NYBG

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AVP for Capital Projects

ENERGY & DECARBONIZATION

WHO WE ARE

The New York Botanical Garden has been a connective hub among people, plants, and the planet since **1891.**

We're rooted in the cultural fabric of New York City, here in the heart of the Bronx—**its greenest borough.**

For more than 130 years, we've invited millions of visitors to make the Garden a part of their lives, exploring the **joy, beauty, and respite of nature.**

NYBG's **250 acres** are home to renowned exhibitions, immersive botanical experiences, art and music, and events with some of the most influential figures in **plant and fungal science, horticulture, and the humanities.**

We're also stewards of globally significant research collections, from the **LuEsther T. Mertz Library collection** to the plant and fungal specimens in the William and Lynda Steere Herbarium, the largest such collection in the Western Hemisphere.

NYBG

GARDEN MAP

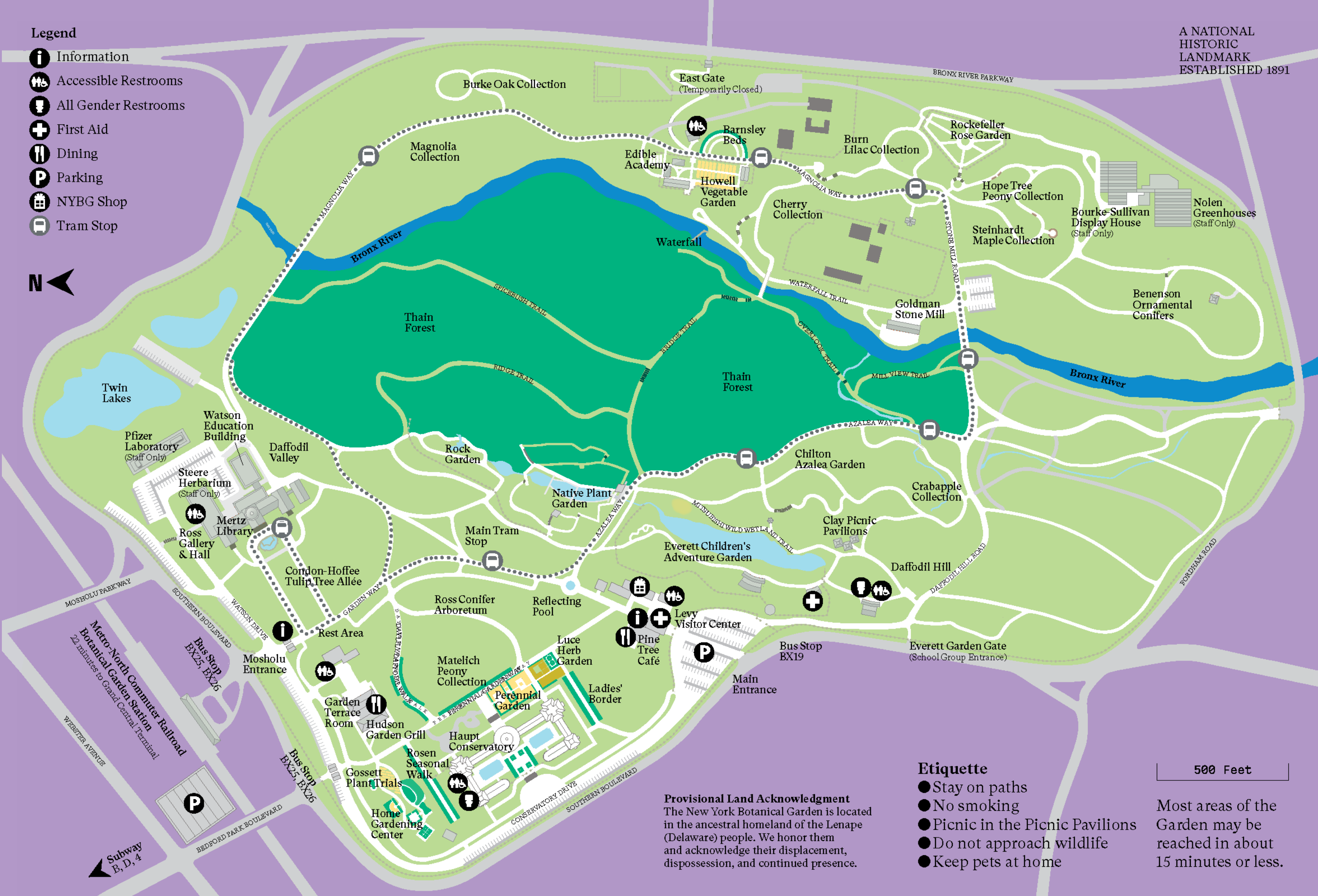
250 Acres

National Historic Landmark Established 1891

Native Forest

Bronx River

Lakes, Streams, & Wetlands



Provisional Land Acknowledgment
The New York Botanical Garden is located in the ancestral homeland of the Lenape (Delaware) people. We honor them and acknowledge their displacement, dispossession, and continued presence.

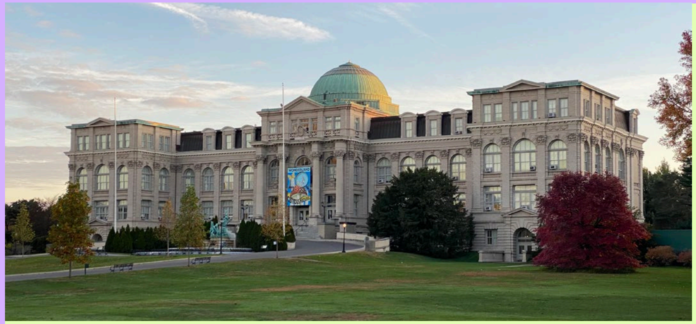
Etiquette
- Stay on paths
- No smoking
- Picnic in the Picnic Pavilions
- Do not approach wildlife
- Keep pets at home

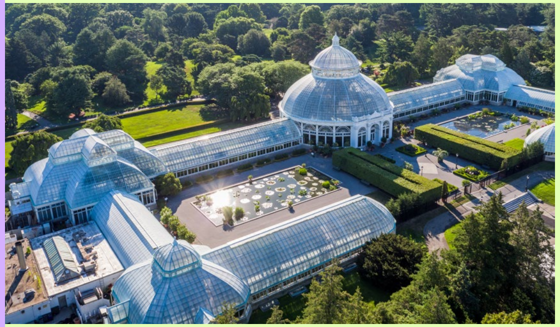
Most areas of the Garden may be reached in about 15 minutes or less.

BUILDINGS

25+ Buildings & Structures (Built 1891 – 2018)

- Conservatory & Glasshouses
- Botanical Museum & Exhibition Galleries
- Botanical Public Library
- Herbarium: *Largest in the Western Hemisphere*
- Visitor Center
- Restaurants & Catering Venues
- Education Centers
- Laboratories
- BOH Facilities









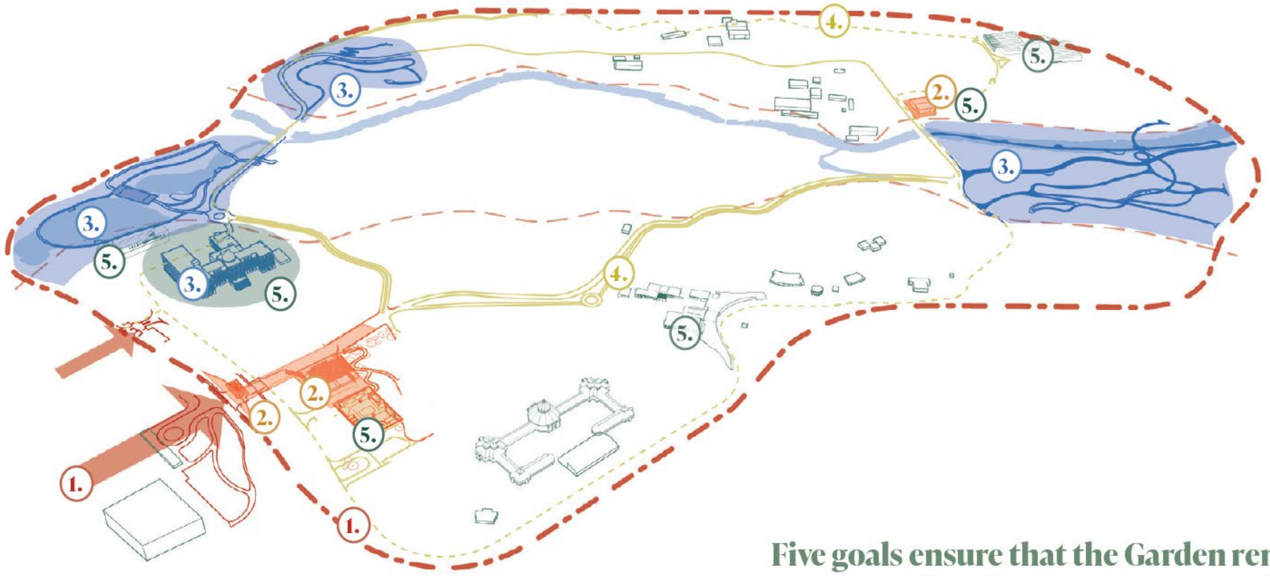
GARDENS

- Native Plant Garden
- Rose Garden
- Azalea Garden
- Lilacs Collection
- Peony Collection
- Maple Collection
- Oak Collection
- Magnolia Collection
- Cherry Collection
- Home Gardening Center

& More

COMPREHENSIVE MASTER PLAN FOR 2050

Garden 2050 Goals – Welcoming, Vibrant, and Sustainable



Five goals ensure that the Garden remains a beacon of horticultural beauty and education while providing opportunities to welcome, restore and reconnect.

FIGURE 3. **NYBG MASTER PLAN: GOALS**
Source: OLIN, 2023.

Prepared By:

NYBG + OLIN

GARDEN 2050 GOALS

1. *CHAPTER 1:* **NURTURE DISCOVERY AND COMMUNITY**

- **Welcome, Orient, and Guide visitors** and enhance the relationships of collections, buildings and circulation to encourage self-direction.
- **Establish a cohesive identity** and a "sense of place" throughout the onsite experience.

2. *CHAPTER 2:* **EXPAND EXPERIENCE AND REVENUE POTENTIAL**

- **Provide improved amenities and access** to meet the current and projected needs of visitors and Garden constituents.
- **Facilitate new opportunities** for programs, exhibitions, education, and experiences.

3. *CHAPTER 3:* **REVEAL PROGRAMMATIC EXCELLENCE**

- **Showcase NYBG programs** that are difficult to access - scientific inquiry and sustainable horticultural practices.
- **Highlight the ecological significance** of our landscape and natural features.
- **Cultivate a more dynamic and energetic work** and research environment.

4. *CHAPTER 4:* **PRESERVE THE BEAUTY OF THE GARDEN**

- **Organize operational support services** /areas/circulation/technology to minimize disruption to the visitor experience and the Garden's living collections.
- **Preserve open spaces** for the benefit of historic character of the Garden and native habitat.

5. *CHAPTER 5:* **STRENGTHEN CLIMATE RESILIENCE AND SUSTAINABILITY**

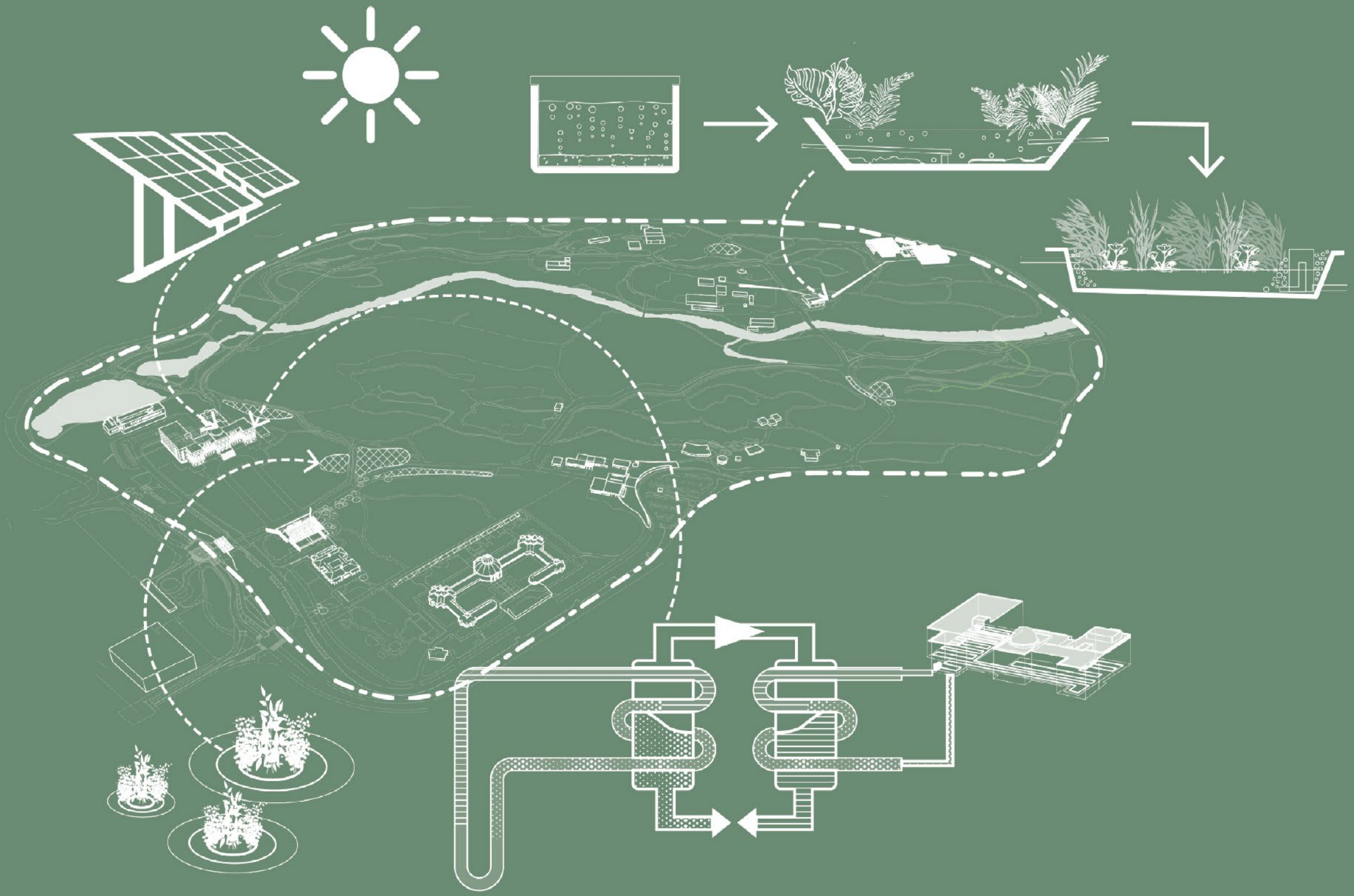
- **Strengthen the resiliency and sustainability of the Garden** while minimizing the environmental impact of building systems, infrastructure, equipment and vehicles.
- **Strengthen the sustainability of the Garden** by reducing resource use across operational areas

NYBG

STRENGTHEN CLIMATE RESILIENCE AND SUSTAINABILITY

Strengthen the resiliency of the Garden while minimizing the environmental impact of building systems, infrastructure, equipment and vehicles.

Strengthen the sustainability of the Garden by reducing resource use across operational areas.



NYBG

OPERATIONAL CARBON AND ELECTRIFICATION

- Operational Carbon
  - Heating, Ventilation & Cooling
  - Lighting
  - Lawn Mowing
  - Internal Transportation of People and Goods
- NYC has committed to reducing its greenhouse gas (GHG) emissions, relative to the baseline of 2005 levels, 40% by 2030 and 80% by 2050
  - *Local Law 97 of 2019*

EXISTING OPERATIONAL ENERGY DEMANDS

- NYBG is prioritizing efforts to minimize operational energy demands. Measures implemented between 2005 to 2021 include:
  - Installation of Building Management System (BMS)
  - Conversion of building equipment and systems to replace heavy fossil fuel dependent systems
  - Extensive replacement of light fixtures with LED
  - Installation of variable frequency drives (VFDs) and smart valves in building level motors and pumps
  - Replacement of older inefficient building HVAC systems by more efficient systems
  - New structures utilized more energy efficient technologies, such as geothermal and solar photovoltaic systems

Energy Use Category	Source	Energy Demand (kWh) 2005	Energy Demand (kWh) 2021	Change from 2005	Remarks
Stationary fuel for buildings and site operations	Distillate Oil (#1-4)	5,068,074	40,402	-99.20%	Efforts to transition from fossil fuel-based systems to natural gas have reduced oil usage.
	Natural Gas	17,740,406	14,939,829	-15.79%	Reduction is due to several building system efficiency measures.
Fuel for on-site transportation	Gasoline	1,165,649	584,565	-49.85%	NYBG's efforts to transition from fossil fuel driven vehicles to CNG powered ones, have reduced its gasoline and diesel consumption.
	Diesel Oil	356,240	279,863	-21.44%	
	CNG	27,549	252,919	+818.09%	The increase in CNG usage is due to replacement of gasoline and diesel oil by natural gas, as the primary vehicle fuel.
Purchased energy for buildings and site operations	Electricity	9,490,063	9,114,186	-3.96%	Implementation of several energy efficiency measures have resulted in this reduction.
TOTAL OPERATIONAL ENERGY DEMAND		**33,847,982**	**25,440,708**	**-24.84%**	

Note:
The reported units for several of the above energy sources have been converted to kWh equivalents for comparison.
While Local Law 97 considers only building-related energy use, this figure presents an overall operational energy use profile that includes other drivers of energy demand (ex: internal transportation, lawn mowing, etc).

Figure 279. OPERATIONAL ENERGY PROFILE
Source: A10, Year: 2023

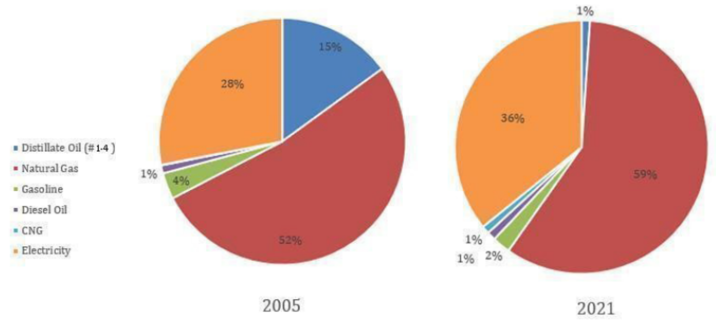


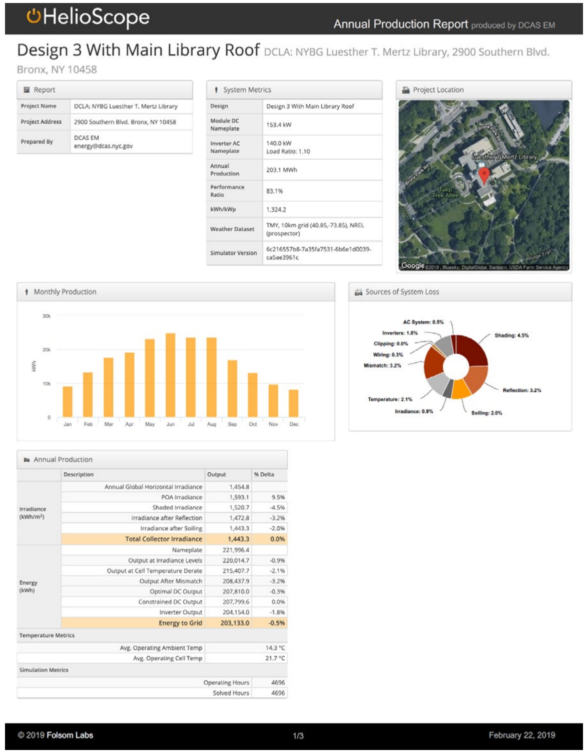
Figure 280. COMPARISON OF ENERGY SOURCES
Source: A10, Year: 2023

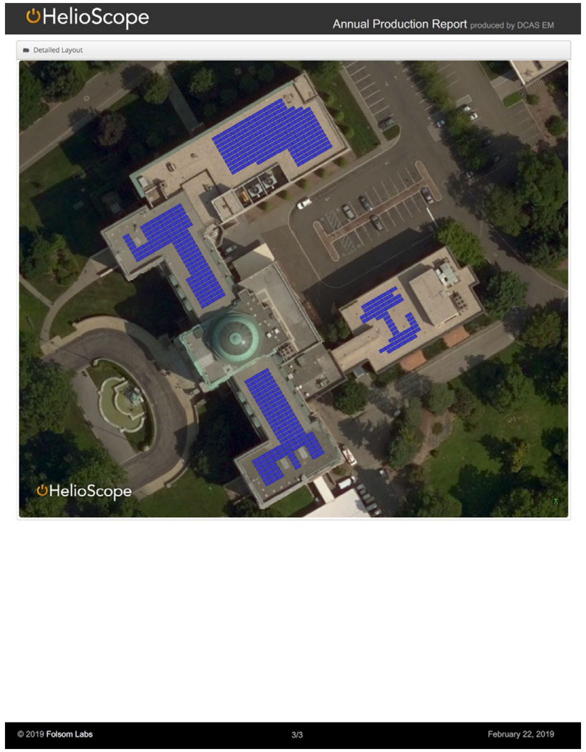
EXISTING ELECTRIFICATION AND OFFSETS

- Since 2019, NYBG has made efforts to offset some of its energy through purchase of renewable energy certificates (RECs)
- Solar renewable energy feasibility studies have been performed in collaboration with NYC Department of Administrative Services (DCAS)
  - Cumulatively, the 6 locations studied have a potential to offset **11% of the 2021 electricity demand**
- Challenges:
  - Funding
  - Structural limitations
  - Existing roofing conditions

Location	Generation Potential (kWh)	Ability to offset 2021 electricity demand
Mertz Library roof	203,133	2.23%
Operations Garage roof	26,484	0.29%
Bedford Garage roof	339,841	3.73%
Butler Building roof	119,080	1.31%
EA Haupt Conservatory Canopy	254,762	2.80%
Solar Boulder Canopy	39,048	0.43%
TOTAL	**982,348**	**10.78%**

Figure 278. SUMMARY OF ANNUAL SOLAR ENERGY GENERATION POTENTIAL REPORT
Source: A10, 2023.





PROPOSED DECARBONIZATION ROADMAP

- Local Law 97 of 2019 is a set of laws designed to enable NYC to achieve its goal of carbon neutrality.

- The Garden, as is, is currently within the annual Carbon Emissions Intensity threshold and is expected to be within the limits until 2029.

- Based on the proposed energy conservation measures and their implementation timelines, the projected annual emissions between 2022 and 2049 are observed to be within the threshold.

- NYBG must pursue additional PV infrastructure and efficiency measures to further lower emissions and achieve NYC 2050 goals.

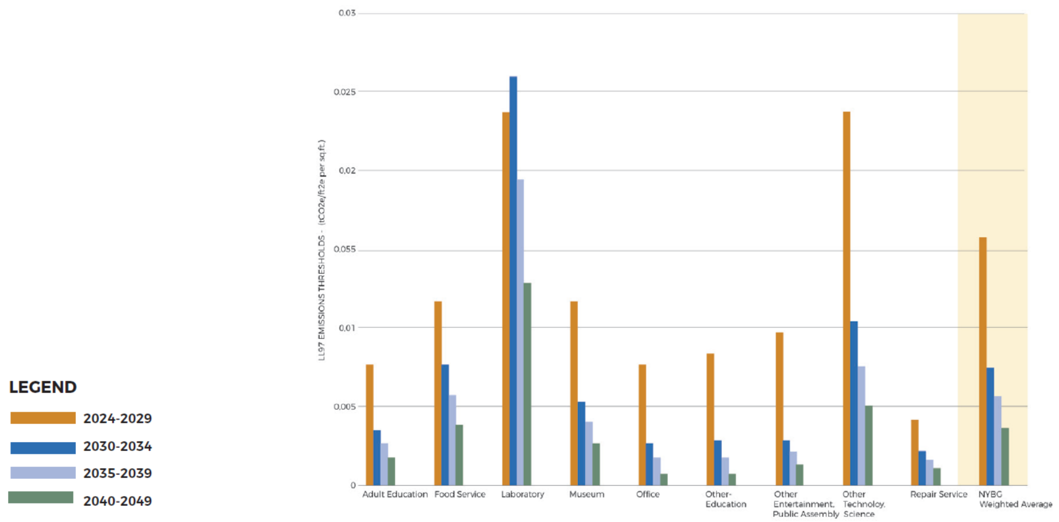


FIGURE 282. LL97 DECARBONIZATION TARGET BY BUILDING USE
Source: A10, 2023.

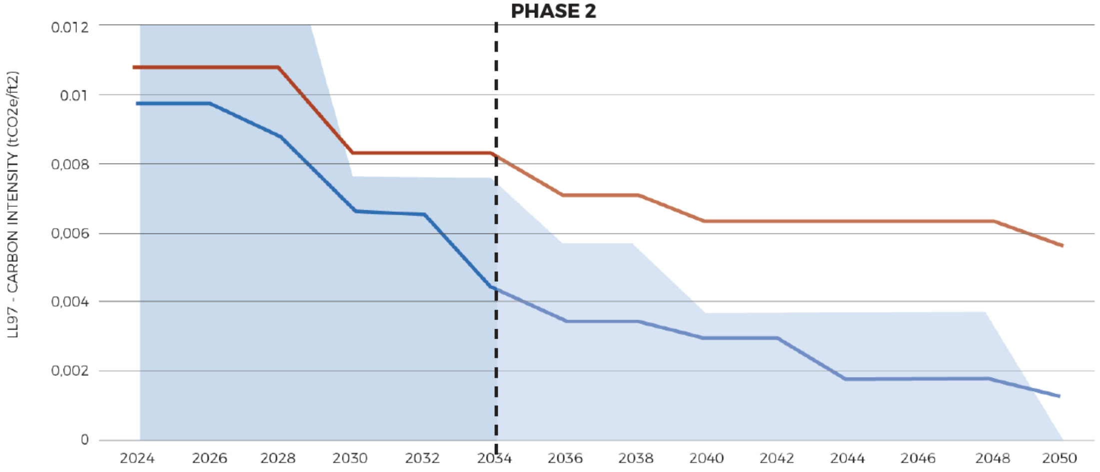
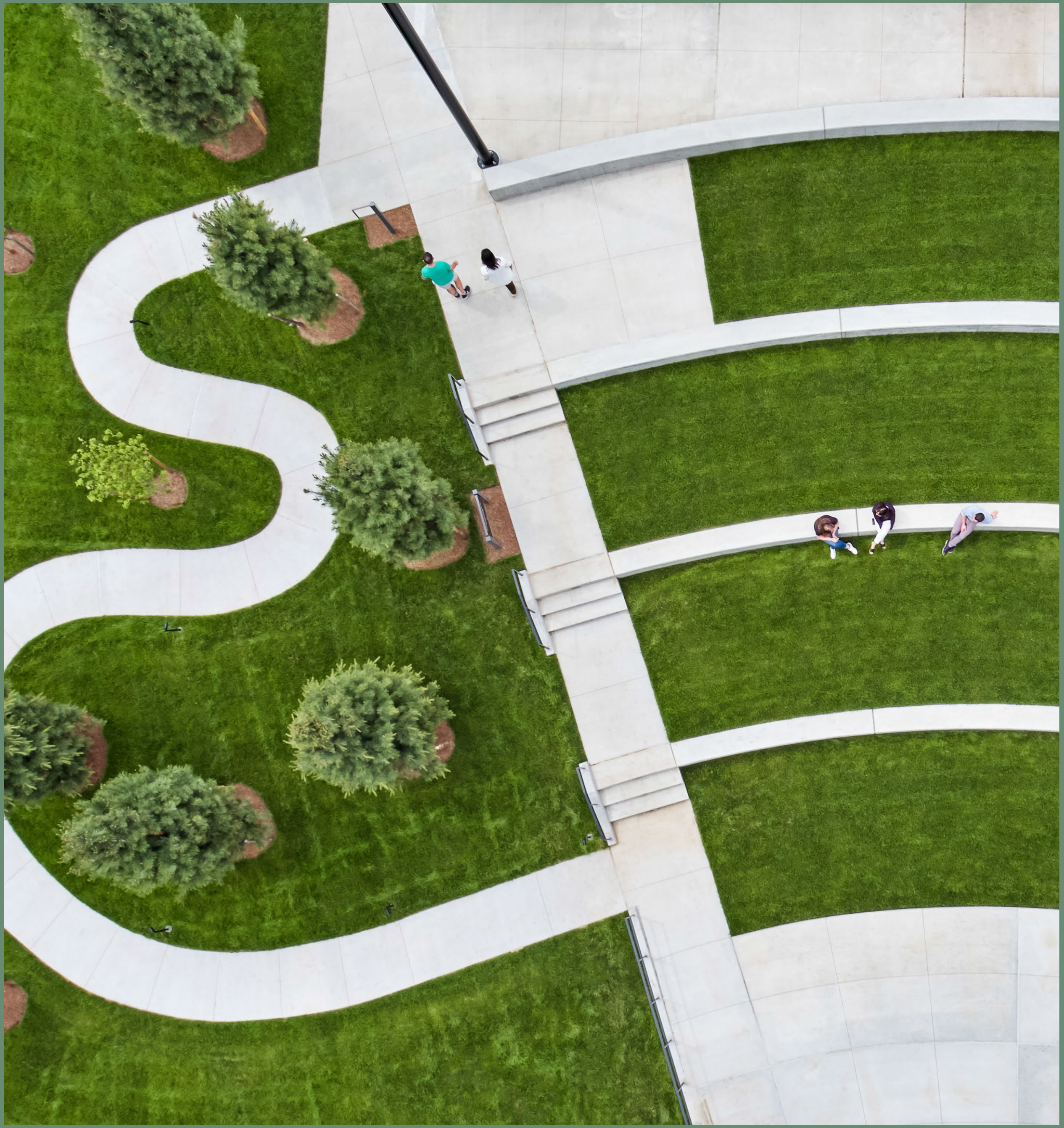


FIGURE 283. DECARBONIZATION ROADMAP
Source: A10, 2023.

RECOMMENDATIONS

- **For all new construction and major renovation projects:**
    - Achieve an **all-electric mechanical system** for new construction and **net zero or better** operations by using building envelope analysis, GSHPs/ASHPs, roof-top PV panels and other low carbon strategies.
    - Achieve **below EUI target** per building typology or **30-40% reduction** over LEED ASHRAE Baseline.
    - Install **roof photovoltaic systems** for all new roof constructions and roof-renovations, where feasible.
    - Provide **building-level energy metering** of utilities and sub-meter end uses that comprise at least 10% of the project's overall energy use.
    - **Integrate BMS** with the sub-metering.
    - Complete fundamental and enhanced **HVAC and envelope commissioning**.



PHASE 1A
0-5 YEARS

MEP: PHASE 1A

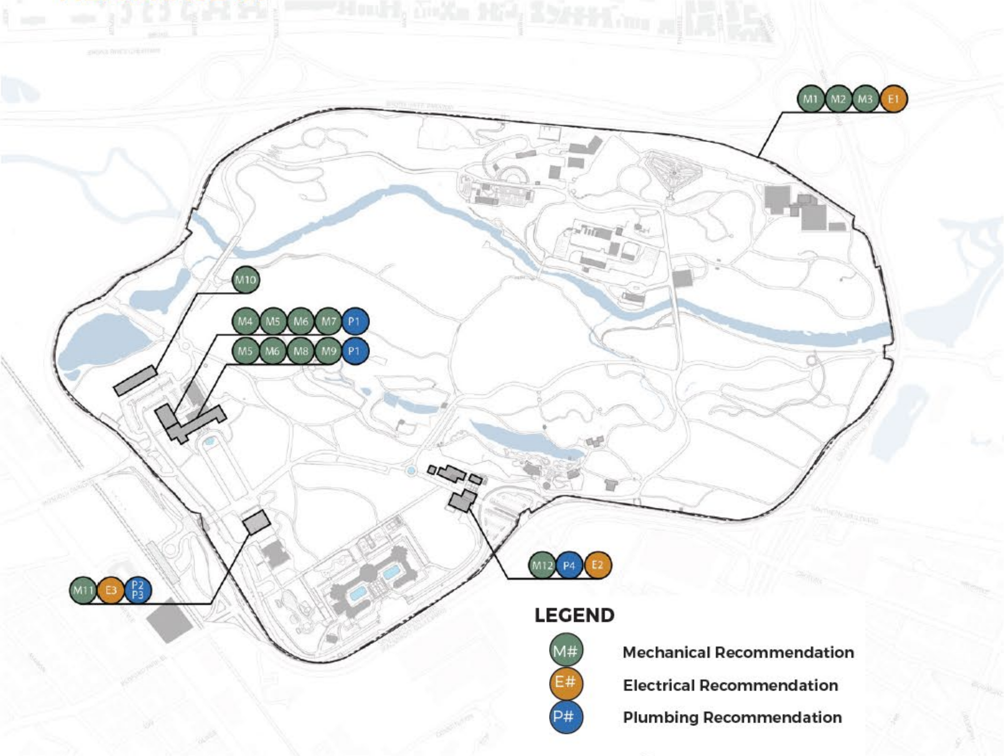


FIGURE 289. MEP RECOMMENDATIONS: PROPOSED PHASE 1A
Source: OLIN, 2023.

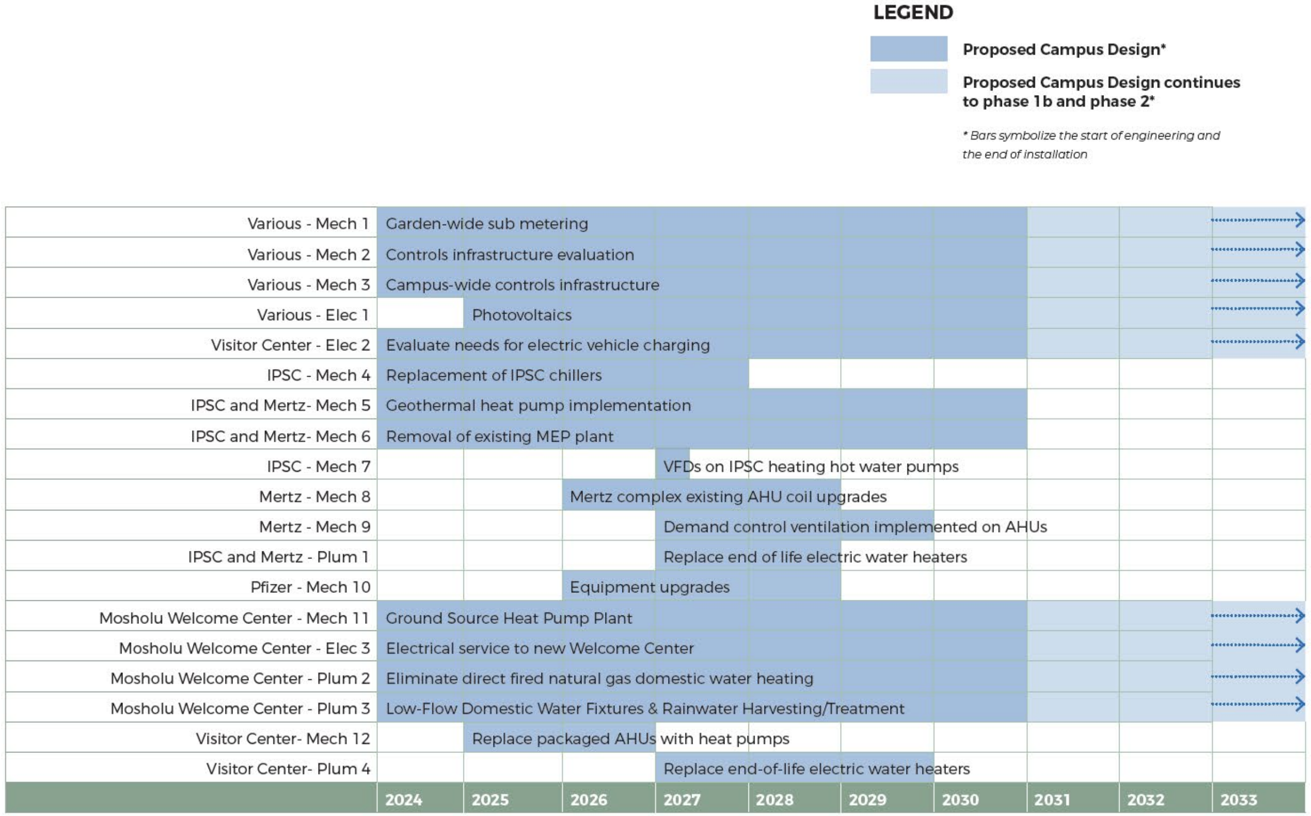


FIGURE 290. MEP RECOMMENDATIONS: PROPOSED PHASE 1A
Source: ARUP, 2023.

PHASE 1B
5-10 YEARS

MEP: PHASE 1B

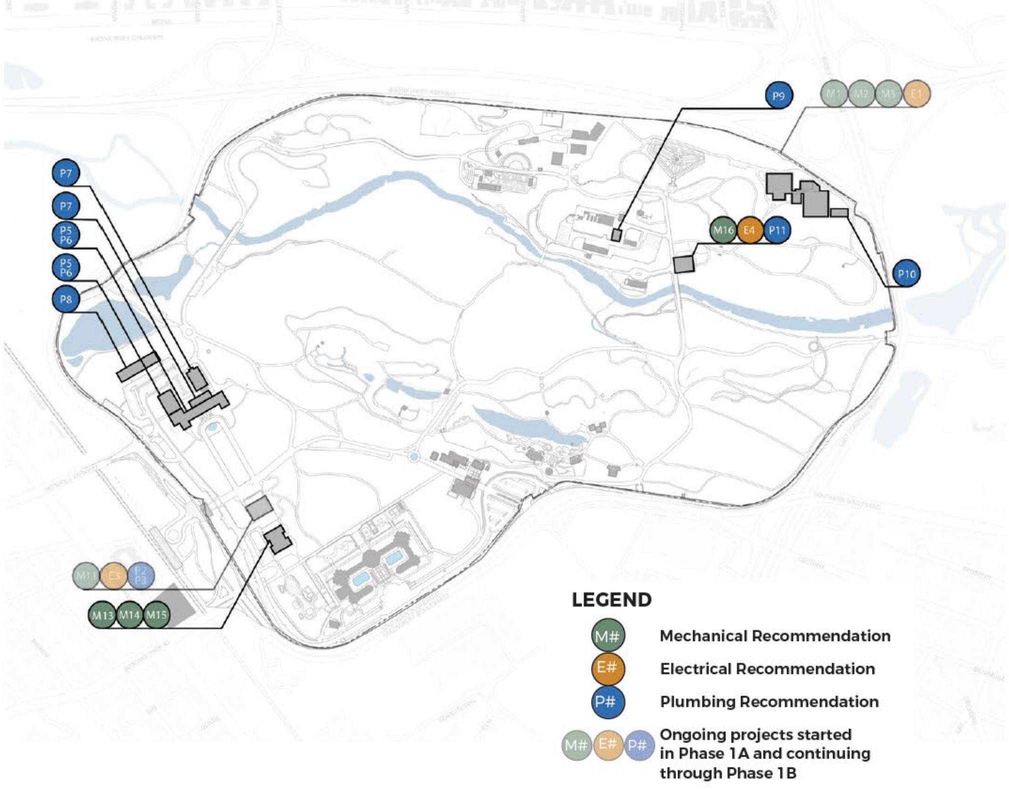


FIGURE 291. MEP RECOMMENDATIONS: PROPOSED PHASE 1B
Source: OLIN, 2023.

FIGURE 292. MEP RECOMMENDATIONS: PROPOSED PHASE 1B
Source: ARUP, 2023.

PHASE 2
10+ YEARS

MEP: PHASE 2

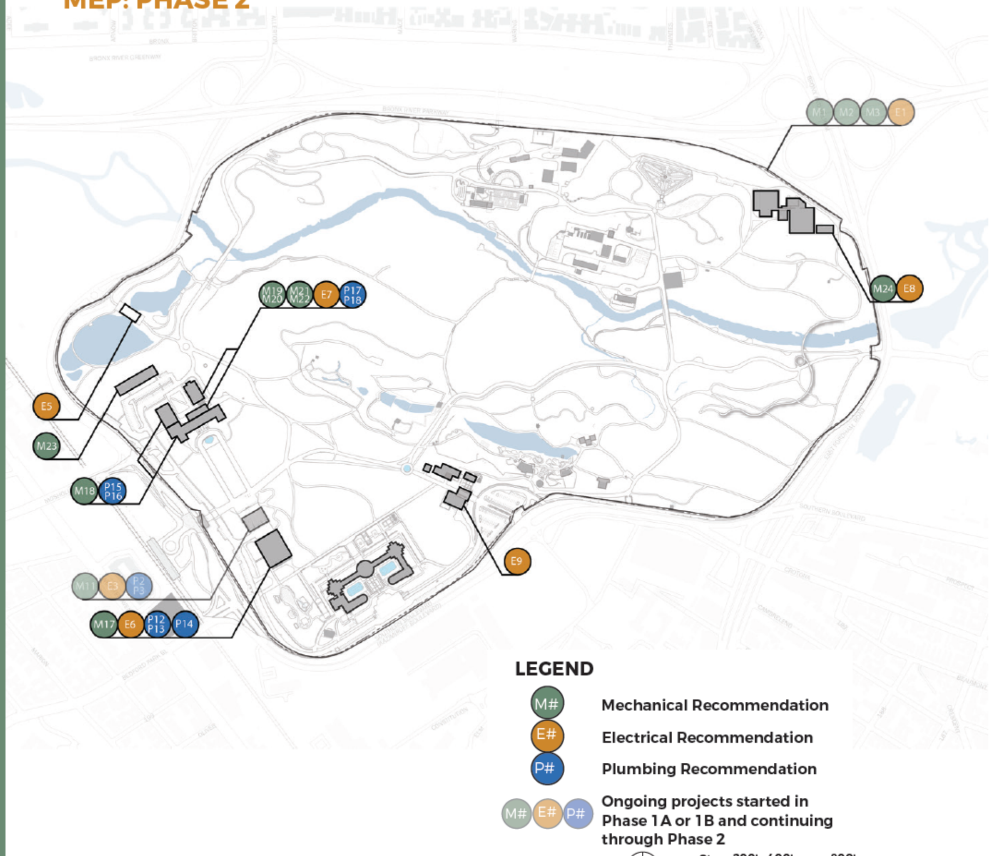


FIGURE 293. MEP RECOMMENDATIONS: PROPOSED PHASE 2
Source: OLIN, 2023.

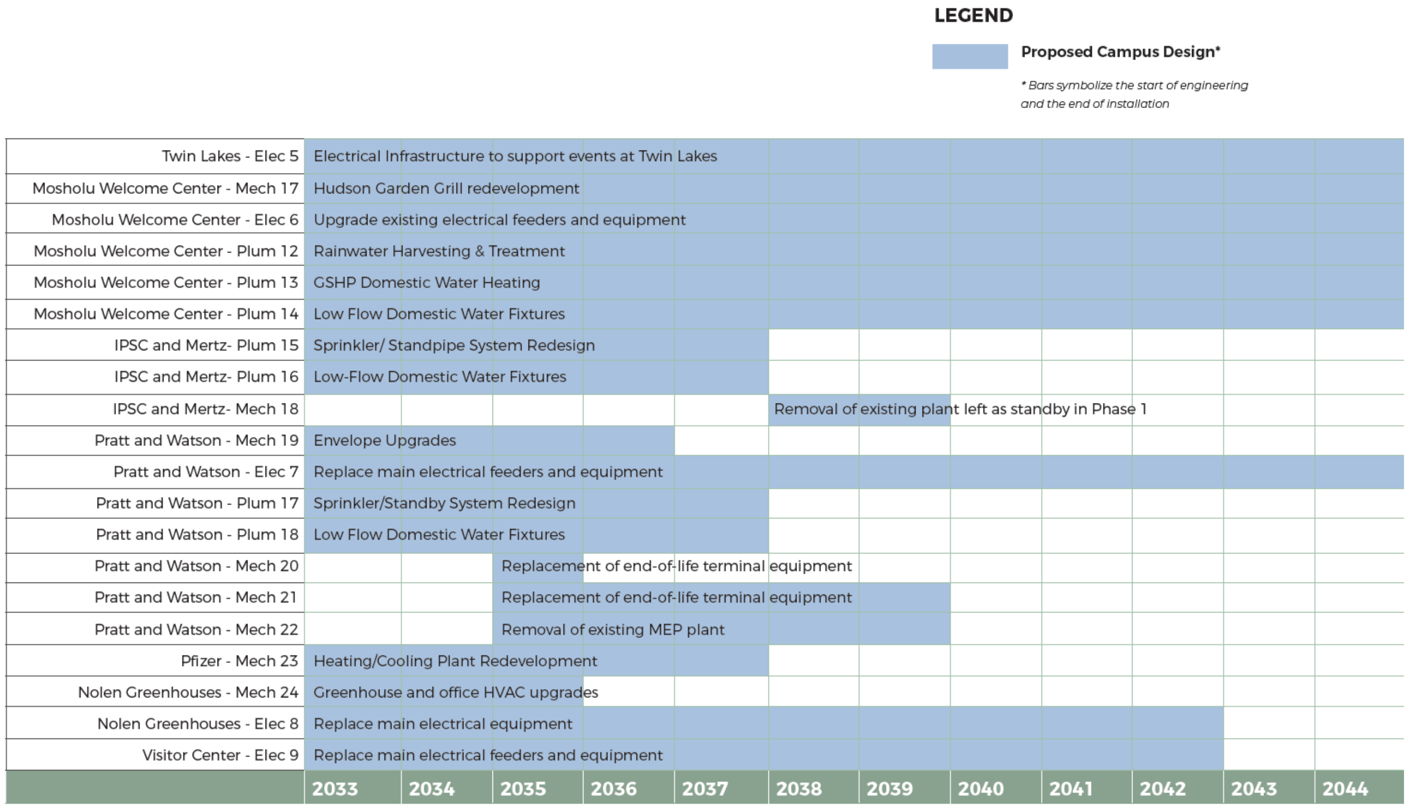


FIGURE 294. MEP RECOMMENDATIONS: PROPOSED PHASE 2
Source: ARUP, 2023.

EMBODIED CARBON AND SEQUESTRATION

- Embodied Carbon
    - Existing site paving materials: 7,719,012 kg CO_2 eq. (i.e. asphalt, stone, gravel, decking, brick & cobbles, wood fiber and wood mulch)
- Sequestration = Net Positive
    - Existing extensive planting inventory (i.e. significant ground and canopy cover composed of deciduous and coniferous trees, and grasses)
    - Overall net positive with 23,593,565 kg CO_2 eq.

RECOMMENDATIONS

- Analyze wood structure for new buildings
- Reduce project embodied carbon by a minimum of 10-20% in structure and enclosure
- 50-60% of new wood by cost to be FSC-certified
- Divert at least 80-95% of construction and demolition waste
- Compost 100% of organic waste and provide sufficient space to do so

SITE OPERATIONS CENTER

NET POSITIVE ENERGY

NYBG + MG ARCHITECTS

SUSTAINABLE DESIGN FEATURES

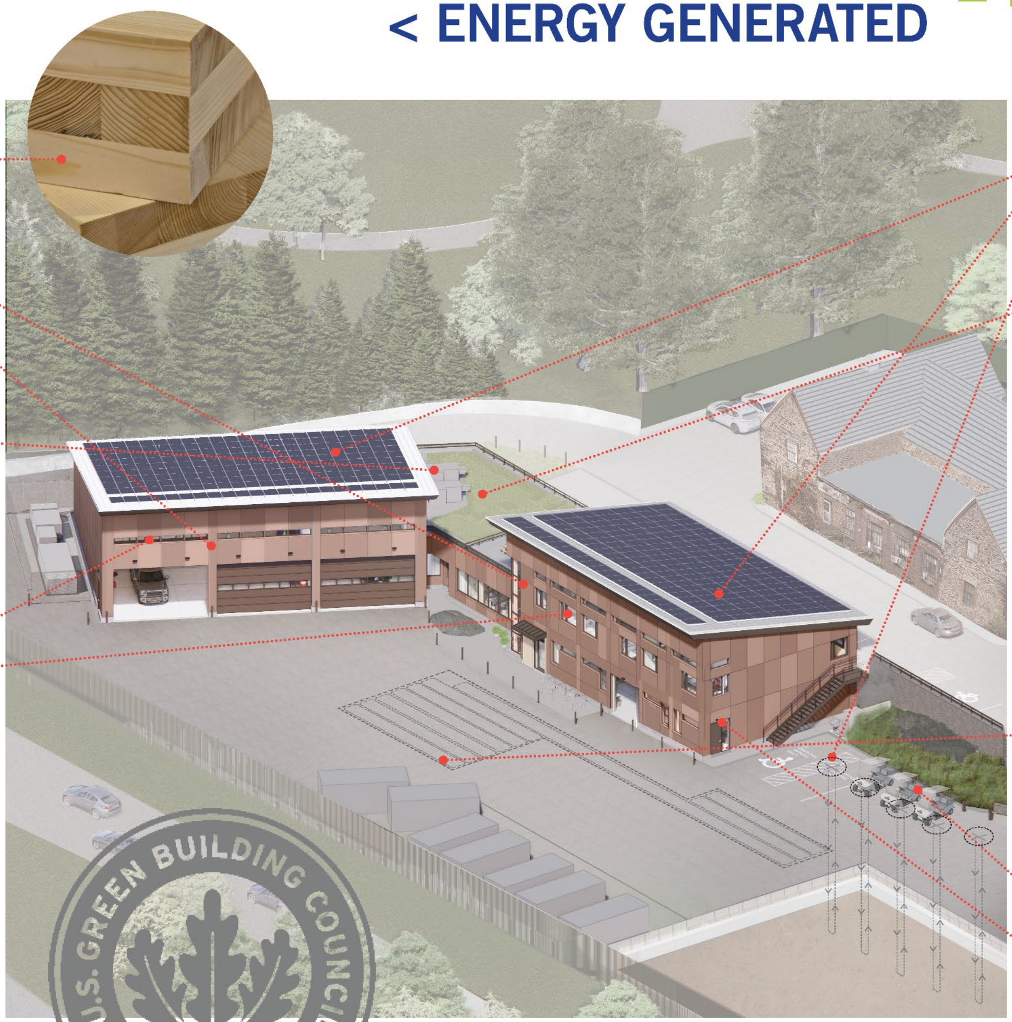
ENERGY CONSUMED
< ENERGY GENERATED = NET POSITIVE ENERGY

EMBODIED CARBON REDUCTION
MASS TIMBER STRUCTURE
UHPC CONCRETE CLADDING

ENERGY EFFICIENCY
GEOTHERMAL HEAT PUMPS
ENERGY RECOVERY VENTILATORS
HIGH PERFORMANCE LED LIGHTING

EXTERIOR ENVELOPE
OPTIMIZED PERFORMANCE GLAZING
HIGH INSULATION WALLS & ROOF
THERMAL BREAK ASSEMBLIES

INTERIOR STRATEGIES
HEALTHY INTERIOR FINISHES
ENERGY STAR EQUIPMENT



TARGET: U.S. GREEN BUILDING COUNCIL LEED PLATINUM USGBC

ON-SITE RENEWABLE ENERGY
ROOFTOP SOLAR PANELS
GEOTHERMAL WELL FIELD (x10)

GREEN ROOF
HEAT ISLAND REDUCTION
ESTABLISHMENT IRRIGATION ONLY

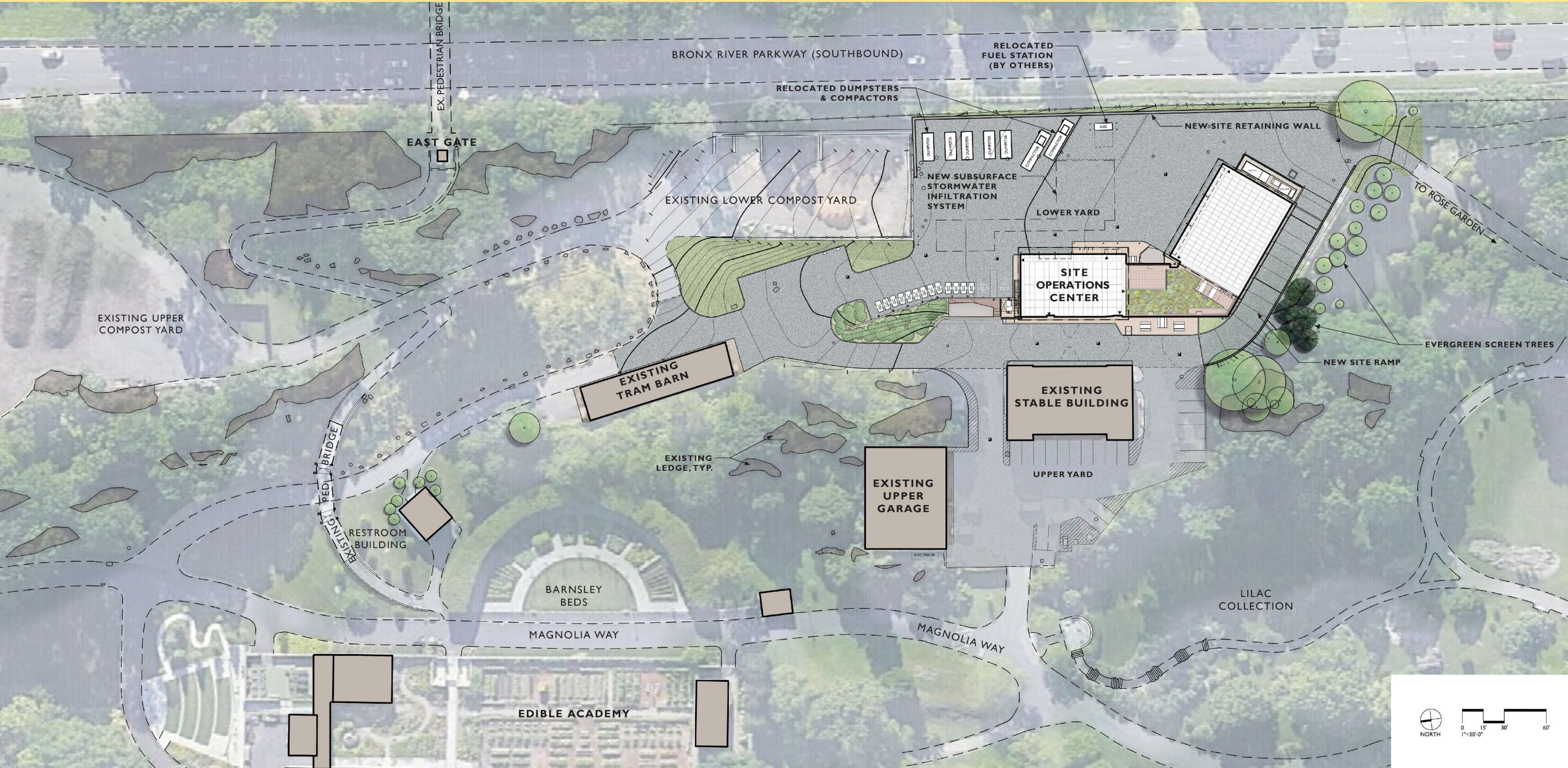
DAYLIGHTING
OPTIMIZE NATURAL LIGHT & SHADING

WATER
LOW FLOW FIXTURES
ON-SITE STORMWATER INFRASTRUCTURE

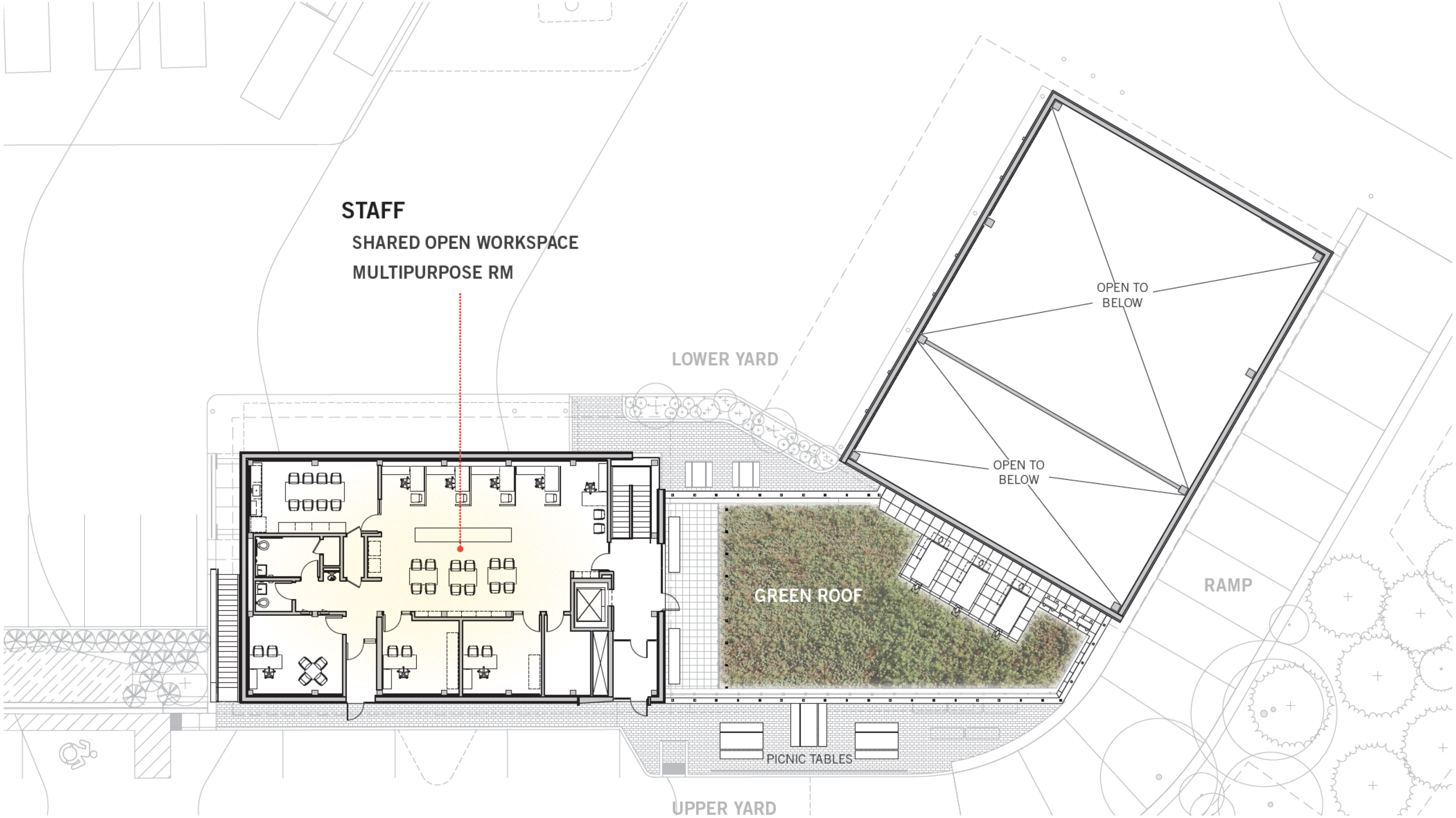
SITE IMPROVEMENTS
NATIVE AND ADAPTIVE PLANTINGS
EV CHARGING STATIONS
DARK SKY COMPLIANT LIGHTING

EXISTING SITE PLAN

PROPOSED SITE PLAN

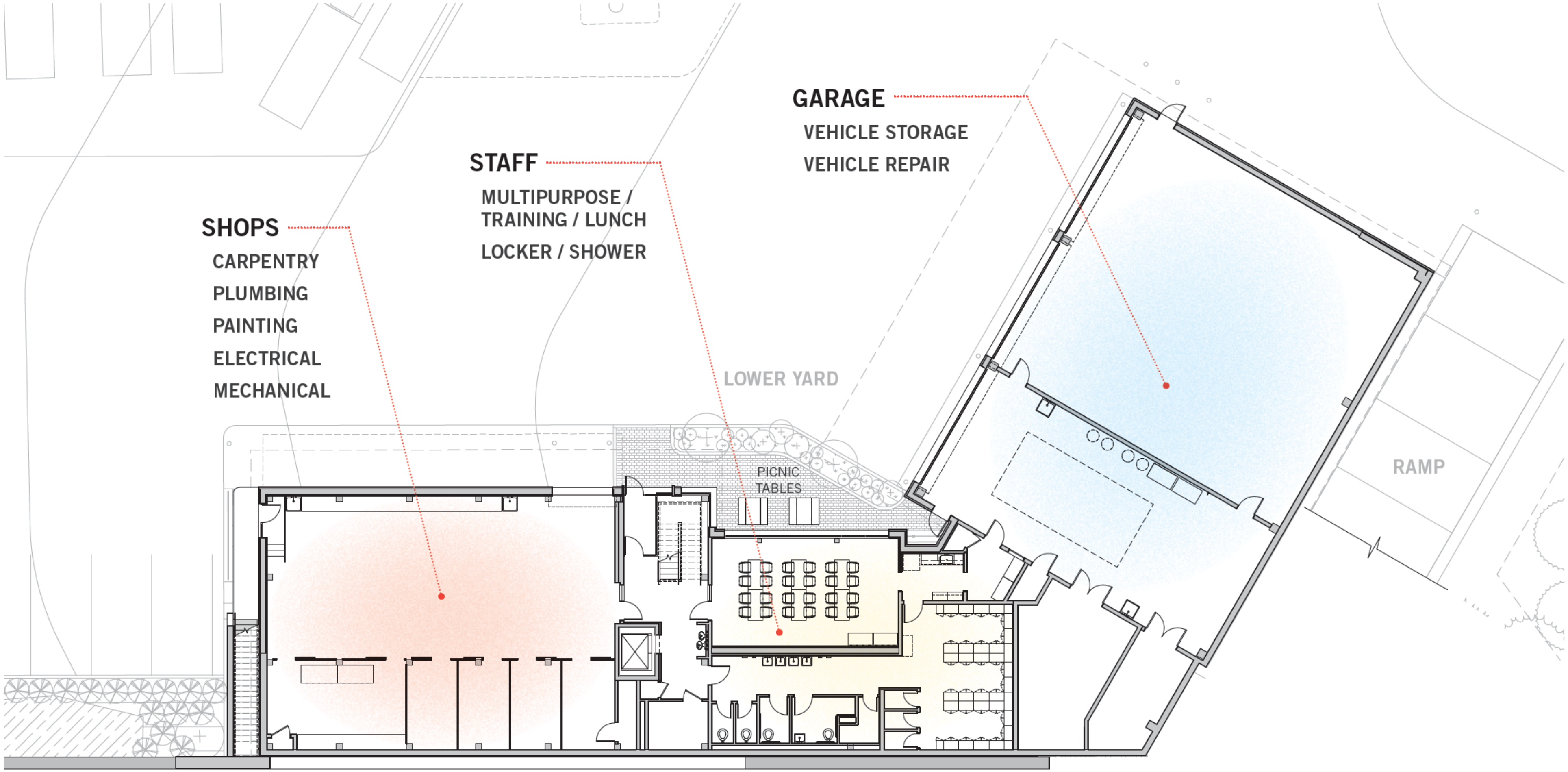


Floor Plans
Upper Level



Floor Plans

Lower Level



ENERGY EFFICIENCY

- **Ground Source Heat Pumps (GSHPs)**
  - (7) Water-to-Air Heat Pumps to provide heating and cooling to the conditioned spaces
  - (1) Water-to-Water Heat Pump to provide heating only to the spaces requiring heating only
- **Energy Recovery Ventilators (ERVs)**
  - (3) 100% Outdoor Air Handling Units with Energy Recovery Ventilators provided to serve the office spaces, locker room and shop areas.
- **High Performance LED Lighting**

Table 20: Energy and Cost Summary (Proposed Design with PV)

LL31 / LL32 Baseline			LEED Baseline			Proposed Design (with PV)		
LEED Baseline	Electricity kWh	Natural Gas Btu	LEED Baseline	Electricity kWh	Natural Gas Btu	Proposed Design	Electricity kWh	Natural Gas Btu
Space Cool	9,960	0	Space Cool	17,611	0	Space Cool	2,338	0
Heat Reject.	53	0	Heat Reject.	0	0	Heat Reject.	0	0
Refrigeration	0	0	Refrigeration	0	0	Refrigeration	0	0
Space Heat	40,270	0	Space Heat	26,218	0	Space Heat	5,928	0
HP Supp.	0	0	HP Supp.	227	0	HP Supp.	2	0
Hot Water	7,918	0	Hot Water	7,842	0	Hot Water	4,176	0
Vent. Fans	16,805	0	Vent. Fans	64,209	0	Vent. Fans	14,464	0
Pumps & Aux.	11,460	0	Pumps & Aux.	2,657	0	Pumps & Aux.	10,764	0
Ext. Usage	2,070	0	Ext. Usage	3,052	0	Ext. Usage	1,481	0
Misc. Equip.	48,120	0	Misc. Equip.	48,117	0	Misc. Equip.	22,003	0
PV Generator	0	0	PV Generator	0	0	PV Generator	1,081	0
Area Lights	13,848	0	Area Lights	23,405	0	Area Lights	3,782	0
Total	150,493	0	Total	193,338	0	Total	66,019	0
Cost ($)	30,099	0	Cost ($)	38,667	0	Cost ($)	13,204	0
Total Energy (MBTU)		513.6	Total Energy (MBTU)		659.9	Total Energy (MBTU)		225.3
Total Cost ($)		30,099	Total Cost ($)		38,667	Total Cost ($)		13,204
						Energy Savings (%)		65.9%
						Cost Savings (%)		65.9%

Table 21: Energy Demand Summary

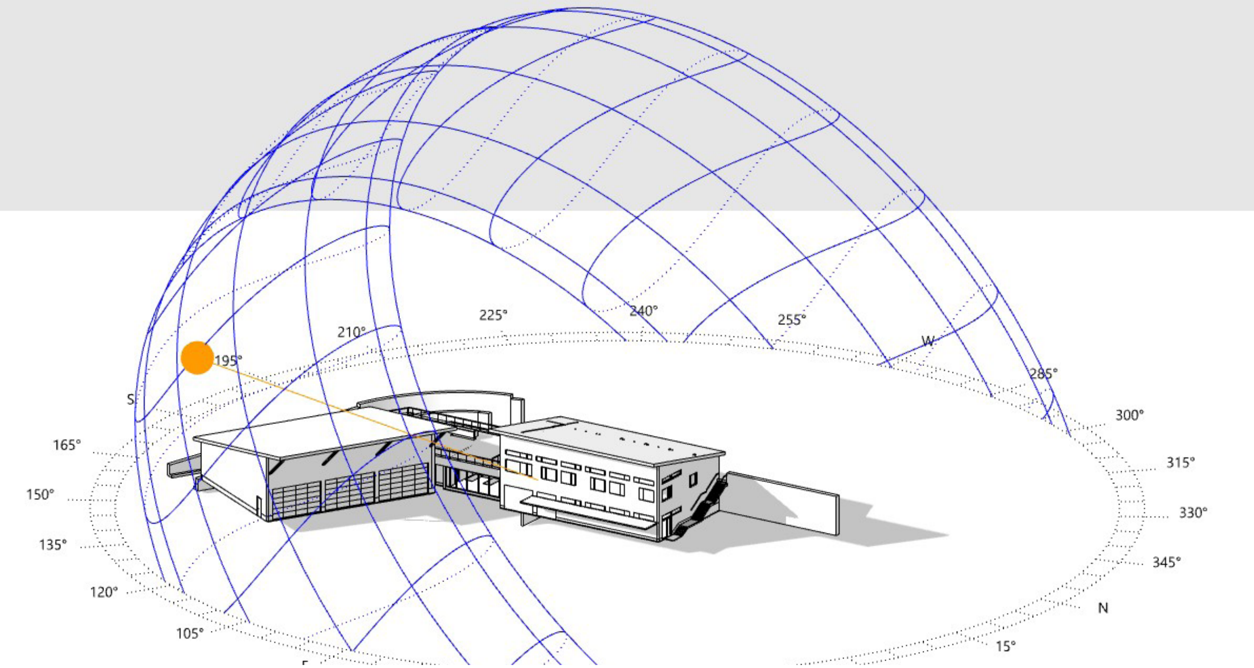
LL31 / LL32 Baseline			LEED Baseline			Proposed Design (with PV)		
LEED Baseline	Electricity kW	Natural Gas Btu/h	LEED Baseline	Electricity kW	Natural Gas Btu/h	Proposed Design	Electricity kW	Natural Gas Btu/h
Space Cool	0.08	0	Space Cool	0.01	0	Space Cool	0.43	0
Heat Reject.	0.00	0	Heat Reject.	0.00	0	Heat Reject.	0.00	0
Refrigeration	0.00	0	Refrigeration	0.00	0	Refrigeration	0.00	0
Space Heat	109.14	0	Space Heat	52.69	0	Space Heat	12.81	0
HP Supp.	0.25	0	HP Supp.	41.49	0	HP Supp.	0.00	0
Hot Water	0.69	0	Hot Water	0.69	0	Hot Water	1.86	0
Vent. Fans	4.45	0	Vent. Fans	20.57	0	Vent. Fans	14.84	0
Pumps & Aux.	1.98	0	Pumps & Aux.	0.00	0	Pumps & Aux.	9.33	0
Ext. Usage	0.47	0	Ext. Usage	0.70	0	Ext. Usage	0.00	0
Misc. Equip.	6.14	0	Misc. Equip.	6.14	0	Misc. Equip.	13.68	0
PV Generator	0.00	0	PV Generator	0.00	0	PV Generator	0.00	0
Area Lights	3.37	0	Area Lights	4.86	0	Area Lights	2.21	0
Total	126.56	0	Total	127.16	0	Total	55.16	0

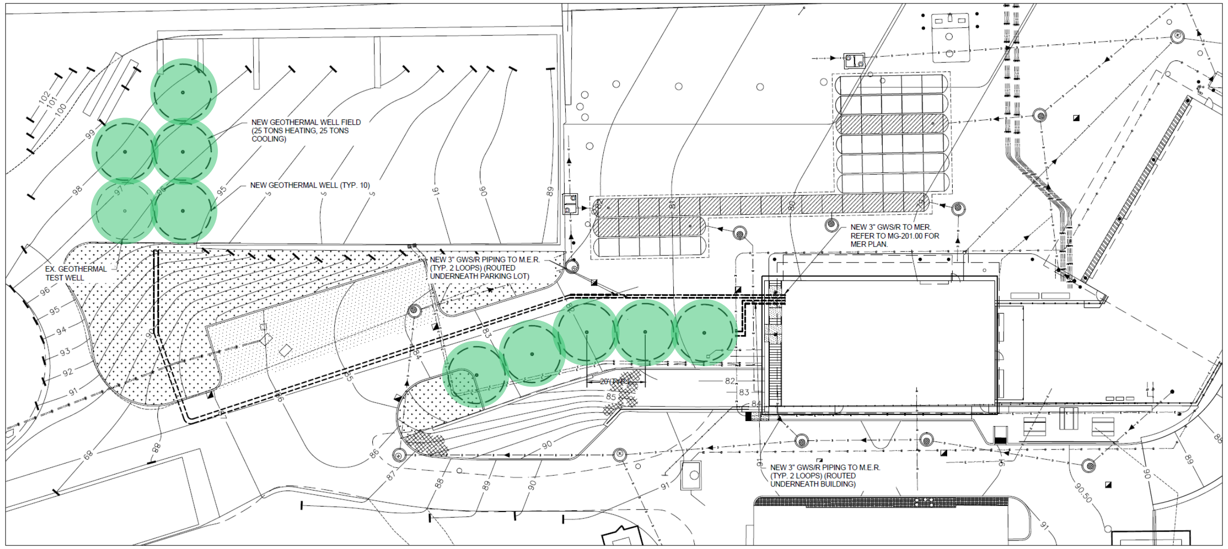
EXTERIOR ENVELOPE

- **Optimized Performance Glazing**
  - Optimized daylighting strategies
  - Steel rib garage doors having R-7.35 (U-0.14)
  - Triple-glazed UPVC windows having R-5.88 (U-0.17)
- **High Insulation Roof**
  - Prefabricated wood framed ventilated roof w/ dense pack fiberglass (14.5” R-4.2/inch = R-61)
- **High Insulation Walls**
  - Prefabricated wood framed and sheathed perimeter walls with dense pack fiberglass (9.5” R-4.2/inch = R-40)

ON-SITE RENEWABLE ENERGY

- 351 Rooftop Solar Photovoltaic Panels
  - Proposed Design Electricity Use: **130,721 kWh/yr**
  - Proposed PV Array Output: **149,223 kWh/yr**
  - Net Positive Energy Output: **18,502 kWh/yr**
  - Energy Cost Savings: **$29,845 / yr**
- 10 Geothermal Wells
  - Closed Loop Geothermal Wells approx. 500 ft deep
  - Total Cooling Capacity is estimated to be 25 tons
  - Total Heating Capacity is estimated to be 300 MBH

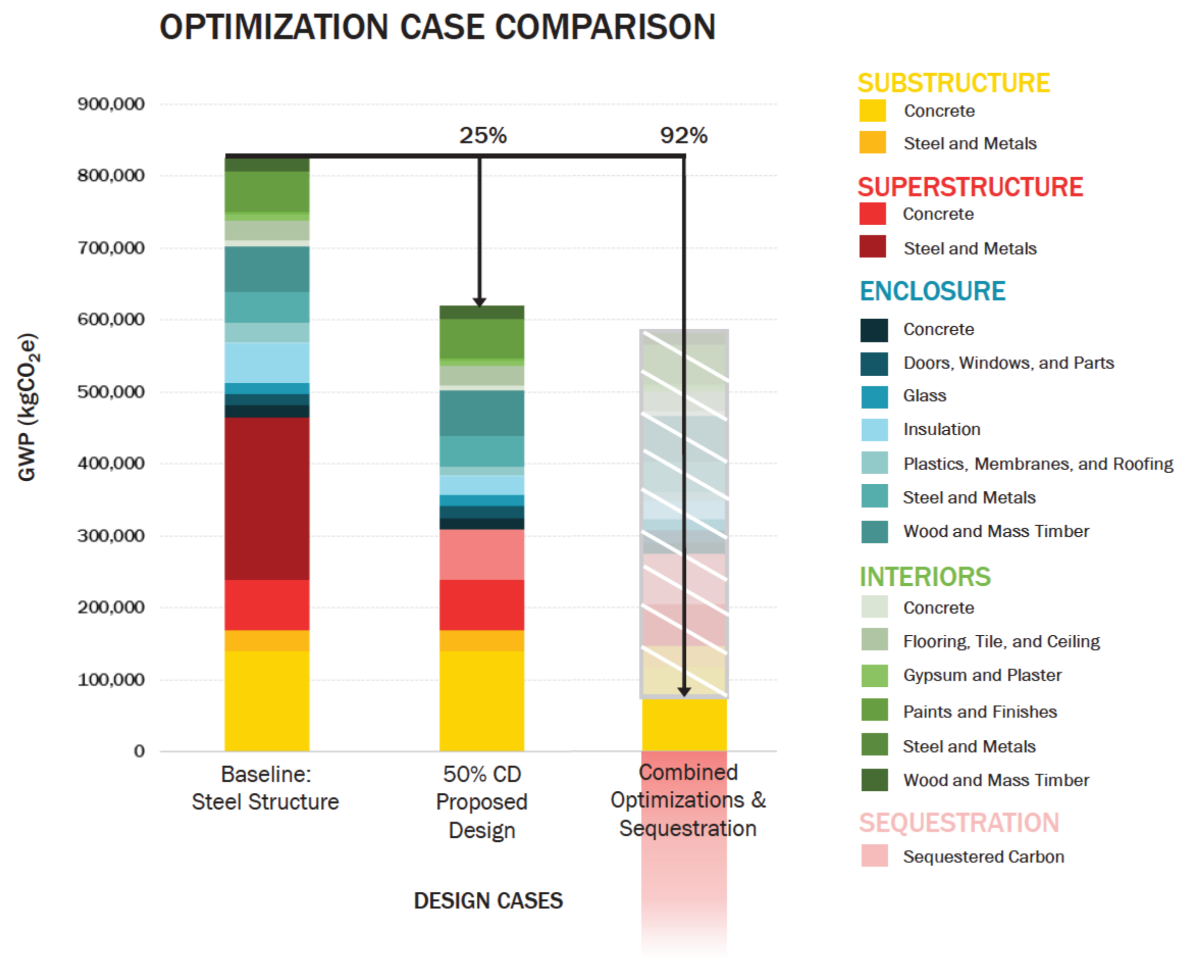




1 MECHANICAL GEOTHERMAL SITE PLAN
SCALE: 1/16" = 1'-0"

EMBODIED CARBON OPTIMIZATION

- Mass Timber Structure
  - Replacing the steel structure for mass timber results in a 19% embodied carbon reduction compared to the baseline
- Proposed Design
  - Ultra-High Performance Concrete (UHPC)
  - Owens Corning Formular NGX 250 Insulation
  - Hydrotech Liquid Roofing Membrane
  - Results in additional 6% embodied carbon reduction compared to baseline
- Concrete Optimization
  - With the procurement of an optimized concrete mix, the project demonstrates up to a 29% reduction from the baseline



In addition to the material optimizations, the project demonstrates significant savings due to the **sequestration potential of wood products**, including the timber structure, wood paneling, and interior wood framing.

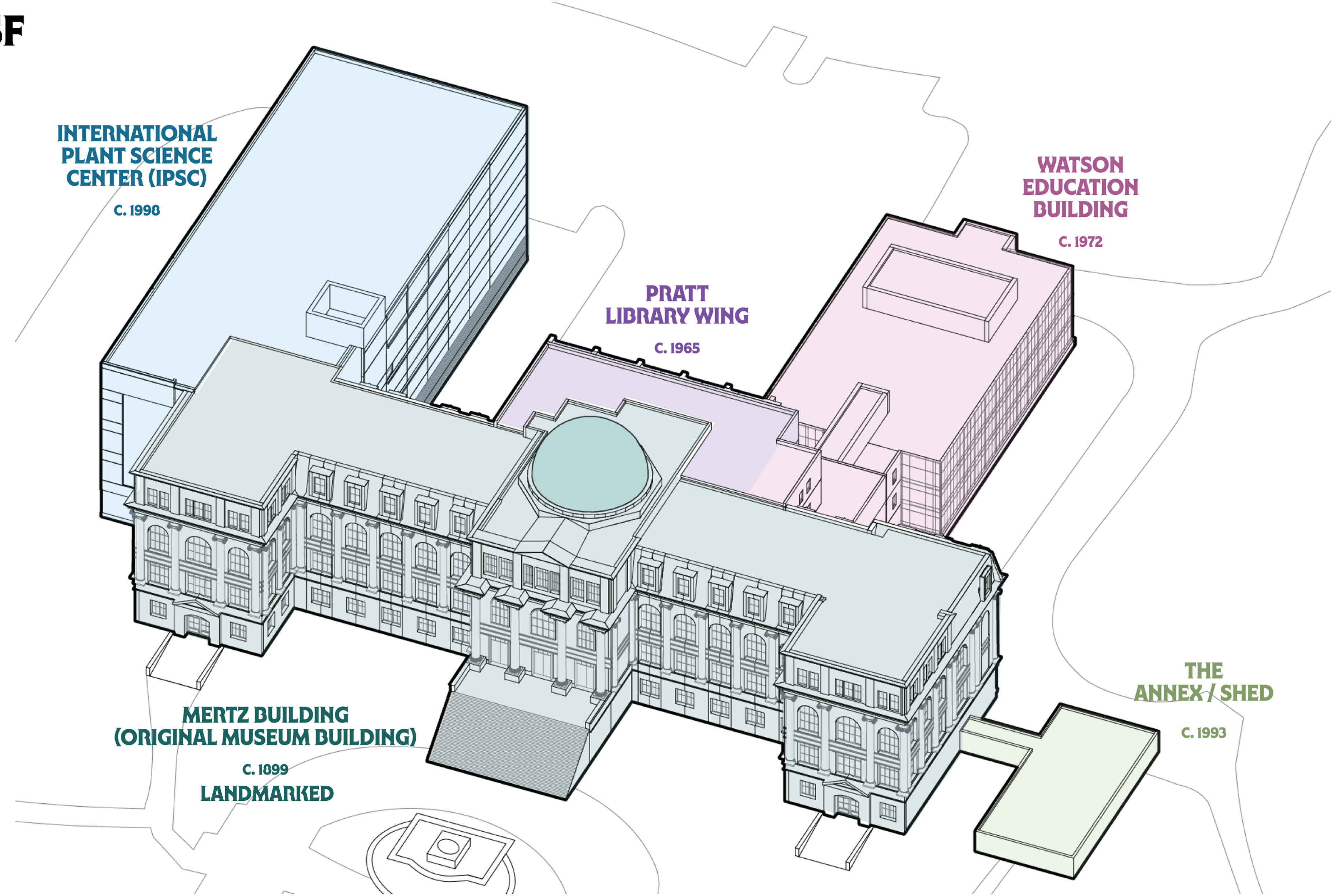
MUSEUM COMPLEX

ROADMAP TO NET ZERO

NYBG

MUSEUM COMPLEX

193,600 NET SF



EXISTING CONDITIONS:
MERTZ BUILDING C. 1889
LANDMARKED

HVAC:

- (2) 300 HP Dual-Fuel Steam Boilers *(outlived useful life)*
- (1) 100 HP Gas-Fueled Steam Boiler *(outlived useful life)*
- (37) Air-Handler Units *(used for heating only)*
- (50+) Window-Mounted Air Conditioning Units cool 80% of the building
- 20% of the building is cooled by IPSC's HVAC

Renewable Energy Systems:

- None

EXISTING CONDITIONS:
IPSC c. 1998

HVAC:

- (2) 300-ton Chillers *(outlived useful life)*
- (2) 300 BAC Cooling Towers
- Air-Handler Units provide heating, which is supplied by the Mertz Building's Steam Boilers

Renewable Energy Systems:

- None

EXISTING CONDITIONS:
PRATT WING C. 1965

HVAC:

- 75-ton Air-Cooled Chiller located on the roof *(outlived useful life)*
- (2) Air-Handler Units located in Mech Penthouse *(outlived useful life)*
- Perimeter Radiant Heaters provide heating via AHUs, which are supplied by the **Mertz Building's Steam Boilers**

Renewable Energy Systems:

- None

EXISTING CONDITIONS:
WATSON BUILDING C. 1972

HVAC:

- (2) Rooftop Air-Handling Units with ducted distribution for cooling only *(outlived useful life)*
- Perimeter Fan Coil Units provide heating and cooling in each space *(outlived useful life)*
    - Heating is supplied via hot water from heat exchanger, which is supplied by the **Mertz Building's Steam Boilers**

Renewable Energy Systems:

- None

ROADMAP TO NET ZERO

PHASE 1: IN PROGRESS
IPSC Chiller Replacement

PHASE 2: SCHEDULED
IPSC + Mertz Geothermal Project

PHASE 3: FEASIBILITY STUDY
Pratt + Watson Geothermal Project

PHASE 4: PLANNED
Solar Photovoltaics

OTHER INITIATIVES
Lighting, BMS Upgrades, Sub-Metering, etc.

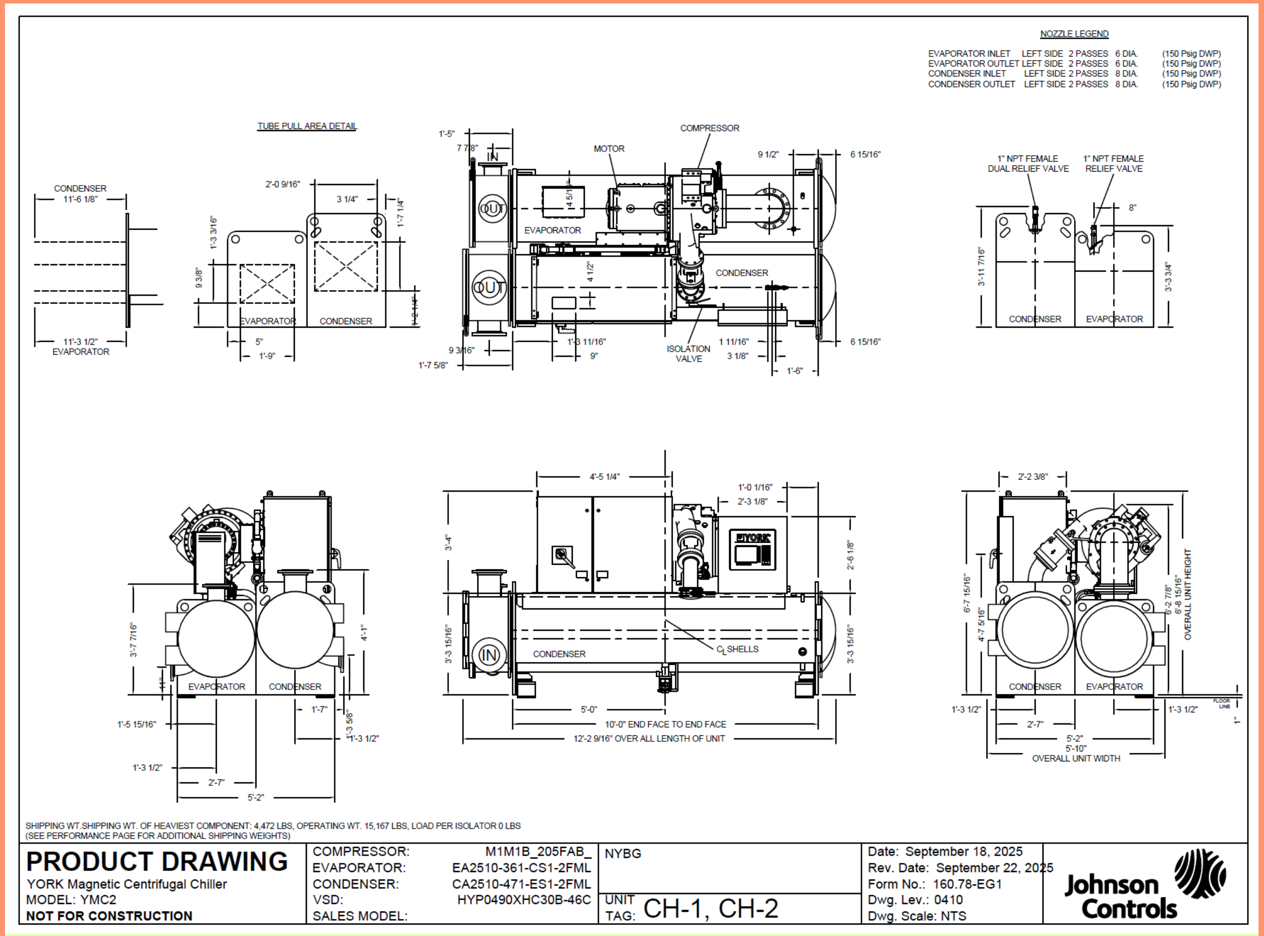
PHASE 1 (IN PROGRESS)
REPLACEMENT OF CHILLERS

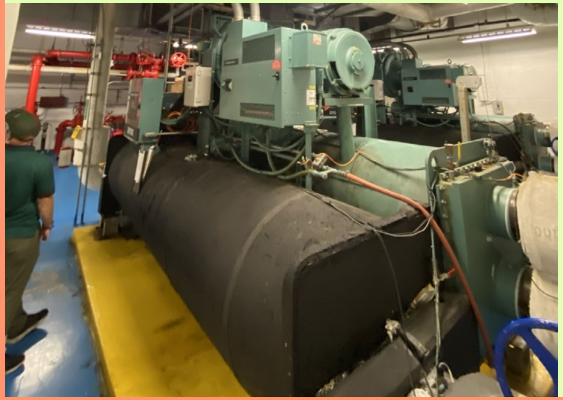
Scope:

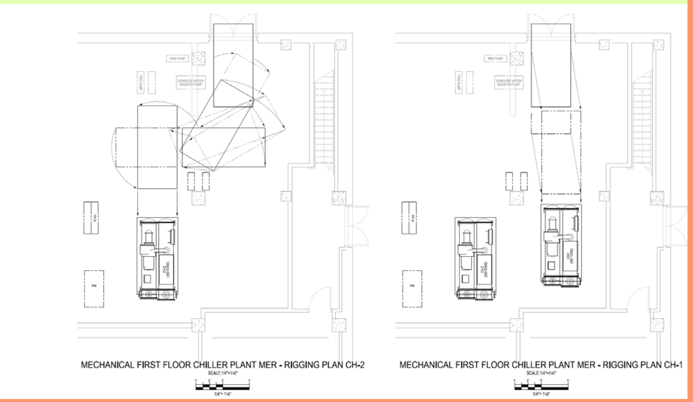
- Replacement of two (2) 300-ton Chillers

Funding:

- NYC Department of Citywide Administrative Services FY26







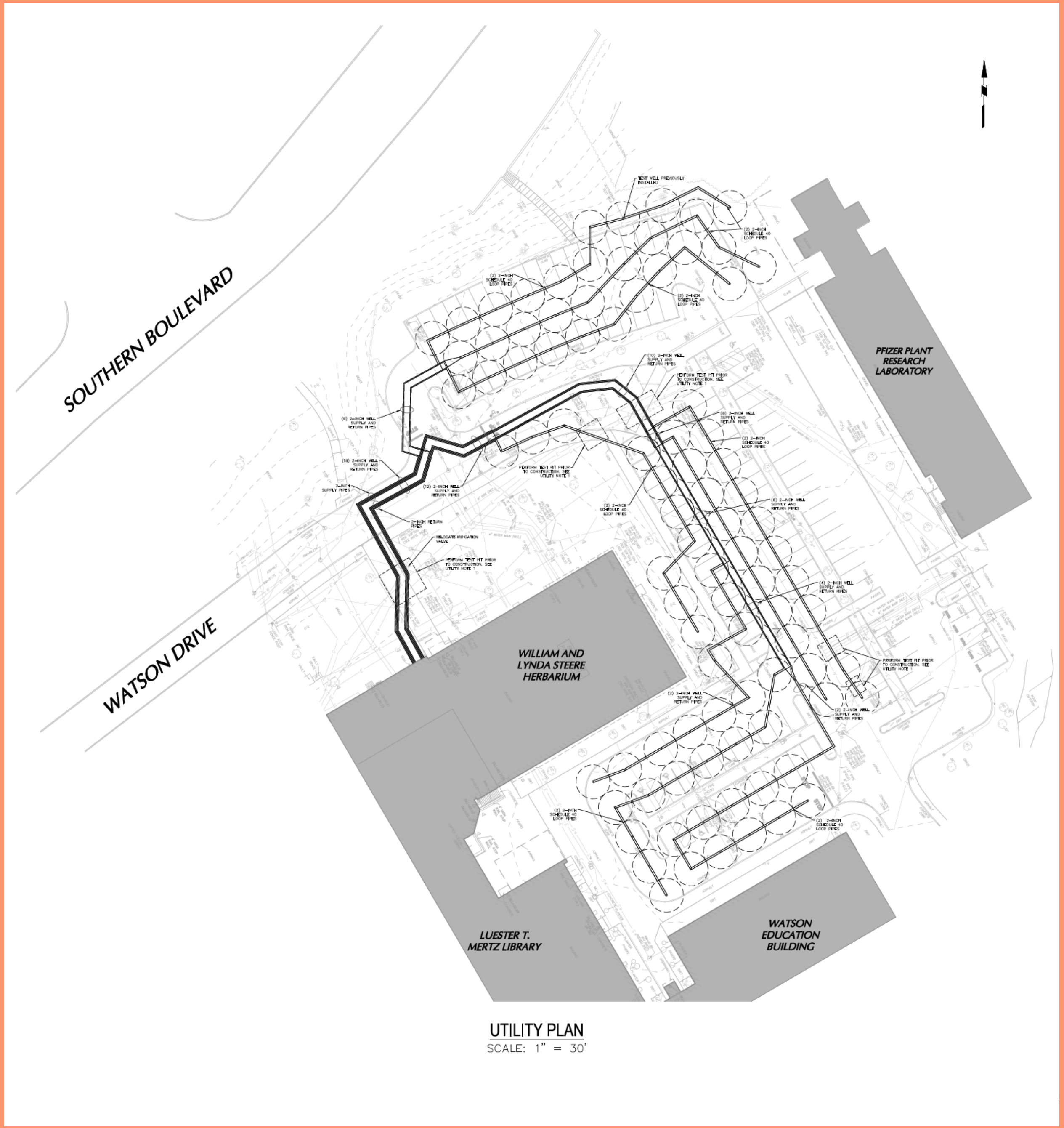
PHASE 2
GEOTHERMAL: MERTZ + IPSC

Scope:

- Removal of two (2) steam boilers from Mertz Building
- Installation of nine (9) electrified ground source heat pumps
- Installation of 90 geothermal wells (500 ft deep)
- Installation of dual-temp pump system
- Modification of (37) Air-Handling Units *(to allow for heating <u>and</u> cooling)*
- Removal of 50+ Window-Mounted Air Conditioning Units

Funding:

- City (NYC Department of Cultural Affairs) & Private



PHASE 3
GEOTHERMAL: PRATT + WATSON

Goal:

- Removal of remaining steam boiler
- Installation of electrified ground source heat pumps supplemented by a geothermal well field

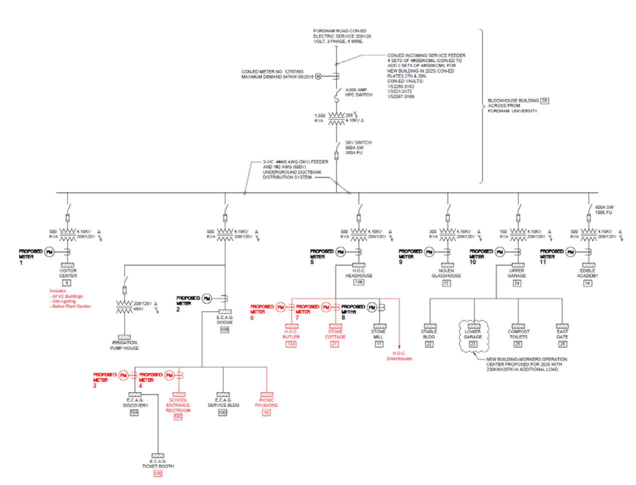
PHASE 4
SOLAR PHOTOVOLTAICS

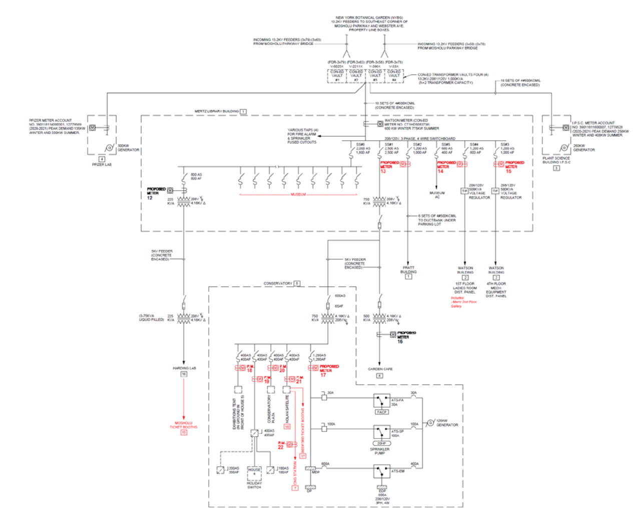
Goal:

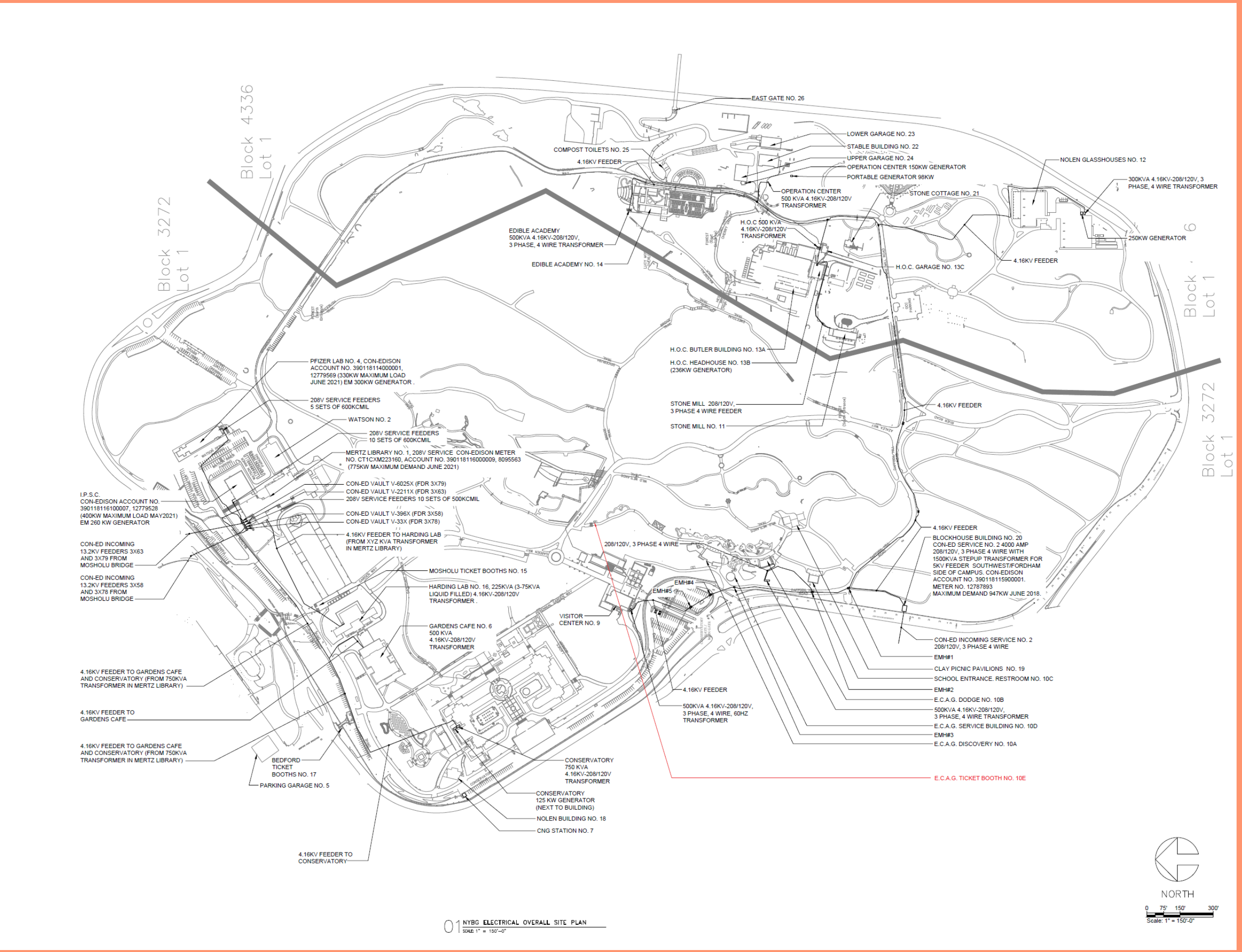
- Roof replacement throughout Museum Complex roofing *(outlived useful life)*
- Installation of solar photovoltaic panel system, where feasible

OTHER INITIATIVES

- LIGHTING & CONTROLS
- BMS UPGRADES
- SUB-METERING







NYBG

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ENERGY & DECARBONIZATION