00%
	83	Lighting Fixtures - Globe Lighting Billards Lighting LED	0	$ 61,317	40	24		2.00%	2.00%
	84	Lighting Fixtures - 4ft Track Lighting in Lounge	0	$ 1,461	30	16		2.00%	2.00%
	85	Exterior Lighting Controls Panels	0	$ 15,000	40	16		2.00%	2.00%
	86	Lighting Fixtures - Interior -18- 2x2 Flat Panel LED - Indian Point and Freeman Room	1	$ 4,876	30	4		2.00%	2.00%
	87	Fire Alarm System - Panel Only	1	$ 15,633	20	14		2.00%	2.00%
	88	Fire Alarm - Devices Only	1	$ 13,077	20	20		2.00%	2.00%
	89	Security System - CCTV System - Entire System	1	$ 31,285	10	10	$ 100	2.00%	2.00%
	90	Security System - Intrusion Alarm System	1	$ 5,609	20	12		2.00%	2.00%
	91	Security System - CCTV System - DVR only	1	$ 8,757	7	5		2.00%	2.00%
	92	Emergency Light Units	1	$ 9,749	20	16		2.00%	2.00%
	93	Commerical (Resturant) Kitchen Casework - Average	1	$ 36,638	40	7		2.00%	2.00%
	94	Kitchen Equipment - All equipment	1	$ 36,308	30	23		2.00%	2.00%
	95	Wayfinding Interior Signage	1	$ 3,615	20	13		2.00%	2.00%
	96	Kitchenette - Port Nelson and Wellington Rm and - Qty 2	1	$ 12,108	20	4		2.00%	2.00%
	97	Roller Window Shades	1	$ 33,581	20	13		2.00%	2.00%
RETROFIT	111	A32 Walls Above Grade	1					2.00%	2.00%
RETROFIT	112	▪ remove existing brick/block/metal panel façade	1	$ 62,077	61	0		2.00%	2.00%
RETROFIT	113	▪ supply and install prefab insulated wall panels	1	$ 310,385	61	0		2.00%	2.00%
RETROFIT	114	▪ supply and install prefinished metal siding	1	$ 471,786	61	0		2.00%	2.00%
RETROFIT	115	A33 Windows and Entrances	1					2.00%	2.00%
RETROFIT	116	▪ replace aluminum sliding double door entrances	1	$ 40,000	25	0	$ 500	2.00%	2.00%
RETROFIT	117	▪ replace insulated metal single exits	1	$ 26,600	25	0		2.00%	2.00%
RETROFIT	118	replace windows with high performance triple pane aluminum windows including interior patching	1	$ 223,808	40	0		2.00%	2.00%
RETROFIT	119	A34 Roof Coverings	1					2.00%	2.00%
RETROFIT	120	▪ remove existing roof finish	1	$ 43,229	61	0		2.00%	2.00%
RETROFIT	121	▪ new mod bit roof finish with 4" EPS insulation	1	$ 605,209	20	0	$ 1,000	2.00%	2.00%
RETROFIT	122	▪ allowance for removing, reinstalling mechanical	1	$ 40,000	61	0		2.00%	2.00%
RETROFIT	123		1					2.00%	2.00%
RETROFIT	124	A35 Projections	1					2.00%	2.00%
RETROFIT	125	▪ soffit replacement	1	$ 22,519	61	0		2.00%	2.00%
RETROFIT	126	▪ canopies - no change	1					2.00%	2.00%
RETROFIT	128		1					2.00%	2.00%
RETROFIT	136	C13 Heating, Ventilation, Air Conditioning	1					2.00%	2.00%
RETROFIT	137	▪ upgrade CAV rooftop units with VFD, controllers	1	$ 60,000	20	0	$ 200	2.00%	2.00%
RETROFIT	148		1					2.00%	2.00%
RETROFIT	149	C14 Controls	1					2.00%	2.00%
RETROFIT	150	▪ building automated controls - connect to existing system	1	$ 5,000	20	0	$ 200	2.00%	2.00%
RETROFIT	152		1					2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
157	C22 Lighting, devices and heating	1					2.00%	2.00%
158	▪ install LED retrofit kits to all existing lights	1	$ 43,229	15	0		2.00%	2.00%
160		1					2.00%	2.00%
161	GENERAL REQUIREMENTS AND FEES Z11 General Requirements and Overheads	1					2.00%	2.00%
162	▪ contractor's overheads	1	$ 249,515	61	0		2.00%	2.00%
163	Z12 Contractor's Profit	1					2.00%	2.00%
164	▪ contractor's profit	1	$ 191,295	61	0		2.00%	2.00%
165	ALLOWANCES	1					2.00%	2.00%
166	Z21 Design Allowance	1					2.00%	2.00%
167	▪ design development contingency	1	$ 210,425	61	0		2.00%	2.00%
168	Z23 Construction Contingency	1					2.00%	2.00%
169	▪ construction contingency	1	$ 231,467	61	0		2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ 195,384	61	0		2.00%	2.00%

Input : NZER ASHP

Line No.	Building Components Subject to M&R	Include in Option		Cost	Useful Life (years)	Current Age	Annual Service Cost	Annual Service Cost Escalation Rate	Annual Capital Cost Escalation Rate
	Units	0=no or 1=yes		$	Years	Years	$	2.00%	2.00%
1	Structural Slab on Grade - Non-Industrial 1979	0	$	6,754	75	44		2.00%	2.00%
2	Structural Slab on Grade - Non-Industrial 2007	0	$	3,019	75	16		2.00%	2.00%
3	Foundation Wall and Footings - No Basement 2007	0	$	7,483	75	16		2.00%	2.00%
4	Foundation Wall and Footings - No Basement 1979	0	$	11,011	75	44		2.00%	2.00%
5	Roof Top Ladders Qty 1	1	$	7,873	30	4		2.00%	2.00%
6	Single-Story - Steel 1979	0	$	11,492	75	44		2.00%	2.00%
7	Single-Story - Steel 2007	0	$	3,233	75	16		2.00%	2.00%
8	Brick Cavity Walls - CMU Backup 1979	0	$	10,554	75	44		2.00%	2.00%
9	Brick Cavity Walls - CMU Backup 2007	0	$	9,304	75	16		2.00%	2.00%
10	Metal Panel Features	0	$	8,725	60	16		2.00%	2.00%
11	Windows Aluminum Framed (all combined)	0	$	80,878	30	12		2.00%	2.00%
12	Exterior Door HM 3x7 - 1979 - Qty 7	0	$	10,221	30	30		2.00%	2.00%
13	Exterior Door HM 3x7 - 2007 - Qty 3	0	$	4,380	30	16		2.00%	2.00%
14	Door Assembly - Sliding - (all combined)	0	$	56,152	25	16		2.00%	2.00%
15	Skylights - Dome Type	0	$	6,206	30	4		2.00%	2.00%
16	Roof Hatch w interior access ladder and access hatch roof top protection system - Qty 1	1	$	14,193	40	4		2.00%	2.00%
17	Roof - Section 1.0 and 2.1 - SBS Modified Bitumen Roof - East Side 2011 Portion of Building	0	$	343,629	20	12		2.00%	2.00%
18	Roof - Section 2.2 - Built-Up Roof - Original Building Roof - West Side of Site	0	$	91,029	17	16		2.00%	2.00%
19	Roof - Section 3.0 - Metal Roof Canopy - Front Entrances	0	$	20,768	40	16		2.00%	2.00%
20	Roof - Section 4 - Shingled Roof - Shed/Garbage Building Roof	0	$	7,540	20	5		2.00%	2.00%
21	GWB Drywall Walls - Standard	0	$	18,506	50	44		2.00%	2.00%
22	CMU Block Walls 2007	0	$	79,914	60	16		2.00%	2.00%
23	CMU Block Walls 1979	0	$	118,054	62	44		2.00%	2.00%
24	Folding Partition Wall 1 - OS - Indian Wells / Freeman Rooms	1	$	16,183	20	16		2.00%	2.00%
25	Folding Partitions (all combined)	1	$	99,075	20	9		2.00%	2.00%
26	Swinging Aluminum and Glass Doors Qty 2	1	$	14,268	30	16		2.00%	2.00%
27	Swinging Hollow Metal Doors - Qty 11	1	$	34,866	40	10		2.00%	2.00%
28	Swinging Wood Doors 2007 - Qty 13	1	$	25,950	40	16		2.00%	2.00%
29	Swinging Wood Doors 1979 - Qty 10	1	$	19,961	40	40		2.00%	2.00%
30	Automatic Door Operators - Washrooms - Qty 4,Gymansium 1	1	$	14,036	15	5		2.00%	2.00%
31	Automatic Door Operators - Qty 5 - Gymnasium, Washrooms	1	$	14,036	15	5		2.00%	2.00%
32	Roll Up Security Door - 8 x 4	1	$	10,722	40	16		2.00%	2.00%
33	Restroom - Complete	1	$	186,292	30	16		2.00%	2.00%
34	Ceramic Tile - washrooms (4)	1	$	16,272	30	16		2.00%	2.00%
35	Red Sound Accoustical Panels-Auditorium and behind Reception	1	$	16,938	30	16		2.00%	2.00%
36	Acoustical Baffling - Billard Area	1	$	8,045	20	20		2.00%	2.00%
37	Acoustical Baffling - Lounge Area	1	$	6,896	20	4		2.00%	2.00%
38	Carpeting - Billiards Area	1	$	8,105	12	2		2.00%	2.00%
39	Ceramic Tile - New Section Main Coordior and 4 Washrooms	1	$	66,077	30	16		2.00%	2.00%
40	Vinyl Sheet Floor - Multipurpose rooms (New Secton)	1	$	28,061	20	16		2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
BASE CASE	41	Rubber Flooring - Pulastic 5+2 - Auditorium & kitchen (all combined)	1	$ 113,435	20	10		2.00%	2.00%
	42	Vinyl Composite Tile - Community Rooms x 9	1	$ 13,841	20	16		2.00%	2.00%
	43	Ceramic (Quarry Style) Tile - Original Main Cooridor and office kitchenette	1	$ 49,140	45	44		2.00%	2.00%
	44	Painted / Sealed Concrete	1	$ 10,412	40	40		2.00%	2.00%
	45	Mondo Sport Rubber Floor - Dining Room (Lounge and Card Room)	1	$ 16,123	20	5		2.00%	2.00%
	46	Carpeting - Administrative/Customer Reception Area	1	$ 11,638	12	12		2.00%	2.00%
	47	Ceiling Tile System - Standard - 2007 - New Section Multipurpose Rm	1	$ 19,448	25	16		2.00%	2.00%
	48	GWB Finished Plaster Ceilings - 1979 Section	1	$ 54,625	40	40		2.00%	2.00%
	49	Wood Slat Board - part of ceiling finish near main entrance - replacement with different substratrate and strucutre	1	$ 10,262	42	42		2.00%	2.00%
	50	Ceiling Tile System - Enitre Site in Storage Rms. Offices Original Section of Site	1	$ 54,065	25	25		2.00%	2.00%
	51	Ceiling Tile System - Port Nelson and Wellington Room Original Section of Site	1	$ 8,128	25	4		2.00%	2.00%
	52	Painting - Complete Repaint of Entire Interior (all combined)	1	$ 35,956	10	10		2.00%	2.00%
	53	Emergency Eye Wash Stations - 2007	1	$ 2,189	20	16		2.00%	2.00%
	54	Custodial/Utility Sinks - Janitor Closet / Maintenence Room	1	$ 12,929	30	12		2.00%	2.00%
	55	Drinking Fountains - 2010	1	$ 5,380	20	13		2.00%	2.00%
	56	Tankless Water Heater - Gas Qty 1	0	$ 5,593	10	2		2.00%	2.00%
	57	Hot Water Storage Tank - 80 Gallon	0	$ 3,514	13	12		2.00%	2.00%
	58	Domestic Water Piping Dist Complete	1	$ 48,891	50	44		2.00%	2.00%
	59	Back Flow Preventers - DCVA- 2"	1	$ 4,259	35	17	$ 50	2.00%	2.00%
	60	Sanitary Waste - Gravity Disch	1	$ 73,456	50	44		2.00%	2.00%
	61	Roof Drainage - Gravity - Average	1	$ 55,130	75	16		2.00%	2.00%
	62	Natural Gas Supply for Bldg - 1 1/2" Feed	0	$ 25,131	50	16		2.00%	2.00%
	63	HVAC Ductwork	1	$ 48,110	40	16		2.00%	2.00%
	64	Exhaust System - Restroom w/Roof Fan Qty 4	0	$ 4,430	20	17		2.00%	2.00%
	65	RTU #1 - Port Nelson/Wellington Room	0	$ 23,632	20	16		2.00%	2.00%
	66	Eng Air Multizone Unit with 7 VAV box zones	0	$ 260,843	10	6		2.00%	2.00%
	67	RTU 2,3,5,6 (all combined)	0	$ 102,956	20	16		2.00%	2.00%
	68	Make Up Air 1 - Kitchen	0	$ 59,825	20	6		2.00%	2.00%
	69	Exhaust System - RTU - Kiln Room	0	$ 2,755	20	12		2.00%	2.00%
	70	Exhaust System - RTU - 2007 Expansion	0	$ 1,686	20	16		2.00%	2.00%
	71	Exhaust System - RTU - Commercial Kitchen	0	$ 7,711	20	16		2.00%	2.00%
	72	Building Automation System (BAS) - Software upgrade and System component renewals as needed	1	$ 29,011	10	10		2.00%	2.00%
	73	Kitchen Hood Suppression	1	$ 10,142	20	20		2.00%	2.00%
	74	Main Electrical Service - Transformers	1	$ 15,488	50	16		2.00%	2.00%
	75	Main Electrical Service - 500A/480Y/277V	1	$ 31,253	45	44		2.00%	2.00%
	76	Distribution Equipment - Panelboards	1	$ 46,420	45	44		2.00%	2.00%
	77	Main Electrical Service - Transformers - 1979	1	$ 24,135	45	44		2.00%	2.00%
	78	Branch Wiring - Equipment & Devices	1	$ 71,761	50	16		2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
79	Lighting Fixtures - 2x4 Interior Space Lighting LED	0	$ 50,168	30	16		2.00%	2.00%
80	Exterior Lighting - Wall Pack LED 50 W	0	$ 11,551	30	8		2.00%	2.00%
81	Lighting Fixtures - 2x2 Interior Space Lighting LED	0	$ 16,723	30	16		2.00%	2.00%
82	Lighting Fixtures - Pot Lighting Common Areas Space Lighting LED	0	$ 18,693	30	16		2.00%	2.00%
83	Lighting Fixtures - Globe Lighting Billards Lighting LED	0	$ 61,317	40	24		2.00%	2.00%
84	Lighting Fixtures - 4ft Track Lighting in Lounge	0	$ 1,461	30	16		2.00%	2.00%
85	Exterior Lighting Controls Panels	0	$ 15,000	40	16		2.00%	2.00%
86	Lighting Fixtures - Interior -18- 2x2 Flat Panel LED - Indian Point and Freeman Room	0	$ 4,876	30	4		2.00%	2.00%
87	Fire Alarm System - Panel Only	1	$ 15,633	20	14		2.00%	2.00%
88	Fire Alarm - Devices Only	1	$ 13,077	20	20		2.00%	2.00%
89	Security System - CCTV System - Entire System	1	$ 31,285	10	10	$ 100	2.00%	2.00%
90	Security System - Intrusion Alarm System	1	$ 5,609	20	12		2.00%	2.00%
91	Security System - CCTV System - DVR only	1	$ 8,757	7	5		2.00%	2.00%
92	Emergency Light Units	1	$ 9,749	20	16		2.00%	2.00%
93	Commerical (Resturant) Kitchen Casework - Average	1	$ 36,638	40	7		2.00%	2.00%
94	Kitchen Equipment - All equipment	1	$ 36,308	30	23		2.00%	2.00%
95	Wayfinding Interior Signage	1	$ 3,615	20	13		2.00%	2.00%
96	Kitchenette - Port Nelson and Wellington Rm and - Qty 2	1	$ 12,108	20	4		2.00%	2.00%
97	Roller Window Shades	1	$ 33,581	20	13		2.00%	2.00%
98		1					2.00%	2.00%
99		1					2.00%	2.00%
100	A31 Walls Below Grade	1					2.00%	2.00%
101	▪ remove concrete sidewalk and dispose	1	$ 4,212	61	0		2.00%	2.00%
102	▪ remove asphalt paving and dispose	1	$ 982	61	0		2.00%	2.00%
103	▪ excavate to 2 feet below grade	1	$ 6,616	61	0		2.00%	2.00%
104	▪ new 2" EPS fin insulation	1	$ 5,215	61	0		2.00%	2.00%
105	▪ backfill to subgrade	1	$ 8,270	61	0		2.00%	2.00%
106	▪ reinstate concrete sidewalks	1	$ 25,269	61	0		2.00%	2.00%
107	▪ reinstate asphalt paving	1	$ 4,911	61	0		2.00%	2.00%
108	▪ reinstate landscaping	1	$ 7,805	61	0		2.00%	2.00%
109	▪ new 4" EPS insulation to foundation walls	1	$ 10,444	61	0		2.00%	2.00%
110	▪ cement board	1	$ 7,460	61	0		2.00%	2.00%
111	A32 Walls Above Grade	1			0		2.00%	2.00%
112	▪ remove existing brick/block/metal panel façade	1	$ 62,077	61	0		2.00%	2.00%
113	▪ supply and install prefab insulated wall panels	1	$ 310,385	61	0		2.00%	2.00%
114	▪ supply and install prefinished metal siding	1	$ 471,786	61	0		2.00%	2.00%
115	A33 Windows and Entrances	1			0		2.00%	2.00%
116	▪ replace aluminum sliding double door entrances	1	$ 40,000	25	0	$ 500	2.00%	2.00%
117	▪ replace insulated metal single exits	1	$ 26,600	25	0		2.00%	2.00%
118	replace windows with high performance triple pane aluminum windows including interior patching	1	$ 223,808	40	0		2.00%	2.00%
119	A34 Roof Coverings	1			0		2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
RETROFIT	120	■ remove existing roof finish	1	$ 43,229	61	0		2.00%	2.00%
	121	■ new mod bit roof finish with 8" EPS insulation	1	$ 691,668	20	0	$ 1,000	2.00%	2.00%
	122	■ allowance for removing, reinstalling mechanical	1	$ 10,000	61	0		2.00%	2.00%
	123	■ allowance to increase parapet height	1	$ 34,000	61	0		2.00%	2.00%
	124	A35 Projections	1					2.00%	2.00%
	125	■ soffit replacement	1	$ 22,519	61	0		2.00%	2.00%
	126	■ canopies - no change	1					2.00%	2.00%
	127	FINISHES	1					2.00%	2.00%
	128	B22 Ceiling Finishes	1					2.00%	2.00%
	129	■ cut and patch ceilings for new mechanical/electrical	1	$ 54,037		0		2.00%	2.00%
	130	B23 Wall Finishes Total	1					2.00%	2.00%
	131	■ cut and patch wall finishes	1	$ 54,037	61	0		2.00%	2.00%
	132	MECHANICAL	1					2.00%	2.00%
	133	C11 Plumbing and Drainage	1					2.00%	2.00%
	134	■ new 80gal HP hot water tanks	1	$ 16,000	10	0		2.00%	2.00%
	135	■ add insulation to internal RWLs and vent piping	1	$ 20,000	61	0		2.00%	2.00%
	136	C13 Heating, Ventilation, Air Conditioning	1					2.00%	2.00%
	137	■ VRF ASHP condensing units - 8 tons	1	$ 90,000	15	0	$ 500	2.00%	2.00%
	138		1					2.00%	2.00%
	139		1					2.00%	2.00%
	140		1					2.00%	2.00%
	141	■ VRF fancoils	1	$ 161,500	20	0		2.00%	2.00%
	142	■ refrigerant piping, branch controllers	1	$ 200,000	20	0	$ 500	2.00%	2.00%
	143	■ VAVs	1	$ 48,000	25	0		2.00%	2.00%
	144	■ ERV 1500cfm	1	$ 60,000	25	0	$ 100	2.00%	2.00%
	145	■ ERV 900cfm	1	$ 28,000	25	0	$ 100	2.00%	2.00%
	146	■ new ERV ductwork, EDH	1	$ 216,000	61	0		2.00%	2.00%
	147	■ replace kitchen MAU 1200 cfm with electric heater	1	$ 35,000	20	0		2.00%	2.00%
	148	■ replace kitchen hood and exhaust system	1	$ 25,000	25	0		2.00%	2.00%
	149	C14 Controls	1					2.00%	2.00%
	150	■ building automated controls - connect to existing system	1	$ 151,302	20	0	$ 500	2.00%	2.00%
	151	ELECTRICAL C21 Services and Distribution	1					2.00%	2.00%
	152	■ replace main entrance, 400A switchgear	1	$ 25,000	40	0		2.00%	2.00%
	153	■ new feeders	1	$ 50,000	61	0		2.00%	2.00%
	154	■ new panel, transformer for HVAC	1	$ 20,000	61	0		2.00%	2.00%
	155	■ new disconnects, mechanical connections	1	$ 15,000	40	0		2.00%	2.00%
	156		1					2.00%	2.00%
	157	C22 Lighting, devices and heating	1	$ 367,449	25	0		2.00%	2.00%
	158		1					2.00%	2.00%
	159	ANCILLARY WORK D22 Alterations	1					2.00%	2.00%
	160		1					2.00%	2.00%
	161	GENERAL REQUIREMENTS AND FEES Z11 General Requirements and Overheads	1					2.00%	2.00%
	162	■ contractor's overheads	1	$ 548,037	61	0		2.00%	2.00%
	163	Z12 Contractor's Profit	1					2.00%	2.00%
	164	■ contractor's profit	1	$ 420,162	61	0		2.00%	2.00%
	165	ALLOWANCES	1					2.00%	2.00%
	166	Z21 Design Allowance	1					2.00%	2.00%
	167	■ design development contingency	1	$ 462,178	61	0		2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes		Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
168	Z23 Construction Contingency	1						2.00%	2.00%
169	construction contingency	1	$	508,395	61	0		2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$	365,358	61	0		2.00%	2.00%

Input : NZER GSHP

Line No.	Building Components Subject to M&R	Include in Option		Cost	Useful Life (years)	Current Age	Annual Service Cost	Annual Service Cost Escalation Rate	Annual Capital Cost Escalation Rate
	Units	0=no or 1=yes		$	Years	Years	$	2.00%	2.00%
1	Structural Slab on Grade - Non-Industrial 1979	0	$	6,754	75	44		2.00%	2.00%
2	Structural Slab on Grade - Non-Industrial 2007	0	$	3,019	75	16		2.00%	2.00%
3	Foundation Wall and Footings - No Basement 2007	0	$	7,483	75	16		2.00%	2.00%
4	Foundation Wall and Footings - No Basement 1979	0	$	11,011	75	44		2.00%	2.00%
5	Roof Top Ladders Qty 1	1	$	7,873	30	4		2.00%	2.00%
6	Single-Story - Steel 1979	0	$	11,492	75	44		2.00%	2.00%
7	Single-Story - Steel 2007	0	$	3,233	75	16		2.00%	2.00%
8	Brick Cavity Walls - CMU Backup 1979	0	$	10,554	75	44		2.00%	2.00%
9	Brick Cavity Walls - CMU Backup 2007	0	$	9,304	75	16		2.00%	2.00%
10	Metal Panel Features	0	$	8,725	60	16		2.00%	2.00%
11	Windows Aluminum Framed (all combined)	0	$	80,878	30	12		2.00%	2.00%
12	Exterior Door HM 3x7 - 1979 - Qty 7	0	$	10,221	30	30		2.00%	2.00%
13	Exterior Door HM 3x7 - 2007 - Qty 3	0	$	4,380	30	16		2.00%	2.00%
14	Door Assembly - Sliding - (all combined)	0	$	56,152	25	16		2.00%	2.00%
15	Skylights - Dome Type	0	$	6,206	30	4		2.00%	2.00%
16	Roof Hatch w interior access ladder and access hatch roof top protection system - Qty 1	1	$	14,193	40	4		2.00%	2.00%
17	Roof - Section 1.0 and 2.1 - SBS Modified Bitumen Roof - East Side 2011 Portion of Building	0	$	343,629	20	12		2.00%	2.00%
18	Roof - Section 2.2 - Built-Up Roof - Original Building Roof - West Side of Site	0	$	91,029	17	16		2.00%	2.00%
19	Roof - Section 3.0 - Metal Roof Canopy - Front Entrances	0	$	20,768	40	16		2.00%	2.00%
20	Roof - Section 4 - Shingled Roof - Shed/Garbage Building Roof	0	$	7,540	20	5		2.00%	2.00%
21	GWB Drywall Walls - Standard	0	$	18,506	50	44		2.00%	2.00%
22	CMU Block Walls 2007	0	$	79,914	60	16		2.00%	2.00%
23	CMU Block Walls 1979	0	$	118,054	62	44		2.00%	2.00%
24	Folding Partition Wall 1 - OS - Indian Wells / Freeman Rooms	1	$	16,183	20	16		2.00%	2.00%
25	Folding Partitions (all combined)	1	$	99,075	20	9		2.00%	2.00%
26	Swinging Aluminum and Glass Doors Qty 2	1	$	14,268	30	16		2.00%	2.00%
27	Swinging Hollow Metal Doors - Qty 11	1	$	34,866	40	10		2.00%	2.00%
28	Swinging Wood Doors 2007 - Qty 13	1	$	25,950	40	16		2.00%	2.00%
29	Swinging Wood Doors 1979 - Qty 10	1	$	19,961	40	40		2.00%	2.00%
30	Automatic Door Operators - Washrooms - Qty 4,Gymansium 1	1	$	14,036	15	5		2.00%	2.00%
31	Automatic Door Operators - Qty 5 - Gymnasium, Washrooms	1	$	14,036	15	5		2.00%	2.00%
32	Roll Up Security Door - 8 x 4	1	$	10,722	40	16		2.00%	2.00%
33	Restroom - Complete	1	$	186,292	30	16		2.00%	2.00%
34	Ceramic Tile - washrooms (4)	1	$	16,272	30	16		2.00%	2.00%
35	Red Sound Accoustical Panels-Auditorium and behind Reception	1	$	16,938	30	16		2.00%	2.00%
36	Acoustical Baffling - Billard Area	1	$	8,045	20	20		2.00%	2.00%
37	Acoustical Baffling - Lounge Area	1	$	6,896	20	4		2.00%	2.00%
38	Carpeting - Billiards Area	1	$	8,105	12	2		2.00%	2.00%
39	Ceramic Tile - New Section Main Coordior and 4 Washrooms	1	$	66,077	30	16		2.00%	2.00%
40	Vinyl Sheet Floor - Multipurpose rooms (New Secton)	1	$	28,061	20	16		2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
BASE CASE	41	Rubber Flooring - Pulastic 5+2 - Auditorium & kitchen (all combined)	1	$ 113,435	20	10		2.00%	2.00%
	42	Vinyl Composite Tile - Community Rooms x 9	1	$ 13,841	20	16		2.00%	2.00%
	43	Ceramic (Quarry Style) Tile - Original Main Cooridor and office kitchenette	1	$ 49,140	45	44		2.00%	2.00%
	44	Painted / Sealed Concrete	1	$ 10,412	40	40		2.00%	2.00%
	45	Mondo Sport Rubber Floor - Dining Room (Lounge and Card Room)	1	$ 16,123	20	5		2.00%	2.00%
	46	Carpeting - Administrative/Customer Reception Area	1	$ 11,638	12	12		2.00%	2.00%
	47	Ceiling Tile System - Standard - 2007 - New Section Multipurpose Rm	1	$ 19,448	25	16		2.00%	2.00%
	48	GWB Finished Plaster Ceilings - 1979 Section	1	$ 54,625	40	40		2.00%	2.00%
	49	Wood Slat Board - part of ceiling finish near main entrance - replacement with different substratrate and strucutre	1	$ 10,262	42	42		2.00%	2.00%
	50	Ceiling Tile System - Enitre Site in Storage Rms. Offices Original Section of Site	1	$ 54,065	25	25		2.00%	2.00%
	51	Ceiling Tile System - Port Nelson and Wellington Room Original Section of Site	1	$ 8,128	25	4		2.00%	2.00%
	52	Painting - Complete Repaint of Entire Interior (all combined)	1	$ 35,956	10	10		2.00%	2.00%
	53	Emergency Eye Wash Stations - 2007	1	$ 2,189	20	16		2.00%	2.00%
	54	Custodial/Utility Sinks - Janitor Closet / Maintenence Room	1	$ 12,929	30	12		2.00%	2.00%
	55	Drinking Fountains - 2010	1	$ 5,380	20	13		2.00%	2.00%
	56	Tankless Water Heater - Gas Qty 1	0	$ 5,593	10	2		2.00%	2.00%
	57	Hot Water Storage Tank - 80 Gallon	0	$ 3,514	13	12		2.00%	2.00%
	58	Domestic Water Piping Dist Complete	1	$ 48,891	50	44		2.00%	2.00%
	59	Back Flow Preventers - DCVA- 2"	1	$ 4,259	35	17		2.00%	2.00%
	60	Sanitary Waste - Gravity Disch	1	$ 73,456	50	44		2.00%	2.00%
	61	Roof Drainage - Gravity - Average	1	$ 55,130	75	16		2.00%	2.00%
	62	Natural Gas Supply for Bldg - 1 1/2" Feed	0	$ 25,131	50	16		2.00%	2.00%
	63	HVAC Ductwork	1	$ 48,110	40	16		2.00%	2.00%
	64	Exhaust System - Restroom w/Roof Fan Qty 4	0	$ 4,430	20	17		2.00%	2.00%
	65	RTU #1 - Port Nelson/Wellington Room	0	$ 23,632	20	16		2.00%	2.00%
	66	Eng Air Multizone Unit with 7 VAV box zones	0	$ 260,843	10	6		2.00%	2.00%
	67	RTU 2,3,5,6 (all combined)	0	$ 102,956	20	16		2.00%	2.00%
	68	Make Up Air 1 - Kitchen	0	$ 59,825	20	6		2.00%	2.00%
	69	Exhaust System - RTU - Kiln Room	0	$ 2,755	20	12		2.00%	2.00%
	70	Exhaust System - RTU - 2007 Expansion	0	$ 1,686	20	16		2.00%	2.00%
	71	Exhaust System - RTU - Commercial Kitchen	0	$ 7,711	20	16		2.00%	2.00%
	72	Building Automation System (BAS) - Software upgrade and System component renewals as needed	1	$ 29,011	10	10		2.00%	2.00%
	73	Kitchen Hood Suppression	1	$ 10,142	20	20		2.00%	2.00%
	74	Main Electrical Service - Transformers	1	$ 15,488	50	16		2.00%	2.00%
	75	Main Electrical Service - 500A/480Y/277V	1	$ 31,253	45	44		2.00%	2.00%
	76	Distribution Equipment - Panelboards	1	$ 46,420	45	44		2.00%	2.00%
	77	Main Electrical Service - Transformers - 1979	1	$ 24,135	45	44		2.00%	2.00%
	78	Branch Wiring - Equipment & Devices	1	$ 71,761	50	16		2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
79	Lighting Fixtures - 2x4 Interior Space Lighting LED	0	$ 50,168	30	16		2.00%	2.00%
80	Exterior Lighting - Wall Pack LED 50 W	0	$ 11,551	30	8		2.00%	2.00%
81	Lighting Fixtures - 2x2 Interior Space Lighting LED	0	$ 16,723	30	16		2.00%	2.00%
82	Lighting Fixtures - Pot Lighting Common Areas Space Lighting LED	0	$ 18,693	30	16		2.00%	2.00%
83	Lighting Fixtures - Globe Lighting Billards Lighting LED	0	$ 61,317	40	24		2.00%	2.00%
84	Lighting Fixtures - 4ft Track Lighting in Lounge	0	$ 1,461	30	16		2.00%	2.00%
85	Exterior Lighting Controls Panels	0	$ 15,000	40	16		2.00%	2.00%
86	Lighting Fixtures - Interior -18- 2x2 Flat Panel LED - Indian Point and Freeman Room	0	$ 4,876	30	4		2.00%	2.00%
87	Fire Alarm System - Panel Only	1	$ 15,633	20	14		2.00%	2.00%
88	Fire Alarm - Devices Only	1	$ 13,077	20	20		2.00%	2.00%
89	Security System - CCTV System - Entire System	1	$ 31,285	10	10	$ 100	2.00%	2.00%
90	Security System - Intrusion Alarm System	1	$ 5,609	20	12		2.00%	2.00%
91	Security System - CCTV System - DVR only	1	$ 8,757	7	5		2.00%	2.00%
92	Emergency Light Units	1	$ 9,749	20	16		2.00%	2.00%
93	Commerical (Resturant) Kitchen Casework - Average	1	$ 36,638	40	7		2.00%	2.00%
94	Kitchen Equipment - All equipment	1	$ 36,308	30	23		2.00%	2.00%
95	Wayfinding Interior Signage	1	$ 3,615	20	13		2.00%	2.00%
96	Kitchenette - Port Nelson and Wellington Rm and - Qty 2	1	$ 12,108	20	4		2.00%	2.00%
97	Roller Window Shades	1	$ 33,581	20	13		2.00%	2.00%
98		1					2.00%	2.00%
99		1					2.00%	2.00%
100	A31 Walls Below Grade	1			0		2.00%	2.00%
101	▪ remove concrete sidewalk and dispose	1	$ 4,212	61	0		2.00%	2.00%
102	▪ remove asphalt paving and dispose	1	$ 982	61	0		2.00%	2.00%
103	▪ excavate to 2 feet below grade	1	$ 6,616	61	0		2.00%	2.00%
104	▪ new 2" EPS fin insulation	1	$ 5,215	61	0		2.00%	2.00%
105	▪ backfill to subgrade	1	$ 8,270	61	0		2.00%	2.00%
106	▪ reinstate concrete sidewalks	1	$ 25,269	61	0		2.00%	2.00%
107	▪ reinstate asphalt paving	1	$ 4,911	61	0		2.00%	2.00%
108	▪ reinstate landscaping	1	$ 7,805	61	0		2.00%	2.00%
109	▪ new 4" EPS insulation to foundation walls	1	$ 10,444	61	0		2.00%	2.00%
110	▪ cement board	1	$ 7,460	61	0		2.00%	2.00%
111	A32 Walls Above Grade	1			0		2.00%	2.00%
112	▪ remove existing brick/block/metal panel façade	1	$ 62,077	61	0		2.00%	2.00%
113	▪ supply and install prefab insulated wall panels	1	$ 310,385	61	0		2.00%	2.00%
114	▪ supply and install prefinished metal siding	1	$ 471,786	61	0		2.00%	2.00%
115	A33 Windows and Entrances	1			0		2.00%	2.00%
116	▪ replace aluminum sliding double door entrances	1	$ 40,000	25	0	$ 500	2.00%	2.00%
117	▪ replace insulated metal single exits	1	$ 26,600	25	0		2.00%	2.00%
118	▪ replace windows with high performance triple pane aluminum windows including interior patching	1	$ 223,808	40	0		2.00%	2.00%
119	A34 Roof Coverings	1			0		2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
RETROFIT	120	▪ remove existing roof finish	1	$ 43,229	61	0		2.00%	2.00%
	121	▪ new mod bit roof finish with 8" EPS insulation	1	$ 691,668	20	0	$ 1,000	2.00%	2.00%
	122	▪ allowance for removing, reinstalling mechanical	1	$ 10,000	61	0		2.00%	2.00%
	123	▪ allowance to increase parapet height	1	$ 34,000	61			2.00%	2.00%
	124	A35 Projections	1			0		2.00%	2.00%
	125	▪ soffit replacement	1	$ 22,519	61	0		2.00%	2.00%
	126	▪ canopies - no change	1			0		2.00%	2.00%
	127	FINISHES	1			0		2.00%	2.00%
	128	B22 Ceiling Finishes	1					2.00%	2.00%
	129	▪ cut and patch ceilings for new mechanical/electrical	1	$ 54,037	61	0		2.00%	2.00%
	130	B23 Wall Finishes Total	1			0		2.00%	2.00%
	131	▪ cut and patch walls for new mechanical/electrical	1	$ 54,037	61	0		2.00%	2.00%
	132	MECHANICAL	1			0		2.00%	2.00%
	133	C11 Plumbing and Drainage	1					2.00%	2.00%
	134	▪ new 80gal HP hot water tanks	1	$ 16,000	10	0		2.00%	2.00%
	135	▪ add insulation to internal RWLs and vent piping	1	$ 20,000	61	0		2.00%	2.00%
	136	C13 Heating, Ventilation, Air Conditioning	1			0		2.00%	2.00%
	137	▪ geothermal wells, testing	1	$ 90,000	61	0		2.00%	2.00%
	138	▪ gshp piping, trenching, backfill, reinstatement	1	$ 45,000	61	0		2.00%	2.00%
	139	▪ gshp circulation pumps, interior piping, HX	1	$ 50,000	25	0		2.00%	2.00%
	140	▪ VRF condensing units - 8 tons	1	$ 70,000	25	0	$ 400	2.00%	2.00%
	141	▪ VRF fancoils	1	$ 161,500	25	0		2.00%	2.00%
	142	▪ refrigerant piping, branch controllers	1	$ 200,000	25	0	$ 500	2.00%	2.00%
	143	▪ VAVs	1	$ 48,000	25	0		2.00%	2.00%
	144	▪ ERV 1500cfm	1	$ 60,000	25	0	$ 100	2.00%	2.00%
	145	▪ ERV 900cfm	1	$ 28,000	25	0	$ 100	2.00%	2.00%
	146	▪ new ERV ductwork, EDH	1	$ 216,000	61	0		2.00%	2.00%
	147	▪ replace kitchen MAU 1200 cfm with electric heater	1	$ 35,000	20	0		2.00%	2.00%
	148	▪ replace kitchen hood and exhaust system	1	$ 25,000	25	0		2.00%	2.00%
	149	C14 Controls	1			0		2.00%	2.00%
	150	▪ building automated controls - connect to existing system	1	$ 151,302	20	0	$ 500	2.00%	2.00%
	151	ELECTRICAL C21 Services and Distribution	1					2.00%	2.00%
	152	▪ replace main entrance, 400A switchgear	1	$ 25,000	40	0		2.00%	2.00%
	153	▪ new feeders	1	$ 50,000	61	0		2.00%	2.00%
	154	▪ new panel, transformer for HVAC	1	$ 20,000	61	0		2.00%	2.00%
	155	▪ new disconnects, mechanical connections	1	$ 15,000	40	0		2.00%	2.00%
	156		1					2.00%	2.00%
	157	C22 Lighting, devices and heating	1	$ 367,449	25	0		2.00%	2.00%
	158		1			0		2.00%	2.00%
	159	ANCILLARY WORK D22 Alterations	1					2.00%	2.00%
	160	▪ building addition for new mechanical equipment	1	$ 375,000	61	0		2.00%	2.00%
	161	GENERAL REQUIREMENTS AND FEES Z11 General Requirements and Overheads	1					2.00%	2.00%
	162	▪ contractor's overheads	1	$ 629,037	61	0		2.00%	2.00%
	163	Z12 Contractor's Profit	1					2.00%	2.00%
	164	▪ contractor's profit	1	$ 482,262	61	0		2.00%	2.00%

Line No.	Building Components Subject to M&R	Include in Option 0=no or 1=yes	Cost	Useful Life (years)	Current Age	Annual Service Cost	Annual Service Cost Escalation Rate	Annual Capital Cost Escalation Rate
	Units	0=no or 1=yes	$	Years	Years	$	2.00%	2.00%
165	ALLOWANCES	1					2.00%	2.00%
166	Z21 Design Allowance	1					2.00%	2.00%
167	▪ design development contingency	1	$ 530,488	61	0		2.00%	2.00%
168	Z23 Construction Contingency	1					2.00%	2.00%
169	▪ construction contingency	1	$ 583,536	61	0		2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ 419,358	61	0		2.00%	2.00%

Input : NZE

Line No.	Building Components Subject to M&R	Include in Option		Cost	Useful Life (years)	Current Age	Annual Service Cost	Annual Service Cost Escalation Rate	Annual Capital Cost Escalation Rate
	Units	0=no or 1=yes		$	Years	Years	$	2.00%	2.00%
1	Structural Slab on Grade - Non-Industrial 1979	0	$	6,754	75	44		2.00%	2.00%
2	Structural Slab on Grade - Non-Industrial 2007	0	$	3,019	75	16		2.00%	2.00%
3	Foundation Wall and Footings - No Basement 2007	0	$	7,483	75	16		2.00%	2.00%
4	Foundation Wall and Footings - No Basement 1979	0	$	11,011	75	44		2.00%	2.00%
5	Roof Top Ladders Qty 1	1	$	7,873	30	4		2.00%	2.00%
6	Single-Story - Steel 1979	0	$	11,492	75	44		2.00%	2.00%
7	Single-Story - Steel 2007	0	$	3,233	75	16		2.00%	2.00%
8	Brick Cavity Walls - CMU Backup 1979	0	$	10,554	75	44		2.00%	2.00%
9	Brick Cavity Walls - CMU Backup 2007	0	$	9,304	75	16		2.00%	2.00%
10	Metal Panel Features	0	$	8,725	60	16		2.00%	2.00%
11	Windows Aluminum Framed (all combined)	0	$	80,878	30	12		2.00%	2.00%
12	Exterior Door HM 3x7 - 1979 - Qty 7	0	$	10,221	30	30		2.00%	2.00%
13	Exterior Door HM 3x7 - 2007 - Qty 3	0	$	4,380	30	16		2.00%	2.00%
14	Door Assembly - Sliding - (all combined)	0	$	56,152	25	16		2.00%	2.00%
15	Skylights - Dome Type	0	$	6,206	30	4		2.00%	2.00%
16	Roof Hatch w interior access ladder and access hatch roof top protection system - Qty 1	1	$	14,193	40	4		2.00%	2.00%
17	Roof - Section 1.0 and 2.1 - SBS Modified Bitumen Roof - East Side 2011 Portion of Building	0	$	343,629	20	12		2.00%	2.00%
18	Roof - Section 2.2 - Built-Up Roof - Original Building Roof - West Side of Site	0	$	91,029	17	16		2.00%	2.00%
19	Roof - Section 3.0 - Metal Roof Canopy - Front Entrances	0	$	20,768	40	16		2.00%	2.00%
20	Roof - Section 4 - Shingled Roof - Shed/Garbage Building Roof	0	$	7,540	20	5		2.00%	2.00%
21	GWB Drywall Walls - Standard	0	$	18,506	50	44		2.00%	2.00%
22	CMU Block Walls 2007	0	$	79,914	60	16		2.00%	2.00%
23	CMU Block Walls 1979	0	$	118,054	62	44		2.00%	2.00%
24	Folding Partition Wall 1 - OS - Indian Wells / Freeman Rooms	1	$	16,183	20	16		2.00%	2.00%
25	Folding Partitions (all combined)	1	$	99,075	20	9		2.00%	2.00%
26	Swinging Aluminum and Glass Doors Qty 2	1	$	14,268	30	16		2.00%	2.00%
27	Swinging Hollow Metal Doors - Qty 11	1	$	34,866	40	10		2.00%	2.00%
28	Swinging Wood Doors 2007 - Qty 13	1	$	25,950	40	16		2.00%	2.00%
29	Swinging Wood Doors 1979 - Qty 10	1	$	19,961	40	40		2.00%	2.00%
30	Automatic Door Operators - Washrooms - Qty 4,Gymansium 1	1	$	14,036	15	5		2.00%	2.00%
31	Automatic Door Operators - Qty 5 - Gymnasium, Washrooms	1	$	14,036	15	5		2.00%	2.00%
32	Roll Up Security Door - 8 x 4	1	$	10,722	40	16		2.00%	2.00%
33	Restroom - Complete	1	$	186,292	30	16		2.00%	2.00%
34	Ceramic Tile - washrooms (4)	1	$	16,272	30	16		2.00%	2.00%
35	Red Sound Accoustical Panels-Auditorium and behind Reception	1	$	16,938	30	16		2.00%	2.00%
36	Acoustical Baffling - Billard Area	1	$	8,045	20	20		2.00%	2.00%
37	Acoustical Baffling - Lounge Area	1	$	6,896	20	4		2.00%	2.00%
38	Carpeting - Billiards Area	1	$	8,105	12	2		2.00%	2.00%
39	Ceramic Tile - New Section Main Coordior and 4 Washrooms	1	$	66,077	30	16		2.00%	2.00%
40	Vinyl Sheet Floor - Multipurpose rooms (New Secton)	1	$	28,061	20	16		2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
BASE CASE	41	Rubber Flooring - Pulastic 5+2 - Auditorium & kitchen (all combined)	1	$ 113,435	20	10		2.00%	2.00%
	42	Vinyl Composite Tile - Community Rooms x 9	1	$ 13,841	20	16		2.00%	2.00%
	43	Ceramic (Quarry Style) Tile - Original Main Cooridor and office kitchenette	1	$ 49,140	45	44		2.00%	2.00%
	44	Painted / Sealed Concrete	1	$ 10,412	40	40		2.00%	2.00%
	45	Mondo Sport Rubber Floor - Dining Room (Lounge and Card Room)	1	$ 16,123	20	5		2.00%	2.00%
	46	Carpeting - Administrative/Customer Reception Area	1	$ 11,638	12	12		2.00%	2.00%
	47	Ceiling Tile System - Standard - 2007 - New Section Multipurpose Rm	1	$ 19,448	25	16		2.00%	2.00%
	48	GWB Finished Plaster Ceilings - 1979 Section	1	$ 54,625	40	40		2.00%	2.00%
	49	Wood Slat Board - part of ceiling finish near main entrance - replacement with different substratrate and strucutre	1	$ 10,262	42	42		2.00%	2.00%
	50	Ceiling Tile System - Enitre Site in Storage Rms. Offices Original Section of Site	1	$ 54,065	25	25		2.00%	2.00%
	51	Ceiling Tile System - Port Nelson and Wellington Room Original Section of Site	1	$ 8,128	25	4		2.00%	2.00%
	52	Painting - Complete Repaint of Entire Interior (all combined)	1	$ 35,956	10	10		2.00%	2.00%
	53	Emergency Eye Wash Stations - 2007	1	$ 2,189	20	16		2.00%	2.00%
	54	Custodial/Utility Sinks - Janitor Closet / Maintenence Room	1	$ 12,929	30	12		2.00%	2.00%
	55	Drinking Fountains - 2010	1	$ 5,380	20	13		2.00%	2.00%
	56	Tankless Water Heater - Gas Qty 1	0	$ 5,593	10	2		2.00%	2.00%
	57	Hot Water Storage Tank - 80 Gallon	0	$ 3,514	13	12		2.00%	2.00%
	58	Domestic Water Piping Dist Complete	1	$ 48,891	50	44		2.00%	2.00%
	59	Back Flow Preventers - DCVA- 2"	1	$ 4,259	35	17		2.00%	2.00%
	60	Sanitary Waste - Gravity Disch	1	$ 73,456	50	44		2.00%	2.00%
	61	Roof Drainage - Gravity - Average	1	$ 55,130	75	16		2.00%	2.00%
	62	Natural Gas Supply for Bldg - 1 1/2" Feed	0	$ 25,131	50	16		2.00%	2.00%
	63	HVAC Ductwork	1	$ 48,110	40	16		2.00%	2.00%
	64	Exhaust System - Restroom w/Roof Fan Qty 4	0	$ 4,430	20	17		2.00%	2.00%
	65	RTU #1 - Port Nelson/Wellington Room	0	$ 23,632	20	16		2.00%	2.00%
	66	Eng Air Multizone Unit with 7 VAV box zones	0	$ 260,843	10	6		2.00%	2.00%
	67	RTU 2,3,5,6 (all combined)	0	$ 102,956	20	16		2.00%	2.00%
	68	Make Up Air 1 - Kitchen	0	$ 59,825	20	6		2.00%	2.00%
	69	Exhaust System - RTU - Kiln Room	0	$ 2,755	20	12		2.00%	2.00%
	70	Exhaust System - RTU - 2007 Expansion	0	$ 1,686	20	16		2.00%	2.00%
	71	Exhaust System - RTU - Commercial Kitchen	0	$ 7,711	20	16		2.00%	2.00%
	72	Building Automation System (BAS) - Software upgrade and System component renewals as needed	1	$ 29,011	10	10		2.00%	2.00%
	73	Kitchen Hood Suppression	1	$ 10,142	20	20		2.00%	2.00%
	74	Main Electrical Service - Transformers	1	$ 15,488	50	16		2.00%	2.00%
	75	Main Electrical Service - 500A/480Y/277V	1	$ 31,253	45	44		2.00%	2.00%
	76	Distribution Equipment - Panelboards	1	$ 46,420	45	44		2.00%	2.00%
	77	Main Electrical Service - Transformers - 1979	1	$ 24,135	45	44		2.00%	2.00%
	78	Branch Wiring - Equipment & Devices	1	$ 71,761	50	16		2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
79	Lighting Fixtures - 2x4 Interior Space Lighting LED	0	$ 50,168	30	16		2.00%	2.00%
80	Exterior Lighting - Wall Pack LED 50 W	0	$ 11,551	30	8		2.00%	2.00%
81	Lighting Fixtures - 2x2 Interior Space Lighting LED	0	$ 16,723	30	16		2.00%	2.00%
82	Lighting Fixtures - Pot Lighting Common Areas Space Lighting LED	0	$ 18,693	30	16		2.00%	2.00%
83	Lighting Fixtures - Globe Lighting Billards Lighting LED	0	$ 61,317	40	24		2.00%	2.00%
84	Lighting Fixtures - 4ft Track Lighting in Lounge	0	$ 1,461	30	16		2.00%	2.00%
85	Exterior Lighting Controls Panels	0	$ 15,000	40	16		2.00%	2.00%
86	Lighting Fixtures - Interior -18- 2x2 Flat Panel LED - Indian Point and Freeman Room	0	$ 4,876	30	4		2.00%	2.00%
87	Fire Alarm System - Panel Only	1	$ 15,633	20	14		2.00%	2.00%
88	Fire Alarm - Devices Only	1	$ 13,077	20	20		2.00%	2.00%
89	Security System - CCTV System - Entire System	1	$ 31,285	10	10	$ 100	2.00%	2.00%
90	Security System - Intrusion Alarm System	1	$ 5,609	20	12		2.00%	2.00%
91	Security System - CCTV System - DVR only	1	$ 8,757	7	5		2.00%	2.00%
92	Emergency Light Units	1	$ 9,749	20	16		2.00%	2.00%
93	Commerical (Resturant) Kitchen Casework - Average	1	$ 36,638	40	7		2.00%	2.00%
94	Kitchen Equipment - All equipment	1	$ 36,308	30	23		2.00%	2.00%
95	Wayfinding Interior Signage	1	$ 3,615	20	13		2.00%	2.00%
96	Kitchenette - Port Nelson and Wellington Rm and - Qty 2	1	$ 12,108	20	4		2.00%	2.00%
97	Roller Window Shades	1	$ 33,581	20	13		2.00%	2.00%
98		1					2.00%	2.00%
99		1					2.00%	2.00%
100	A31 Walls Below Grade	1		0	0	$ -	2.00%	2.00%
101	▪ remove concrete sidewalk and dispose	1	$ 4,212	61	0	$ -	2.00%	2.00%
102	▪ remove asphalt paving and dispose	1	$ 982	61	0	$ -	2.00%	2.00%
103	▪ excavate to 2 feet below grade	1	$ 6,616	61	0	$ -	2.00%	2.00%
104	▪ new 2" EPS fin insulation	1	$ 5,215	61	0	$ -	2.00%	2.00%
105	▪ backfill to subgrade	1	$ 8,270	61	0	$ -	2.00%	2.00%
106	▪ reinstate concrete sidewalks	1	$ 25,269	61	0	$ -	2.00%	2.00%
107	▪ reinstate asphalt paving	1	$ 4,911	61	0	$ -	2.00%	2.00%
108	▪ reinstate landscaping	1	$ 7,805	61	0	$ -	2.00%	2.00%
109	▪ new 4" EPS insulation to foundation walls	1	$ 10,444	61	0	$ -	2.00%	2.00%
110	▪ cement board	1	$ 7,460	61	0	$ -	2.00%	2.00%
111	A32 Walls Above Grade	1		0	0	$ -	2.00%	2.00%
112	▪ remove existing brick/block/metal panel façade	1	$ 62,077	61	0	$ -	2.00%	2.00%
113	▪ supply and install prefab insulated wall panels	1	$ 310,385	61	0	$ -	2.00%	2.00%
114	▪ supply and install prefinished metal siding	1	$ 471,786	61	0	$ -	2.00%	2.00%
115	A33 Windows and Entrances	1		0	0	$ -	2.00%	2.00%
116	▪ replace aluminum sliding double door entrances	1	$ 40,000	25	0	$ 500	2.00%	2.00%
117	▪ replace insulated metal single exits	1	$ 26,600	25	0	$ -	2.00%	2.00%
118	▪ replace windows with high performance triple pane aluminum windows including interior patching	1	$ 223,808	40	0	$ -	2.00%	2.00%
119	A34 Roof Coverings	1		0	0	$ -	2.00%	2.00%

	Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
RETROFIT	120	▪ remove existing roof finish	1	$ 43,229	61	0	$ -	2.00%	2.00%
	121	▪ new mod bit roof finish with 8" EPS insulation	1	$ 691,668	20	0	$ 1,000	2.00%	2.00%
	122	▪ allowance for removing, reinstalling mechanical	1	$ 10,000	61	0	$ -	2.00%	2.00%
	123	▪ allowance to increase parapet height	1	$ 34,000	61	0	$ -	2.00%	2.00%
	124	A35 Projections	1		0	0	$ -	2.00%	2.00%
	125	▪ soffit replacement	1	$ 22,519	61	0	$ -	2.00%	2.00%
	126	▪ canopies - no change	1		0	0	$ -	2.00%	2.00%
	127	FINISHES	1		0	0	$ -	2.00%	2.00%
	128	B22 Ceiling Finishes	1		0	0	$ -	2.00%	2.00%
	129	▪ cut and patch ceilings for new mechanical/electrical	1	$ 54,037	61	0	$ -	2.00%	2.00%
	130	B23 Wall Finishes Total	1		0	0	$ -	2.00%	2.00%
	131	▪ cut and patch walls for new mechanical/electrical	1	$ 54,037	61	0	$ -	2.00%	2.00%
	132	MECHANICAL	1		0	0	$ -	2.00%	2.00%
	133	C11 Plumbing and Drainage	1		0	0	$ -	2.00%	2.00%
	134	▪ new 80gal HP hot water tanks	1	$ 16,000	10	0	$ -	2.00%	2.00%
	135	▪ add insulation to internal RWLs and vent piping	1	$ 20,000	61	0	$ -	2.00%	2.00%
	136	C13 Heating, Ventilation, Air Conditioning	1		0	0	$ -	2.00%	2.00%
	137	▪ geothermal wells, testing	1	$ 90,000	61	0	$ -	2.00%	2.00%
	138	▪ gshp piping, trenching, backfill, reinstatement	1	$ 45,000	61	0	$ -	2.00%	2.00%
	139	▪ gshp circulation pumps, interior piping, HX	1	$ 50,000	25	0	$ -	2.00%	2.00%
	140	▪ VRF condensing units - 8 tons	1	$ 70,000	25	0	$ 400	2.00%	2.00%
	141	▪ VRF fancoils	1	$ 161,500	25	0	$ -	2.00%	2.00%
	142	▪ refrigerant piping, branch controllers	1	$ 200,000	25	0	$ 500	2.00%	2.00%
	143	▪ VAVs	1	$ 48,000	25	0	$ -	2.00%	2.00%
	144	▪ ERV 1500cfm	1	$ 60,000	25	0	$ 100	2.00%	2.00%
	145	▪ ERV 900cfm	1	$ 28,000	25	0	$ 100	2.00%	2.00%
	146	▪ new ERV ductwork, EDH	1	$ 216,000	61	0	$ -	2.00%	2.00%
	147	▪ replace kitchen MAU 1200 cfm with electric heater	1	$ 35,000	20	0	$ -	2.00%	2.00%
	148	▪ replace kitchen hood and exhaust system	1	$ 25,000	25	0	$ -	2.00%	2.00%
	149	C14 Controls	1		0	0	$ -	2.00%	2.00%
	150	▪ building automated controls - connect to existing system	1	$ 151,302	20	0	$ 500	2.00%	2.00%
	151	ELECTRICAL C21 Services and Distribution	1		0	0	$ -	2.00%	2.00%
	152	▪ replace main entrance, 400A switchgear	1	$ 25,000	40	0	$ -	2.00%	2.00%
	153	▪ new feeders	1	$ 50,000	61	0	$ -	2.00%	2.00%
	154	▪ new panel, transformer for HVAC	1	$ 20,000	61	0	$ -	2.00%	2.00%
	155	▪ new disconnects, mechanical connections	1	$ 15,000	40	0	$ -	2.00%	2.00%
	156	▪ photovoltaic system complete with racking, inverters	0		0	0		2.00%	2.00%
	157	C22 Lighting, Devices and Heating	1	$ 367,449	25	0	$ -	2.00%	2.00%
	158		1		0	0	$ -	2.00%	2.00%
	159	ANCILLARY WORK D22 Alterations	1		0	0	$ -	2.00%	2.00%
	160	▪ building addition for new mechanical equipment	1	$ 375,000	61	0	$ -	2.00%	2.00%
	161	GENERAL REQUIREMENTS AND FEES Z11 General Requirements and Overheads	1		0	0	$ -	2.00%	2.00%
	162	▪ contractor's overheads	1	$ 734,637	61	0	$ -	2.00%	2.00%
	163	Z12 Contractor's Profit	1		0	0	$ -	2.00%	2.00%

Line No.	Building Components Subject to M&R Units	Include in Option 0=no or 1=yes	Cost $	Useful Life (years) Years	Current Age Years	Annual Service Cost $	Annual Service Cost Escalation Rate 2.00%	Annual Capital Cost Escalation Rate 2.00%
164	▪ contractor's profit	1	$ 563,222	61	0	$ -	2.00%	2.00%
165	ALLOWANCES	1		0	0	$ -	2.00%	2.00%
166	Z21 Design Allowance	1		0	0	$ -	2.00%	2.00%
167	▪ design development contingency	1	$ 619,544	61	0	$ -	2.00%	2.00%
168	Z23 Construction Contingency	1		0	0	$ -	2.00%	2.00%
169	▪ construction contingency	1	$ 681,498	61	0	$ -	2.00%	2.00%
170	construction contingency for 2024 - 10%	1	$ 419,358	61	0	$ -	2.00%	2.00%
199	0	1	$ -	0	0	$ -	2.00%	2.00%
200	Array Size 220 kWdc	1	$ 704,000			$ 6,228	2.00%	2.00%