



**Old Opera House
204 N. George Street
Charles Town, WV
Mechanical/Electrical Feasibility Study
September 18, 2023**

1) Background:

Comfort Design Incorporated (CDi) was contacted by Patrick Wallace with Old Opera House Theatre Company and Arts Centre to investigate and prepare a mechanical HVAC (Heating, Ventilation, & Air Conditioning) feasibility study on the Old Opera House Theatre building mechanical system replacement. This study and report will provide engineering recommendations on a mechanical system with electrical support requirements for HVAC replacement in the existing building. A site visit was performed on July 25th, 2023, by Joshua L. Catlett and Heather M. Bowers from CDi.

2) Existing:

Heating/Cooling: The existing building is heated by two fuel oil gas fired boilers with hot water coils on local air handling units. The existing building is cooled with multiple direct expansion (DX) air conditioning (AC) split systems. The air handling units are located in the basement and in the second-floor closet in the Dressing Room. All units have supply and return air ducts providing conditioned air to the occupied spaces.

Unit A (Dance Studio): The Dance Studio is being conditioned by a 3-ton AC split system and hot water coil with the AHU located in the Dressing Room closet and the outdoor unit located at the back of the building. The supply air is ducted above the ceiling with branch ducts to ceiling diffusers. The return air is fed from a duct riser located in the Construction Set room with high and low wall return grilles at the rear wall of the space.

Manufacturer: Heil	Manufacturer: Heil
Indoor AHU: Model - MB12F1900A3 Serial – EDD2X36FA1	Outdoor Condenser: Model – H2A3366K Serial: - Not Legible

Unit B (Dressing Room): The Dressing Room is being conditioned by a 3-ton AC split system and hot water coil with the AHU located in the Dressing Room closet with the outdoor unit located at the back of the building. The supply air is ducted above the ceiling with branch ducts to ceiling diffusers and wall registers/grilles. The return air is fed from a duct located in the closet with low wall return register/grille in the corridor wall of the space.

Manufacturer: Heil	Manufacturer: Heil
Indoor AHU: Model - MB12F1900A3 Serial – EDD2X36FA1	Outdoor Condenser: Model – H2A3366K Serial: - Not Legible



Unit C (Meeting Room): The Meeting Room is being conditioned by a 3-ton AC split system and hot water coil with the AHU located in the basement mechanical room with the outdoor unit located at the back of the building. The supply air is ducted above the ceiling with branch ducts to wall registers/grilles. The return air is fed from a duct located in the mechanical room with low wall return register/grille in the wall of the space.

Manufacturer: First Company	Manufacturer: Commercial Comfort
Indoor AHU: Model – 36HBXB-HW	Outdoor Condenser: Model: – CAC036HC
Serial – FC347375	Serial: - E050837353

Unit D (Lobby): The Lobby is being conditioned by a 5-ton AC split system and hot water coil with the AHU located in the basement storage room under the Lobby with the outdoor unit located at the back of the building. The supply air is ducted under the floor in the basement with branch ducts to floor registers/grilles. The return air is fed from a duct located in the storage room with wall return register/grille in the wall of the stairs down to the basement.

Manufacturer: First Company	Manufacturer: Commercial Comfort
Indoor AHU: Model – 60HBXB-HW	Outdoor Condenser: Model: – CAC060HC
Serial – FC347376	Serial: - E051207058

Unit E&F (Auditorium/Balcony): The Auditorium is being conditioned by two 10-ton AC split system and hot water coils with the AHU located in the basement mechanical room with the outdoor units located at the back of the building. The supply air is ducted from in the basement to the above the ceiling with branch ducts to ceiling diffusers. The return air is fed from a duct located in the mechanical room under the Auditorium with low wall return register/grilles in the wall under the stage.

Unit E

Manufacturer: ICP	Manufacturer: ICP
Indoor AHU: Model – HBC120M2AA	Outdoor Condenser: Model: – CAE120HA
Serial – 4204X01251	Serial: - G054230084

Unit F

Manufacturer: ICP	Manufacturer: ICP
Indoor AHU: Model – HBC120M2AA	Outdoor Condenser: Model: – CAE120HA
Serial – 1404F24565	Serial: - G054230077

Unit G (Green Room): The Green Room is being conditioned by a 3-ton AC split system and hot water coil with the AHU located in the basement mechanical/crawlspace with the outdoor unit located at the back of the building. The supply air is ducted under the floor in the basement mechanical/crawlspace with branch ducts to floor registers/grilles. The return air is fed from a duct located in the basement mechanical/crawlspace with floor return register/grille in the corridor and Green Room.

Manufacturer: Heil	Manufacturer: Heil
Indoor AHU: Model – FSM2X3600A1	Outdoor Condenser: Model – H2A3366K
Serial – A046382132	Serial: - Not Legible



Hot Water Boilers: The building is heated with two fuel oil gas boilers. Boiler #1 is in the basement closet under the Stage and Boiler #2 is located in the rear of the mechanical/crawlspace under the Construction Set room. Boiler #1 serves Units C, D, E, F. Boiler #2 serves Units A, B, & G.

Boiler #1 Mfr.:	Weil-McLain	Boiler #2 Mfr.:	Weil-McLain
	Model – 578		Model – P-SGO-5
	4.45 GPH		1.45 GPH
	521,000 btuh		174,000 btuh

Electrical Service:

Electrical service rating is 600A, 208/120V, 3 phase, 4W service. Incoming electrical enters the building through a 600A main disconnect and connects to a 600A, Main Distribution Panel (MDP) with a main circuit breaker rated for 600A.

The Main Distribution Panel (MDP) is located on the interior of an exterior wall in a storage area in the basement. The MDP feeds three 200A, 208/120V, 3 phase panels, a 100A, 208/120V, 3 phase panel, a 125A, single phase lighting panel, an indoor HVAC unit (40A, 208/120V, 3 phase), and outdoor HVAC unit (150A, 208/120V, 3 phase).

The panel located directly beside the MDP is labeled Panel 2 (P-2) and is a 200A, 208/120V, 3 phase panel. It is directly fed from the MDP. It provides power to upper and lower stage lighting panels, fire alarm system, existing HVAC equipment such as the furnace, Green Room outdoor and indoor units, and a few small motor loads.

There are a total of four panels located on the first floor. Location of Panel 1 (P-1) is in the set construction area and panels P-3, P-6, P-9 are located on the stage. Panels P-1, P-3, and P-6 are fed directly from the MDP and P-2 is fed from a 60A, 2 pole breaker installed in panel 2 (P-2). Panels 3,6, and 9 are primarily used for stage lighting and receptacles with no HVAC loads connected. Panel 1 (P-1) is a 200A, 208/120V, 3 phase, 4W panel and contains much of the HVAC loads for the smaller offices and workspaces within the building. It also supplies power to panel P-5 located within the upstairs dressing room.

3) Observations:

The existing AC indoor/outdoor units (A-G), boiler #1, and boiler #2 are beyond their life expectancy and need to be withdrawn from use. The supply/return air ducts and grilles/registers throughout the building were found to be both in inadequate condition for reuse and acceptable condition for reuse. The engineer and contractor shall determine the acceptable reuse of ductwork during design and installation.



The existing Main Distribution Panel was installed in 2012 and still has capacity to house up to (6) 3 pole breakers depending on their size. Several of the existing panels are outdated and do not have the spare capacity to house any additional loads.

4) Findings:

An ACCA Manual N was performed on the existing building spaces to determine the mechanical systems zoning and heating/cooling loads. See attached floor plans for zoning schematic. The following is the conditioned zones:

<u>Basement Storage</u> Heating: 20,753 btuh (1.7 tons) Cooling: 23,981 btuh (2.0 tons)	<u>Balcony</u> Heating: 44,068 btuh (3.7 tons) Cooling: 58,831 btuh (4.9 tons)
<u>Basement Mech/Crawlspace</u> Heating: 11,483 btuh (0.9 tons) Cooling: 16,140 btuh (1.3 tons)	<u>Green Room</u> Heating: 20,549 btuh (1.7 tons) Cooling: 26,796 btuh (2.2 tons)
<u>Basement Meeting</u> Heating: 27,743 btuh (2.3 tons) Cooling: 42,846 btuh (3.6 tons)	<u>Dance Studio</u> Heating: 32,447 btuh (2.7 tons) Cooling: 31,839 btuh (2.6 tons)
<u>Lobby</u> Heating: 19,092 btuh (1.6 tons) Cooling: 22,272 btuh (1.9 tons)	<u>Construction Set Room</u> Heating: 26,151 btuh (2.2 tons) Cooling: 26,660 btuh (2.2 tons)
<u>Auditorium</u> Heating: 128,744 btuh (10.7 tons) Cooling: 214,298 btuh (17.9 tons)	<u>Dressing Rooms</u> Heating: 17,729 btuh (1.5 tons) Cooling: 21,192 btuh (1.8 tons)
<u>Stage</u> Heating: 101,763 btuh (8.5 tons) Cooling: 105,032 btuh (8.8 tons)	

The existing electrical equipment in several areas of the building is outdated and needs to be upgraded with new panels, circuit breakers, and wiring. The existing electrical service size needs to be increased to support any upgrades to the mechanical system.

Proposed Work:

Demolition: The existing building mechanical systems will be demolished. The mechanical contractor will be responsible for removing the existing diffusers/registers, ductwork, indoor air handling units and outdoor condensing units. The general contractor shall patch, and repair existing mechanical openings as required.



The existing incoming electrical gear will be demolished. The electrical contractor will be responsible for removing the existing electrical gear, including disconnects, panels, and abandoned wiring and conduits to existing mechanical equipment. Panels deemed outdated will be removed. Branch circuits to remain in use will be field investigated to determine if the circuit wiring and conduits can be reused.

Space Heating & Cooling: It is proposed that the building be heated, ventilated, and air conditioned by a new Variable Refrigerant Flow Heat Recovery System (VRF). The VRF system will have multiple indoor air handling units (AHU) connected to each outdoor designated condensing unit (HP). The following is the VRF system configuration:

Outdoor Units	Cool/Heat Capacity	Zone Names	Indoor Units	AHU Type	Cool/Heat Capacity
Mitsubishi/Trane TURYE0723AN40AN	6.0 tons	Basement Storage	Mitsubishi/Trane TPVFYP024AM141A	Multi-position	2.0 tons
		Basement Meeting	Mitsubishi/Trane TPVFYP048AM141A	Multi-position	4.0 tons
Mitsubishi/Trane TUHYE3603BN40AN	30 tons	Upper Auditorium	Mitsubishi/Trane TPEFYP072MH140A	Ceiling-Concealed	6.0 tons
		Balcony	Mitsubishi/Trane TPEFYP072MH140A	Ceiling-Concealed	6.0 tons
		Lower Auditorium	Mitsubishi/Trane TPEFYP072MH140A	Ceiling-Concealed	6.0 tons
		Lower Auditorium	Mitsubishi/Trane TPEFYP072MH140A	Ceiling-Concealed	6.0 tons
		Lower Auditorium	Mitsubishi/Trane TPEFYP072MH140A	Ceiling-Concealed	6.0 tons
Mitsubishi/Trane TUHYE1443AN40AN	12 tons	Stage Catwalk	Mitsubishi/Trane TPFFYP012CS140A	Floor-Standing	1.0 tons
		Stage Catwalk	Mitsubishi/Trane TPFFYP012CS140A	Floor-Standing	1.0 tons
		Stage Catwalk	Mitsubishi/Trane TPFFYP012CS140A	Floor-Standing	1.0 tons
		Stage Catwalk	Mitsubishi/Trane TPFFYP012CS140A	Floor-Standing	1.0 tons
		Stage Lower	Mitsubishi/Trane TPVFYP036AM141A	Multi-position	3.0 tons
		Stage Lower	Mitsubishi/Trane TPVFYP036AM141A	Multi-position	3.0 tons
		Orchestra Pit	Mitsubishi/Trane TPVFYP024AM141A	Multi-position	2.0 tons



Mitsubishi/Trane TUHYE1443AN40AN	12 tons	Green Room	Mitsubishi/Trane TPVFYP036AM141A	Multi- position	3.0 tons
		Dance Studio	Mitsubishi/Trane TPVFYP036AM141A	Multi- position	3.0 tons
		Construction Set Room	Mitsubishi/Trane TPLFYP018FM140A	Ceiling- Cassette	1.5 tons
		Construction Set Room	Mitsubishi/Trane TPLFYP018FM140A	Ceiling- Cassette	1.5 tons
		Dressing Room	Mitsubishi/Trane TPVFYP024AM141A	Multi- position	2.0 tons
		Lobby	Mitsubishi/Trane TPVFYP024AM141A	Multi- position	2.0 tons

Zoning Systems Summary:

Basement Storage – The new AHU shall be installed in the mechanical/storage space. The conditioned air will be provided to the spaces through new insulated galvanized steel supply and return duct distribution systems. The supply and return air ducting will be connected to new ceiling and/or wall mounted diffusers/registers located within the occupied spaces.

Basement Meeting – The new AHU shall be installed in the same location as the existing AHU in the mechanical/storage space. The conditioned air will be provided to the spaces through existing supply/return ducts and new insulated galvanized steel supply and return duct. The new supply and return air duct will be connected to additional supply and return ceiling and/or wall mounted diffusers/registers located within the occupied spaces.

Upper Auditorium – The new AHU shall be installed above the ceiling of the Auditorium. The conditioned air will be provided to the space through a new insulated galvanized steel supply and return duct distribution systems. The supply air ducting will be connected to the existing ceiling supply air diffusers. The return air ducting will be connected to a custom above ceiling plenum box made to fit the existing exhaust ceiling grille of the Auditorium.

Balcony – The new AHU shall be installed above the ceiling of the Balcony. The conditioned air will be provided to the space through a new insulated galvanized steel supply and return duct distribution systems. The supply air ducting will be connected to the existing and new ceiling supply air diffusers. The return air ducting will be connected to a custom above ceiling plenum box made to fit the existing exhaust ceiling grille of the Balcony.

Lower Auditorium – The new AHUs (3 total) shall be installed in the mechanical/storage space in the approximate location of the existing AHUs. The conditioned air will be provided to the spaces through new insulated galvanized steel supply and return duct distribution systems. The supply and return ductwork will be in the basement



mechanical/storage spaces and connected to new floor and/or wall mounted diffusers/registers located within the occupied spaces.

Stage Catwalk – The new AHUs (4 total) shall be installed on wall mounted platforms located above the catwalk. The height above the catwalk shall be determined by the theater staff.

Stage Lower – The new AHUs (2 total) shall be installed in the mechanical/storage space below the Stage. The conditioned air will be provided to the spaces through new insulated galvanized steel supply and return duct distribution systems. The supply and return ductwork will be in the basement mechanical/storage spaces and connected to new floor and/or wall mounted diffusers/registers located within the occupied spaces.

Orchestra Pit – The new AHU shall be installed in the mechanical/storage space below the Stage. The conditioned air will be provided to the spaces through new insulated galvanized steel supply and return duct distribution systems. The supply and return ductwork will be in the basement mechanical/storage spaces and connected to new floor and/or wall mounted diffusers/registers located within the occupied spaces.

Green Room – The new AHU shall be installed in the same location as the existing AHU in the mechanical/crawlspace. The conditioned air will be provided to the spaces through the existing supply/return ducts and existing diffuser/registers. Additional ductwork and diffusers/registers shall be provided as needed.

Dance Studio – The new AHU shall be installed in the same location as the existing AHU in the second-floor mechanical closet of the Dressing Room. The conditioned air will be provided to the spaces through the existing supply/return ducts and existing diffuser/registers. Additional ductwork and diffusers/registers shall be provided as needed.

Construction Set Room – The new AHUs (2 total) shall be installed in the room, mounted at the ceiling height, and suspended from the structure. The final location of each AHU shall be determined by the theater staff.

Dressing Room – The new AHU shall be installed in the same location as the existing AHU in the mechanical/crawlspace. The conditioned air will be provided to the spaces through the existing supply/return ducts and existing diffuser/registers. Additional ductwork and diffusers/registers shall be provided as needed.

Lobby – The new AHU shall be installed in the same location as the existing AHU in the basement storage below the Lobby. The conditioned air will be provided to the space through the existing supply/return ducts and existing diffuser/registers. Additional ductwork and diffusers/registers shall be provided as needed.



Automatic Temperature Control: The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controller, and/or integrated web-based interface. The CMCN shall support operation monitoring, scheduling, and error email distribution. The simple touch remote controller can control each group. The simple touch controller functions include on/off, operation mode, temperature setting, fan speed setting, and error notice. Central controller can control or monitor each indoor unit. Central controller features include the same as the local remote controller plus ability to set schedules, permit/prohibit local operation, set temperature range limits, and many more functions as listed in submittal data.

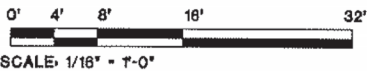
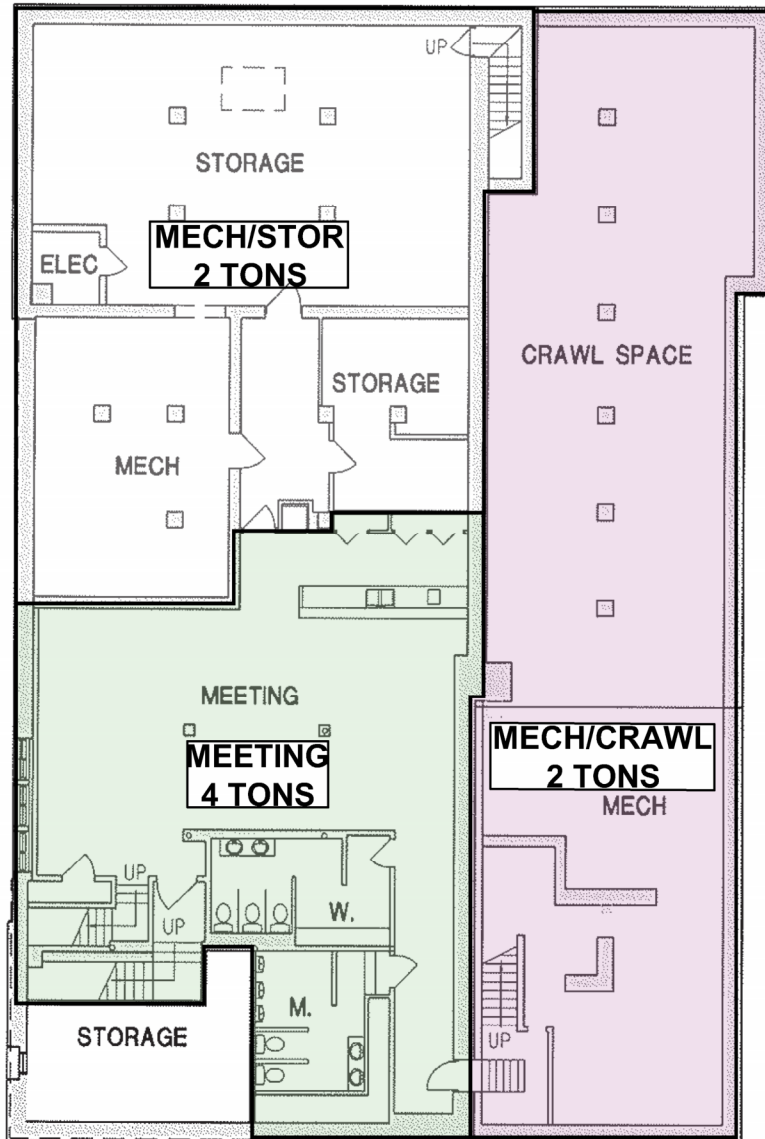
Ventilation: Each AHU, if applicable, will have an outside air duct connected to the return air with a modulating outside air damper. The unit will maintain the dampers to the minimum outside air design flow during occupied/unoccupied operation and increase to the maximum outside air design flow during a scheduled ventilation cycle or CO2 sensor demand control.

Electrical

The electrical service size will be upgraded to 1200A, 208/120V, 3 phase, 4W service. New electrical gear including main disconnect, 1200A switchgear, CT Cabinet, (2) 400A, 3 phase panels boards, (4) 200A, 3 phase panelboards, and (3) 100A sub panelboards will be installed. All new disconnects, wiring, and conduits to new mechanical equipment will be provided. New branch circuit wiring to existing circuits remaining in use will be provided if investigation of circuit deems the existing circuit wiring is damaged and can not be reused. Light fixtures that have not been updated to LED will be installed to meet Energy Compliance Codes.

Joshua L. Catlett, P.E.
Professional Mechanical Engineer

Heather Bowers
Electrical Design Engineer



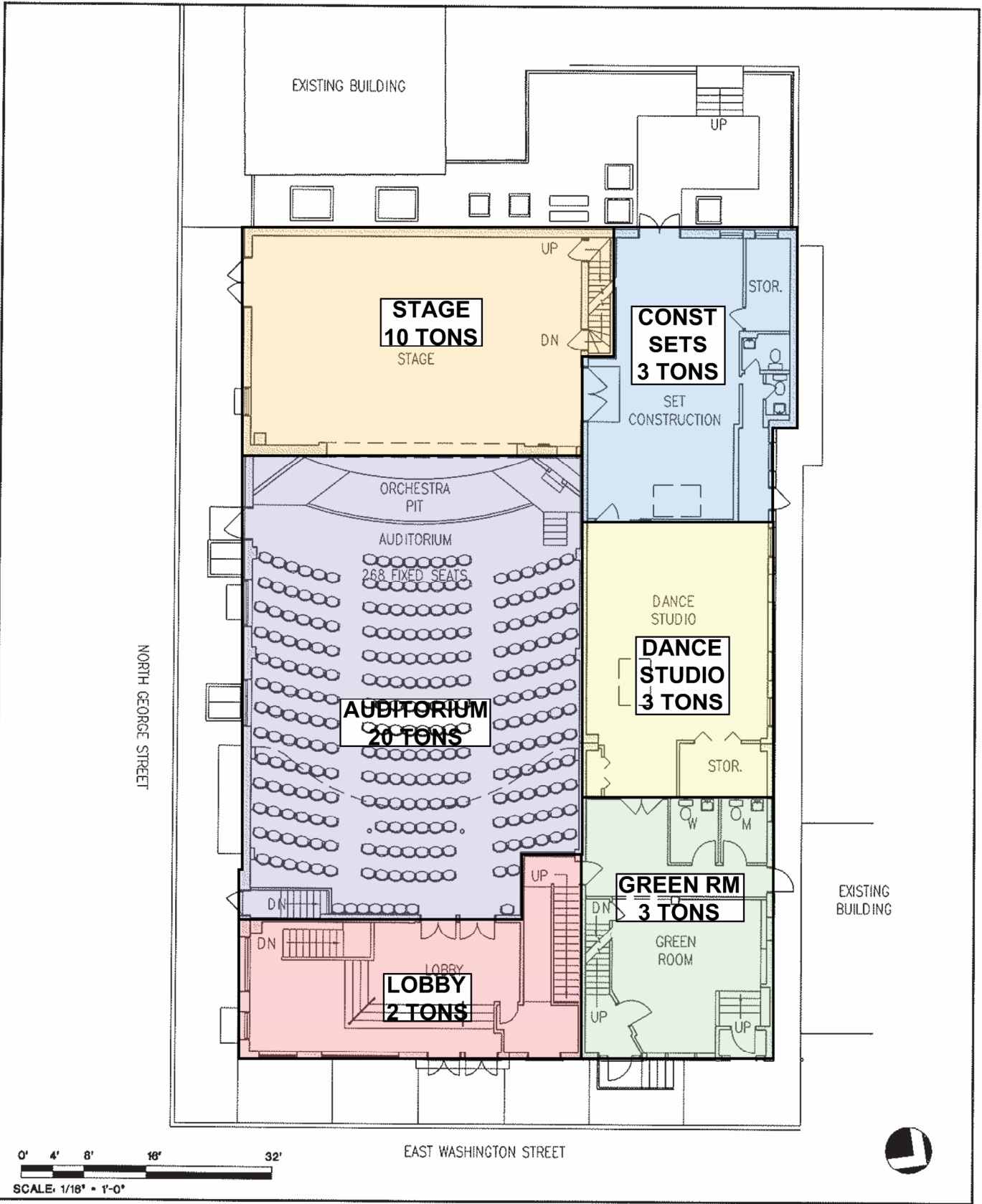
THE OLD OPERA HOUSE
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EXISTING BASEMENT PLAN

PROJ. NO. 108012 08/19/09



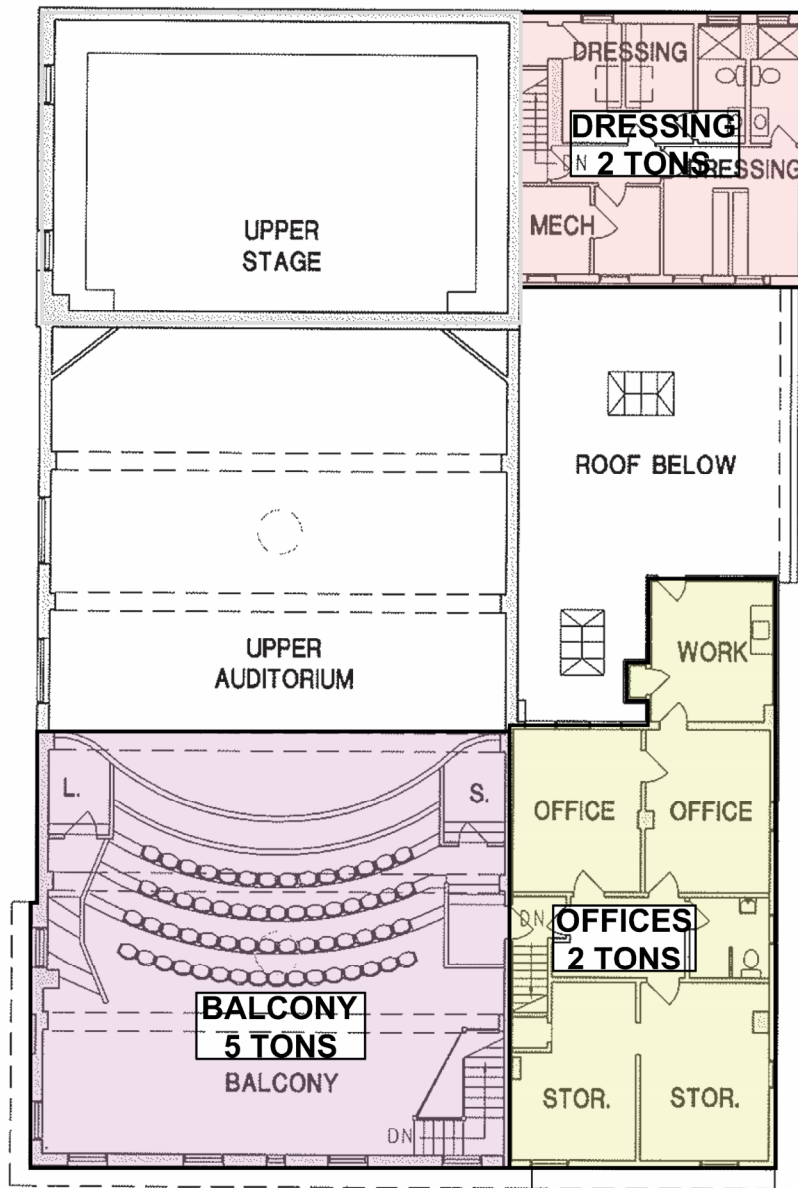
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EXISTING FIRST FLOOR PLAN

PROJ. NO. 108012 08/19/09



0' 4' 8' 18' 32'
 SCALE: 1/16" = 1'-0"



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EXISTING SECOND FLOOR PLAN

PROJ. NO. 108012 08/19/09