

# *LEADING THE WAY* **CampusEnergy**2022

Feb. 15-18 | Westin Boston Seaport District Hotel | Boston, Mass.



INTERNATIONAL  
DISTRICT ENERGY  
ASSOCIATION

# Implementation of a Campus-wide Conversion from Steam to LTHW

Dano Weisbord, Smith College

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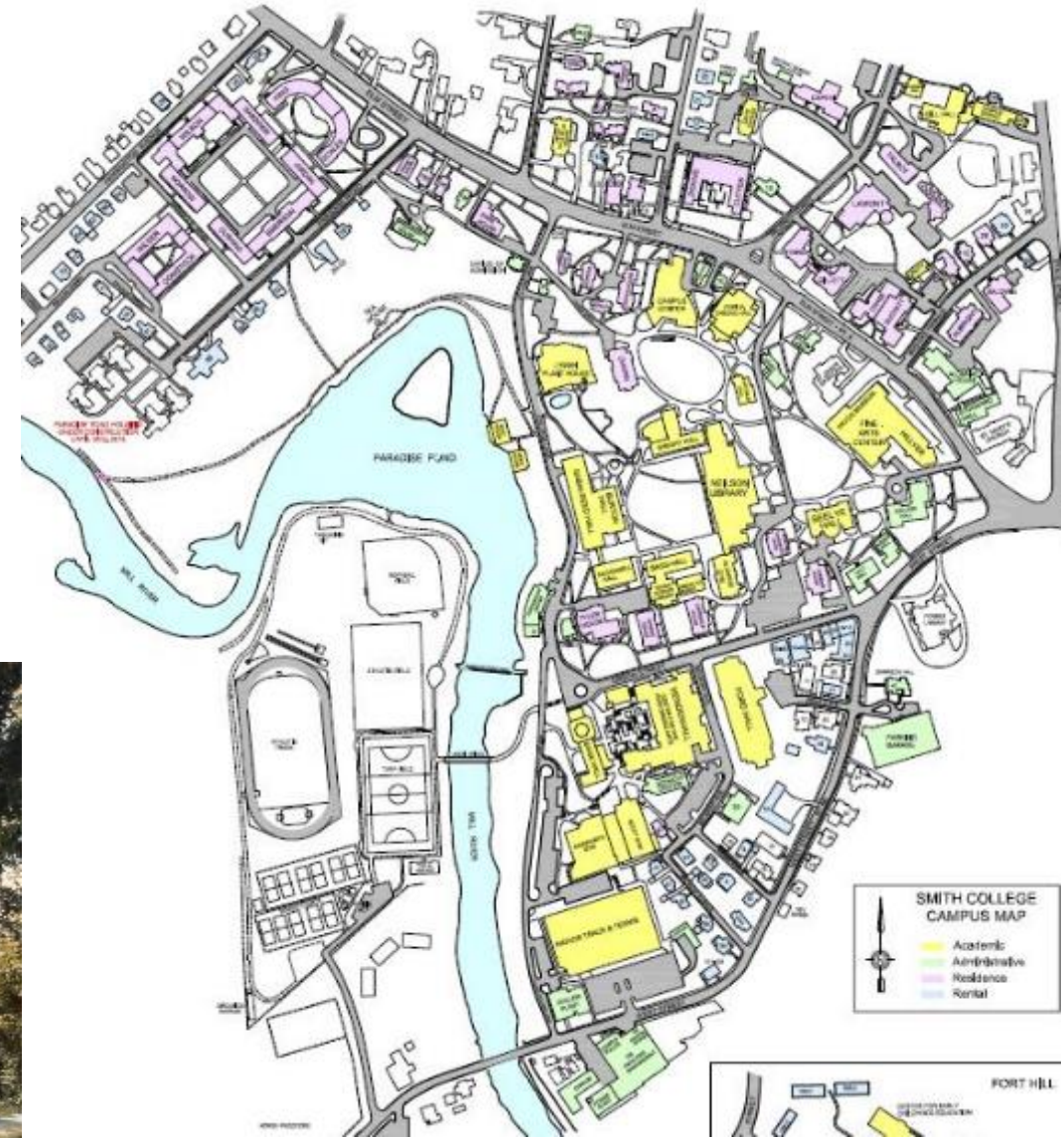
Justin Nash, BOND

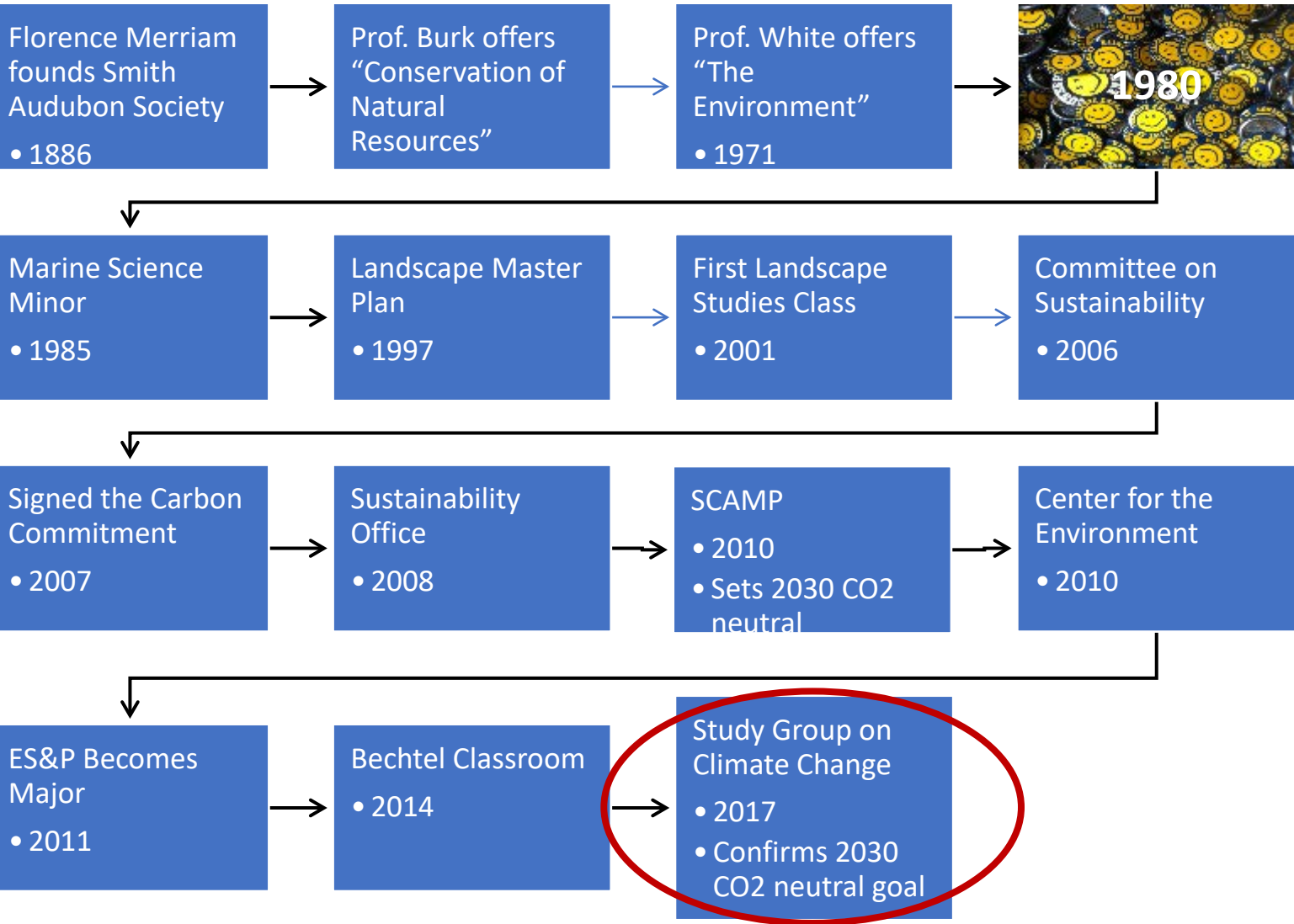




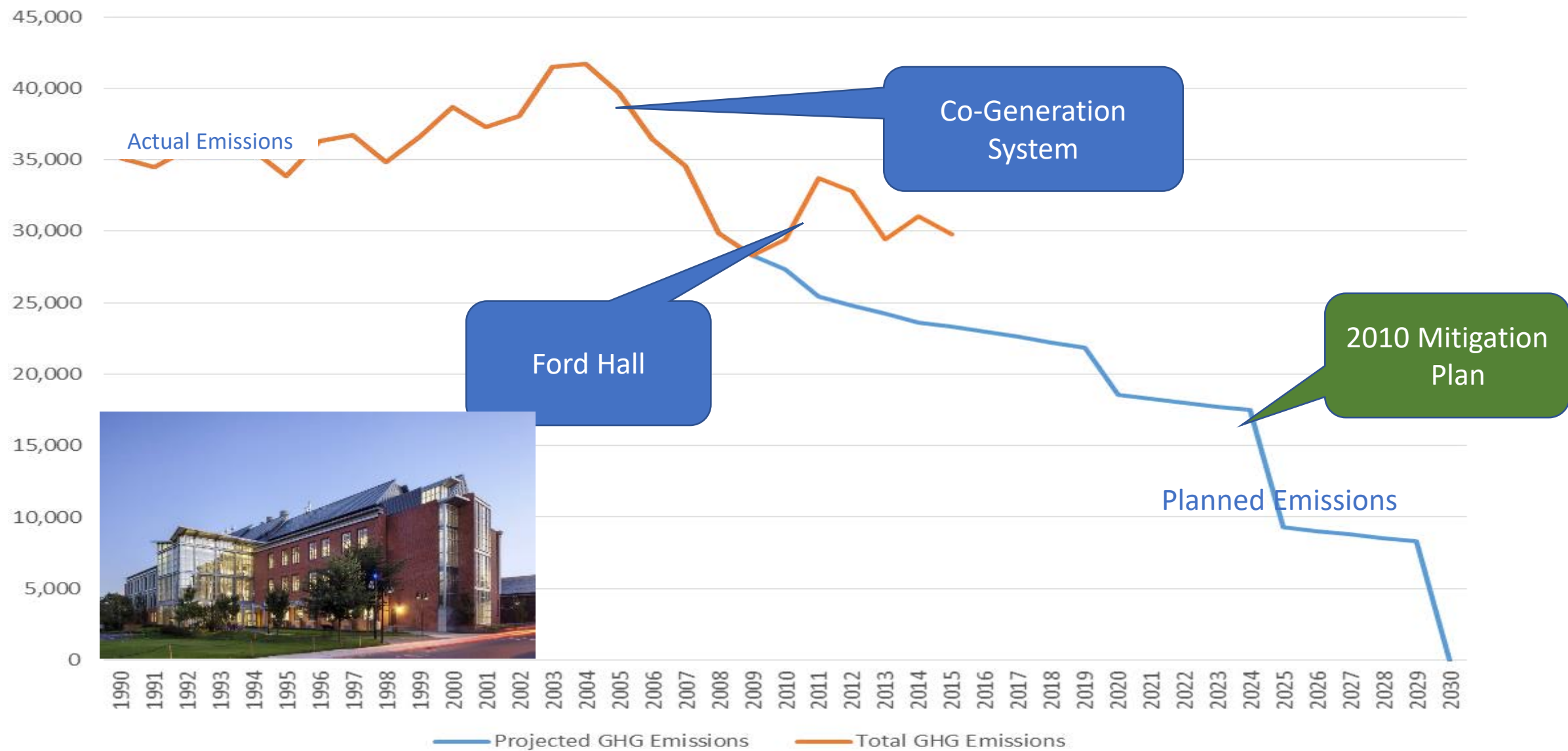
# About Smith College

- 2,500 undergraduate women
  - 40% science, math, engineering majors
  - 500 graduate students
- 114 buildings
- 3 million GSF
- 126 acres
- Quasi-urban context

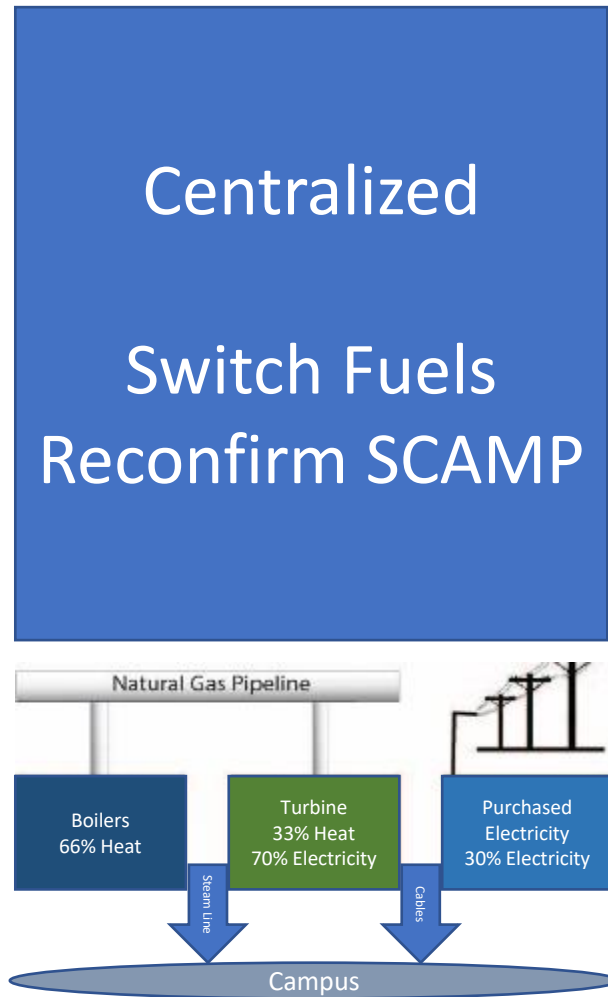








# Our Initial Model



Decentralize

Move to 100%  
Electric, Super-  
Insulated  
Buildings



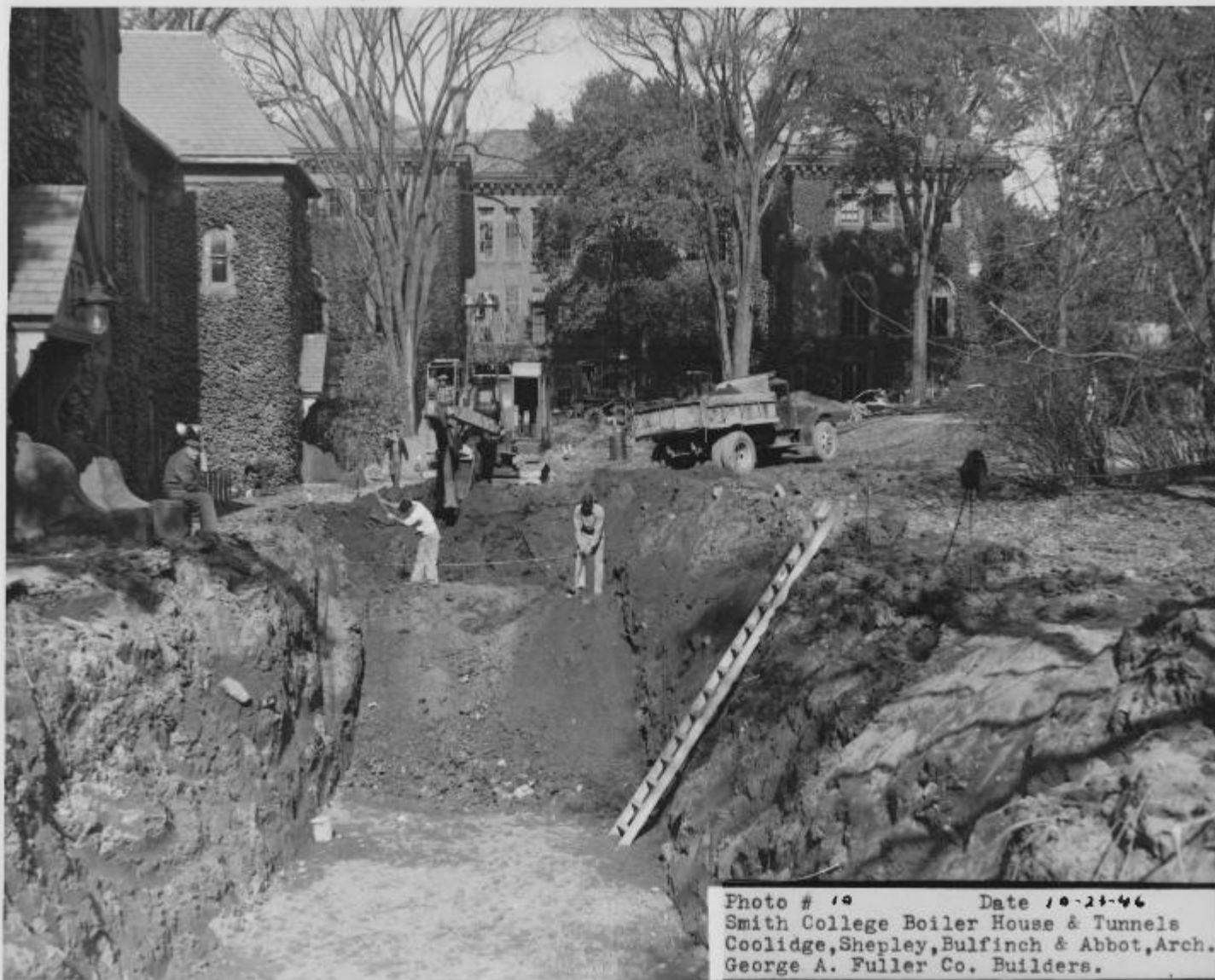
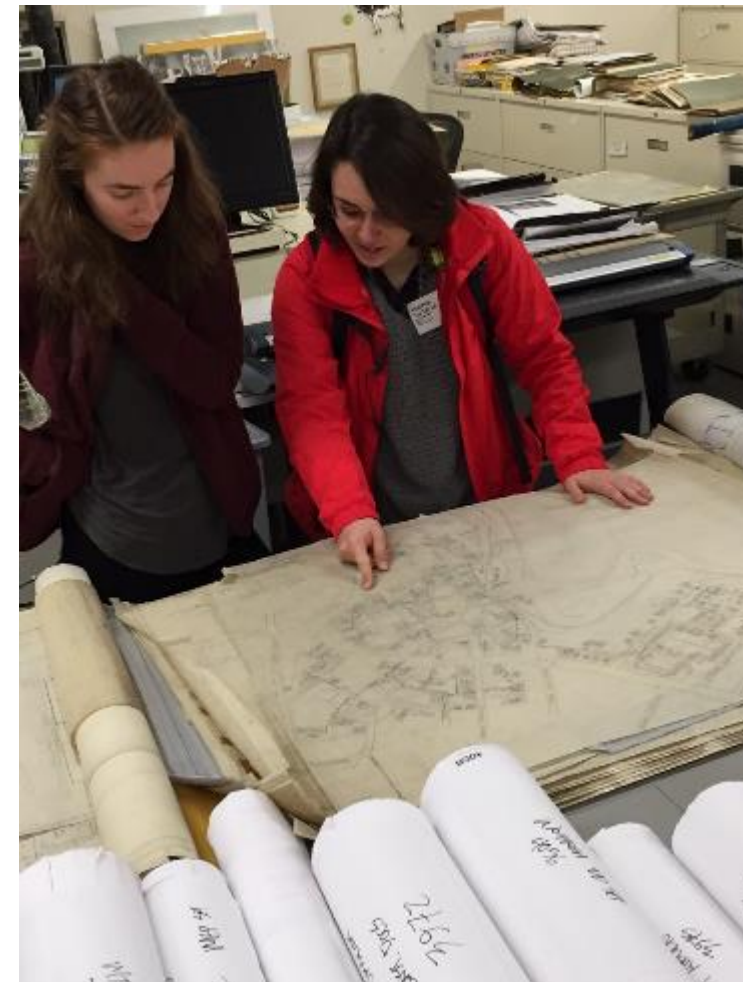


Photo # 19 Date 10-21-46  
Smith College Boiler House & Tunnels  
Coolidge, Shepley, Bulfinch & Abbot, Arch.  
George A. Fuller Co. Builders.

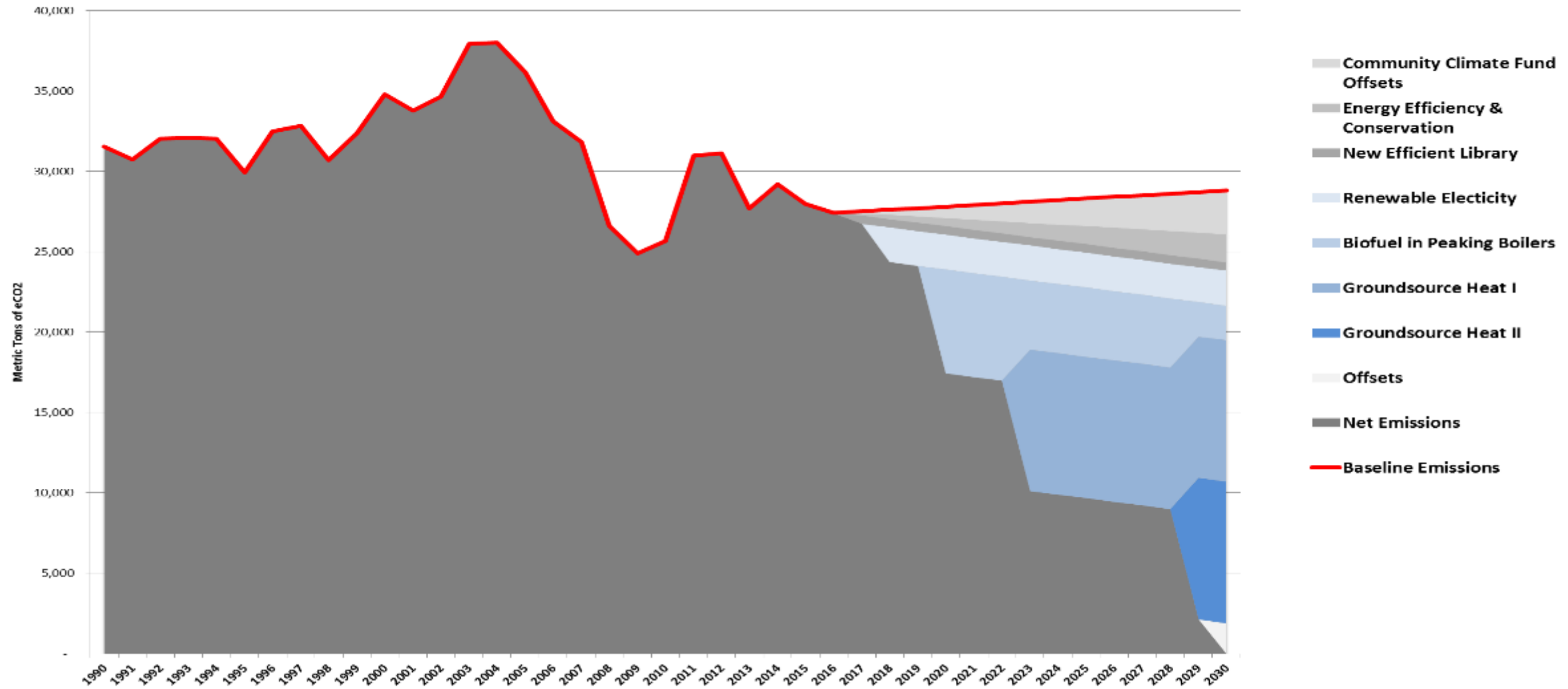






## Mitigation Visualization

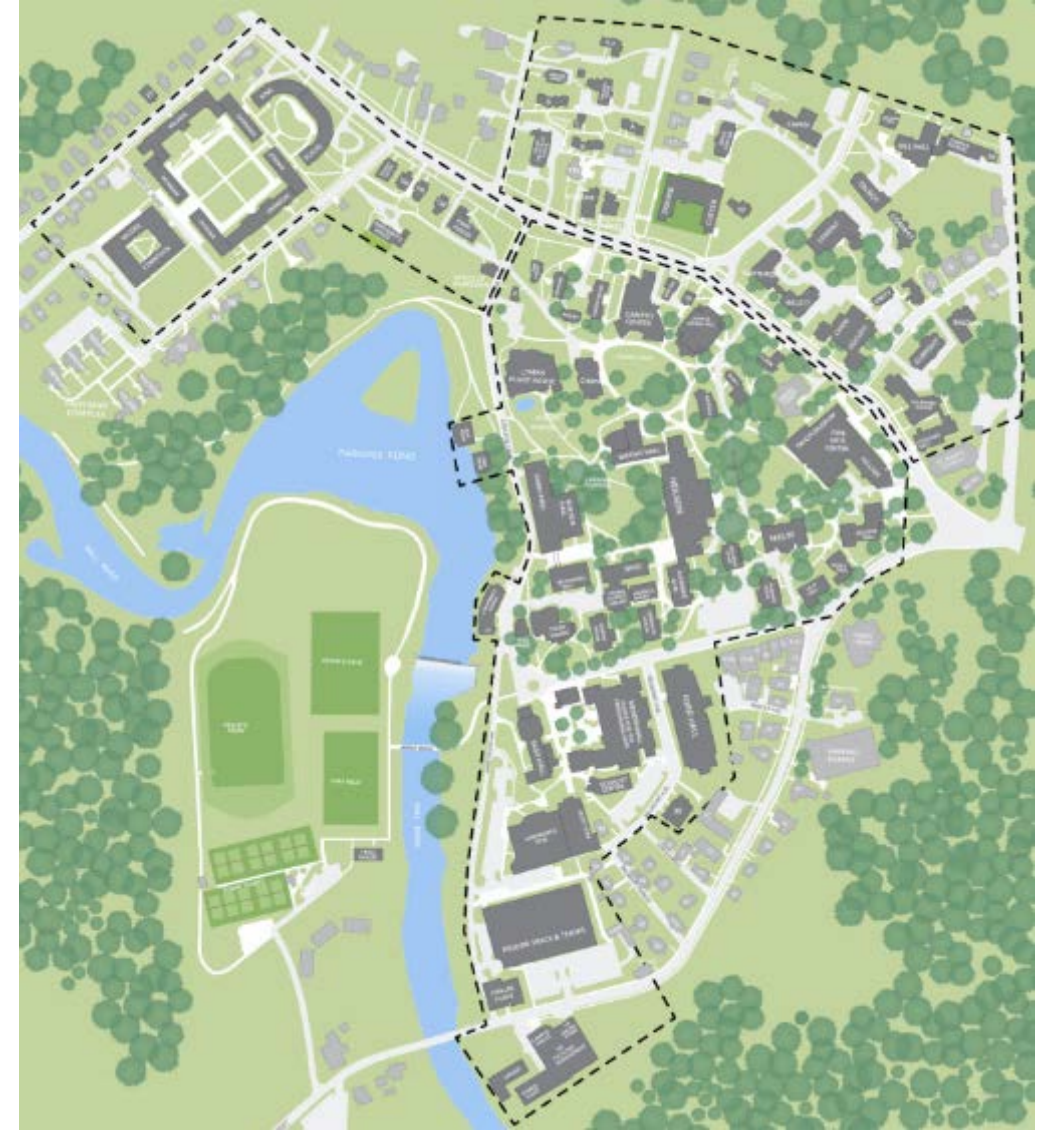
Tons of eCO<sub>2</sub>





# Existing Systems

- Master Plan Scope
  - 104 buildings (2.9 million GSF)
- Boiler Plant – Central Steam System
  - Serves 79 buildings (2.6 million GSF)
- Chiller Plant – Central CW System
  - Serves 28 buildings (1.4 million GSF)
- Local Stand-Alone Heating and Cooling Systems



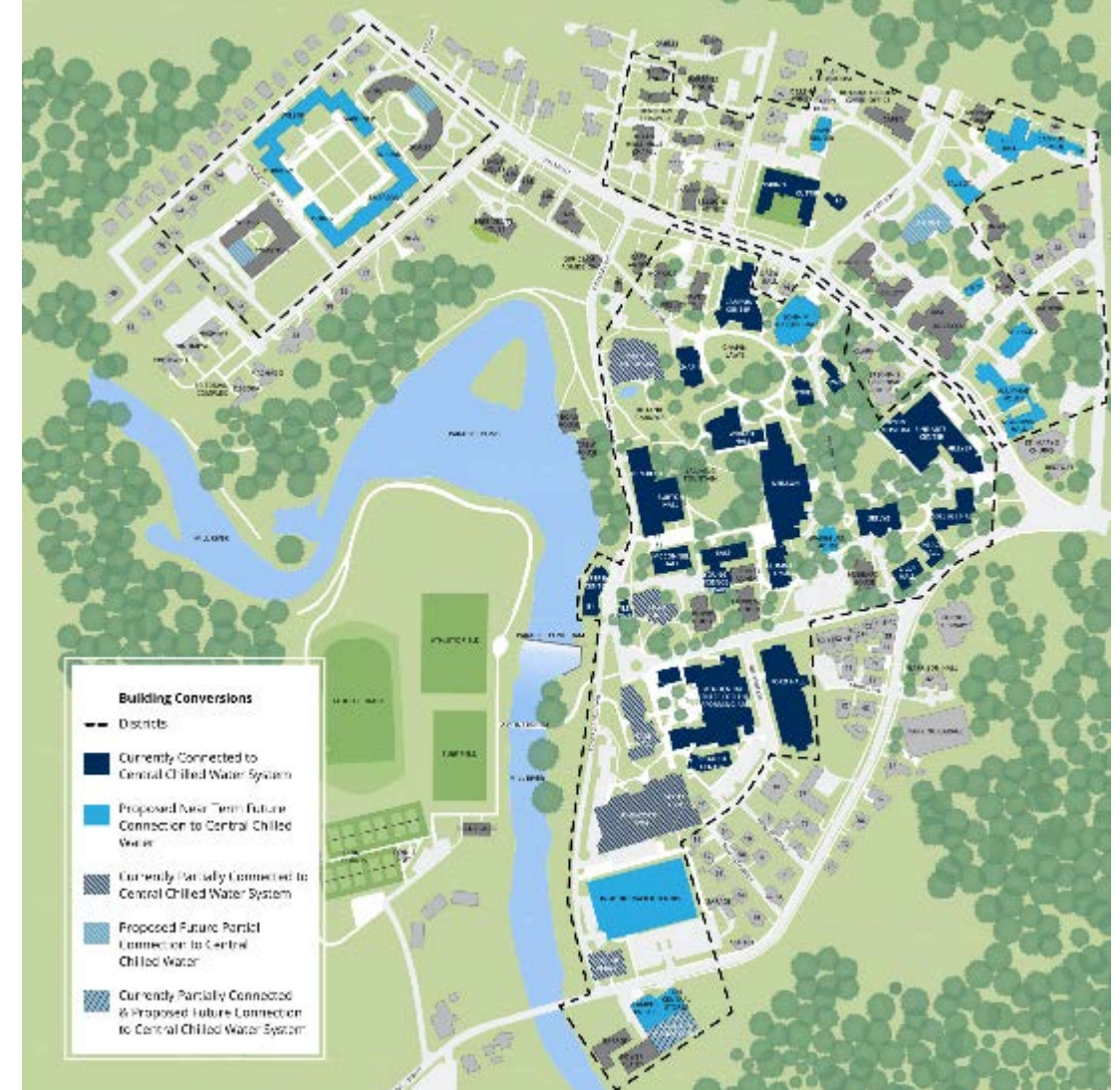
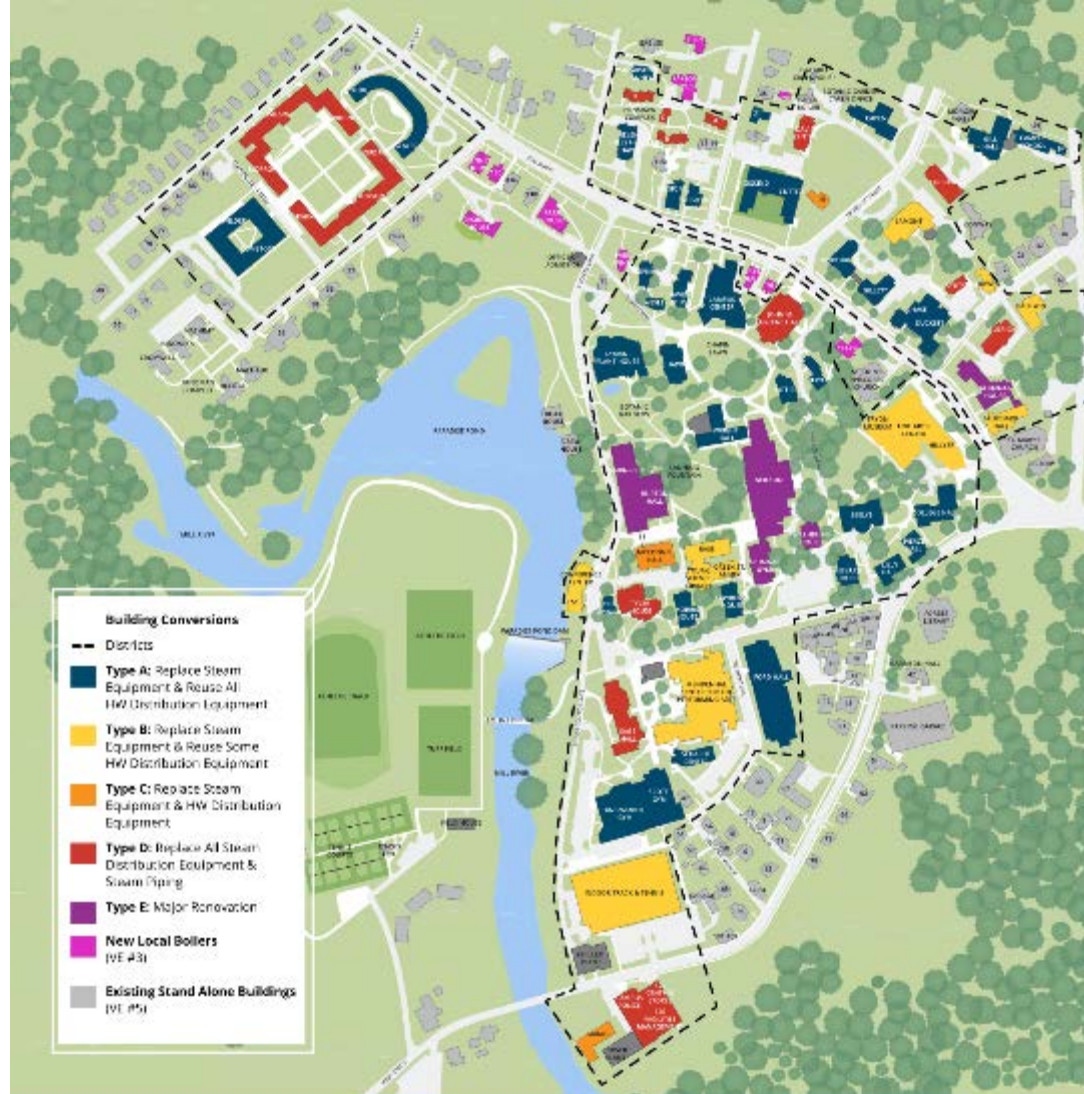
# Energy Master Plan

## **Energy Master Plan to achieve carbon neutrality by 2030**

- Convert central steam system to low temperature hot water
- Electrify the heating system
  - Minimize natural gas
  - Heat pump chillers with geothermal system and new energy plant
- Convert building heating systems to low temp hot water
- Additional future cooling capacity
- New Distribution Piping on campus
- Phased approach: Use information gathered in first phases to inform future phases



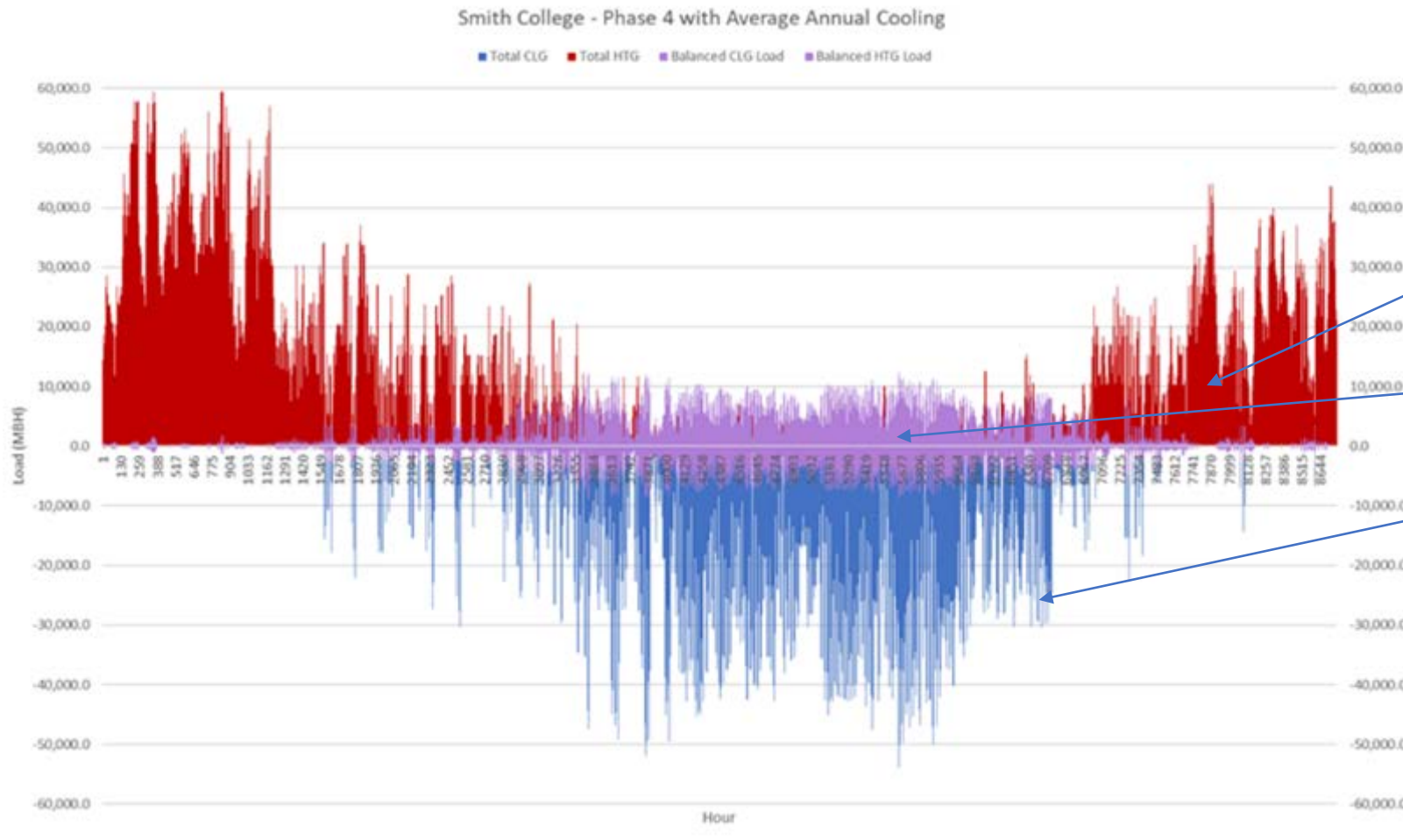
# Building Modifications



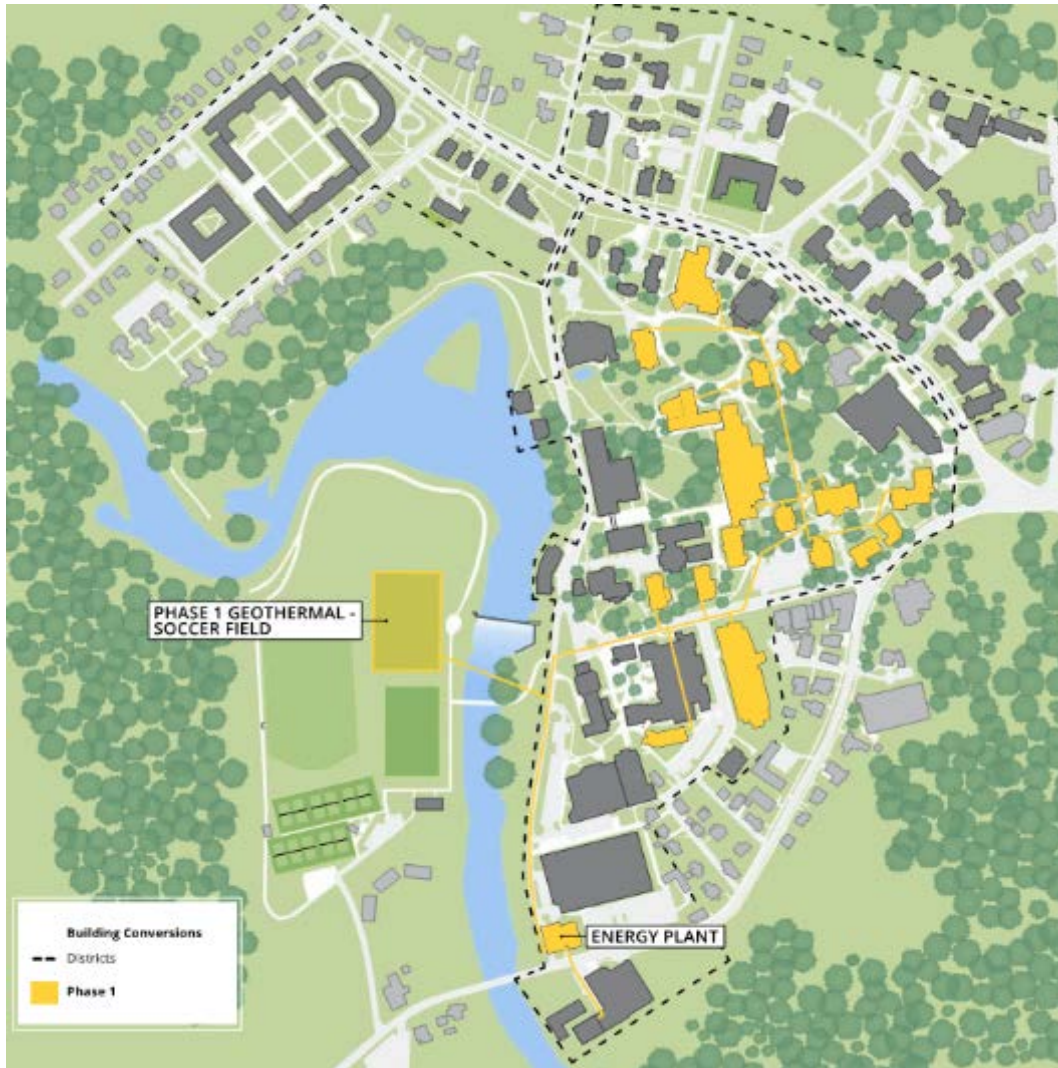


# Future Campus Thermal Profile

- Assumption:
  - Convert to low temp hot water
  - Additional Cooling Capacity
  - Includes domestic hot water



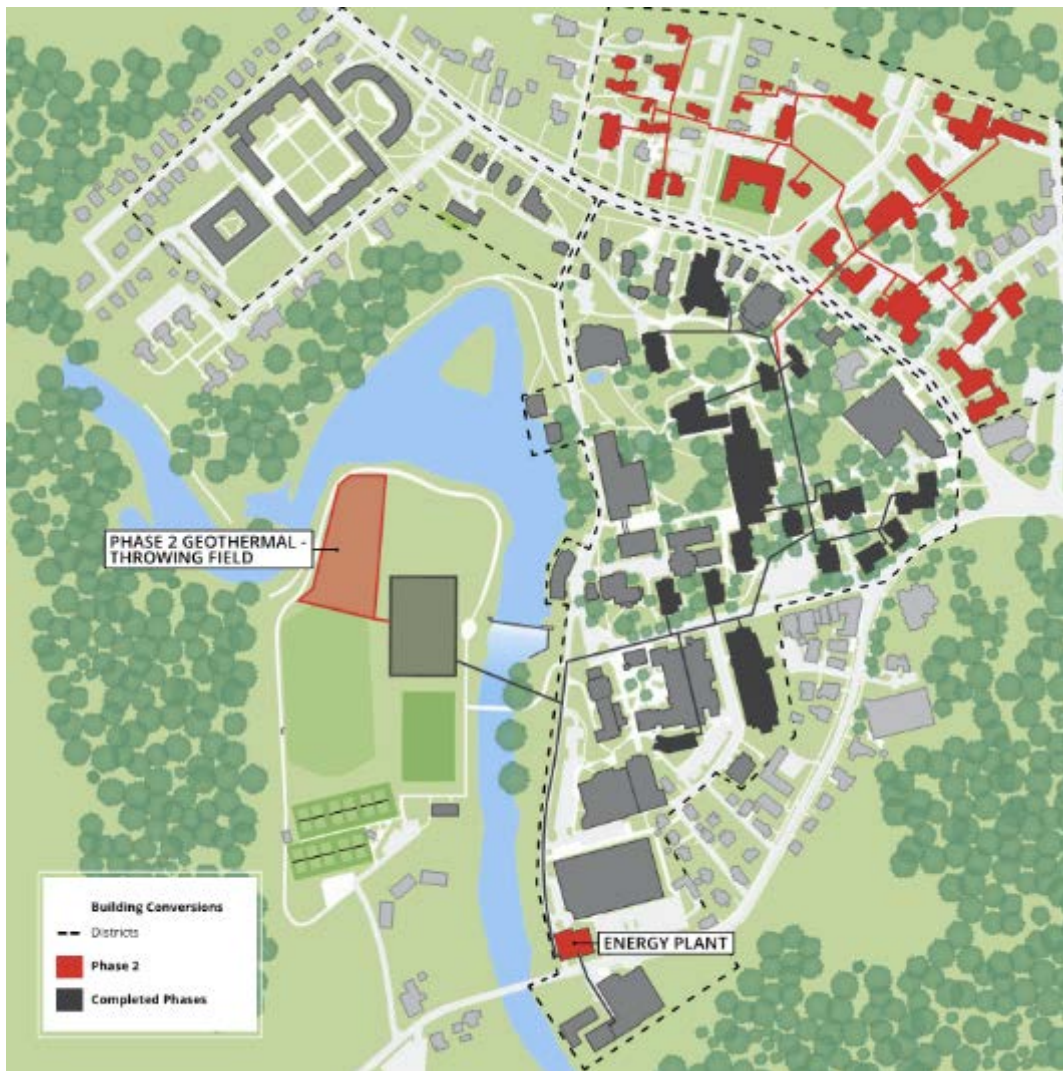
# Phase 1 – Initial Central Campus



- Central Campus Buildings with low cost conversion
- Initial Bore Field
- Distribution Piping
- Direction Bore to connect GHXs to Energy Plant
- Four heat pump chillers (high turn-down)
- Steam to HW converter or dual fuel boiler in boiler plant
- Install SHARC system



# Phase 2 – North East District

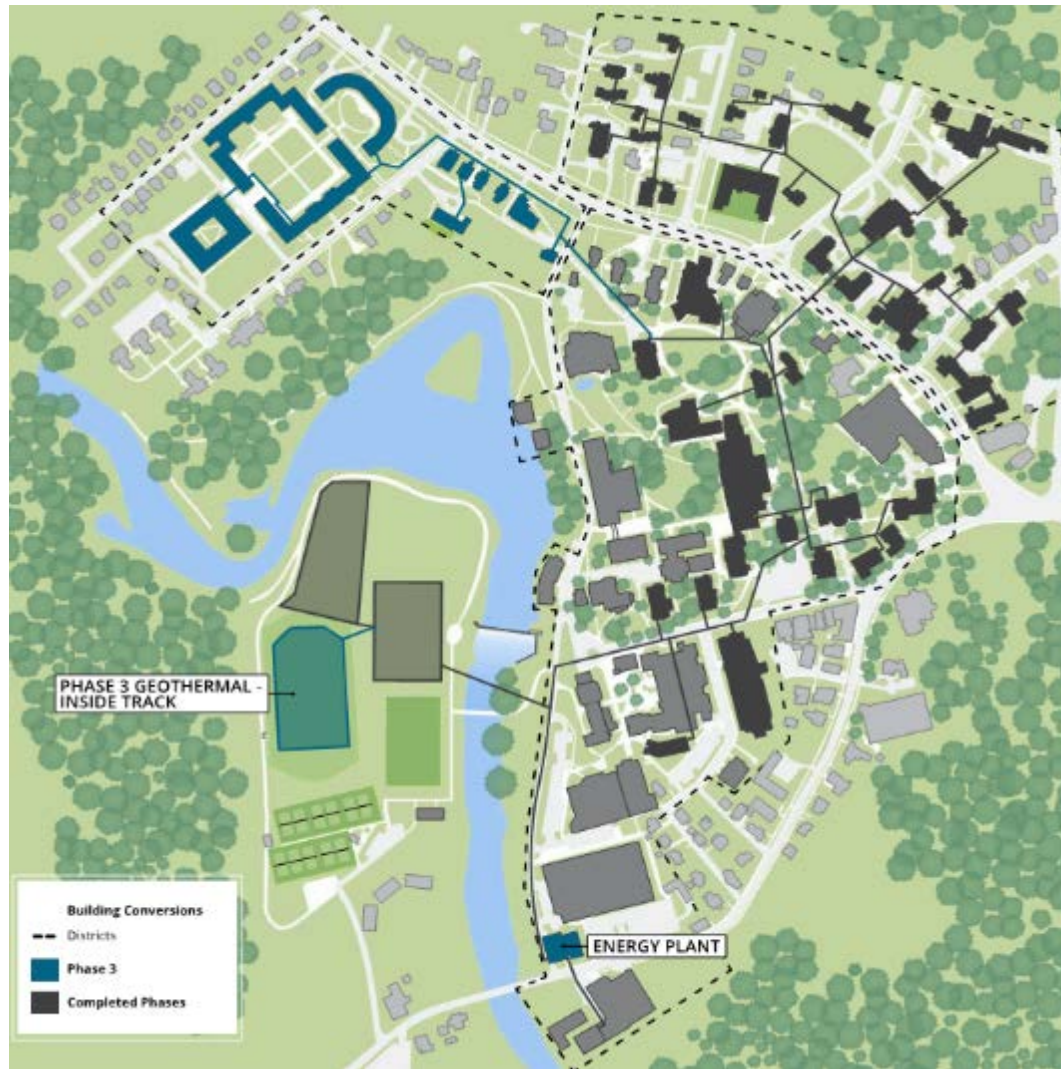


- North East District Building Conversion
- Distribution Piping
- Additional Bore Field
- Additional Heat Pump Chiller
- Install TES Tanks



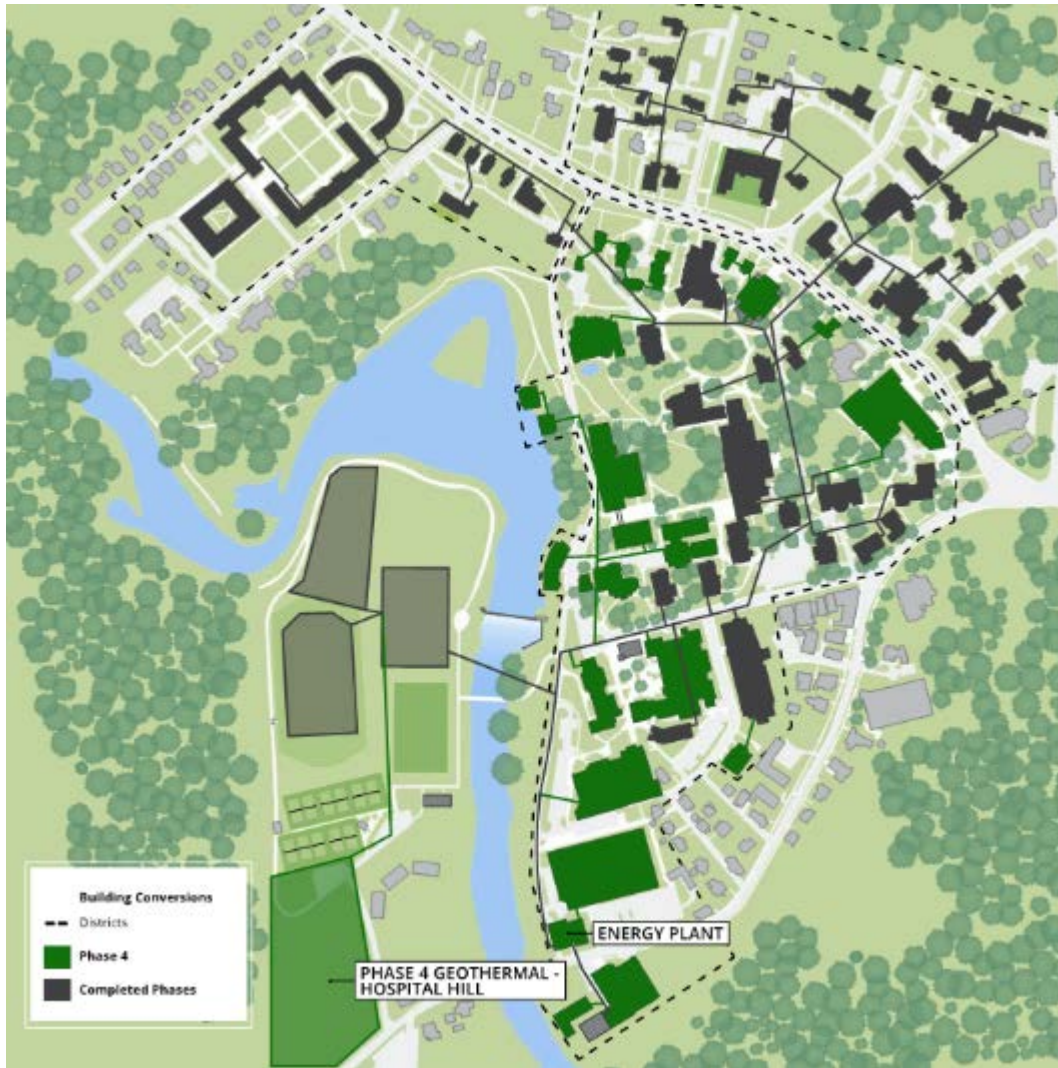


# Phase 3 – North West District



- North West District Building Conversion
- Distribution Piping
- Additional Bore Field
- Additional Heat Pump in Energy Plant

# Phase 4 – Remaining Central District

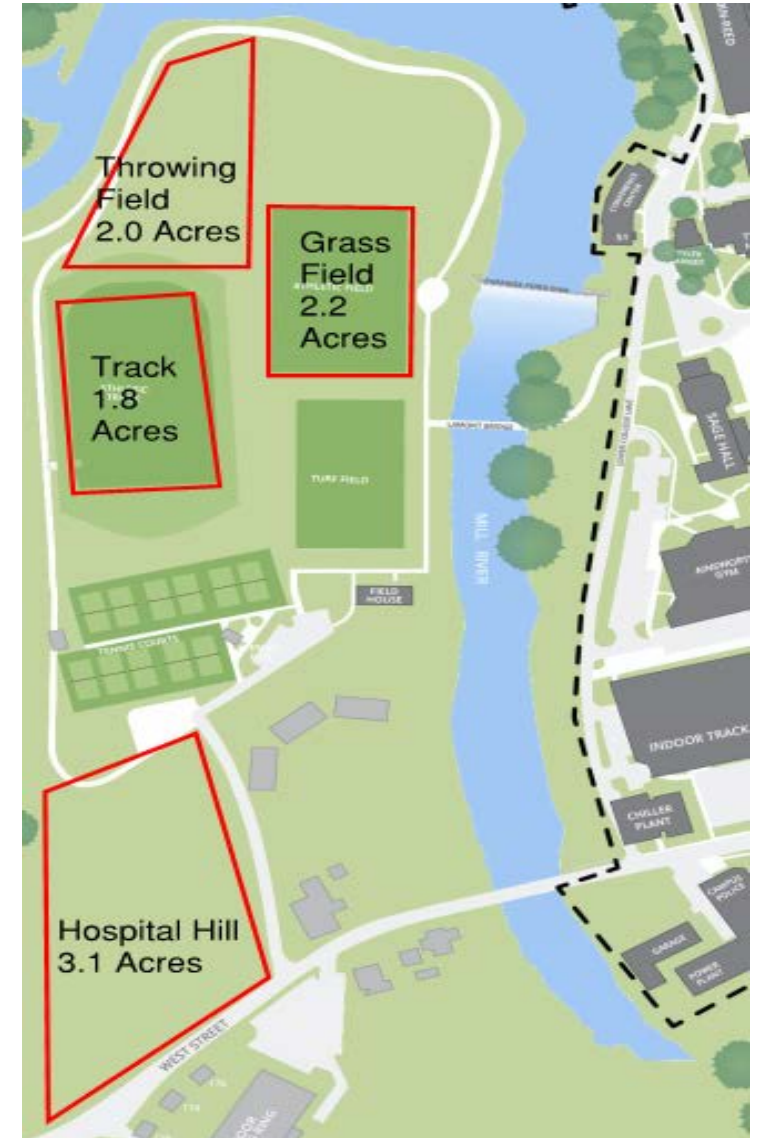


- Completion of Central District Building Conversion
- Distribution Piping
- Additional Bore Field
- Dual Fuel Peaking Boilers
- Additional Chiller in Energy Plant



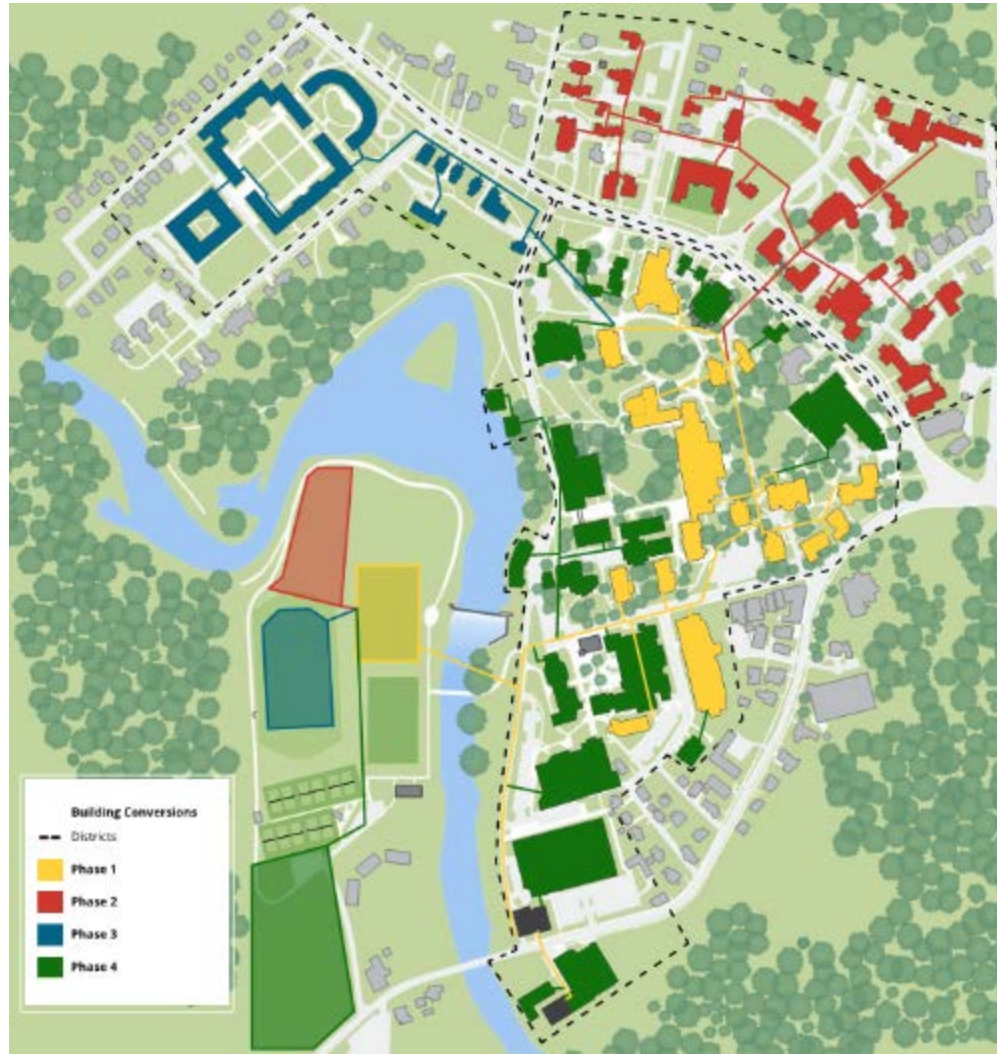
# GHX Field

- GHX Located on Athletic Fields
  - Potential 9.1 acres identified
- Goal – find most cost efficient GHX for available acreage.
- Shallower – less \$, more acreage
  - Deeper – more \$, less acreage





# Full Campus



## CM/GC - Direct Const. Costs:

Building Conversion Costs	\$17,978,856
Distribution Piping and Trenching Cost	\$8,554,310
Geo HX Drilling and Installation	\$15,509,000
Electrical Expansion	\$4,585,000
Energy Plant	\$11,470,523
Hybrid Systems (Sewage HR, TES, Boiler)	\$3,010,000

## Sub Total Construction Cost:

Contingency	20%	\$12,221,538
		<b>\$73,329,227</b>

Annual Escalation (5%/ Yr.) 5%

Escalated from: 2020\$ to:

## Owner Direct Costs:

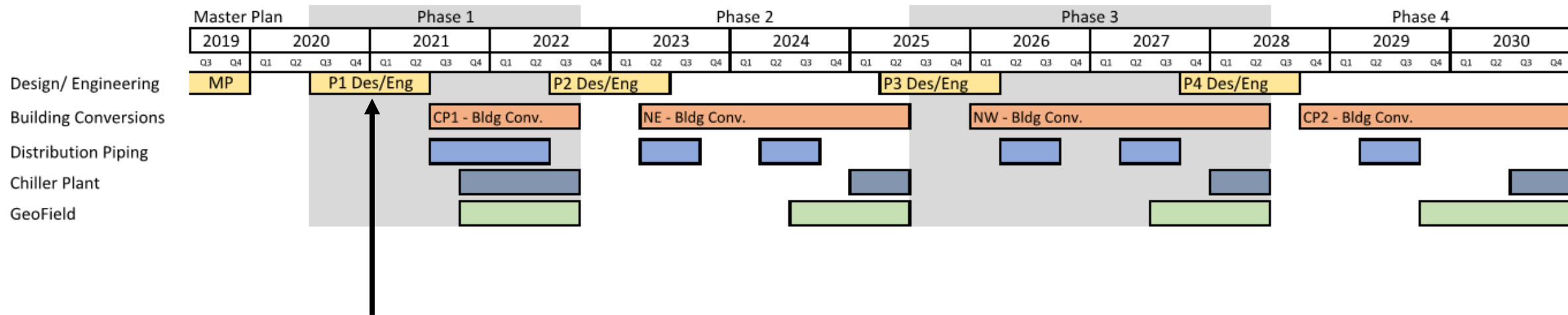
Design Fees	~8%	\$5,866,338
Surveying	0.15%	\$109,994
Environ/Asbestos	0.50%	\$366,646
Geotech/Testing	0.45%	\$329,982
Permits/Plan Approvals	0.25%	\$183,323
		<b>\$6,856,283</b>

Total Estimated Project Cost - Today's \$'s = **\$80,185,509**

Total Project Cost - Escalated \$'s = **\$98,277,704**

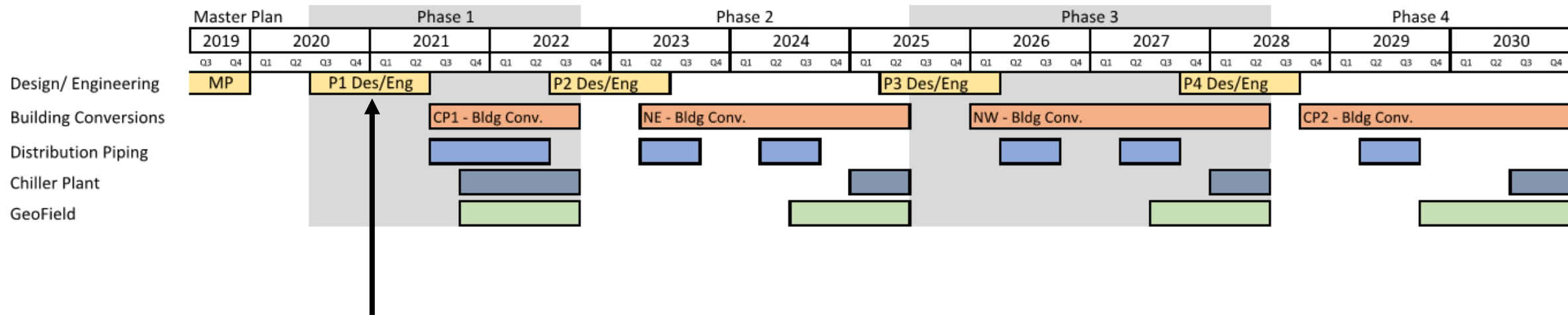
Construction Costs Denominated in 2020 \$

# Initial Implementation Timeframe



Initiate Integrated Project Delivery with Owner, Engineer, and Contractor

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Initiate Integrated Project Delivery with Owner, Engineer, and Contractor



# Cost Estimate Summary

<div>BOND</div> <div>Building</div>	BOND District Energy		
	PRECONSTRUCTION Estimating Summary		
	Client: Smith College	Date	7-Dec-21
	Project: District Energy Master Plan - Preliminary Program Estimate		

Summary Costs by Phase (detail breakdown below)				
Project Phase	Construction	Owner Soft Costs	Subtotal	Notes
Phase 1	\$ 46,520,544	\$ 11,560,355	\$ 58,080,899	100% CD Docs with Subcontractor/Vendor Pricing
Phase 2	\$ 36,030,590	\$ 8,953,602	\$ 44,984,192	Schematic Design with Subcontractor/Vendor Pricing
Phase 3	\$ 43,869,497	\$ 10,901,570	\$ 54,771,067	Schematic Design with Subcontractor/Vendor Pricing
Phase 4	\$ 56,698,658	\$ 14,089,616	\$ 70,788,274	Schematic Design with Subcontractor/Vendor Pricing
<b>Subtotal</b>	<b>\$ 183,119,289</b>	<b>\$ 45,505,143</b>	<b>\$ 228,624,432</b>	

Construction Costs (includes escalation and design/estimating contingency)					
Project Phase	Buildings	Distribution Systems	Geothermal Wells	Plant Upgrades	Subtotal
Phase 1	\$ 13,712,116	\$ 12,537,395	\$ 7,019,080	\$ 13,251,953	\$ 46,520,544
Phase 2	\$ 19,767,713	\$ 7,036,638	\$ 6,776,318	\$ 2,449,922	\$ 36,030,590
Phase 3	\$ 29,816,201	\$ 5,606,008	\$ 5,751,363	\$ 2,695,924	\$ 43,869,497
Phase 4	\$ 31,543,213	\$ 3,869,574	\$ 15,577,519	\$ 5,708,352	\$ 56,698,658
<b>Subtotal Construction</b>	<b>\$ 94,839,243</b>	<b>\$ 29,049,615</b>	<b>\$ 35,124,280</b>	<b>\$ 24,106,151</b>	<b>\$ 183,119,289</b>

Owner Costs					
Project Phase	Design Fees	Precon & Survey	Testing & permits	Owner Contingency	Subtotal
<b>Percentage</b>	<b>8%</b>	<b>0.65%</b>	<b>1.20%</b>	<b>15%</b>	<b>25%</b>
Phase 1	\$ 3,721,644	\$ 302,384	\$ 558,247	\$ 6,978,082	\$ 11,560,355
Phase 2	\$ 2,882,447	\$ 234,199	\$ 432,367	\$ 5,404,589	\$ 8,953,602
Phase 3	\$ 3,509,560	\$ 285,152	\$ 526,434	\$ 6,580,424	\$ 10,901,570
Phase 4	\$ 4,535,893	\$ 368,541	\$ 680,384	\$ 8,504,799	\$ 14,089,616
<b>Subtotal Owner</b>	<b>\$ 14,649,543</b>	<b>\$ 1,190,275</b>	<b>\$ 2,197,431</b>	<b>\$ 27,467,893</b>	<b>\$ 45,505,143</b>




# Implementation Planning – the problem

1. Minimize impacts to core business
2. Achieve savings as quickly as possible
3. Implement a culture of continuous improvement

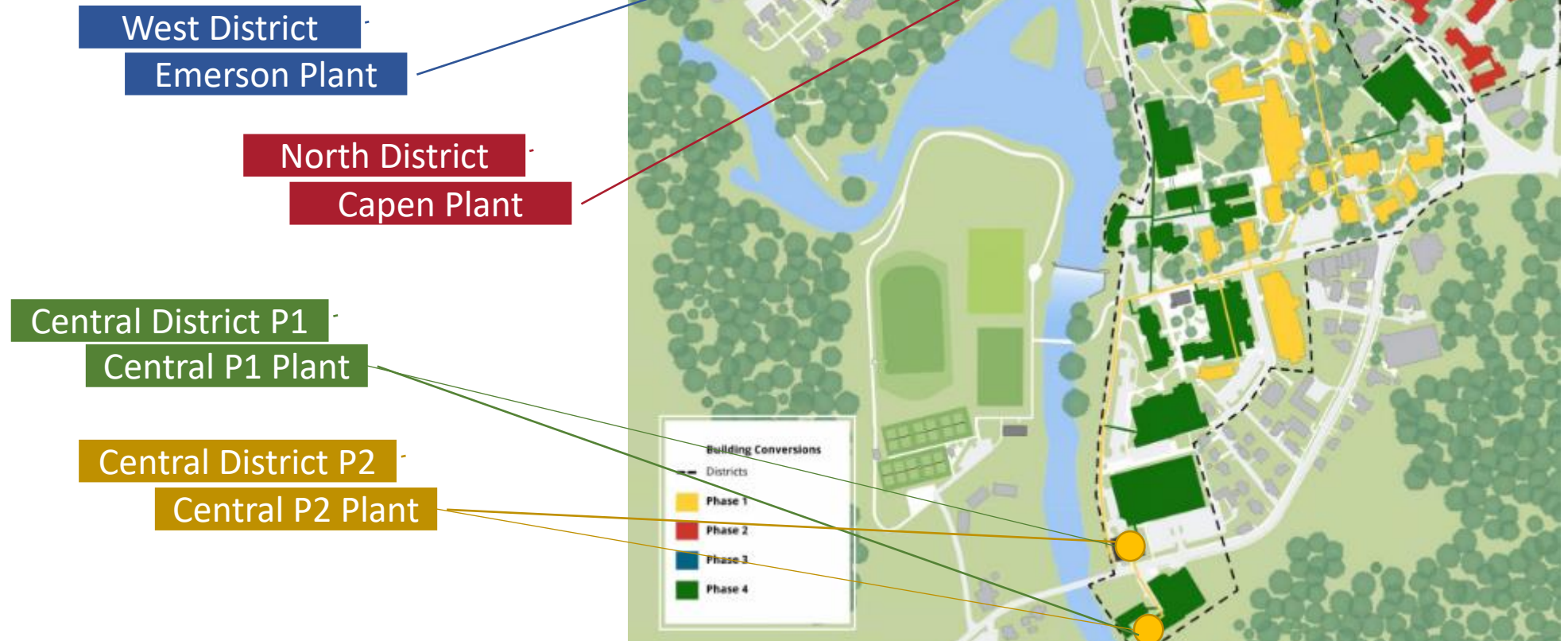




# Implementation Planning – the solution

1. Start small  Integrate our team with campus stakeholders and build up from there
2. Start on the periphery  Manage impact to existing steam operations, work into to the campus core
3. Phased implementation  Overlap construction, Cx and operations of LTHW. Implement lessons learned on subsequent phases

# Energy Districts





# Vertical Heat Exchanger: CAPEX Optimized

## Central District (P1+P2)

- Bore Count: 306 (P1=150 & P2=156)
- % of Annual Cooling Energy: 61%
- % of Annual Heating Energy: 75%
- % of Peak Cooling Load: 40%
- % of Peak Heating Load: 95%
- \$5,985,412 for 150 wells

## North District

- Bore Count: 80
- % of Annual Cooling Energy: 65%
- % of Annual Heating Energy: 54%
- % of Peak Cooling Load: 32%
- % of Peak Heating Load: 22%

## • West District

- Bore Count: 160
- % of Annual Cooling Energy: 90%
- % of Annual Heating Energy: 99%
- % of Peak Cooling Load: 51%
- % of Peak Heating Load: 72%

# GHX Field

## 2019 Energy Master Plan

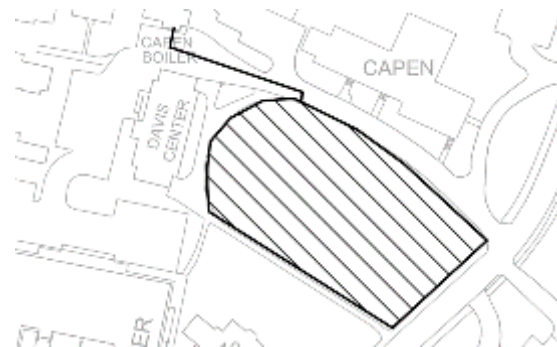
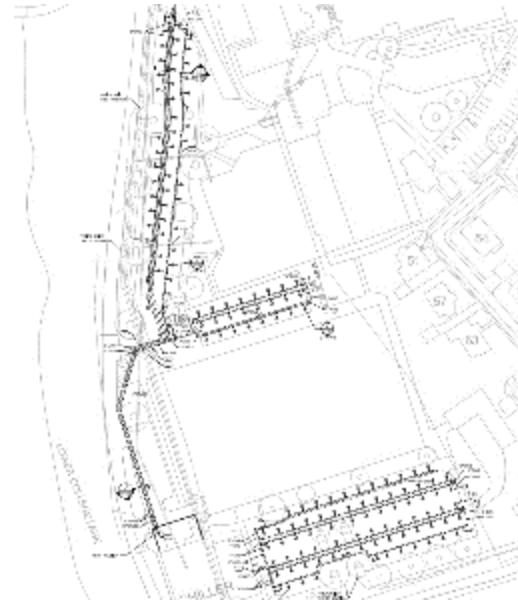


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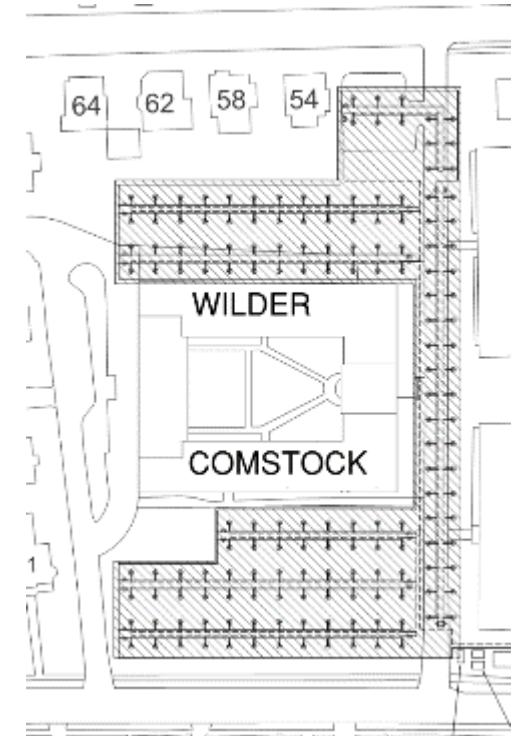
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## Current Recommendations (GHX Located adjacent to District Energy Plants)

### Central District (P1)



### West District

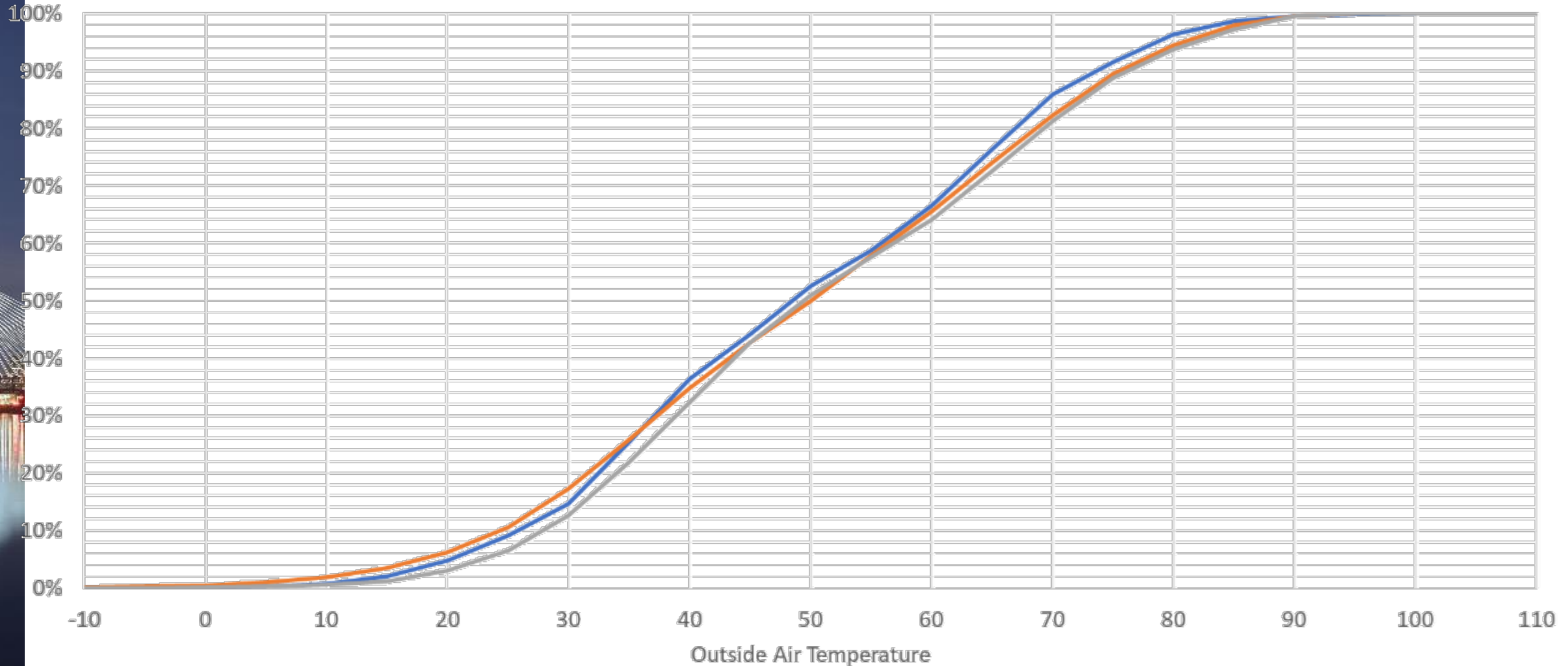


### North District





# Historical Temperature Distribution

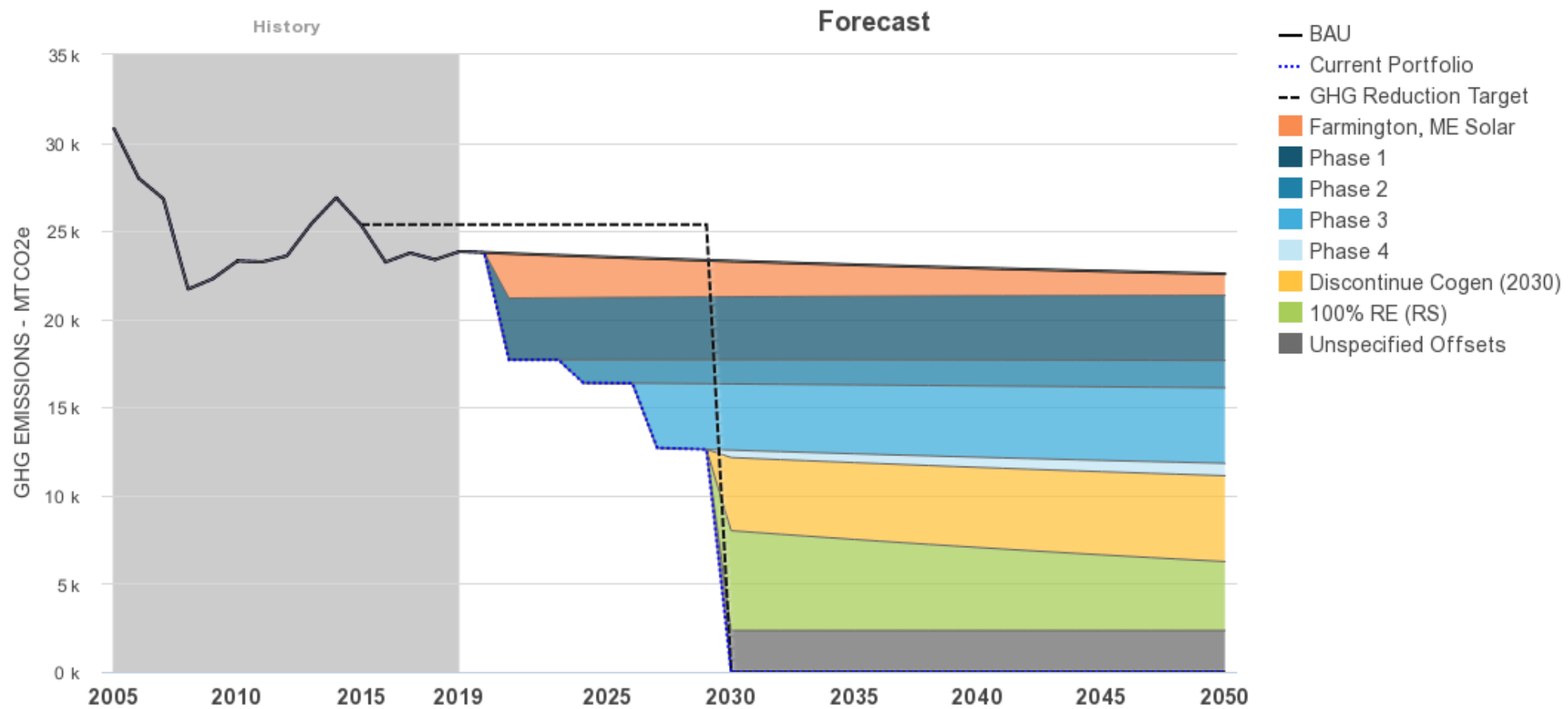


# VE Cost Estimate Summary

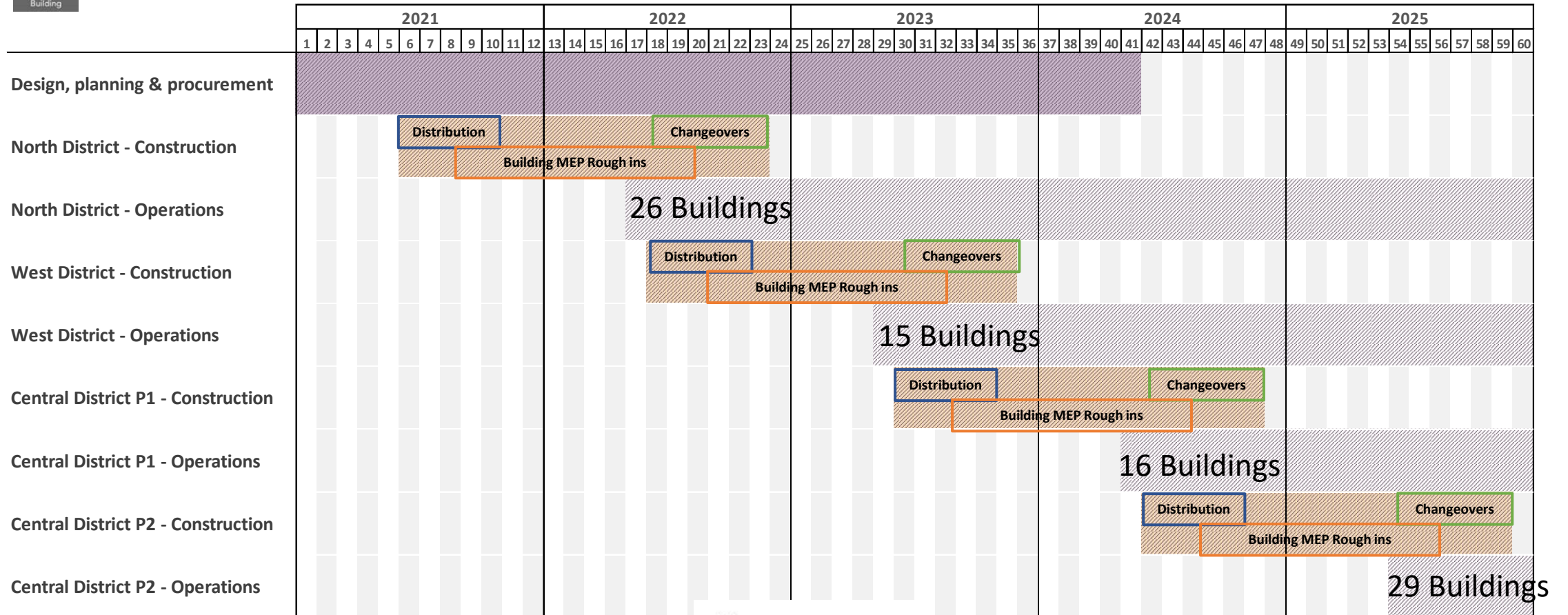
No.	Item Description	Target Value	Date Added	Expected Documents Published Date	Estimate Due Date
	<b>VE #1 THRU #8 -SALAS O'BRIEN</b>				
1	<u>VE 1: Eliminate redundancy on DHWHXs for non dorm/non lab buildings.*</u>	\$ (887,552)	11/2/2021	11/2/2021	11/16/2021
2	<u>VE 2: Eliminate BTU meter for domestic hot water service.</u> (all buildings)	\$ (1,848,554)	11/2/2021	11/2/2021	11/16/2021
3	<u>VE 3: Increased HW Distribution Temp</u> (refer to attached pdf - Dual Temp Loop -1 60 Deg HWS in Lieu of 130 Deg HWS ) - Still in Pricing - Estimated Value	\$ (3,252,844)	11/2/2021	11/2/2021	11/16/2021
4	<u>VE 4: Removal of buildings from new campus system</u> (to be discussed w/Smith) { convert high conversion cost (all steam) buildings currently connected to the campus steam distribution system to standalone systems (VRF/Air Source heat pumps or split systems) instead of connecting them to the new hydronic district energy system. }	\$ (4,909,539)	11/2/2021	11/17/2021	12/8/2021
5	<u>VE 5: Removal of standalone buildings from project</u> (to be discussed w/Smith) ( That are not on the Existing Steam Distribution System)	\$ (5,300,606)	11/2/2021	11/2/2021	11/16/2021
6	<u>VE 6: Remove Chilled Water Connections to Henshaw Complex</u> (Impact on Utilities pricing)	\$ (100,552)	11/10/2021	11/12/2021	11/16/2021
7	<u>VE 7: Domestic Hot Water – remove connection to the campus low temp hot water system for specific buildings</u> <ul style="list-style-type: none"> <li>• MEP/SOB to provide a list of buildings that will and will not be connected to the campus low temperature hot water system by Wednesday 11/17.</li> <li>o Existing Domestic Hot Water Systems will remain (currently design/priced domestic hot water connections to the campus system incl. equipment, piping, controls, electrical, etc. will be removed from the scope of work)</li> <li>o Maintain the new connections to the campus low temperature hot water system (as currently priced)</li> </ul>	\$ (8,591,041)	11/15/2021	11/17/2021	12/8/2021
8	<u>VE 8 Revised Central Plant Design - Compare previous estimate to combination of above</u> MEP: Floorplan/narrative – Oct 15 Bond: Pricing 11/05 1. Phase 1 – boilers in existing steam plant, SD complete, target pricing on 11/23 2. Phase 2 – TBD, need to determine ASAP 3. Phase 3 – remote energy island, SD complete, target pricing on 11/19 4. Phase 4, boilers in existing steam plant and GSHPs in chiller plant, SD for boilers complete, design for GSHP's target December 1st, target pricing December 15th	TBD		11/3/2021	12/15/2021
9	<u>VE 9: Missing Building Scope</u>	TBD		11/3/2021	12/9/2021
	<b>TOTALS:</b>	\$ (24,890,688)			



# Current Transition Plan

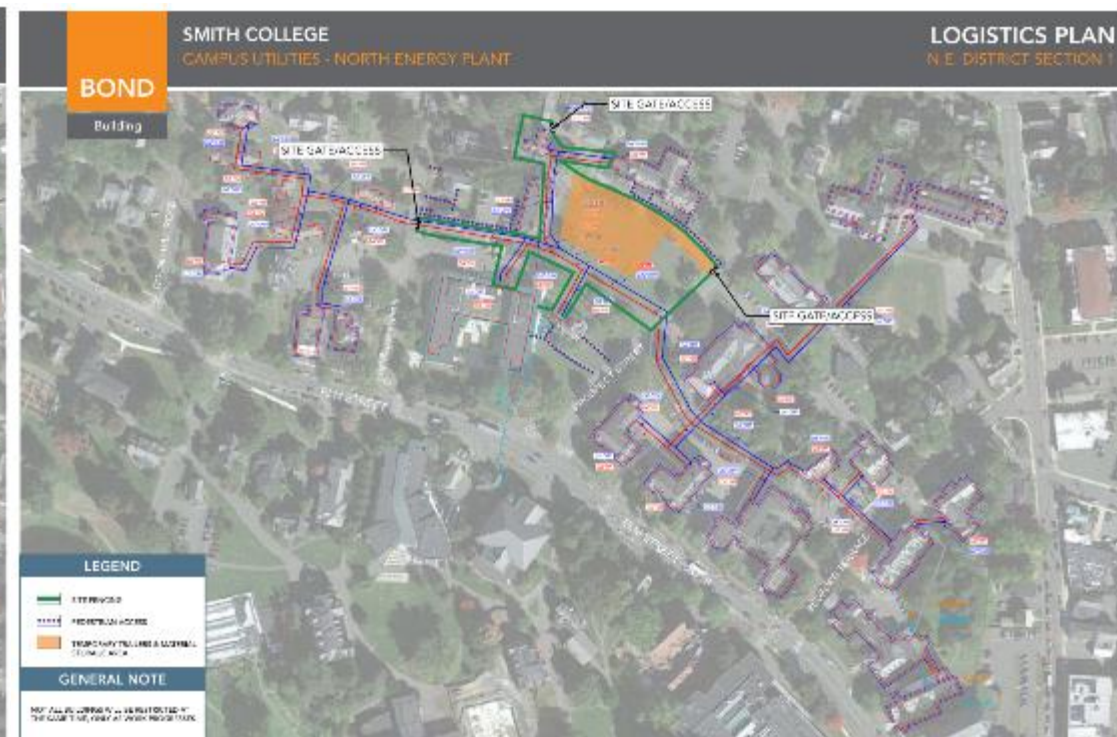


# Phased Approach



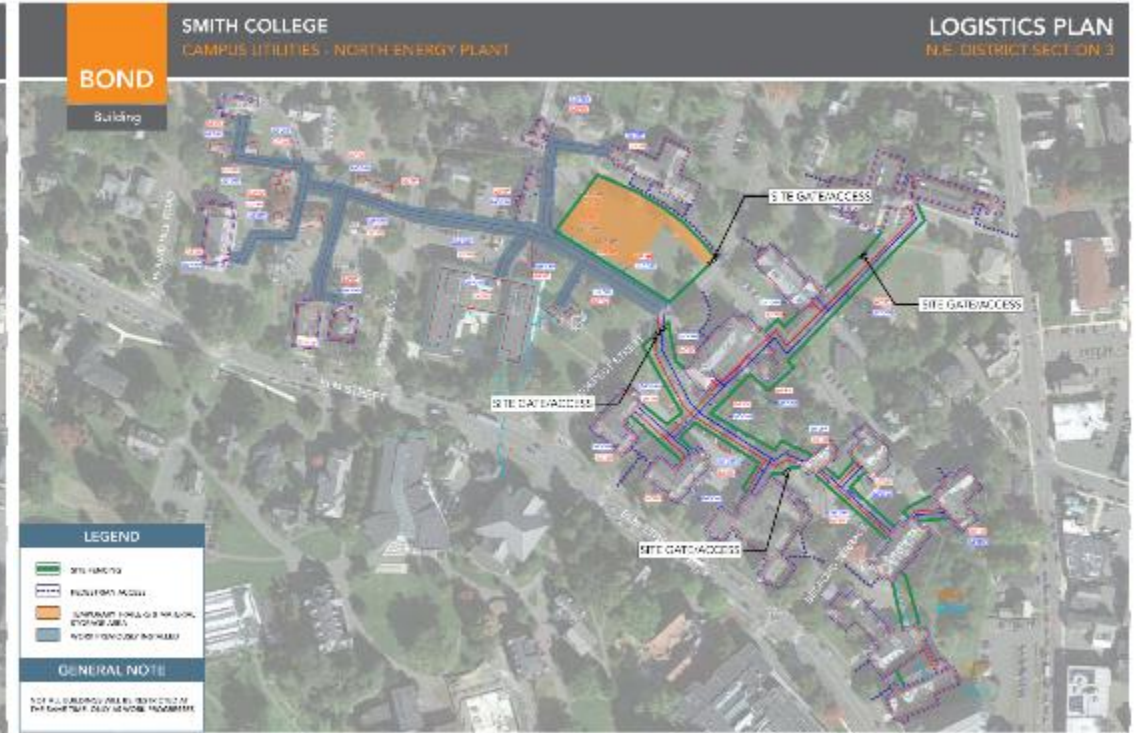
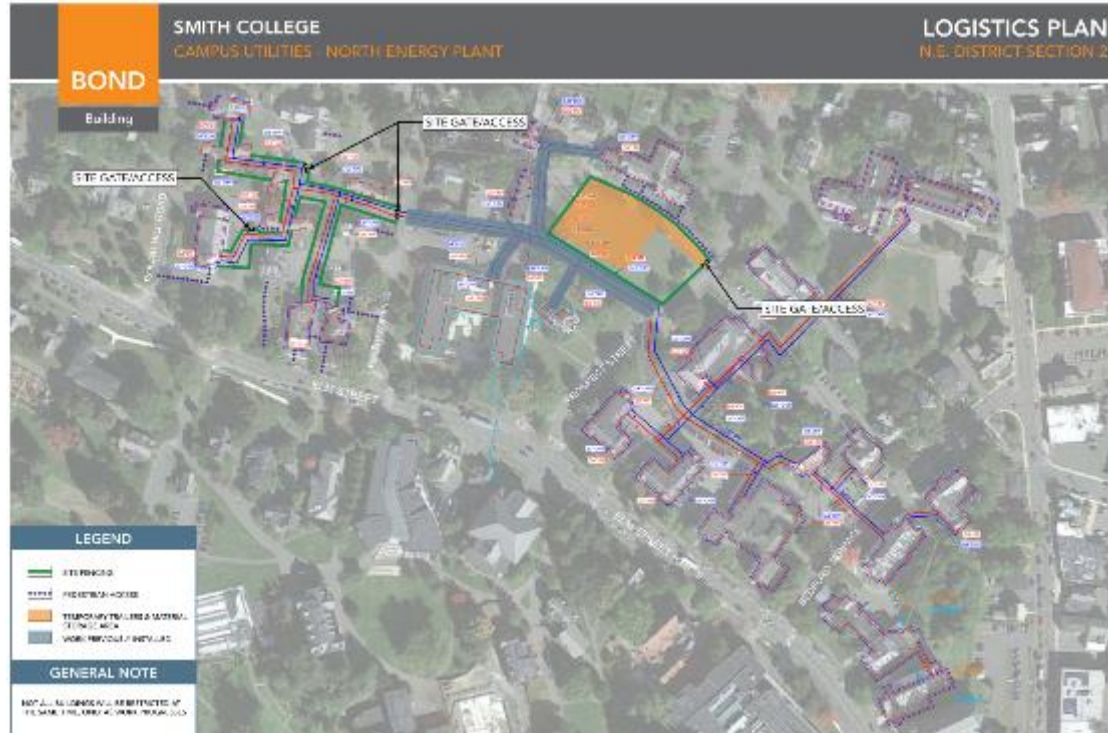


# Phased Approach





# Phased Approach





# Questions?



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