Corporation of the City of
NEW WESTMINSTER

Attachment # 2

Massey Theatre Renovation HVAC & Public Realm

Proposed Scope Additions Recommendation Memo

October 23, 2024

MASSEY THEATRE RENOVATION
HVAC & PUBLIC REALM PROPOSED SCOPE ADDITIONS RECOMMENDATION

Heating, Ventilation and Air Conditioning (HVAC) System Scope Addition

EXECUTIVE SUMMARY

We recommend the selection of an air source heat pump (ASHP) system for the HVAC system upgrade of the Massey Theatre Renovation project. This recommendation is based on the ASHP system's superior performance in the areas of greenhouse gas (GHG) emissions reduction, energy use, structural impacts, acoustic impacts and operational/maintenance costs.

The upgrade would require an extension to the project schedule. It is estimated that the project completion date would extend from December 2025 to June 2026 (+6 months), incorporating a 12 month facility shutdown period from July 2025 to June 2026 inclusive.

The estimated total cost of the ASHP system is $8.8 million, including hard costs, soft costs and contingency reserves.

BACKGROUND

The provision of comfortable indoor environments equipped to address evolving climate demands is a key part of addressing the future utility of the Massey Theatre Complex.

A 2019 mechanical systems assessment described the Heating and Air Conditioning systems at the Massey Theatre as *"primarily heated air conditioned and ventilated with a packaged rooftop multi-zone unit located on the roof…the equipment has exceeded its service life, is undersized for both cooling capacity and ventilation air capacity and is in need of upgrade replacement."* [p.5, Massey Theatre Mechanical Systems Assessment, 2019]

This assessment was confirmed through the 2023 study, Massey Theatre Project Phase 1 Scope Definition, which called for the replacement of rooftop units and the introduction of cooling and ventilation to the entrance lobby. [p.17, Massey Theatre Project Phase 1 Scope Definition]

OPTIONS EVALUATION

Four potential HVAC system options were evaluated before arriving at the recommended ASHP system. The four systems reviewed included:

1. Air source heat pump (ASHP)
2. Chiller + boiler
3. Decentralized air-handling units (AHUs)
4. AHUs + variable refrigerant flow (VRF)

Option 1: Air Source Heat Pump (ASHP)

As a centralized system capable of heat recovery, the ASHP system is flexible and highly efficient. It includes a large, centralized air source heat pump located on the roof of the new concrete utility addition. The system includes an electric back-up boiler for assured performance on particularly cold days. It also includes a 4-pipe hydronic piping system serviced by terminal units that distribute conditioned air to the desired zones throughout the facility.

Paired with an electric boiler backup, the ASHP system represents a significant reduction in energy use and GHG emissions. The detailed energy model estimates a 92% reduction in GHG emissions compared to a "business as usual" replacement of the existing HVAC system. The upgrade would remove the need for the existing gas service entirely, which currently provides the fuel source for the existing boiler system that provides space heating.

Upgraded ventilation would be provided by replacing the large existing roof top unit (RTU) with centralized heat recovery ventilation (HRV). This system offers the greatest number of zones of the four systems studied, which is advantageous for local user control and customization based on the different program and user needs in different parts of the building.

This system requires the largest mechanical room and most ceiling space for the associated hydronic piping and mechanical equipment, however this disadvantage is of limited impact due to the large size of these existing spaces in the Complex.

Electronic controls of the ASHP system are compatible with City IT's preference for cloud-based building management software, and can be integrated with the City's virtual server requirements and standardized system for HVAC controls.

Refer to Appendix 1 for the detailed energy model report.

Option 2: Chiller + Boiler

This system includes a gas-fired condensing boiler and air cooled chiller, serviced by 4-pipe hydronic piping system to distribute conditioned air to the desired zones. Centralized HRV would provide fresh air ventilation and would replace the existing RTU. While chilled water piping would need to be added, existing heating water piping from the existing boiler system could be reused if piping conditions are deemed to be in good operating condition. Further, this system could be a candidate for FortisBC funding due to the ongoing use of gas provided by FortisBC. This system offers the lower GHG emissions improvement of the four systems studied.

This system is not considered to be as well-aligned with the City's climate goals as the ASHP system, therefore it is not recommended.

Option 3: Decentralized AHUs

This system includes separate AHUs for each zone, complete with variable air volume control. AHUs includes highly efficient heat pumps with electric back up boilers. Ventilation would be provided by the individual AHUs, and replace the existing centralized RTU.

This option offers the lowest number of available customizable zones. It therefore offers decreased opportunity for users to customize air condition based on the needs of the space, and leads to reduced occupant thermal comfort and potentially less efficient operation overall.

It also introduces the greatest structural burden on the existing facility by scattering new AHUs on each roof of the facility. This introduces new point loads to the existing roof structure, as well as introduces new snow load risk and subsequent snow removal burden. Costly structural upgrades may be required to address these risks.

This system is considered to carry more risk and offer reduced performance compared to the ASHP system, and is therefore not recommended.

Option 4: AHUs + VRF

This system is another highly efficient option and is considered the “runner up”. AHUs would be provided for the Theatre zone, with an air-cooled VRF system providing conditioned air for the other zones via ducted fan coil units or cassettes. Ventilation would be provided via the new individual AHUs for the studio spaces, and a large centralized HRV for the remaining spaces. The existing RTU would be removed. As this system uses refrigerants in contact with ventilation air, refrigerant selection is limited to a safe range of flammability / toxicity.

This option would require the least ceiling space of the four systems studied, due to the thin profile of the VRF refrigerant piping compared to the thicker 4 pipe hydronic piping required for the other systems.

While this option is very energy efficient, it would likely incur higher semi-annual maintenance costs to the City to inspect outdoor unit components such as compressors, heat exchangers and condenser fans, plus perform regular refrigerant system and temperature checks. Specialized external technicians are required to do this work, and would be required to do so more often than with the recommended ASHP system. Additionally, proprietary components of the selected equipment could complicate ongoing maintenance, and trigger the need for a dedicated maintenance contract with a manufacturer, introducing higher operational cost to the City. This option also doesn’t include a back up system if the system fails to perform, such as on particularly cold days.

This is system is considered to impose greater operational burden than the recommended ASHP system while offering the same performance. It is therefore not recommended.

RECOMMENDED SYSTEM SELECTION

We recommend the selection of Option 1: ASHP system for the HVAC system upgrade of the Massey Theatre Complex.
This recommendation is based on a comparison of GHG emission reductions, operational energy use, structural implications for the existing facility, acoustic impacts and ongoing operational cost.

The table below summarizes the comparative performance of each system studied.

	ASHP System	**Chiller + Boiler**	**Decentralized AHUs**	**AHUs + VRF**
GHG Emissions Reduction	👍	👎	👍	👍
Electrical Impact	Moderate equip. load	lowest equip. load	highest equip. load	highest equip. load
Structural Implications	least impact	least impact	multiple roofs require upgrade	multiple roofs require upgrade
Acoustic Impacts	improved acoustic performance	improved acoustic performance	decreased acoustic performance	likely same as baseline
Operational Cost	lowest cost	high cost	highest cost	low cost

GHG Emissions Reduction

In response to the City's 2019 declaration of a climate emergency, the associated GHG reduction targets, and the 1st of the 7 bold steps in CEERS, GHG emissions reduction is considered a priority criterion. Three of the four systems studied perform favourably, except the chiller + boiler system. The chiller + boiler system was therefore considered non-viable early on, due to poor GHG emissions reduction performance relative to other options. The remaining options were left "on the table" to be evaluated against the supporting criteria.

Electrical Impact

Electrical impact was an evaluation of the relative ongoing energy requirements of the proposed systems. Higher efficiency and reduced electrical demand can lower the required electrical service and equipment sizing, and reduce the overall impact of the facility on the electrical grid. Preference was given to systems with lower electrical impact.

The ASHP system performed most favourably against the electrical impact criterion, with the exception of the gas-fired chiller + boiler system. The chiller + boiler system is not considered a viable contender, because it uses fossil fuels to achieve a low electrical impact.

Structural Implications

Structural implications included an assessment of the necessary structural upgrades to the facility to support the equipment required by the systems under review. Centralized systems, such as the ASHP system, that can be installed on the new concrete utility addition roof require no upgrades to existing roofs. Distributed systems, such as the decentralized AHU or VRF system, add equipment loading and collect snow drift weight to multiple existing roofs and may require extensive structural
upgrades. Preference was given to systems with fewer structural implications.

The ASHP system performed most favourably against the structural implications criterion, as it locates new roof-top equipment only on the new utility addition, which is already designed to withstand its load. It does not require upgrades to the other roofs of the facility and does not create additional snow removal burden for City maintenance staff.

Acoustic Impacts

Acoustic impacts rated the likelihood of increased mechanical systems noise inside the facility – a key consideration in a theatrical environment. Centralized outdoor systems were identified as the least acoustically impactful. Preference was given to systems with low predicted acoustic impact.

The ASHP system performed most favourably against the acoustic impact criterion, as it located the furthest away from the Theatre, and is acoustically separated by solid concrete structure and the intervening spaces between the new utility addition and the Theatre.

Operational Cost

Operational cost considered the predicted energy consumption of each system and associated utility consumption cost only. It did not include high or lower staff maintenance burden due to differing levels of scheduled or unscheduled maintenance. Preference was given to systems with lower predicted operational cost.

Based on the performance predicted in the detailed energy model report, the recommended ASHP system represents approximately $37,000 annual saving on electric and gas bills compared to a like-for-like replacement of the "business as usual" system. This is a net saving that considers elimination of gas consumption and the associated utility cost, which is then offset by an increase in electric consumption to bring heating and cooling to the facility through all-electric means. Importantly, the ASHP system is predicted to achieve this saving while reducing GHG emissions by 92% and greatly improving heating/cooling performance within the facility for occupants.

Based on these selection criteria, Option 1 ASHP system was selected for detailed energy modelling and costing.

CLASS D COST ESTIMATE – OPTION 1 ASHP SYSTEM

Option 1 ASHP system is estimated to cost $8.8 million, including all soft costs, hard costs and contingencies. The level of accuracy of a Class D cost estimate is +/- 20%. This is an improvement on the accuracy of the previous "Rough Order of Magnitude" budget estimate provided in June 2024, which estimated the HVAC system upgrade to cost $7.9 million within +/- 50% accuracy.

Refer to Appendix 2 for the Class D cost estimate.

Public Realm Scope Addition

EXECUTIVE SUMMARY

We recommend proceeding with a public realm scope addition, including landscaping, civil and site work upgrades, to the MTR project.

This recommendation is based on achieving a cohesive site plan that reflects the complex shared use, cultural history and interdependent relationships between the MTR site and the adjoining lands, as well the deficit conditions that will be left behind by the large gym demolition and drain tile replacement works associated with the approved minimum viable option (MVO) scope.

The public realm scope upgrade responds to opportunities created by the concurrent New West Secondary School (NWSS) and Massey Theatre Society (MTS) projects to create a logically connected and appropriately serviced site. It proposes upgrades to parking lot configuration and function, building accessibility at building entrances, the active transport pathway network, plus basic landscaping and civil service provisions such as streetlighting, stormwater system and electric vehicle charging infrastructure.

The public realm scope addition would be completed in the same facility closure period as the proposed HVAC upgrade. Together with HVAC, the public realm upgrade would require an extension to the project schedule. It is estimated that the project completion date would extend from December 2025 to June 2026 (+6 months), incorporating a 12 month facility shutdown period from July 2025 to June 2026 inclusive.

The estimated total cost of the public realm upgrade is $5.2 million, including hard costs, soft costs, public art allowance and contingency reserves.

BACKGROUND

The MTR project boundary falls within a larger masterplan area that also includes the adjacent NWSS Re-Memorialization project and the Massey Theatre Society (MTS) landscape Gathering Place project. The goal of the MTR public realm upgrade scope addition is not only to address temporary conditions left by the large gym demolition and drain tile replacement, but also to tie together all site improvements in the masterplan area under a unified and logical site plan, that creates a cohesive network of spaces and services that responds to the site and surrounding neighbourhood.

The minimum viable option (MVO) scope, approved in 2023, does not include provision for public realm, site works or landscape treatment upgrades. It allows only for a temporary asphalt pavement applied over the large gym demolition footprint only. The intent behind this temporary solution was to perform the minimum amount of work to tie the demolition footprint area into the existing shared parking lot area, until a future time when a more extensive site improvement upgrade could be designed and delivered. It is recommended to address this situation now, as there are numerous issues with the temporary solution, such as:

- Absence of site plan to guide the design and integration of the additional paved area into the existing shared parking lot
- The existing shared parking lot has paved areas that are in poor condition, and require remediation
- Costs to reinstate a temporary solution exceed the initial understanding MVO scope, specifically with respect to backfill material, grading requirements, exterior lighting and drainage
- With the demolition of the large gym and old NWSS, there is limited-to-no exterior lighting, which should be addressed for public safety and site functionality. Drainage and associated landscaping should also be reviewed

- Pedestrian pathways are informal, with a high volume of students traversing the parking lot each day, through and around traffic. More formalized connections are required for safety and functionality
- NWSS is proceeding with the adjacent Re-Memorialization project, which includes a portion of the City lands adjacent to the shared parking lot delivered to a temporary "passive green space" condition, plus a new multi-use pathway.

To address these issues, the public realm scope addition is recommended to be added to the project now. The following section categorizes the public realm scope addition into site needs ("must do") and site recommendations ("should do").

SITE NEEDS – "MUST DO"

To appropriately address and make good residual site conditions created by the MVO scope of work, the following additional works are considered public realm site needs that must be added to the MVO Phase 3 – Balance of Building Work approved scope.

Demolition Footprint Area & Existing Shared Parking Lot

- Backfill, grading, paving and linemarking of the demolition footprint area
- Repaving areas of existing shared parking lot that are in poor condition
- Linemarking adjustments within the existing shared parking lot to respond to addition of new demolition footprint area
- Drainage improvements across the existing shared parking lot and demolition footprint area, including new stormwater service connections
- Exterior lighting additions within the existing shared parking lot and demolition footprint area
- Pedestrian pathway connection through the existing shared parking lot to the new NWSS multi-use pathway
- Appropriate concrete curbs, landscaping and signage within demolition footprint area
- Redesign of northwest entrance building entrance ramp to avoid conflict with new parking lot configuration.

Drain Tile Replacement - Existing Landscaping Reinstatement

Replacement of the drain tile around the perimeter of the building will require removal of some existing landscaping. At the 8 Ave frontage, landscaping was only recently installed as part of the separate MTS Gathering Place project. The affected landscaping must be reinstated by the MTR project following the perimeter drain tile work. This includes:

- Regrading garden bed away from the building's face
- Replacing affected sections of concrete planter wall and limestone pathway
- Replacing affected trees, shrubs and irrigation

SITE RECOMMENDATIONS – "SHOULD DO"

There is a strong rationale to perform a public realm upgrade for the complete site, which not only addresses the site needs described above, but also creates a cohesive site that logically responds to the broader masterplan area. It is recommended to undertake this complete scope of work to take advantage of efficiencies in executing under a single contract, within a single facility shutdown period. It is also recommended to perform this upgrade scope in its entirety, to avoid further piecemeal development of the site.

The following section provides a narrative of the recommended public realm landscape plan.

OVERALL LANDSCAPE SITE PLAN

The proposed landscape site plan consists of four key spaces: memorial paths with contemplation glades, the Massey Theatre main entry plaza, a secondary entry plaza, and the back of house area at the rear parking lot. Each space is designed to enhance the public realm, improve connectivity with the surrounding areas, and respect the site's historical significance.

The western boundary of the MTR project overlaps the NWSS Re-Memorialization area project boundary. This area of the landscape plan not only honours the site's diverse cultural heritage, but also strengthens connections between key destinations, such as the Massey Theatre, New West Secondary School, and the NWSS Re-Memorialization project.

It focuses on a sinuous pathway, with gentle curves, meandering through the landscape, creating a series of glades for quiet reflection. These spaces provide an inviting environment for people to honour their loved ones. The pathways are surrounded by native meadows, tall grasses, and trees, aligning with the City's biodiversity strategy to enhance the ecological health of the urban forest and green spaces.

The southern and eastern boundaries introduce new connection points from the existing bus shelter to the new MTS Gathering Place project, NWSS Re-Memorialization project, the building's secondary entrance and further connections to the new school and arena. These pathways, reflecting the curvilinear design language of the MTS Gathering Place project, create a seamless network that promotes walking, cycling, and public transportation, supporting the City's vision of a car-light community.

The site plan also includes civil upgrades to stormwater infrastructure, exterior lighting, parking lot condition and functionality, electric vehicle charging stations and active transport infrastructure.

MAIN ENTRY PLAZA – 8 AVE FRONTAGE

Several improvements are proposed for the entry plaza to make it a more welcoming space, where people can gather or spend time during theatre intermissions. Efforts have been made to preserve the existing grove of trees and create a central grove, encircled by a curvilinear ramp that connects the elevated landing space to the lower plaza. At the plaza level, custom curvilinear benches will follow the overall design language of the site and surround the tree groves, creating an open and inviting environment.

NORTH-WEST ENTRY PLAZA – REAR PARKING LOT

Thoughtful consideration has been given to improving the connection between the front and back faces of the Massey Theatre. Pathways will now extend from the bus shelter and entry plaza at the 8 Ave frontage to the back of the house and north-west entrance, with a green buffer along the pathways to separate pedestrian circulation from vehicular traffic in the parking lot. This important to improve pedestrian safety.

The design emphasizes the enhancement of the public realm by removing several parking spaces near the building entrance to create a new plaza with seating, shaded by a canopy of trees and native plantings. A raised planter will further separate the parking area from the plaza. This decision not only improves the quality of the public space but also aligns with the City's car-light initiative, encouraging walking, cycling, and sustainable transportation over additional parking.

BACK OF HOUSE & WEST ENTRANCE

To separate the new waste staging area and loading zone from the west entrance, existing plantings will be extended to create a substantial buffer between the two areas, while still providing a connection from the parking lot to the entry ramp. To make the space more accessible, benches will be placed in the planted area facing the street, offering a waiting area for visitors to the theatre, school and arena to be picked up or dropped off.

PARKING LOT

In addition to the site needs / “must do” work described above, 20 electric vehicle (EV) charging stations are proposed as part of the recommended / “should do” public realm upgrade. This includes EV charger stations + bases, and associated electrical infrastructure.

Overall, this public realm scope addition is a conscious effort to create a people-centered public realm that integrates the natural environment, addresses known functionality and servicing issues, responds to opportunities presented by the recent NWSS and MTS separate projects, and supports long-term sustainability through active transport and pollution-free vehicle infrastructure.

CLASS D COST ESTIMATE – PUBLIC REALM

The public realm scope addition is estimated to cost $5.2 million, including all soft costs, hard costs, public art allowance and contingencies. The level of accuracy of a Class D cost estimate is +/- 20%. This is an improvement on the accuracy of the previous “Rough Order of Magnitude” budget estimate provided in June 2024, which estimated the public realm scope addition to cost $4.1 million within +/- 50% accuracy.

Refer to Appendix 2 for the Class D cost estimate.

Yours Sincerely

Alex Godfrey
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Appendix 1 – Energy Model Report

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October 3, 2024 Project Number: VR22211A

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Attention: Ben Nielsen

Re: Massey Theatre Renovations - Energy Modelling Report

- Proposed Upgrades vs. Existing

1.0 BACKGROUND

It is our understanding that the Massey Theatre consists of one 3-storey building with a main auditorium and other supporting spaces. The proposed renovations include upgrades of exterior wall assembly, installation of better performance glazing, replacement of the old RTU for main auditorium, installation of ERVs for other supporting spaces, and replacement of central heating and cooling equipment.

2.0 PURPOSE

The purpose of this report is to verify the energy performance of the proposed renovations against the existing building. In order to determine the building's energy performance, the proposed and existing energy models were developed using DesignBuilder, benchmarked against existing energy bills. The energy modelling inputs, and thermal bridge calculations are included within the appendices.

3.0 MODELLING RESULT SUMMARY

3.1 MODELLING INPUTS

The mechanical system, envelope assemblies, nominal R values are based on information provided by the architects and the mechanical engineers. The thermal performance of windows and doors is assumed per ASHARE 90.1 – 2019. The energy models are built as per the architectural drawings received on April 15th, 2024. In addition, the gym to be demolished is not included in the energy analysis.

3.2 Output Summary

Table 1 and Figure 1 below outline the energy consumption summary for the proposed and existing buildings categorized by end uses. It should be noted that the results shown below use assumptions such as operating schedules and typical climactic data to illustrate compliance over a typical year and do not represent actual annual energy consumption.

Table 1: Energy Consumption by End Use

Energy Consumption (kWh)			
End Uses	**Proposed**	**Existing**	**Energy Savings**
Heating	455,418	807,351	44%
Cooling	61,228	7,137	-758%
Interior Lighting	248,223	248,223	0%
Exterior Lighting	2,190	2,190	0%
Interior Equipment	46,550	46,550	0%
Fans	176,186	50,745	-247%
Pumps	674	469	-44%
Water Systems	732	731	0%
Elevator	21,455	0	-
TOTAL	1,012,656	1,163,397	13%

Table 2: Greenhouse Gas Emissions

	Proposed	**Existing**	**GHG Savings**
Greenhouse Gas Intensity (kg CO2e/m2/year)	1.5	19.23	92%
Greenhouse Gas Emissions (kt CO2e/year)	12	153	141

Note: unit is tonnes (t) not kilotonnes (kt)

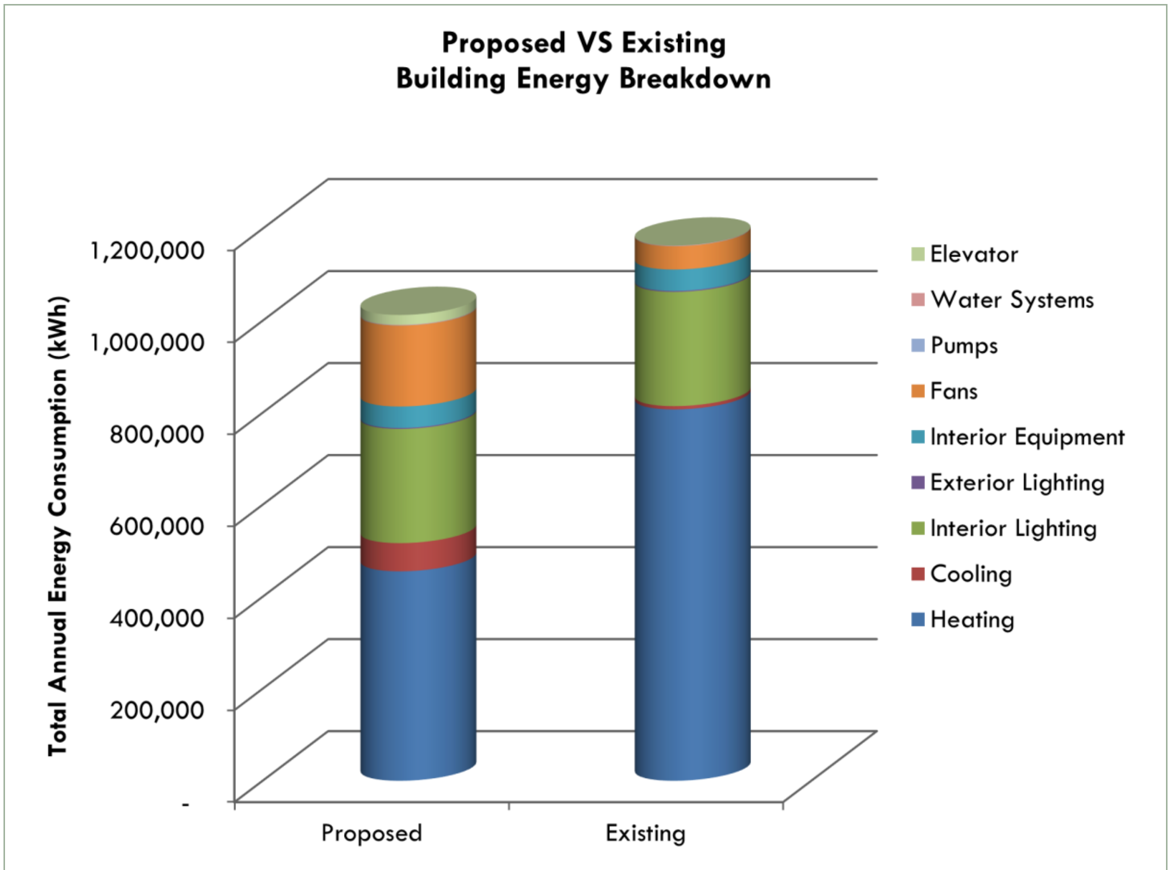

Figure 1: Energy Consumption by End Use, Proposed vs Existing

3.3 ENERGY IMPACTS OF THE PROPOSED RENOVATIONS

Following renovations are proposed against the existing building:

- The current central gas boiler system and roof top units (RTUs) have been replaced by an Air Source Heat Pump (ASHP) with electric back-up boilers for heating and cooling. The high efficiency ASHP can save 44% heating energy and provide cooling.
- ERVs are designed for most spaces except the main auditorium (SRE 70%), providing thermal comfort and ventilation.
- A new RTU is proposed for the auditorium to provide heating, cooling, and ventilation.
- The increased supply air flow rates introduced by the new RTU and ERV have led to more fan energy consumption than the existing building. However, the new RTU and ERV are proposed to improve the indoor air quality and thermal comfort in the building In both heating and cooling because there is not sufficient heating, cooling, or ventilation in the existing building.

- An elevator is designed for the proposed building, providing convenience to the occupants with extra energy consumption.
- The proposed mechanical renovations will fully electrify the building and significantly reduce carbon emissions compared to the existing building.

4.0 CONCLUSION

The proposed renovations are estimated to result in about 13% energy savings overall and 92% GHGI savings, mainly due to the replacement of the gas-fired boiler with the high-efficiency ASHP. Although there is an energy increase in cooling and fans, the new mechanical systems can provide better thermal comfort and indoor air quality than the existing building.

It is recommended the project team review the assumptions and details of mechanical systems as well as other design parameters listed in the Appendices. Closure

The inputs are confirmed by the project team as a true representation of the proposed building submitted for approval at this time.

This report was prepared by JRS for Proscenium Architecture + Interiors Inc. Any use that a third party makes of this report, or any reliance or decisions made based on it, are the sole responsibility of such third party.

If you should have any questions or wish to discuss this report in further detail, please contact the undersigned.

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Encl: Appendix A – Modelling Input Parameters
Appendix B – Thermal Bridging Analysis

APPENDIX A

Modelling Input Parameters

MODELLING INPUT PARAMETERS TABLE

MODEL INPUTS	PROPOSED	EXISTING BUILDING
GENERAL BUILDING INFORMATION		
Project Location	735 8th Ave, New Westminster, BC	
Weather File	CAN_BC_Vancouver.Intl.AP.718920_CWEC2016	
Total Number of Buildings	1	
Total Number of Stories	3-storey	
Modelled Floor Area (m²)	7,971 m²	7,971 m²
Orientation of Plan North	Northeast	
Energy Code	ASHRAE 90.1-2019 NECB 2020	
Modeling Software/Version	DesignBuilder V7.1.2.006	
Modeller	HX/ZWA/JCU	
GLAZING INFORMATION		
Glazing Assembly U-Value (Including Frame) (IP)	U-0.36 @ Fixed U-0.63 @ Entrance *Note: Double-glazed aluminum assumed by JRS based on ASHRAE 90.1 Table 5.5-4*	U-0.62 *Note: Double-glazed aluminum no thermal break ½ air space assumed by JRS based on ASHRAE Fundamentals 2017*
Glazing Solar Heat Gain Coefficient (SHGC, Including Frame)	SHGC-0.36 @ Fixed SHGC-0.33 @ Entrance *Note: Double-glazed aluminum assumed by JRS based on ASHRAE 90.1 Table 5.5-4*	SHGC-0.57 *Note: Uncoated double-glazing 5c 1/8 fixed aluminum based on ASHRAE Fundamentals 2017*
WWR	7%	7%
Shading Device	All building components have been included in energy model, as well as shading devices	

ENVELOPE INFORMATION (IP)		
Overall Wall Effective R-Value	R-14.4 *Note: Calculated by JRS*	R-2.4
Overall Roof Effective R-Value	R-3.6	R-3.6
Overall Exposed Floor Effective R-Value	R-1.5	R-1.5
Opaque Door R-Value	R-1.4	R-1.4
Infiltration	0.67 L/s/m2 @ operating pressure	0.67 L/s/m2 @ operating pressure
INTERNAL LOADS		
Lighting Power Density	Auditorium: 6.5 W/m2 Studio: 10.5 Corridor: 4.4 Elec/Mech room: 4.6 Concession/kitchen: 11.7 Elev Lobby: 7 Lobby: 9 Office: 7.1 Stairs: 5.3 Storage: 4.1 Washroom: 6.8 Workshop: 13.5 *Note: Per NECB 2020*	As Proposed
Lighting Control	N/A	N/A
Exterior Lights	500 W *Note: Per NECB 2020*	As proposed
Miscellaneous Equipment	Auditorium: 2.5 Others: as per NECB 2020 Latent fraction: 11% Sensible fraction: 62%	As proposed
Process Load	N/A	As proposed
Elevator	Per BC Hydro New Constructions Program's Energy modelling guideline	N/A
Appliances	N/A – Included in Misc. Equipment	
Low Flow Plumbing Fixture	N/A - DHW flow rates Per NECB	As proposed

DESIGN CONDITIONS

Indoor Design Temperatures (Heat/Cool)	Per NECB	Per NECB
Thermostat Temperature Schedule (Heat/Cool/Setback)	Per NECB	Per NECB
Operation Schedule (Zone Group, Plant, Lighting)	Per NECB	Per NECB
Humidity Control	N/A	N/A

HVAC SYSTEM

System Description	Auditorium: ASHP + RTU-5 (heat/cool) + back up electric boiler Others: ASHP+ ERV + fan coils (heat/cool) + back up electric boiler *Note: Provided by Mechanical*	Main Theatre: RTU-1 (heat/cool) *Note: FLMR-70-547 HW installed in 1979* Drama Room: warm air heating from adjacent AHU Band Rooms: warm air heating from adjacent AHU Small Gymnasium: rooftop AHU Main Theatre Lobby: N/A Administration Offices: Small Packaged AC Unit, YORK Model D4CE048A25A Upper Floor Corridor: No Ventilation or Cooling System
Ventilation: System Level	RTU ERV	RTU AHU
Outdoor Air (supply)	RTU-5: 28,000 cfm (20 cfm/person) ERV: 2,300 cfm (20 cfm/person and per NECB occupant density) *Note: Assumed by JRS*	RTU-1: 3,000 cfm
System Fan Power (SA/RA/EA)	RTU: SA/RA - 0.5 W/cfm ERV: SA/EA - 0.5 W/cfm *Note: Assumed by JRS*	RTU-1: 26,000/23,000/0 cfm
Heat Recovery Ventilator Efficiency	ERV: SRE 70%	N/A
Heating Efficiency	COP-3.2 *Note: Assumed by JRS*	VRF heating: COP 3.2 @ 8.3C MUA gas-fired furnace: 81% Electric heating: 100%
Cooling Efficiency	EER-10.32 *Note: Assumed by JRS*	VRF cooling: EER 10.8 Split system cooling: COP 3.28

Local Exhaust Fan	N/A	N/A
Parking Ventilation Fan Power	N/A	N/A
Filters & Other System Features	N/A	N/A
PLANT INFORMATION		
SPACE HEATING PLANT		
Heating Type	ASHP + Backup Boiler (Electric)	Gas-fired Boilers Note: 12 Multitherm, modular boilers installed in 1982; Six of these boilers were removed in early 2007 prior to the installation of a new, more efficient boiler. Six of the original Multitherm boilers remain.
Heating Efficiency	ASHP: COP 3.2 Backup electric boiler: 100%	80%
Pump Power	1.5 kW *Note: Assumed by JRS*	As propsoed
Pump Control	VFD	VFD
SPACE COOLING PLANT		
Cooling Type	ASHP	N/A
Cooling Efficiency	EER 10.32	N/A
Pump Power	1 kW *Note: Assumed by JRS*	N/A
Pump Control	VFD	N/A
DOMESTIC HOT WATER HEATING		
Heating Type	Electric Water Heaters	Giant, Model 172ETE-3F7M, electric tank with 4.5 kW heating and 60 Gallon storage tank
Heating Efficiency	97% *Note: Assumed by JRS*	81%

Storage Tank Insulation	R12	As proposed
DOMESTIC HOT WATER PUMPS		
Pump Control	Constant	As proposed
Pump Power	0.5 kW *Note: estimated by JRS*	As proposed

APPENDIX B

Thermal Bridging Analysis

EXTERIOR ABOVE-GRADE WALL

Clear Field Area Method

Select Area Calculation (Choose One)	Area	Units
	33491.73	ft²
User Defined Area	Enter User Defined Opaque Area	ft²

Overall Opaque Wall Thermal Performance	
Opaque U-Value (BTU/hr ft² °F)	**0.070**
Effective R-Value (hr ft² °F/BTU)	**14.4**

Proposed Building Entries

Add/Remove Detail	Transmittance Type	Include	Transmittance Description	Area, Length or Amount Takeoff	Units	Transmittance Value	Units	Source Reference	Heat Flow (BTU/hr°F)	%Total Heat Flow
								Totals	2332.9	100%
Add Clear Field	Clear Field	☑	EW5 - Stucco on Interior Insulated Wood Frame	15311.69	ft²	0.051	BTU/ hr ft² °F	8.1.2	780.9	33%
Remove Clear Field	Clear Field	☑	EW7(a) - Panel Cladding on Exterior Insulated Wood Studs	5156.76	ft²	0.056	BTU/ hr ft² °F	8.1.7	288.8	12%
Remove Clear Field	Clear Field	☑	EW8(a) & EW9 - Stucco on Exterior Insulated CIP/CMU	12812.59	ft²	0.066	BTU/ hr ft² °F	7.1.3	845.6	36%
Remove Clear Field	Clear Field	☑	CW Spandrel	210.69	ft²	0.205	BTU/ hr ft² °F	2.3.1	43.2	2%
Add Linear Interface Detail	Linear Interface Detail	☑	Storefront sill intersection at grade	46.69	ft	0.495	BTU/ hr ft °F	2.5.1	23.1	1%
Remove Linear Interface Detail	Linear Interface Detail	☑	Framed wall at grade	114.76	ft	0.477	BTU/ hr ft °F	8.6.4	54.7	2%
Remove Linear Interface Detail	Linear Interface Detail	☑	Framed wall at floor joist bypass	1030.05	ft	0.070	BTU/ hr ft °F	8.2.1	72.1	3%
Remove Linear Interface Detail	Linear Interface Detail	☑	Roof parapet at CIP/CMU	530.06	ft	0.252	BTU/ hr ft °F	7.5.1	133.6	6%
Remove Linear Interface Detail	Linear Interface Detail	☑	Roof parapet at wood frame	1038.50	ft	0.035	BTU/ hr ft °F	8.4.2	36.3	2%
Remove Linear Interface Detail	Linear Interface Detail	☑	Roof parapet at exterior insulated wood studs	130.31	ft	0.026	BTU/ hr ft °F	8.4.1	3.4	0%
Remove Linear Interface Detail	Linear Interface Detail	☑	Party wall intersection	829.00	ft	0.014	BTU/ hr ft °F	8.7.3	11.7	1%
Remove Linear Interface Detail	Linear Interface Detail	☑	Punched window perimeter at wood frame	349.00	ft	0.001	BTU/ hr ft °F	8.3.2	0.3	0%
Remove Linear Interface Detail	Linear Interface Detail	☑	Punched window perimeter at exterior insulated wood studs	0.00	ft	0.023	BTU/ hr ft °F	8.3.2	0.0	0%
Remove Linear Interface Detail	Linear Interface Detail	☑	Punched window perimeter at exterior insulated CIP/CMU	12.00	ft	0.206	BTU/ hr ft °F	7.3.12	2.5	0%
Remove Linear Interface Detail	Linear Interface Detail	☑	Wood frame at roof deck	384.55	ft	0.031	BTU/ hr ft °F	8.4.1	11.9	1%
Remove Linear Interface Detail	Linear Interface Detail	☑	Exterior insulated wood studs at roof deck	38.00	ft	0.021	BTU/ hr ft °F	8.2.5	0.8	0%
Remove Linear Interface Detail	Linear Interface Detail	☑	Exterior insulated CIP/CMU at roof deck	363.24	ft	0.057	BTU/ hr ft °F	8.4.4	20.7	1%
Remove Linear Interface Detail	Linear Interface Detail	☑	Exterior insulated CIP/CMU at floor bypass	190.44	ft	0.013	BTU/ hr ft °F	7.2.1	2.5	0%
Remove Linear Interface Detail	Linear Interface Detail	☐			ft		BTU/ hr ft °F		0.0	0%
Add Point Interface Detail	Point Interface Detail	☑	Glass Canopy Intersection	8	#	0.093	BTU/ hr °F	2.4.1	0.7	0%

ROOF

Clear Field Area Method

Select Area Calculation (Choose One)	Area	Units
○ Sum of Active Clear Field Areas (Default)	381.84	ft²
○ User Defined Area	Enter User Defined Opaque Area	ft²

Overall Opaque Wall Thermal Performance	
Opaque U-Value (BTU/hr ft² °F)	0.319
Effective R-Value (hr ft² °F/BTU)	3.1

Proposed Building Entries

Add/Remove Detail	Transmittance Type	Include	Transmittance Description	Area, Length or Amount Takeoff	Units	Transmittance Value	Units	Source Reference	Heat Flow (BTU/hr °F)	% Total Heat Flow
								Totals	121.9	100%
Add Clear Field	Clear Field	☑	R1 - Flat, Wood Joist	381.84	ft²	0.278	BTU/ hr ft² °F	calc	106.1	87%
Remove Clear Field	Clear Field	☐	R1 - Sloped, TJI	4220.67	ft²	0.023	BTU/ hr ft² °F	calc	0.0	0%
Remove Clear Field	Clear Field	☐	R2 - Deck, TJI	88.86	ft²	0.023	BTU/ hr ft² °F	calc	0.0	0%
Add Linear Interface Detail	Linear Interface Detail	☐	Roof curbs	#REF!	ft		BTU/ hr ft °F		-	-
Remove Linear Interface Detail	Linear Interface Detail	☑	Intersection with masonry firewall	277.58	ft	0.057	BTU/ hr ft °F	8.4.4	15.8	13%
Remove Linear Interface Detail	Linear Interface Detail	☐	Enter Description Here	Enter Length Here	ft	Enter Psi-Value Here	BTU/ hr ft °F	Enter Source Here	-	-
Add Point Interface Detail	Point Interface Detail	☐	Roof Drains	Enter Amount Here	#	Enter Chi-Value Here	BTU/ hr °F	10.4.1/10.4.2	-	-

Appendix 2 – Class D Cost Estimate

Mech HVAC + Public Realm Cost Estimates Class D Last updated: Oct 23, 2024

Massey Theatre Renovation (MTR) Project

A. Mech HVAC					
Estimated Construction Cost			**Notes 1**	**Notes 2**	**Business as Usual**
Oct 4 estimate ASHP system		$ 4,399,543			$ 2,161,096.05
Demo and Abatement	Allowance	Incl.			Incl.
Finishes R&R	Allowance	Incl.			Incl.
Misc - Lighting Fixtures, Fire Alarm, Security	Allowance	$ 500,000			$ 500,000
Misc - Structural, Transformer Upgrade	Allowance	$ 500,000			$ 500,000
MTS Decamping, Make Good, Relocation Etc	Allowance	$ 50,000			$ 50,000
Construction Manager Fee	5%	Incl.			$ 160,554.80
Subtotal Construction Cost		**$ 5,449,543**			**$ 3,371,650.85**
Design Cost					
A/M/E/S Design Fees	16.6%	$ 904,624			$ 559,694.04
Feasibility Study Fees		$ 31,000			$ -
ESC Monitoring Fees	Allowance	$ 31,000	Based on 21 month schedule		$ 31,000
CM Precon Fee Extension	Allowance	$ 15,000			$ 15,000
Misc. Professional Fees	2%	$ 100,000			$ 67,433
Subtotal Design Cost		**$ 1,081,624**			**$ 673,127.06**
Other Soft Costs					
Insurance Re-Up & Adder		$ 448,000			$ 448,000
TCPM Fees	Allowance	$ 120,000	Based on 21 month schedule		$ -
Subtotal Other Soft Costs		**$ 568,000**			**$ 448,000**
Contingency Reserves					
Design Contingency	10%	$ 544,954			$ 337,165.09
Construction Contingency	15%	$ 817,431			$ 505,747.63
General Owner Contingency	5%	$ 317,708			$ 202,238.90
Subtotal Contingency Reserves		**$ 1,680,094**			**$ 1,045,151.61**
A. Estimated Mech HVAC Total Cost		**$ 8,779,261**			**$ 5,537,929.52**
Rounded		**$ 8,800,000**			**$ 5,500,000.00**
Incremental Cost Upgrade vs BAU		**$ 3,300,000**			

B. Public Realm					
Estimated Construction Cost		**Site Recomm.**	**Site Needs**		**Business as Usual**
			$ 1,362,860.00	Demo Footprint	
Class D PFS Concept Plan Oct 2024		$ 3,260,000	$ 100,000.00	Drain tile landscape	$ 431,000.00
Construction Manager Fee	5%	$ 163,000	$ 73,143.00		$ 21,550.00
Subtotal Construction Cost		**$ 3,423,000**	**$ 1,536,003**		**$ 452,550.00**
Design Cost					
Civil, Elec/Lighting, Landscape Professional Design Fees	Allowance	$ 310,000	$ 200,000.00		$ 10,000.00
Feasibility Study Fees		$ 14,100	$ 14,100		$ -
Archaeology and Environmental	Allowance	$ 120,000	$ 120,000		$ 120,000.00
Arborist	Allowance	$ 75,000	$ 75,000		$ -
Misc. Professional Fees	2%	$ 68,460	$ 30,720.06		$ 2,600.00
Subtotal Design Cost		**$ 587,560**	**$ 439,820**		**$ 132,600.00**
Contingency Reserves					
Design Contingency	10%	$ 342,300	$ 153,600		$ 45,255.00
Construction Contingency	15%	$ 513,450	$ 230,400		$ 67,882.50
General Owner Contingency	5%	$ 188,265	$ 84,480		$ 29,257.50
Subtotal Contingency Reserves		**$ 1,044,015**	**$ 468,481**		**$ 142,395.00**
B. Public Realm Total		**$ 5,054,575**	**$ 2,444,304**		**$ 727,545.00**
1% Public Art Budget (New Capital Costs	**1%**	**$ 138,338**	**$ -**		**$ 62,655**
Rounded		**$ 5,200,000**	**$ 2,500,000**		**$ 700,000.00**
Incremental Cost Upgrade vs BAU		**$ 4,500,000**			
A & B TOTAL ESTIMATED COST		$ 13,972,174	$ 11,223,565		$ 6,328,129
A & B TOTAL ESTIMATED COST (rounded)		**$ 14,000,000**	**$ 11,300,000**		**$ 6,300,000**
Total Incremental Cost Upgrade v BAU		**$ 7,700,000**	**$ 5,000,000**		