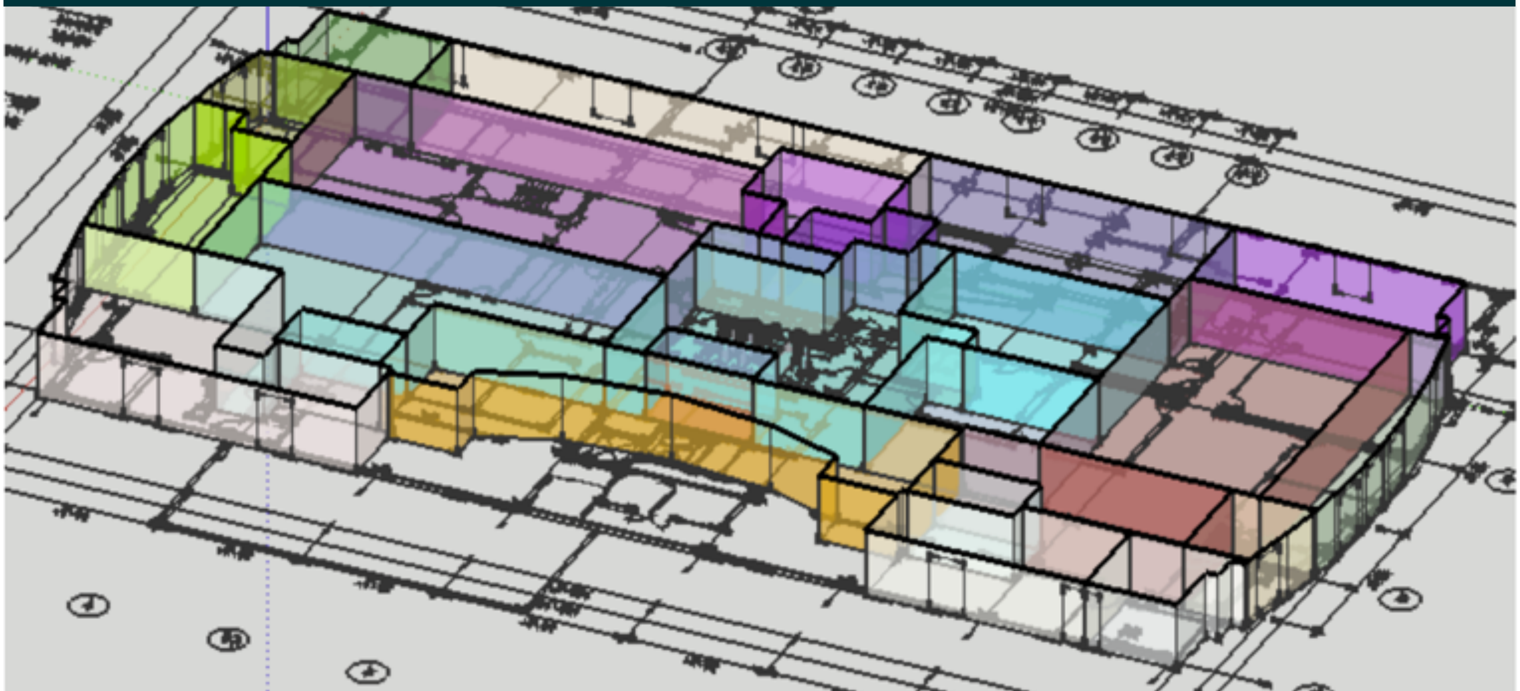

Preliminary Energy Performance Analysis

Arlington County 4.1 Site Plan Submission

1901 N Moore St

Arlington, Virginia

Arlington 4.1 SP Report v2.0

April 23rd, 2021

SUSTAINABLE BUILDING PARTNERS

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Disclaimer: *This analysis is not intended to predict the absolute energy consumption of the proposed facility but rather it is intended to estimate order of magnitude savings for alternative systems and building options based on refined assumptions, building performance metrics and energy modeling expertise. Change in weather conditions, operational characteristics, end-user, miscellaneous electrical loads, controls alterations and other unpredictable metrics prevent the model from accurately predicting the actual annual energy consumption of any facility.*

Purpose

Design Evaluation

Sustainable Building Partners, LLC (SBP) has developed a preliminary box energy simulation using EnergyPlus v9.1 (OpenStudio v2.8) for the proposed 1901 N Moore St building in Arlington, Virginia. SBP utilizes the model as a design tool specifically for the purpose of enhancing the energy performance of the facility, reducing carbon emissions, and to provide the design team with data to use in the decision-making process.

Figure 1: Rendering of 1901 N Moore St (as of 4/13/21 Progress)

Arlington County 4.1 Site Plan Submission

As part of the conditions packaged for the Arlington 4.1 Site Plan Submission (SPC), the project is required to demonstrate compliance the following energy performance targets:

- **16% Energy Cost Savings as compared to a LEED Baseline design (ASHRAE 90.1-2010 Appendix G)**
- **EnergyStar score of ≥75**

As part of this process, the team will also evaluate the feasibility of certain electrification strategies.

LEED Benchmarking

This project will be pursuing LEED V4: New Construction. As part of this process, the design is required to achieve 5% energy costs savings as compared to an ASHRAE 90.1-2010 Appendix G Baseline design. This analysis does not specifically evaluate LEED performance, but does reflect general savings expectations.

Preliminary Energy Estimates

This section of the report summarizes the results of the whole building hourly energy simulation. Table 1 of this report summarizes the energy modeling results for the currently specified design.

Summary of Performance & Primary Design Alternates

The current design is anticipated to achieve ≥16% energy cost savings. **Error! Reference source not found.** provides the currently proposed performance.

Table 1: Annual Energy Consumption Estimates

Model Deign	Description	Annual Energy Cost (Cost/Unit)	Energy Cost Savings	Site EUI (kBtu/sf)	Source EUI (kBtu/sf)	GHG (MT CO2e)	Energy Star Score
Proposed	**As of 4/13/21 Progress Set** Heating: Gas DOAS DHW: Gas Condensing Boilers	$1,090	**17 – 19%**	**46**	**105**	**1,620**	**75+**
Tier 1	**15%+** Savings with *High Level* of Confidence	$1,135	**16%+**	**47**	**110**	**1670**	**75+**
Tier 2	**25%+** Savings with *High Level* of Confidence	$1,000	**25%+**	**37**	**95**	**1,400**	**85+**

Primary Features Driving Energy Performance

- Air-cooled variable refrigerant flow systems (heat recovery similar to Daikin REYQ)
- Decoupled ventilation provided by gas-fired DOAS
- High-efficiency gas-fired condensing boilers
- Anticipated 10%+ interior lighting power reduction (common only, ≤0.54 W/sf)
- Anticipated 40%+ garage lighting power reduction (LED fixtures, ≤0.15 W/sf)
- EnergyStar appliances
- Low flow plumbing fixtures
- High performance windows

Additional design details have been summarized later in the report.

Design Tiers

These hypothetical designs were established at the beginning of the design process to serve as performance targets as the design progressed.

- **Tier 1**: Proposed design plus additional load reduction and energy saving strategies that would increase the overall energy performance of the building and maintain a high level of confidence that the design obtains at least 15%+ energy cost savings.

- **Tier 2**: Tier 1 plus additional measures to achieve at least 25%+ energy cost savings.

Design Challenges & Limitations

The following subsections summarize the primary limiting factors and other unique conditions associated with this design.

Preliminary Design

Throughout the early-design process, the project team has been evaluating the feasibility of incorporating various Energy Efficiency Opportunities (EEOs) presented in this analysis. Many of the EEOs will likely be part of the base design, but cannot be fully incorporated and quantified until later in the design process (e.g. lighting). The remaining measures will be fully vetted and established as a design target moving forward if deemed feasible for this project based on energy savings, first cost, and site and architectural limitations.

Energy Use Intensity

The building's site Energy Use Intensity (EUI) sits well within the 'typical' range for multifamily building and is reasonable given the design conditions. There are a few design factors that yield a slightly elevated site EUI, but these factors do not signify a poor design. Specifically, the use of on-site natural gas systems (e.g. DHW, RTU furnace) yield an increase in *site* EUI compared to an electric system, but this delta is eliminated when evaluating energy as a *source* EUI or greenhouse gas emissions metric. Site EUI is not a useful metric when used to compare different energy systems as it does not capture generation, distribution, and transmission losses associated with grid electricity.

Energy Efficiency Opportunities

The following is a list of specific load reduction and energy savings strategies that could increase the overall energy performance of the building. The measures are grouped by design component, but otherwise, are not in any particular order. SBP has provided the results of each measure for informational purposes only and does not necessarily recommend the inclusion of all measures.

Table 2: Detailed Energy Savings Strategies

EEO	Energy Saving Measure	Energy Cost Savings		EUI Reduct (kBtu/sf)*		GHG Reduction (mtCO2eq)*	Design Scheme
				Site	Source		
	Building Envelope						
1	Exterior Wall - No Continuous Insulation *– performance reduction measure*	-$17,000	-3.7%	-2.6%	-3.5%	-3.3%	--
2	Exterior Wall - 2" C.I. Insulation (R-10)	$1,700	0.4%	0.3%	0.4%	0.3%	Tier 2
3	Exterior Wall – R-19 + R-7.5 C.I	$700	0.1%	0.1%	0.1%	0.1%	--
4	R-40 Roof Insulation	$2,000	0.4%	0.4%	0.4%	0.4%	Tier 2
5	Window Upgrade - U-Value	$5,600	1.2%	0.9%	1.2%	1.1%	Tier 2
6	Window Upgrade - SHGC	$1,300	0.3%	0.1%	0.3%	0.2%	Tier 2
7a	Reduced Window-Wall Ratio (40%)	$4.5k – $7k	1.0 - 1.5%	0.7 – 1.0%	0.9 – 1.4%	0.8 – 1.3%	--
7b	Reduced Window-Wall Ratio (30%)	$9k – $14k	2.0 – 3.0%	1.4 – 2.1%	1.9 – 2.8%	1.7 – 2.5%	--
	Lighting						
8	Interior Lighting Power Reduction (Owner)	$6,500	**1.2%**	0.7%	1.0%	0.9%	Tier 1 (partial)
9	Dwelling Unit Lighting Reduction	$9,000	**1.7%**	0.8%	1.1%	1.0%	Tier 2
10	Garage Lighting Power Reduction	$6,000	**1.2%**	0.6%	0.9%	0.8%	Tier 1 (partial)
	Plug-Loads/Process Equipment						
11	Energy Star Dryers	$5,400	**1.0%**	0.8%	1.1%	1.0%	Tier 2
12	Garage Fan VFD Controls	$5,800	**1.1%**	0.3%	0.4%	0.4%	Tier 1
	Domestic Hot Water						
13	Premium Low Flow Fixtures	$14,000	**2.7%**	0.7%	0.3%	0.4%	Tier 2
14	In-Unit Electric Storage Water Heaters Insulation *– performance reduction*	-$69,000	**-15.4%**	-1.1%	-12.6%	-9.4%	--
	HVAC						
15	Ventilation Energy Recovery	$15,000	**3.0%**	13.7%	5.4%	7.7%	Tier 2
16	Reduce Corridor Outside Air	$19,000	**3.8%**	7.0%	4.8%	5.5%	--
17	Decoupled Corridor Outside Air	$18,000– 25,000	**4.0 – 5.5%**	10.0 – 11.0%	7.0 – 8.0%	5.0 – 6.0%	Tier 2
18	Split System Heat Pumps in Dwelling Units *– performance reduction*	(-$22,000) – (-$18,000)	**(-5%) – (-4%)**	(-2.0) – (-3.0%)	(-3.0) – (-4.0%)	(-3.0) – (-4.0%)	--

***Negative (-) values represents an increase in overall EUI or GHG**

Measure Narrative Descriptions

Listed below are narrative descriptions of the Load Reduction Opportunities summarized in Table 2.

<table>
<tr><th colspan="2">EEO-1: Exterior Wall - No Continuous Insulation (Adverse Measure, not recommended)</th></tr>
<tr><th>Design Condition</th><th>Proposed Upgrade</th></tr>
<tr><td>▪ The design has not yet defined insulation levels. SBP has modeled insulation for metal-framed construction that meets the prescriptive requirements of ASHRAE 90.1-2010 at:
o R-7.5 C.I. + R-13 Batt</td><td>▪ This measure has been provided for information purposes only and is intended to quantify the benefit of continuous insulation. This measure is not recommended.
o This measure evaluates the complete removal of the continuous insulation in the proposed wall assembly</td></tr>
<tr><th colspan="2">Additional Benefits/Discussion</th></tr>
<tr><td colspan="2">o This measure does not assess the moisture/condensation implication of removing insulation
o Removing continuous insulation would not meet Prescriptive energy code requirements</td></tr>
</table>

<table>
<tr><th colspan="2">EEO-2: Exterior Wall Upgrade – 2” Continuous Insulation</th></tr>
<tr><th>Design Condition</th><th>Proposed Upgrade</th></tr>
<tr><td>▪ The design has not yet defined insulation levels. SBP has modeled insulation for metal-framed construction that meets the prescriptive requirements of ASHRAE 90.1-2010 at:
o R-7.5 C.I. + R-13 Batt</td><td>▪ Continuous insulation is generally the most effective way to mitigate heat loss as it avoids thermal bridging and subsequent performance derating typically caused by framing systems.
▪ Consider using 2” of continuous insulation at an effective performance of R-10 C.I.</td></tr>
<tr><th colspan="2">Additional Benefits/Discussion</th></tr>
<tr><td colspan="2">o Insulation measures provide improvements to overall thermal comfort, though these benefits are not directly captured in this analysis.
o Insulated measure typically see diminishing returns as more insulation is added with the first few inches provides the highest value.</td></tr>
</table>

<table>
<tr><th colspan="2">EEO-3: Increased Above Grade Wall Insulation (R-19)</th></tr>
<tr><th>Design Condition</th><th>Proposed Upgrade</th></tr>
<tr><td>▪ The design has not yet defined insulation levels. SBP has modeled insulation for metal-framed construction that meets the prescriptive requirements of ASHRAE 90.1-2010 at:
o R-7.5 C.I. + R-13 Batt</td><td>▪ Consider installing batt insulation at R-19 or better for all exterior walls.</td></tr>
<tr><th colspan="2">Additional Benefits/Discussion</th></tr>
<tr><td colspan="2">o Insulation measures are generally subject to diminishing returns and it’s not always cost-effective to increase insulation thickness/R-value.
o R-19 batt insulation requires 2x6 framing, where R-13 only requires 2x4 framing. As a result, this increase in insulation also results in a small loss of interior floor area (roughly 2” along the exterior walls).</td></tr>
</table>

EEO-4: Increased Roof Insulation (R-40)	
Design Condition	Proposed Upgrade
▪ The roof insulation was assumed at R-20 based on standard design practice.	▪ Consider installing insulation at R-40 or better at all roof areas.
Additional Benefits/Discussion	
o Insulation measures are generally subject to diminishing returns and it's not always cost-effective to increase insulation thickness/R-value.	

EEO-5: Window Upgrade - Reduced Conductivity	
Design Condition	Proposed Upgrade
▪ The window performance is not currently defined and been estimated based on typical performance values for aluminum frame with double pane low-e glazing. Whole assembly performance as follows: o U-0.45 / 0.40 SHGC (frame + glass)	▪ Consider targeting a window assembly performance of U-0.35 or better. This can be achieved through a variety of strategies including but not limited to: o Argon-fill – 35% reduction in conductivity, which reduces both conduction and convection within the IGU. The use of argon gas can improve the COG U-value of the IGU to 0.25 (~14%). o Room-Side Low-E (Surface #4) - Surface #4 low-E reduces the emissivity of the interior surface by approximately 75% compared to clear glass, which reduces heat loss and improves thermal comfort in the space. A room-side low-E coating can reduce Center of Glass U-values to around 0.23 for glass with air fill and 0.20 for glass with argon. o Premium thermally broken framing
Additional Benefits/Discussion	
o Note that assembly U-value (frame + glass) is the performance regulated by ASHRAE and IGU performance is impacted considerably by framing decisions. For example, an IGU with U-0.29 coupled with thermally-broken aluminum framing is generally in the range of U-0.38-0.50 o The performance values used in this analysis are conservative and may be exceeded	

EEO-6: Window Upgrade – Reduced SHGC	
Design Condition	Proposed Upgrade
▪ The window performance is not currently defined and been estimated based on typical performance values for aluminum frame with double pane low-e glazing. Whole assembly performance as follows: o U-0.45 / 0.40 SHGC (frame + glass)	▪ Consider selecting a glass with a performance of 0.25 or lower, which is consistent with products such as PPG Solarban 70XL or Viracon VNE 1-63.
Additional Benefits/Discussion	
o SHGC reduction options that significantly impact VLT can result in reduced natural light in spaces and increased electric lighting energy in buildings with active daylight controls.	

EEO-7a: Reduced Window Area (40%)	
Design Condition	Proposed Upgrade
▪ The window area is currently specified at 56% of the gross wall area. ▪ Update (4/13/21 Progress)	▪ Consider reducing glazing area to 40% of the gross window area.
Additional Benefits/Discussion	
o N/A	

EEO-7b: Reduced Window Area (30%)	
Design Condition	Proposed Upgrade
▪ The window area is currently specified at 56% of the gross wall area. ▪ Update (4/13/21 Progress)	▪ Consider reducing glazing area to 30% of the gross window area.
Additional Benefits/Discussion	
o N/A	

EEO-8: Lighting Power Reduction – Owner Controlled	
Design Condition	Proposed Upgrade
▪ The lighting designs were not available for this analysis and were estimated at 0.60 W/sf. ▪ Update (4/13/21 Progress): The design is anticipated to achieve ≥10% LPD reduction (0.54 W/sf).	▪ Consider designing back-of-house and front-of-house lighting to a total lighting power density of 0.48 W/sf or less (20%. reduction).
Additional Benefits/Discussion	
o Maintenance/Replacement Savings – LED fixtures typically have a useful life of 50,000 Hours o Improved Light Quality – LED are available in a variety of colors and qualities to match most applications. Particularly they are available with high CRIs and are able to closely match natural light	

EEO-9: Lighting Power Reduction – Dwelling Units	
Design Condition	Proposed Upgrade
▪ The lighting designs were not available for this analysis and were modeled in line with the LEED Multifamily Midrise simulation guideline allowance of 0.90 W/sf. This power is weighted average reflecting both hard-wired fixtures as well as future plug-in type fixtures not in the current design scope.	▪ Consider a design that uses all LED type fixtures and works to minimize total lighting power in the space. Note however that the baseline allowance is very aggressive, thus an all-LED design does not necessarily dictate savings and additional effort should be made to ensure only high efficacy LED are used and over lit areas are avoided. This measure assumes a 20% reduction below the allowance.
Additional Benefits/Discussion	
o This measure yields a split-benefit with tenant seeing most of the direct savings	

EEO-10: Lighting Power Reduction – Garage Lighting	
Design Condition	Proposed Upgrade
▪ The lighting designs were not available for this analysis and were estimated at 0.20 W/sf. ▪ Update (4/13/21 Progress): The design is anticipated to achieve ≥40% LPD reduction (0.15 W/sf) given the all LED design.	▪ Consider an all LED design package as well as a thoughtful fixture layout that avoids over-lighting. A well-designed lighting system that uses primarily LED fixtures can achieve lighting powers in the range of 0.08 – 0.15 W/sf. This measure assumes an LPD of 0.12 W/sf in the parking area.
Additional Benefits/Discussion	
o Maintenance/Replacement Savings – LED fixtures typically have a useful life of 50,000 Hours o Improved Light Quality – LED are available in a variety of colors and qualities to match most applications. Particularly they are available with high CRIs and are able to closely match natural light	

EEO-11: EnergyStar Dryers	
Design Condition	Proposed Upgrade
▪ The appliance selections were not available for the first iteration of this analysis, but the dryers are assumed to be standard performance units.	▪ EnergyStar has recently added a rating standard for residential clothes dryers. Consider installing EnergyStar qualified Dryers in all residential units. This Dryers generally yield about a 20% reduction in energy as compared to a unit meeting the minimum federal standard.
Additional Benefits/Discussion	
o The dryers are assumed to be electric	

EEO-12: Garage Ventilation VFD Controls	
Design Condition	Proposed Upgrade
▪ The garage ventilation system is not yet defined and but is assumed to be a code-required contaminant-monitoring system that cycles the exhaust fans on/off based on emissions thresholds.	▪ Consider incorporating a VFD controls into the existing system that allows the exhaust and make-up air fans to modulate between 5% - 100% based on emissions concentration. This allows the system to take advantage of fan-affinity laws to yield a lower operating fan power at part-load.
Additional Benefits/Discussion	
o The VFD control may also eliminate the need for a separate small minimum flow fan, as the VFD may allow the system to modulate down to the 5% minimum flow required by code.	

EEO-13: Premium Low Flow Fixtures	
Design Condition	Proposed Upgrade
▪ The plumbing fixture flow rates have not yet been defined and have been assumed as follows: o Showers – 2.0 GPM o Kitchen Faucets – 1.5 GPM o Lavatory Faucets – 1.5 GPM	▪ Reductions in hot-water plumbing fixtures can provide substantial savings in multifamily buildings – particularly buildings that use electric resistance water heating systems. ▪ SBP recommends considering the following: o Showers – 1.5 GPM o Kitchen Faucets – 1.5 GPM o Lavatory Faucets – 1.0 GPM
Additional Benefits/Discussion	
o The measure savings do not take in to account direct water savings and only assess plumbing-related energy savings (domestic hot water). o No further reductions are recommended for the kitchen faucets. There is little value in premium flow rates for this fixture type since the usage patterns (i.e. filling pots) don't yield "real" savings. o This measure yields a split-benefit with tenant seeing most of the direct savings	

EEO-14: In-Unit Electric Storage Hot Water System *(Adverse Measure, not recommended)*	
Design Condition	Proposed Upgrade
▪ The domestic hot water system is specified as a central gas-fired boiler system with unfired storage tanks. The boilers will be high efficiency condensing units.	▪ Many multifamily building designs specify in-unit electric resistance water heaters which represent a low-performing system with the electric heating elements operating at a 1.0 COP (excluding tank losses). The efficiency limitations combined with a high cost-per-unit-energy utility rate yields an operating cost that far exceeds an equivalent gas-fired system. ▪ **This measure is not recommended, but has been provided to show the inherent value of the current central gas-fired system in terms of energy cost and carbon emissions.**
Additional Benefits/Discussion	
o Electric resistance systems yield higher overall carbon emissions *(The current VA electric grid profile uses >55% fossil fuel sources which generally yields a scenario where on-site gas-heating becomes a lower carbon option)* o In-unit electric systems limit future upgrades and adaptation. A central gas-fired system provides a very adaptable infrastructure that can be converted to an all-electric system in the future (e.g. water-to-water heat pump, etc) should the electric grid profile shift to lower-carbon sources. o In-unit heat pump water heaters were ruled out as a potential upgrade as these are not cost effective for large multifamily facilities o This measure would shift water heating costs from the owner to the tenant o This measure would yield higher unit electric load requirements	

EEO-15: Ventilation Energy Recovery	
Design Condition	Proposed Upgrade
▪ The current analysis assumes that ventilation air will be provided by a 100% outside air DOAS system that does not have energy recovery.	▪ Ventilation loads generally represent about ~50% of the total building load in a multifamily building and play a significantly role in the energy consumption profile. ▪ Consider installing enthalpy wheels at each DOAS in order to pre-condition all incoming outside air.
Additional Benefits/Discussion	
o This measure assumes all exhaust becomes centralized and is served by DOAS exhaust fans	

<table>
<tr><th colspan="2">EEO-16: Reduced Corridor Ventilation</th></tr>
<tr><th>Design Condition</th><th>Proposed Upgrade</th></tr>
<tr><td>▪ The ventilation designs were not available for this analysis, but SBP estimated a 0.25 CFM/sf corridor ventilation rate based on typical designs.</td><td>▪ Code-minimum corridor ventilation is 0.06 CFM/sf. Generally, multifamily corridors are pressurized in order to created compartmentalization at the dwelling units, to mitigate stack effect, and to serve as exhaust makeup. Unfortunately, this adds a considerable amount of heating and cooling load and inflates the overall operating costs.
▪ Consider designing OA to 0.15 CFM/sf or lower as well as:
o Installing weather-stripping at all apartment entry doors
o Minimize/eliminate apartment exhaust makeup air provided to the corridors
o Avoid ventilation ‘safety factors’</td></tr>
<tr><th colspan="2">Additional Benefits/Discussion</th></tr>
<tr><td colspan="2">o SBP has not performed a full load evaluation to ensure 0.15 CFM/sf can adequately condition corridors
o Weather-stripping & general air-sealing can created full compartmentalization at the dwelling units</td></tr>
</table>

<table>
<tr><th colspan="2">EEO-17: Decoupled Corridor Ventilation</th></tr>
<tr><th>Design Condition</th><th>Proposed Upgrade</th></tr>
<tr><td>▪ The current design specifies a central ventilation system that also provides primary space conditioning and pressurization to the corridors. The full design is not specified and has assumes that the corridors will receive 0.25 CFM/sf of supply air from the 100% OA DOAS – in line with typical designs.</td><td>▪ This measure builds on the benefits of EEO-16 and further reduces the corridor ventilation down near code-minimum (0.1 CFM/sf) but also provides local recirculating VRFs that provide primary general space conditioning & humidity control.</td></tr>
<tr><th colspan="2">Additional Benefits/Discussion</th></tr>
<tr><td colspan="2">o Similar to EEO-16, this measure would also incorporate weather-stripping for apartment compartmentalization.
o Independent VRFs allow for better control of temperature and humidity in the corridors</td></tr>
</table>

<table>
<tr><th colspan="2">EEO-18: Split System Heat Pumps (Adverse Measure, not recommended)</th></tr>
<tr><th>Design Condition</th><th>Proposed Upgrade</th></tr>
<tr><td>▪ The base design specifies VRF throughout all dwelling units and amenity/common areas.</td><td>▪ This measure has been provided for informational purposes only and is intended to quantify the impact of installing code minimum 14 SEER, 8.2 HSPF split system heat pumps in all of the dwelling units.</td></tr>
<tr><th colspan="2">Additional Benefits/Discussion</th></tr>
<tr><td colspan="2">o This yields an <u>increase</u> in total energy cost.
o This likely yields an increase in unit electric loads as a result of the electric auxiliary coil</td></tr>
</table>

Preliminary Design Assumptions

General Design Parameters

Gross Floor Area: 466,482 GSF
Floors: 24 Floors + Penthouse + Below-Grade Parking
Unit Count: 424 Units

Exterior Opaque Constructions

Envelope constructions were developed in accordance with ASHRAE 90.1-2010 Table 5.5-4, ASHRAE 90.1 Appendix A and ASHRAE Fundamentals Chapter 25 Table 4.

Table 3: Opaque Envelope Performance Summary

Assembly Type	Description*	Proposed Performance*
Exterior Walls	R-7.5 C.I. + R-13 Batt Between Metal Studs	U-0.064
Balcony Edge	No Thermal Break	U-0.123
Slab Edge	R-7.5 C.I on Floor Slab	U-0.126
Roof	R-20 C.I. Over Concrete Deck	U-0.048
Floor Over Unconditioned	R-10 Batt Between Steel Joist	U-0.038

**All assembly details and performances have been estimated*

Window Assemblies

All performance has been estimated based on typical performance values.

Window Area: **56% Window-to-Wall Ratio** (**as of 4/13/21 Progress set**)
**Includes vision glass & associated framing/mullions*

Basis of Design:
1" IGU, Double-pane, low-E (surface #2)
Thermally broken aluminum frames

Table 4: Window Assembly Performance (frame+glass)

Window	U-value	SHGC
All Windows	0.40 – 0.45	≤0.40

Base Building HVAC Narrative

Ventilation System

DOAS – Assumed as Constant Volume, Air-Cooled DX, Gas-fired Furnace, Hot Gas Reheat, fully decoupled from local HVAC:

- Dwelling Units, Amenity, Common Areas: ASHRAE 62
- Corridors: 0.25 CFM/sf

Local HVAC

Each floor is assumed to be served by one VRF condensing unit with multiple fan coil units serving individual spaces

- 11.9 EER / 18 - 20 IEER / 3.5 COP
- ECM Motors
- Constant Volume (cycling fans at dwelling units)
- Local thermostats control system operation.

Domestic Hot Water System Narrative

The primary DHW system is specified as follows

- Central gas-fired boilers with unfired storage tanks
- Boilers: Gas-fired condensing @ 95% E_t
- Storage: TBD (estimated ~7-gal/unit)

Plumbing fixtures were not defined for this analysis, so hot water-consuming fixtures were estimated as follows:

- Showers – 2.0 GPM
- Kitchen Faucets – 1.5 GPM
- Lavatory Faucets – 1.5 GPM

Plug-Loads/Appliance Narrative

The following dwelling unit appliance assumptions were made:

- Refrigerators – EnergyStar qualified
- Dishwashers – EnergyStar qualified
- Clothes Washers – EnergyStar qualified
- Electric Dryers – Standard
- Electric Ranges

Lighting

The following lighting assumptions were made:

- Interior: 0.54 W/sf (**design target, ≥10% reduction**)
- Dwelling Units: 0.90 W/sf
- Parking Garage**: 0.15 W/sf (anticipated based LED design)**
- Retail (out of scope): 1.40 W/sf

Acronym Legend

AHU	Air-Handling Unit
CHW	Chilled Water
COP	Coefficient of Performance
CRI	Color Rendering Index
CS	Core & Shell
CW	Condenser Water
DEC	Design Energy Cost
DHW	Domestic Hot Water
EA	Energy & Atmosphere
ECM	Electronically Commutated Motor
EEO	Energy Efficiency Opportunity
EER	Energy Efficiency Ratio
EF	Energy Factor
EUI	Energy Use Index (kBtu/sf)
FCU	Fan Coil Unit
FP	Fan-Powered
HP	Heat Pump OR Horsepower
HSPF	Heating Seasonal Performance Factor
HW	Hot Water
LPD	Lighting Power Density
NC	New Construction
PRM	Performance Rating Method
REC	Renewable Energy Credit
RTU	Rooftop Unit
SAT	Supply Air Temperature
SC	Shading Coefficient
SEER	Seasonal Energy Efficiency Ratio
SHGC	Solar Heat Gain Coefficient
VAV	Variable Air Volume
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
VT	Visible Transmittance