Justice40 District Geothermal Heat Pump Systems Deployment in Connecticut (JUDGE-CT)

(District Geothermal Heating + Cooling Deployment in a CT Environmental Justice Community)

DOE Award Number: DE-EE0010667

Recipient: CT Department of Energy & Environmental Protection

Principal Investigator: Becca Trietch, becca.trietch@ct.gov

Project web page: https://portal.ct.gov/deep/energy/ulbrich-heights-community-geothermal-project

Budget Period 1 Report (Nov. 2024)

Team members:

- University of Connecticut
- Northeast Energy Efficiency Partnerships
- Wallingford Housing Authority
- Wallingford Electric Division
- LN Consulting

Advisory Committee members represent:

- CT Housing Financing Authority
- CT Department of Housing
- CT Office of Climate Planning
- CT Office of Environmental Justice
- CT Office of Workforce Strategy
- CT Department of Public Health
- Emergent Urban Concepts
- Eversource Energy
- Meriden Housing Authority
- Wallingford residents
- Oak Ridge National Laboratory

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Acknowledgements

DEEP wishes to thank its project partners for the countless hours and considerable personal effort they have devoted to this challenging and seminal project. Particular thanks to the NEEP team – especially Chase Macpherson – for their dedication and hard work.

DEEP, UConn, and NEEP express their appreciation for the contributions of the members of the Advisory Committee and want to especially thank Jared Rodriguez, of Emergent Urban Concepts, for his valuable insights.

Connecticut Department of Energy & Environmental Protection

Zoemma Warshafsky	Sabrina Xie	Becca Trietch
Jeff Howard	Seema Malani	Vicki Hackett

University of Connecticut

Ravi Gorthala	Prathamesh Pati

Northeast Energy Efficiency Partnerships

Chase Macpherson	Yiran He
Kelly O'Connell	Michael Anderson

LN Consulting	Wallingford Housing Authority	Wallingford Electric Division
Ian Donahue	Ron Canalia	Don Mauritz
George Martin	Chris Pisani	
Greg Estep		

Advisory Committee

Jared Rodriguez	Emergent Urban Concepts
Adelheid Koepfer	Wallingford resident and clean energy advocate
Pasquale Guliano	CT Housing Finance Authority
Miguel Rivera	CT Department of Housing
Nikki Bruno	Eversource
Jonathan Harris	Eversource
Eric Bosworth	Eversource
June Wooding	Eversource
Annie Decker	CT DEEP Office of Legal, Planning and Regulatory Affairs
Sarah Huang	CT DEEP Environmental Justice Office
Edith Pestana	CT DEEP Environmental Justice Office
Doris Johnson	CT DEEP Environmental Justice Office
Rebecca French	CT DEEP Office of Climate Planning
Xiaobing Liu	Oak Ridge National Laboratory
Allie Mulrooney	CT Office of Workforce Strategy
Kelli-Marie Vallieres	CT Office of Workforce Strategy
Billy Huang	CT Office of Workforce Strategy
Robert Cappelletti	Meriden Housing Authority
Sarah Walters	CT Department of Public Health

Executive Summary

This is the Budget Period 1 final report for a DOE-funded project (award number DE-EE0010667) undertaken by the Connecticut Department of Energy and Environmental Protection (DEEP; Office of Affordable Housing Energy Retrofits), the University of Connecticut (Institute for Advanced Systems Engineering), and other members of a comprehensive project team.

The report marks the team's completion of most required tasks and milestones. Work completed for Task 1 includes an extensive technical analysis and design, with corresponding plans for permitting and maintenance. Components for Task 2 involved broad outreach and community-engagement efforts (including stakeholder meetings and a webinar as well as development of a formal engagement plan), a web page, and a case study. For Task 3, the team undertook a formal statewide geothermal workforce needs assessment, developed corresponding recommendations for both the state as a whole and the Wallingford project, and held several workshops. For Task 4, the team drafted a data-sharing plan.

The diverse activities undertaken for this project have proven productive in multiple ways. They have helped raise the profile of geothermal heating and cooling within Connecticut, contributing significantly to considerable recent attention to and excitement about geothermal energy across the state. The project has brought welcome attention to geothermal energy within the Connecticut General Assembly. Within CT DEEP as well as other partner organizations – Northeast Energy Efficiency Partnerships (NEEP), University of Connecticut's Institute for Advanced Systems Engineering, Wallingford Housing Authority, and Wallingford Electric Division – the work has contributed materially to development of geothermal technical expertise, has provided important insights into the geothermal policy landscape, and has yielded experience in developing and assessing pathways to community-scale renewable-thermal projects. The project also has served to establish or deepen important connections between the partner organizations and a variety of sister organizations and enterprises across the region's geothermal landscape, including members of the project's Advisory Committee.

Despite these positive developments, the project team regrettably decided not to pursue Phase 2 funding to construct a community geothermal system at the Wallingford facility. There are two primary reasons for this decision:

(1) Although it was projected that the envisioned system would save each tenant household hundreds of dollars in energy costs each year, the overall projected economics of the initial design are not as favorable as expected. Two factors – exacerbated by exceptionally high material and labor costs – pushed projected capital costs higher than anticipated:

- The thermal load of the target facility's 132 residential apartments is quite uniform. Lacking load diversity, the central geothermal system required to serve the simultaneous peak load of all apartments would be quite substantial. Moreover, no waste heat would be available to help offset the heating load.

- Wallingford Housing Authority (WHA), which owns the site, had indicated at the time of the team's application for Phase 1 funding that it anticipated replacement of the facility's existing gas boilers; however, during the Phase 1 work the organization learned that state funds would

not be allocated for that replacement, which, accordingly, could not proceed. As a consequence, the avoided cost of ultimately replacing the gas boilers could not be factored into the near-term capital cost of the geothermal scenario. Moreover, because WHA does not own the air conditioning units the tenants use, the avoided cost of replacing these units also could not be counted as a factor in the geothermal cost analysis.

(2) Development of viable arrangements for ownership and financial management of this major retrofit project proved to be more difficult than expected. The principal factors:

- WHA does not have financial resources to support construction of the project, so all capital costs would have to be borne by other entities.

- WHA does not have financial resources to support operation and maintenance of the envisioned community geothermal facility. Nor does it have legal authority to impose "common charges" on tenants for operation and maintenance of the geothermal facility or for maintenance of the envisioned water-source heat pump system. And the facility's small maintenance staff would be hard pressed to perform regular maintenance on the water-source heat pump system.

- Wallingford Electric Division, the municipal electric utility serving the site, indicated it would not be prepared to own or operate the system.

- Connecticut statutes do not explicitly provide the state's regulated utilities – including Yankee Gas, which supplies natural gas to the site – authority to build, own, or operate networked geothermal projects. The question of whether the Public Utilities Regulatory Authority has authority to permit the companies to conduct such projects on a pilot basis has not been tested.

- U.S. Treasury Department rules for the federal tax credits that would be essential for this project require that the party owning the community geothermal facility also own the water-source heat pump system. This would preclude or significantly complicate multi-party ownership models.

The materials provided in this report – especially the case study, the workforce development analysis and recommendations, and the technical, economic, and environmental analysis – provide important touchstones for future community geothermal projects in Connecticut. The project partners remain committed to pursuing viable community geothermal initiatives and believe the prospects for community geothermal projects in Connecticut are strong. DEEP looks forward to engaging with DOE, UConn, NEEP, and other regional partners, including partners in the newly launched New England Heat Pump Accelerator Coalition, to identify suitable project sites, viable ownership models, and applicable funding streams.

Section 1:
Progress toward Meeting Objectives and Milestones

1.1 Progress toward meeting project objectives

As shown in the accompanying table, this report marks the team's completion of all required tasks and milestones. Work completed for Task 1 includes an extensive technical analysis and design, with corresponding plans for permitting and maintenance. Components for Task 2 involved broad outreach and community-engagement efforts, including stakeholder meetings and a webinar as well as development of a formal engagement plan, a web page, and a preliminary case study. For Task 3, the team undertook a formal statewide geothermal workforce needs assessment, developed corresponding recommendations for both the state as a whole and the Wallingford project, and held several workshops. For Task 4, the team developed a data-sharing plan.

Task		Milestone		
No.	**Title**	**No.**	**Description**	**Note**
1	Technical and Economic Feasibility Assessment & Procurement Drafting	1.1	Functional analysis and design model completed	Plans, drawings, and preliminary scope are in Appendix B and on the project web page.
		1.2	Geothermal system designs drafted and included in the draft procurement scope of work	
		1.3	Scope of work finalized for use in the procurement process selected by the Coalition	
	Develop an Analysis & Design Model (opensource) and use it to Complete Technical, Economic, and Environmental Assessments	1.1.1	Completion of analysis for at least three conceptual network geothermal plant configurations	Analysis is in Appendix C and on project web page.
	Project-Specific Technical Outreach & Coalition Design Decisions	1.4.1	Written feedback received from the project's Technical Advisory Committee on the technical project approach	Written comments were compiled and submitted to DOE by e-mail.
	Permitting and Maintenance Plan	1.5.1	Applied for permits and completed a maintenance plan	Required permits are identified in Appendix F. Maintenance plan is outlined in Appendix D.
2	Outreach & Community Engagement	2.1	Kick-Off meeting held with the project's advisory committee	Meeting minutes were submitted to DOE via e-mail.
		2.2	Finalize the community-engagement plan by incorporating feedback received from the Advisory Committee and DOE	Final community engagement plan is in Appendix I and on project web page.
		2.3	Host a webinar with Coalition members and affordable-housing stakeholders; post the recording on an appropriate CT DEEP web page	Webinar is on project web page. Case study is in Appendix G and on project web page.
		2.4	Publicly post the design case study on a CT DEEP web page	

3	Workforce Transition, Development, & Training Plan	3.1	Geothermal workforce needs assessment report complete (report focus on gap identification via data mining and surveys)	Assessment is in Appendix E and on project web page.
		3.2	Geothermal workforce development plan complete	Local and statewide planning documents are in Appendix E and on the project web page.
		3.2.1	4 geothermal workforce workshops completed	Workshop minutes and recordings were submitted to DOE by e-mail and are available on the project web page.
4	Project Management & Data Sharing	4.1	All required and proposed deliverables for Budget Period 1 submitted to DOE	Data sharing plan is in Appendix J.

1.2 Progress toward meeting DEI plan objectives and milestones

The DEI plan calls for:

- environmental impact deliverables and metrics;
- economic impact deliverables and metrics; and
- social impact deliverables and metrics.

The project focuses on an affordable-housing facility in a designated Connecticut Environmental Justice Community. The project's Advisory Committee includes members of groups representing or addressing the interests of key communities: affordable housing, environmental justice, public health, and Wallingford residents. DEI concerns are addressed in: the Community Engagement Plan (Appendix I); the case study (Appendix G); and the statewide workforce assessment, the local workforce development plan, and the recommendations for a statewide workforce development plan (Appendix E).

Environmental and economic impacts are addressed in the Technical, Economic, and Environmental Assessment (Appendix C).

Section 2:

Design, Economics, and Impacts

2.1 Engineering feasibility and technical design

A 90 percent design plan, construction specifications, etc., have been completed and are presented in Appendix B.

See also Appendix H: Data uploaded to DOE Geothermal Data Repository

2.2 Technical, economic, and environmental assessment

The detailed technical, economic, and environmental assessment is presented in Appendix C. This material describes:

- *technical modeling methodology and results*, including: site characterization; discussion of modeling and analytical methods; borehole data; and key assumptions;
- *economic modeling and results*, including: system configuration alternatives; role of local, state, and federal financial incentives; construction, operating, and lifecycle costs; energy consumption and reduction in long-term energy costs; and
- *environmental assessment,* including: current reliance on fossil fuels and inefficient air conditioning; improvement in energy consumption; improvement in greenhouse gas emissions; improvement in air quality.

Section 3:
Workforce, Permitting, Maintenance, and Case Study

3.1 Workforce development plans

The report includes two workforce development documents, both of which are in Appendix E:

- NEEP recommendations for a statewide geothermal workforce development plan
- Wallingford-specific geothermal workforce development plan

3.2 Permitting plan

See Appendix F: Permitting plan

3.3 Maintenance plan

See Appendix D: Maintenance plan

3.4 Case study

See Appendix G: Case study

Appendices

Appendix A	Cost estimates
Appendix B	Detailed design plans, drawings and related information
Appendix C	Technical, economic, and environmental assessment
Appendix D	Maintenance plan
Appendix E	Workforce needs assessment and development plans
Appendix F	Permitting plan
Appendix G	Case study
Appendix H	Data uploaded to Geothermal Data Repository
Appendix I	Community Engagement Plan
Appendix J	Data sharing plan

Appendix A – Cost estimates

The following estimates are for the proposed community geothermal heat pump system (GHP) as well as the GHP system in combination with heat pump water heaters (HPWH) and solar photovoltaic (PV). Also shown are estimates for two alternative systems: air-source heat pumps (ASHP) and distributed geothermal (dGHP).

For details and a narrative, see the Technical, Economic, and Environmental Assessment (Appendix C).

A.1 Capital cost estimate

	Baseline[2]	GHP	GHP + HPWH	GHP + PV	GHP + PV + HPWH	ASHP	dGHP
Gross Capital Cost ($)	392,000	8,687,504	9,347,504	11,401,499	12,061,499	4,683,600	8,399,562
Utility Incentives ($)	-	845,000	1,043,000	845,000	1,043,000	367,500	845,000
Federal ITC ($)	-	3,137,002	3,137,002	4,222,600	4,222,600	-	2,982,225
Net Capital Cost ($)	392,000	4,705,502	5,167,502	6,333,899	6,795,899	4,316,100	4,572,337
Net Incremental Capital Cost ($)		4,313,502	4,775,502	5,941,899	6,403,899	3,924,100	4,180,337

A.2 Operating/maintenance cost estimate

	Baseline[2]	GHP	GHP + HPWH	GHP + PV	GHP + PV + HPWH	ASHP	dGHP
Annual O&M Costs ($)[3]	-	156,942	189,942	174,942	174,942	304,700	138,500

A.3 Tenant cost estimate

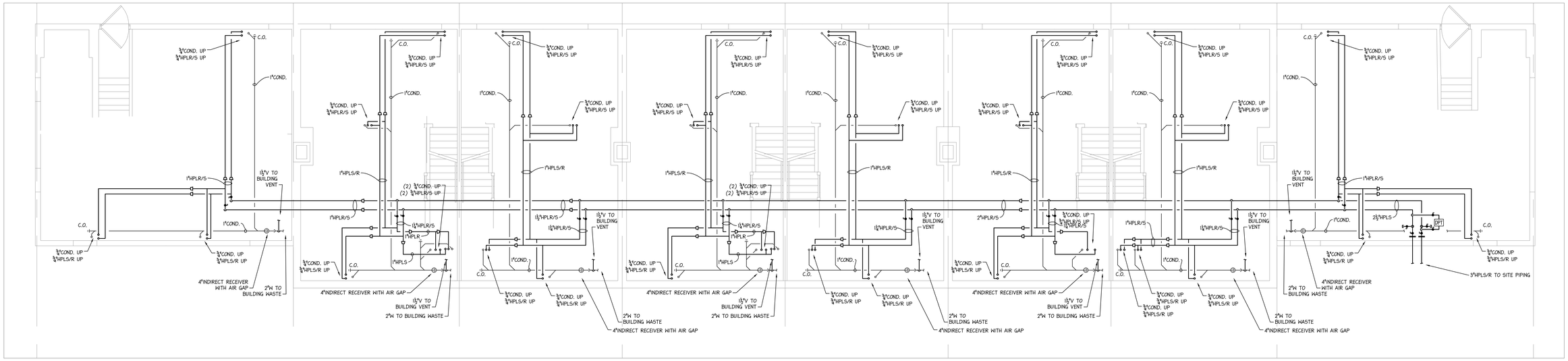
	Baseline	GHP	GHP + HPWH	GHP + PV	GHP + PV + HPWH	ASHP	dGHP
Annual Electricity Consumption (kWh/year)	810,378	997,168	1,126,389	87,385	216,606	1,149,811	1,015,270
Annual Gas Consumption (MMBtu/year)	6,617	1,517	0	1,517	0	1,517	1,517
Annual Electricity Cost ($/year)	104,701	128,834	145,529	11,290	28,217	148,556	131,173
Annual Gas Cost ($/year)	125,485	28,954	246	40,244	246	28,954	28,954
Total Annual Utility Costs ($/year)	230,186	157,788	145,775	40,244	28,463	177,509	160,126
Annual Utility Cost Per Tenant ($/year)	1,744	1,195	1,104	305	216	1,345	1,213
Tenant Utility Cost Reduction ($/year)	-	548	639	1,439	1,528	399	531
Percentage Reduction	-	31%	37%	83%	88%	23%	30%

Appendix B – Detailed design plans, drawings and related information

This appendix contains three items:

- Design drawings
- Design report
- Scope of work for construction management firm

Design drawings



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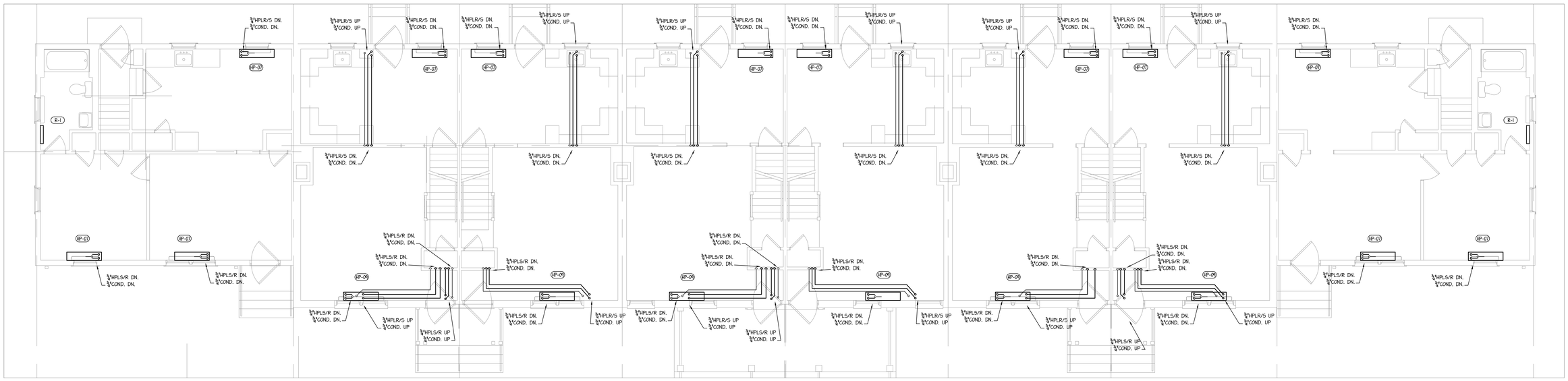

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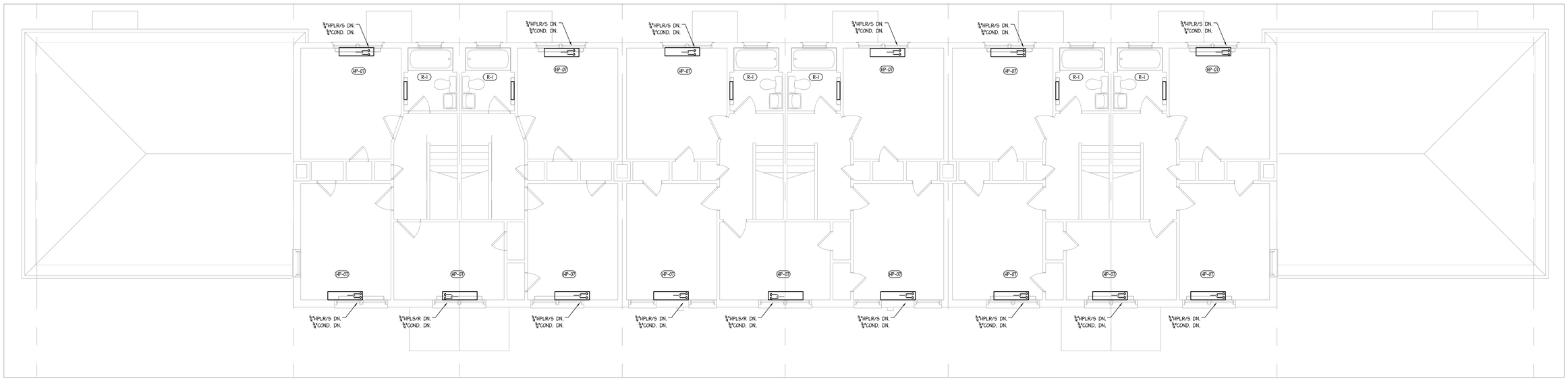

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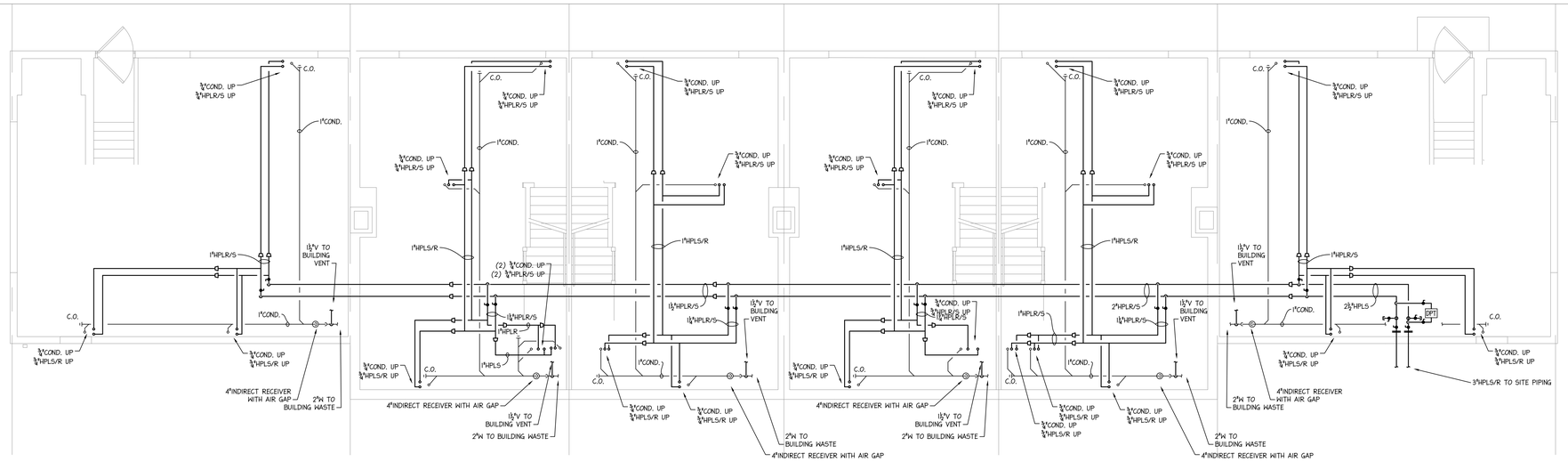

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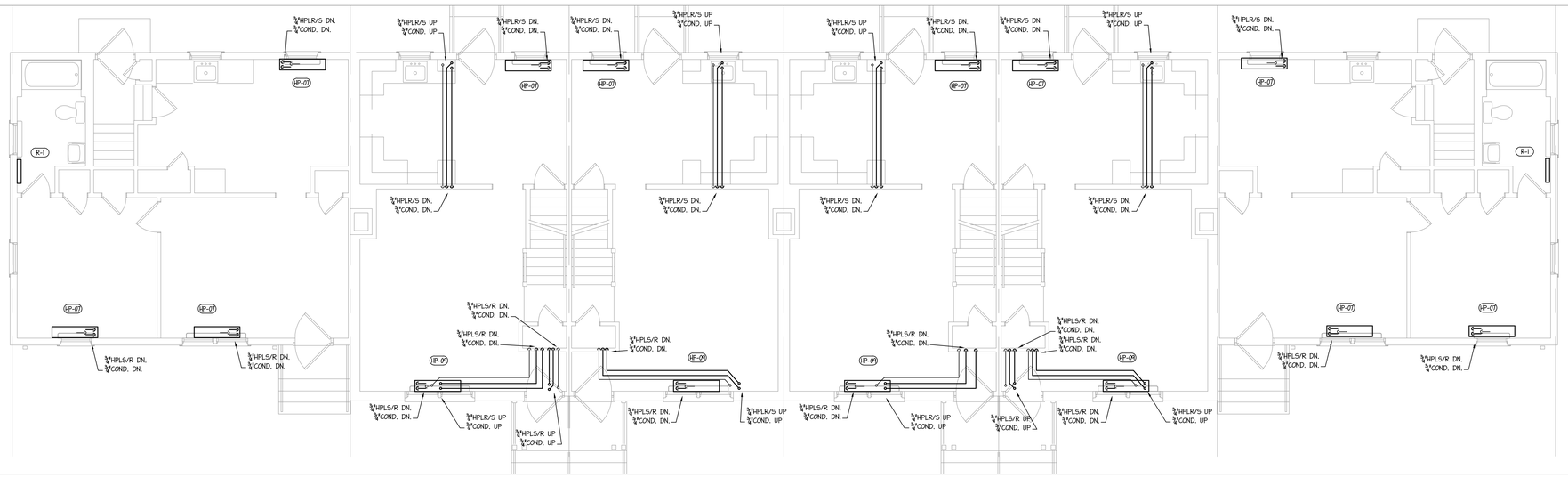

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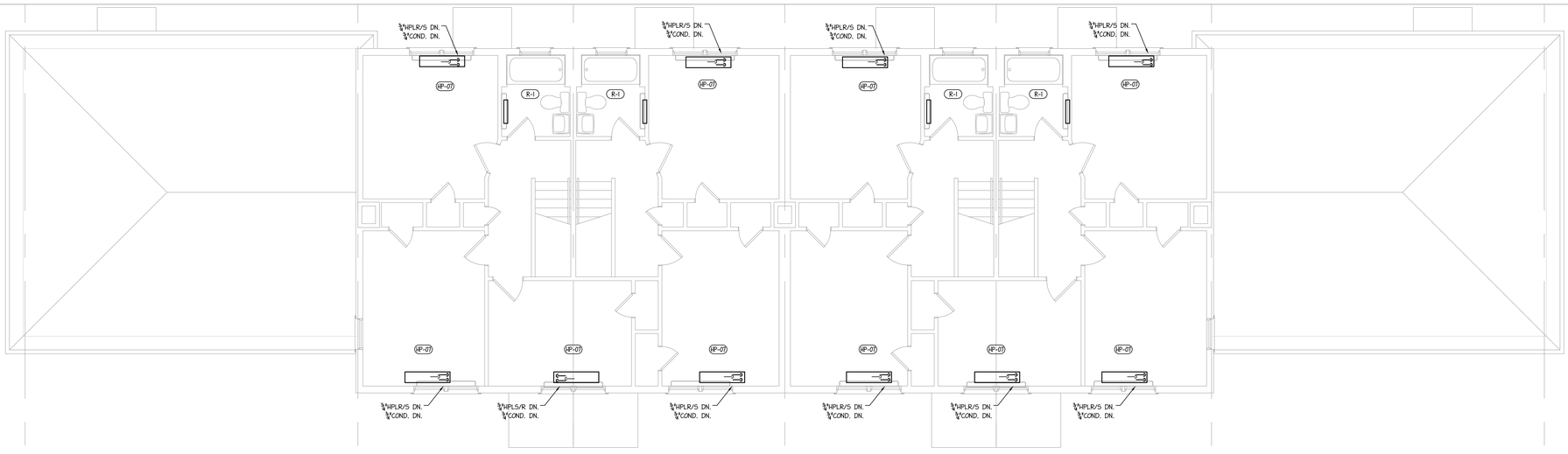

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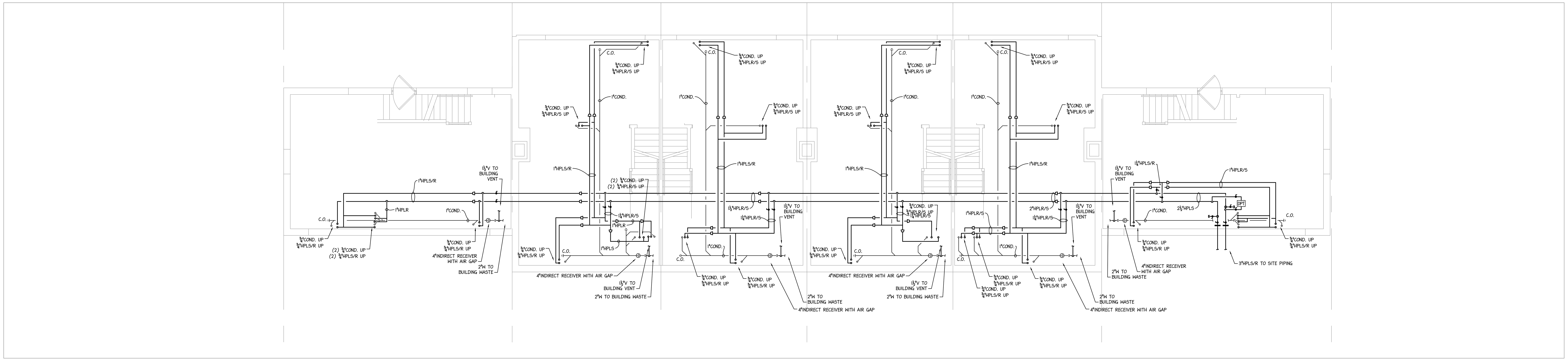

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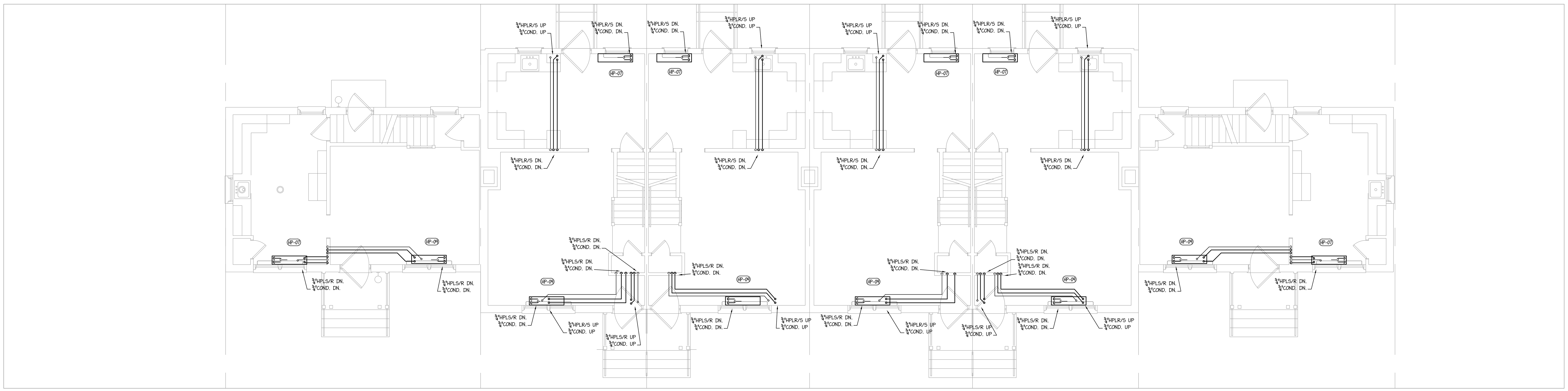

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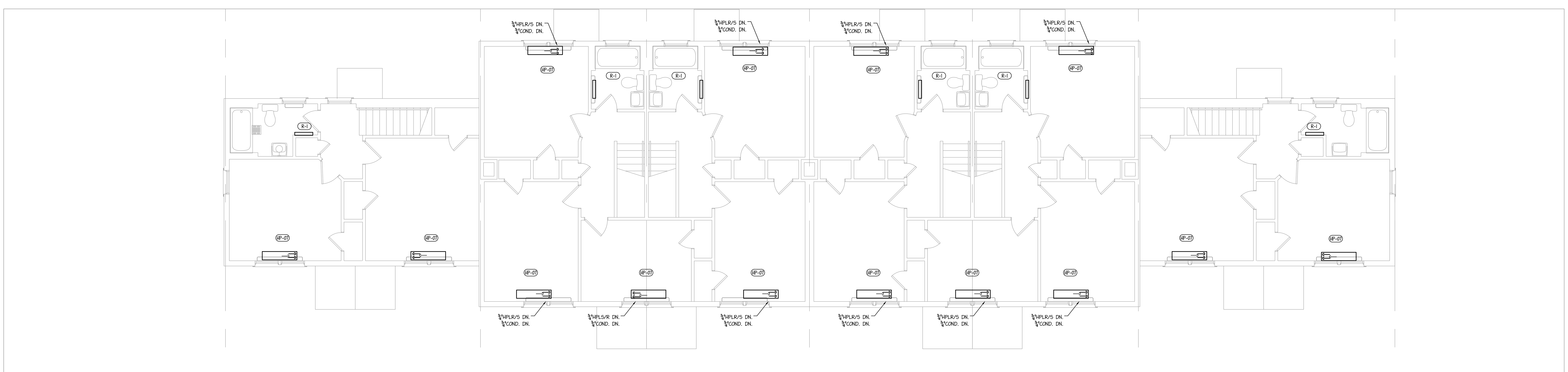

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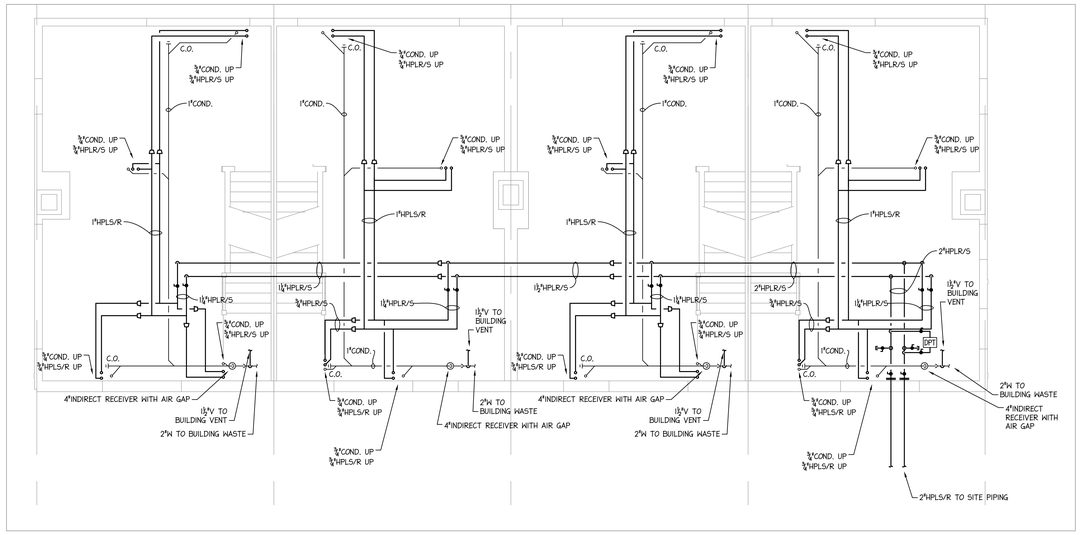

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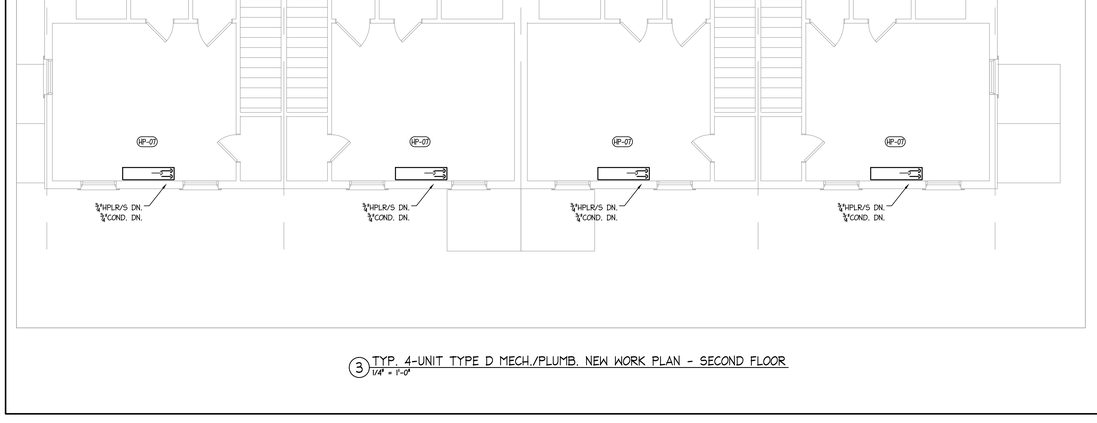

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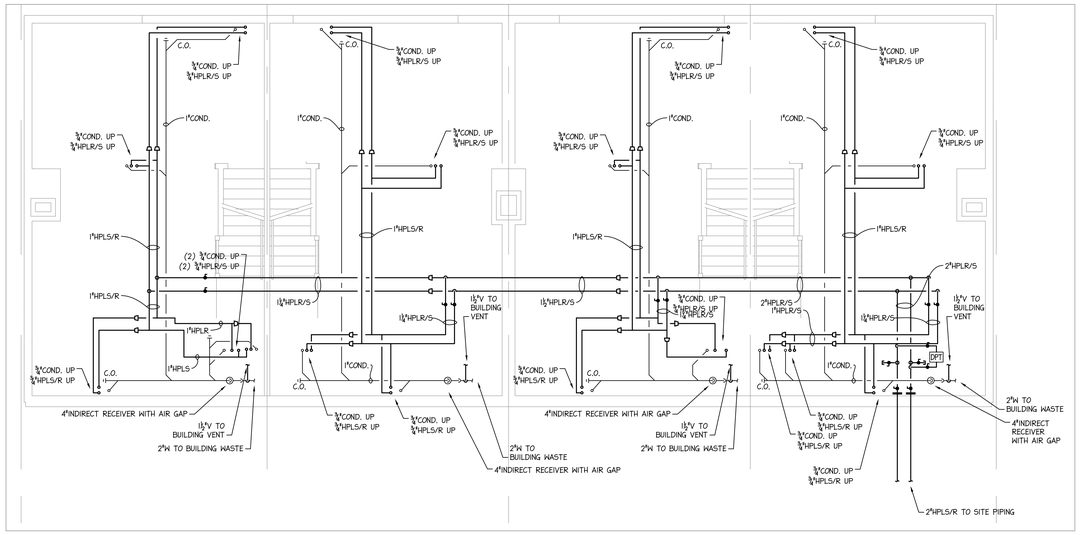

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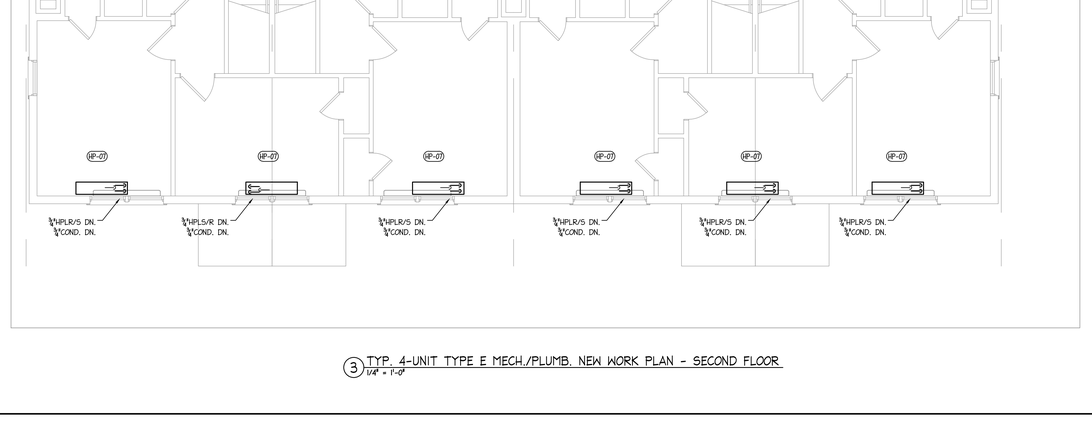

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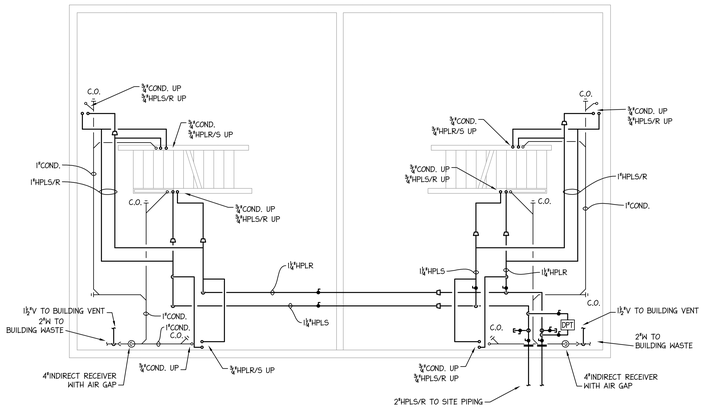

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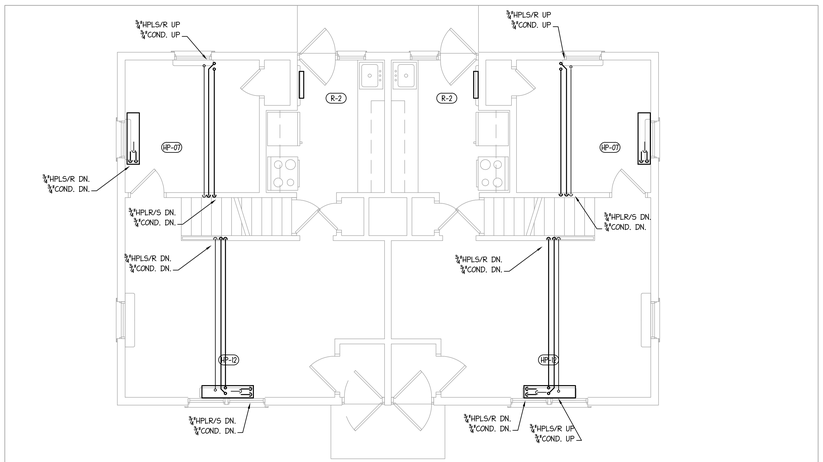

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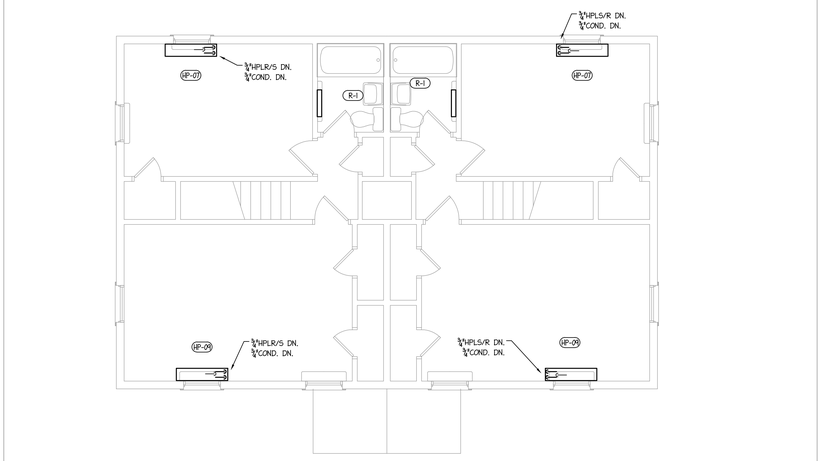

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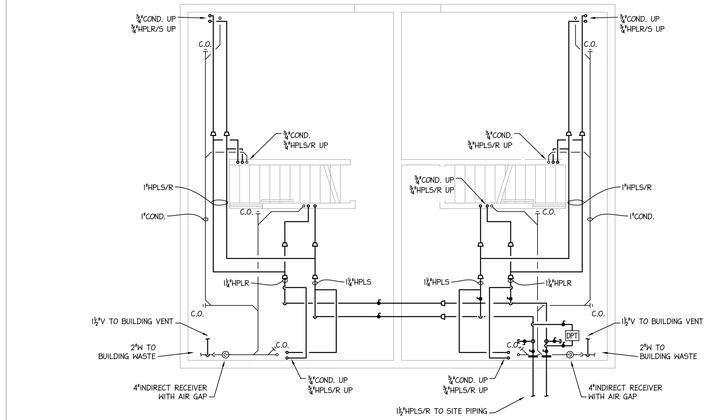

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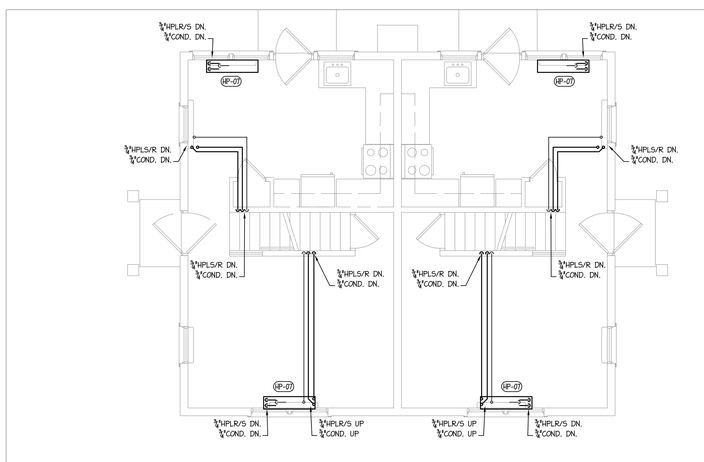

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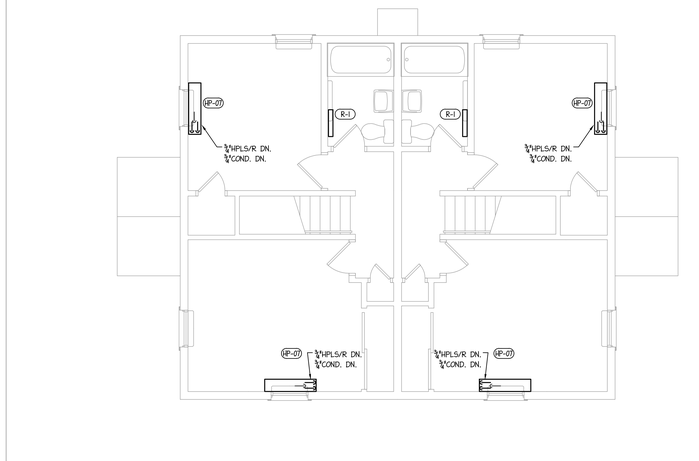

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DATE	07/29/2024

NO.	DATE	REVISION
1		

PROJECT TITLE
CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

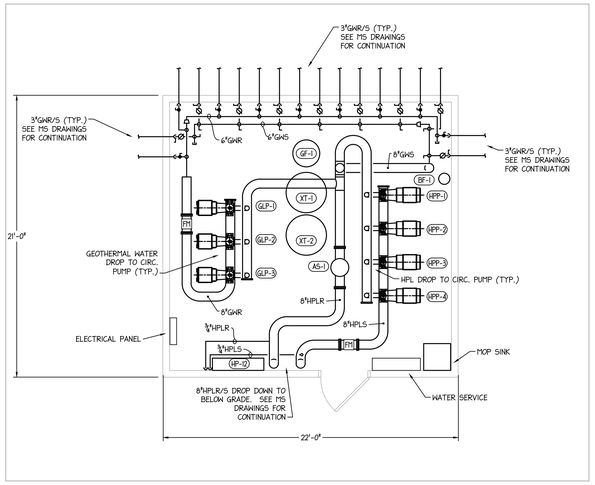
SHEET TITLE
TYPICAL 2-UNIT MECHANICAL/PLUMBING FLOOR PLANS

SCALE: 1/4" = 1'-0"

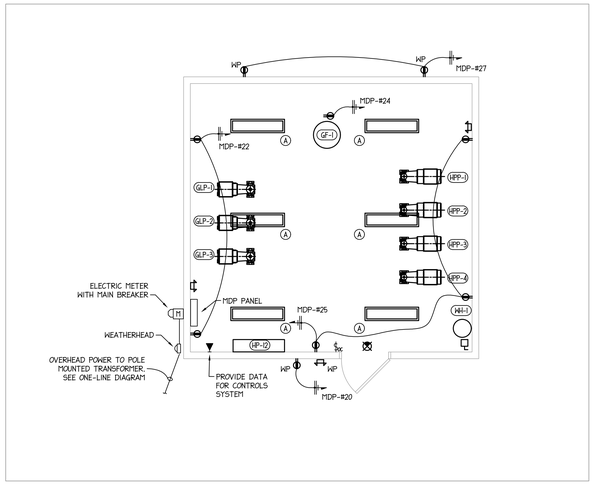
PROJECT NO. 23409

SHEET NO.

M1.15



1 PUMP HOUSE MECHANICAL NEW WORK PLAN
1/4" = 1'-0"



2 PUMP HOUSE ELECTRICAL NEW WORK PLAN
1/4" = 1'-0"

3 PUMP HOUSE FIRST FLOOR PLUMBING & FIRE PROTECTION NEW WORK PLAN
1/4" = 1'-0"

4 PUMP HOUSE UNDERSLAB PLUMBING NEW WORK PLAN
1/4" = 1'-0"

lnconsulting.com
208 Flynn Ave, #2J
Burlington, VT 05401
(802) 660-1763
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CONCEPTUAL DRAWINGS

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PROJECT TITLE:
CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

SHEET TITLE:
PUMP HOUSE MECHANICAL, ELECTRICAL AND PLUMBING FLOOR PLANS

SCALE: 1/4" = 1'-0"

PROJECT NO. 23409

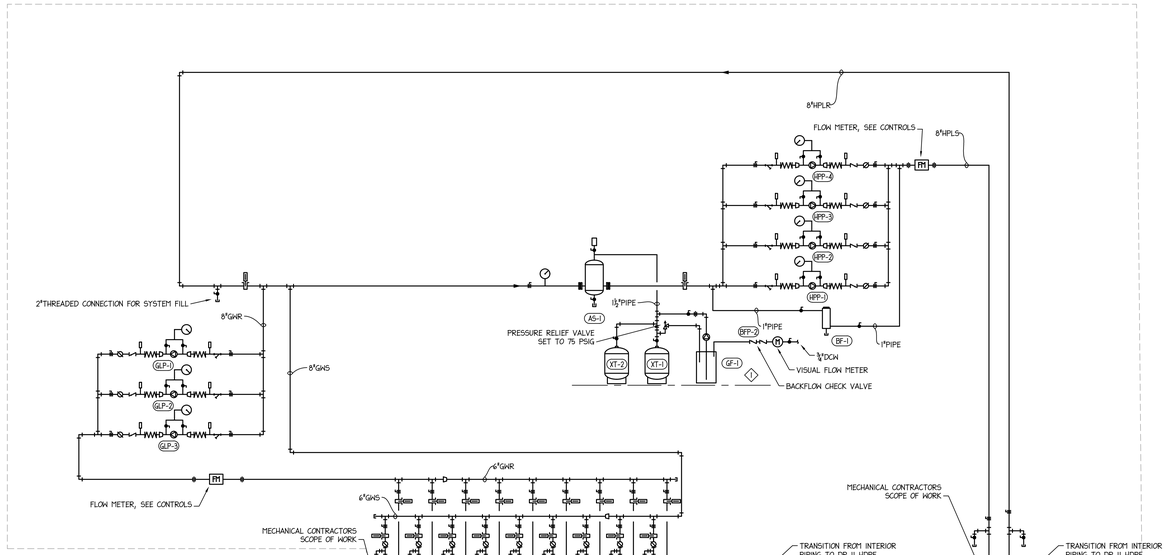
SHEET NO.

M1.16

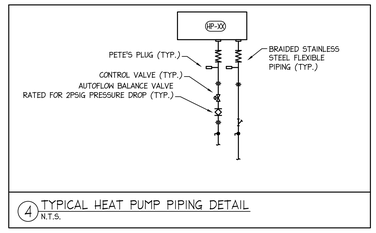
MECHANICAL LEGEND	
SYMBOL	DESCRIPTION
	2-WAY ELECTRONIC CONTROL VALVE
	3-WAY ELECTRONIC CONTROL VALVE
	BUTTERFLY VALVE
	FULL PORT BALL VALVE
	BALANCING VALVE
	FLOW CHECK VALVE
	PIPE STRAINER
D	PIPE REDUCER
	FLEXIBLE CONNECTOR
	PUMP
M	WATER METER
	PRESSURE REDUCING VALVE
	AUTOMATIC AIR VENT
	PRESSURE GAGE
	THERMOMETER
	TIE INTO EXISTING

GENERAL MECHANICAL NOTES:

1. PIPING, SPECIALTIES, ETC. FOR EQUIPMENT SHALL BE INSTALLED TO PERMIT EQUIPMENT SERVICE CLEARANCES, AND EQUIPMENT REMOVAL WITH OUT PIPING MODIFICATIONS.
2. COORDINATE CONTROL VALVE REQUIREMENTS WITH MECHANICAL CONTROLS DRAWINGS.
3. HEAT PUMP LOOP SYSTEM TO BE FILLED WITH 18% BY VOLUME PROPYLENE GLYCOL SOLUTION TO PROVIDE FREEZE PROTECTION TO 21 DEGREES F.



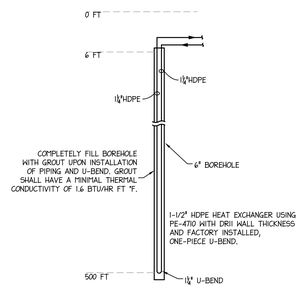
1 HYDRONIC SYSTEM PIPING ONE-LINE DIAGRAM
N.T.S.



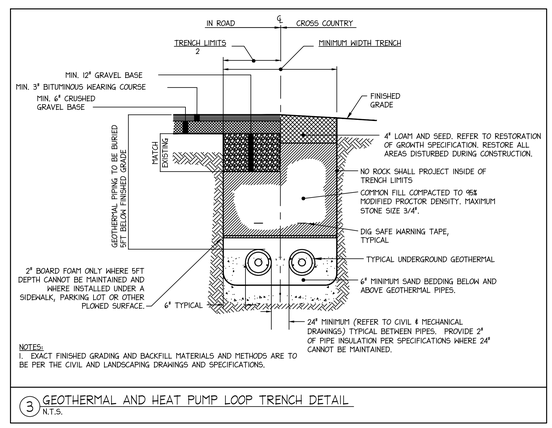
4 TYPICAL HEAT PUMP PIPING DETAIL
N.T.S.

BORE-HOLE NOTES

1. PROVIDE 6" DIAMETER, 500' DEEP BOREHOLES PER STATE OF CONNECTICUT AGENCY OF NATURAL RESOURCES (ANR) REQUIREMENTS.
2. WELL DRILLER SHALL BE LICENSED AND CERTIFIED BY AND PERFORM THE WORK IN ACCORDANCE WITH THE STATE OF CONNECTICUT ANR REQUIREMENTS.
3. WELL DRILLER SHALL PROVIDE A PRICE FOR THE FOLLOWING:
   A. PROPOSED BOREHOLES AS INDICATED.
   B. DRII HDPE LOOP PIPING WITHIN BOREHOLES (U-BENDS).
   C. DRII HDPE LOOP PIPING BACK TO BUILDING.
4. BOREHOLE CONTRACTOR SHALL SUBMIT PROPOSED GROUT FOR APPROVAL. THE BOREHOLE CONTRACTOR SHALL BE RESPONSIBLE FOR TESTING OF THE INSTALLED GROUT.
5. BURIED PIPE SHALL BE AT LEAST 5-FEET BELOW GRADE. PIPES SHALL HAVE 24" BETWEEN EACH PIPE IN THE TRENCH. 2" FOAM INSULATION IS REQUIRED ABOVE THE PIPING IF 5-FEET BURIAL DEPTH CANNOT BE MAINTAINED AND WHERE PIPING IS RUN UNDER A PLOWED SURFACE (PARKING LOT/SIDEWALK). 2" FOAM INSULATION IS REQUIRED BETWEEN PIPING WITHIN THE TRENCH IF 24" SPACING CANNOT BE MAINTAINED.



2 TYPICAL GEOTHERMAL BOREHOLE DIAGRAM
N.T.S.



NOTES:
1. EXACT FINISHED GRADING AND BACKFILL MATERIALS AND METHODS ARE TO BE PER THE CIVIL AND LANDSCAPING DRAWINGS AND SPECIFICATIONS.

3 GEOTHERMAL AND HEAT PUMP LOOP TRENCH DETAIL
N.T.S.

lnconsulting.com
208 Flynn Ave. #2U
Burlington, VT 05401
(802) 660-1766
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CONCEPTUAL DRAWINGS
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PROJECT TITLE: CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL ULBRICH HEIGHTS GEOTHERMAL PROJECT WALLINGFORD, CT

SHEET TITLE: MECHANICAL HYDRONIC ONE-LINE DIAGRAM AND GEOTHERMAL DETAILS

SCALE: N.T.S.
PROJECT NO. 23409
SHEET NO.
M3.01

LEGEND	
SYMBOL	DESCRIPTION
A	AUDIBLE/VISUAL ALARM
AFS	AIR FLOW STATION TRANSMITTER
CAF	CLEAN AGENT FIRE SUPPRESSION SYSTEM ACTIVATION SIGNAL
CS	CURRENT SENSOR
CO	CARBON MONOXIDE SENSOR
CO2	CARBON DIOXIDE SENSOR
DM	DAMPER MOTOR ACTUATOR
DD	DUCT SMOKE DETECTOR (FURNISHED BY OTHERS)
DP	DIFFERENTIAL PRESSURE TRANSMITTER
HL	HIGH TEMPERATURE LIMIT CUTOFF
LM	LOW WATER CUTOFF
NOX	NITROGEN DIOXIDE SENSOR
R	RELAY WITH H-O-A SWITCH
OC	OCCUPANCY SENSOR
PT	PRESSURE TRANSDUCER
PF	PROOF OF FLOW SWITCH
RH	RELATIVE HUMIDITY SENSOR
SP	STATIC PRESSURE TRANSMITTER
T	TEMPERATURE SENSOR
V	VALVE ACTUATOR
VPT	VELOCITY PRESSURE TRANSMITTER
T	WALL MOUNTED SPACE SENSOR
TH	WALL MOUNTED TEMPERATURE AND HUMIDITY SENSOR
TC	WALL MOUNTED COMBINATION TEMPERATURE, RELATIVE HUMIDITY, CO2 SENSOR
T/H	MOMENTARY SWITCH (MAY BE INSTALLED ON COMBINATION THERMOSTAT)
◇	SPECIFIC NOTE
	THERMOMETER WELL
	MOTORIZED BUTTERFLY VALVE
AI	ANALOG INPUT
AO	ANALOG OUTPUT
ATC	AUTOMATIC TEMPERATURE CONTROLS
CC	COOLING COIL
CHR	CHILLED WATER RETURN
CHS	CHILLED WATER SUPPLY
DHWR	DOMESTIC HOT WATER RECIRCULATED
DI	DIGITAL INPUT
DO	DIGITAL OUTPUT
EA	EXHAUST AIR
EAD	EXHAUST AIR DAMPER
FF	FINAL FILTER
HWS	HEATING HOT WATER SUPPLY
HWR	HEATING HOT WATER RETURN
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
OA	OUTDOOR AIR
OAD	OUTDOOR AIR DAMPER
PF	PRE-FILTER
PHC	PRE-HEAT COIL
RA	RETURN AIR
RAF	RETURN AIR FAN
RHC	RE-HEAT COIL
SA	SUPPLY AIR
S.F.	SUPPLY AIR FAN
SR	SPRING RETURN
V.A.V.	VARIABLE AIR VOLUME
VFD	VARIABLE FREQUENCY DRIVE (OR ECM)

DIRECT DIGITAL CONTROLS GENERAL NOTES

1. ALL NEW CONTROLS WORK SHALL UTILIZE A COMPLETE DIRECT DIGITAL CONTROLS SYSTEM. THE CONTROLS SYSTEM SHALL BE WEB BASED FOR REMOTE ACCESS. COORDINATE REMOTE ACCESS REQUIREMENTS WITH AGENCY OF DIGITAL SERVICES (ADS). CONTROLS SYSTEM BY OWNER APPROVED VENDOR TO PROVIDE SEAMLESS INTEGRATION WITH THE EXISTING FACILITY CONTROL SYSTEM. COORDINATE THE CONTROLS SERVER REQUIREMENTS WITH THE OWNER.

2. THE CONTROLS CONTRACTOR SHALL PROVIDE ALL THE NECESSARY MATERIALS, LABOR AND ACCESSORIES IN ORDER TO PROVIDE A COMPLETE WORKING DIRECT DIGITAL CONTROLS SYSTEM. THE CONTROLS CONTRACTOR IS TO SUPPLY THE PC TO BE USED BY THE MAINTENANCE PERSONNEL AND SHALL HAVE A WEB BROWSER THAT WILL BE UTILIZED TO ACCESS THE DDC SYSTEM.

3. PROVIDE A COMPLETE AND OPERATIONAL DIRECT DIGITAL CONTROLS SYSTEM INCLUDING ALL REQUIRED WIRING, PROGRAMMING, DEVICES, AND OPERATIONS MANUALS. THE CONTROLS CONTRACTOR'S WORK SHALL INCLUDE BUT NOT BE LIMITED TO: PROVIDING SENSORS FOR THE CONTROLS SYSTEM, AUTOMATIC CONTROL VALVES AND ACTUATORS, CONTROL MODULE(S), CONDUCTORS, CONDUIT, "FRONT END" GRAPHICS, PROGRAMMING, AND CONNECTION TO THE COMMUNICATIONS BUS.

4. THE CONTROLS CONTRACTOR SHALL BE RESPONSIBLE FOR ALL CONTROLS CONDUIT. ALL CONTROLS CONDUCTORS SHALL BE INSTALLED WITHIN E.M.T. OR FLEXIBLE METAL CONDUIT FOR ALL EXPOSED INSTALLATIONS, WITHIN MECHANICAL ROOMS AND INACCESSIBLE SPACES. THE CONTROLS CONDUIT SHALL BE A MINIMUM OF 3/4" EMT. FINAL DROPS TO TEMPERATURE SENSORS MAY BE IN 1/2" EMT. RUN CONTROLS CONDUCTORS FREE AIR ON J-HOOKS WHERE NOT IN MECHANICAL ROOMS OR INACCESSIBLE LOCATIONS.

5. EXTEND TEMPERATURE CONTROLS COMMUNICATION BUS TO CONTROL MODULE LOCATIONS IN E.M.T.

6. A MAXIMUM DISTANCE OF 4'-0" SHALL BE PERMITTED FOR UTILIZING FLEXIBLE METAL CONDUIT OR SEAL TIGHT CONDUIT.

7. PROVIDE CONTROLS TO ACCOMMODATE CONTROLS POINTS LIST, DIAGRAMS AND SEQUENCE OF OPERATIONS.

8. ALL CONTROLS CONDUCTORS SHALL BE EXTENDED TO THE TEMPERATURE CONTROLS PANELS.

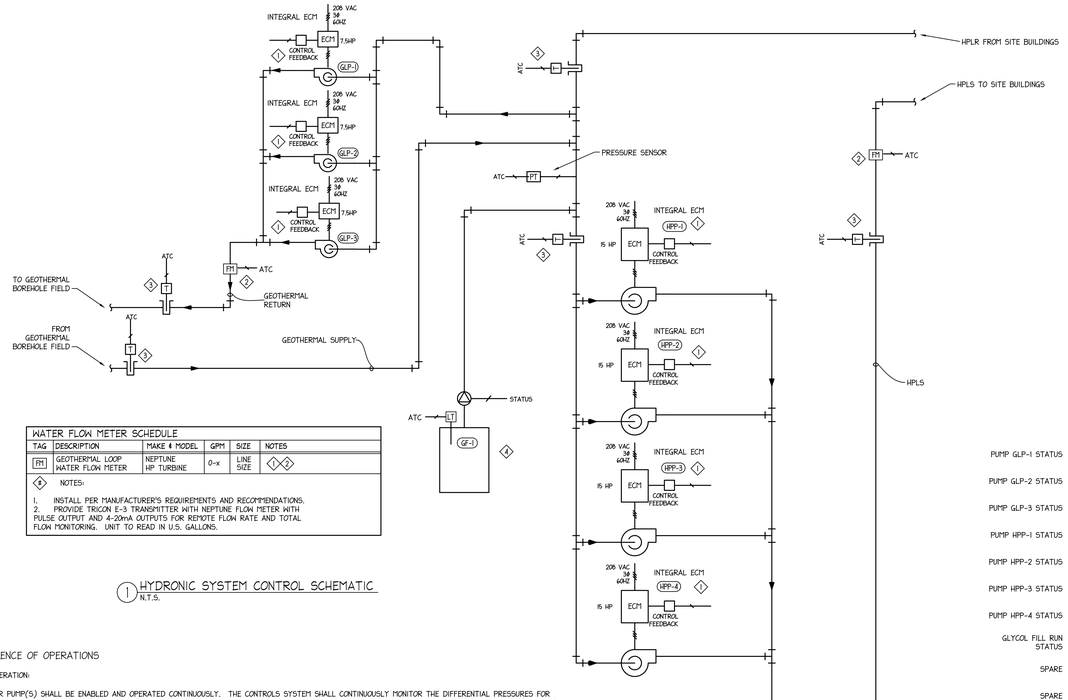
9. ALL CONTROLS MODULES SHALL BE MOUNTED IN A PROTECTIVE ENCLOSURE (NEMA 1).

10. THE TEMPERATURE CONTROLS CONTRACTOR IS RESPONSIBLE FOR ASSISTING THE TESTING AND BALANCE AGENT DURING ALL PHASES OF THE BALANCING PROCESS. THE TEMPERATURE CONTROLS CONTRACTOR SHALL WORK IN CONJUNCTION WITH THE TESTING AND BALANCE AGENT TO COMPLETE THE BALANCE AND CALIBRATION OF ALL SYSTEMS.

11. COORDINATE LOCATION OF ALL TEMPERATURE SENSORS AND CONTROL VALVES IN FIELD. VERIFY LOCATION WITH ENGINEER PRIOR TO INSTALLATION.

12. CONTROLS CONTRACTOR WILL COORDINATE WITH OWNER AND ENGINEER ALARMS THAT ARE CRITICAL, AND ALARMS THAT REQUIRE ATTENTION IN A LESS CRITICAL TIME PERIOD. CONTRACTOR TO ATTEND MEETING WITH OWNER AND ENGINEER TO CREATE ALARM PRIORITY SCHEDULE.

13. CONTROLS CONTRACTOR IS TO COORDINATE CONTROLS DEVICE/SYSTEM POWER REQUIREMENTS WITH ELECTRICAL CONTRACTOR TO ENSURE POWER IS PROVIDED IN THE LOCATIONS NECESSARY. COORDINATE QUANTITIES OF POWER CIRCUITS REQUIRED FOR THE CONTROLS EQUIPMENT/DEVICES WITH THE ELECTRICAL CONTRACTOR. CONTROLS CONTRACTOR IS RESPONSIBLE FOR ALL COSTS ASSOCIATED WITH THE ELECTRICAL POWER REQUIRED FOR THE CONTROLS DEVICES/SYSTEM.

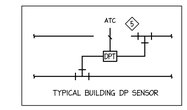


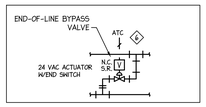
WATER FLOW METER SCHEDULE					
TAG	DESCRIPTION	MAKE & MODEL	GPM	SIZE	NOTES
FM	GEOTHERMAL LOOP WATER FLOW METER	NEPTUNE HP TURBINE	0-x	LINE SIZE	1 2

◇ NOTES:

1. INSTALL PER MANUFACTURER'S REQUIREMENTS AND RECOMMENDATIONS.
2. PROVIDE TRIGON E-3 TRANSMITTER WITH NEPTUNE FLOW METER WITH PULSE OUTPUT AND 4-20mA OUTPUTS FOR REMOTE FLOW RATE AND TOTAL FLOW MONITORING. UNIT TO READ IN U.S. GALLONS.

1 HYDRONIC SYSTEM CONTROL SCHEMATIC
N.T.S.





HYDRONIC SYSTEMS SEQUENCE OF OPERATIONS

HEAT PUMP LOOP CIRCULATOR OPERATION:

THE HEAT PUMP LOOP CIRCULATOR PUMP(S) SHALL BE ENABLED AND OPERATED CONTINUOUSLY. THE CONTROLS SYSTEM SHALL CONTINUOUSLY MONITOR THE DIFFERENTIAL PRESSURES FOR EACH BUILDING. THE CIRCULATOR PUMPS SHALL OPERATE TO MAINTAIN THE WORK-CASE DIFFERENTIAL PRESSURE AT SET POINT. DIFFERENTIAL PRESSURE SET POINTS SHALL BE SET DURING BALANCING BY THE BALANCING CONTRACTOR. THE CIRCULATOR PUMPS SHALL OPERATE AS A LEAD/LAG/LAG/LAG. WHEN THE LEAD CIRCULATOR REACHES 75% SPEED (ADJ.), THE FIRST LAG CIRCULATOR SHALL ENABLE AND THE (2) CIRCULATORS SHALL MODULATE TOGETHER. WHEN (2) CIRCULATORS REACH 75% SPEED (ADJ.), THE THIRD LAG CIRCULATOR SHALL BE ENABLED AND ALL (3) CIRCULATORS SHALL MODULATE TOGETHER. WHEN (3) CIRCULATORS REACH 75% SPEED (ADJ.), THE FOURTH LAG CIRCULATOR SHALL BE ENABLED AND THE (4) CIRCULATORS SHALL MODULATE TOGETHER. WHEN MULTIPLE CIRCULATORS DROP TO 40% SPEED (ADJ.), (1) LAG CIRCULATOR SHALL DISABLE. THIS SHALL CONTINUE UNTIL ONLY THE LEAD CIRCULATOR REMAINS OPERATING. THE LEAD/LAG/LAG/LAG ORDER SHALL SWITCH EVERY 240 HOURS (ADJ.). IF, WITH THE LEAD CIRCULATOR OPERATING AT MINIMUM SPEED THE LOOP D.P. RISES ABOVE SET POINT, THE BYPASS VALVE SHALL BE MODULATED OPEN TO MAINTAIN THE D.P. AS THE LOOP D.P. REDUCES, THE FIRST STAGE OF MODULATION SHALL BE TO CLOSE THE BYPASS VALVE AND ONCE THE VALVE IS FULLY CLOSED, THE PUMP SPEED MAY BE INCREASED. IF THE LEAD PUMP FAILS, THEN THE LAG PUMP(S) WILL ENABLE AND AN ALARM WILL BE INITIATED.

GEOTHERMAL FIELD CIRCULATOR PUMPS OPERATION:

THE GEOTHERMAL CIRCULATORS SHALL OPERATE IN A LEAD/LAG/LAG CONFIGURATION. THE BMS SHALL CONTINUOUSLY MONITOR THE HEAT PUMP LOOP SUPPLY TEMPERATURE. WHEN THE LOOP SUPPLY TEMPERATURE DROPS TO 46°F (ADJ.), THE LEAD GEOTHERMAL CIRCULATOR PUMP SHALL BE ENABLED. ONCE ENABLED, THE LEAD CIRCULATOR SHALL MODULATE AS NECESSARY TO MAINTAIN THE HEAT PUMP LOOP SUPPLY TEMPERATURE AT 48°F (ADJ.). IF THE LEAD CIRCULATOR REACHES 75% SPEED (ADJ.), THE FIRST LAG CIRCULATOR SHALL BE ENABLED AND THE (2) CIRCULATORS SHALL MODULATE TOGETHER. IF THE (2) CIRCULATORS REACH 75% SPEED (ADJ.), THE SECOND LAG CIRCULATOR SHALL BE ENABLED AND ALL (3) CIRCULATORS SHALL MODULATE TOGETHER. WHEN MULTIPLE CIRCULATORS DROP TO 40% SPEED (ADJ.), (1) LAG CIRCULATOR SHALL DISABLE. THIS SHALL CONTINUE UNTIL ONLY THE LEAD CIRCULATOR REMAINS OPERATING. THE LEAD/LAG/LAG ORDER SHALL SWITCH EVERY 240 HOURS (ADJ.). IF THE LEAD PUMP FAILS, THEN THE LAG PUMP(S) WILL ENABLE AND AN ALARM WILL BE INITIATED.

WHEN THE GEOTHERMAL SUPPLY TEMPERATURE RISES ABOVE 48°F (ADJ.) THE LEAD CIRCULATOR SHALL DISABLE. WHEN THE HEAT PUMP LOOP SUPPLY TEMPERATURE RISES TO 75°F (ADJ.) THE LEAD GEOTHERMAL CIRCULATOR SHALL BE ENABLED. ONCE ENABLED, THE LEAD CIRCULATOR AND THE (2) LAG CIRCULATORS SHALL MODULATE AS INDICATED ABOVE TO MAINTAIN THE HEAT PUMP LOOP SUPPLY TEMPERATURE OF 70°F (ADJ.). WHEN THE HEAT PUMP LOOP SUPPLY TEMPERATURE DROPS BELOW 70°F (ADJ.), THE LEAD GEOTHERMAL CIRCULATOR SHALL DISABLE.

GLYCOL FILL SEQUENCE OF OPERATIONS

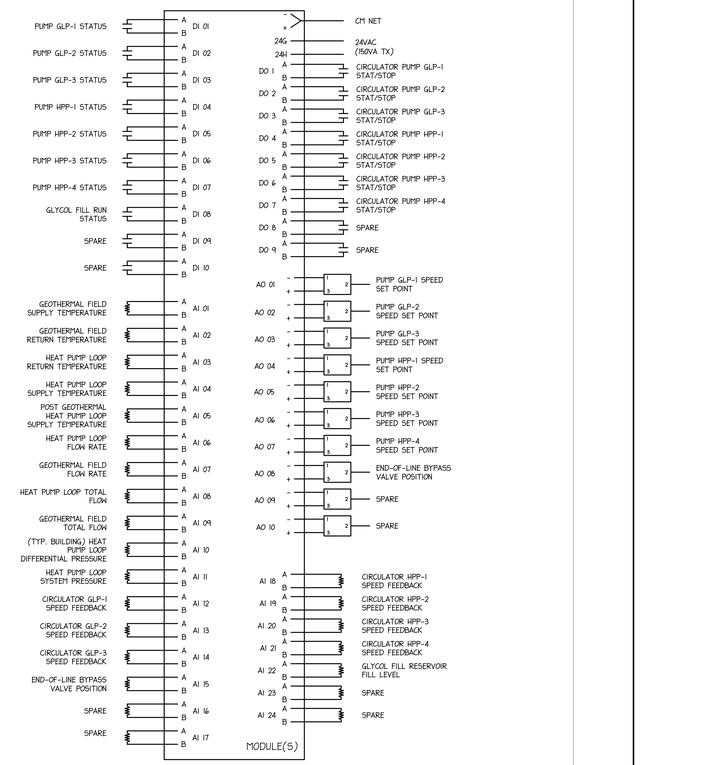
GLYCOL FEEDER TO OPERATE UNDER IT'S OWN CONTROLS TO MAINTAIN SYSTEM FILL PRESSURE AT SET POINT (INITIAL SET POINT TO BE 25 PSIG). SYSTEM SHALL MONITOR GLYCOL FEEDER STATUS. IF GLYCOL FEEDER RUNS FOR MORE THAN 30 SECONDS (ADJ.), AN ALARM IS TO BE SENT TO THE SYSTEM.

ALARM POINTS

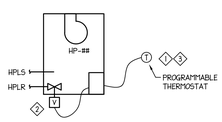
HEAT PUMP LOOP DIFF. PRESS. HIGH
HEAT PUMP LOOP DIFF. PRESS. LOW
GEOTHERMAL COMBINED FLOW LOW
GEO. WATER LOOP TEMPERATURE HIGH
GEO. WATER LOOP TEMPERATURE LOW
HEAT PUMP LOOP TEMPERATURE HIGH
HEAT PUMP LOOP TEMPERATURE LOW
SYSTEM FILL PRESSURE LOW
VALVE FAILURE (TYP.)
HEAT PUMP ALARM (TYP.)
CIRCULATOR PUMP FAILURE (TYP.)
GLYCOL FILL PUMP OPERATION 30 SECONDS (ADJ.)
GF-1 RESERVOIR LEVEL LOW
GF-1 FAIL

◇ NOTES

1. GENERALLY ALL VFD'S OR ECM CONTROLLERS ARE FACTORY INSTALLED ON THE PUMPS. COORDINATE ALL CONTROL WIRING CONNECTIONS WITH THE MANUFACTURER'S DIAGRAMS. CONTROLS CONTRACTOR TO PROVIDE BACNET INTEGRATION AND SHALL MAP THE BACNET POINTS OF THE CIRCULATORS. MINIMUM MAPPED POINTS ARE FLOW, HEAD, RPM, SPEED, HORSEPOWER (IF AVAILABLE), ALARM.
2. FLOW METERS ARE TO BE INSTALLED ON THE GEOTHERMAL RETURN (TO THE FIELD) LINE AND ON THE MAIN HEAT PUMP LOOP SUPPLY LINE. FLOW METERS ARE TO BE INSTALLED PER MANUFACTURER'S REQUIREMENTS TO PROVIDE ACCURATE FLOW. ENSURE SUFFICIENT STRAIGHT PIPE IS PROVIDED UPSTREAM/DOWNSTREAM.
3. INSTALL TEMPERATURE SENSORS IN THE LINES AS INDICATED. TEMPERATURE SENSORS ARE TO BE INSTALLED WITHIN THERMAL WELLS. PROVIDE THERMAL WELLS TO THE MECHANICAL CONTRACTOR AS NECESSARY TO FACILITATE INSTALLING THE TEMPERATURE SENSORS.
4. INSTALL A LEVEL SENSOR ON THE GLYCOL FILL PUMP. COORDINATE REQUIREMENTS WITH SUBMITTED PRODUCT.
5. INSTALL A DIFFERENTIAL PRESSURE SENSOR WITHIN EACH BUILDING FOR REMOTE MONITORING. COORDINATE INSTALLATION REQUIREMENTS WITH THE MECHANICAL CONTRACTOR. PROVIDE INTERNET ACCESS TO ENABLE REMOTE DIFFERENTIAL PRESSURE SENSORS TO BE CONNECTED TO THE MAIN BMS.
6. INSTALL AN END-OF-LINE BYPASS VALVE AT THE END OF THE LONGEST PIPING RUN. PLEASE NOTE THAT IF THE SYSTEM IS CONSTRUCTED IN PHASES, MULTIPLE BYPASS VALVES MAY BE REQUIRED DEPENDING ON CONSTRUCTION SCHEDULE. PROVIDE INTERNET ACCESS TO ENABLE REMOTE MONITORING AND CONTROL OF THE BYPASS CONTROL VALVE.



2 HYDRONIC SYSTEM CONTROL POINTS SCHEMATIC
N.T.S.



3 (TYPICAL) WATER SOURCE HEAT PUMP CONTROL DIAGRAM
N.T.S.

SEQUENCE OF OPERATION

SYSTEM START UP
HEAT PUMP UNIT SHALL OPERATE BASED ON MANUFACTURER'S CONTROLS AND THE PROGRAMMABLE THERMOSTAT TO MAINTAIN THE SPACE TEMPERATURE.

HEATING AND COOLING MODES
DURING A CALL FOR HEATING OR COOLING, THE UNIT SHALL OPEN THE CONTROL VALVE AND ENABLE THE FAN/RAMP THE FAN SPEED UP AS NECESSARY, AND ENABLE THE COMPRESSOR AS NECESSARY TO MAINTAIN SPACE TEMPERATURE SET POINT. WHEN THE UNIT IS NO LONGER HEATING/COOLING, THE CONTROL VALVE IS TO BE CLOSED AND THE FAN AND COMPRESSOR SHALL BE DISABLED.

◇ NOTES

1. INSTALL HEAT PUMP MANUFACTURER PROVIDED PROGRAMMABLE THERMOSTAT WITHIN THE ROOM THAT THE HEAT PUMP IS LOCATED IN ON AN INTERIOR WALL. INSTALL APPROXIMATELY 46"+/- A.F.F.

2. PROVIDE CONTROL VALVE (BASED ON SPECIFICATIONS) FOR EACH HEAT PUMP. HEAT PUMP SHALL OPERATE THE CONTROL VALVE WHEN THE COMPRESSOR IS ENABLED. PROVIDE ALL FIELD WIRING AS NECESSARY.

3. WORK WITH THE BUILDING OCCUPANT(S) FOR PRELIMINARY DESIRED TEMPERATURE SET POINTS AND OCCUPANCY SCHEDULES.

lnconsulting.com
208 Flynn Ave. #3J
Burlington, VT 05401
(802) 660-7765
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PROJECT TITLE
CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

SHEET TITLE
MECHANICAL CONTROLS DIAGRAMS, LEGENDS & NOTES

SCALE: N.T.S.
PROJECT NO. 23409
SHEET NO.
M4.01

MECHANICAL GENERAL NEW WORK NOTES:

1. ALL NEW AIR DUCTING SHALL BE RATED FOR AN AIR PRESSURE PER THE SPECIFICATIONS. 4" W.C. UNLESS OTHERWISE INDICATED.
2. ALL INSULATION SHALL BE FURNISHED AND INSTALLED AS PER THE SPECIFICATIONS.
3. PROVIDE SHEET METAL GAUGE AND HANGER SPACING PER THE CURRENT EDITION OF SMACNA HVAC DUCT CONSTRUCTION STANDARDS.
4. ALL 90° ELBOWS SHALL BE PROVIDED WITH TURNING VANES. PROVIDE TWO (2) TURNING VANES FOR DUCT WORK UNDER 12" WIDE, AND PROVIDE THREE (3) TURNING VANES FOR DUCTS BETWEEN 12" & 18" WIDE. PROVIDE AN ADDITIONAL TURNING VANE FOR EVERY MULTIPLE OF 3" IN DUCT WIDTH. INSTALL TURNING VANES AS PER CURRENT EDITION OF SMACNA DUCT CONSTRUCTION STANDARDS.
5. PROVIDE ALL EQUIPMENT AND MATERIALS NECESSARY FOR MOUNTING ALL MECHANICAL EQUIPMENT.
6. FLEXIBLE DUCTS NOT PERMITTED ON INLET OR OUTLET OF VAV BOXES.
7. ALL VOLUME DAMPERS SHALL BE LOCKING QUADRANT TYPE AND CONSTRUCTED OF 18 GA. GALVANIZED STEEL.
8. ALL VOLUME DAMPERS SHALL BE ULTRA LOW-LEAK AND SHALL HAVE A ROUND SHAFT WITH SHAFT SEALS AT THE PENETRATIONS IN THE DUCTWORK. VOLUME DAMPER NOT CONFORMING TO THE ULTRA-LOW LEAK STANDARD SHALL BE REMOVED AND REPLACED AT THE MECHANICAL CONTRACTORS EXPENSE.
9. 5' MINIMUM, 7' MAXIMUM FLEXIBLE AIR DUCTS ON ALL TAKEOFFS.
10. A MINIMUM AND MAXIMUM OF (2) CHANGES IN DIRECTION SHALL BE ALLOWED IN ALL FLEXIBLE DUCT TAKE-OFFS. ANY FLEXIBLE DUCT TAKE-OFFS NOT SUPPORTED OR WITH GREATER THAN (2) CHANGES IN DIRECTION SHALL BE REMOVED AND REPLACED AT THE MECHANICAL CONTRACTORS EXPENSE.
11. COORDINATE THE LOCATION OF VAV BOXES WITH OTHER TRADES. ALL VAV BOXES SHALL BE INSTALLED IN AN ACCESSIBLE LOCATION APPROVED BY OWNER AND THE ENGINEER.
12. ALL SUSPENDED DUCT WORK, AND PIPING SHALL BE PROVIDED WITH SEISMIC BRACING AS REQUIRED. ALL EQUIPMENT SHALL BE PROVIDED WITH SEISMIC BRACING.
13. ALL DUCT WORK 144 SQ. IN. AND OVER IN CROSS SECTIONAL AREA SHALL BE FABRICATED USING DUCT-MATE FLANGES. NO SLIP AND DRIVE CONNECTIONS SHALL BE PERMITTED. TDF CONNECTIONS ARE ACCEPTABLE FOR DUCTS JOINTS OVER 30" AND 4" W.G. PRESSURE.
14. PROVIDE ALL EQUIPMENT AND MATERIALS NECESSARY FOR INSTALLATION AND DEMO WORK IN CONFINED SPACES (TRENCH WORK ETC.) PER OSHA STANDARDS AND ALL STATE AND LOCAL REQUIREMENTS WHERE APPLICABLE.
15. COORDINATE THE REMOVAL AND REPLACEMENT OF ALL EXISTING CEILING TILES, LIGHTING, AND FIRE ALARM DEVICES FOR INSTALLATION OF NEW MECHANICAL EQUIPMENT, PIPING, AND DUCTWORK. COORDINATE WITH ARCHITECTURAL PLANS FOR CEILING SCOPE OF WORK.
16. COORDINATE ALL DIFFUSER INSTALLATIONS WITH CEILING GRID AND/OR ARCHITECTURAL REFLECTED CEILING PLAN.
17. MECHANICAL CONTRACTOR SHALL REFERENCE CONTROLS DRAWINGS IN ADDITION TO MECHANICAL SCHEDULES FOR MOTORS REQUIRING VARIABLE FREQUENCY DRIVES. SPECIFICATIONS SHALL BE REFERENCED FOR VFD REQUIREMENTS. VFDS SHALL BE FURNISHED AND INSTALLED AS FOLLOWS:
    A. WHEN VFD IS PROVIDED WITH THE MECHANICAL EQUIPMENT, SUCH AS ERV, AIR HANDLING UNITS, AND MAKE-UP AIR UNITS, ETC., THEY SHALL BE FURNISHED AND INSTALLED BY MANUFACTURER.
    B. WHEN VFD IS REQUIRED FOR EQUIPMENT AS INDICATED IN CONTROLS DIAGRAMS AND/OR SCHEDULES, SUCH AS PUMPS, FANS, ETC., THEY SHALL BE FURNISHED AND INSTALLED BY THE ELECTRICAL CONTRACTOR.
18. SEE PIPING SPECIFICATION SECTION FOR VIBRATION ISOLATION HANGER REQUIREMENTS.
19. COORDINATE DIFFUSER AND ACCESS PANEL LOCATIONS WITH ARCHITECTURAL REFLECTED CEILING PLANS.
20. COORDINATE THERMOSTAT LOCATIONS WITH ARCHITECTURAL AND INTERIOR PLANS.
21. CONTRACTOR TO INSTALL ISOLATION VALVES ON THE HEATING HOT WATER LINES AS NECESSARY TO FACILITATE PHASING. COORDINATE PHASING PLAN WITH THE CONSTRUCTION MANAGER.
22. MECHANICAL CONTRACTOR TO REVIEW ARCHITECTURAL FLOOR PLANS FOR WALL AND CEILING CONSTRUCTION TYPE THROUGHOUT THE FACILITY. MECHANICAL EQUIPMENT, PIPING AND DUCTWORK TO BE CONCEALED WITHIN WALLS AND ABOVE CEILINGS. FOR CONCRETE BLOCK WALLS, MECHANICAL CONTRACTOR TO COORDINATE ROUTING AND INSTALLATION WITH MASON TO KEEP UTILITIES CONCEALED IN THE BLOCK. FOR AREAS WITH HARD CEILINGS, PROVIDE PLASTER FRAMES FOR INSTALLATION OF DIFFUSERS, ETC. WHERE MECHANICAL EQUIPMENT, DAMPER, ETC. IS REQUIRED TO BE INSTALLED ABOVE A HARD CEILING, PROVIDE 24"x24" HINGED ACCESS DOOR.

TESTING AND BALANCING GENERAL NOTES:

1. BALANCING CONTRACTOR IS RESPONSIBLE FOR COORDINATING PHASING WITH CONSTRUCTION MANAGER. BALANCING CONTRACTOR TO BALANCE EACH PHASE AT THE COMPLETION OF EACH PHASE. A FINAL BALANCING VERIFICATION WILL BE REQUIRED AT THE COMPLETION OF THE PROJECT TO CONFIRM FINAL SYSTEM DP AND STATIC PRESSURE SET POINTS ETC.
    THE BALANCE CONTRACTOR SHALL SUBMIT A FORMAL BALANCE REPORT AT THE COMPLETION OF EACH PHASE OF WORK.
2. THE BALANCE CONTRACTOR SHALL BE RESPONSIBLE FOR TEMPERATURE CONTROL VERIFICATION, SEQUENCE OF OPERATIONS VERIFICATION, AND SYSTEM COMMISSIONING AT THE COMPLETION OF EACH PHASE OF WORK. THE BALANCE CONTRACTOR SHALL BE PRESENT DURING THE FINAL CONTROLS SYSTEM COMMISSIONING PROCESS AND SHALL ASSIST THE COMMISSIONING AGENT, THE CONTROLS CONTRACTOR, AND THE MECHANICAL CONTRACTOR DURING THE COMMISSIONING PROCESS.
3. THE TESTING AND BALANCE AGENT SHALL BE RESPONSIBLE FOR TEMPERATURE CONTROLS SEQUENCE OF OPERATIONS VERIFICATION AS OUTLINED IN THE SPECIFICATIONS. THE TESTING AND BALANCING AGENT SHALL WORK WITH THE CONTROLS CONTRACTOR TO VERIFY THE CORRECT OPERATIONS OF ALL CONTROLS SEQUENCES.
4. THE TESTING AND BALANCING AGENT SHALL BE RESPONSIBLE FOR ASSISTING THE COMMISSIONING AGENT AS REQUIRED. THE TESTING AND BALANCING AGENT SHALL BE ON SITE DURING THE COMMISSIONING PROCESS, AND SHALL WORK WITH THE COMMISSIONING AGENT TO VERIFY THE CORRECT OPERATIONS OF ALL CONTROLS SEQUENCES.

GENERAL ALTERNATE EQUIPMENT NOTES:

1. ALTERNATE EQUIPMENT: SUBMIT PRELIMINARY DATA TO ENGINEER FOR WRITTEN APPROVAL FOR ALTERNATE EQUIPMENT.
2. GENERAL ALTERNATE NOTE: THE MECHANICAL, PLUMBING AND ELECTRICAL DESIGNS ARE BASED ON THE SCHEDULED MECHANICAL EQUIPMENT. IF APPROVED ALTERNATE MECHANICAL EQUIPMENT IS PROVIDED BUT THE POWER REQUIREMENTS DIFFER FROM THE PROPOSED EQUIPMENT, THE MECHANICAL CONTRACTOR SHALL COORDINATE ALL REQUIREMENTS WITH THE ELECTRICAL CONTRACTOR INCLUDING CIRCUIT BREAKER, CONDUCTOR, AND CONDUIT SIZES. ANY ALTERNATE EQUIPMENT FEEDS SHALL STILL COME FROM THE SAME PANEL AS CURRENTLY DESIGNED. IF THE EQUIPMENT PIPING OR DUCT CONNECTION LOCATIONS OR SIZES DIFFER FROM THE PROPOSED EQUIPMENT, THE MECHANICAL CONTRACTOR SHALL COORDINATE AND PROVIDE ALL REQUIRED MODIFICATIONS AS REQUIRED TO ACCOMMODATE ALTERNATE UNIT.

HVAC LEGEND

HVAC PIPING ABBREVIATIONS

COND.	CONDENSATE
DCW	DOMESTIC COLD WATER
DHW	DOMESTIC HOT WATER
HPLR	HEAT PUMP LOOP RETURN
HPLS	HEAT PUMP LOOP SUPPLY
GWR	GEOTHERMAL LOOP RETURN
GWS	GEOTHERMAL LOOP SUPPLY
W	SANITARY WASTE
V	VENT

HVAC ABBREVIATIONS

A.F.F.	ABOVE FINISHED FLOOR
DN	DOWN

HVAC SYMBOLS

AIR VENT
BALL VALVE
BALANCE VALVE
BUTTERFLY VALVE
CHECK VALVE
AUTOMATIC CONTROL VALVE (TWO-WAY)
AUTOMATIC CONTROL VALVE (THREE WAY)
FLANGED CONNECTION
FLEXIBLE CONNECTOR
GATE VALVE
NEEDLE VALVE
PIPE CAP
PRESSURE GAUGE
THERMOMETER
HOSEBIBB
PUMP
PIPE TURNED DOWN
PIPE TURNED UP
PIPE OUTLET
PIPE PITCH
PIPE REDUCER
PIPE STRAINER
PIPE TEE DOWN
PIPE TEE FLANGE
PIPE UNION
PIPE WELL
PUMP SUCTION DIFFUSER
RELIEF VALVE

AHU-1
NEW EQUIPMENT DESIGNATION — EQUIPMENT NUMBER

PUMP SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	GPM	HEAD	RPM	EFF.	ELEC. DATA	NOTES:
HPP-1	HEAT PUMP LOOP CIRCULATOR	GRUNDFOS NBSE 05-070-2P-15HP	270	120'	3308	75	208V-3Ø-15HP	1,2,3,4,5
HPP-2	HEAT PUMP LOOP CIRCULATOR	GRUNDFOS NBSE 05-070-2P-15HP	270	120'	3308	75	208V-3Ø-15HP	1,2,3,4,5
HPP-3	HEAT PUMP LOOP CIRCULATOR	GRUNDFOS NBSE 05-070-2P-15HP	270	120'	3308	75	208V-3Ø-15HP	1,2,3,4,5
HPP-4	HEAT PUMP LOOP CIRCULATOR	GRUNDFOS NBSE 05-070-2P-15HP	270	120'	3308	75	208V-3Ø-15HP	1,2,3,4,5
GLP-1	GEOTHERMAL BOREHOLE CIRCULATOR PUMPS	GRUNDFOS NBSE 025-095-4P-7.5HP	270	60'	1684	75	208V-3Ø-7.5HP	1,2,3,4,5
GLP-2	GEOTHERMAL BOREHOLE CIRCULATOR PUMPS	GRUNDFOS NBSE 025-095-4P-7.5HP	270	60'	1684	75	208V-3Ø-7.5HP	1,2,3,4,5
GLP-3	GEOTHERMAL BOREHOLE CIRCULATOR PUMPS	GRUNDFOS NBSE 025-095-4P-7.5HP	270	60'	1684	75	208V-3Ø-7.5HP	1,2,3,4,5

1. PUMP NOTES:

1. PUMP SHALL HAVE EC MOTOR (IE5 EFFICIENCY RATED) WITH VARIABLE SPEED CAPABILITIES.
2. PROVIDE FLEXIBLE CONNECTIONS TO EQUIPMENT.
3. SEE PUMP INSTALLATION DETAIL FOR PUMP SPECIALITIES AND INSTALLATION. PROVIDE SEPARATE STRAINER BEFORE EACH PUMP. TRIPLE DUTY VALVES MAY BE USED AS A BALANCE VALVE AND CHECK VALVE. A SEPARATE ISOLATION VALVE IS REQUIRED. PROVIDE SUCTION DIFFUSER FOR EACH PUMP PER MANUFACTURER'S RECOMMENDATIONS.
4. PUMPS ARE TO HAVE BACNET CONNECTION CAPABILITIES PROVIDED.
5. PUMP IS TO BE INSTALLED ON A 4" CONCRETE HOUSE KEEPING PAD ON A MANUFACTURER PROVIDE SUPPORT RAIL. PROVIDE WITH HOUSED SPRING VIBRATION ISOLATORS FOR PUMP STAND.

APPROVED ALTERNATE MANUFACTURERS: TACO, ARMSTRONG, WILO. ALTERNATE MANUFACTURER PUMPS MUST MEET OR EXCEED STATED EFFICIENCIES AND FEATURES. ALTERNATE PRODUCTS MUST MATCH PUMP TYPE (BASE MOUNTED/VERTICAL INLINE ETC.). ALTERNATE PUMP TYPES FOR EACH PUMP MUST BE SUBMITTED TO ENGINEER FOR APPROVAL PRIOR TO BIDDING.

CHEMICAL BYPASS FEEDER SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	CAPACITY	NOTES:
BF-1	HEAT PUMP SYSTEM BYPASS FEEDER	NEPTUNE DBF-10MP	10 GAL	1,2,3

1. NOTES:

1. FURNISH AND INSTALL AS PER MANUFACTURER'S RECOMMENDATIONS. PROVIDE ISOLATION VALVES AS PER ONE-LINE DIAGRAM.
2. PROVIDE SUPPORT LEGS.
3. PROVIDE WITH INTEGRAL FILTER.

AIR SEPARATOR SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	GPM	REMARKS:
AS-1	HEAT PUMP LOOP AIR SEPARATOR	SPIROTHERM VHN800-FA	1064	PROVIDE SUPPORT FROM STRUCTURE. MOUNT AS HIGH AS POSSIBLE.

NOTES:

1. PROVIDE ASME RATED CONSTRUCTION. 125 PSIG DESIGN PRESSURE.
2. PROVIDE FLANGED CONNECTIONS.
3. PROVIDE AUTOMATIC AIR VENT WITH ISOLATION VALVE TO PERMIT AIR VENT REPLACEMENT WITHOUT SHUTTING DOWN THE SYSTEM. PIPE AIR VENT TO GLYCOL FILL PUMP.

EXPANSION TANK SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	TANK VOLUME	DIMENSIONS	REMARKS:
XT-1	HEAT PUMP LOOP EXPANSION TANK	TACO CA-1400-125	370.0 GALLON	36"Ø x 103"	SEE FLOOR PLAN FOR LOCATION
XT-2	HEAT PUMP LOOP EXPANSION TANK	TACO CA-1400-125	370.0 GALLON	36"Ø x 103"	SEE FLOOR PLAN FOR LOCATION

NOTES:

1. PROVIDE ASME RATED CONSTRUCTION. 125 PSIG DESIGN PRESSURE.
2. PROVIDE DRAIN WITH BALL VALVE AND 4" THICK CONCRETE HOUSE KEEPING PAD.
3. ADJUST FACTORY PRESSURE SETTINGS TO MEET SYSTEM REQUIREMENTS.
4. PROVIDE ANCHOR CLIPS.
5. PROVIDE SIGHT GLASS.

APPROVED ALTERNATE MANUFACTURERS: JOHN WOOD, BAG, AMTROL

GLYCOL FEED SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	PRES.	CAPACITY	ELEC. DATA	NOTES:
GF-1	GLYCOL FEED PUMP AND TANK	AXIOM INDUSTRIES SF100	25	55 GAL	120V-60HZ-0.9A	1

1. NOTES:

1. FURNISH AND INSTALL AS PER MANUFACTURER'S RECOMMENDATIONS.

(TYP.) WATER SOURCE HEAT PUMP SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	HEATING (40°F EWT)	COP	COOLING (90°F EWT)	EER	AIRFLOW (CFM)	WATER FLOW	ELECTRICAL	REMARKS	OUTDOOR AIR
HP-07	CONSOLE HEAT PUMP, 0.5-TON	DAIKIN W-THM4	6,500	4.18	7,900	14.4	295 CFM	1.8 GPM @ 1.7'	240V/1Ø/60HZ 4.0MCA/15MOP	PIPE SIZE TO AND FROM UNIT SHALL BE ¾" (TYP.)	-
HP-09	CONSOLE HEAT PUMP, 0.75-TON	DAIKIN W-THM4	7,700	3.92	9,400	13.4	355 CFM	2.3 GPM @ 3.4'	240V/1Ø/60HZ 4.9MCA/15MOP	PIPE SIZE TO AND FROM UNIT SHALL BE ¾" (TYP.)	-
HP-12	CONSOLE HEAT PUMP, 1.0-TON	DAIKIN W-THM4	10,200	3.70	11,100	12.8	370 CFM	3.0 GPM @ 5.3'	240V/1Ø/60HZ 5.8MCA/15MOP	PIPE SIZE TO AND FROM UNIT SHALL BE ¾" (TYP.)	-

GENERAL NOTES:

1. IN THE RESIDENCES, PIPE CONDENSATE TO INDIRECT RECEIVER IN BASEMENT WHIGH IS TO BE TIED INTO BUILDING SANITARY SEWER SYSTEM. SEE PLUMBING DRAWINGS FOR ROUTING AND ENSURE PIPING IS RUN AT 1/4" PER FOOT SLOPE. HEAT PUMP WITHIN THE PUMP HOUSE CONDENSATE IS TO BE RUN PROTECTED ALONG THE WALL TO THE NEAREST FLOOR DRAIN.
2. FURNISH AND INSTALL WALL MOUNTED THERMOSTAT (COORDINATE WITH DDC CONTRACTOR). COORDINATE EXACT LOCATIONS IN THE FIELD WITH ARCHITECT/OWNER.
3. PERFORMANCE DATA FOR HEAT PUMPS BASED ON 40°F E.W.T., 70°F DB/59°F WB E.A.T. FOR HEATING AND 90°F E.W.T., 80°F DB/67°F WB E.A.T. FOR COOLING.
4. PROVIDE UNITS WITH LOW SOUND PACKAGE WHERE APPLICABLE. PROVIDE WITH ELASTOMERIC FOAM INSULATION (FOR GEOTHERMAL OPERATION).
5. PROVIDE AUTO-FLOW BALANCING VALVE FOR EACH UNIT ADJUSTED TO THE GPM INDICATED ON THE SCHEDULE.
6. PROVIDE LOW PRESSURE DROP HOSE KITS.
7. HEAT PUMPS TO BE PROVIDED WITH REMOTE MOUNTED, PROGRAMMABLE THERMOSTAT FOR EACH HEAT PUMP. LOCATE THERMOSTAT WITHIN THE ROOM THE UNIT IS LOCATED IN, ON AN INTERIOR WALL.
8. UNITS TO HAVE CONTROLS TO SELECT UNIT MODE.
9. ALTERNATE MANUFACTURER'S MUST MEET OR EXCEED THE SPECIFIED EQUIPMENTS PUBLISHED PERFORMANCE AND SOUND DATA.
10. UNITS ARE TO BE PROVIDED WITH 2-WAY CONTROL VALVES. SEE SPECIFICATIONS.

APPROVED ALTERNATE MANUFACTURERS: CLIMATE MASTER, FLORIDA HEAT PUMP/BOSCH, WATERFURNACE

ELECTRIC RADIATOR HEATER SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	BTU/HR.	WATTS	ELEC. DATA	REMARKS:
R-1	24" ELECTRIC BASEBOARD	OULLET RBH0352	1,194	350	120 V/1Ø/ 2.92A	1,2,3
R-2	24" ELECTRIC PANEL RADIATOR	RUNTAL EMP-6	2,627	770	120 V/1Ø/ 6.4A	1,2,3

1. NOTES:

1. PROVIDE EQUIPMENT SUPPORT FROM WALL STRUCTURE.
2. COORDINATE UNIT MOUNTING STYLE IN THE FIELD.
3. COORDINATE EXACT LOCATION WITH ARCHITECTURAL AND EQUIPMENT PLANS.

DOMESTIC WATER HEATING EQUIPMENT SCHEDULE

TAG	DESCRIPTION	MAKE AND MODEL	CAPACITY	GPH RATING @ 90°F	ELECTRICAL	COLD WATER CONNECTION	HOT WATER CONNECTION	SIZE	NOTES:
WH-1	COMMERCIAL WATER HEATER	A.O. SMITH DEL-6	6 GAL.	14	208V-1P-14.4FLA-2.0HOP-3KW	3/4"	3/4"	14-1/4"Ø X 15-1/2"H	1,2
MV-1	MIXING VALVE	CALEFFI MIXING VALVE 520510A	-	9 GPM @ 20 PSI DROP	-	3/4"	3/4"	-	4
TX-1	POTABLE WATER EXPANSION TANK	AMTROL THERM-X-TROL ST-5	2.0 GAL.	-	-	3/4"	-	-	3

NOTES:

1. FURNISH AND INSTALL PRESSURE/TEMPERATURE RELIEF VALVE IF NOT SUPPLIED BY WATER HEATER MANUFACTURER. PIPE TO NEAREST FLOOR DRAIN. ENSURE DRAIN IS ROUTED AND PROTECTED FROM ACCIDENTAL DAMAGE IF ROUTED ACROSS THE FLOOR.
2. WATER HEATER IS TO BE INSTALLED ON A PLATFORM MOUNTED HIGH ON THE WALL. WATER HEATER IS TO BE SECURED TO THE WALL TO PREVENT TIPPING.
3. SET PRE-CHARGE PRESSURE EQUAL TO WATER SERVICE OPERATING PRESSURE (APPROX. 50 PSIG).
4. INSTALL MIXING VALVE IN LOCATION PER THE WATER HEATER DETAIL.

PLUMBING FIXTURE SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	C.W.	H.W.	WASTE	VENT	FAUCET	NOTES
MS-1	FREESTANDING UTILITY SINK	FIAT PRODUCTS SF-1-F	1/2"	1/2"	1-1/2"	1-1/2"	FIAT PRODUCTS A1	PROVIDE WITH INTEGRAL DRAIN AND OPTIONAL "FIAT PRODUCTS" A1 FAUCET.
HB-1	NON-FREEZE, ANTI SIPHON WALL HYDRANT	WOODFORD PRODUCTS MODEL 24E67-BR	3/4"	-	-	-	-	RECESSED, NON-FREEZE, ANTI SIPHON, AUTOMATIC DRAINING WALL HYDRANT, BRONZE FINISH.
HB-2	MILD CLIMATE WALL HYDRANT	WOODFORD MODEL 824	3/4"	-	-	-	-	WALL MOUNTED, ANTI-SIPHON, MILD CLIMATE, COLD ONLY WALL HYDRANT.
FD-1	MECHANICAL ROOM FLOOR DRAIN	ZURN PRODUCTS #ZB-520-DG-ANH	-	-	4"	2"	N/A	PROVIDE WITH DURESIST GRATE, SURE-SEAL TRAP SEAL, P-TRAP
FI	VISUAL FLOW METER FOR DOH INJECTION INTO GF-1	NEPTUNE T-10 METER	3/4"	-	-	-	N/A	INSTALL TO MEASURE THE DOMESTIC WATER DISCHARGED INTO THE GLYCOL FILL. ENSURE METER IS READABLE FROM THE FILL VALVE LOCATION. PROVIDE ISOLATION VALVE UPSTREAM.
BFP-1	WATER SERVICE ENTRANCE BACKFLOW PREVENTER	WATTS LF009M2QT	1"	-	-	-	N/A	PIPE RELIEF TO FLOOR DRAIN.
BFP-2	GF-1 BACKFLOW PREVENTER	WATTS LF009M3QT	3/4"	-	-	-	N/A	PIPE RELIEF TO FLOOR DRAIN.
PRV-1	WATER ENTRANCE PRESSURE REDUCING VALVE	WATTS LF223-1"	1"	-	-	-	N/A	SET TO 50 PSIG.

GENERAL NOTES:

1. INSTALL CHECK VALVES ON ALL SUPPLIES TO MOP SINKS (UNLESS FIXTURES ARE PROVIDED WITH INTEGRAL CHECK VALVES).
2. ALL PLUMBING FIXTURES AND SPECIALTIES ARE TO BE LEAD FREE TO COMPLY WITH ANTI-LEAD LAWS.

EXPOSED STRUCTURE (NO CEILING) - PROVIDE ORDINARY HAZARD, GROUP I WET FIRE PROTECTION SPRINKLER SYSTEM COVERAGE FOR THE PUMP HOUSE. PIPING MAY BE EXPOSED WITHIN THE SPACES. ALL PIPING TO BE CLEANED AND PREPARED FOR PAINTING UNDER OTHER DIVISIONS. SPRINKLER HEADS TO BE UPRIGHT PENDENT TYPE.

SEE ARCHITECTURAL PLANS FOR CEILING HEIGHTS, ETC.

DENSITY: 0.15 GPM/1500 SQFT + 250 GPM HOSE

FIRE PROTECTION GENERAL NOTES:

1. FIRE PROTECTION SYSTEM AND SPRINKLER HEAD CONFIGURATION SHALL CONFORM TO CURRENT EDITION OF NFPA 13, AUTHORITY HAVING JURISDICTION, LOCAL BUILDING CODES.
2. ALL SPRINKLER HEADS INSTALLED SHALL BE QUICK RESPONSE WITH TEMPERATURE RATING TO SUIT THE OCCUPANCY/USAGE OF THE INSTALLED LOCATION, UNLESS OTHERWISE NOTED. SPRINKLER HEAD TYPE TO BE AS NOTED IN THE SCHEDULE.
3. THE FIRE PROTECTION DRAWINGS ARE DIAGRAMMATIC IN NATURE AND ARE INTENDED TO SHOW GENERAL MAIN PIPING LAYOUT. ACTUAL MAIN AND BRANCH PIPE SIZING SHALL BE DETERMINED BY FIRE PROTECTION DESIGNER AND HYDRAULIC CALCULATIONS. THE FIRE PROTECTION CONTRACTOR IS RESPONSIBLE FOR PROVIDING COMPLETE FIRE PROTECTION COVERAGE PER CURRENT EDITION OF NFPA 13 INCLUDING ALL CONCEALED SPACES WHERE APPLICABLE. THE FIRE PROTECTION CONTRACTOR SHALL REVIEW THE ARCHITECTURAL PLANS, SECTIONS, AND ELEVATIONS PRIOR TO BIDDING. THE FIRE PROTECTION DRAWINGS SHOULD NOT BE UTILIZED FOR FIRE PROTECTION DESIGN. THE FIRE PROTECTION CONTRACTOR SHALL PROVIDE SPRINKLER SYSTEM DESIGN, SPRINKLER HEAD LAYOUT, AND FLOW CALCULATIONS (HYDRAULIC DESIGN). ACTUAL PIPE SIZES SHALL BE DETERMINED BASED ON THE ACTUAL PIPING LAYOUT AND HYDRAULIC CALCULATIONS. THIS SHALL BE COMPLETED BY A CERTIFIED STATE OF CONNECTICUT FIRE PROTECTION PROFESSIONAL ENGINEER. SHOP DRAWINGS SHALL BE SUBMITTED TO PROJECT ENGINEER FOR REVIEW AND APPROVAL.
4. PROVIDE FIRE AND SMOKE PROOF CAULKING FOR ALL WALL PENETRATIONS. COORDINATE ALL FIRE AND SMOKE PROOFING WITH THE CONSTRUCTION SUPERVISOR.
5. PROVIDE SEISMIC BRACING FOR SPRINKLER PIPING INSTALLATION PER NFPA 13 AND STATE BUILDING CODE REQUIREMENTS.
6. ALL NEW SPRINKLER HEADS SHALL HAVE REMOVABLE ESCUTCHEONS TO ALLOW CEILING TILE REPLACEMENT.
7. PROVIDE SPRINKLER SYSTEM AND SPRINKLER SYSTEM TEST DRAINS PER CODE. PIPE TO AN APPROVED DISCHARGE POINT.
8. PROVIDE AUXILIARY DRAINS AS REQUIRED PER NFPA 13, AND AS REQUIRED TO FACILITATE DRAINAGE OF THE SYSTEMS. PIPE AUXILIARY DRAINS TO ACCESSIBLE LOCATIONS. COORDINATE EXACT DRAIN LOCATIONS WITH ARCHITECT AND AUTHORITY HAVING JURISDICTION. ALL PIPING SHALL BE PITCHED TO DRAIN.
9. REFER TO SPECIFICATIONS FOR PIPE AND FITTING MATERIAL REQUIREMENTS.
10. COORDINATE FIRE PROTECTION PIPING (BRANCH, MAINS, ETC) WITH MECHANICAL AND ELECTRICAL EQUIPMENT. DO NOT LOCATE ANY PIPING WITHIN 12" UNDER MECHANICAL EQUIPMENT OR BLOCK ACCESS TO ELECTRICAL EQUIPMENT. ANY PIPING RUN UNDER EQUIPMENT SHALL BE REROUTED AT THE CONTRACTORS EXPENSE.

1 FIRE PROTECTION DESIGN
N.T.S.

lnconsulting.com
208 Flynn Ave. #2J
Burlington, VT 05401
(802) 660-7763
LN CONSULTING

CONCEPTUAL DRAWINGS
NOT FOR CONSTRUCTION

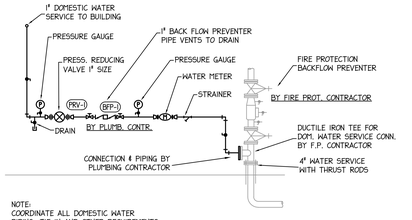
DRAWN	IWD
APPROVED	IWD
DATE	07/29/2024

NO.	DATE	REVISION
1		

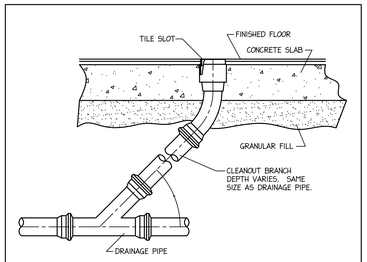
PROJECT TITLE: CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL ULBRICH HEIGHTS GEOTHERMAL PROJECT WALLINGFORD, CT

SHEET TITLE: MECHANICAL, PLUMBING AND FIRE PROTECTION SCHEDULES AND NOTES

SCALE: N.T.S.
PROJECT NO. 23409
SHEET NO.
M5.01



1 DOMESTIC WATER & SPRINKLER SERVICE DIAGRAM
N.T.S.



6 CLEAN-OUT DETAIL
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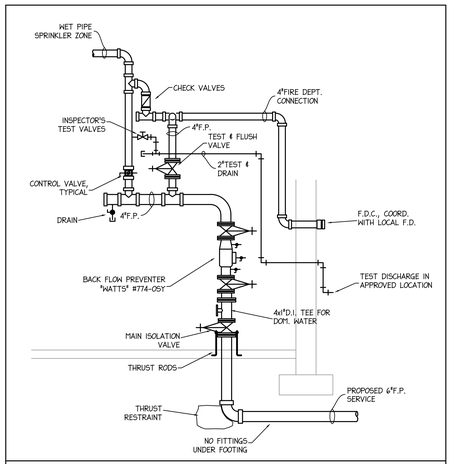

11 FIRE PROTECTION SERVICE ENTRANCE DIAGRAM
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15 TYPICAL VENT THROUGH ROOF SCHEMATIC
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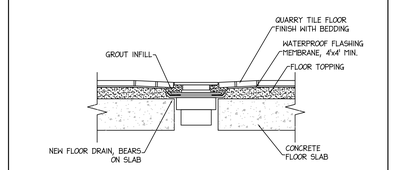
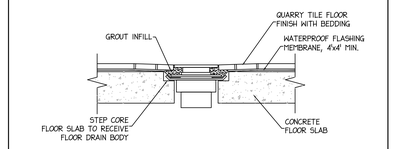
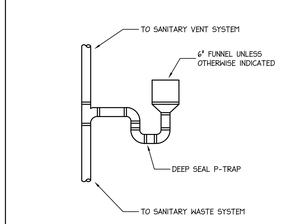


FLOOR DRAIN DETAIL WITH TOPPING

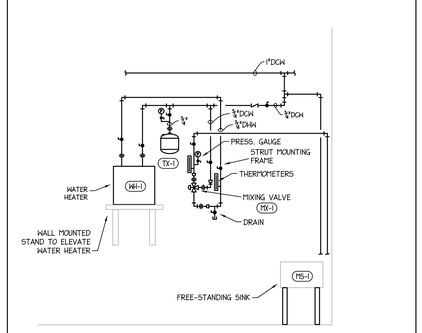


FLOOR DRAIN DETAIL WITHOUT TOPPING

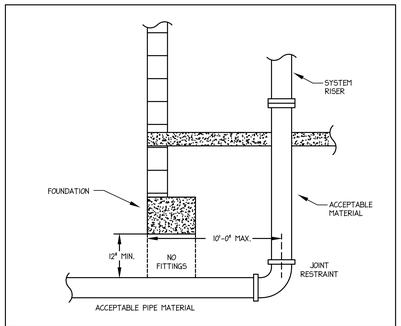
2 FLOOR DRAIN INSTALLATION DETAILS
NOT TO SCALE



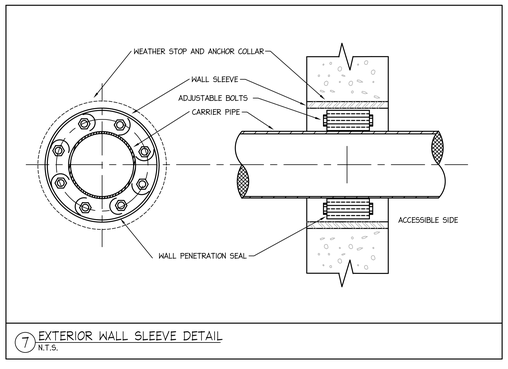
3 INDIRECT WASTE RECEIVER DETAIL
N.T.S.



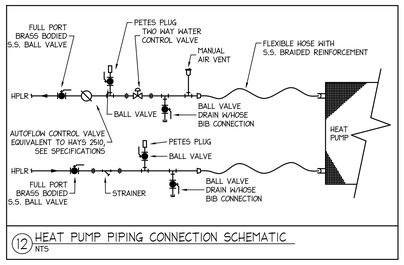
4 DOMESTIC WATER HEATER & MIXING VALVE DIAGRAM
N.T.S.



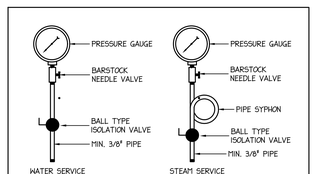
5 FIRE PROTECTION RISER ENTRANCE CLEARANCES
N.T.S.



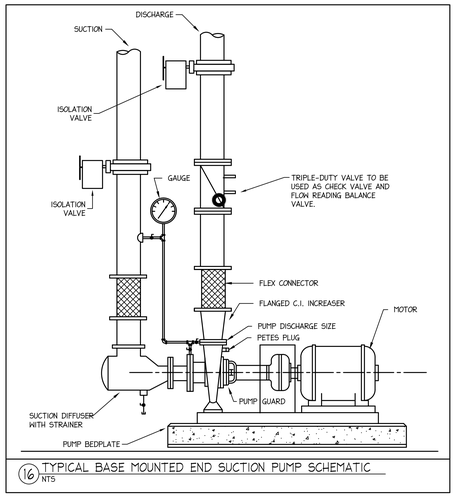
7 EXTERIOR WALL SLEEVE DETAIL
N.T.S.



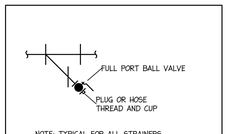
12 HEAT PUMP PIPING CONNECTION SCHEMATIC
NTS



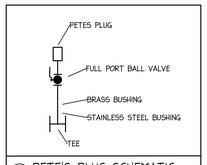
13 PRESSURE GAUGE ASSEMBLY
N.T.S.



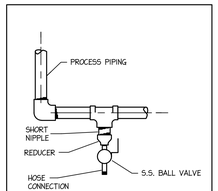
16 TYPICAL BASE MOUNTED END SUCTION PUMP SCHEMATIC
NTS



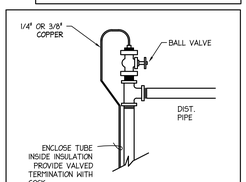
8 STRAINER PIPING SCHEMATIC
NTS



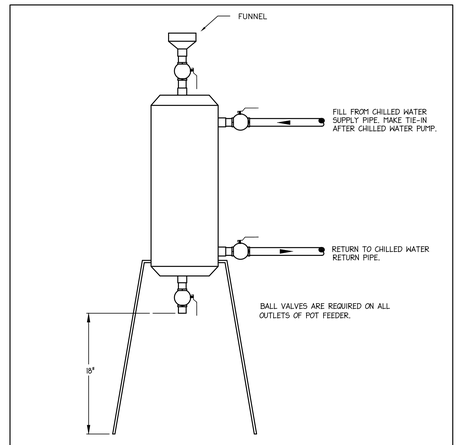
9 PETE'S PLUG SCHEMATIC
NTS



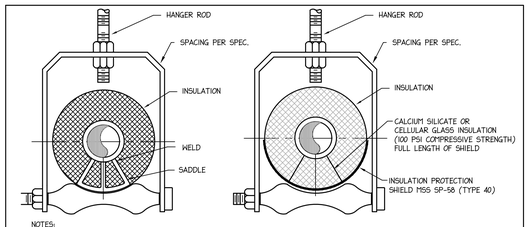
14 TYPICAL LOW POINT DRAIN
NTS



17 HIGH POINT MANUAL AIR VENT
NTS



10 CHEMICAL FEEDER DETAIL
N.T.S.



18 ADJUSTABLE ROLLER HANGER
NTS

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CONCEPTUAL DRAWINGS

NOT FOR CONSTRUCTION

NO.	DATE	REVISION
	DRAWN	IWD
	APPROVED	IWD
	DATE	07/29/2024
1		

PROJECT TITLE
CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

SHEET TITLE
MECHANICAL, PLUMBING AND FIRE PROTECTION DETAILS

SCALE: N.T.S.

PROJECT NO. 23409

SHEET NO.
M6.01

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CONCEPTUAL DRAWINGS

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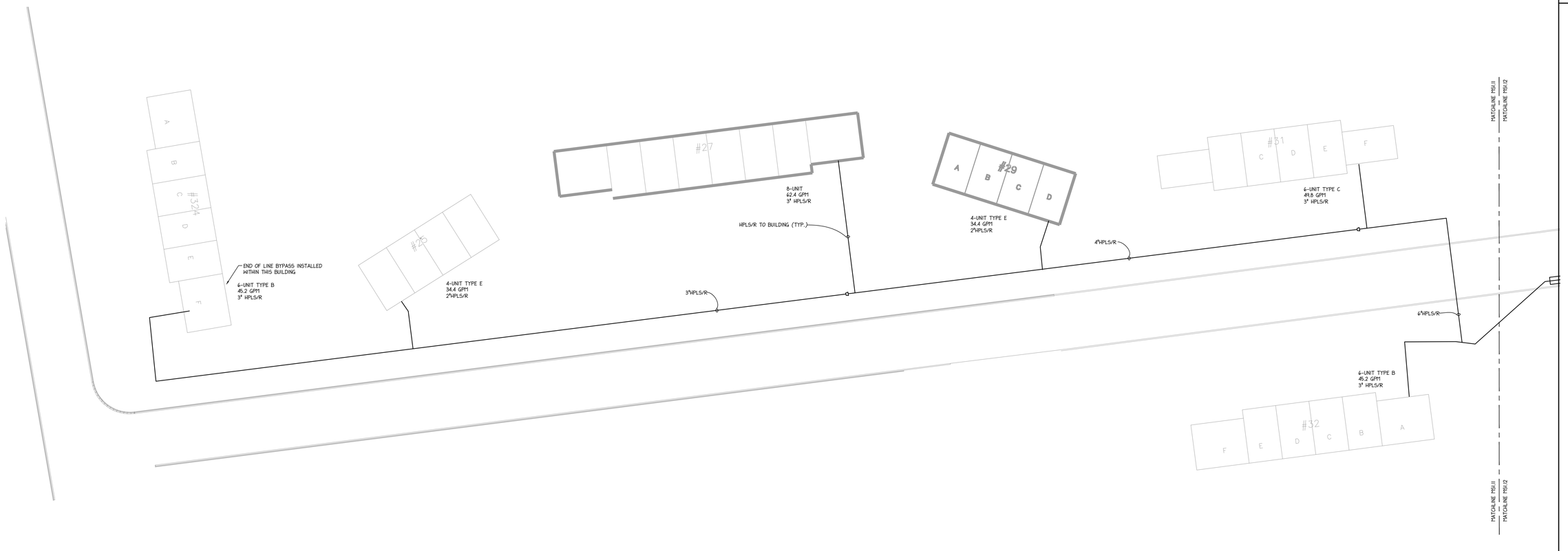

1 HEAT PUMP LOOP SERVING BUILDINGS SITE PLAN
1" = 20'-0"

0' 20' 40' 80' 120'
Bar Scale 1" = 20'

DRAWN		IWD
APPROVED		IWD
DATE		07/29/2024
1		
NO.	DATE	REVISION

PROJECT TITLE
CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

SHEET TITLE
HEAT PUMP LOOP SERVING BUILDINGS SITE PLAN

SCALE: AS NOTED
PROJECT NO. 23409
SHEET NO.
MS1.11

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CONCEPTUAL DRAWINGS

NOT FOR CONSTRUCTION

MATCHLINE MS1.11
MATCHLINE MS1.12

TRANSITION FROM BURIED, UNINSULATED HDPE PIPING TO PRE-INSULATED PIPING BELOW GRADE. ENSURE THAT HDPE OUTER JACKET IS WELDED TO BURIED UNINSULATED PIPING TO PROVIDE A WATER-TIGHT SEAL.

AS PART OF THE REDUCED, 72 UNIT SCOPE, PIPING WOULD BE CAPPED IN THIS LOCATION.

6" PRE-INSULATED HDPE PIPING RUN UNDER BRIDGE. PROVIDE HANGERS/SUPPORTS FROM BRIDGE EVERY 4FT. PIPING TO BE EQUIVALENT TO TRICON HDPE PIPING SYSTEM WITH HDPE CASING. PROVIDE PIPE HANGERS WITH ROLLERS AND SADDLES TO PROTECT THE JACKETING. COORDINATE INSTALLATION REQUIREMENTS WITH THE TOWN.

4-UNIT TYPE D
30.8 GPM
2" HPLS/R

6-UNIT TYPE B
49.8 GPM
3" HPLS/R

6-UNIT TYPE B
45.2 GPM
3" HPLS/R

4-UNIT TYPE E
34.4 GPM
2"HPLS/R

6-UNIT TYPE B
45.2 GPM
3" HPLS/R

4-UNIT TYPE E
34.4 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

2-UNIT TYPE A
17.8 GPM
2"HPLS/R

8-UNIT
62.4 GPM
3" HPLS/R

6-UNIT TYPE B
49.8 GPM
3" HPLS/R

6-UNIT TYPE B
45.2 GPM
3" HPLS/R

6-UNIT TYPE B
45.2 GPM
3" HPLS/R

4-UNIT TYPE D
30.8 GPM
2" HPLS/R

NEW PUMP HOUSE BUILDING

AS PART OF THE REDUCED, 72 UNIT SCOPE, PIPING WOULD BE CAPPED IN THIS LOCATION.

AS PART O
72 UNIT SC
WOULD BE
LOCATION.

MATCHLINE MS1.12
MATCHLINE MS1.13

MATCHLINE MS1.12
MATCHLINE MS1.13

1 HEAT PUMP LOOP SERVING BUILDINGS SITE PLAN
1" = 20'-0"

Bar Scale 1" = 20'

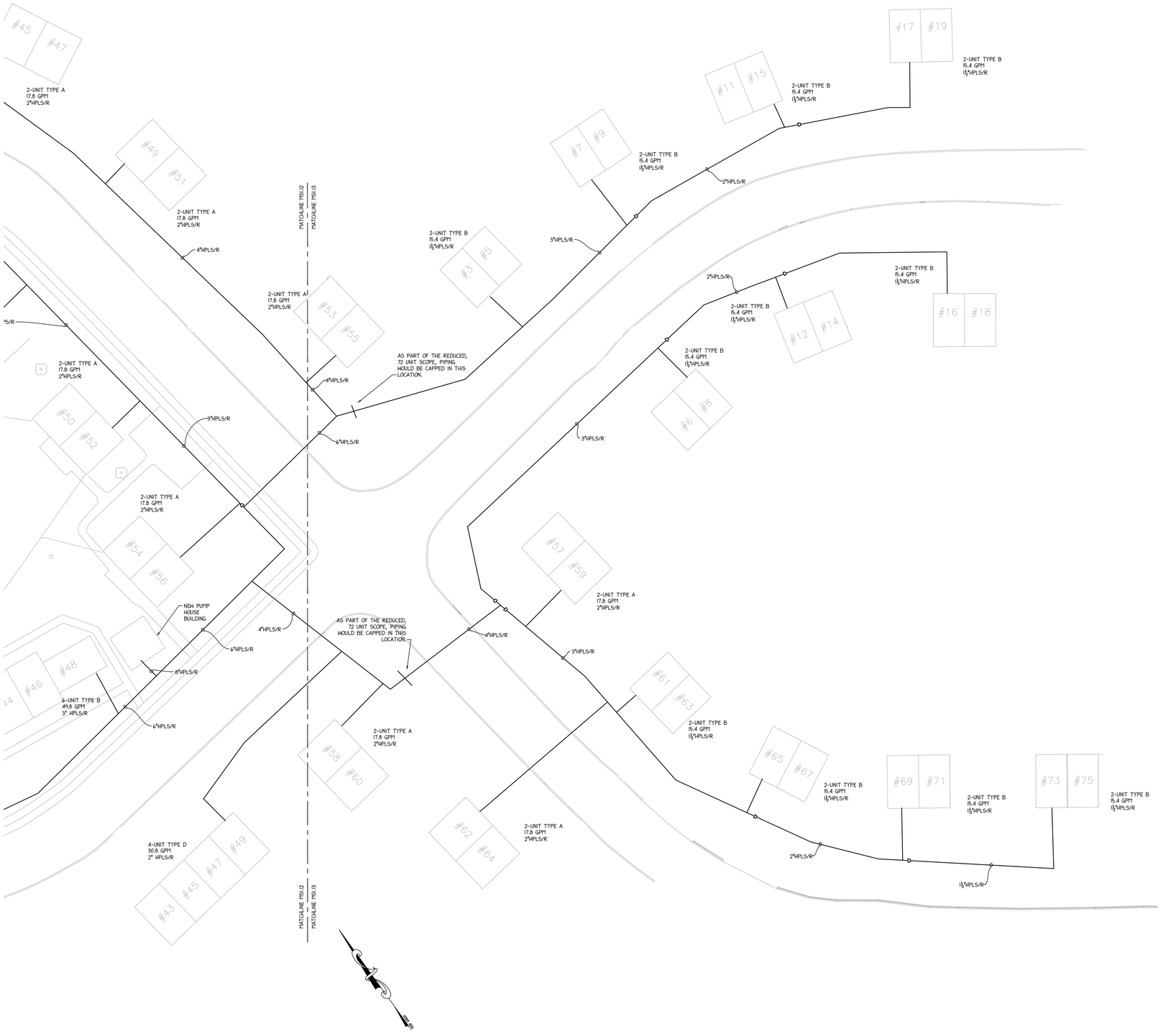
DRAWN	IWD
APPROVED	IWD
DATE	07/29/2024

NO.	DATE	REVISION
1		

PROJECT TITLE
CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

SHEET TITLE
HEAT PUMP LOOP SERVING BUILDINGS SITE PLAN

SCALE: AS NOTED
PROJECT NO: 23409
SHEET NO.
MS1.12



1 HEAT PUMP LOOP SERVING BUILDINGS SITE PLAN
1" = 20'-0"

0' 20' 40' 80' 120'
Bar Scale 1" = 20'

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CONCEPTUAL DRAWINGS
NOT FOR CONSTRUCTION

DRAWN	IWD
APPROVED	IWD
DATE	07/29/2024

NO.	DATE	REVISION
1		

PROJECT TITLE
CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

SHEET TITLE
HEAT PUMP LOOP SERVING BUILDINGS SITE PLAN

SCALE: AS NOTED
PROJECT NO. 23409
SHEET NO.
MS1.13

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CONCEPTUAL DRAWINGS

NOT FOR CONSTRUCTION

EXISTING YARD DRAIN

EXISTING STORM DRAINAGE PIPING

EXISTING YARD DRAIN

NOTE: SEE ONE-LINE DIAGRAM FOR PIPE SIZES

TYPICAL GEOTHERMAL BOREHOLE

20'-0"

20'-0"

GEOTHERMAL TEST BOREHOLE TO BE REUSED

EXISTING YARD DRAIN

NEW PUMP HOUSE BUILDING SEE DRAWING M1.16

EXISTING YARD DRAIN

1 GEOTHERMAL BOREHOLE SITE PLAN
1" = 10'-0"

DRAWN	IWD
APPROVED	IWD
DATE	07/29/2024

NO.	DATE	REVISION
1		

PROJECT TITLE
CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

SHEET TITLE
GEOTHERMAL BOREHOLE SITE PLAN

SCALE: AS NOTED

PROJECT NO. 23409

SHEET NO.

MS1.14

LEGEND	
SYMBOL	DESCRIPTION
□³	DISCONNECT SWITCH
S_{OC}	WALL SWITCH WITH INTEGRAL OCCUPANCY SENSOR WITH DIMMING.
◀DX▷	DATA OUTLET-"X"=# OF DATA. NO NUMBER = (2) JACKS
S_S	DUPLEX RECEPTACLE. RECEPTS. WITH AN "S" OR "S" ARE TO BE SURFACE MOUNTED. NO "S" MEANS RECESSED.
S_{XX}	DUPLEX RECEPTACLE LOCATED XX" AFF, UNLESS LABELED WITH XX. XX EQUALS APPROX. HEIGHT AFF. COORDINATE WITH ARCHITECTURAL FOR EXACT HEIGHT.
GFCI	GFCI RECEPTACLE
WP	WEATHERPROOF RECEPTACLE
A	TYPICAL SQUARE OR RECTANGULAR LIGHT FIXTURE, LETTER INDICATES CONTROL
	TYPICAL EXIT LIGHT FIXTURE
	HOME RUN
M	ELECTRIC MOTOR
(B)	JUNCTION BOX

LIGHTING SCHEDULE

TAG	DESCRIPTION	MAKE & MODEL	LAMP(S)	VOLTS	REMARKS
(A)	4' LED STRIP LIGHT	LITHONIA LIGHTING CLX-L48-5000LM1-SEF-MVOLT-GZ10-40K-80CRI	32W LED	120V	COORDINATE INSTALLATION HARDWARE WITH PROPOSED CEILING TYPE. PROVIDE CHAINS WHERE NO CEILING IS PRESENT. DO NOT LOCATE ABOVE MECHANICAL/ELECTRICAL EQUIPMENT. FIXTURE TO BE PENDANT MOUNTED.
	EMERGENCY EGRESS WALL PACK	ISOLITE OWL-ET1-WH-MB	17W LED	120V	PROVIDE WITH SELF DIAGNOSTICS. UNIT LOCATED OUTDOORS IS TO BE PROVIDED WITH INTERNAL HEATER "HX" OPTION.
	EXIT SIGN W/EMERGENCY	EELP XCTXGB	1.2W LED	120V	COORDINATE WALL OR CEILING MOUNT WITH PROPOSED LOCATION. PROVIDE SELF DIAGNOSTIC. AIM LIGHTS FOR BEST COVERAGE. ARROWS AS NOTED AND/OR REQUIRED BASED ON FIELD CONDITIONS.

NOTES:
1. THE LIGHTING SHALL BE ENERGY STAR OR DESIGN LIGHTS RATED WHERE APPLICABLE. ALL SUBSTITUTE FIXTURES SHALL MATCH OR EXCEED THE SPECIFIED FIXTURES EFFICIENCY.
2. PROVIDE ALL HARDWARE REQUIRED FOR PENDANT MOUNTING. CONTRACTOR TO VERIFY CEILING OR SURFACE TYPES. COORDINATE EXACT INSTALLATION ELEVATION WITH ARCHITECTURAL RCPS.
3. ALL LIGHT FIXTURE PROVIDED WITH 1-100% 0-10V DIMMING UNLESS NOTED OTHERWISE.
4. MOUNTING REQUIREMENTS AND EXACT LOCATIONS FOR ALL FIXTURES IS TO BE COORDINATED WITH ARCHITECTURAL DRAWINGS.
5. ALL TRIM AND COLORS TO BE SELECTED BY ARCHITECT.

EQUIPMENT SCHEDULE

TAG	DESCRIPTION	LOCATION	HP	KW	FLA/MCA	V	PH	CONDUCTORS	GROUND	CONDUIT	STARTER TYPE	BREAKER SIZE	PANEL FEED	NOTES
(HPP-1)	HEAT PUMP LOOP CIRCULATOR	PUMP HOUSE	1.5	-	4.6.2	208	3Φ	3#6	1#8	3/4"	ECM	70A	SEE SCHEDULES	1
(HPP-2)	HEAT PUMP LOOP CIRCULATOR	PUMP HOUSE	1.5	-	4.6.2	208	3Φ	3#6	1#8	3/4"	ECM	70A	SEE SCHEDULES	1
(HPP-3)	HEAT PUMP LOOP CIRCULATOR	PUMP HOUSE	1.5	-	4.6.2	208	3Φ	3#6	1#8	3/4"	ECM	70A	SEE SCHEDULES	1
(HPP-4)	HEAT PUMP LOOP CIRCULATOR	PUMP HOUSE	1.5	-	4.6.2	208	3Φ	3#6	1#8	3/4"	ECM	70A	SEE SCHEDULES	1
(GLP-1)	GEOTHERMAL LOOP CIRCULATOR	PUMP HOUSE	7.5	-	24.2	208	3Φ	3#10	1#10	1/2"	ECM	40A	SEE SCHEDULES	1
(GLP-2)	GEOTHERMAL LOOP CIRCULATOR	PUMP HOUSE	7.5	-	24.2	208	3Φ	3#10	1#10	1/2"	ECM	40A	SEE SCHEDULES	1
(GLP-3)	GEOTHERMAL LOOP CIRCULATOR	PUMP HOUSE	7.5	-	24.2	208	3Φ	3#10	1#10	1/2"	ECM	40A	SEE SCHEDULES	1
(GLP-4)	GEOTHERMAL LOOP CIRCULATOR	PUMP HOUSE	7.5	-	24.2	208	3Φ	3#10	1#10	1/2"	ECM	40A	SEE SCHEDULES	1
(WH-1)	ELECTRIC WATER HEATER	PUMP HOUSE	-	3.0	14.4	208	1Φ	2#12	1#12	1/2"	-	20A	SEE SCHEDULES	5
(GF-1)	GLYCOL FEED PUMP	PUMP HOUSE	-	-	0.9	120	1Φ	2#12	1#12	1/2"	-	15A	SEE SCHEDULES	2
(EP-07)	TYPICAL CONSOLE HEAT PUMP	SEE PLANS	-	-	4.0	240	1Φ	2#12	1#12	1/2"	-	15A	SEE SCHEDULES	3
(EP-09)	TYPICAL CONSOLE HEAT PUMP	SEE PLANS	-	-	4.9	240	1Φ	2#12	1#12	1/2"	-	15A	SEE SCHEDULES	3
(EP-12)	TYPICAL CONSOLE HEAT PUMP	SEE PLANS	-	-	5.8	240 /208	1Φ	2#12	1#12	1/2"	-	15A	SEE SCHEDULES	3
(R-1)	ELECTRIC BASEBOARD HEATER	SEE PLANS	-	0.35	3.0	120	1Φ	2#12	1#12	1/2"	-	20A	SEE SCHEDULES	4
(E-2)	ELECTRIC PANEL HEATER	SEE PLANS	-	0.77	6.4	120	1Φ	2#12	1#12	1/2"	-	20A	SEE SCHEDULES	4

NOTES:
1. PROVIDE CURRENT LIMITING FUSED DISCONNECT FOR EACH CIRCULATOR PUMP.
2. PROVIDE LOCAL RECEPTACLE FOR GLYCOL FILL PUMP.
3. FOR EACH RESIDENTIAL HEAT PUMP, PROVIDE LOCAL DISCONNECT WITHIN ENCLOSURE. PROVIDE AND INSTALL NEW BREAKER(S) AS NECESSARY WITHIN EXISTING APARTMENT ELECTRICAL PANEL. COORDINATE EXACT BREAKER TYPE WITH EACH PANEL.
4. ELECTRIC PANEL RADIATOR IS TO BE POWERED FROM LOCAL RECEPTACLE CIRCUIT. PROVIDE LOCAL DISCONNECT SWITCH.
5. PROVIDE LOCAL DISCONNECT FOR EQUIPMENT.

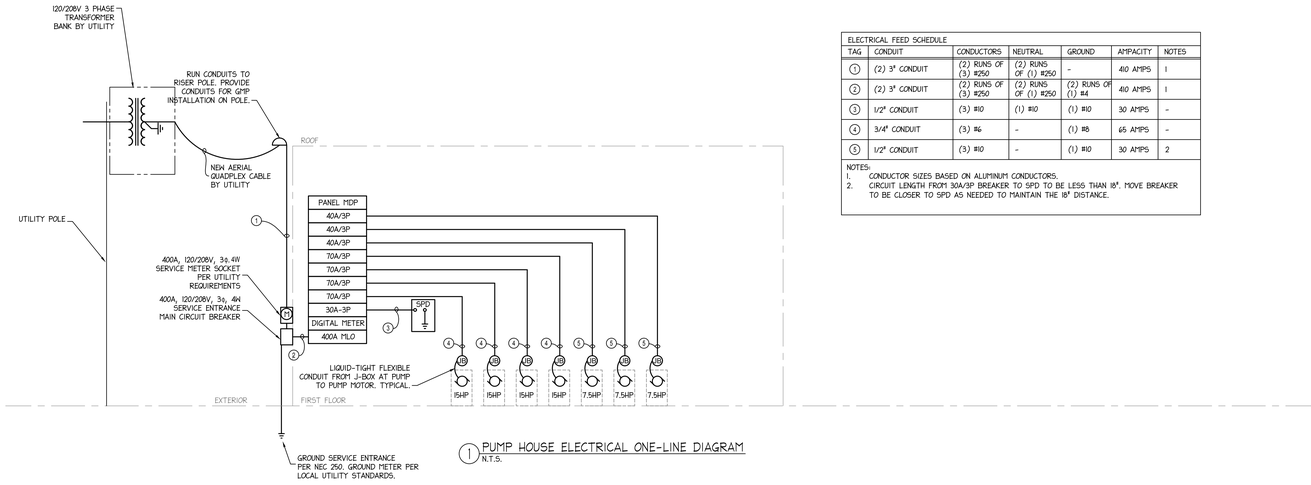
GENERAL NOTES:
1. REFER TO ALL EQUIPMENT SUBMITTALS FOR FINAL CIRCUITING AND CONNECTION REQUIREMENTS.
2. CONNECTION TO EACH DEVICE IN SEALTIGHT.
3. PROVIDE A LOCAL DISCONNECT AT EACH DEVICE LOCATION. DISCONNECT TO BE NEMA 3R FOR EXTERIOR LOCATIONS. COORDINATE DISCONNECT OR BREAKER SIZE WITH APPROVED SHOP DRAWINGS PRIOR TO PURCHASE.

ELECTRICAL PANEL SCHEDULE: PANEL MDP

VOLTAGE: 120/208V | NEUTRAL: CU OR AL | LOCATION: SEE DRAWINGS | FED FROM: UTILITY
AMPERAGE: 400A | NEUTRAL RATING: 100% |
INTERRUPTANCE: 42KAIC | MAIN TYPE: M.L.O. |
PHASE: 3PH | MAIN RATING: 400A | MOUNTING: SURFACE
WIRE: 4W | TRIM STYLE: HINGED DOOR IN DOOR

LOAD DESCRIPTION	CKT. BKR.	A	B	C	CKT. NO.	A	B	C	CKT. BKR.	LOAD DESCRIPTION
HEAT PUMP CIRCULATOR (HPP-1)	3P-70A				1 2				3P-70A	HEAT PUMP CIRCULATOR (HPP-2)
-	-				3 4				-	-
-	-				5 6				-	-
HEAT PUMP CIRCULATOR (HPP-3)	3P-70A				7 8				3P-70A	HEAT PUMP CIRCULATOR (HPP-4)
-	-				9 10				-	-
-	-				11 12				-	-
GEOTHERMAL CIRCULATOR (GLP-1)	3P-40A				13 14				3P-40A	GEOTHERMAL CIRCULATOR (GLP-2)
-	-				15 16				-	-
-	-				17 18				-	-
GEOTHERMAL CIRCULATOR (GLP-3)	3P-40A				19 20				1P-20A	RECEPTACLE CIRCUIT
-	-				21 22				1P-20A	RECEPTACLE CIRCUIT
-	-				23 24				1P-20A	LIGHTING POWER (GF-1)
RECEPTACLE CIRCUIT	1P-20A				25 26				2P-20A	WATER HEATER (WH-1)
RECEPTACLE CIRCUIT	1P-20A				27 28				-	-
PREPARED SPACE	-				29 30				1P-20A	SPARE
-	-				25 26				1P-20A	SPARE
SPARE	1P-20A				27 28				1P-20A	SPARE
SPARE	1P-20A				29 30				1P-20A	SPARE
SPARE	1P-20A				25 26				3P-30A	SURGE PROTECTION DEVICE (SPD)
SPARE	1P-20A				27 28				-	-
SPARE	1P-20A				29 30				-	-
NOTES:	TOTAL	0.0	0.0	0.0		0.0	0.0	0.0	TOTAL	

1. NEUTRAL SHARING IS NOT PERMITTED. PROVIDE ONE NEUTRAL PER CIRCUIT.



1 PUMP HOUSE ELECTRICAL ONE-LINE DIAGRAM
N.T.S.

ELECTRICAL FEED SCHEDULE						
TAG	CONDUIT	CONDUCTORS	NEUTRAL	GROUND	AMPACITY	NOTES
1	(2) 3" CONDUIT	(2) RUNS OF (3) #250	(2) RUNS OF (1) #250	-	410 AMPS	1
2	(2) 3" CONDUIT	(2) RUNS OF (3) #250	(2) RUNS OF (1) #250	(2) RUNS OF (1) #4	410 AMPS	1
3	1/2" CONDUIT	(3) #10	(1) #10	(1) #10	30 AMPS	-
4	3/4" CONDUIT	(3) #6	-	(1) #8	65 AMPS	-
5	1/2" CONDUIT	(3) #10	-	(1) #10	30 AMPS	2

NOTES:
1. CONDUCTOR SIZES BASED ON ALUMINUM CONDUCTORS.
2. CIRCUIT LENGTH FROM 30A/3P BREAKER TO SPD TO BE LESS THAN 18', MOVE BREAKER TO BE CLOSER TO SPD AS NEEDED TO MAINTAIN THE 18' DISTANCE.

ELECTRICAL GENERAL NOTES:

1. THE ELECTRICAL CONTRACTOR SHALL FURNISH AND INSTALL ALL LABOR AND MATERIALS NECESSARY TO PROVIDE A COMPLETE, CODE COMPLIANT ELECTRICAL SYSTEM. THE DRAWINGS ARE SCHEMATIC IN NATURE AND INDICATE GENERAL ARRANGEMENT AND ROUTING OF CONDUIT. THE ELECTRICAL CONTRACTOR SHALL NOT INSTALL EQUIPMENT, DEVICES, OR CONDUIT IN A NON-CODE COMPLIANT FASHION DUE TO DRAWINGS INTERPRETATION. THE ELECTRICAL CONTRACTOR SHALL PROVIDE MODIFICATIONS OF ILLUSTRATED WORK IN ORDER TO ACCOMMODATE JOB CONDITIONS AT NO EXTRA COST TO THE OWNER.
2. THE ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR PROVIDING POWER AND THE FINAL ELECTRICAL CONNECTIONS TO ALL EQUIPMENT REQUIRING POWER INDICATED ON THE ELECTRICAL, ARCHITECTURAL AND MECHANICAL/PLUMBING DRAWINGS. THE ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR REVIEWING ALL DRAWINGS PRIOR TO BIDDING AND INDICATING CONFLICTS. THE ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR COORDINATING WITH ALL OTHER TRADES DURING CONSTRUCTION.
3. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE LATEST EDITION OF THE NATIONAL ELECTRIC CODE (NEC.) AND CONNECTICUT ELECTRICAL SAFETY CODE.
4. ALL ELECTRICAL EQUIPMENT, TRANSFORMER, AND LUMINARIES SHALL BE GROUNDED IN ACCORDANCE WITH ARTICLE 250 OF THE NEC.
5. THE ELECTRICAL CONTRACTOR SHALL FURNISH AND INSTALL ALL LABOR, MATERIALS, TOOLS, EQUIPMENT, SERVICES AND RELATE
6. ACCESSORIES NEEDED FOR THE COMPLETE INSTALLATION OF ALL WORK SHOWN ON THE DRAWINGS AND REQUIRED BY CODE.
7. COORDINATE ALL WORK WITH OTHER TRADES. PROVIDE A COORDINATION DRAWING TO THE ENGINEER, CONSTRUCTION MANAGER, AND ALL OTHER TRADES SHOWING THE LOCATION OF ALL DEVICES AND EQUIPMENT.
8. THE ELECTRICAL CONTRACTOR IS RESPONSIBLE FOR ALL TEMPORARY POWER AND LIGHTING DURING ALL PHASES OF THE WORK.
9. COORDINATE ALL UTILITY SHUT DOWNS WITH THE CONSTRUCTION MANAGER, UTILITY AND OWNER.
10. PROVIDE POWER TO ALL MOTORIZED DOORS. FEED FROM LOCAL POWER PANEL.
11. PROVIDE POWER TO ALL HEAT PUMP LOCATIONS FOR HVAC CONTROLS.
12. PROVIDE CONDUIT SEAL SIMILAR TO JACKMOON SEALING PLUG FOR ALL EXTERIOR PENETRATIONS. COORDINATE SIZE AND CONDUCTOR QUANTITIES.
13. ALL INSTALLATIONS SHALL BE AS DICTATED IN SPECIFICATIONS.
14. CONTRACTOR TO PROVIDE ALL CONDUIT, PULL STRINGS, AND ACCESSORIES FOR TELECOM/DATA ROUGH IN. CONTRACTOR TO PROVIDE BOX WITH BLANK COVER PLATE AT EACH DEVICE LOCATION. CONTRACTOR TO PROVIDE ALL CABLING, DATA JACKS, EQUIPMENT RACKS AND PATCH PANELS.
15. CONTRACTOR TO PROVIDE SECURITY/VIDEO MONITORING SYSTEM PER SPECIFICATIONS.
16. ELECTRICAL CONTRACTOR TO REVIEW ARCHITECTURAL FLOOR PLANS FOR WALL AND CEILING CONSTRUCTION TYPE THROUGHOUT THE FACILITY. ELECTRICAL POWER, TELECOM, FIRE ALARM, SECURITY SYSTEM CONDUITS AND CONDUCTORS TO BE CONCEALED WITHIN WALLS AND ABOVE CEILINGS. FOR CONCRETE BLOCK WALLS, ELECTRICAL CONTRACTOR TO COORDINATE ROUTING AND INSTALLATION WITH MASON TO KEEP UTILITIES CONCEALED IN THE BLOCK. FOR AREAS WITH HARD CEILINGS, PROVIDE PLASTER FRAMES FOR INSTALLATION OF RECESSED LIGHT FIXTURES. WHERE ELECTRICAL EQUIPMENT, JUNCTION BOXES, ETC. ARE REQUIRED TO BE INSTALLED ABOVE A HARD CEILING, PROVIDE 24"X24" HINGED ACCESS DOOR.
17. ALL RECEPTACLES SHALL BE TAMPER RESISTANT TYPE.
18. GENERALLY, ALL DEVICES ON THE EXTERIOR OF THE BUILDING ARE TO BE SURFACE MOUNTED DEVICES. COORDINATE DETAIL WITH ARCHITECTURAL.

ELECTRICAL GENERAL RECEPTACLE NOTES:

1. IN GENERAL, ALL RECEPTACLES LOCATED ON EXTERIOR WALLS WILL BE SURFACE MOUNTED WITH EXPOSED E.M.T. CONDUIT RUN TO THE BOX.

LIGHTING GENERAL NOTES:

1. EXACT LIGHT FIXTURE MOUNTING ELEVATIONS TO BE COORDINATED IN THE FIELD. APPROXIMATE ELEVATIONS FOR SPACES WITH CEILINGS ABOVE 10'-0" HAVE BEEN NOTED ON THE PLANS FOR BIDDING PURPOSES.
2. ALL ROOMS TO HAVE OCCUPANCY SENSORS TO DISABLE FIXTURES WHEN OCCUPANCY IS NO LONGER SENSED.

lncconsulting.com
208 Flynn Ave, #2J
Burlington, VT 05401
(802) 864-7763
LN CONSULTING

CONCEPTUAL DRAWINGS
NOT FOR CONSTRUCTION

DRAWN	IWD
APPROVED	IWD
DATE	07/29/2024
1	
NO.	DATE REVISION

PROJECT TITLE: CT DEEP WALLINGFORD COMMUNITY GEOTHERMAL
ULBRICH HEIGHTS GEOTHERMAL PROJECT
WALLINGFORD, CT

SHEET TITLE: ELECTRICAL SCHEDULES, LEGENDS, NOTES AND ONE-LINE DIAGRAM

SCALE: N.T.S.
PROJECT NO. 23409
SHEET NO.
E5.01

Design report

Connecticut Community Geothermal Design Report

During the beginning phases of this project, it was important to confirm with the local utility that there is sufficient grid capacity to accommodate an all-electric heat pump heating and cooling system in this area. Wallingford Electric has confirmed that there is sufficient grid capacity at Ulbrich Heights to proceed with a geothermal heat pump system for the community. As part of this project, electrical, telecom, water, and sewer interconnections will be required for the pump house facility which will contain the main system infrastructure equipment. Additional information about the pump house facility is indicated below.

The design for the Wallingford Housing-Ulbrich Heights Community Geothermal system utilized computer based energy modeling software and ground source heat exchanger modeling software to size the geothermal system and the heating and cooling equipment that will ultimately condition the housing complex.

The University of Connecticut (UConn) utilized TRNSYS EnergyPlus/Open Studio software to model the Ulbrich Heights housing complex buildings. The results of this energy modeling determined both the peak heating and cooling loads for the housing complex as well as the cumulative heating and cooling loads throughout the course of a calendar year.

Prior to completing the geothermal design, a geothermal well driller was hired to perform a Thermal Conductivity Test at Ulbrich Heights in an area that was identified as a possible location for a geothermal borehole field. The well driller installed closed-loop geothermal piping within a borehole that is filled with a thermally conductive grout. The well driller then set up testing equipment to measure the soil's thermal conductivity, thermal diffusivity, and the undisturbed ground temperature. This information enables more accurate modeling of the geothermal system using actual soil conditions and characteristics from the specific site. This testing is also useful to provide information about underground geology. The geology of each individual site varies, and the test well provides information regarding depth to bedrock and if there are areas of unstable soil that would make drilling more difficult. The depth to bedrock helps to understand how much casing is required for each borehole. Casing is typically steel pipe that is driven into bedrock to seal surface water and contaminants from entering the borehole and ultimately the ground water supply. The amount of casing that is required directly affects the cost to install the geothermal system.

L.N. Consulting utilized the load data generated by UConn and input that data into Ground Loop Design (GLD Gaia Geothermal) geothermal modeling software. The thermal conductivity, thermal diffusivity and undisturbed ground temperature were also input into the modeling software. Using the modeling software, we were able to determine that (90) 500-foot deep closed-loop boreholes (45,000 total vertical borehole feed) would be required to condition all of the buildings on the site while maintaining acceptable inlet and outlet water temperatures. A closed-loop geothermal system was selected to condition this complex due to the very minimal maintenance required compared to an open-loop geothermal system.

Conditioning for the facilities will be via Water-Source Heat Pumps (WSHPs). These heat pumps utilize the refrigeration cycle to exchange heat energy between a common water loop and the indoor air. The common water loop is a propylene glycol solution that is conditioned by the geothermal borehole field. Circulator pumps located within a pump house building circulate the propylene glycol solution through

buried supply and return pipes to each individual building and ultimately to each individual zone heat pump. A second set of circulator pumps is utilized to pump the propylene glycol solution through the geothermal borehole field to be conditioned by the Earth. The Energy Model data that was provided by UConn was also used to size the individual zone level heat pumps. The pump house facility location was selected as being roughly centralized within the housing complex and in an open area between (2) buildings with relatively easy access from the main road (to ease future maintenance). Centrally locating the pump house reduces the size of the common loop piping mains since they can be split after leaving the pump house. By containing all of the main system pumps and equipment within a single building, the electrical and plumbing services required to support the facility are minimized compared to having multiple pump houses located throughout the site.

The preliminary layout for the pump house is for a building that is approximately 400 sq.ft to house the heat pump loop and geothermal loop circulator pumps along with containing the main geothermal borehole field manifold. All of the geothermal borehole field loops exit from the pump house and balance valves allow for balancing of each individual branch. The total calculated tonnage of capacity that is required to be provided by the geothermal field is approximately 250 tons of cooling and approximately 95 tons of heating. The energy model calculated building cooling load is approximately 180 tons, and the heating load is approximately 170 tons. The geothermal field loads are skewed more towards cooling due to the compressor waste heat generated by the heat pumps which is a benefit in heating mode (less heating required from the geothermal field) but increases the load on the geothermal system in cooling mode as this is additional heat that must be rejected by the geothermal field. The pump house building will also contain domestic water and sanitary waste systems for servicing and maintenance work along with adding water to the system as air is removed. Telecom will need to be provided to the facility for the Direct Digital Controls (DDC) system that will operate the equipment. We recommend providing a fire protection sprinkler system in the facility to protect the facility in case of a fire.

Using site plans of the Ulbrich Heights housing complex, a location for the geothermal borehole field was selected. There is a relatively large greenspace, approximately centrally located within the housing complex. This greenspace is also adjacent to the proposed pump house which minimizes underground piping that runs from the pump house to the borehole field. As indicated above, the results of the energy model and GLD software indicated that (90) boreholes were required to properly condition the housing complex. L.N. Consulting laid out the required quantity of boreholes in the available green space while maintaining approximately 20 feet spacing between boreholes.

Sizing of the underground supply and return common piping (heat pump loop piping) network is based on the connected load of all of the heat pumps served by individual main piping sections and branches to maintain a desired pressure drop through the piping system. As indicated above, the individual heat pump sizes were determined based on the load data provided by the UConn Energy Modeling results. For this project, we have elected to utilize console style heat pumps. The console heat pumps are ductless style units that are located within the space they serve. Currently, the apartments have hot water convectors located within each room. The console style heat pumps will replace the current hot water convectors which will allow for individual room zone control as well as eliminating the need to add ductwork for each heat pump unit which will reduce cost. The typical heat pumps are 0.5 to 1.0-ton units. The current basis of design are Daikin W-MHW console style units. All of the heat pumps within each apartment are 0.5 or 0.75-tons. The individual heat pumps must be sized based on individual

space peak loads, which results in approximately 350-tons of total connected heat pump equipment on the system versus the peak, diversified cooling demand of the entire apartment complex of 180-tons. Although the final layout is subject to change as the project and design progress, the current design incorporates approximately 11,000 linear feet of horizontal heat pump loop piping and approximately 9,000 linear feet of horizontal piping serving the geothermal borehole field. The horizontal piping will be run at approximately 5 feet below finished grade with supply and return piping being spaced a minimum of 24" apart from each other.

Conclusion/Next Steps:

The mechanical, electrical and plumbing drawings that have been developed as part of this phase utilized the design information indicated above. These drawings can be utilized to obtain the services of an Architect and other necessary sub-consultants such as Civil Engineer(s), Structural Engineers, etc. The MEP engineers will need to work with the rest of the design team to generate a set of bid documents. Bid documents will be utilized to hire a General Contractor (GC) or Construction Manager (CM) to facilitate the installation of the project in accordance with the bid documents. The Architect will work with the contractors to obtain all necessary permits required for construction to begin and for the project to be completed.

Scope of Work for Construction Management Firm

Project Title: Wallingford Community Geothermal Project

Project Location: Ulbrich Heights Facility, Wallingford, CT

Client Name: [TBD]

Date: [TBD]

1. Introduction

This Scope of Work (SOW) outlines the services and deliverables to be provided by [Construction Management Firm Name] for the Wallingford Community Geothermal Project – Ulbrich Heights Facility, Wallingford, CT. The purpose of this document is to clearly define the roles and responsibilities of the Construction Management Firm in overseeing the construction process to ensure project success.

2. Objectives

The primary objectives of the Construction Management Firm are:

- To ensure the project is completed on time, within budget, and to the specified quality standards.
- To manage all aspects of construction to mitigate risks and resolve issues promptly.
- To coordinate between all stakeholders, including the client, subcontractors, and regulatory agencies.

3. Scope of Services

The Construction Management Firm will provide the following services:

3.1 Pre-Construction Services

- Project Planning and Scheduling: Develop a detailed project schedule including milestones and critical path.
- Budget Management: Prepare and manage the project budget, including cost estimation and financial forecasting.
- Permitting and Approvals: Assist with obtaining necessary permits and approvals from local authorities.
- Contractor Selection: Assist in the selection of contractors and subcontractors, including the preparation of bid documents and evaluation of proposals.

3.2 Construction Phase Services

- Project Coordination: Serve as the primary point of contact between the client, contractors, and design team.
- Site Management: Oversee daily operations on-site, ensuring adherence to safety regulations, quality standards, and project specifications.
- Quality Control: Implement quality control procedures to ensure that all work meets the required standards and specifications.
- Schedule Management: Monitor project progress and adjust schedules as needed to ensure timely completion.
- Cost Management: Track project expenditures and manage changes to the budget. Provide regular cost reports to the client.
- Change Management: Manage and document changes to the project scope, including assessing impacts and obtaining client approval.

3.3 Post-Construction Services

- Final Inspections and Punch List: Coordinate and conduct final inspections, prepare a punch list of incomplete or unsatisfactory work, and ensure all items are addressed.
- Project Close-Out: Prepare and submit final project documentation, including as-built drawings, warranties, and maintenance manuals.
- Client Handover: Facilitate the handover of the project to the client, including providing training on building systems if required.

4. Deliverables

The Construction Management Firm will deliver:

- Detailed project schedules and budgets.
- Regular progress reports, including updates on schedule and budget.
- Documentation of all permits, approvals, and inspections.
- Final project documentation and a comprehensive punch list.

5. Timeline

- Project Kick-Off: [TBD]
- Pre-Construction Completion: [TBD]
- Construction Start Date: [TBD]
- Projected Completion Date: [TBD]

- Post-Construction Services Completion: Q3 2027

6. Performance Metrics

The success of the Construction Management Firm will be evaluated based on:

- Adherence to project schedule and budget.
- Quality of construction and compliance with project specifications.
- Effective communication and coordination with all stakeholders.
- Timely resolution of issues and changes.

7. Terms and Conditions

- Payment Terms: [TBD]
- Change Order Process: [TBD]
- Termination Clause: [TBD]
- Insurance and Bonding: [TBD]

8. Signatures

Client Representative:
Name: [TBD]
Title: [TBD]
Signature: _____
Date: _____

Construction Management Firm Representative:
Name: [TBD]
Title: [TBD]
Signature: _____
Date: _____

Appendix C – Technical, economic, and environmental assessment

Technical, Economic, and Environmental Assessment for Ulbrich Heights Community Geothermal Heat Pump Project

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Submitted to

Connecticut Department of Energy and Environmental Protection

By

Ravi Gorthala, Ph.D.

University of Connecticut

October 2024

Executive Summary

This report presents the results of a study of the potential for clean onsite energy and energy efficiency technologies for Ulbrich Heights, an affordable housing community in Wallingford, Connecticut. The technical team, including University of Connecticut and LN Consulting, a mechanical electrical and plumbing (MEP) firm, evaluated a community geothermal heat pump (GHP) system consisting of a central geothermal system (central geothermal well field, pumphouse, and associated piping) plus a thermal distribution system (piping within the residential buildings and water-source heat pumps [WSHPs] in each apartment). The evaluation assesses GHP both with and without deployment of on-site photovoltaics (PV) and heat pump water heaters (HPWH). It also compares GHP with two basic alternative systems: distributed air-source heat pumps (ASHPs) and distributed geothermal heat pump (dGHP). Tables 1 through 3 summarize the results of the evaluation of these clean and energy-efficient technologies.

The estimates of net capital costs incorporate anticipated incentives from the federal Investment Tax Credit (ITC), Wallingford Electric Division (WED), and Yankee Gas. GHP is sized to meet the Ulbrich Heights facility's heating and cooling consumption as simulated in EnergyPlus and TRNSYS. HPWH is sized via extrapolation from summer heating loads. ASHP and dGHP are sized on the basis of degree-day heating and cooling, using monthly utility data. PV is sized with consideration of rooftop space available and the site's overall electric monthly electric load. Additional technologies such as sewer water heat recovery are considered but determined not to be feasible.

Equipment and Operation

The 38-building Ulbrich Heights affordable-housing complex is managed by Wallingford Housing Authority (WHA). With a portfolio of residential garden-style and duplex housing options, the 132,178 ft^2 of conditioned living space houses 132 tenant households (apartments). Monthly electricity consumption, gas consumption, and facility occupancy are shown in Figures 1 through 3. As shown in Figures 1 and 2, while electricity consumption has trended upward, gas consumption has an opposite trend. While the increasing trend in electricity consumption may be attributable to the increasing occupancy depicted in Figure 3, there is a slight downward trend of gas consumption that may be partly attributable to replacement of 15 of the facility's gas hot water heaters with electric resistance. The increasing trend in electricity consumption may partly be attributed to increased electric-resistance water heater load as well. As shown in Table 1, the tenants' annual energy consumption is approximately 810 MWh of electricity and 6,617 MMBtu of natural gas, at a total cost of $230,186 and an average annual cost of $1,744 per tenant (utility rates are $0.1292/kWh for electricity and $18.93/MMBtu for gas). As shown in Table 3, accounting for both on-site emissions and grid emissions, the residential facility is responsible for 603 tons of annual CO_2 emissions.

Each apartment in the complex employs a hydronic space-heating system with heat convectors controlled by a single-zone thermostat. Most apartments use one or more window air-conditioning units in bedroom and living spaces. WHA maintenance personnel repair or replace old/broken gas-fired boilers and domestic water heaters. WHA has replaced 15 of the domestic hot water heaters with electric resistance water heaters; and 22 of the newest apartments had electric-resistance water heaters installed during construction. Tenants own the cooling equipment, and repair and replacement of this equipment is their responsibility.

While WHA has no formal commitment to carbon emissions reduction, the agency has systematically improved the efficiency of the Ulbrich Heights buildings via WED's weatherization program and third-party value-added contractor network.

Modeling Parameters

The following considerations have informed the analysis:

- **PV** is a clean energy technology of significant interest because each Ulbrich Heights building has enough roof space for a significant installation. Approximately 60,311 ft^2 of roof space is available. Roof arrays would be preferable to land and parking lot canopies that would entail additional construction costs. The structural integrity and load-bearing capacity of the roofs have not been evaluated for this analysis.

- **HPWH** is a technology of interest because WHA has installed electric-resistance during the most recent construction of 17 percent of the facility's apartments and under the site's maintenance plan gas-fired water heaters for other apartments gradually are being replaced with electric-resistance equipment. Electric-resistance water heating is highly inefficient. Upgrading to more efficient HPWH units would bring significant tenant electricity savings as well as further reduction in the facility's natural gas consumption and site carbon emissions.

- **PV + HPWH** combines the benefits of these technologies. It would be expected to provide deeper reductions in site carbon emissions but at a significantly higher cost of implementation.

- **ASHP** is modeled as another technology solution for economic and environmental performance comparisons. It would provide emissions improvements against the baseline but not against GHP – at lower capital cost but higher operating cost than GHP.

- Similarly, a **dGHP** system – with an individual geothermal system for each building – was modeled as an alternative space heating and cooling technology solution for economic and environmental performance comparison.

- Additionally, sewer water heat-recovery, solar thermal, and thermal energy storage technologies were considered to supplement the GHP system in an early analysis. Sewer pipe locations and sewer flowrate data were obtained, but the sewer flowrates were highly intermittent and therefore sewer water heat recovery was not further considered in the design process. Also, since the estimated building heating and cooling loads were fairly balanced, it was concluded that adopting solar thermal or thermal energy storage could not reduce the size of the borefield.

The GHP system scenarios are based on building loads obtained from EnergyPlus, a building-energy modeling tool. The model the team developed accounts for the actual geometry of the buildings, which was derived from architectural drawings developed for a recent facility renovation plan. Building envelope properties such as wall R-values, window types, and air infiltration rates are inputs in the model, using data from a small sample of Home Energy audits performed by WED contractors. The team tuned the model to match the actual average billed energy consumption. The model incorporates schedules for lighting, interior loads such as appliances and hot water usage, and occupancy.

The following inputs and assumptions are used in the energy and economic performance calculations:

- Utility rates of $0.1292/kWh and $18.9276/MMBtu, with corresponding assumed annual escalation rates of 1.7% and 1.5%.

- System efficiency degradation rates of
    - 0.1% for GHP, dGHP, and HPWH;
    - 0.5% degradation for PV, ASHP, and pump equipment.

- For the ASHP scenario, 75% equipment replacement costs at years 10 and 20.

- Federal ITC for GSHP and solar PV is 30% plus 10% domestic-content bonus; WED incentives are $300/ton for GHP, $300/ton for ASHP, and $750/unit for HPWH, with no incentives for PV; Yankee Gas incentives are $740,000 for GHP, $750/ton for ASHP, and $750/unit for HPWH. The project team was unable to determine whether the facility would qualify for ASHP and HPWH incentives under the federal energy-efficient commercial buildings deduction program.

Clean Energy Technology Analysis Results

A summary of the analytical results that are presented in Tables 1, 2, and 3:

- A networked, community **GHP** system was sized to meet 100% of the heating and cooling loads derived from the utility data. It has a net capital cost of $4.7 million ($4.3 million incremental, i.e., beyond baseline cost of replacing existing boilers), reduces natural gas consumption for heating 77% against the baseline, increases electricity consumption 23%, reduces annual carbon emissions 41%, and yields a simple payback of nearly 80 years. The lifecycle cost (LCC) for a 30-year period is $8.6 million.

- The GHP system with HPWHs (**GHP+HPWH**) sized to meet the average domestic hot water load of approximately 118 MMBtu per month has a net capital cost of $5.2 million ($4.8 million incremental), eliminates natural gas needed for both space heating and hot water, increases electrical consumption 39% against the baseline, reduces annual carbon emissions 50%, and has a payback of 74 years.

- The GHP system combined with a 900 kW PV system (**GHP+PV**) has a net capital cost of $6.3 million ($5.9 million incremental), serves 81% of the annual facility electric load, reduces annual carbon emissions 81% against the baseline, and has a simple payback of 36 years.

- The GHP system combined with PV and HPWHs (**GHP+PV+HPWH**) has a net capital cost of $6.8 million ($6.4 million incremental), eliminates natural gas consumption, serves 73% of the annual facility electric load, reduces annual carbon emissions 90%, and has a payback of 36 years.

- The **ASHP** scenario has a net capital cost of $4.3 million ($3.9 million incremental), increases electrical consumption 42% against the baseline, reduces natural gas consumption 77%, reduces annual carbon emissions 34%, and has a payback of 110 years.

- A **dGHP** system has a net capital cost of $4.6 million ($4.2 million incremental), increases electrical consumption 25% against the baseline, reduces natural gas consumption 77%, reduces annual carbon emissions 40%, and has a payback of about 80 years.

- An analysis of **ASHP+PV+HPWH** was not specifically performed. Like the GSHP+PV+HPWH scenario, it would eliminate on-site fossil-fuel emissions. Its lifecycle cost would be significantly higher, however, due to ASHP's far higher lifecycle costs.

- Overall, **ASHP** technology solution has the lowest net implementation cost but also the highest payback (111 years) and the highest lifecycle costs (2.5 times that of GHP). Therefore, **community GHP** is a more suitable option even though it has a slightly higher net capital cost. However, the **GHP+PV+HPWH** combination of technologies offers an economically and environmentally attractive solution: although initially more expensive than GHP alone, it provides full-site decarbonization, yields a payback time and lifecycle cost that are nearly the lowest, significantly reduces tenant utility cost burden, and offers significant environmental benefits by further reducing carbon emissions, particulate (PM2.5) emissions, and NOx emissions. The differences between the network GHP system performance and the **distributed GHP** system performance are not significant. Though an analysis of **ASHP+PV+HPWH** wasn't specifically performed, this scenario would result in freeing the Ulbrich Heights property from fossil fuels; but the anticipated life-cycle costs would be higher than the GHP+PV+HPWH scenario, since ASHPs have a higher estimated life-cycle cost. And a final note: the central GHP borefield and a closed loop system would require that only a few trees be removed from the site.

Table 1: Annual Tenant Energy Consumption and Utility Costs[1]

	Baseline	GHP	GHP + HPWH	GHP + PV	GHP + PV + HPWH	ASHP	dGHP
Annual Electricity Consumption (kWh/year)	810,378	997,168	1,126,389	87,385	216,606	1,149,811	1,015,270
Annual Gas Consumption (MMBtu/year)	6,617	1,517	0	1,517	0	1,517	1,517
Annual Electricity Cost ($/year)	104,701	128,834	145,529	11,290	28,217	148,556	131,173
Annual Gas Cost ($/year)	125,485	28,954	246	40,244	246	28,954	28,954
Total Annual Utility Costs ($/year)	230,186	157,788	145,775	40,244	28,463	177,509	160,126
Annual Utility Cost Per Tenant ($/year)	1,744	1,195	1,104	305	216	1,345	1,213
Tenant Utility Cost Reduction ($/year)	-	548	639	1,439	1,528	399	531
Percentage Reduction	-	31%	37%	83%	88%	23%	30%

[1] Includes only tenant electric and natural gas consumption

Table 2: Other Economic Results

	Baseline[2]	GHP	GHP + HPWH	GHP + PV	GHP + PV + HPWH	ASHP	dGHP
Gross Capital Cost ($)	392,000	8,687,504	9,347,504	11,401,499	12,061,499	4,683,600	8,399,562
Utility Incentives ($)	-	845,000	1,043,000	845,000	1,043,000	367,500	845,000
Federal ITC ($)	-	3,137,002	3,137,002	4,222,600	4,222,600	-	2,982,225
Net Capital Cost ($)	392,000	4,705,502	5,167,502	6,333,899	6,795,899	4,316,100	4,572,337
Net Incremental Capital Cost ($)		4,313,502	4,775,502	5,941,899	6,403,899	3,924,100	4,180,337
Annual O&M Costs ($)[3]	-	156,942	189,942	174,942	174,942	304,700	138,500
Simple Payback (years)[4]	-	79.6	73.5	35.7	36.2	110.8	80.4
LCC ($; 30- yr)	-	8,606,547	6,605,196	9,922,442	6,682,315	21,505,849	7,752,355

[2] Baseline reflects WHA estimate of cost of staff replacement of existing boilers. [3] O&M costs covers both owner' costs and tenant costs. [4] Simple Payback is calculated as ratio of net incremental capital cost from baseline to annual energy cost savings

Table 3: Emission Results[5]

	Baseline	GHP	GHP + HPWH	GHP + PV	GHP + PV + HPWH	ASHP	dGHP
Annual Carbon Emissions (tons)	603	356	302	112	58	397	361
Percent Reduction	-	41%	50%	81%	90%	34%	40%
Annual NOx Emissions (lb.)	1,159.0	820.7	770.5	198.4	148.2	925.1	833.1
Percent Reduction		29%	34%	83%	87%	20%	28%
Annual PM2.5 Emissions (lb.)	85.7	56.9	51.7	15.1	9.9	63.9	57.7
Percent Reduction		34%	40%	82%	88%	25%	33%

[5] Estimated using current grid emission factors and onsite emission factors (source: NREL Reopt); estimates do not account for projected future Connecticut grid greening

Conclusion

This techno-economic and environmental study showed that a community geothermal system with WSHPs in each apartment (but retaining gas-fired water heaters) in the Ulbrich Heights affordable-housing facility in Wallingford, CT, would markedly reduce tenants' energy costs as well as emissions of CO_2, particulates, and NOx. A fully electrified solution incorporating GHP, PV, and HPWH would have lower lifecycle costs, offer even better environmental benefits, and further reduce energy cost burden on tenants. Alternative deployment of ASHPs would be cheaper initially but far more expensive than other options in the long term and would produce more modest reductions in emissions (and correspondingly larger demands on the grid). In this particular facility, deployment of distributed GHP, rather than centralized community GHP, would have comparable environmental results and modestly better economic results due to reduced network piping and elimination of the pumphouse. With the Connecticut electricity grid getting greener as the state progressively moves toward satisfying its statutory requirement for a zero-carbon grid by 2040, the environmental benefit of all of these electrification solutions would become more attractive year by year.

A significant barrier for the GHP technology scenarios for this facility is the initial cost of implementation, which remains high even after state and local clean energy incentives and results in long payback periods. This barrier would be expected to be less significant in a community or facility with more diverse thermal loads and especially with available sources of waste heat, because this would reduce the required borefield capacity (and borehole drilling is one of the most expensive aspects of GHP installation). It should be noted that this study addresses an issue that has gotten relatively little attention in the technical literature: comparing the costs of networked geothermal heat pump systems and those of distributed geothermal heat pump systems.

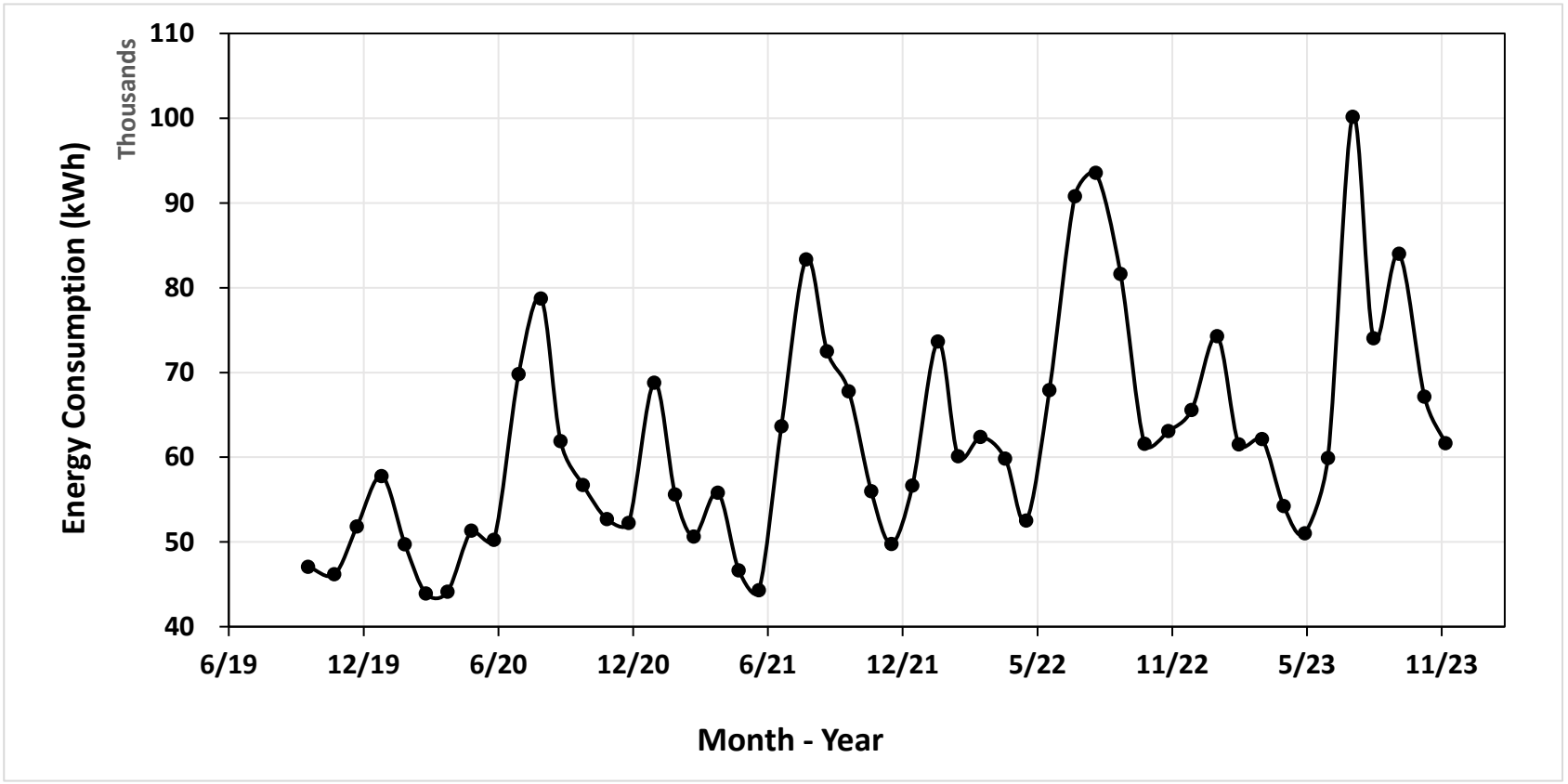

Figure 1. Ulbrich Heights monthly electricity consumption

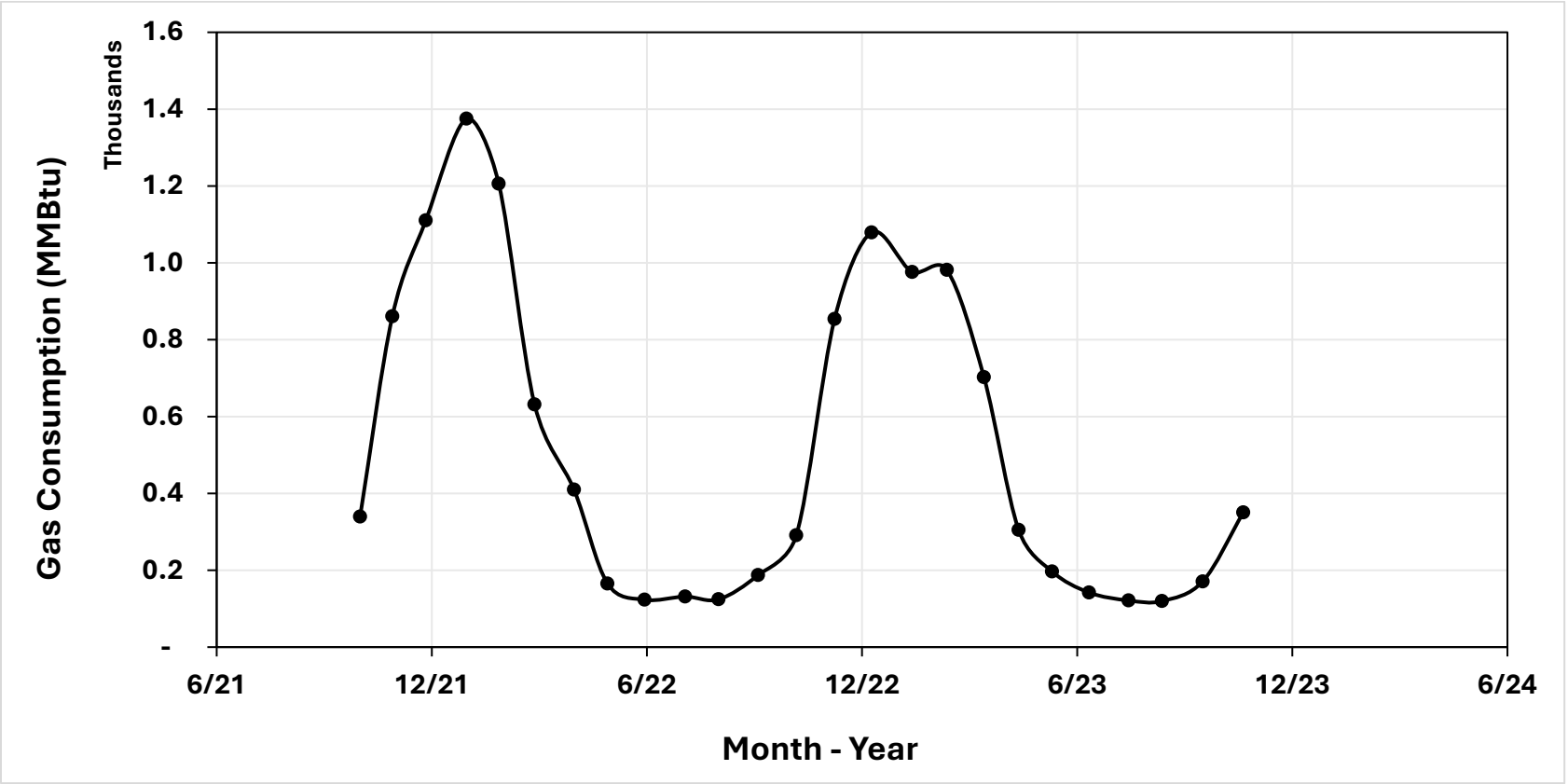

Figure 2. Ulbrich Heights monthly natural gas consumption

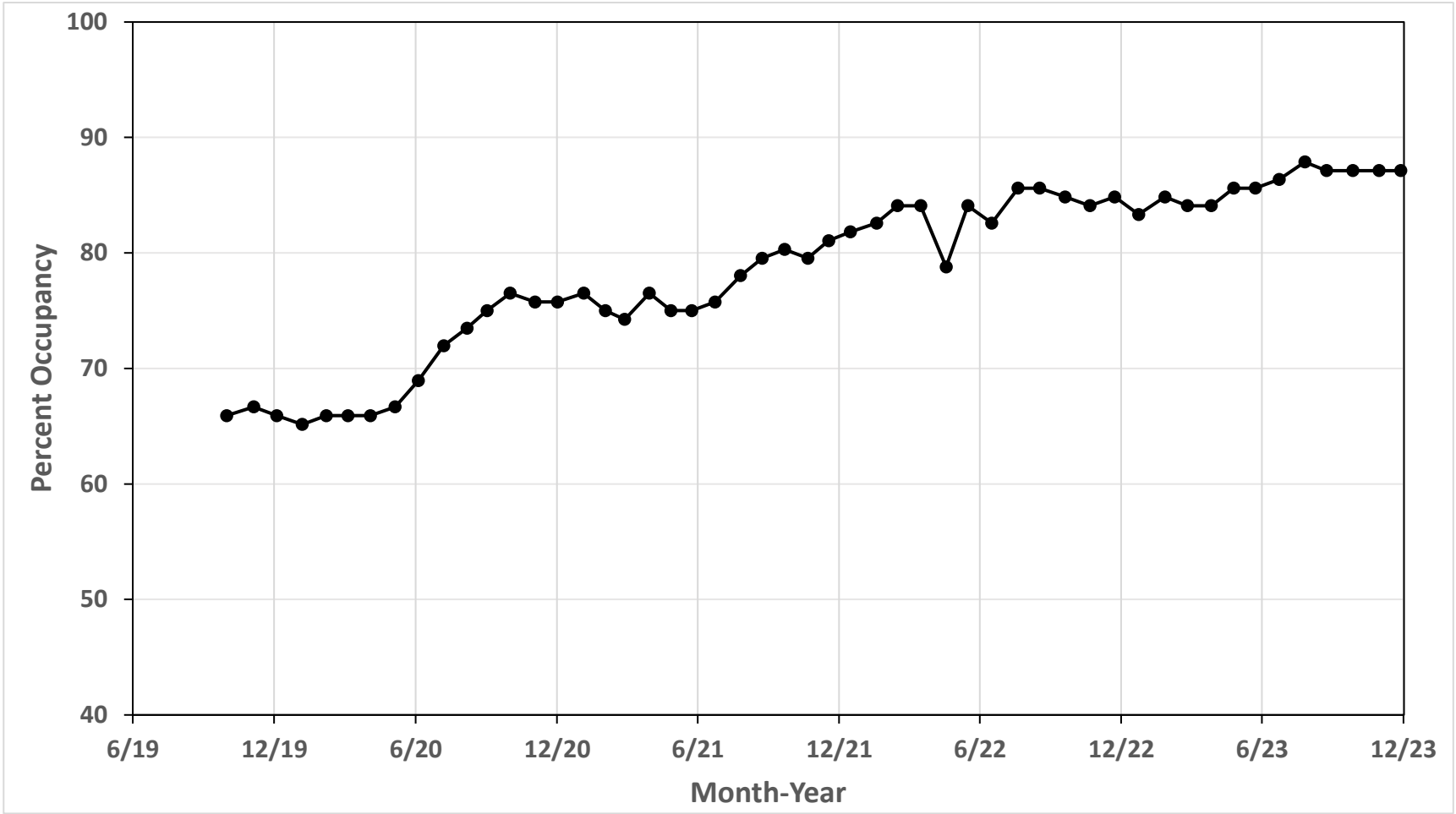

Figure 3. Ulbrich Heights monthly tenant occupancy

Appendix D – Maintenance plan

Maintenance of central geothermal facility:

- Annual water testing
- Annual addition of biocides and corrosion inhibitors as needed
- Annual inspection of operation of all pumps
- Regular inspection of central controls
- *Note:* These tasks would be handled through a subscription service

Maintenance of WSHP distribution system:

- Regular inspection of piping within residential buildings
- Semiannual replacement of WSHP filters
- Semiannual inspection of WSHP fans and condensate drains
- *Note:* These tasks could be handled either through a subscription service or by plant personnel

Appendix E – Workforce needs assessment and development plans

This appendix has three components:

- Statewide geothermal workforce needs assessment
- NEEP recommendations for a statewide geothermal workforce development plan
- Local geothermal workforce development plan

Statewide geothermal workforce needs assessment

Connecticut Geothermal Industry Workforce Needs Assessment

MAY 2024

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Authors

The report's lead authors were Yiran He, Senior Associate of Policy and Programs at Northeast Energy Efficiency Partnerships (NEEP), and Chase Macpherson and Kelly O'Connell, Senior Associates of Community Solutions at NEEP.

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About NEEP

NEEP was founded in 1996 as a non-profit whose mission is to serve the Northeast and Mid-Atlantic to accelerate regional collaboration to promote advanced energy efficiency and related solutions in homes, buildings, industry, and communities. Our vision is that the region's homes, buildings, and communities are transformed into efficient, affordable, low-carbon resilient places to live, work, and play.

Disclaimer: NEEP verified the data used for this white paper to the best of our ability. This paper reflects the opinion and judgments of the NEEP staff and does not necessarily reflect those of NEEP Board members, NEEP Sponsors, or project participants and funders.

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Executive Summary

During research on the state of the geothermal workforce in Connecticut, NEEP explored barriers to geothermal growth, specifically focusing on workforce needs, challenges, and opportunities. Three major barriers to the growth of geothermal technology were identified through this research: inadequate awareness of and/or interest in geothermal careers, tension between an uneven supply of workers and an increasing demand for projects, and the remaining high upfront costs that further constrains geothermal uptake. This report discusses barriers to the growth of the workforce required to meet the anticipated rising demand.

The project team surveyed and interviewed a wide range of experts and professionals in the geothermal industry. Survey respondents included geothermal system installers, drillers, manufacturers, the relevant facilities managers, and heating, ventilation, and air conditioning (HVAC) training center staff. Interviewees represented various industry stakeholders including unions, consultants, and well drillers. These interviews surfaced three main topics: licensing requirements, drilling as a bottleneck, and recruiting and training new entrants to the industry.

This needs assessment outlines:

- Disparities in opinions in the industry about state HVAC licensing requirements.
- Difficulties in getting both new workers and equipment for geothermal drilling.
- Current opportunities and barriers for new entrants interested in geothermal careers.

Through surveys and 19 interviews, the team found that overall geothermal growth in Connecticut is limited by high upfront costs, mostly due to drilling. Drilling costs can constitute over 50 percent of total project costs. Growth of the geothermal workforce was found to be limited by the following factors:

- Prospective entrants to the industry lacking adequate awareness of and interest in pursuing careers in the geothermal industry.
- Inadequate availability of drillers and drilling equipment is one of the major bottlenecks faced by geothermal projects.
- The growth of heat pump-focused companies, or the entrance of heat pump installers from other states, is constrained by certain licensing requirements. The industry may also benefit from improved clarity from the Department of Consumer Protection about certain licensing pathways or rules. Further avenues for research include the demographics and diversity of training centers' students and recipients of geothermal certifications, the preparedness of facilities managers to maintain geothermal systems, and the options available to increase the number of trainers and educators.

Through the survey and interviews, the team gathered recommendations and suggestions to improve the geothermal industry. These included early outreach and targeted marketing of trade career opportunities, coordinated drill rig manufacturing and driller training, more equipment for technical high school HVAC programs to teach with, adjustments to licensing requirements to facilitate growth for heat pump focused companies, and expanded access to classroom trainings that satisfy licensing requirements. Other suggestions included standardizing bore field specifications, offering incentives to contractors to pursue geothermal, connecting

homeowners to geothermal contractors and drillers, creating a list of contact information for geothermal well drillers to connect with contractors, and making residents and businesses more aware of the geothermal incentives. This Needs Assessment and further outreach with industry stakeholders will inform a full Geothermal Workforce Development Plan for Connecticut.

Introduction

In 2008, Connecticut set statewide goals to reduce statewide GHG emissions: 10 percent below 1990 levels by 2020, 45 percent reduction from 2001 levels by 2030, and 80 percent below 2001 levels by 2050. To meet Connecticut's climate goals, the state urgently needs to decarbonize its thermal sector. Emissions in the residential sector (from on-site fossil fuel combustion) need to fall 36 percent from 2022 to meet the 2030 target and 77 percent from 2022 to meet the 2050 target.[1] To put the residential sector's emissions in line with the statewide 2030 target, they must decrease 6.9 times faster from 2022 through 2029 than the rate of emissions reductions between 2001 and 2022; and reductions must be 4.2 times faster from 2030 onward to put the sector in line with the 2050 statewide target. In the commercial sector, the situation is even more dire; commercial sector emissions from on-site fossil fuel combustion increased slightly from 2001 to 2022, meaning that all emissions reductions necessary to put the sector in line with the 2030 and 2050 targets must occur from 2023 onward.[2]

Geothermal heat pumps (also referred to as ground-source heat pumps, or GSHPs) are among the most efficient technologies available on the market for space and water heating. The ground temperature of approximately 55 degrees Fahrenheit in Connecticut can be utilized to maintain loop temperatures at a high efficiency throughout the year. Figure 1 shows three different configurations of ground loops. Reliable and stable heating and cooling at a high efficiency helps to minimize electric peak demand, which has long-term benefits for grid management. As Connecticut's electric grid becomes emissions-free – a Connecticut mandate by 2040 – GSHPs are also guaranteed to align with the state's GHG reduction goals.

However, deployment of this technology is nascent due to cost and market barriers, including a lack of sufficient and highly trained workforce for project installations. Initial conversations about the difficulties of installing geothermal heat pumps in Connecticut highlighted that shovel-ready geothermal projects might wait months for drillers to be available, causing significant delays in project implementation. This workforce challenge is a significant barrier to increased adoption and scalability. Furthermore, although geothermal is one of the most energy-efficient space heating options available, upfront costs associated with installation and equipment are among the highest. Workforce shortages, as well as high upfront costs, are factors that may slow the rate of wide-scale adoption.

Installing a networked geothermal project involves multiple processes: the heat pump or system must be manufactured, the holes drilled, the plumbing and piping fitted, and equipment must be transported to the site

[1] Synapse analysis for CT DEEP using Connecticut Greenhouse Gas Reduction Progress Reports

[2] CT DEEP, "Connecticut Greenhouse Gas Inventory: 1990-2021, with preliminary look at 2022," https://portal.ct.gov/-/media/deep/climatechange/1990-2021-ghg-inventory/deep_ghg_report_90-21_pre-22.pdf.

and installed. A trained, licensed workforce must exist at each of these steps. Research questions included:

- "What are the biggest bottlenecks in the industry?"
- "How do we pinpoint where the bottlenecks are in this process?"
- "Why do these bottlenecks exist?"
- "What kinds of recommendations can we make to address them?"

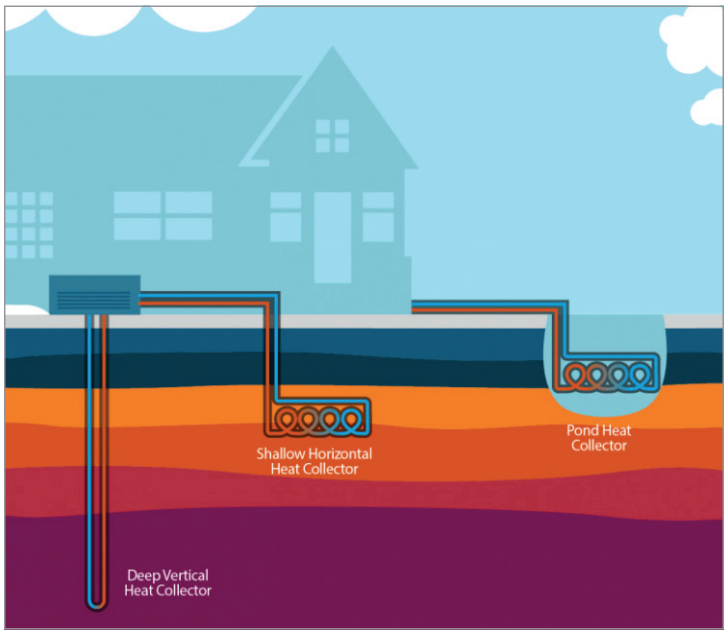


Figure 1. ***Adapted from the U.S. Department of Energy showing configurations of ground loops***

This assessment seeks to understand the current state of the geothermal workforce across the residential and commercial sectors in Connecticut, and whether the status of training infrastructure and the current rate of growth will be sufficient to meet the growing demand for decarbonization. It considers the full supply chain, including drilling equipment, and describes the nature of the current workforce and training programs most applicable to community geothermal heating and cooling.

This study combines the results of surveys and interviews conducted between October 2023 and April 2024. Surveys were crafted by NEEP, with guidance from CT DEEP, to inform interviews conducted by members of the NEEP team.

This workforce needs assessment is part of a larger project in which the Connecticut Department of Energy and Environmental Protection (CT DEEP), The University of Connecticut, Northeast Energy Efficiency Partnerships (NEEP), the Wallingford Housing Authority (WHA), and the Wallingford Electric Division public utility are using funding from the U.S. Department of Energy to explore the feasibility of a networked geothermal heating and cooling system for Ulbrich Heights, a public housing complex in Wallingford, CT. During Phase 1 the team is designing the system, facilitating a project advisory committee, creating a community engagement plan, and conducting this workforce needs assessment. This assessment will inform the workforce development plan to be delivered to CT DEEP by September 25, 2024.

Methods

To begin, the project team assembled a list of stakeholder categories across the geothermal industry, ranging from procurement entities to educational institutions, nonprofits, industry associations, the public sector, specific companies, and workforce groups. Next, initial interviews were conducted with stakeholders across these categories to understand their main concerns in expanding the geothermal industry. Survey questions

and formalized interviews were designed after these initial conversations. The surveys were intended to provide primarily quantitative data, while the interviews focused on qualitative data.

Initial interviews

Initial interviewees were chosen through representative and purposive sampling to provide a diverse range of perspectives. They included experts from utilities, companies installing geothermal projects, and manufacturing companies. The research team asked about topics including the range of sizes of companies operating in the field, if there were bottlenecks in growing the size of the workforce, the number of projects the existing workforce could handle, change in demand for geothermal projects, professional development pathways in the field, and more. The team also began the process of purposive sampling through these calls, asking interviewees for help with outreach to other contacts the team identified as knowledgeable about the landscape of the geothermal industry in the state, as well as suggestions for any other contacts that initial interviewees thought would be valuable.

Survey

To explore equity considerations, the team examined the existing demographic patterns and professional development pathways in the geothermal industry. The team determined that questions of demographics in the workforce and training programs, major categories of hiring barriers, and major categories of barriers in professional development could be asked of a wider audience if they were sent out as a survey, rather than trying to schedule time with each potential respondent organization.

Target respondents for the surveys were grouped into four categories: Wallingford Housing Authority facilities managers, training centers, trade schools, and a larger industry category that included drillers, engineering companies, and geothermal installers.

The project team surveyed the existing facilities managers at the Wallingford Housing Authority about resources (time and money) spent on current heating system maintenance and the level of staff experience with heat pumps.

The team referenced a list of training centers with HVAC (Heating, Ventilation, and Air Conditioning) programs, of which there are nine in the state, as well as a list of technical high schools with HVAC programs from the Connecticut Technical Education and Career System's (CTECS) website. The surveys for these two groups, trade schools and training centers, asked about the diversity of the student body and the geothermal trainings or courses offered.

Drillers, engineering companies, and installers of geothermal systems in Connecticut were found through the Energize CT database and outreach within the project team's network. The survey for this group asked about each company's capacity to undertake geothermal projects; employee demographics; salaries; training and licensing requirements and pathways; as well as trends in turnover, recruitment, and hiring.

Surveys were created through Survey Monkey and disseminated via email.

Secondary Research

To understand the current geothermal heating and cooling workforce available in the state, the team utilized several online resources for secondary research. These included Energize Connecticut's participating contractor list, the Connecticut Department of Consumer Protection's list of drilling license holders, the International Ground Source Heat Pump Association member directory, and the Energize Connecticut Energy Dashboard.

Interviews

Interviews were designed to gather additional qualitative information. These interviews probed in greater detail institutional barriers to licensing, previous actions taken to galvanize the workforce, clarifications on professional development pathways, and changes expected to occur in the industry over the next decade. The following categories of stakeholders were targeted for interviews:

- Utilities
- Drilling Companies
- Unions
- Installers
- Manufacturers
- CT Technical Education and Career System

The project team considers the interviewees to be topic area experts. Interviews were mostly conducted over video calls. In total, 19 interviews were conducted, each lasting approximately 30 minutes.

After an interview with staff from the Connecticut Technical Education and Career System (CTECS), upon suggestion of the interviewee, the team requested and received data from CTECS' Education Consultant of Data Management & Research.

Limitations

The team achieved the greatest success in collecting interview data. Interviewees across industry subsectors were eager to share their perspectives on the past and hopes for the future of the geothermal industry and provided welcome assistance in helping the team reach other stakeholders.

Survey results are more limited. Completion of a survey was expected to require 15 to 20 minutes, which may represent a significant amount of unpaid time, especially for a smaller company. It is possible that this constrained the number of survey responses received or biased the responses if companies with administrative staff (who have time to answer desktop surveys during their workdays) were more likely to respond than companies without administrative staff.

The research period also fell within an academic year, which may account for the difficulty the team experienced in getting information from trade schools.

Stakeholder Survey Results

The survey results reported here are anonymized and representative of the body of data we gathered. Not all data are presented; instead, high-level themes across survey and interview responses are reported.

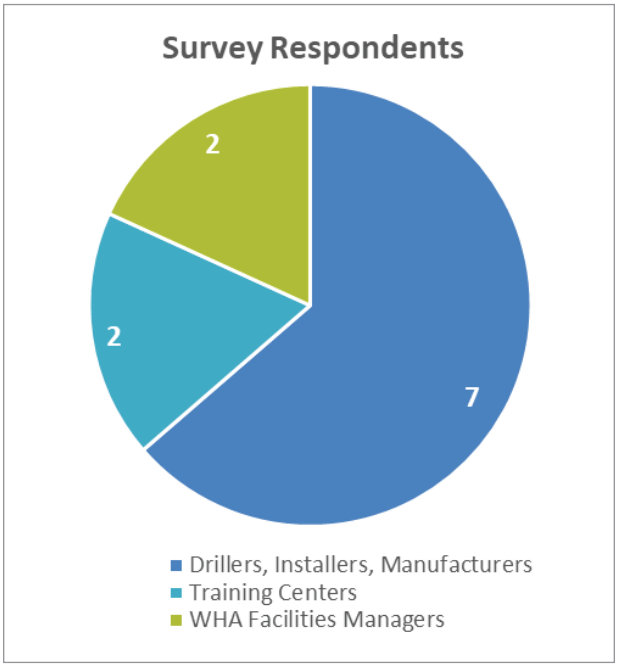


Figure 2. ***Survey Respondent Stakeholder Groups***

The project team received 11 survey responses across the four stakeholder groups surveyed, with the most responses from drillers, installers, and manufacturers (see Figure 2).[3]

Wallingford Housing Authority Facilities Managers

There are two facilities staff members at the Wallingford Housing Authority (WHA), a facilities manager and a maintenance technician, and both responded to the survey.

This survey was tailored to understanding the Housing Authority's time and money spent on maintaining the heating system of Ulbrich Heights. Both respondents reported spending up to 50 percent of their time maintaining the heating system of Ulbrich Heights both during and outside of the heating season. The facilities manager reported spending more time than the technician on system maintenance. This translated to an average of fifteen hours per week for the facilities manager versus four hours per week for the maintenance technician.

The project team was also interested in gauging familiarity with heat pumps, which may transfer to geothermal maintenance work. While neither respondent has worked with a geothermal heat pump system, both indicated some familiarity with the concept. The survey responses did not indicate what current limitations might exist for geothermal adoption at Wallingford Housing Authority, so the project team will need to seek out additional information.

Local Trade Schools

The team sent the survey to eleven trade schools but received no responses. Additional phone outreach was conducted but resulted in only one brief conversation. Eventually, through an introduction from Connecticut's

[3] No survey responses were received from local trade schools.

Office of Workforce Strategy, the team was able to schedule an interview with the state-wide consultant for licensed trades in the technical high school system. Key takeaways from that discussion are reported in a later section covering interview results.

Training Centers

Two of the nine training centers in Connecticut (independent of the CT Technical Education and Career System) invited to respond completed the survey. Some inconsistencies exist between the two responses, because one respondent filled out the wrong version of the survey.[4]

The first training center respondent reported that geothermal content is not mandatory within their HVAC program and is provided only at the instructor 's discretion. Of the 65-85 students reported to be in the HVAC program, the respondent estimated that 40 students went through geothermal-relevant training trained on geothermal within the past year based on their conversations with students. However, the same respondent reported that the overall number of students being trained is declining, and it is unclear whether the geothermal course content will be expanded due to a lack of instructor experience in geothermal systems.

The survey inquired about student demographics. The center reported that of the students offered some geothermal training, two percent are women and 40 percent are minorities. The respondent was unsure if the school focuses any recruitment spending on women and/or minorities.

The respondent stated that HVAC technicians represent the bulk of tradespeople moving into geothermal due to their familiarity with water source heat pumps for commercial applications. Additionally, many tradespeople looking to make the switch can access online retraining through companies such as Budderfly, Inc. and Dandelion Energy. However, the respondent was hesitant to predict which related trades, if any, may be likely to transition to the geothermal industry.

When students complete the HVAC program, the training center helps them find apprenticeships in geothermal careers. It was unclear from the survey response what employer outreach strategies are employed. The most common pathways reported for professionals entering the geothermal workforce after graduation were green energy certificates and the Connecticut Registered Apprenticeship Program. These certificates are available after a student graduates and require a level of knowledge outside the current purview of the training center. In describing the main challenge of the training center, one respondent stated, "A lot of it has to do with the students' engagement and understanding of basic systems. Geothermal systems use concepts that typically only competent licensed technicians hold. Our student population struggles with mathematics, computer literacy, and basic understanding of how to use tools properly." This response seems to imply that geothermal systems require advanced skills that are taught outside the center's curriculum and are acquired by certification.

[4] During the survey outreach period, Connecticut DEEP advertised the surveys on their LinkedIn account. It is likely that the respondent was unclear on the difference between trade school and training center versions of the survey.

The respondent provided a further written response about the center's challenge with students' grasp of foundational skills such as computer literacy and experience with tools. Given that HVAC instructors spent substantial time building these foundational skills, the respondent suggested specialized geothermal training was out of reach. Instead, the respondent proposed, "I do, however, have some students that excel in class and would love to offer this specialized training to them but think some sort of incentive should be offered. Perhaps an additional certification or possibly ensured job placement?" In addition, the respondent proposed starting outreach and education of the trades during elementary and secondary school. This would include assistance from the state with training plans and incentives for students to choose a pathway toward geothermal careers.

The second respondent indicated that their HVAC training center offers no classes on geothermal energy for its approximately 70 students and growing. The respondent did not see any plans for expansion of a geothermal program or indication of other tradespeople moving to geothermal, citing inadequate market demand for geothermal systems. Yet as the training center grows, the respondent reported, there is increased inquiries about air source heat pump training.

Drillers, Installers, Manufacturers, and Engineering Companies

The team sent a survey to 97 Connecticut firms expected to be involved in geothermal. The firms were identified primarily from the Energize CT database, the International Ground Source Heat Pump Association (IGSHPA) directory, and communication with other project team contacts. From this outreach, the team received seven responses (7 percent) from a variety of firms working in geothermal well-drilling, geothermal design and engineering, geothermal manufacturing, geothermal installation, HVAC, and service/maintenance work (see Figure 3). When polled about the proportion of the firm's work that is geothermal-related, the range spanned from zero percent to 100 percent, with four of the seven respondents spending more than 50% of their time on geothermal.

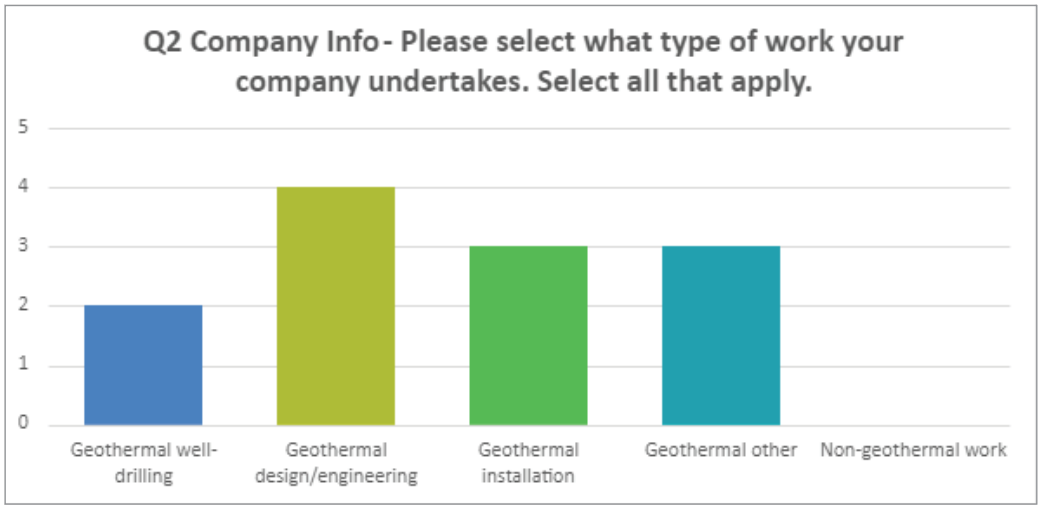


Figure 3. ***Company Work Type Graph***

The survey asked where the companies conduct their operations. Six of the seven respondent firms reported working in Connecticut and 22 additional states (see Figure 4). Two companies reported working internationally in Canada, the UK, Australia, and South Korea. The headquarters of the firms surveyed included Guilford and Bethlehem, CT; Michigan; Burlington, VT; Winnipeg, Canada; Baton Rouge, LA; and Mount Vernon, NY. The seventh firm noted that it would expand into Connecticut when work is available. The respondent was hopeful about the northeast becoming more favorable to heat pumps and indicated willingness to register in the state.

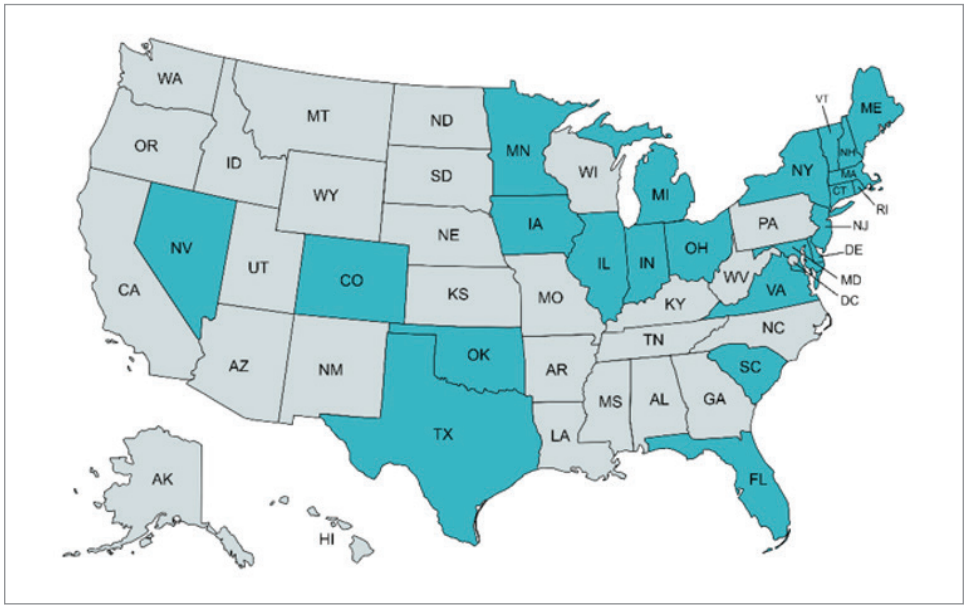


Figure 4. ***Map of Surveyed Firms Geographic Reach (blue states indicate where firms conduct work)***

The second section of the survey invited respondents to include information about the company capacity and employee demographics. Of the seven companies, the average number of employees per firm was 7.4. The smallest company had three employees, and the largest company had 15. An average of 67 percent of the firms' employees work on geothermal projects. Of these, 77 percent are employed full-time. The respondents reported an average of 14 percent of geothermal employees are women and an average of 7 percent are minorities. Only one company reported having employees represented by unions or labor agreements, with 33 percent of their employees falling into this category.

Respondents provided information regarding their company compensation and benefits. The surveyed firms reported various geothermal job titles, the most common being driller, design engineer, and project manager (see Figure 5). For salaried geothermal roles, the respondents reported three ranges: $65,000 - $200,000, $100,000 - $150,000, and $64,000 - $130,000. Respondents were also asked about employees compensated hourly; only one firm reporting this compensation structure, with a range of $30 to $40 per hour. In addition, most respondents indicated that geothermal employees are offered numerous benefits such as medical, dental, paid time off, life insurance, standard 401k, and a bonus structure. One respondent reported that their company did not provide any benefits.

Figure 5. ***Word Cloud of Geothermal Job Titles (size of word is related to response frequency)***

The next survey section inquired about required and preferred training/certifications. Most common responses included licensed well driller, safety, installation certifications, and design certifications. Specific certifications mentioned included the National Ground Water Association (NGWA) certification, the International Ground Source Heat Pump Association (IGSHPA) accreditation, DesignBuilder training, Certified GeoExchange Designer, U.S. Environmental Protection Agency refrigerant certification, and Occupational Safety and Health Administration 30 (OSHA 30) certification. Respondents were then asked where their company's employees receive training. Using in-house curriculum or on-the-job training for submission to licensing applications were common responses. Also reported were external sources such as training from the National Council of Examiners for Engineering and Surveying (NCEES) State Professional Services, IGSHPA, and HVAC manufacturers and suppliers. One respondent reported that their company has applied to the recently developed Connecticut Registered Apprenticeship program as an avenue for training. Apprenticeships were not reported widely among the firms responding to the survey, with only two of the seven respondents hosting apprentices (see Figure 6).

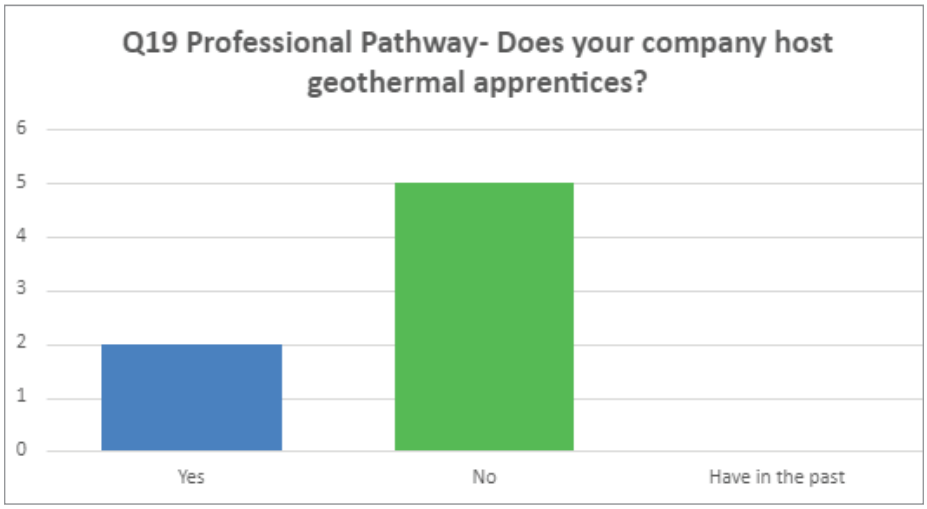


Figure 6. ***Geothermal Apprentices Graph***

Three out of seven respondents indicated that licensing of geothermal workers in Connecticut is “moderately difficult” and two indicated “moderately easy,” suggesting there is not currently extreme difficulty (see Figure 7). Recommendations collected from open responses for improving the licensing process and training in Connecticut included: organizing and tapping into the state’s well driller apprenticeship program; and developing geothermal Centers of Excellence, an emerging concept for regional stakeholder support to bolster the geothermal workforce. Additionally, respondents cited standardized licensing across the country and local geological training as approaches that would benefit their company’s training process. Another respondent stated: “There are no barriers at this point. The only barriers we see are actual well drillers and growth of geothermal installers. This includes overcoming the additional cost for geothermal.”

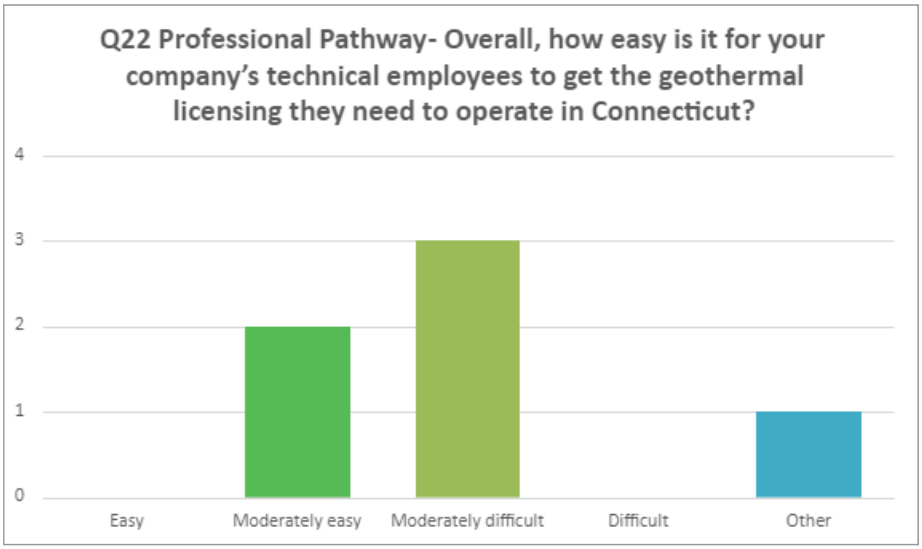


Figure 7. ***Geothermal Licensing Graph***

The respondents next reported on company growth. They indicated moderate growth or little growth in the last year. Three firms reported hiring one geothermal employee in the last year, with one firm hiring three new employees: one energy modeler and two “level one” design engineers, both working on geothermal. None of these employees were hired to replace departing personnel; and only one new staff member was reported to be represented by a union. When asked about growth in the last five years, no growth was reported but one firm reported hiring an additional two principal engineers and one person for drafting. Respondents uniformly reported that geothermal roles do not turn over more quickly than other related roles. Supporting this, the firms reported their employees remain on staff an average of 8.8 years (with a range of 5 to 18 years). The survey then asked about predicted future company growth. Four respondents expected to create 1 or 2 new geothermal positions in the next year, with one expecting to create 7. Some firms looked to train and promote from within, while others expected to expand to new cities.

Understanding how to foster geothermal growth was a key objective of the survey. When asked for input on why individuals want to work in geothermal, the team received responses such as climate justice, reducing environmental impact, opportunities for learning, job permanence, and participation in a green industry. On the other hand, respondents reported major difficulty "finding people willing to be trained," closely followed by "finding workers with adequate training" (see Figure 8). Retention of employees was challenging due to the respondents reporting difficulty of "ensuring enough work can support employee salaries" and, given the hard and dirty work, "finding people who want to work, and want to work in well drilling."

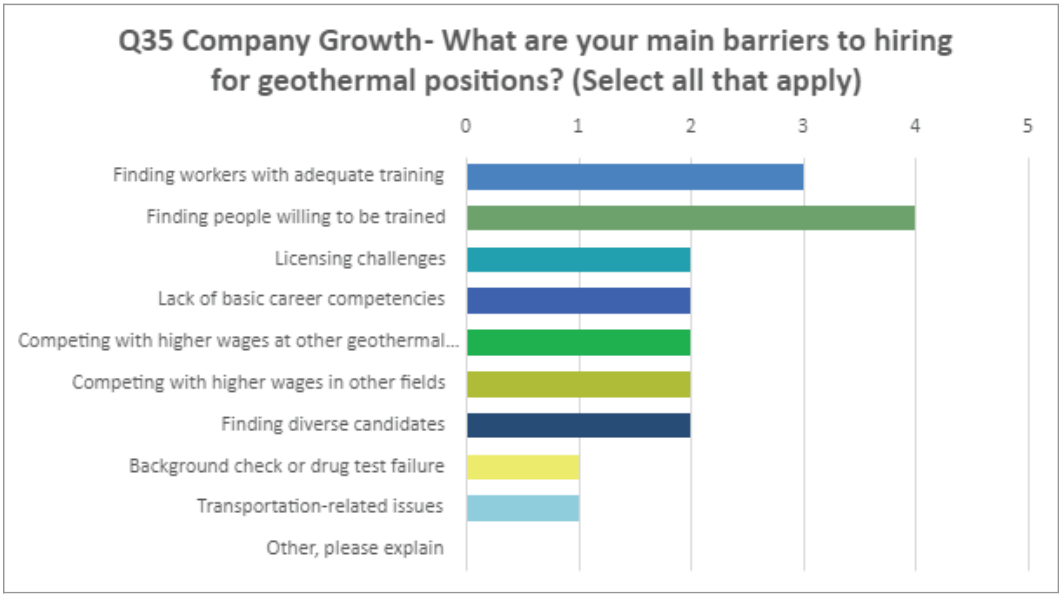


Figure 8. ***Company Hiring Barriers Graph***

Respondents reported inadequate availability of qualified workers and the considerable cost for a customer to install geothermal as two key barriers to growing their geothermal businesses (see Figure 9).

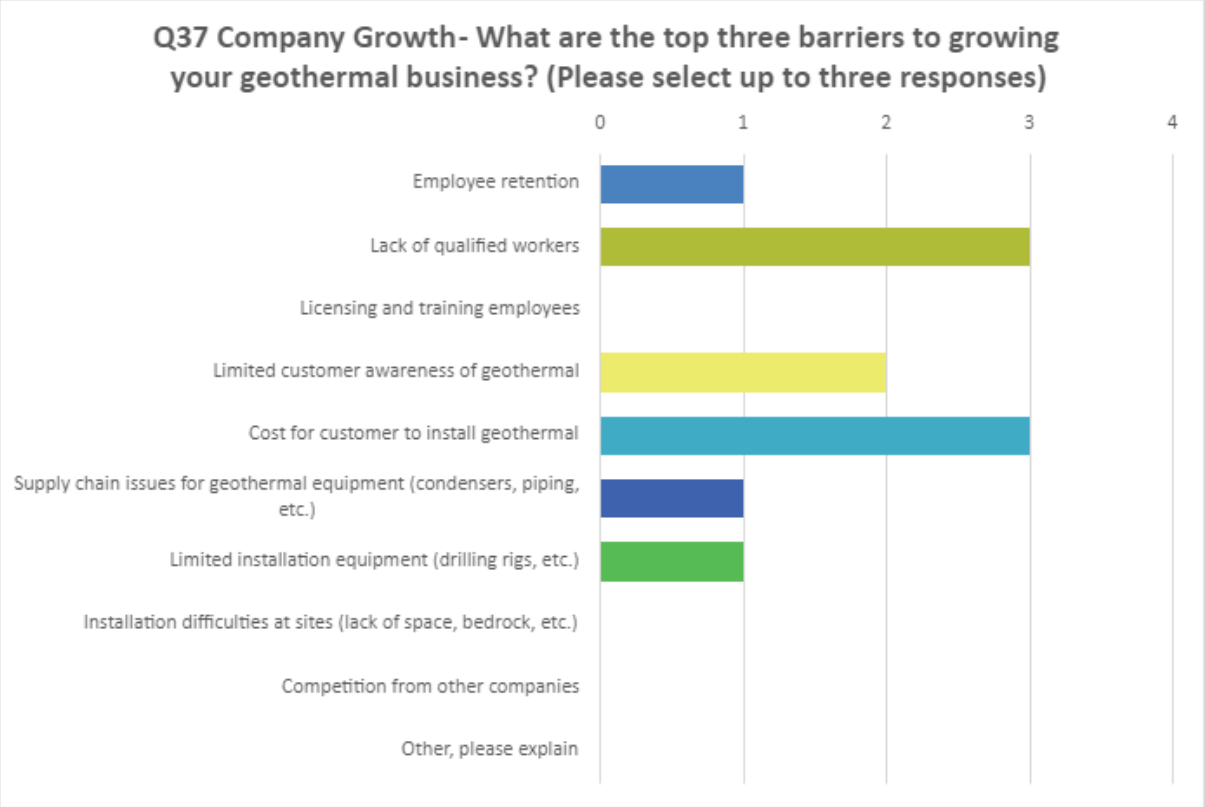


Figure 9. ***Company Growth Barriers Graph***

At their current capacity, two companies reported completing 100 geothermal projects per year, with two others reporting 10 and 20-30 projects per year. This translates into the current capacity of most firms being able to undertake three to five projects at once. When asked about the nature of their capacity constraints, three firms responded that personnel considerations were the limiting factor and one firm responded that both equipment and personnel were the limiting factors (see Figure 10). One respondent indicated that the availability of "quality projects" limited the firm's capacity.

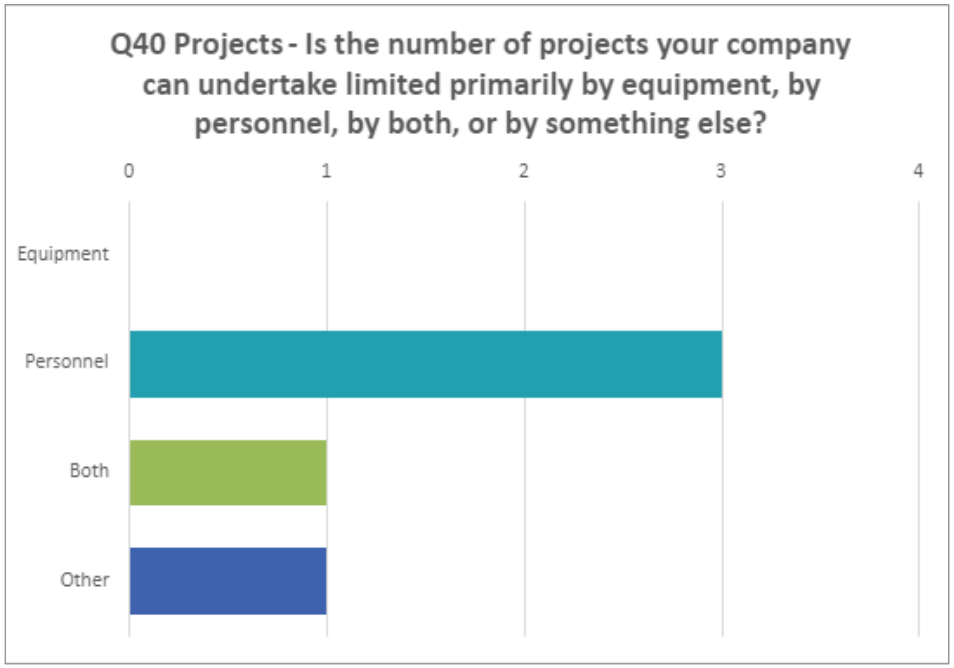


Figure 10. ***Project Limitations Graph***

The final section of the survey allowed the respondents to submit open-ended responses regarding how the state of Connecticut can assist geothermal firms. Suggestions included:

- Standardizing bore field specifications;
- Encouraging individuals to pursue drilling and mechanical career paths;
- Offering incentives for contractors to pursue geothermal;
- Connecting homeowners to geothermal contractors and drillers;
- Creating a list of contact information for geothermal well drillers to connect with contractors;
- Guiding residential and commercial clients to take full advantage of incentives to make geothermal affordable; and
- Providing bridge loans to builders for geothermal.

Secondary Research

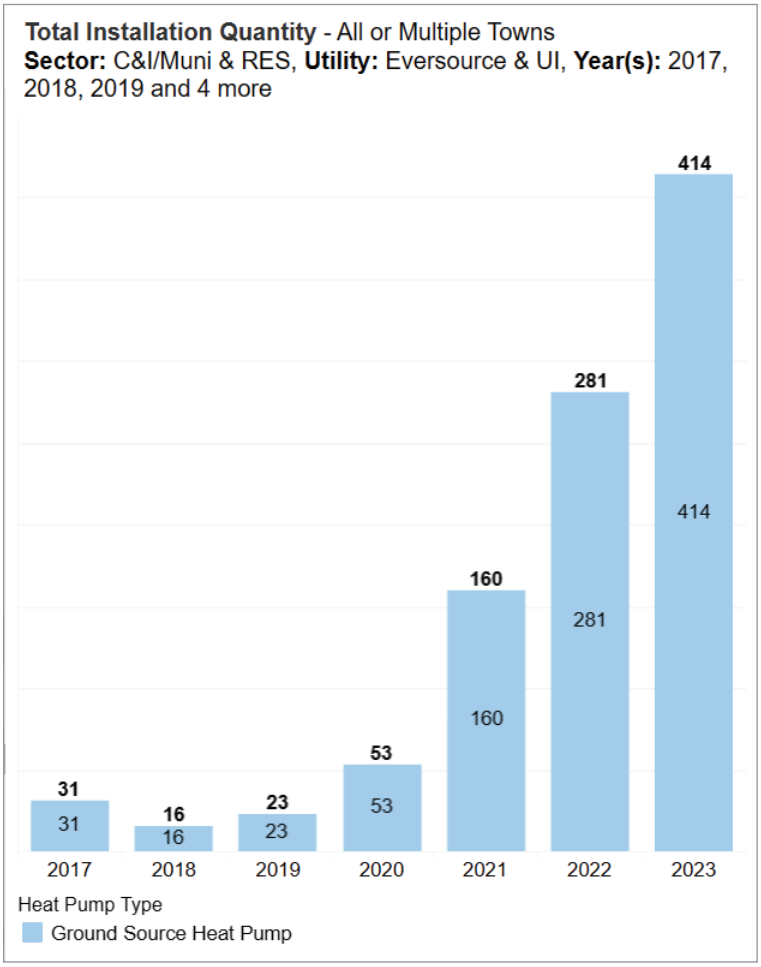


Figure 11. ***Ground Source Heat Pump Installations in Connecticut since 2017***

The annual rate of ground source heat pump installations in Connecticut has risen 25-fold since 2018 (see Figure 11)[5]. Ground source heat pump installations as a percentage of overall heat pump installations in residential and commercial/institutional properties increased from less than 0.4 percent in 2017 to 2.3 percent in 2023. Applications include applications for residential, commercial, and municipal building examples.

Energize CT's list of participating contractors identifies 75 ground source heat pump installation businesses operating in the state. All but five of these companies also install air source heat pumps. The only businesses that offer only ground source heat pump installation are Dandelion Energy and King Energy. A handful of companies install water source heat pumps in addition to ground source heat pumps.

The Connecticut Department of Consumer Protection (DCP) offers geothermal well drilling licenses (W-8 Limited Geothermal Driller and W-10 Limited Direct Exchange Geothermal Driller) and geothermal contractor licenses (W-7 Limited Geothermal Contractor and W-9 Limited Direct Exchange Geothermal Contractor) for drilling, installation of piping, casing, and heat transfer media, etc. However, these licenses are relatively new, and the DCP website does not yet allow uses to download lists of license holders for them. According to DCP records, 97 people in CT hold W-1 Unlimited Driller Well Contractor or W-2 Unlimited Well Driller licenses. Of those 97 license holders, 76 have an address in Connecticut. There are 54 people with W-3 Limited Non-Water-Supply Contractor or W-4 Limited Non-Water-Supply Driller licenses in the state, and 27 of them have an address in Connecticut. See Table 1 for the available drilling licenses.

[5] From Connecticut Energy Dashboard

Table 1. *Drilling licenses offered by the Connecticut Department of Consumer Protection*

LICENSE TYPE	This registration permits the registrant to…	NUMBER OF LICENSE HOLDERS	NUMBER OF LICENSE HOLDERS BASED IN CT
W-1 Unlimited Well Driller Contractor	Engage in well construction	**72**	**56**
W-2 Unlimited Well Driller	Construct a well, including but not limited to, the installation, repair and maintenance of pumps, pump motors, pump piping, valves, wiring, electric controls and tanks. Registrants must be in direct and regular employment of a contractor registered for this work.	**25**	**20**
W-3 Limited Non-Water-Supply Contractor	Construct a non-water-supply well, including but not limited to, the installation, repair and maintenance of pumps, pump motors, pump piping, valves, wiring, electric controls, and tanks.	**39**	**20**
W-4 Limited Non-Water-Supply Driller	Construct a non-water-supply well, including, but not limited to, the installation, repair and maintenance of pumps, pump motors, pump piping, valves, wiring, electric controls and tanks. Registrants must be in the direct and regular employment of a contractor registered for this work.	**15**	**7**
W-5 Limited Well Casing Extension Contractor	Perform well casing extension, repair, and maintenance work. The registrant's ability to repair is limited solely to the well casing extension and excludes any other parts of a well.	**42**	**40**
W-6 Limited Well Casing Extension Journeyperson	Perform well casing extension, repair, and maintenance work only while in the employ of a contractor licensed for this work.	**27**	**27**
W-7 Limited Geothermal Contractor	Construct a geothermal bore hole or geothermal system, up to and including the manifold connection, including, but not limited to, the installation, repair, and maintenance of piping, casing, heat transfer media, pumps, pump motors, and valves. This registration excludes work on direct exchange systems.	–	–
W-8 Limited Geothermal Driller	Construct a geothermal bore hole or geothermal system, up to and including the manifold connection, including, but not limited to, the installation, repair and maintenance of piping, casing, heat transfer media, pumps, pump motors, and valves. Registrants must be in direct and regular employment of a contractor registered for this work. This registration excludes work on direct exchange systems.	–	–
W-9 Limited Direct Exchange Geothermal Contractor	Construct a geothermal bore hole or geothermal system, up to and including the manifold connection, but limited to those geothermal bore holes employing direct exchange or direct expansion technology, including but not limited to, drilling associated with the installation of copper or other piping containing a direct exchange heat transfer medium, the installation, repair and maintenance of piping, casing, and heat transfer media.	–	–
W-10 Limited Direct Exchange Geothermal Driller	Construct a geothermal bore hole or geothermal system up to and including the manifold connection but limited to those bore holes employing direct exchange or direct expansion technology, and associated components of a direct exchange geothermal system. This includes but is not limited to, drilling associated with the installation of copper or other piping containing a direct exchange heat transfer medium, the installation, repair and maintenance of piping, casing, and heat transfer media. Registrants must be in the direct and regular employment of a contractor registered for this work.	–	–

As mentioned previously, nine training centers in Connecticut offer HVAC programs. These programs' web sites do not clearly indicate whether they offer geothermal curricula.

According to a report by the Geothermal Heat Pump Consortium in 2013 for the U.S. Department of Energy, there are 14 main job classifications or "personnel qualifications" in the geothermal industry. These job titles are as follows:

- Ground Source Heat Pump System Project Manager
- Ground Source Heat Pump System Engineer/Designer
- Geological Formation Thermal Properties Tester
- Ground Source Heat Pump System Commissioning Agent
- Vertical Loop Driller
- Horizontal Directional Driller
- Ground Heat Exchanger Grouter
- Ground Heat Exchanger Looper
- Ground Source Heat Pump System Water Well Driller
- Ground Source Heat Pump System Water Well Pump Installer
- Ground Source Heat Pump Mechanical System Installer
- Ground Source Heat Pump System Operations/Maintenance Technician
- Ground Source Heat Pump System Inspector/Regulator
- Ground Source Heat Pump System Trainer

Several of these titles are consistent with those provided in the survey by industry players. Survey results included project managers, lead installers, drillers, and trainers.

Five IGSHPA, or International Ground Source Heat Pump Association, members are based in Connecticut, and 56 members include Connecticut in their service territory. IGSHPA members include manufacturers, product distributors, engineers, designers, ground loop installers, drillers, and more.

Interview Insights

Across the 19 interviews with a wide range of industry stakeholders, a few general themes about the industry emerged. Multiple interviewees spoke about the prevalence of small "mom and pop" shops, both among drilling companies and heat pump installers. A ground source heat pump manufacturer said that, by volume, most of their heat pump sales are to small businesses, and that their main base of customers installs other types of HVAC equipment, such as air source heat pumps and traditional fossil fuel systems, in addition to ground source heat pumps. Many drilling companies are small and do small projects within a local service territory, while a few much larger companies travel for larger jobs. In addition to the size of these small businesses, stakeholders mentioned that the geothermal workforce is aging and that many small businesses do not seem to have a clear line of succession in place.

Only a few companies focus solely on geothermal systems in CT. According to Local 777, the plumbers, pipefitters, and HVAC-R union in the state, it does roughly 75 percent of the commercial geothermal projects and very few of the residential projects.

Beyond the general composition of the industry, the interviewees tended to focus on three main topics: drilling as a bottleneck, licensing, and worker training and recruitment.

Drilling as a Bottleneck

Many interviewees identified a shortage of drillers and drill rigs as the biggest current bottleneck and understood this to be a consensus view in the industry. Because many drilling companies are smaller and unwilling to travel far for jobs, there is a strain on drillers that are equipped to do larger projects. One interviewee estimated that only one or two drilling companies in New England can do very large projects (requiring 50 boreholes or more), and that the rest of the demand is currently met by larger companies coming in from Canada or other parts of the U.S. Another interviewee said that there are more drilling companies with the capacity for large projects in New England but agreed that drilling is still a bottleneck. According to Dandelion Energy, drilling costs can constitute over 50 percent of the cost of a geothermal heating and cooling project. As noted by a different interviewee, installation of more conventional fossil fuel heating systems or air source heat pump systems can be easier for contractors because they are able to do all the work themselves; geothermal installations require additional coordination of a well driller which adds additional time and cost to the project.

Drilling has become a significant constraint for three key reasons: historic fluctuations in geothermal demand due to changing federal incentives, limited access to equipment, and inadequate interest in or awareness of drilling careers. Multiple interviewees noted that many drillers do well water or oil drilling rather than exclusively geothermal work. When the federal geothermal tax credit expired in 2016 (and was not reinstated until 2018), many drillers left the geothermal industry for more stable, consistent opportunities. The high upfront installation cost of geothermal heating and cooling is a major constraint on demand and uptake, so the availability and dollar amount of federal tax credits has a significant impact. One potential strategy for increasing drilling capacity is enticing well water and oil drillers to geothermal, but there would have to be a clear benefit for them and their businesses.

IGSHPA is developing training for geothermal drilling and has collaborated with NGWA to reach the audience of well water drillers. According to the executive director of IGSHPA, Jeff Hammond, trainings are geared toward people with existing drilling knowledge who are interested in transitioning to geothermal, rather than training new drillers.

Based on the interviews, it is unclear whether the drilling bottleneck is more intense in the commercial sector or residential sector. Residential projects attract more of the “mom and pop shops,” and the supply and demand may be better matched. Contradictorily, one interviewee said that he saw more drilling capacity going to large jobs that were more efficient and profitable for drillers, and he suspected this may be cannibalizing the residential sector.

The limited availability of drill rigs is another key factor. Interviewees indicated that important constraints include the slow rate of rig manufacturing and the limited number of foreign-built rigs that come to the United States. One interviewee from a drilling company said it was difficult to find a working used drill rig and that even new ones sometimes have mechanical problems.

One interviewee mentioned that water well and natural gas drilling require larger rigs that can reach greater depths than geothermal drilling typically requires, and that many drillers use these larger rigs for geothermal drilling. This results in geothermal projects incurring unnecessarily high fuel and equipment-transport costs. Geothermal-only drillers may be able to use smaller equipment, but diversification seems to be an important part of many drillers' business models. The International Union of Operating Engineers Local 150 runs a geothermal drilling apprenticeship program in the Chicago area; at the New York Geothermal Energy Organization Albany Conference in April 2024, David Bowers from Local 150 said that the organization takes advantage of the transferrable skills between geothermal, well water, and oil and gas drilling to help ensure that apprentices consistently have work placements.

Finally, an interviewee mentioned that drilling costs vary across the country because of differences in geology. In the Midwest, drillers often drill smaller boreholes and drilling cost can be $20-25 per foot, including casing and grout. In the Northeast, drilling costs are closer to $40-50 per foot because geology is more challenging, underscoring the importance of compressing costs.

Some industry stakeholders are proposing innovative solutions to the problem of driller and drill rig constraints. The Geothermal Market Capacity Coalition[6] has coalesced around the concept of a drill rig manufacturing and driller training hub as a geothermal "center of excellence." Sustainable Westchester has developed a proposal for the county government to purchase a drill rig that would be used for local training and leased for local projects.

Finally, many interviewees mentioned the difficult nature of drilling jobs as a deterrent to new entrants. One drilling company said it does have the capacity to train people in-house, it is just difficult to find and retain workers. This company said that most of its drillers and field technicians are in their 40s and 50s, and the company worries about being able to replace them. Difficulty with staffing can also create push and pull with the need for equipment. This drilling company at one time had three drilling rigs but did not have adequate staff and ended up selling one. According to the interviewee, however, the demand for drilling projects is not presently a limiting factor for the company.

Licensing

Licensing requirements for HVAC contractors in Connecticut have prompted much disagreement and even tension between various industry stakeholders. Some feel that DCP's current requirements are critical for ensuring quality work and protecting union jobs, while others feel that the requirements are overly burdensome to heat pump installers and are holding back geothermal development in Connecticut compared to neighboring states.

In 2023, Dandelion Energy lobbied for legislation that would create a small-system heat pump installer license – applicable to both air- and ground-source installers – without requirements for training on installation of

6 The Geothermal Market Capacity Coalition is a group of leading ground source heat pump manufacturers, contractors and geothermal drillers, trades groups, and educational, environmental, and advocacy organizations. The Geothermal Market Capacity Coalition (GMCC) aligns industry stakeholders to relieve supply chain, labor, and capacity shortages that are crippling growth.

fossil fuel systems. The legislation also sought exemptions for licensing requirements for systems under 10 tons (for residential applications). Dandelion argued this would streamline licensing of the heat pump workforce, reduce training costs, and enable broader deployment of heat pumps to accelerate progress toward the state's decarbonization goals. A union in the state and a pro-union nonprofit opposed the legislation, contending it would undermine installation quality and training requirements that benefit workers. The legislative effort failed.

Some interviewees indicated that the licensing issue is only of concern to heat pump-only companies and is not a major constraint because so few of these companies operate in the state. However, a stakeholder from a heat pump-only company said that the problem will likely affect more businesses as deployment of air- and ground-source heat pumps accelerates and that neighboring states with licensing requirements more conducive to heat-pump-only businesses have been able to attract more firms employing this business model. In Massachusetts, there is no statewide HVAC license, and contractors handling lesser amounts of chemical refrigerants (amounts typically needed for residential applications) need only EPA certification.

Some disagreement on licensing requirements stems from differing opinions on how much fossil fuel systems training is necessary for safely decommissioning these systems when they are replaced with heat pumps. Some heat pump companies and other stakeholders have argued that workers need only limited training hours on fossil fuel systems to decommission them safely, while others have said that more robust education and training is required. One suggestion that some industry stakeholders have made is removing or reducing the number of hours of training on fossil fuel systems in the D-2 Limited Warm Air, Air Conditioning, and Refrigeration Journeyperson license to make it more applicable to heat pump installers.

Interviewees identified several other concerns regarding Connecticut HVAC licensing. First, some said that the limited set of accredited training programs that count toward classroom hours presents a major barrier to new entrants who did not attend a technical high school, and these courses often are quite costly. At the time of the interviews, one interviewee was taking a year-long course for $30,000 to qualify for a CT license exam. Other programs that offer similar training at a lower price, such as Building Performance Institute, Efficiency for All programs in CT, and heat pump dealer/manufacturer training, do not count toward the hours required to sit for a license exam. Secondly, interviewees indicated it is difficult to transfer out-of-state experience in residential applications to Connecticut on-the-job training (OJT) requirements. The interviewee who mentioned he was taking the year-long course at a technical school that currently installs heat pumps in New York and plans to petition to use his out-of-state experience to replace the in-state OJT requirements. Currently, he does only weatherization work in Connecticut.

Recruitment and Training

All technical high schools in Connecticut are run by one organization, the Connecticut Technical Education and Career System (CTECS). There are 20 schools across the state, and 11 of them offer an HVAC program. Other relevant program areas include Electrical; Plumbing and Heating; and Architecture. As of March 2024, each HVAC program was staffed with two teachers.

CTECS demographics data obtained by the research team is from March 2024. The data distinguishes between two programs – the 9-12th grade program and the adult program. The data also describes CTECS's overall student demographic data and the HVAC programs specifically.

Enrollment for the 9-12th grade HVAC program totals 562 students. The HVAC program is heavily male dominated; 10.7 percent identify as female, and 89.3 percent identify as male. In contrast, in the overall 9-12th student body has a notably higher percentage of female students; 38.8 percent of the students identify as female, 60.5 percent identify as male, and 0.7 percent identify as nonbinary. Students in the HVAC program are less racially diverse than students in the system overall; 56 percent of the students in the 9-12th HVAC program are white, while 39.2 percent of students in CTECS are white.

CTECS HVAC adult program enrollment totals 260 students. In this program, approximately 1.9 percent of the students identify as female, 98.1 percent as male, and 0.4 percent as nonbinary. The percentages are similar for the CTECS adult HVAC program, with approximately 2.8 percent identifying as female, 96.7 percent identifying as male, and 0.1 percent identifying as nonbinary. In the adult HVAC program, 55 percent of students are white, while 61.2 percent of students in the total adult student body are white. The CTECS Education Consultant of Data Management & Research noted that the adult education program data may be incomplete due to lower than 100 percent participation by students in demographic surveys.

In discussion about the technical high schools' curricula and resources for heat pump and geothermal training, some inconsistencies arose. According to CTECS, all the HVAC programs teach curricula on heat pumps and geothermal, and the system viewed these as "need to know" topic areas. In a brief phone conversation, however, a teacher at a technical high school said they did not teach geothermal heat pump material; and other sources said that not all technical high school HVAC programs cover geothermal. Also, multiple interviewees mentioned a consistent need for teachers, despite the fact that the HVAC programs are all currently fully staffed (according to CTECS).

One theme that emerged as a need for technical high schools was access to training equipment or funding for equipment. Anecdotally, one HVAC teacher said they had a barely functioning air conditioning unit to train on. Other stakeholders mentioned hearing about the severe need for equipment. One interviewee suggested that ground source heat pump manufacturers could help fill the need for equipment in the schools and raise awareness of and bolster education on geothermal systems.

Energize CT, a utility-funded energy efficiency program, does help fill some equipment and curriculum gaps. Green STEP (Sustainability Technical Education Program) is part of Energize CT and offers specialized curricula and training for public high schools on various sustainability and efficiency topics. The program originally was focused on providing training in CTECS schools, but in 2022 and 2023 it began pilot programs offering paid opportunities for public school students after school and during the summer. The Green STEP curriculum does not currently include geothermal content, but it could be expanded to include it, according to utility representatives running the program. Energize CT also supports the "E-House" Initiative at CTECS schools, where students build model homes and learn about energy efficiency and renewable energy. Since the program began in 2011, seven

E-Houses have been built at technical schools in Connecticut. These houses do not use geothermal, but they do use heat pumps and offer foundational education needed for geothermal heating and cooling.

Unions recruit from technical high schools in Connecticut, although the percentage of technical school students that go into the unions is unclear. Local 777, the plumbers, pipefitters, and HVAC-R union for the state, gets 500-600 applicants every year and accepts only 75 apprentices. According to the interviewee from Local 777, the number of new apprentices accepted is based on the projections of future careers, to assure that apprentices accepted have adequate work opportunities in the long term. If demand for geothermal projects rises significantly, Local 777 may need to bring in additional instructors from the field.

Some interviewees indicated that the barriers to union apprenticeships are significant, especially for people who did not attend technical high schools. Local 777 says it actively recruits veterans, women, minorities, and people who did not attend technical schools. More conversation is needed to understand the nuance of barriers to union apprenticeship.

Local 478, the Connecticut chapter of the International Union of Operating Engineers (IUOE), offers drilling training for natural gas and well water drilling. While they do not offer training specific to geothermal well drilling, apprentices can gain all the necessary skills for geothermal drilling from the existing curriculum. Local 478 gets about 350 applicants for apprentices every year (for drilling and other skills) and accepts 25 to 40. The limiting factor for acceptance is the demand for projects; similarly to Local 777, they accept only as many apprentices as they believe they will be able to provide full-time employment. There may be opportunity for the state to project future geothermal uptake based on the historic new investments from the Inflation Reduction Act and Bipartisan Infrastructure Law.

In addition to its existing drilling curriculum, Local 478 is working to bring a geothermal well drilling apprenticeship program to Connecticut. IUOE Local 150 in the Chicago area developed a geothermal drilling apprenticeship program in 2009. It is currently the only registered geothermal well drilling apprenticeship in the country.

IGSHPA, the preeminent organization for geothermal trainings and certifications, is in the process of releasing updated curricula that are modular and readily applicable in school settings. IGSHPA is using the U.S. Department of Energy's 14 geothermal job descriptions and is creating modules for entry-level positions, service technicians, commercial design and inspection, residential design, and more. In New York, IGSHPA accreditation is required for accessing geothermal incentives. IGSHPA leadership believes that the new topic areas and design of the trainings should enable the program to reach larger audiences.

Conclusion

Overall, the project team identified three major barriers to the growth of geothermal technologies in Connecticut: inadequate public awareness of geothermal careers, high upfront costs, and the relationship between supply of workers and demand for projects. Among segments of the population that could be attracted to geothermal careers, awareness of geothermal career paths lags, behind what will be needed to scale up geothermal technologies. Marketing the types of positions that become available and making them appealing and accessible to new entrants will be critical for aggressively scaling up the geothermal industry to help meet Connecticut's climate goals. Meanwhile, the steep upfront costs associated with geothermal heating and cooling (especially for retrofits) also pose a major challenge for the market growth needed to drive geothermal deployment and employment. At the same time, multiple stakeholders highlighted the tension between supply and demand and voiced a consensus that geothermal is becoming more popular and demand is rising. While some stakeholders expressed that current demand for geothermal installations in Connecticut is mostly being met by the existing workforce, this demand level must increase to be in line with Connecticut's climate goals. Therefore, Connecticut must work towards growing both the geothermal workforce and demand for geothermal in parallel. An increased supply of drillers (and drill rigs) could bring down the price of drilling, which constitutes a substantial portion of the upfront costs for geothermal projects. With growing awareness of geothermal technology and access to newly increased federal tax incentives and other initiatives for geothermal, more consumers will likely be drawn to geothermal. In tandem, workers will need to be in place to serve this demand.

Various recommendations for the Workforce Development Plan have arisen during the surveying and interviewing for this needs assessment. These recommendations include early outreach and targeted marketing of trade career opportunities, coordinated drill rig manufacturing and driller training, adjustments to licensing requirements to facilitate heat pump-only company growth, and expanded access to classroom trainings that satisfy licensing requirements.

Next Steps

While this research is foundational to understanding Connecticut's geothermal workforce, the project team encountered several challenges that may limit its utility. Despite reaching out to many stakeholders from firms, training centers, unions, and trade schools in Connecticut, the response rate to the surveys was low. Many stakeholders were unresponsive or indicated they were too busy to participate. The small sample size also posed difficulties for quantifiable results about job growth and industry projections. Given the research and stakeholder participation gathered, the project team is confident that the information presented in this report is valuable and provides insight from a broad cross-section of voices in the industry. But further research is needed to form a complete picture of the geothermal workforce.

With more time, further insights from educators and new entrants and trainees should be collected, both to achieve a larger sample size and to hear a wider range of perspectives. Some additional questions to explore in future Connecticut geothermal workforce studies are: What messages do new entrants hear about the geothermal industry that draws them to it? What do new entrants to the industry feel are the greatest barriers

to industry growth? What employment barriers do employers mention that new entrants do not, and what does that imply about missing steps in the path to accessing quality jobs? Would a sample including more trade schools provide additional insights?

Additionally, the survey responses gathered from training centers provided only limited information on demographics and diversity and geothermal certifications, presenting avenues for further research. Additional research should also explore the ability of facilities managers to maintain geothermal systems post-installation, and the possible need for training or additional staff to support this work.

In May 2024, NEEP will host four geothermal workforce solution workshops with the goal of reconciling some of the conflicting viewpoints outlined here and developing proposed solutions for the current barriers and bottlenecks. These workshops will inform a Connecticut Geothermal Workforce Development Plan providing recommendations to the state on how to facilitate development of the state's geothermal workforce. NEEP will develop the Workforce Development Plan during Phase I of the project and, if the project team is awarded Phase 2 funds, implement it as part of the continued project activities.

The team will explore these recommendations and others through workshops and further conversation with industry stakeholders to support successful scale-up of the geothermal workforce in alignment with Connecticut's climate and grid-management goals.

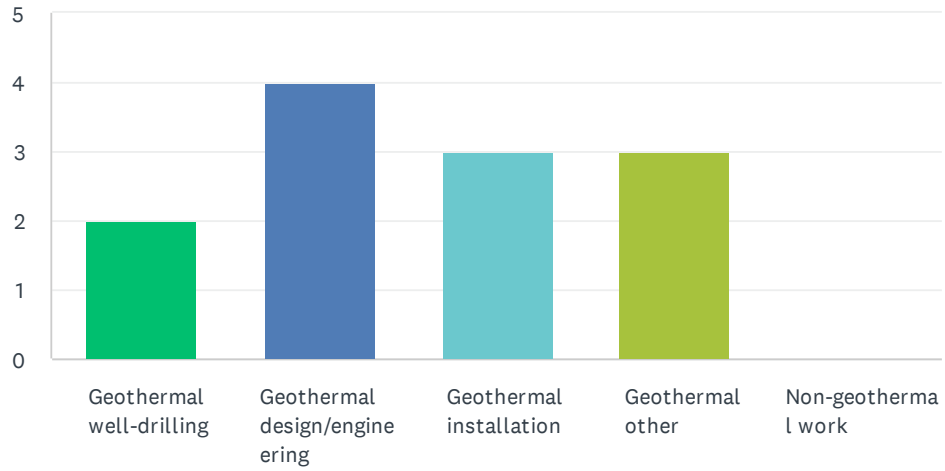
APPENDIX

This appendix reflects summary survey data from training centers, WHA facilities managers, and drillers, installers, manufacturers, and engineering companies. The data is exported from the SurveyMonkey platform and contains both summary graphs and open responses. Respondent organizations, emails, or any other identifying information have been redacted.

Note: One respondent from a training center incorrectly completed a survey intended for local trade schools.

Q2 Company Info -- Please select what type of work your company undertakes. Select all that apply.

Answered: 7 Skipped: 0



ANSWER CHOICES	RESPONSES	
Geothermal well-drilling	28.57%	2
Geothermal design/engineering	57.14%	4
Geothermal installation	42.86%	3
Geothermal other	42.86%	3
Non-geothermal work	0.00%	0
Total Respondents: 7		

#	EXPLANATION	DATE
1	Service work	2/13/2024 4:09 PM
2	Educator , SME, Journalist	2/6/2024 10:57 PM
3	Manufacturing of Slim Jim lake plates & geothermal HVAC wholesale distributor	1/23/2024 9:48 AM
4	We can install the indoor equipment and controls	1/8/2024 3:12 PM

Q3 Company Info -- What proportion of your work is geothermal related?

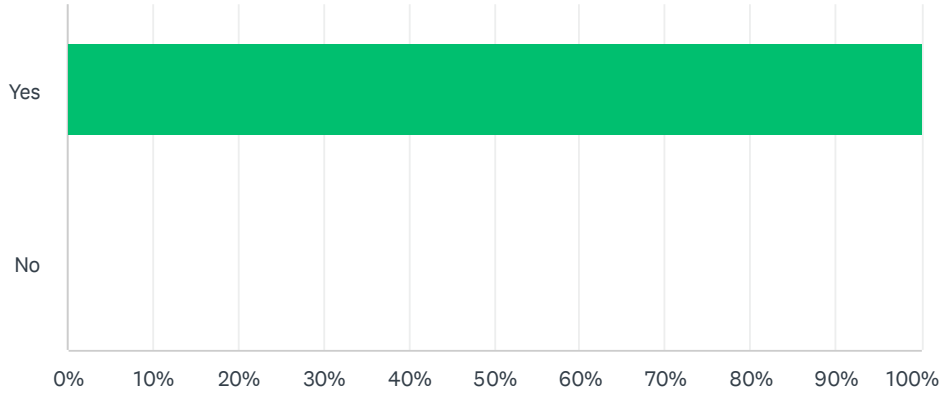
Answered: 7 Skipped: 0

#	RESPONSES	DATE
1	What?	2/13/2024 4:09 PM
2	75%	2/8/2024 12:55 PM
3	50%	2/6/2024 10:57 PM

4	15%	1/28/2024 12:29 PM
5	100%	1/24/2024 3:16 PM
6	99%	1/23/2024 9:48 AM
7	0	1/8/2024 3:12 PM

Q4 Company Info -- Does your company currently work in Connecticut?

Answered: 6 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	100.00%	6
No	0.00%	0
TOTAL		6

Q5 Company Info -- In which state(s) does your company work?

Answered: 7 Skipped: 0

#	RESPONSES	DATE
1	Ct	2/13/2024 4:09 PM
2	CT, NY, RI, MA	2/8/2024 12:55 PM
3	Michigan, Indiana, Massachusetts, New York, Texas, Oklahoma, Vermont, Ohio, Nevada, Colorado, Illinois, Iowa, Minnesota,	2/6/2024 10:57 PM
4	Vermont, New York, Maine, Connecticut, New Hampshire, Massachusetts, South Carolina, Florida, Ohio, Rhode Island	1/28/2024 12:29 PM
5	Across U.S., Canada and internationally	1/24/2024 3:16 PM
6	All US states plus the UK, Australia, & South Korea	1/23/2024 9:48 AM
7	New York, New Jersey, Connecticut, Delaware, Maryland, Virginia	1/8/2024 3:12 PM

Q6 Company Info -- Where is your company’s headquarters?

Answered: 7 Skipped: 0

#	RESPONSES	DATE
1	Guilford ct	2/13/2024 4:09 PM
2	BETHLEHEM, CT	2/8/2024 12:55 PM
3	Michigan	2/6/2024 10:57 PM
4	Burlington, Vermont	1/28/2024 12:29 PM
5	Winnipeg, MB, Canada	1/24/2024 3:16 PM
6	Baton Rouge, La.	1/23/2024 9:48 AM
7	Mount Vernon, N.Y.	1/8/2024 3:12 PM

Q7 Company Info -- If your company is not currently registered to do geothermal work in Connecticut, do you plan to expand into Connecticut? Why or why not?

Answered: 6 Skipped: 1

#	RESPONSES	DATE
1	We already do	2/13/2024 4:09 PM
2	As a consultant there is a possibility.	2/6/2024 10:57 PM
3	We are licensed to do work in CT.	1/28/2024 12:29 PM
4	Not currently registered to work in CT, but willing to register as required	1/24/2024 3:16 PM
5	Yes, because the northeast is becoming more favorable in waster source heat pumps	1/23/2024 9:48 AM
6	Yes, if the work is available	1/8/2024 3:12 PM

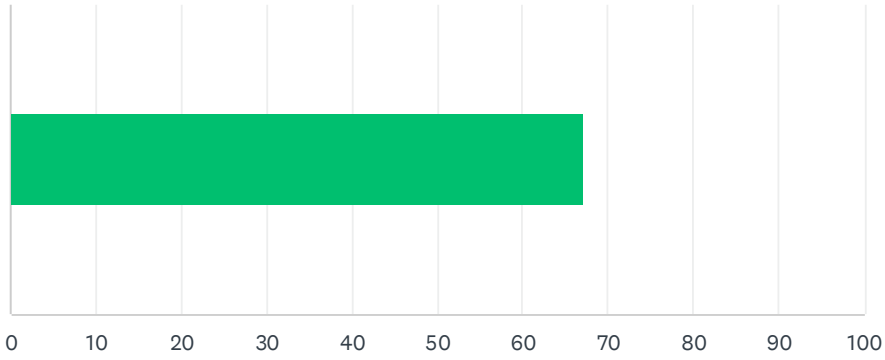
Q8 Employee Info -- How many employees does your company have total?

Answered: 7 Skipped: 0

#	RESPONSES	DATE
1	3	2/13/2024 4:09 PM
2	15	2/8/2024 12:55 PM
3	3	2/6/2024 10:57 PM
4	11	1/28/2024 12:29 PM
5	4	1/24/2024 3:16 PM
6	8	1/23/2024 9:48 AM
7	8	1/8/2024 3:12 PM

Q9 Employee Info -- What percent of employees at your company work on geothermal projects?

Answered: 7 Skipped: 0

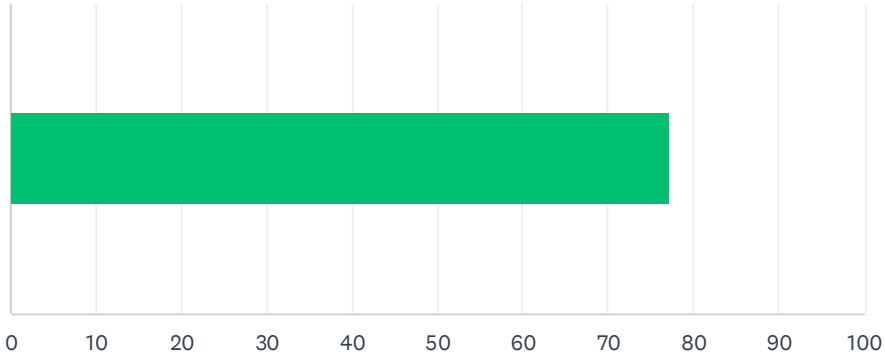


ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	67	470	7
Total Respondents: 7			

#		DATE
1	35	2/13/2024 4:09 PM
2	60	2/8/2024 12:55 PM
3	100	2/6/2024 10:57 PM
4	70	1/28/2024 12:29 PM
5	100	1/24/2024 3:16 PM
6	100	1/23/2024 9:48 AM
7	5	1/8/2024 3:12 PM

Q10 Employee Info -- What percent of geothermal employees are full-time?

Answered: 7 Skipped: 0

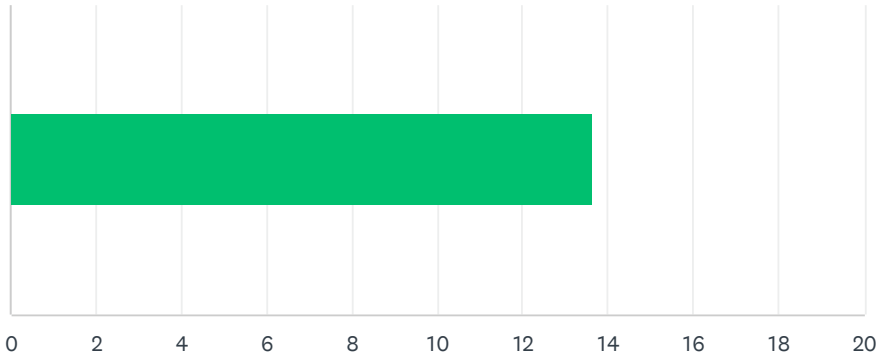


ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	77	541	7
Total Respondents: 7			

#		DATE
1	38	2/13/2024 4:09 PM
2	100	2/8/2024 12:55 PM
3	100	2/6/2024 10:57 PM
4	100	1/28/2024 12:29 PM
5	100	1/24/2024 3:16 PM
6	100	1/23/2024 9:48 AM
7	3	1/8/2024 3:12 PM

Q11 Employee Info -- What percent of geothermal employees are women?

Answered: 6 Skipped: 1

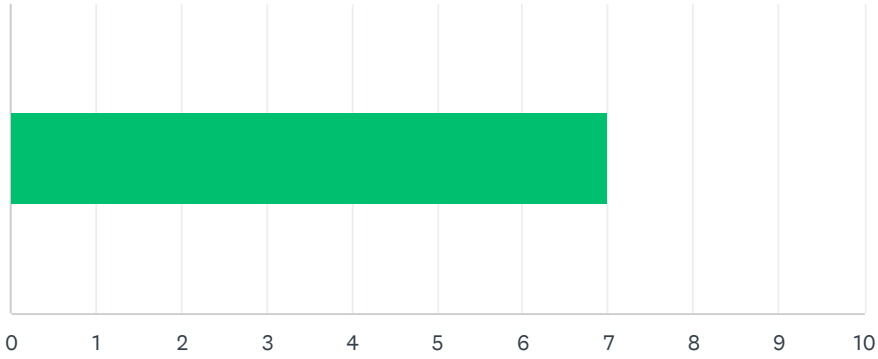


ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	14	82	6
Total Respondents: 6			

#		DATE
1	0	2/8/2024 12:55 PM
2	33	2/6/2024 10:57 PM
3	10	1/28/2024 12:29 PM
4	0	1/24/2024 3:16 PM
5	38	1/23/2024 9:48 AM
6	1	1/8/2024 3:12 PM

Q12 Employee Info -- What percent of geothermal employees are minorities? (Definition of minority)

Answered: 4 Skipped: 3

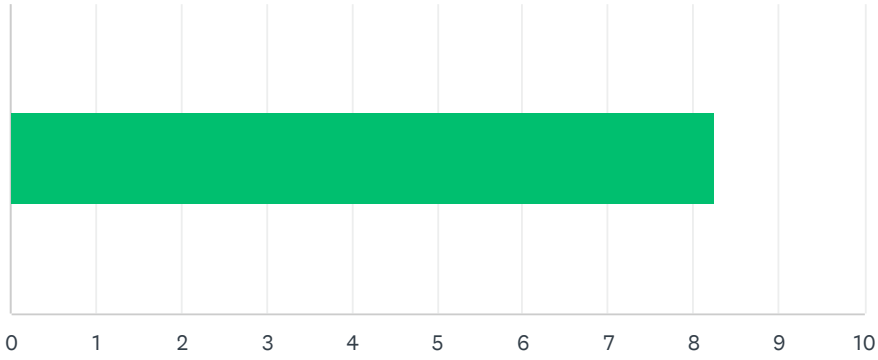


ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	7	28	4
Total Respondents: 4			

#		DATE
1	11	2/8/2024 12:55 PM
2	0	1/24/2024 3:16 PM
3	12	1/23/2024 9:48 AM
4	5	1/8/2024 3:12 PM

Q13 Employee Info -- What percent of these geothermal employees are represented by unions, collective bargaining agreements, and/or project labor agreements?

Answered: 4 Skipped: 3



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	8	33	4
Total Respondents: 4			

#		DATE
1	0	2/8/2024 12:55 PM
2	33	2/6/2024 10:57 PM
3	0	1/24/2024 3:16 PM
4	0	1/8/2024 3:12 PM

Q14 Employee Info -- Please share job titles for each geothermal role.

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	WELL DRILLER, GROUTER, TIE IN/PIPING	2/8/2024 12:55 PM
2	Consultant, driller, project management, trainer	2/6/2024 10:57 PM
3	Geothermal/Mechanical - Principal Geothermal/Mechanical - Project Manager Geothermal/Mechanical - Energy Modeler Geothermal/Mechanical - Level 1 Design Engineer Geothermal/Mechanical - Level 2 Design Engineer	1/28/2024 12:29 PM
4	3 people with PE / P.Eng 3 people with CGD accreditation	1/24/2024 3:16 PM
5	General manager Design engineer Project manager Shift manager Lead installer	1/23/2024 9:48 AM

Q15 Employee Info -- For those on a salary, what is the range and median?

Answered: 3 Skipped: 4

#	RESPONSES	DATE
1	$65,000-$200,000	1/28/2024 12:29 PM
2	$100k - $150k	1/24/2024 3:16 PM

3	$64,000-$130,000	1/23/2024 9:48 AM

Q16 Employee Info -- For those with hourly wages, what is the range and median?

Answered: 2 Skipped: 5

#	RESPONSES	DATE
1	$30-$40	1/28/2024 12:29 PM
2	M/a	1/23/2024 9:48 AM

Q17 Employee Info -- Does your company use any other pay structures?

Answered: 3 Skipped: 4

#	RESPONSES	DATE
1	No	1/28/2024 12:29 PM
2	no	1/24/2024 3:16 PM
3	No	1/23/2024 9:48 AM

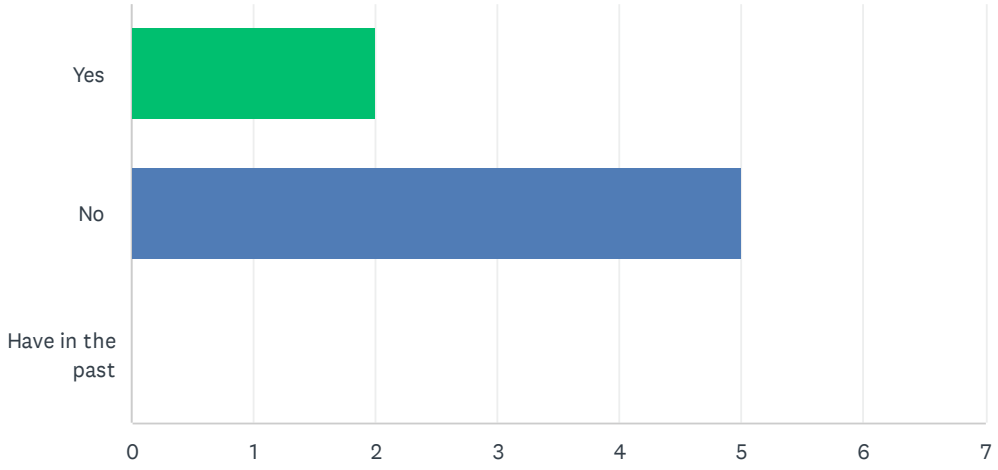
Q18 Employee Info -- What benefits does your company provide to full-time geothermal employees? To part-time geothermal employees?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	MEDICAL/DENTAL, PAID TIME OFF, LTD, STD, 401K	2/8/2024 12:55 PM
2	401K, Bonus Structure, Health Insurance	1/28/2024 12:29 PM
3	medical / dental	1/24/2024 3:16 PM
4	All full time… Health, PTO, dental, life	1/23/2024 9:48 AM
5	We don't provide any at this time	1/8/2024 3:12 PM

Q19 Professional Pathway -- Does your company host geothermal apprentices?

Answered: 7 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	28.57%	2
No	71.43%	5
Have in the past	0.00%	0
TOTAL		7

Q20 Professional Pathway -- What are the required or desirable training/certifications for each position at your company?

Answered: 6 Skipped: 1

#	RESPONSES	DATE
1	LICENSED WELL DRILLER, NGWA CERTIFICATION, IGSHPA ACCREDIDATION	2/8/2024 12:55 PM
2	Driller, PM, Safety, Geoscience	2/6/2024 10:57 PM
3	Engineering Intern Professional Engineer IGSHPA Certification Design Builder and Energy Plus training GLDesign training	1/28/2024 12:29 PM
4	PE, CGD	1/24/2024 3:16 PM
5	Install certifications, design certifications	1/23/2024 9:48 AM
6	EPA Refrigerant Certification, OSHA 30 (either have it or plan to get it)	1/8/2024 3:12 PM

Q21 Professional Pathway -- Where does your company get their necessary training/licensing?

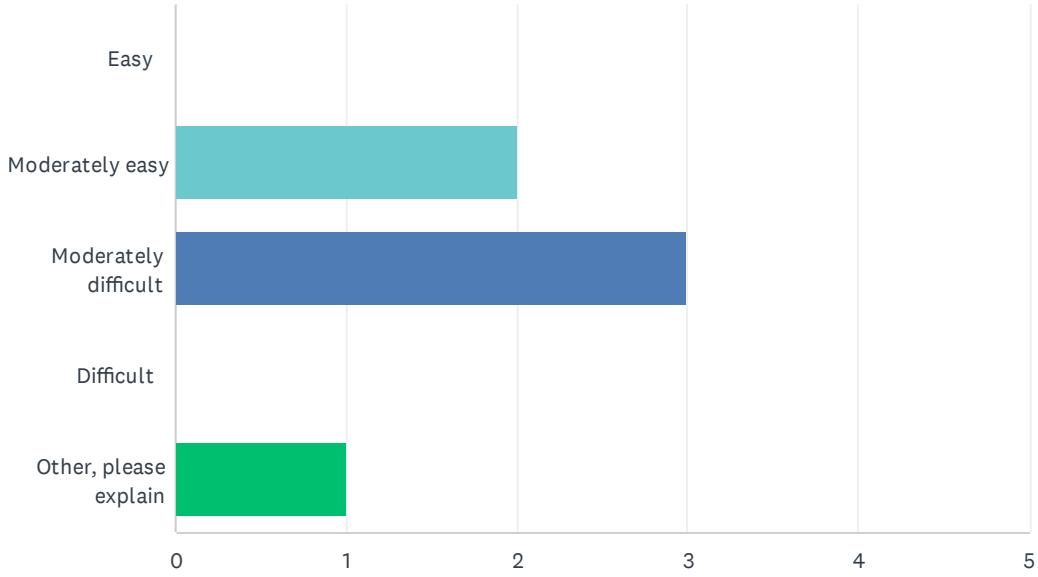
Answered: 6 Skipped: 1

#	RESPONSES	DATE
1	ON THE JOB. RECENTLY CT HAS DEVELOPED AN APPRENTICESHIP PROGRAM THAT WE HAVE APPLIED FOR. UP UNTIL NOW WE HAVE LOGGED TRAINING HOURS AND	2/8/2024 12:55 PM

	SUBMITTED LICENSING APPLICATIONS BASED ON THE TRAINING WELL DRILLER'S RECOMMENDATIONS.	
2	Internally	2/6/2024 10:57 PM
3	NCEES State Professional Services IGSHPA	1/28/2024 12:29 PM
4	teach CGD course	1/24/2024 3:16 PM
5	Vendors and in house curriculum	1/23/2024 9:48 AM
6	Online/In-Person HVAC Manufacturer/Supplier training	1/8/2024 3:12 PM

Q22 Professional Pathway -- Overall, how easy is it for your company's technical employees to get the geothermal licensing they need to operate in Connecticut?

Answered: 6 Skipped: 1



ANSWER CHOICES	RESPONSES	
Easy	0.00%	0
Moderately easy	33.33%	2
Moderately difficult	50.00%	3
Difficult	0.00%	0
Other, please explain	16.67%	1
TOTAL		6

#	OTHER, PLEASE EXPLAIN	DATE
1	Not sure	1/8/2024 3:12 PM

Q23 Professional Pathway -- What types of additional geothermal training, certification, and/or licensing would benefit your company?

Answered: 3 Skipped: 4

#	RESPONSES	DATE
1	Standardized licensing for USA	2/6/2024 10:57 PM
2	N/A	1/28/2024 12:29 PM
3	Local geological information	1/23/2024 9:48 AM

Q24 Professional Pathway -- How could the geothermal licensing process in Connecticut be improved?

Answered: 4 Skipped: 3

#	RESPONSES	DATE
1	WE ARE HOPING THAT THE WELL DRILLER APPRENTICESHIP PROGRAM IN CT WILL BE AN EASIER WAY FOR OUR EMPLOYEES TO FOLLOW AN ORGANIZED PATH TO BECOMING LICENSED WELL DRILLERS.	2/8/2024 12:55 PM
2	Centers of Excellence	2/6/2024 10:57 PM
3	N/A	1/28/2024 12:29 PM
4	N/a	1/23/2024 9:48 AM

Q25 Company Growth -- What are your company’s main barriers to training geothermal employees? (Please elaborate if there are differences between training new and existing employees)

Answered: 2 Skipped: 5

#	RESPONSES	DATE
1	There are no barriers at this point. The only barriers we see are actual well drillers and growth of geothermal installers. This includes overcoming the additional cost for geothermal.	1/28/2024 12:29 PM
2	N/	1/23/2024 9:48 AM

Q26 Company Growth -- What is the average number of years geothermal employees have worked at your company?

Answered: 5 Skipped: 2

#	RESPONSES	DATE

1	AVERAGE 10 YEARS	2/8/2024 12:55 PM
2	5	2/6/2024 10:57 PM
3	18	1/28/2024 12:29 PM
4	5	1/24/2024 3:16 PM
5	6	1/23/2024 9:48 AM

Q27 Company Growth -- How many new geothermal positions has your company created in the last year? What were the position titles?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	OUR FIELD EMPLOYEES ARE NOT LIMITED TO GEOTHERMAL POSITIONS. WE HAVE WELL DRILLERS, WELL DRILLER HELPERS, A GROUT CREW, TIE IN CREW, HYDRO-SURGE AND PUMP INSTALLERS. OUR SERVICES INCLUDE DOMESTIC WATER WELLS, HYDRO SURGE AND PUMPS AS WELL AS THE GEOTHERMAL PORTION.	2/8/2024 12:55 PM
2	1	2/6/2024 10:57 PM
3	Three (1)Geothermal/Mechanical - Energy Modeler (2)Geothermal/Mechanical - Level 1 Design Engineer	1/28/2024 12:29 PM
4	1 PE	1/24/2024 3:16 PM
5	1…training manager	1/23/2024 9:48 AM

Q28 Company Growth -- How many employees hired in the last year were represented by a union?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	NONE	2/8/2024 12:55 PM
2	1	2/6/2024 10:57 PM
3	0	1/28/2024 12:29 PM
4	0	1/24/2024 3:16 PM
5	0	1/23/2024 9:48 AM

Q29 Company Growth -- How many of your company’s current geothermal staff was hired in the last year to replace personnel who left the firm?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	NONE	2/8/2024 12:55 PM

2	0	2/6/2024 10:57 PM
3	0	1/28/2024 12:29 PM
4	0	1/24/2024 3:16 PM
5	0	1/23/2024 9:48 AM

Q30 Company Growth -- How many new geothermal positions has your company created in the last 5 years? What were the position titles?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	SEE ANSWER TO QUESTION 27.	2/8/2024 12:55 PM
2	1	2/6/2024 10:57 PM
3	Three (2)Geothermal/Mechanical - Energy Modeler (2)Geothermal/Mechanical - Level 1 Design Engineer	1/28/2024 12:29 PM
4	3 PEs. 1 drafting	1/24/2024 3:16 PM
5	0	1/23/2024 9:48 AM

Q31 Company Growth -- Do some geothermal positions at your company tend to turn over more quickly than others? Which ones? Why?

Answered: 3 Skipped: 4

#	RESPONSES	DATE
1	NO	2/8/2024 12:55 PM
2	No.	1/28/2024 12:29 PM
3	No	1/23/2024 9:48 AM

Q32 Company Growth -- How many additional geothermal positions do you expect to create in the next year?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	WE ARE CURRENTLY WORKING ON TRAINING OUR CURRENT EMPLOYEES SO THAT WE CAN PROMOTE THEM FROM WITHIN. IN THIS CASE WE WILL BE LOOKING FOR 1-2 WELL DRILLERS HELPERS SO TRAIN.	2/8/2024 12:55 PM
2	7	2/6/2024 10:57 PM
3	1 to 2	1/28/2024 12:29 PM
4	1	1/24/2024 3:16 PM

5	1 or 2	1/23/2024 9:48 AM

Q33 Company Growth -- If you expect to create geothermal positions in the next year, what positions will they be for? Are you currently/will you soon be trying to hire more employees?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	WELL DRILLERS HELPERS. WE ARE NOT CURRENTLY ACTIVELY SEEKING OUT NEW EMPLOYEES BUT ARE ALWAYS WILLING TO INTERVIEW AN APPLICANT.	2/8/2024 12:55 PM
2	Yes	2/6/2024 10:57 PM
3	(1(1)Geothermal/Mechanical - Project (1)Geothermal/Mechanical - Design Engineer Level 2	1/28/2024 12:29 PM
4	PE and support	1/24/2024 3:16 PM
5	Expanding to new cities	1/23/2024 9:48 AM

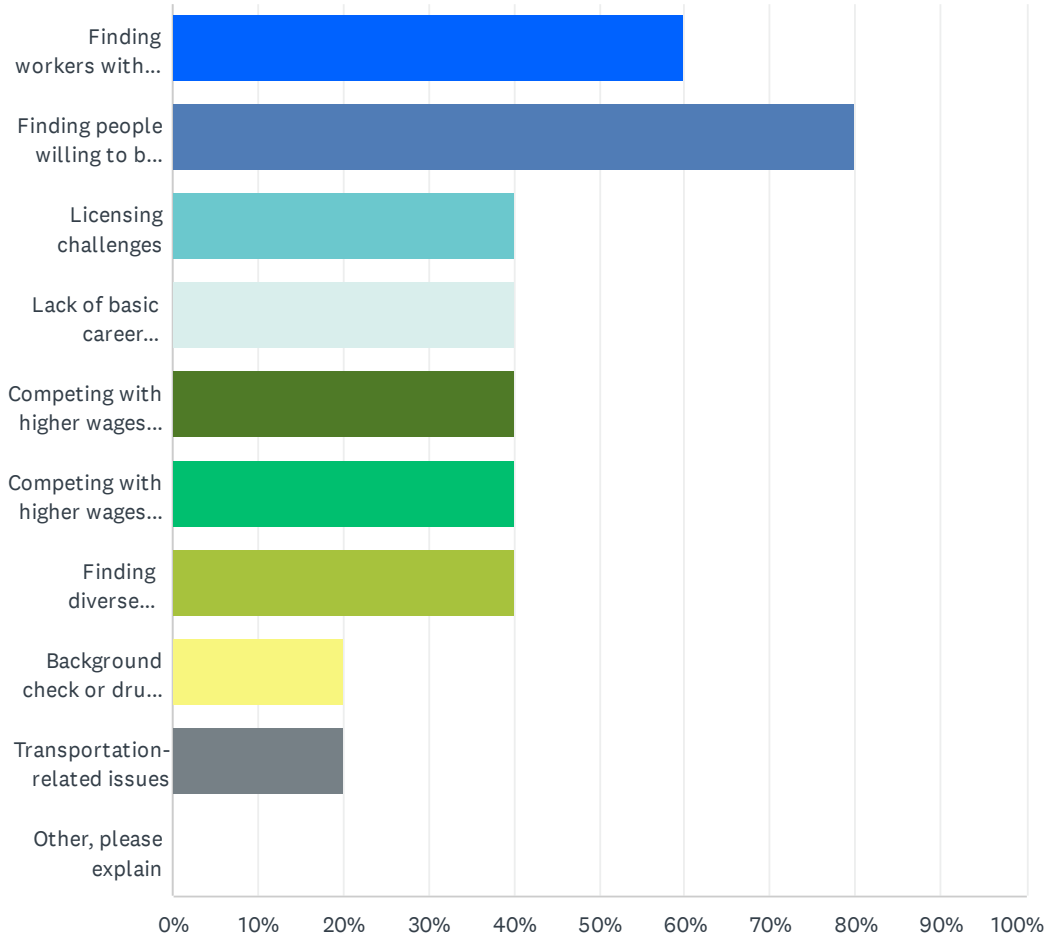
Q34 Company Growth -- Why do you think people want to work in geothermal? What aspects of the work/geothermal field do you highlight in recruiting employees?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	THE WELL DRILLING PORTION OF A GEOTHERMAL PROJECT IS HARD WORK, DIRTY AND NOT MANY PEOPLE WANT TO DO IT. WE HAVE BEEN LUCKY TO RETAIN OUR EMPLOYEES FOR 5-32 YEARS CURRENTLY. PEOPLE LOOK AT GEOTHERMAL AS THE FUTURE SO IT IS ATTRACTIVE TO SOMEONE WHO WANTS A PERMANENT JOB.	2/8/2024 12:55 PM
2	Climate justice	2/6/2024 10:57 PM
3	Individuals who are interested in efficient and carbon free ways to heat and cool buildings. Allows for fully electrified building. Allows for net-zero building operation when renewables are used. Reduces fossil fuels in building.	1/28/2024 12:29 PM
4	interest in reducing impact on environment	1/24/2024 3:16 PM
5	Green industry, younger hires like the learning involved	1/23/2024 9:48 AM

Q35 Company Growth -- What are your main barriers to hiring for geothermal positions? (Select all that apply)

Answered: 5 Skipped: 2



ANSWER CHOICES	RESPONSES	
Finding workers with adequate training	60%	3
Finding people willing to be trained	80%	4
Licensing challenges	40%	2
Lack of basic career competencies	40%	2
Competing with higher wages at other geothermal companies	40%	2
Competing with higher wages in other fields	40%	2
Finding diverse candidates	40%	2
Background check or drug test failure	20%	1
Transportation-related issues	20%	1
Other, please explain	0%	0
Total Respondents: 5		

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

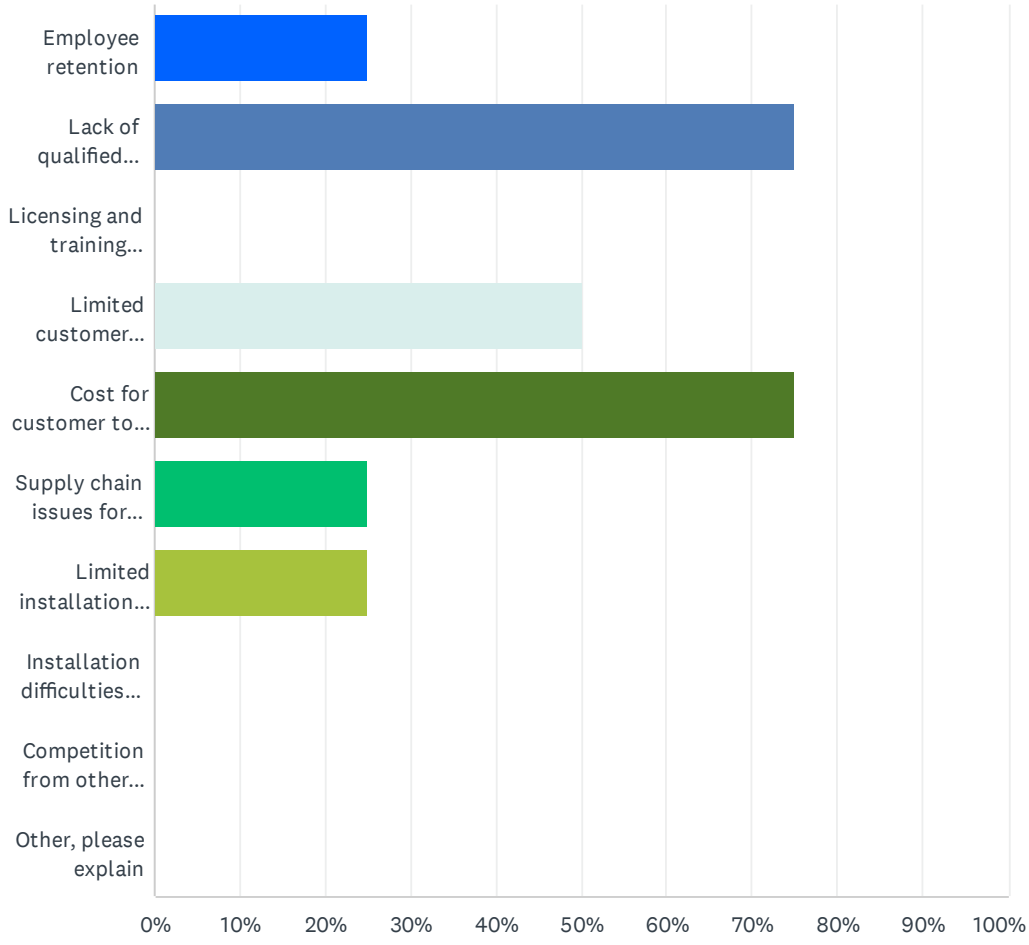
Q36 Company Growth -- What are your main barriers to retention for geothermal employees?

Answered: 3 Skipped: 4

#	RESPONSES	DATE
1	FINDING PEOPLE WHO WANT TO WORK AND WANT TO WORK IN WELL DRILLING.	2/8/2024 12:55 PM
2	Ensuring enough work can support employee salaries.	1/28/2024 12:29 PM
3	None	1/23/2024 9:48 AM

Q37 Company Growth -- What are the top three barriers to growing your geothermal business? (Please select up to three responses)

Answered: 4 Skipped: 3



ANSWER CHOICES	RESPONSES	
Employee retention	25.00%	1
Lack of qualified workers	75.00%	3
Licensing and training employees	0.00%	0
Limited customer awareness of geothermal	50.00%	2
Cost for customer to install geothermal	75.00%	3
Supply chain issues for geothermal equipment (condensers, piping, etc.)	25.00%	1
Limited installation equipment (drilling rigs, etc.)	25.00%	1
Installation difficulties at sites (lack of space, bedrock, etc.)	0.00%	0
Competition from other companies	0.00%	0
Other, please explain	0.00%	0
Total Respondents: 4		

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q38 Projects -- How many geothermal projects do you typically complete per year?

Answered: 4 Skipped: 3

#	RESPONSES	DATE
1	100	2/8/2024 12:55 PM
2	10	1/28/2024 12:29 PM
3	20-30	1/24/2024 3:16 PM
4	100	1/23/2024 9:48 AM

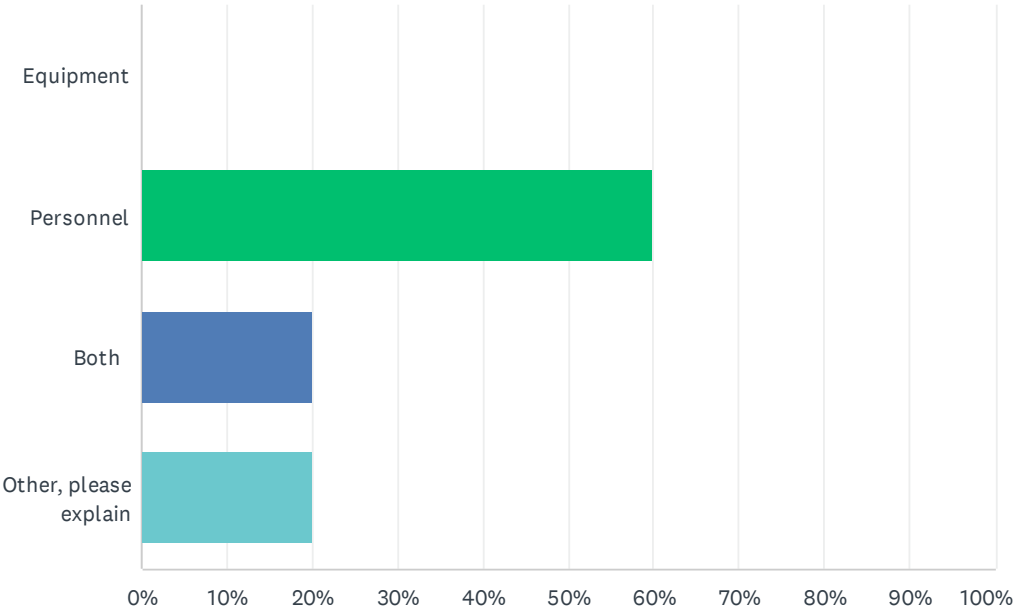
Q39 Projects -- How many geothermal projects can your company undertake at once?

Answered: 5 Skipped: 2

#	RESPONSES	DATE
1	4-5	2/8/2024 12:55 PM
2	6	2/6/2024 10:57 PM
3	10	1/28/2024 12:29 PM
4	3-5	1/24/2024 3:16 PM
5	3-5	1/23/2024 9:48 AM

Q40 Projects -- Is the number of projects your company can undertake limited primarily by equipment, by personnel, by both, or by something else?

Answered: 5 Skipped: 2



#	OTHER, PLEASE EXPLAIN	DATE
1	Quality projects	2/6/2024 10:57 PM

Q41 How can the State of Connecticut help your company with any challenges or barriers to geothermal work that you identified in this survey?

Answered: 3 Skipped: 4

#	RESPONSES	DATE
1	HELP FIND PEOPLE WHO WANT TO WORK, AND WANT TO WORK IN THIS INDUSTRY	2/8/2024 12:55 PM
2	Standardize borefield specifications	2/6/2024 10:57 PM
3	Encourage individuals to pursue well drilling and mechanical careers. Offer incentives for contractors to pursue geothermal. Offer information to home owners on how to connect to well drillers and mechanical contractors interested in pursuing geothermal. Offer guidnace to residential and commercial clients on how to ensure they can maximize their project to take advantage of all the incentives (IRA, etc.) to make geothermal affordable. Provide means to fund construction bridge loans so that it would not cost anymore to residential and commercial builders who want to take pursue geothermal. loan would be paid after contruction based on geothermal incentives.	1/28/2024 12:29 PM

Q42 Please feel free to use this space to share any additional comments not covered above.

Answered: 0 Skipped: 7

#	RESPONSES	DATE
	There are no responses.	

Q2 What is the focus of your training center?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	HVAC	1/22/2024 1:43 PM

Q3 How many classes does the center offer on geothermal heating and cooling systems? If it does not offer any, are there plans to add this topic?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	None and no.	1/22/2024 1:43 PM

Q4 How many students does the center host in a year? How has this number changed over the last 10-15 years?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Approximately 70 and we have been growing for the past 10 years.	1/22/2024 1:43 PM

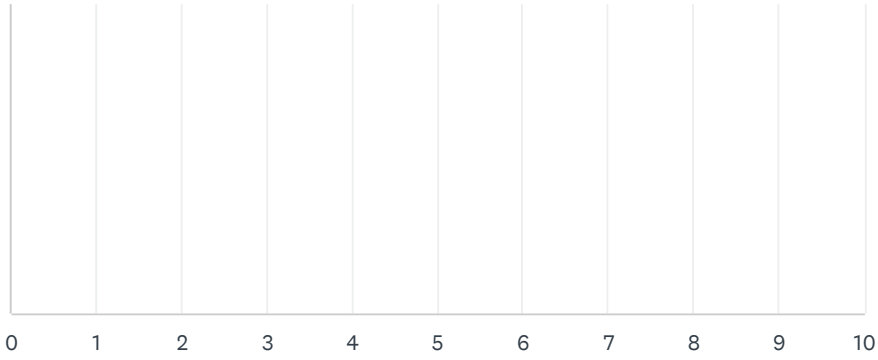
Q5 How many students go through geothermal-relevant training?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	None	1/22/2024 1:43 PM

Q6 What percentage of your students taking geothermal classes are women?

Answered: 1 Skipped: 0



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	0	0	1
Total Respondents: 1			

#		DATE
1	0	1/22/2024 1:43 PM

Q7 What percentage of your students taking geothermal classes are minorities? (Definition of minority)

Answered: 0 Skipped: 1

⚠ No matching responses.

ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	0	0	0
Total Respondents: 0			

#		DATE
	There are no responses.	

Q8 Does your center focus any recruitment spending on women and/or minorities?

Answered: 0 Skipped: 1

⚠ No matching responses.

ANSWER CHOICES	RESPONSES	
Yes	0.00%	0
No	0.00%	0
Not sure	0.00%	0
TOTAL		0

Q9 If answered yes above, what percentage of spending is focused?

Answered: 0 Skipped: 1

⚠ No matching responses.

ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	0	0	0
Total Respondents: 0			

#		DATE
	There are no responses.	

Q10 Does your training center plan on expanding its geothermal program in the next few years?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	No	1/22/2024 1:43 PM

Q11 What other geothermal workforce development initiatives are occurring in the region?

Answered: 0 Skipped: 1

#	RESPONSES	DATE
	There are no responses.	

Q12 What are the current pathways for professionals entering the geothermal workforce?

Answered: 0 Skipped: 1

#	RESPONSES	DATE
	There are no responses.	

Q13 What technical high schools, colleges, or apprenticeship programs are feeders to the geothermal industry?

Answered: 0 Skipped: 1

#	RESPONSES	DATE
	There are no responses.	

Q14 What re-training is readily available for other tradespeople who want to start working in geothermal?

Answered: 0 Skipped: 1

#	RESPONSES	DATE
	There are no responses.	

Q15 Are there any related trades from which your center sees workers moving into geothermal?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	No	1/22/2024 1:43 PM

Q16 Are there any related trades in declining industries whose workforces you anticipate may want to be re-skilled or upskilled for geothermal work in the next 10 years?

Answered: 0 Skipped: 1

#	RESPONSES	DATE
	There are no responses.	

Q17 How can the State of Connecticut assist with the development of geothermal training programs and growing the geothermal workforce?

Answered: 0 Skipped: 1

#	RESPONSES	DATE
	There are no responses.	

Q18 What are your center's main barriers to growing the geothermal workforce?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Lack of market demand for these systems	1/22/2024 1:43 PM

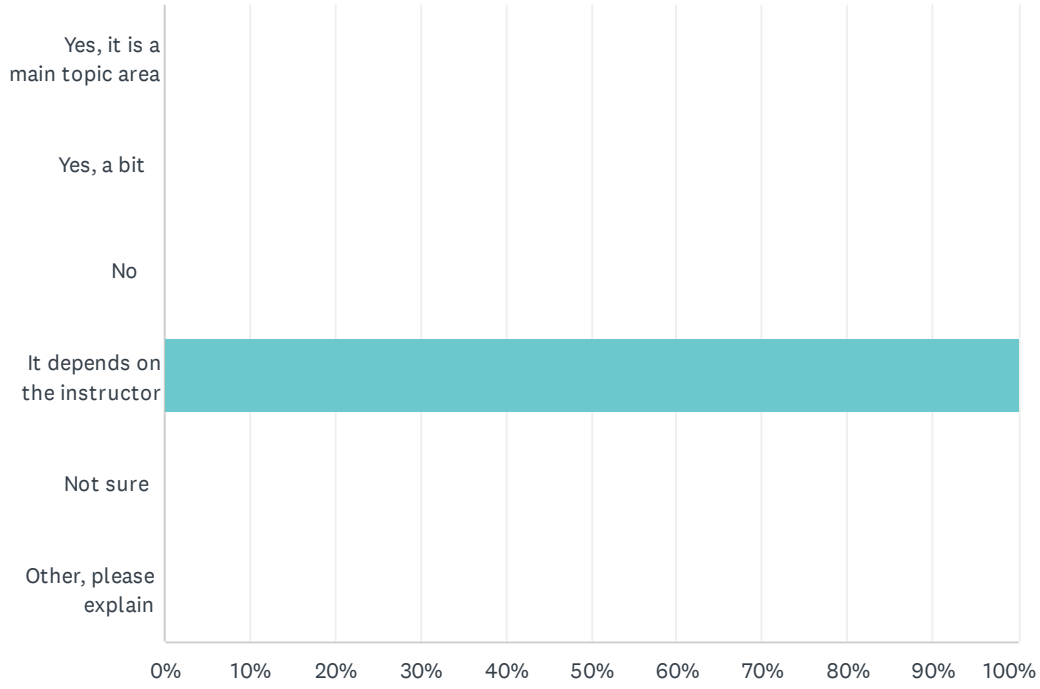
Q19 Please feel free to use this space to share any additional comments not covered above.

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	While we have seen an increase in demand for our training on air source heat pumps we have had no requests for geothermal training.	1/22/2024 1:43 PM

Q2 Does your school have any course material on geothermal heating and cooling in the HVAC program?

Answered: 1 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes, it is a main topic area	0.00%	0
Yes, a bit	0.00%	0
No	0.00%	0
It depends on the instructor	100.00%	1
Not sure	0.00%	0
Other, please explain	0.00%	0
TOTAL		1

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q3 How many students does the school host in a year? How has this number changed over the last 10-15 years?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	65-85 per year in the HVAC program, this number is down compared to years past	1/22/2024 10:10 PM

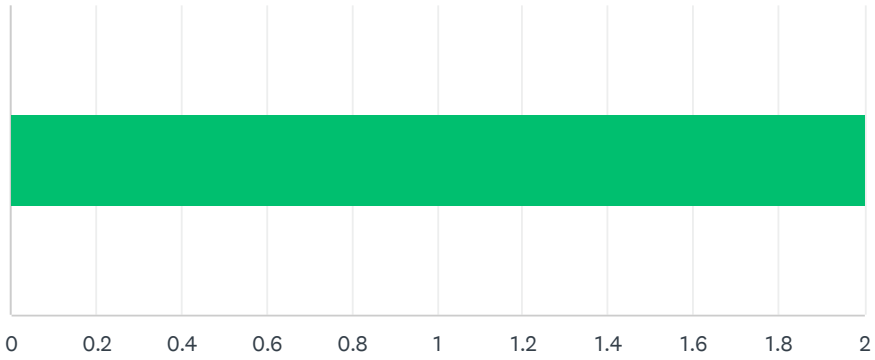
Q4 How many students go through geothermal-relevant training?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	It is based on the instructor. I have discussed it with roughly 40 students within the past year	1/22/2024 10:10 PM

Q5 What percentage of your students participating in geothermal-relevant training are women?

Answered: 1 Skipped: 0

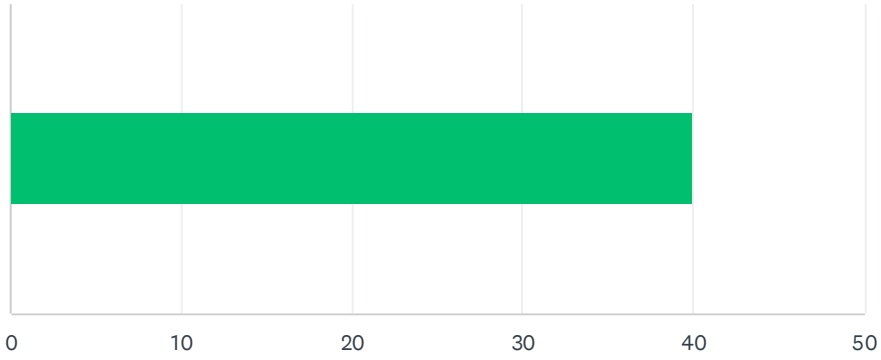


ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	2	2	1
Total Respondents: 1			

#		DATE
1	2	1/22/2024 10:10 PM

Q6 What percentage of your students participating in geothermal-relevant training are minorities? (Definition of minority)

Answered: 1 Skipped: 0

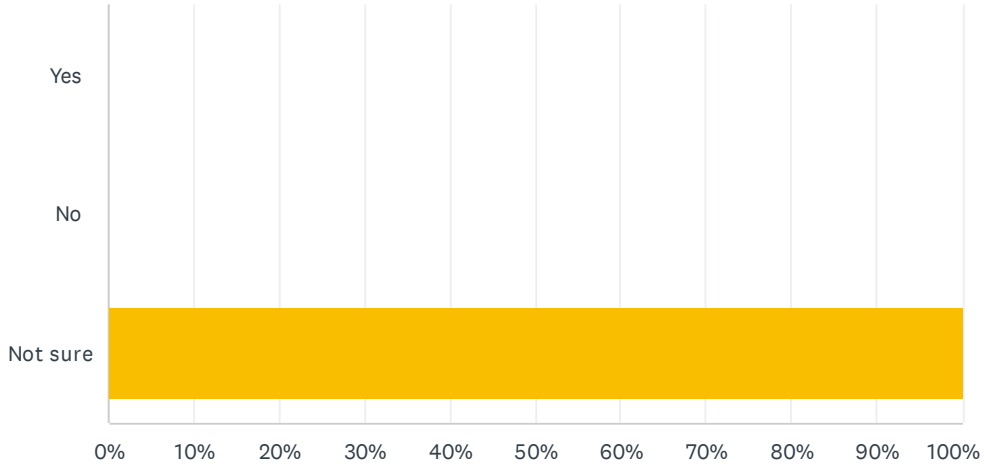


ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	40	40	1
Total Respondents: 1			

#		DATE
1	40	1/22/2024 10:10 PM

Q7 Does your school focus any recruitment spending on women and/or minorities?

Answered: 1 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	0.00%	0
No	0.00%	0
Not sure	100.00%	1
TOTAL		1

Q8 If answered yes above, what percentage of spending is focused?

Answered: 0 Skipped: 1

⚠ No matching responses.

ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
	0	0	0
Total Respondents: 0			

#		DATE
	There are no responses.	

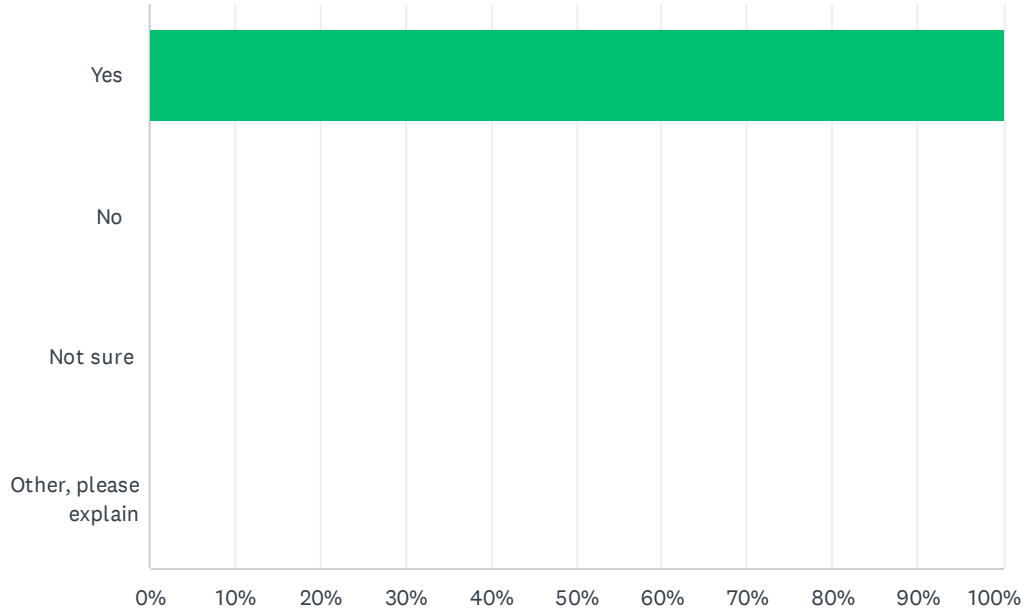
Q9 What are the current pathways for professionals entering the geothermal workforce after graduating from your school?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Green energy certificate, CT apprenticeship program	1/22/2024 10:10 PM

Q10 Does your school help students find apprenticeships in geothermal careers?

Answered: 1 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	100.00%	1
No	0.00%	0
Not sure	0.00%	0
Other, please explain	0.00%	0
TOTAL		1

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q11 Does your school plan on expanding its geothermal program in the next few years?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Unsure. We do have a geothermal trainer and we do cover some it in class, but unfortunate a majority of our instructors do not have experience in geothermal systems	1/22/2024 10:10 PM

Q12 What other geothermal workforce development initiatives are occurring in the region?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Partner companies such as Budderfly in Shelton CT and Dandelion Energy	1/22/2024 10:10 PM

Q13 What re-training is readily available for other tradespeople who want to start working in geothermal?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Online or manufacturer based.	1/22/2024 10:10 PM

Q14 Are there any related trades from which your school sees workers moving into geothermal?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Most HVAC. Geothermal uses the same concept as water source heat pumps in commercial applications so there is a strong crossover	1/22/2024 10:10 PM

Q15 Are there related trades in declining industries whose workforces you anticipate may want to be re-skilled or upskilled for geothermal work in the next 10 years?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Unsure	1/22/2024 10:10 PM

Q16 What are your school's main barriers to growing the geothermal workforce?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	A lot of it has to do with the students engagement and understanding of basic systems. Geothermal systems use concepts that typically only competent licensed technicians hold. Are student population struggle with mathematics, computer literacy, and basic understandings of how to use tools properly	1/22/2024 10:10 PM

Q17 How can the State of Connecticut assist with the development of geothermal training programs and growing the geothermal workforce?

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	Promote the trades better during K-8 and 9-12 grades. Assist with training plans and incentives for students to chose that pathway	1/22/2024 10:10 PM

Q18 Please feel free to use this space to share any additional comments not covered above.

Answered: 1 Skipped: 0

#	RESPONSES	DATE
1	As mentioned above, our student population entering into trade school are having difficulties with the basics. The States current curriculum is theory heavy, but is quite overwhelming for most of these students. I would personally like to push green energy, along with geothermal systems, cogeneration, and of the sort, but unfortunately I think it is a far stretch that my students will be able to comprehend this technology. I do however have some students that excel in class and would love to offer this specialized training to them, but think some sort of incentive should be offered. Perhaps an additional certification or possibly ensured job placement?	1/22/2024 10:10 PM

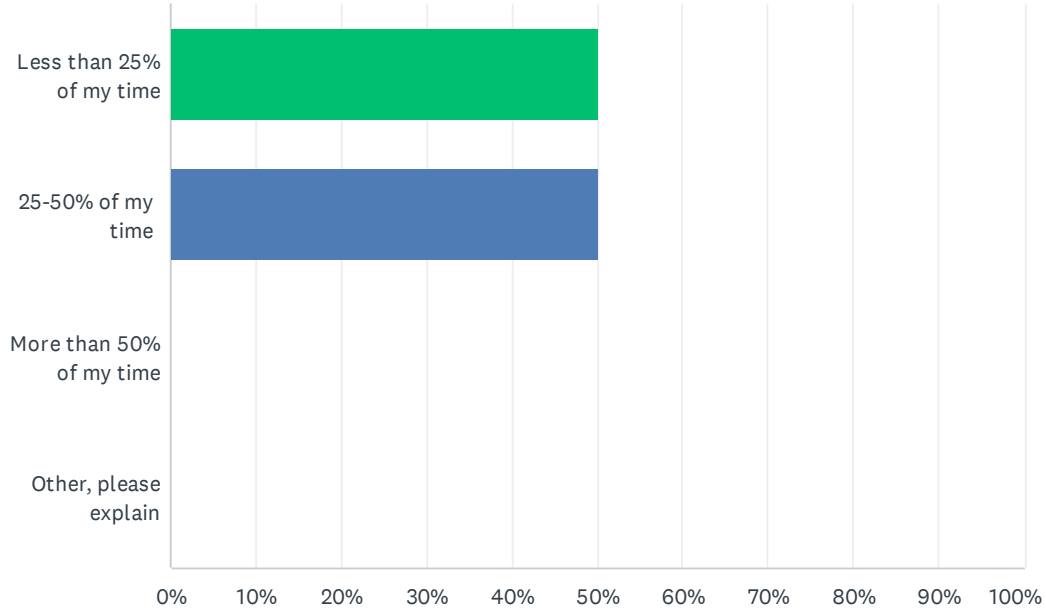
Q1 What is your title at W.H.A.?

Answered: 2 Skipped: 0

#	RESPONSES	DATE
1	Maintainer	1/22/2024 12:56 PM
2	Facilities Manager	1/22/2024 12:14 PM

Q2 During the heating season, how much of your time do you currently spend maintaining the heating system of the Ulbrich Heights buildings?

Answered: 2 Skipped: 0

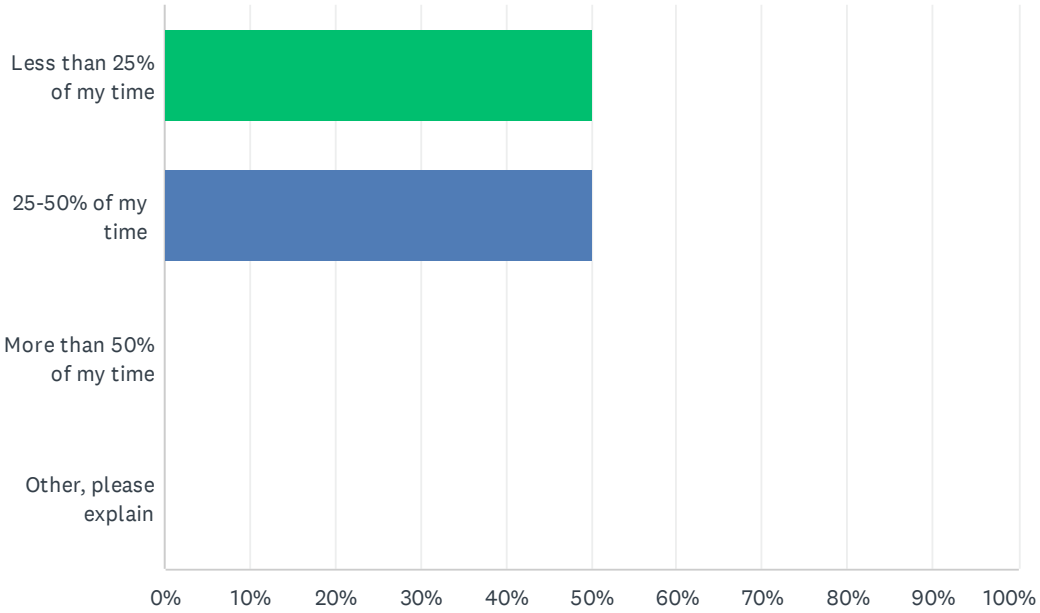


ANSWER CHOICES	RESPONSES	
Less than 25% of my time	50.00%	1
25-50% of my time	50.00%	1
More than 50% of my time	0.00%	0
Other, please explain	0.00%	0
TOTAL		2

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q3 Outside of the heating season, how much of your time do you currently spend maintaining the heating system of the Ulbrich Heights buildings?

Answered: 2 Skipped: 0



ANSWER CHOICES	RESPONSES	
Less than 25% of my time	50.00%	1
25-50% of my time	50.00%	1
More than 50% of my time	0.00%	0
Other, please explain	0.00%	0
TOTAL		2

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

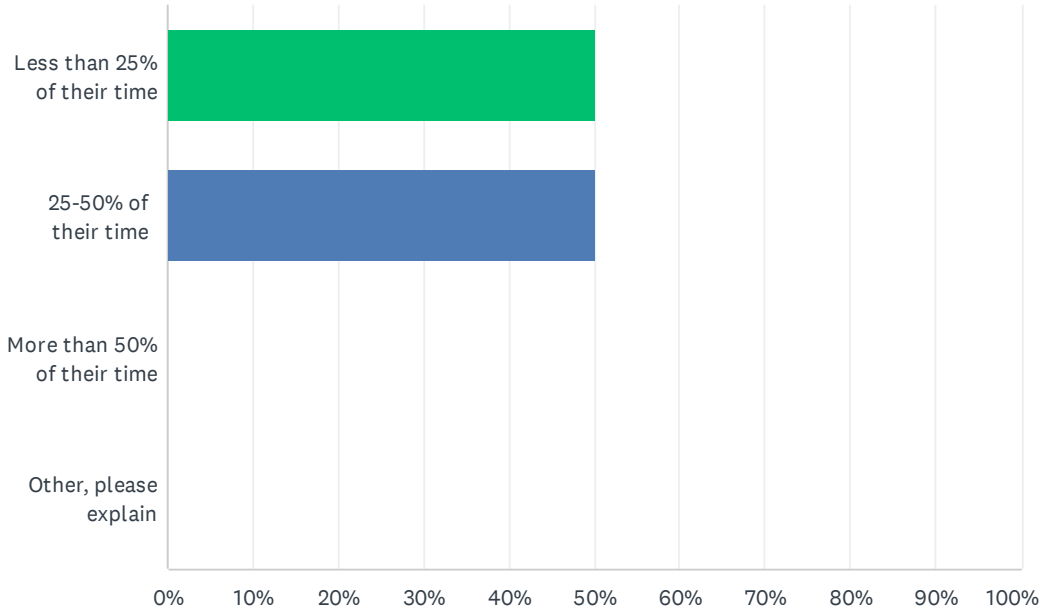
Q4 How much time do contractors and the facilities staff, as a whole, in hours per week, spend maintaining the heating system at Ulbrich Heights?

Answered: 2 Skipped: 0

#	RESPONSES	DATE
1	4	1/22/2024 12:56 PM
2	15	1/22/2024 12:14 PM

Q5 During the heating season, how much time do contractors and the facilities staff, as a whole, as an approximate percent of their time, spend maintaining the heating system at Ulbrich Heights?

Answered: 2 Skipped: 0

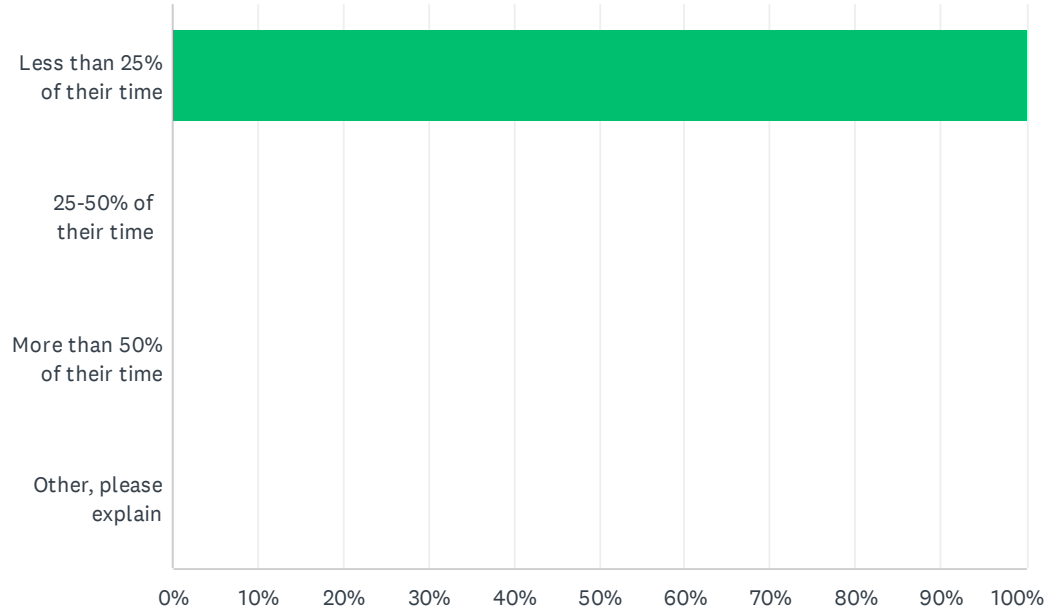


ANSWER CHOICES	RESPONSES	
Less than 25% of their time	50.00%	1
25-50% of their time	50.00%	1
More than 50% of their time	0.00%	0
Other, please explain	0.00%	0
TOTAL		2

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q6 Outside of the heating season, how much time do contractors and the facilities staff, as a whole, as an approximate percent of their time, spend maintaining the heating system at Ulbrich Heights?

Answered: 2 Skipped: 0

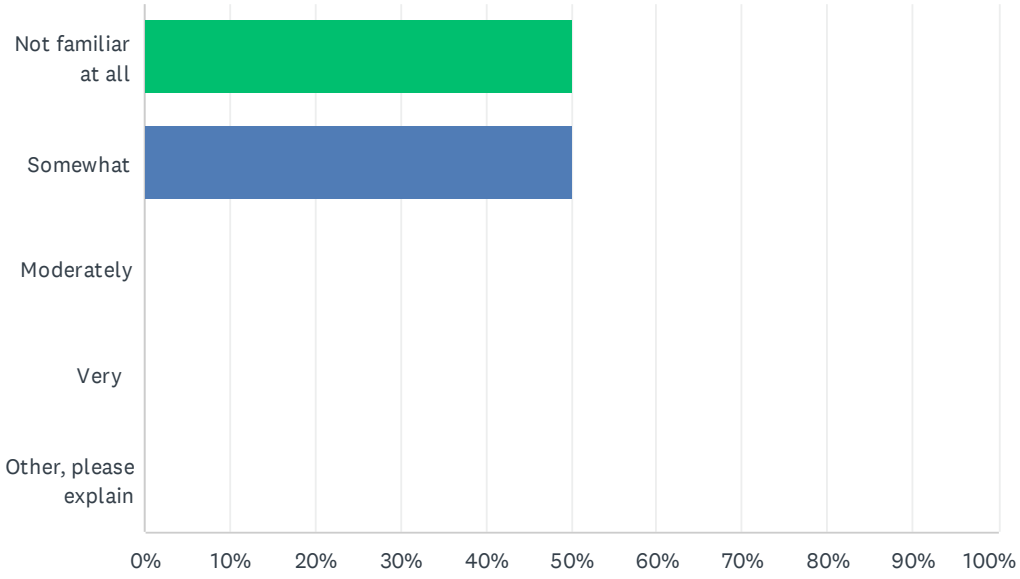


ANSWER CHOICES	RESPONSES	
Less than 25% of their time	100.00%	2
25-50% of their time	0.00%	0
More than 50% of their time	0.00%	0
Other, please explain	0.00%	0
TOTAL		2

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q7 How familiar are you with geothermal heat pumps?

Answered: 2 Skipped: 0

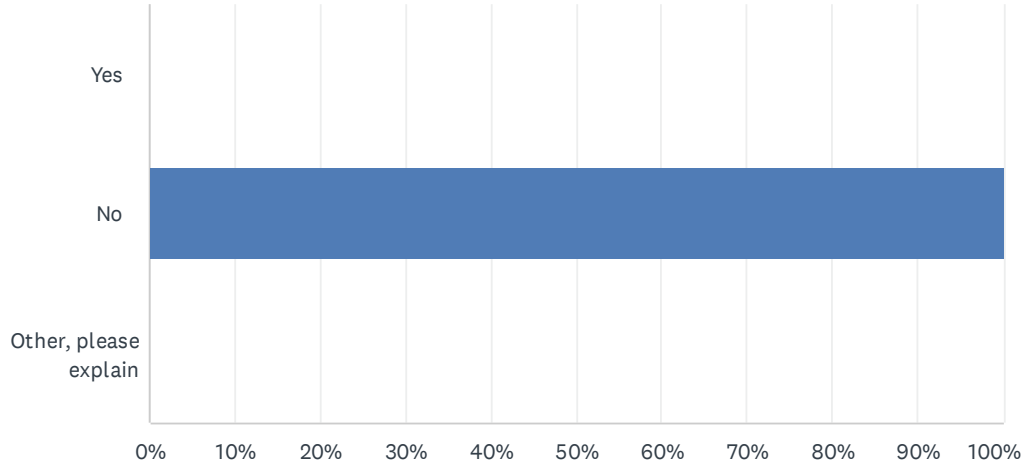


ANSWER CHOICES	RESPONSES	
Not familiar at all	50.00%	1
Somewhat	50.00%	1
Moderately	0.00%	0
Very	0.00%	0
Other, please explain	0.00%	0
TOTAL		2

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q8 Have you ever worked with a geothermal heat pump system before?

Answered: 2 Skipped: 0

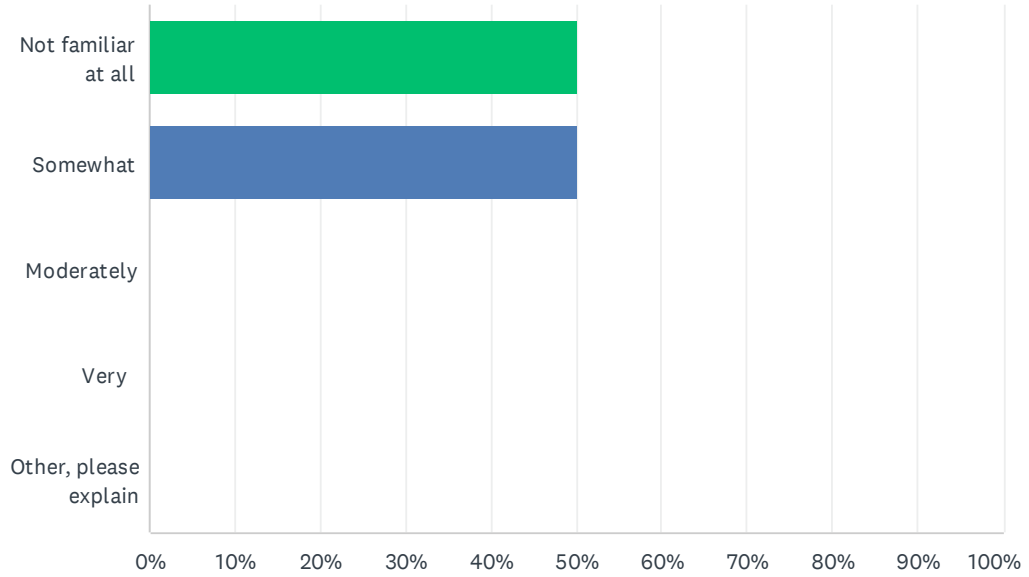


ANSWER CHOICES	RESPONSES	
Yes	0.00%	0
No	100.00%	2
Other, please explain	0.00%	0
TOTAL		2

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q9 How familiar are you with ground source and geothermal heat pumps?

Answered: 2 Skipped: 0



ANSWER CHOICES	RESPONSES	
Not familiar at all	50.00%	1
Somewhat	50.00%	1
Moderately	0.00%	0
Very	0.00%	0
Other, please explain	0.00%	0
TOTAL		2

#	OTHER, PLEASE EXPLAIN	DATE
	There are no responses.	

Q10 Please feel free to use this space to share any additional comments not covered above.

Answered: 0 Skipped: 2

#	RESPONSES	DATE
	There are no responses.	

Q11 If you have interest in learning more about ground source and geothermal heat pumps, please provide contact information below.

Answered: 0 Skipped: 2

#	RESPONSES	DATE
	There are no responses.	

NEEP recommendations for a statewide geothermal workforce development plan

Geothermal Heat Pump Workforce Development Plan for Connecticut

SEPTEMBER 2024

Contents

Authors

The report's lead authors were Michael Anderson, Senior Manager of Community Solutions at Northeast Energy Efficiency Partnerships (NEEP), Yiran He, Senior Associate of Policy and Programs at NEEP, Chase Macpherson, Senior Associate of Community Solutions at NEEP, and Kelly O'Connell, Senior Associate of Community Solutions at NEEP.

Acknowledgments

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Executive Summary

This statewide workforce development plan was produced for the Connecticut Department of Energy and Environmental Protection (CT DEEP) project, District Geothermal Heating + Cooling Deployment in an Environmental Justice Community. This project is funded by the U.S. Department of Energy (DOE) and is centered on the design of a technically- and economically-feasible low-temperature geothermal heating and cooling system for a low-income community in Wallingford, Connecticut, that the Connecticut Office of Environmental Justice identified in 2022 as an Environmental Justice Community. As part of the grant application to DOE, the project team proposed to create a workforce plan for the geothermal industry in Connecticut, based on a needs assessment. The project is being pursued by a coalition of partners, including the Connecticut Department of Energy and Environmental Protection (CT DEEP), Northeast Energy Efficiency Partnerships (NEEP), the University of Connecticut, LN Consulting, the Wallingford Housing Authority, and the Wallingford Electric Division. Construction of the Wallingford system is contingent on availability of funding, including a further award from DOE. Carrying out the recommendations outlined in this plan likewise is contingent on availability of funding but, regardless, the information in this plan will help advance the state's clean energy economy. DEEP expects to explore multiple avenues for funding that may align with this report, including the New England Heat Pump Accelerator Coalition, for which the U.S. Environmental Protection Agency recently announced support.

To prepare this workforce development plan, the coalition completed the *Connecticut Geothermal Industry Workforce Needs Assessment*, which focused on statewide and project-specific gaps in the geothermal workforce in Connecticut. The coalition then held a series of four workshops in May 2024 to inform the identification of programs and initiatives that can fill the gaps identified by the workforce needs assessment. The purpose of this plan is to recommend strategies for overcoming gaps in the state's geothermal workforce that can be implemented within the next 30 months. A separate workforce plan specific to the project in Wallingford will also be developed as part of the DOE-funded project.

New financial incentives for geothermal projects in Connecticut from federal, state, and utility programs are likely to drive increased demand if incentives drive down the installation and operating costs for these systems. This demand could continue to rise as the technology matures and becomes more widespread, resulting in lower manufacturing and installation costs, increased competition among manufacturers and installers, and ongoing improvements in geothermal system efficiency and performance. As more geothermal systems are installed in the state, the geothermal workforce will need to grow apace. If Connecticut agencies and geothermal players can procure sufficient funding, the strategies proposed in this plan would facilitate the growth of Connecticut's domestic geothermal workforce by reducing barriers to entry for workers with skills that are transferrable to the geothermal sector, individuals without prior geothermal experience who are interested in a career in the industry, and companies and technicians currently performing similar work in other states.

The recommendations are grouped into four main topic areas: equity, recruitment and training, licensing, and drilling.

Area of Need	Main Recommendation	Recommended Actions
Equity	Embed equity in workforce development programs through targeted outreach efforts, establish clearly defined equity related program goals, and use holistic approaches for recruiting and training individuals from underrepresented communities.	Invest a predetermined percentage of funding for recruitment in targeted communities. Establish equity centered goals for metrics, such as dollars spent on outreach, the number of individuals entering training programs, and successful candidate placements. Use strategies like wraparound services, soft-skill training, and subsidies for training programs and related expenses.
Recruitment and Training	Increase awareness of geothermal careers with marketing campaigns and accessible low-cost training opportunities.	Create a marketing campaign illustrating career pathways in geothermal. Provide scholarship opportunities for HVAC training courses. Prompt state funded energy efficiency programs, such as Energize CT's Green STEP program, to include geothermal curricula in its trainings. Prompt Connecticut training centers and institutions to use new modularized trainings such as those offered by the International Ground Source Heat Pump Association.
Licensing	Clarify the applicability of heating, piping, and cooling licenses to facilitate the growth of businesses focused on heat pumps. Streamline entry into the field and licensure in Connecticut	Update the description of the limited cooling licenses on CT DCP's website to clarify that they cover heat pump installation. Create informational resources about the licensing pathways available for geothermal professionals, including for those with out-of-state experience or licenses.
Drilling	Retrain existing drillers, entice drilling companies to diversify their businesses into geothermal drilling, and increase the availability of drill rig equipment.	Establish a hub where professionals in the drilling industry can share costly training equipment and resources. Support IUOE Local 478 in bringing a geothermal well driller apprenticeship program to CT. Discuss public ownership of drill rigs with local governments, councils of governments, and others.

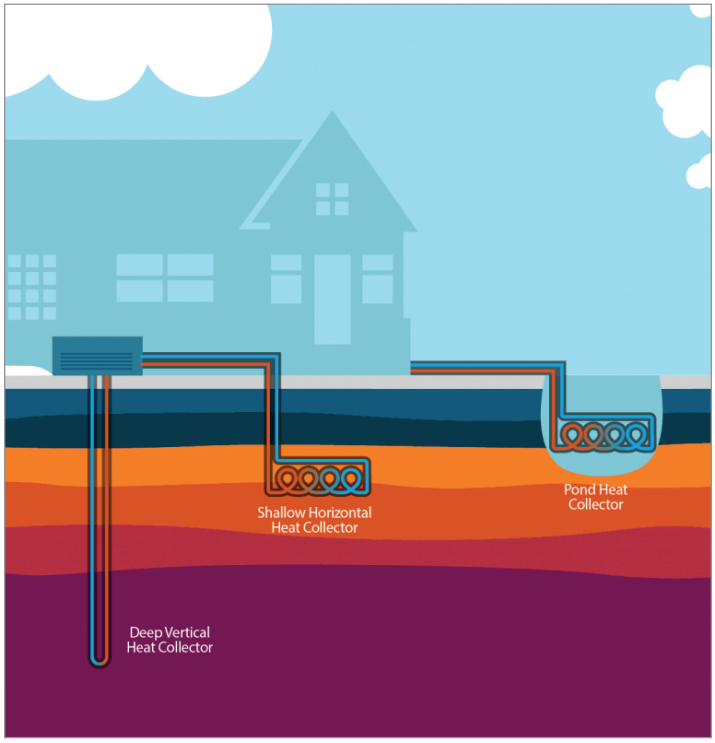
1. Introduction and Background

This section provides background information on geothermal systems and their benefits and a summary of the project and its location at Ulbrich Heights in Wallingford. The next section summarizes the data collection methods and findings of the workforce needs assessment, and the final section describes the recommended strategies for adoption.

1.1 Introduction to geothermal systems

Geothermal systems employ the ground's relatively constant temperature as a thermal resource to provide space heating and cooling for residential and commercial facilities. In Connecticut, temperatures at approximately ten feet below ground remain a constant 50 degrees. When ambient air temperatures are warm, geothermal systems utilize the cool temperatures below ground to provide space cooling. When the ambient air is cold, geothermal systems use the warmer temperatures below ground to provide space heating. Temperature exchange occurs by circulating a heat-transfer fluid through a network of buried pipes known as a ground loop (see Figure 1).

Figure 1. ***Adapted from the U.S. Department of Energy, showing configurations of ground loops***



Networked geothermal is a highly energy efficient application of geothermal heating and cooling. A networked geothermal system connects multiple buildings to a large underground fluid distribution loop. This configuration is often more efficient than a single-building geothermal system due to reductions in thermal energy waste created when multiple buildings with different heating/cooling profiles are connected. Networked geothermal systems perform well in cold weather and are a proven technology with the potential to support community-scale heating and cooling decarbonization. Multiple colleges and universities, mixed-use commercial-residential properties, and multifamily residential properties have installed or are developing networked geothermal systems. Many other entities have also installed commercial-scale non-networked geothermal projects in Connecticut, such as those in Manchester and Willimantic. See CT DEEP's Geothermal Energy webpage for more examples of geothermal projects across Connecticut.

Historically, one consistent barrier to networked geothermal uptake has been the relatively high up-front cost of system installation. As federal and state/utility incentives (both tax credits and rebates) have increased in recent years, the number of geothermal systems installed in Connecticut also has risen. Geothermal system installations in Connecticut increased by 192 percent from 2020 to 2021, by 52 percent from 2021 to 2022, and by 82 percent from 2022 to 2023.[1] With federal and state/utility financial incentives potentially available through 2034, this upward trend is likely to continue.

1.2 Benefits of geothermal systems

Increased uptake of geothermal systems is critical for Connecticut to achieve greenhouse gas (GHG) reduction targets while minimizing grid impacts of electrification. Connecticut has set statewide goals to reduce GHG emissions 45 percent below 2001 levels by 2030, and 80 percent below 2001 levels by 2050. To achieve these goals, Connecticut must decrease the use of fossil fuels for residential heating, which currently accounts for 21 percent of the state's total greenhouse gas emissions. To bring the residential sector's emissions in line with the 2030 target, reductions must occur 6.9 times faster from 2022 through 2029 than they did between 2001 and 2022. The state must also reduce emissions from fossil fuels for heating commercial facilities. Commercial-sector combustion emissions did not decrease sufficiently between 2001 and 2022, and in fact increased slightly, so emissions reductions from 2023 onward will need to be even more aggressive than specified above to achieve 2030 and 2050 targets.[2]

Developing replicable and scalable models for energy efficiency and decarbonization projects in affordable housing communities is important for several reasons. Residential and commercial buildings account for 33 percent of GHG pollution in Connecticut. According to the Connecticut Housing Data Hub, in 2022 there were 94,264 government-assisted rental units across the state. According to the Connecticut Housing Assessment research report by the Urban Institute from December 2020, there are nearly 2.2 million total housing units in the state, so government-assisted rental units make up roughly five percent of the housing stock. Reducing energy consumption in affordable housing communities will help Connecticut reach its GHG reduction goals.

Affordable housing energy efficiency programs help reduce utility costs for residents. Low-income households spend a disproportionate amount of household income on utility costs compared to higher-income households. Lower utility bills can free up needed resources and decrease housing cost burdens for low-income stakeholders. Energy efficiency programs improve comfort, health, and safety. Efficiency programs enhance indoor air quality and thermal comfort, improving overall well-being for residents. Energy efficiency programs can help preserve affordable housing. Given that energy efficiency reduces operating costs and increases net income and property values, property owners are less likely to raise rents and have increased access to capital for repairs or renovations. Additionally, energy efficiency programs provide community economic benefits through the creation of local jobs.

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[1] From Connecticut Energy Dashboard.

[2] Synapse analysis for CT DEEP using Connecticut Greenhouse Gas Reduction Progress Reports.

1.3 Ulbrich Heights project

The DOE's Geothermal Technologies Office is investing millions of dollars in development of reliable and scalable networked geothermal models through the Community Geothermal Heating and Cooling Design and Deployment program. This program is funding a project at Ulbrich Heights in Wallingford, Connecticut, that is led by CT DEEP in partnership with Northeast Energy Efficiency Partnerships (NEEP), the University of Connecticut, the Wallingford Housing Authority, the Wallingford Electric Division, and LN Consulting. The objective of the Ulbrich Heights project is to contribute to development of replicable models for affordable housing energy efficiency and decarbonization programs in Connecticut and beyond.

Ulbrich Heights is a 132-unit affordable housing complex in a low-income community in Wallingford, Connecticut, that the Connecticut Office of Environmental Justice identified in 2022 as an Environmental Justice Community.[3] The Ulbrich Heights Community Geothermal Project includes community engagement activities and the design of a networked geothermal heating and cooling system that will serve at least 50 percent of the apartments at the property. Currently, natural gas boilers heat and window-mounted air conditioning units cool the apartments at Ulbrich Heights. Installation of a networked geothermal system in half of the units at Ulbrich Heights would eliminate 155 tons of annual CO_2 pollution, improve indoor and outdoor air quality, and enhance resident comfort and safety.

In addition to system design and community engagement activities, the Ulbrich Heights project also involves completion of a workforce needs assessment and a workforce development plan. The workforce needs assessment identified and analyzed gaps between current labor market capabilities and the workforce required to meet growing geothermal market demand. This statewide workforce development plan proposes initial systematic solutions to address barriers to entry and fill skill gaps, enabling CT DEEP to ensure the geothermal workforce scales up effectively and at the pace needed to meet Connecticut's GHG emission targets. This statewide workforce development will significantly inform a separate workforce plan specifically tailored to the Ulbrich Heights project.

NEEP derived the strategies outlined in this plan from recommendations and feedback that stakeholders provided during the research and outreach for the workforce needs assessment and workshop series. Stakeholders underscored the need for development at all career stages, from entry-level to mid- and late-career workers, to advance the geothermal workforce. In section 3, NEEP proposes that CT DEEP pursue the strategies described to bridge the current gaps and prepare for significant geothermal market growth.

[3] In 2022, the census block group where Ulbrich Heights is located reported that 30 percent of the population was living below the federal poverty level. https://geodata.ct.gov/datasets/CTDEEP::environmental-justice-2022-set/explore?layer=0&location=41.454345%2C-72.806161%2C13.00.

2. Data Collection

A recent workforce needs assessment and a series of workshops inform this workforce development plan. This section describes the methods and findings of each of these efforts.

2.1 Workforce needs assessment

The Connecticut Geothermal Workforce Needs Assessment identified three major barriers to the uptake of geothermal projects in the state: inadequate awareness of and/or interest in geothermal careers, a tension between an uneven supply of workers and an increasing demand for projects, and high upfront costs that constrain geothermal uptake. This workforce development plan discusses these barriers as they relate to the growth of the geothermal workforce and makes suggestions for growing the geothermal workforce in Connecticut.

Methods

NEEP conducted a series of surveys and interviews with a wide range of experts and professionals in the geothermal industry between October 2023 and April 2024 to form the Connecticut Geothermal Industry Workforce Needs Assessment, published in June 2024.

Surveys were distributed to four stakeholder categories: Wallingford Housing Authority facilities managers; training centers; trade schools; and industry players such as drillers, engineering companies, and geothermal installers. NEEP received 11 survey responses. To get a deeper understanding of institutional barriers to licensing, prior workforce development initiatives, and expected industry changes, NEEP interviewed members of utilities, drilling companies, unions, installers, manufacturers, and the Connecticut Technical Education and Career System. In total, NEEP conducted 19 interviews.

NEEP supplemented this primary research with secondary research from online resources. For a more detailed description of the methodology and the data collected, please consult the needs assessment.

Findings summary

The NEEP team identified three major barriers to the growth of geothermal technology in Connecticut:

1. low awareness of and/or interest in geothermal careers;
2. tension between an uneven supply of workers and an increasing demand for geothermal projects; and
3. persistently high upfront costs for consumers, which constrain geothermal uptake and inhibit market indicators that the geothermal workforce needs to grow.

Despite the presence of high-paying and in-demand job opportunities, awareness of geothermal career paths lags, particularly in segments of the population that would presumably be attracted to these careers. It is critical that the geothermal industry in Connecticut adjust its marketing strategies for the types of positions that become available in a manner that is appealing and accessible to new entrants to scale up the industry.

Meanwhile, an inadequate supply of drillers and drill rigs has increasingly strained the rising demand for geothermal technology. NEEP found that drilling was particularly cost prohibitive to geothermal growth in Connecticut, with over 50 percent of total project costs attributed to drilling alone. An inadequate supply of drillers and drilling equipment compounds this situation. Although a few stakeholders said current demand is being met, the state needs to expand the workforce to accommodate accelerating demand for system installation and prepare the industry for future growth.

The high upfront costs associated with geothermal systems (especially for building retrofit projects) impedes market growth to drive geothermal deployment and employment. Expanded federal initiatives and tax incentives will likely increase demand and grow awareness of geothermal technology. Workers must be in place to address this demand. Currently, state HVAC licensing requirements, difficulties securing new workers and equipment for drilling, and barriers to attracting and training new entrants to geothermal careers all constrain workforce growth.

2.2 Workshops

Methods

After finalizing the needs assessment, NEEP hosted four virtual geothermal workforce solutions workshops. Each workshop focused on one of four themes: licensing, training new entrants, drilling, and the workforce needs assessment (the latter in partnership with the Connecticut Clean Economy Council).[4] NEEP held the workshops throughout May 2024 to share the workforce needs assessment results and provide a forum for stakeholders to provide their perspectives. Over the course of the four workshops, 45 individuals participated, represented utilities, trade unions such as the United Association of Plumbers and Pipefitters Local 777, drilling firms, state agencies such as the Connecticut Office of Workforce Strategy, and geothermal advocacy organizations such as HEET.[5]

Through the workshops, NEEP collected input and suggestions on how to address industry barriers to inform the workforce development plan.

[4] The Connecticut Clean Economy Council (CCEC) is an advisory council bringing together state and industry leaders to work in collaboration to develop workforce training programs, advance economic justice, and deploy funding for sustainability, climate mitigation, and clean energy. https://portal.ct.gov/gwc/connecticut-clean-economy-council.

[5] HEET is a nonprofit organization that works on transitioning gas utilities to thermal utilities. https://www.heet.org/.

Findings summary

These four workshops yielded critical first-hand research that informed this workforce development plan. During the licensing workshop, the stakeholders discussed the absence of, and desire for, a heat pump-specific license in Connecticut, and concerns regarding the pace of retirement for S-1 and S-2 unlimited heating, piping, and cooling license holders at small companies.[6] Stakeholders also pointed to the need to market career opportunities to young people interested in clean energy careers, as well as to pair recruitment efforts with substantial training and educational offerings.

The workshop on training new entrants identified strategies such as expanding the International Ground Source Heat Pump Association's (IGSHPA) modularized curricula within Connecticut, providing wraparound services for students, and building up resources for technical schools such as training equipment and hands-on experience programs.[7]

During the workshop on drilling, NEEP gathered feedback on how to reduce costs and increase the number of drill operators within the state. Key takeaways included the potential impact of union apprenticeships on expanding the number of drillers, ways the Inflation Reduction Act (IRA) geothermal tax credit can reduce initial costs for commercial projects, and the opportunity for larger networked projects to increase the demand for drillers by driving the project pipeline.

Lastly, the needs assessment workshop held in partnership with the Connecticut Clean Economy Council reinforced the need to increase the availability and accessibility of geothermal careers and training. NEEP heard from stakeholders that this drive to increase visibility must be conducted with an equity focus to ensure that careers are marketed thoughtfully, wraparound services are provided, and trainings are flexible for students. Stakeholders also suggested increasing public awareness and trust in geothermal technologies more broadly, especially among existing HVAC contractors and non-geothermal drillers. Ideally, developers, contractors, and engineers would consider geothermal technologies as a conventional and accessible option for building design and construction.

[6] Some heat pump companies have expressed a desire for a license that does not include fossil fuel equipment, because of the barrier it poses to them hosting apprentices with that full scope of work. S-1 and S-2 Unlimited Heating, Piping, and Cooling licenses are the most comprehensive, time-intensive heating, piping, and cooling licenses offered by the Connecticut Department of Consumer Protection.

[7] The International Ground Source Heat Pump Association (IGSHPA) is a member organization composed of manufacturers, engineers, ground loop installers, drillers, as well as many others working to further the adoption of ground source heat pump technology. https://igshpa.org/.

3. Proposed Strategies for Developing Connecticut's Geothermal Workforce

Using data collected through the needs assessment and workshops, NEEP developed the following recommendations to address key workforce growth challenges.

3.1 Incorporate equity through targeted outreach, clearly defined goals, and support for underrepresented communities

Diversity, equity, inclusion, and access make up a "foundational pillar" described in the draft Connecticut Governor's Workforce Strategic Plan; this pillar's goal is creating a more inclusive economy that ensures workers have a seamless and supported pathway from education and training to successful careers.[8] The Connecticut Office of Workforce Strategy (OWS) is leading an initiative to strengthen the workforce of select industries such as manufacturing and IT/data with a goal of training and placing 2,000 workers from historically underserved populations.[9] However, the state has published no development or equity goals for the geothermal workforce in Connecticut. NEEP recommends that Connecticut use the workforce goals set for the aforementioned sectors as guidelines, set similar goals in the geothermal industry, and establish a goal of 40 percent of training program participants in the geothermal industry being members of CT Environmental Justice Communities, to align with Justice40. It could then use this equity-centered approach as a model for workforce development programs in the broader clean energy sector.

To increase diversity in the geothermal workforce, Connecticut should consider setting equity-centered goals for targeted outreach and recruitment of individuals currently in the HVAC workforce as well as new entrants. Connecticut should set a time-sensitive goal (e.g., by 2025) to source a designated percentage of geothermal recruitment from historically marginalized, low-income, and disadvantaged communities. NEEP recommends that Connecticut develop a corresponding outreach initiative that could target audiences such as recipients of government assistance for HUD Section 3 housing by dedicating a percentage of the time and money spent on marketing, communications materials, and training costs for those audiences. This initiative could include in-person open house events, flyers, targeted outreach in languages other than English, coordination with local community action agencies and other community centers, and coordination with local secondary and tertiary education providers. The state could then track demographic data on attendance at outreach events to measure success in meeting equity goals.

As geothermal education and awareness expands through intentional marketing and stakeholder outreach, the state could establish equity-centered goals. For example, the state could establish goals for the number of candidates entering training programs and receiving interviews, the number of job offers extended, and the number of successful placements. Connecticut could also set workforce development targets for the geothermal

[8] Summary of Governor's Workforce Strategic Plan, https://portal.ct.gov/gwc/strategy.

[9] Strengthening Sectoral Partnerships Initiative (SSPI), Connecticut Office of Workforce Strategy, https://www.eda.gov/sites/default/files/2022-08/Office-of-Workforce-Strategy-CT-Project-Narrative.pdf.

heating and cooling workforce that reflect the state's projected demographics in 2050, the year Connecticut is currently using as the target for its climate goals. These equity goals could be tracked and measured through periodic anonymized surveys of employers in the geothermal industry. While attrition will naturally occur between the recruitment, interviewing, and actual placement phases in the process, the demographic proportions at each stage should remain similar.

There are existing workforce development programs in Connecticut, such as Career ConneCT, that take a holistic approach to workforce development, and some of the regional workforce development boards work on placing people in green jobs. CT DEEP has an opportunity to collaborate with existing workforce programs. Connecticut should consider holistic approaches to workforce development in the geothermal industry that meet the individual needs of potential entrants. Wraparound services can lower barriers for training. For example, providing technical skills training as well as soft skills training like time and finance management can support increased minority representation in the clean energy industry. Addressing housing, transportation, and childcare needs, which can present barriers to professional development, is also critical to equitable career access. Such barriers can prevent entry-level hires from joining smaller companies that cannot easily afford wraparound services. To increase access to new workers from disadvantaged communities, state workforce development efforts should incorporate funding for wraparound services, including but not limited to stipends for childcare and transportation, assistance in getting a driver's license if required, training in general job readiness skills, and post-placement career supports. To support underrepresented communities in joining Connecticut's geothermal workforce, the state can also address cost barriers to taking training courses and paying union dues. Connecticut could consider providing funding directly to training course participants, and grants to community-centered organizations with connections to those in need of funding for supporting program activities such as wraparound services and scholarships.

Connecticut could set up a publicly accessible database to track, report, and support progress toward these goals. By tracking program data, the state can tailor outreach strategies to specific community needs over time.

3.2 Recruiting and training new entrants

3.2.1 Generating awareness and interest in the industry

A broad awareness campaign targeted at young people could benefit the geothermal industry. Research for the needs assessment showed that many companies have a difficult time finding new workers who are genuinely interested in staying in the field because many do not have a clear sense of the industry and available career pathways. CT DEEP could support the creation of marketing materials that illustrate geothermal career pathways, the main job functions, the character of the work, and the contributions that people in geothermal careers can make toward mitigating climate change. Connecticut could engage Local 777, the Connecticut Plumbers, Pipefitters, and HVAC-R union in this process, as they already offer a wide variety of licensing pathways and bring young members to career fairs to talk with students. Other labor unions and related nonprofits, such as the Connecticut Roundtable on Climate and Jobs, could also collaborate to create these materials.

3.2.2 Reaching high school and college students

To increase awareness of the geothermal industry and career pathways, Connecticut should consider a campaign to reach students in technical high school HVAC programs. While the needs assessment revealed a lack of consensus on the extent that geothermal curriculum is being covered in Connecticut Technical Education Career System (CTECS) high school HVAC programs, ample opportunity exists to enhance exposure to the career paths available. One way to do this would be for the Energize CT-sponsored Green Sustainability Technology Education Program (Green STEP) to begin including geothermal heat pump material in its curriculum. Green STEP also offers programming to public school students in the form of after-school or summer classes, so including geothermal in this program would expose a wide range of students to the opportunities within this career path. Green STEP regularly consults with energy efficiency and clean energy industry professionals to help shape the program's curriculum. This process should include members of the geothermal heating and cooling industry.

Geothermal system manufacturers can also raise awareness of the industry by donating or subsidizing the use of geothermal equipment for educational purposes. Access to equipment for training gives students the opportunity to gain hands-on experience with geothermal technologies. Early interventions that build awareness of geothermal technologies and provide high-quality educational opportunities can demonstrate to young people what careers in geothermal are like in practice. Programming could also include site visits, to give people the opportunity to see geothermal systems under construction or in operation first-hand.

Increasing the capacity of technical high school HVAC programs could help expand the pool of people with relevant skills and training. One participant in a workforce solution workshop noted that schools often have lengthy wait lists for technical high school HVAC programs, and a significant number of these students ultimately have no opportunity to participate. The subsequent lack of post-secondary opportunities for affordable geothermal training leaves many young people out of the pipeline to industry careers.

For students who are not in technical high schools, the state and industry should leverage existing career programming. Many schools in Connecticut already have career cluster initiatives and small learning academies targeted at specific industries, and geothermal could be included in those. This would also help address equity concerns with recruiting new entrants, because many of these programs are in schools in large urban areas, where students from disadvantaged communities may not have access to technical school education.

3.2.3 Reaching adults transitioning into the industry

For adults seeking HVAC training for a career in the geothermal industry, the price of training courses may be a serious barrier. The offerings outside of technical high school programs can cost thousands of dollars, likely deterring potential entrants who cannot afford the upfront cost. CT DEEP could explore ways to provide increased scholarship opportunities for members of disadvantaged communities to attend training programs that the CT Department of Consumer Protection accepts toward classroom hour requirements. Alternatively, the CT Department of Consumer Protection could allow heat pump dealer trainings and similar reduced-cost

training programs to count toward the classroom hour requirements for licenses. CT DEEP could also engage the state's regional workforce boards, which already have experience implementing workforce programs for job seekers in the clean energy industry. The Northwest Regional Workforce Investment Board has launched an Architecture, Engineering, and Construction partnership that could include geothermal careers, and the southwestern workforce board WorkPlace has recently launched the Energy Works program with funding from the U.S. Department of Labor. In the Energy Works program job seekers engage in short-term trainings for solar, weatherization, or utility line worker careers, using classroom instruction, hands-on practical exercises, and immersive virtual reality simulations.

Connecticut might also look to the District of Columbia's Sustainable Energy Utility (DCSEU) workforce development program as a model for encouraging businesses to offer more on-the-job training. The DCSEU program connects DC residents who are new to the workforce, between jobs, or looking for a career change with local contractors, businesses, municipal agencies, and other organizations in five month paid externships, across the clean energy sector. DCSEU pays wages with ratepayer funds because the SEU has mandatory workforce objectives. This funding allows employers to take on more hiring risk, and companies that host participants often hire program graduates.

The International Ground Source Heat Pump Association (IGSHPA) is developing and releasing new modularized training courses that correspond with the 14 job descriptions identified in a 2013 report by the Geothermal Heat Pump Consortium on behalf of the U.S. Department of Energy. IGSHPA has already released training courses for service technicians and installers. Upcoming additional courses include those for advanced service technicians, residential design, commercial design, and inspection. IGSHPA plans to have all training program courses available by the end of 2025 and will pilot the programs in select community colleges, vocational and technical colleges, and other training facilities. CT DEEP could coordinate with interested colleges and training facilities to help bring these courses, or others like them that tie directly to one or more geothermal job descriptions, to Connecticut institutions and thereby give Connecticut students access to these new geothermal training opportunities and accreditations. To ensure that programs deliver comprehensive training that supports greenhouse gas emissions reductions, participants should be trained on how to mitigate refrigerant leaks as well.

Finally, Local 777, the Plumbers, Pipefitters, and HVAC-R union in the state, accepts 50 to 75 apprentices per year out of roughly 500 to 600 applications received. Local 777 stated that it will accept only the number of apprentices for which it believes it has job opportunities. As geothermal development expands in Connecticut, the state could work with Local 777 to identify opportunities to expand the number of apprentices it accepts and to encourage those not accepted to seek other career pathways in geothermal.

3.3 Licensing

3.3.1 Licensing content

In Connecticut, the Department of Consumer Protection (CT DCP) controls professional licensing. Currently available heating, piping, and cooling licenses include the S series limited and unlimited heating, piping, and cooling licenses, the OE-2 Operating Engineer Journeyperson license, the G series for gas equipment, the D-3 and D-4 licenses for refrigeration-based equipment, the D-1 and D-2 limited warm air, cooling, and refrigeration licenses (which do not cover oil burners), and the B series for gas and oil burners. See Table 1 for information about the number of license holders in Connecticut for each of these heating, piping, and cooling licenses.

Table 1. ***Heating, Piping, and Cooling Licenses, Uses, and Holders in Connecticut.***

License Type	Main Uses	Number of License Holders in CT
B Series	Gas and oil burners	**1,012**
D-1 and D-2	Limited warm air, cooling, and refrigeration *Covers decommissioning fossil fuel systems	**2,428**
D-3 and D-4	Limited cooling (refrigeration-based equipment) *Does not cover decommissioning fossil fuel systems	**94**
G Series	Gas equipment	**670**
S-1 and S-2	Unlimited heating, piping, and cooling	**4,838**
Other S Series	Limited heating, piping, and cooling	**1,488**

Source: the CT DCP, accessed June 2024

Some industry stakeholders note that the current requirements for heating, piping, and cooling licenses are not conducive to heat pump-only businesses, which are likely to play an increasingly important role as Connecticut pursues its decarbonization goals. Currently, few heat pump-only businesses exist in the state. Reforming licensing requirements might facilitate more in-state geothermal business development or incentivize out-of-state companies to expand operations into Connecticut.

One major topic of disagreement among stakeholders is the amount of training that should be required on equipment for contractors who simply decommission fossil fuel systems and replace them with heat pumps. The general understanding among heat pump contractors in Connecticut seems to be that the lowest-barrier licenses that allow for this work are the D-1 and D-2 Limited Warm Air, Air Conditioning, and Refrigeration Contractor and Journeyperson licenses, respectively. The D-2 license requires approximately 750 hours of training on fossil fuel systems and dedicates 10 of 60 questions to fossil gas systems.[10] The D-3 and D-4 Limited Cooling Contractor and

[10] Connecticut Department of Consumer Protection Occupational Licensing Heating, Piping and Cooling Trades Candidate Information Bulletin 2023. https://candidate.psiexams.com/bulletin/display_bulletin.jsp?ro=yes&actionname=83&bulletinid=59&bulletinurl=.pdf.

Journeyperson licenses allow for installation, repair, replacement, maintenance, or alteration of all refrigeration systems and would likely cover the installation of air-source heat pumps without any training on fossil fuel systems. Identifying the lowest-barrier license that allows for the installation of water-source heat pumps will require more conversation and coordination between CT DEEP and CT DCP.

3.3.2 Licensing accessibility

In addition to identifying curriculum and training considerations for Connecticut licenses, NEEP also identified concerns about the barriers some potential candidates face in obtaining a license. Improving clarity on licensing rules and increasing accessibility to the licensing process could foster further growth of the workforce.

Conversations with the CT DCP and industry stakeholders suggest that the workforce needs greater clarity about licensing pathways. A primer on licensing pathways would be useful to ground-source heat pump installers, those interested in transitioning to ground-source heat pump installation, and new industry entrants. This primer could illustrate training requirements and the scope of work each license permits and outline viable paths to obtaining licenses needed for each stage of geothermal installation (drilling, loop fabrication, heat pump installation, etc.).

A gap may also exist between CT DCP's intention to allow workers to apply out-of-state experience toward their Connecticut on-the-job training requirements and worker access to this training exception. While CT DCP does not have reciprocity with any other jurisdictions for licenses, it does have established equivalencies with some states' licensing programs and considers transcripts from other states for recommendation to an internal review board. While workers with licenses from other jurisdictions may obtain waivers for on-the-job training (OJT) requirements relatively easily, those working without a license in other states find it more difficult to petition for a waiver of OJT requirements for a Connecticut license. NEEP recommends that CT DEEP work with CT DCP to do targeted outreach to industry stakeholders to address knowledge gaps and misconceptions about how to apply out-of-state experience to Connecticut licensing pathways and address any outstanding questions or concerns related to this process. CT DCP could also waive OJT requirements if the applicant has a proven track record of two years of geothermal heat pump business ownership in another state, as recommended by one stakeholder.

3.4 Drilling

3.4.1 Drilling: Recruitment and training

Many observers point to drilling as a major bottleneck for the geothermal industry. Increasing the number of trained, licensed drillers is critical to making geothermal projects easier for contractors to implement, which would help minimize project delays. See Table 2 for a description of the relevant drilling licenses in Connecticut, which are separate from the heating, piping, and cooling licenses discussed above. A driller need not start in a registered apprenticeship but must be a driller trainee for one year (in most cases) before taking the written exams and obtaining a license.

Table 2. *Well Drilling License Types and Scopes of Work in Connecticut.*

License Type	This registration permits the registrant to …
W-1 Unlimited Well Driller Contractor	Engage in well construction.
W-2 Unlimited Well Driller	Construct a well, including the installation, repair and maintenance of pumps, pump motors, pump piping, valves, wiring, electric controls, and tanks, while in the direct and regular employment of a contractor registered for this work.
W-3 Limited Non-Water-Supply Contractor	Construct a non-water-supply well, including the installation, repair and maintenance of pumps, pump motors, pump piping, valves, wiring, electric controls, and tanks.
W-4 Limited Non-Water-Supply Driller	Perform the scope of W-3 license while in the direct and regular employment of a contractor registered for this work.
W-5 Limited Well Casing Extension Contractor	Perform well casing extension, repair, and maintenance work.
W-6 Limited Well Casing Extension Journeyperson	Perform the scope of W-5 license while in the employ of a contractor licensed for this work.
W-7 Limited Geothermal Contractor	Construct a geothermal bore hole or geothermal system, up to and including the manifold connection, including the installation, repair, and maintenance of piping, casing, heat transfer media, pumps, pump motors, and valves. This registration excludes work on direct exchange systems.
W-8 Limited Geothermal Driller	Perform the scope of W-7 license while in the employ of a contractor licensed for this work.
W-9 Limited Direct Exchange Geothermal Contractor	Construct a geothermal bore hole or geothermal system, up to and including the manifold connection, but limited to those geothermal bore holes employing direct exchange or direct expansion technology, including drilling associated with the installation of copper or other piping containing a direct exchange heat transfer medium, the installation, repair, and maintenance of piping, casing, and heat transfer media.
W-10 Limited Direct Exchange Geothermal Driller	Perform the scope of W-9 license while in the employ of a contractor licensed for this work.
Driller Trainee	Perform the work for which they are being trained, only while in the presence and under the supervision of a registered contractor driller. Such driller trainee may also perform minimal cleaning work while not in the presence of such supervising contractor or driller.

Source: https://portal.ct.gov/dcp/licensing/generate-a-roster-of-licenses-permits-registrations, accessed June 2024

Geothermal drilling involves a skill set similar to that of other types of drilling, such as well-water, oil, and natural gas drilling. This transferability of skills creates opportunities to retrain drillers from other industries to work on geothermal projects. IGSHPA gears its geothermal drilling training toward existing drillers. Connecticut could implement this approach at in-state training institutions to increase retraining opportunities for drillers already working in the state. Because demand is more consistent for well-water or other kinds of drilling work, the industry may need a marketing campaign to entice drillers to work on geothermal. This campaign would need to demonstrate the viability of geothermal drilling as a business and convince workers that the demand for geothermal careers will become more and more stable. Connecticut state agencies could collaborate to support a marketing campaign aimed at retraining existing drillers.

Local 478, the Connecticut chapter of the International Union of Operating Engineers (IUOE), is planning to bring a geothermal drilling apprenticeship to its training facility in Meriden. Local 478 is developing this program with guidance from IUOE Local 150 in the Chicago area, which has been offering a geothermal drilling apprenticeship since 2009. Local 478's geothermal training program is currently awaiting approval from the Connecticut Department of Labor. Because it has already been successfully implemented elsewhere, the training director at Local 478 expects the program to be approved.

3.4.2 Drill rig availability

Sustainable Westchester has proposed the purchase of a publicly owned drill rig for the county, which the county or another public entity would lease out for geothermal drilling work. It also aims to provide workforce development opportunities, potentially in partnership with Westchester Community College and the Union of Operating Engineers. Sustainable Westchester has collaborated with the Westchester County Director of Economic Development on a concept paper proposal for this model with a request for funding from the County Board of Legislators.

One potential solution for increasing drill rig availability and driller training opportunities is public ownership of drilling rigs. Sustainable Westchester, in Westchester Country, NY, is a municipal member-based organization, comprising 44 of the county's 45 municipalities.11 A representative of Sustainable Westchester suggested that a public entity in Connecticut could own and lease out a drilling rig and could potentially use it both for drilling within the community and for workforce training. CT DEEP could gauge interest in and assess the feasibility of this approach through coordination with local municipal groups and help identify funding, financing, and payback timelines.

The Geothermal Market Capacity Coalition, a national group with a focus on the Northeast, developed the idea of Geothermal Drilling Centers of Excellence to address

[11] Sustainable Westchester is a municipally led shared service provider working towards achieving a clean energy transition in New York State and strengthening the communities of Westchester County. https://sustainablewestchester.org/.

the need for an increased geothermal drilling workforce.[12] The coalition is composed of leading ground source heat pump manufacturers, contractors, geothermal drillers, trade groups, and educational, environmental, and advocacy organizations. The four main objectives of Geothermal Drilling Centers of Excellence are to provide geothermal training with wraparound services for drillers and other workers, develop innovative drill rig leasing programs, spur domestic drill rig manufacturing, and identify other opportunities for driving industry growth. The Geothermal Market Capacity Coalition has not yet secured funding for the Centers of Excellence but continues to pursue the concept as a means of supporting geothermal drilling growth. CT DEEP is currently an active member of this coalition and should continue to support the coalition's pursuit of funding for the Centers of Excellence as a pathway to provide geothermal workforce training.

Another potential solution for the lack of drill rig availability is decreasing the need for drill rigs. The strategic use of other thermal resources can offset the need for boreholes and help reduce the cost and time required for drilling. Leveraging nearby sources of waste heat can increase system efficiency and reduce first costs for geothermal systems. Examples of waste heat include heat released from commercial refrigeration during winter and excess heat in a building's wastewater. A networked geothermal system in Vancouver distributes waste heat from an ice rink to homes and buildings nearby for heat and hot water, and many other examples exist across the continent. Increasing mechanical, electrical, and plumbing firms' capacity to leverage alternative thermal resources would benefit the industry as networked geothermal systems gain popularity, and the state could achieve this do via webinars, working groups, conferences, etc.

4. Conclusion

Based on extensive conversations with knowledgeable industry stakeholders and research on the current geothermal landscape, this report provides a tailored and specific selection of recommendations to best meet Connecticut's geothermal workforce development needs and support both new and transitioning workers to the industry. In light of the previously published assessment of the current geothermal landscape and workforce in Connecticut, NEEP identified four main topic areas to be addressed in this plan: equity, recruiting and training new entrants, licensing, and drilling.

Equity—Incorporating equity measures in geothermal workforce development will align with support a diverse geothermal workforce, and provide economic benefits to historically-underrepresented communities in Connecticut. While the state has workforce equity goals for some industries, it has no established goals for geothermal heating and cooling workforce development. The state can embed equity in workforce development programs through targeted outreach efforts, by establishing clearly defined equity-related program goals, and by using holistic approaches to recruiting and training for individuals from underrepresented communities. By

[12] The Geothermal Market Capacity Coalition consists of leading ground source heat pump manufacturers; contractors and geothermal drillers; trades groups; and educational, environmental, and advocacy organizations working to relieve supply chain, labor, and capacity shortages. "A National Network of Geothermal Drilling Centers of Excellence," Geothermal Market Capacity Coalition, 666c99a5c7b42cb43c15fe6c_GMCC-Geo-Drilling-CoE-White-Paper.pdf (webflow.com).

investing a predetermined percentage of funding for recruitment in targeted communities, the state can bolster diversity in the workforce. Establishing equity-centered goals and metrics such as dollars spent on outreach, the number of individuals entering training programs, and successful candidate placements will allow the state to measure the effectiveness of its outreach strategies. By incorporating a holistic approach into program design through strategies like wraparound services, soft-skill training, and subsidies for training programs and related expenses, the state can reduce barriers to entry into the geothermal industry for individuals from underserved communities.

Recruiting and Training—To increase worker awareness of the geothermal industry and attract new workers, marketing campaigns and accessible low-cost training opportunities are crucial. To encourage new entrants into the field, the state of Connecticut could create a marketing campaign illustrating career pathways in geothermal; support Connecticut training centers and institutions to use new modularized trainings such as those offered by the IGSHPA; provide more scholarship opportunities for HVAC training courses; prompt state-funded energy efficiency programs, such as Energize CT's Green STEP program, to include geothermal curriculum in their trainings; and increase the capacity of technical high school HVAC programs.

Licensing—The state should clarify the lowest-barrier heating, piping, and cooling licenses that cover the installation of water-source heat pumps in their scope with the CT DCP to facilitate the growth of businesses seeking to focus on heat pumps rather than fossil fuel equipment. To streamline entry into the field and licensure in Connecticut, the state could create informational resources about the pathways available for geothermal professionals. This would make it easier for geothermal professionals to transfer out-of-state work experience, help applicants meet on-the-job training requirements, and make training programs more accessible.

Drilling—The state can address the drilling bottleneck evident in the industry with three strategies: retraining existing drillers, enticing drilling companies to diversify their businesses into geothermal drilling, and increasing the availability of drill rig equipment. Establishing hubs where professionals in the drilling industry can share costly training equipment and resources could enhance the training and retraining of geothermal well drillers. Another idea proposed by the team involves a public entity, like a council of governments, owning and leasing drill rigs. This approach could reduce entry barriers, accelerate geothermal projects by making rigs more readily available, and offer training opportunities for workers. Additionally, bringing existing geothermal well driller apprenticeship programs to Connecticut, potentially supported by state subsidies to encourage companies to take on new hires, would further boost the supply of new drillers entering the industry.

Based on the needs of the consulted stakeholders and the data collected, CT DEEP, its sister agencies, and other geothermal actors in the state should work to establish an equity-centered approach to support every aspect of geothermal workforce development. NEEP recognizes that most of the work outlined in this plan is contingent on the availability of funding, sources of which have not been identified. If funded, however, the strategies outlined in this plan can help Connecticut as it seeks to develop a geothermal workforce at the scale needed to fulfill *Connecticut's climate and grid-management goals.*

4.1 Next steps

NEEP recommends that Connecticut agencies and other geothermal players, contingent on availability of funds, implement short-, medium-, and long-term actions to fill gaps and address inadequacies to support successful scale-up of the geothermal workforce.

4.1.1 Short-term actions

Over the next 12 months, Connecticut should focus on actions that will both address the urgent needs of the current workforce and position the geothermal workforce for future success.

Based on the needs assessment and conversations with industry stakeholders, NEEP recommends collaboration between relevant Connecticut agencies such as CT DEEP, OWS, DCP, Department of Labor, Department of Economic and Community Development, and others as necessary to achieve the following objectives:

- Obtain any available, relevant demographic data that was beyond NEEP's scope during the research for the workforce needs assessment and workforce development plan (this could include demographic data collection from various government agencies or requests for data from entities that do not post publicly, including data on demographics in existing recruitment, interview, and hiring pools); begin to track and measure this data to assess equity-related themes and trends;
- Set equity-centered goals aligning with Justice40 for geothermal workforce outreach, recruitment, and hiring;
- Improve clarity of licensing rules and regulations by creating a primer for industry stakeholders on various licensing pathways for geothermal careers; include additional resources for those already in the industry and willing to transfer into Connecticut's market;
- Identify the lowest-barrier license that covers the installation of water-source heat pumps in its scope of work;
- Connect with heat pump manufacturers, technical high schools, and labor unions to begin planning a campaign to raise awareness of geothermal career pathways for young people (marketing activities could include tabling at career fairs, hosting informational sessions at vocational schools, partnering with community-based organizations for career fairs or construction project site visits, and/or coordinating with industry stakeholders to donate or subsidize the use of HVAC equipment for educational use);
- In consultation with industry representatives, work to include geothermal training topics as part of Green STEP's curriculum and in public schools' career cluster initiatives;
- Coordinate with IGSHPA to bring its new modularized curricula into vocational and technical schools and community colleges in accordance with IGSHPA's plans;
- Promote training on mitigating and handling refrigerant leaks; and
- Establish a working group to direct, facilitate, and continuously evaluate the impact of actions and overall success in developing Connecticut's geothermal workforce (this could be part of a regional sector partnership established by the Office of Workforce Strategy).

4.1.2 Medium-term actions

NEEP recommends that over the next 18 to 30 months Connecticut agencies work to ease pathways of professional development through the following actions:

- Enhance scholarship opportunities for members of disadvantaged and/or environmental justice communities to take geothermal training courses, enroll in technical schools, and join geothermal pre-apprenticeship programs;
- Work with existing training programs to increase the capacity of vocational and technical schools to take on more students;
- Consider creating grants for small businesses to subsidize OJT for targeted candidates in apprenticeships related to geothermal, thereby encouraging companies to take on some hiring risk;
- Support the Department of Labor's approval of geothermal apprenticeship programs such as the geothermal drilling program proposed by Local 478;
- Address misconceptions in the geothermal industry about transferring out-of-state licenses or work experience with targeted outreach and education;
- Explore opportunities to provide accessible wraparound services for students, including stipends for childcare, housing, and transportation, especially for those undergoing training programs (CT DEEP could also develop training and communications packages targeted toward language-isolated communities); and
- Undertake strategic outreach and develop tools for architects and engineers to become more aware of geothermal heating and cooling as an ideal option for designing and retrofitting HVAC systems and to bolster these professionals' willingness and capacity to deploy it.

4.1.3 Long-term actions

NEEP recommends that by the end of the 30-month period, Connecticut should seek to make significant progress on the following actions:

- Institute a formal process of collecting and responsibly storing detailed demographic data for the geothermal workforce through follow-up with participants of various training programs and collaboration with government agencies and private companies; consider ways to share this data in a publicly accessible database;
- Create a portfolio of affordable options for geothermal training that is publicly and easily accessible through existing training programs and on CT DEEP's web pages (such a portfolio can ease barriers to entry for industry entrants);
- Collaborate with the Geothermal Market Capacity Coalition to build a network of geothermal professionals in and around Connecticut to evaluate and begin developing a Center of Excellence for the geothermal industry in the region; and
- Encourage municipalities, councils of government, and/or private and nonprofit entities to establish a nonprofit drilling organization that can provide geothermal services to low-income focused projects; consider public ownership of expensive equipment such as a drill rig; explore supporting such a nonprofit through grants or financing.

Local geothermal workforce development plan

Ulbrich Heights Geothermal Project Workforce Development and Training Plan

Introduction

This localized workforce development plan for Wallingford, Connecticut, was created on behalf of the Connecticut Department of Energy and Environmental Protection (CT DEEP) for its District Geothermal Heating + Cooling Deployment in an Environmental Justice Community project. This project is funded by the U.S. Department of Energy (DOE) and focuses on developing a networked geothermal system for Ulbrich Heights, a multifamily affordable housing complex in Wallingford.

In July 2024, CT DEEP, in collaboration with Northeast Energy Efficiency Partnerships (NEEP), the University of Connecticut, LN Consulting, the Wallingford Housing Authority, and the Wallingford Electric Division, published a Geothermal Heat Pump Workforce Development Plan for Connecticut. This plan builds on the findings of a prior Connecticut Geothermal Industry Workforce Needs Assessment. The plan analyzes the workforce needs assessment's findings and proposes various strategies for the state to consider, including geothermal licensing, drilling, training new professionals, and promoting equity.

Building on insights from these two previous reports, this localized workforce plan details the needs and requirements for designing and deploying a networked geothermal system specific to the town of Wallingford and the Ulbrich Heights project. The plan provides recommendations to establish workforce support structures, uphold labor best practices, and contribute to the growth of the geothermal workforce across the state.

Project Design

This geothermal system design features 90 500-foot-deep boreholes spaced 20 feet apart in a large greenspace that serves as the central common area of the Ulbrich Heights site. This design is based on energy modeling and geothermal field simulations conducted by the project partners. The central common lawn provides sufficient space for all of the system's required boreholes in a single location, as well as sufficient space to install a central pump house enclosure. This enclosure would contain the system's main circulator pumps and a distribution manifold for the geothermal borehole field loops. Centrally locating the pump house offers the advantage of reduced system pipe size. With this configuration, the system's piping can be redistributed after exiting the pump house, allowing each main branch to serve approximately 50 percent of the complex.

The system's boreholes would use 1.25 inches of SDR-11 piping. At the prescribed depth of 500 feet, the likelihood of encountering underground geological issues during drilling is reduced. This depth is typical for networked geothermal installations, matches the test well's depth, and aligns with the property's existing facilities. Water-source heat pumps would be installed in each housing unit and connect to piping that leads to the central pump house.

This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Geothermal Technologies Office (GTO) and the Community Geothermal Heating and Cooling Design and Deployment, Award Number DE-EE0010667 administered by the Connecticut Department of Energy and Environmental Protection (DEEP).

Workforce Needs for Implementing the Ulbrich Heights Project

Networked geothermal system installations require a diverse set of skilled workers and comprehensive project management and oversight. The exact roles of these managers can be flexible, variable, and can sometimes overlap depending on the requirements of the project and preferences of site owners. An **architect** is not mandatory but would likely be helpful in a project of this complexity. The architect would collaborate with the Wallingford Housing Authority (WHA)—owner of Ulbrich Heights. The architect would create more detailed design documents for buildings (e.g., pumphouse, patching interiors of apartments), ensure compliance with applicable building codes, and ensure that construction aligns with the bid document and initial project plans. The **asset manager's owner's representative** ("owner's rep") would facilitate communication and coordination between the owner, architect, and general contractor or construction manager, as well as have the authority to make decisions on behalf of WHA to ensure that the housing authority's interests are represented. A mechanical, electrical, and plumbing (MEP) firm could act as the owner's representative.

A project of this complexity requires either a **general contractor** or a **construction manager**. The general contractor or construction manager would be responsible for hiring and overseeing subcontractors, organizing the workflow, obtaining necessary construction permits, and addressing other project needs as required. While a single entity could perform either role, the construction manager would be subject to a procurement policy, including a request for proposals (RFP) and qualification vetting process. A general contractor would be selected via a bid process based on bid documents created by the project architect and would subcontract all of the contractors needed for the job. Working with a general contractor would be simpler for WHA, which will most likely be publishing RFPs and bids, because it would reduce the number of individual RFPs or bids WHA would need to publish. The RFP and/or bid documents would specify the required work and any provisions that subcontractors must meet.

Additional required roles would include a modeling and design firm (which would typically work under the direction of the project architect), a mechanical engineering contractor, a system controls contractor, a drilling company, pipefitters, heat pump installers (including a technician qualified to decommission the existing natural gas heating systems), electricians, plumbers, installers for any other clean technologies (e.g., a licensed photovoltaic solar installer), and operations and maintenance staff. The team's composition could vary widely based on the in-house capabilities of each contractor or subcontractor. For example, an MEP firm could provide energy modeling services while also acting as the owner's representative. Similarly, a geothermal company could take responsibility for system design, drilling the boreholes, site excavation, controls, and heat pump installation. See Figure 1 for a visual representation of the bidding and construction process.

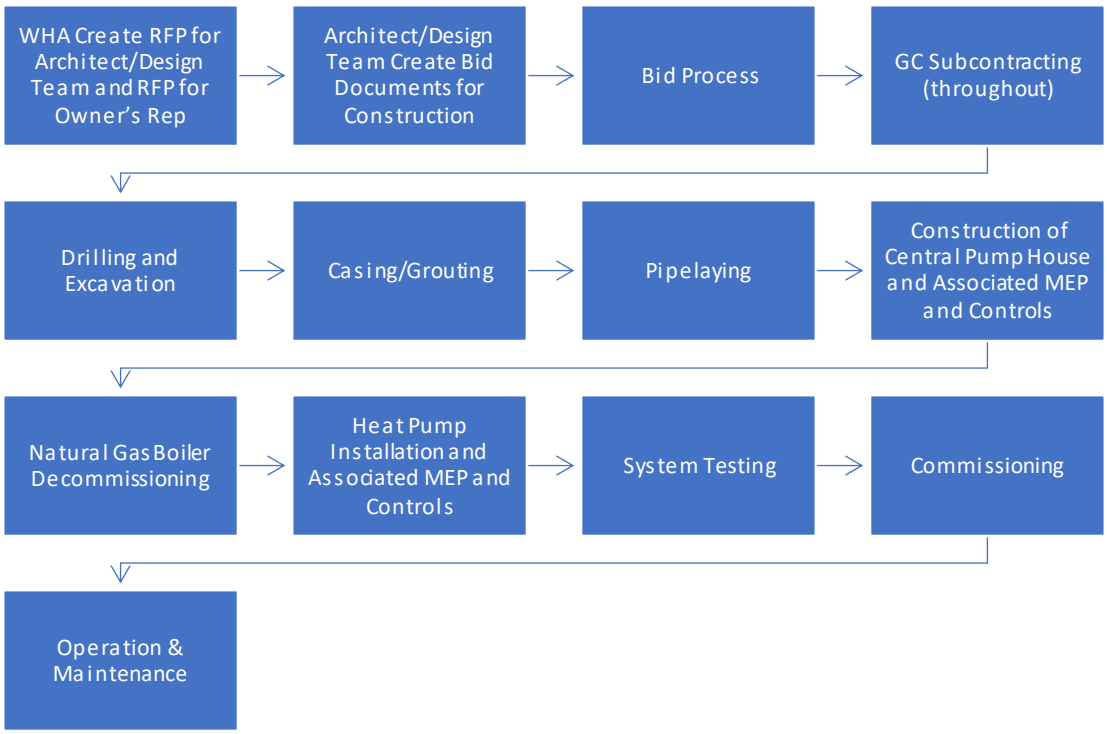


Figure 1. Flow chart of the construction process for a networked geothermal system.

It is difficult to determine the precise number of workers needed to implement this design, as companies utilize varying configurations of workers and subcontractors. The number of workers and drill rigs used, as well as the timeline for completion, would be determined by the drilling companies that submit bids for the project. The drilling company or geothermal contractor would need drillers to drill 90 boreholes 500 feet deep and pipefitters to install approximately 10,000 feet of piping to connect the system to the central pump house and individual units. In one possible configuration and timeline for this part of the construction, a drilling company would use two drilling rigs with about six workers to drill the whole bore field in 45 to 50 days, and then finish all grouting and looping of boreholes two weeks after drilling. The horizontal piping that would connect all boreholes to the pump house and to all buildings might take 4 to 5 weeks. Additionally, HVAC contractors would be required to install 554 ductless heat pumps consoles and decommission 132 natural gas boilers. The specific workforce needed for these tasks would vary based on the contractors' approach and employees' capabilities and licenses.

To maintain the geothermal system, facilities staff would need to replace the filter on each interior heat pump head element ideally two times per year to ensure system efficiency and proper airflow. Facilities staff, or a contracted third party, would also need to check the heat pump units and condensate lines. Additionally, the pump house and geothermal loop would require annual maintenance, such as water testing, addition of biocides and corrosion inhibitors, inspection of pump operations, and inspection of central controls. Given that the workload involved might exceed the capacity of Wallingford Housing Authority maintenance staff, the authority could opt to utilize a third-party contractor to perform system maintenance.

Equity in Hiring

Ulbrich Heights is an affordable housing complex owned by Wallingford Housing Authority, where households must have incomes less than 80 percent of the area median income to qualify for housing. In 2022, the CT DEEP Office of Environmental Justice designated the census block that contains Ulbrich Heights as an Environmental Justice Community. The project team will focus on supporting individuals—such as those from Ulbrich Heights— with restricted income, low educational attainment, language barriers, and other factors that create obstacles to employment and opportunity.

The Governor's Workforce Council Strategic Plan specifies diversity, equity, and inclusion as "foundational pillars" for a capable and sustainable workforce.[1] The project team would therefore focus workforce development strategies on training and hiring individuals from historically underserved and environmental justice communities in Connecticut.

To align with Justice40 criteria, the project team would prioritize construction proposals that employ women- and minority-owned business enterprises (WBE and MBEs) for at least 40 percent of their subcontracts. Additionally, the project would benefit the residents of the Ulbrich Heights complex by meeting Justice40's requirement that 40 percent of benefits go to disadvantaged communities. Justice40 defines seven categories of benefits, and the District Geothermal Heating + Cooling Deployment in an Environmental Justice Community project would address four of these categories: climate change, clean energy and energy efficiency, affordable and sustainable housing, and training and workforce development.[2]

The project team would include equity in hiring goals when drafting RFPs to ensure that the goals and requirements flow down to all subcontractors. To support and track these equity goals, the project team would employ several strategies. For example, NEEP recommends that, to promote equitable access in the bid review process, the project team include a requirement for weighted scoring that favors WBE/MBEs. The project team should also mandate that contractors report whether new project subcontractors are WBE/MBEs and provide appropriate documentation. Additionally, the project team could collect home zip codes of workers and review business ownership structures to determine if the workforce is originating from Connecticut Environmental Justice Communities.

Labor Requirements

Commercial building owners who commit to installing ground source heat pumps (GSHPs) are eligible for tax credits under the federal investment tax credit. The base tax credit is six percent, and will decrease to 5.2 percent in 2033 and 4.4 percent in 2034. Businesses are eligible for "bonus credits" (wherein credits are increased by five times, up to 30 percent total) if projects meet prevailing wage and registered apprenticeship requirements. Prevailing wages are determined by the U.S. secretary of labor and must align with the federal Davis-Bacon Act. To meet the apprenticeship requirements, 15 percent of the total labor hours must be performed by qualified apprentices.

To further center equity in hiring, the project team would draft the RFP to prioritize proposals that plan to voluntarily comply with the U.S. Department of Housing and Urban Development (HUD)'s Section 3 requirements. These requirements focus on creating employment opportunities for low- and very low-

[1] CT.gov, "Governor's Workforce Council Strategic Plan," 2024, https://portal.ct.gov/-/media/gwc/governors-workforce-council-strategic-plan_public-version-february-28-2024.pdf.
[2] The White House, "Justice40: A Whole-of-Government Initiative," https://www.whitehouse.gov/environmentaljustice/justice40/.

income individuals. HUD Section 3 mandates that 25 percent of all labor hours must be performed by Section 3 workers, with 5 percent of all labor hours required to be performed by Targeted Section 3 workers. Section 3 workers are considered low- or very low-income, per income limits established by HUD. These individuals must be employed by a Section 3 business or be designated as YouthBuild participants. YouthBuild is a community-based pre-apprenticeship program that provides job training and educational opportunities for at-risk youth ages 16 to 24 who have previously dropped out of high school. See Figure 2 for information on the criteria for Section 3 workers and businesses. A Targeted Section 3 worker is an individual who is employed by a Section 3 business, or is one of the following: a resident of public housing or Section 8-assisted housing; a resident of other public housing projects or Section 8-assisted housing managed by the PHA that is providing the assistance; or a YouthBuild participant. The nearest YouthBuild program to Wallingford is in Bridgeport, Connecticut.

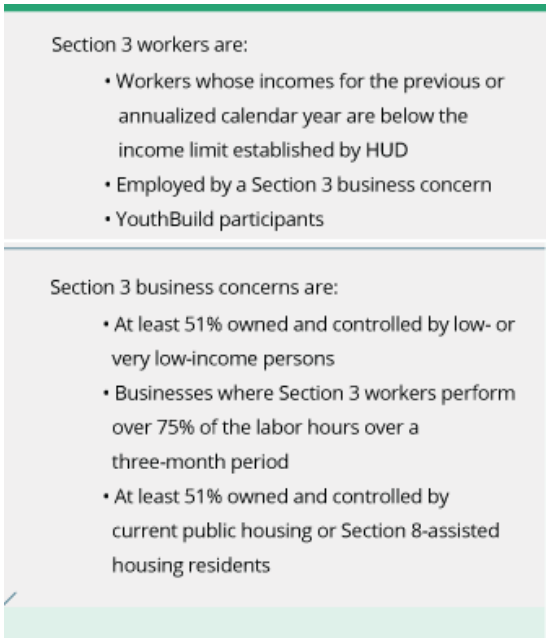


Figure 2. Table defining HUD Section 3 worker and business concerns from the U.S. Department of Housing and Urban Development

According to the Code of Federal Regulations Title 24 Subtitle A Part 75 Subpart B Section 75.9 (24 CFR § 75.9), recipients required to comply with Section 3 and their contractors and subcontractors must make a meaningful effort to provide employment and training to Section 3 workers in the following order of priority:

1. Residents of the public housing projects where the financial assistance is assigned
2. Residents of other public housing projects or Section 8-assisted housing managed by the same public housing authority providing the assistance
3. Participants in YouthBuild programs
4. Low- and very low-income individuals living within the metropolitan area (or nonmetropolitan county) where assistance is being provided

24 CFR § 75.9 also states that the public housing authority complying with HUD Section 3 and its contractors and subcontractors must make their best effort to award contracts to Section 3 business concerns in the following order of priority:

1. Section 3 businesses that provide economic opportunities for residents of the public housing projects for which the assistance is provided
2. Section 3 businesses that provide economic opportunities for residents of other public housing projects or Section-8 assisted housing managed by the public housing authority that is providing the assistance
3. YouthBuild program participants
4. Section 3 businesses that provide economic opportunities to Section 3 workers residing within the metropolitan area (or nonmetropolitan county) in which the assistance is provided

These requirements should be included in the original RFP and bid documents to ensure contractors maintain documentation of hours worked by Section 3 workers and how workers qualify as Section 3. Employers of Section 3 workers must also implement data collection efforts that comply with Section 3 regulations.

If the project is to receive Eversource utility incentives, contractors must be part of Connecticut's Heat Pump Installer Network (HPIN). To participate in the HPIN, contractors must sign the Energize CT Heat Pump Installer Participation Agreement, provide relevant licenses and certificates, and certify compliance with industry training requirements. Geothermal heat pump installers must show certification of installation or service training provided by a ground source heat pump manufacturer within the last five years or be certified as an International Ground Source Heat Pump Association (IGSHPA) installer or GeoExchange designer. Within the first year of participation, all installers must provide a certificate of completion for cold climate heat pump sizing and design training by a manufacturer and complete all assigned heat pump training via the eLearning Center featured in the state's contractor portal. This HPIN requirement will be stated in the RFP.

The applicability of the Build America Buy America Act (BABA) provisions to this project needs to be further investigated. BABA requires that all iron, steel, manufactured goods, and construction materials used in federally funded infrastructure projects are manufactured domestically. BABA only applies to public infrastructure, which is defined as publicly owned infrastructure or privately owned infrastructure primarily used for a public purpose. If BABA is found to apply to this project, then the requirements would need to be incorporated into any procurements and subsequent contracts.

Technical Education and Training Program

To support future growth of the geothermal workforce in the Wallingford area and beyond, NEEP encourages CT DEEP to explore establishing a collaborative relationship with a regional workforce development board that has previously deployed training programs and connected job seekers to training opportunities in the green jobs industry. The project team could work with a workforce development board and industry stakeholders to identify relevant, short-term geothermal training opportunities for existing workers in the field of HVAC and engineering. Because these careers require specialized knowledge and licensing, and the barrier to entry is relatively high, the team proposes that a

short-term program would be most effective if it focused on reskilling existing workers rather than training new entrants.

Several regional workforce boards in Connecticut already have experience and/or ongoing initiatives with clean energy employers to provide training for individuals seeking employment in roles with companies performing solar installations or brownfield remediation, while providing certifications such as OSHA (Occupational Safety and Hazard Administration) designations 10, 30, 40 or HAZWOPER (Hazardous Waste Operations and Emergency Response) certification. For example, Southwestern Connecticut's regional workforce board, The WorkPlace, has a U.S. Department of Labor funded program called EnergyWorks. In this program, job seekers are provided with training for solar, weatherization, or utility line worker roles. Workforce boards would be excellent partners for a new geothermal training program due to their established local presence, extensive experience, and historic and ongoing investment in local workforce development.

This program could draw from training modules from the IGSHPA on topics such as ground source heat pump installation, geothermal system design, or geothermal system maintenance and repair. The project team and workforce boards could explore partnering with a variety of institutions to host in-person training. The project team might also collaborate with local utilities, including Eversource and United Illuminating, as these utilities have diverse workforce needs and have previously partnered with workforce boards.

The program could include both classroom training and paid on-the-job training with geothermal system installers. To encourage employers to host on-the-job trainees, the program could subsidize or completely pay trainees' wages, if funds were available. To ensure that the program is accessible to Connecticut residents from disadvantaged communities, the program would ideally also have funding to provide wraparound services, such as stipends for employment-related transportation and childcare, help with resume writing, or soft skills training.

To ensure that the program benefits are equitably distributed, NEEP recommends that the program aligns with Justice40 metrics by creating a goal that at least 40 percent of candidates in each of the following training program recruitment steps are from Connecticut Environmental Justice (EJ) Communities:

- Candidates in recruitment pools
- Candidates receiving interviews
- Candidates extended training program participation offers
- Candidates participating in the training program

Since the designation of Connecticut EJ Communities is based on geographic location, requiring candidates in the program recruitment pipeline to provide their home zip code would allow for tracking of the latter three goals. Recruitment efforts should focus on directing 40 percent of advertising and outreach to minority-owned businesses and businesses located in or primarily serving Connecticut EJ Communities in an attempt to ensure that people from these communities see the recruiting materials and are aware of the training and potential employment opportunities associated with them.

Conclusion

For any construction project, it is challenging to determine the exact workforce size needed prior to procurements. However, this project-specific workforce plan seeks to identify the required skills and outline the scope of work typical to these roles. The project team could specify project requirements and include workforce-related provisions that meet the state's equity goals in any project-related requests for proposals (RFPs). These provisions could flow down to all subcontractors involved in the project. Networked geothermal projects are highly complex and demand significant coordination between contractors and property owners, making effective communication and community buy-in essential for effective implementation and sustainable operation. Ensuring an adequate workforce is vital for maintaining construction progress and controlling labor costs. Requiring contractors to provide employment or contract opportunities to low-income individuals and women- and minority-owned businesses would support the equitable distribution of workforce opportunities.

Next Steps

If the project team is successful in winning Phase Two funding from the U.S. Department of Energy, the procurement of a project architect would be an immediate first step. The architect would then work with the project team to understand the initial modeling and design and draft construction bid documents. Wallingford Housing Authority should also consider hiring an owner's representative. For Phase 2 of the Community Geothermal Heating and Cooling Design and Deployment Grant, the project team would work to complete construction within 30 months.

Other initial steps could include:

- Drafting an RFP for a construction manager
- Working with an architect to publish bid documents for a general contractor
- Setting quantitative targets for Justice40 goals the project intends to achieve
- Finalizing any workforce stipulations (such as compliance with HUD Section 3 requirements) that would be included in an RFP and would apply to all subcontractors
- Publishing an RFP through CT DEEP to solicit a regional workforce board for collaboration on the geothermal training program

The project team could promote the project to a broader audience throughout the construction process to raise awareness about networked geothermal systems as a solution for decarbonizing multifamily affordable housing. Maintaining and updating the current project website, hosting webinars, and producing visually engaging materials could help reach affordable housing owners, potential geothermal workers, community leaders, and other stakeholders, particularly those from underserved and environmental justice communities.

Appendix F – Permitting plan

Permits that Town of Wallingford Building Department would require:

- building permit for pumphouse
- plumbing permit
- mechanical permit
- electrical permit
- State well drilling permit for geothermal wells

Town of Wallingford permit application: https://www.wallingfordct.gov/Customer-Content/www/CMS/files/AppforPermitBldgDpt_041824_fillabe.pdf

CT Department of Consumer Protection well drilling permit application: https://portal.ct.gov/-/media/dcp/occpro/well-permit-form.pdf

Other components of permitting plan are in Appendix B:

- Site plan
- Elevations
- Foundation plans
- Floor plans

Appendix G – Case study

Connecticut Community Geothermal Case Study – Design and Feasibility

October 2024

From October 2023 to October 2024, the Bureau of Energy and Technology Policy at Connecticut Department of Energy and Environmental Protection (DEEP) led a team to design and assess the feasibility of a community geothermal heating and cooling system in Wallingford, Connecticut. The team included Northeast Energy Efficiency Partnerships (NEEP), the University of Connecticut (UConn) Pratt & Whitney Institute for Advanced Systems Engineering, the Wallingford Housing Authority (WHA), the Wallingford Electric Division (WED), and the engineering firm LN Consulting.[1] This project, entitled "District Geothermal Heating + Cooling Deployment in a CT Environmental Justice Community," was funded by the U.S. Department of Energy (DOE) as part of its competitive Community Geothermal Heating and Cooling Design and Deployment Initiative. The Project Advisory Board included staff from the CT Department of Health, the CT Department of Housing, the CT Housing Financing Authority, the CT Office of Workforce Strategy, a national laboratory, an electric utility, a gas utility, and others. DOE funding for Phase 1 supported an investigation into the feasibility of community geothermal at a chosen site (including initial modeling, design, workforce, and community engagement). After completion of the feasibility investigation, project teams could apply for competitive Phase 2 funding that would support construction and commissioning of the proposed geothermal systems.

CT DEEP: Connecticut Department of Energy and Environmental Protection
DOE: U.S. Department of Energy
NEEP: Northeast Energy Efficiency Partnerships
UConn: University of Connecticut
WED: Wallingford Electric Division
WHA: Wallingford Housing Authority
WSHP: Water-Source Heat Pump

The project involved design of a geothermal system for Ulbrich Heights, an existing multifamily affordable housing community of 132 apartments in Wallingford, Connecticut, owned by WHA. The proposed community geothermal design would retrofit the entire community's heating and air conditioning systems to provide clean and efficient climate control for residents while saving tenants money, improving community air quality, and reducing the facility's greenhouse gas emissions. The system would consist of a large central geothermal system – geothermal wells, pumphouse, and piping – to deliver a ground-conditioned water/glycol solution to each of 38 buildings, where interior piping and water-source heat pumps (WSHPs) would provide heating and cooling in each apartment. This system would replace natural gas boilers, eliminate onsite emissions for space heating, and provide space cooling that would replace inefficient, tenant-owned window air conditioning units. During the project's first phase, the team analyzed best practices and conducted on-site testing and analysis to develop a comprehensive design for this system.

[1] WED is part of the Town of Wallingford Department of Public Utilities.

Other communities across the state, region, and country seeking to implement geothermal systems at similar facilities can learn about the successes and challenges of the first phase of the project through this case study and the project website. The case study describes the team's efforts to build a coalition, design the system, consider deployment options as well as costs and emission reductions, assess workforce development needs, and determine economic and environmental outcomes. Due to challenges described below, the project team ultimately decided not to apply for Phase 2 funding to construct the system.

Coalition Building

Due to the level of coordination, community engagement, and detailed planning required for a community geothermal design and feasibility study, having the right project partners was critical. DEEP assembled the project team through an initial Request for Information in September 2022 and through direct outreach to organizations with competencies necessary for the project. DEEP sought partners with four main categories of expertise: community voice, workforce, technical analysis/ design, and deployment (Figure 1). DEEP then worked with the Connecticut Housing Finance Authority to select a suitable project site. The team selected the Ulbrich Heights community because it is in an area designated in 2022 as a Connecticut Environmental Justice Community and WHA indicated it planned to update the facility's heating system.

Figure 1. *Community geothermal coalition roles*
(as presented in the Department of Energy's "Community Geothermal Heating and Cooling Design and Deployment" announcement)

DEEP maintained close communication and coordination with the WHA staff throughout the planning process. The WHA director in turn helped coordinate and facilitate the team's community engagement activities with residents. Having the municipal electric utility, WED, as a partner made it easier for the team to obtain data about the Ulbrich Heights apartments, such as energy assessment data and electricity usage. UConn and LN Consulting utilized these relationships and data to complete modeling and design for Phase 1. UConn was the technical lead for this project, providing energy and cost modeling, and coordinated extensively with LN Consulting for the system design.

NEEP's role in the project focused on workforce assessment and community engagement. Because Ulbrich Heights is an affordable housing facility in an environmental justice community, it is especially important to have a partner who can emphasize community involvement and ensure that those directly affected by the project are engaged in a meaningful way.[2] At the same time, systematically addressing workforce development is crucial as the geothermal heating and cooling industry expands.

[2] The census block in Wallingford that contains Ulbrich Heights was designated as a CT Environmental Justice Community in 2022 due to greater than 30 percent of the population living below 200 percent of the federal poverty level. The CT mapping is updated yearly based on new census data, and in 2023 the same census block was no longer designated as an environmental justice community. The 2024 mapping was not yet released at the time of publication.

Design

Ulbrich Heights

Ulbrich Heights was built primarily around 1952 and has 132 apartments distributed across 38 buildings and seven building typologies (see Figure 2 and Table 1). Most of the buildings are duplexes (2 apartments each), and the facility also has a mix of garden-style townhome buildings with 4 to 8 apartments each.

Figure 2. ***Seven building types at Ulbrich Heights***

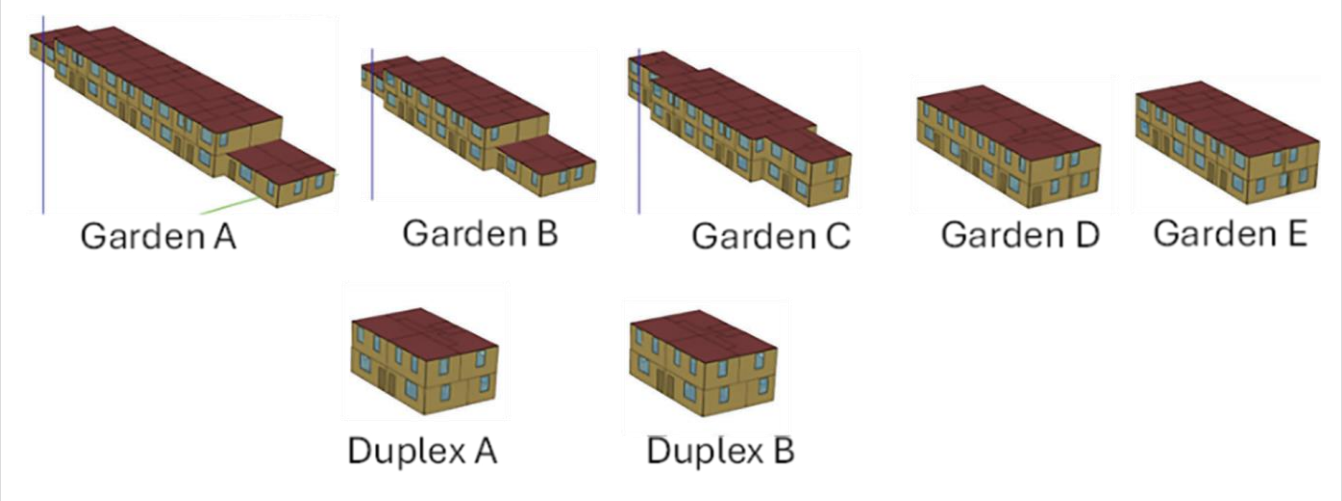


Table 1. ***Breakdown of building type, number of buildings, and number of apartments***

Building Type	Number of Buildings	Number of Apartments Per Building	Total Apartments
Garden A	2	8	16
Garden B	5	6	30
Garden C	3	6	18
Garden D	2	4	8
Garden E	4	4	16
Duplex A	11	2	22
Duplex B	11	2	22
TOTALS	**38**	-	**132**

The project team determined that a central geothermal borefield would be preferable for this project, given that centralizing the boreholes could reduce drilling costs and time for the approximately 14-acre site. Ulbrich Heights has 0.54 acres of green lawn available for a central borefield (see Figure 3). Other greenspaces on the property have trees that would need to be removed to accommodate the borefield.

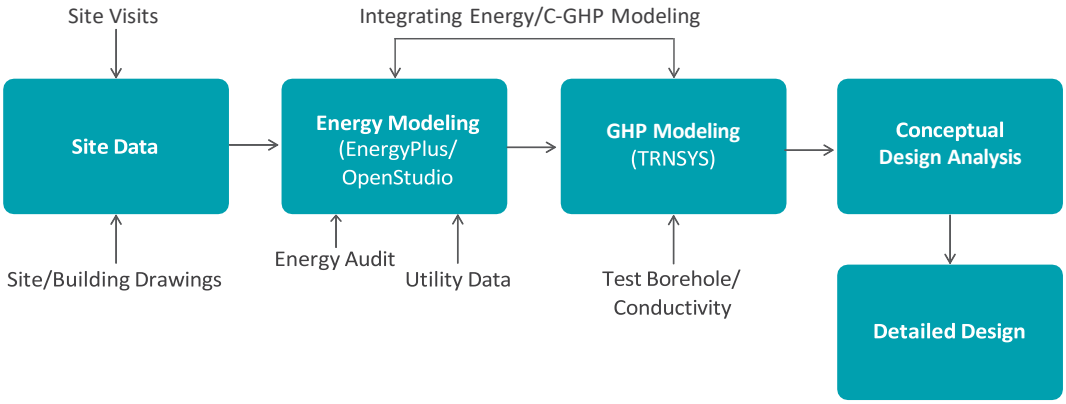
Figure 3. ***Aerial view of Ulbrich Heights with borefield location circled.***

Modeling and Design Process

The University of Connecticut's Institute for Advanced Systems Engineering was the projects technical lead and developed building energy models. The UConn team simulated network piping and supported the WSHP system design, while LN Consulting prepared the conceptual design for the overall geothermal and WSHP systems. The team started the process with data collection on the Ulbrich Heights site. Data collected from site visits and existing sources such as energy audits and utility data from WED informed the UConn team's models. UConn used EnergyPlus and OpenStudio for the energy load modeling, conducted initial geothermal sizing simulations in TRNSYS, then developed an initial field layout in GLD (see Figure 4).[3] Data from a test borehole and conductivity test were critical to the second round of modeling. UConn and LN Consulting worked together to complete the conceptual design analysis, with LN Consulting using GLD for the modeling and final design of the borefield and UConn employing TRNSYS to account for heat gain and loss in the horizontal piping.

[3] EnergyPlus and OpenStudio are software tools for whole-building energy modeling. TRNSYS is Transient System Simulation Tool, a graphical software. GLD is Ground Loop Design, geothermal system design software.

Figure 4. ***Schematic of the community geothermal heat pump system modeling and design process.***



Modeling and Design Considerations

Several factors informed modeling and design of the geothermal system.

Heating and Cooling Loads: Building heating and cooling loads were obtained using the EnergyPlus software and normalized with actual building energy use. The building loads, along with ground thermal properties obtained from the test borehole, were used in modeling and sizing the ground heat exchanger loop.4 Once the team determined the number of ground heat exchangers needed, it developed a layout for the borefield based on the site constraints and a layout of the full geothermal system.

Soil Thermal Data: A contractor drilled a test borehole in February 2024 to determine subsurface geology, including the depth of the bedrock, as well as thermal conductivity, thermal diffusivity, and undisturbed ground temperature. All thermal properties were found to be favorable.

Applicable Codes: The project would be required to comply with the 2021 International Energy Conservation Code mandates. The 2022 Connecticut State Building Code has no specific technical provisions for geothermal systems.

Additional Technologies: With electrification of heating and cooling via the proposed geothermal and WSHP systems, fossil fuels would be used only for domestic water heating.5 To explore full electrification, UConn also considered incorporating heat pump water heaters (HPWHs) and solar photovoltaic (PV) in the overall modeling

[4] A *ground heat exchanger* in this case consists of a vertical borehole, a u-shaped pipe in the borehole, and grout that establishes comprehensive contact between the pipe and the ground.

[5] At present, 72 percent of the apartments have water heaters that use natural gas. The others were built with electric-resistance water heaters or have been converted to electric resistance.

and design. Two alternative electrification scenarios also were considered: air-source heat pumps (ASHPs) instead of geothermal; and distributed geothermal, with separate wells for each building. A similar project conducted by the Meriden (Connecticut) Housing Authority utilized solar PV to accommodate the increased load of electrification and reduce tenant's electric bills. For Ulbrich Heights to employ solar PV, WHA would need to assess the buildings' capacity to support solar arrays and identify a suitable billing arrangement. WED, the local electric utility, does not offer financial incentives for solar installations at this time. Many of the apartments already have received free weatherization services provided by WED.

Design Scenario

The factors outlined above shaped the final design proposed. The design calls for installation of ninety 500-feet-deep boreholes spaced 20 feet apart in the housing community's large central greenspace (see figure 3), using 1-¼"piping. This configuration is based on UConn's energy modeling and geothermal field simulations. Using the greenspace would be advantageous because it can accommodate all the boreholes in a single location and sufficient space would remain for installation of a central pumphouse. This pumphouse would contain the main circulator pumps and the manifold for the geothermal borehole field loops. Locating the pump house centrally would offer the advantage of reducing pipe length. This configuration would allow the piping to split after leaving the pumphouse, with each of two main branches carrying the ground-conditioned water/glycol solution to approximately 50 percent of the community.

The design calls for ninety 500-feet-deep boreholes spaced 20 feet apart, connected to a centrally located pumphouse.

The buildings currently are heated by natural gas-fired boilers, with circulator pumps and hot water "convectors" in each apartment (see Figure 5). The buildings have limited available space to run ductwork without significant architectural rework. To overcome this barrier, the project team selected console-style WSHPs to provide electrified space heating and cooling (see Figure 6). The console units are similar in size to the existing convectors. With this design, piping for ground-conditioned water/glycol solution and piping for condensate would run from the basement in each building, within the walls, and connect to wall-mounted heat pumps in several rooms in each apartment.[6]

Figure 5 (left). ***A convector in a Ulbrich Heights apartment.***
Figure 6 (right). ***An example of a console-style water-source heat pump*** (from WaterFurnace).

[6] Condensate piping would serve as a drain for water that condenses as the heat pumps cool humid air during the cooling season.

Deployment

Ownership – As the Phase 1 work proceeded, ownership of the envisioned system emerged as a variable more complex than the team had anticipated. WHA owns the Ulbrich Heights facility; but the team learned it is not well positioned to own, operate, and maintain the geothermal infrastructure or to maintain the water-source heat pump system. The organization's financial resources are too lean to enable it to contribute materially to the capital investment needed for the new system, to pay the central geothermal system's relatively modest operating and maintenance costs (e.g., cost of electricity for the pumphouse), or to assume responsibility for maintaining the water-source heat pumps in the facility's 38 buildings (note that tenants would be expected to pay for the electricity the heat pumps consume). The team learned that WHA also lacks legal authority to assess tenants for "common charges," which in this case means the agency could not require tenants to pay the cost of operating and maintaining the central geothermal system or the cost of maintaining the heat pumps.

Ownership of the envisioned system emerged as a variable more complex than the team had anticipated.

The team explored two other ownership scenarios as well. WED, as the municipal electric utility, would at least theoretically be able to assess common charges on tenants. But the company indicated it did not have sufficient experience or expertise to undertake an ownership role for the proposed facility. DEEP began a tentative conversation with Eversource, the parent company of Yankee Gas, which supplies natural gas to Ulbrich Heights. Eversource is well qualified to undertake this large geothermal project, given the company's experience developing and implementing a networked geothermal project in Framingham, MA, and Yankee Gas' experience in managing a capital-intensive gas business that involves building, operating, and maintaining underground infrastructure. Crucially, though, no regulatory construct currently exists in Connecticut for a regulated gas company to develop a rate structure and recover costs associated with geothermal projects.[7,8]

A further complication in the ownership equation: Federal rules for geothermal tax credits under the Inflation Reduction Act (IRA) require that the party owning the geothermal system also must own the heat pumps. This seemingly would preclude an arrangement in which WHA owned the heat pumps but a utility or other third party formally owned the central geothermal system. Since the Ulbrich Heights project would be unlikely to proceed without tax credits for both of these major components, it would be essential for the team to identify a way to satisfy the federal rules or work around them.

Logistics – Deployment of the proposed community geothermal system was estimated to take approximately 30 months, but this period could vary significantly depending on equipment and labor availability as well as

[7] Massachusetts, New York, and several other states have adopted statutes enabling regulated gas utilities to develop, own, and operate thermal energy networks. Connecticut has not.

[8] Any of these parties – WHA, WED, and Yankee Gas – could have employed a third-party firm to develop the Ulbrich Heights project under a formal Design/Build/Own/Operate/Maintain or Design/Build/Own/Operate/ Transfer arrangement. However, such arrangements did not appear to offer immediate, clear means to resolve WHA's inability to assess "common charges" or Yankee Gas's lack of explicit statutory authority.

the scheduling preferences of WHA and the tenants. Ultimately, the timeline would be determined during the contractor procurement process. The selected architect would work with contractors to obtain all necessary permits required for construction and ensure the project is completed in a timely manner. Implementation of the geothermal borefield and pumphouse would take approximately one year.

This timeframe could be reduced five to six months if contractors utilized additional personnel and drilling rigs and if work were conducted during the summer to allow for the pumphouse and boreholes to be developed simultaneously. Once the borehole field and the pump house were completed, work on the buried heat pump loop piping and building interior retrofits could begin. The horizontal buried heat pump loop piping would be installed from the pumphouse outwards to the furthest buildings. The buildings closest to the pumphouse would be converted from natural gas-fired boilers to heat pumps first, and the heat pump loop piping would be installed concurrently. This would allow buildings to be brought online as they were completed, limiting the time that individual buildings were without heating or cooling.

Deployment was estimated to take 25-30 months, with drilling being the limiting factor in construction

Drilling, which would take the longest, is the limiting factor in how quickly construction of the rest of the system could proceed. Apartment renovations and installation of the horizontal heat pump loop piping would occur afterwards. Construction (piping, condensate, and power) for an individual apartment is estimated to take about two weeks. With ideal coordination between the trades, this process could be expedited.

The most significant disruption for tenants would be the required removal of existing hydronic heating systems and installation of the heat pumps and associated piping. Other disruptions would include noise and excavation work associated with drilling the geothermal field and installing underground piping. Construction could be phased to limit when these disruptions occur. The general contractor would develop a master plan to guide work in the interior of each building and align the various trade work and schedules.

Maintenance – The proposed systems would require ongoing maintenance. Each WSHP would need regular filter changes, at least every 6 months, to keep fans and coils clean and running efficiently; and condensate drain lines should be checked regularly.[9] Yearly testing of the geothermal water/glycol solution would be required, as would annual inspection of the circulator pumps. Buried piping typically is warrantied for up to 50 years; after the piping is installed, leak tested, and commissioned, no maintenance should be required. The heat pumps and circulator pumps would be expected to last 20 years or more.

[9] A ducted system would require less maintenance, because there would be fewer heat pump filters to change.

Projected Outcomes

The team estimated the cost of constructing, operating, and maintaining a system based on the community geothermal design as well designs involving the variants and alternatives. It also calculated expected changes in environmental emissions.[10]

Estimated capital cost for the community geothermal design is roughly $8.7 million, with annual operating and maintenance costs around $158,000.

Capital and Operating/Maintenance Costs – The estimated capital cost for the community geothermal design is roughly $8.7 million, with annual operating and maintenance costs around $158,000.[11] WED would be expected to provide a one-time incentive of $105,000; and Yankee Gas, the facility's gas utility, would be expected to provide a state-mandated incentive of $740,000. A federal Investment Tax Credit, bolstered by the IRA, would cover up to 40 percent of the remaining capital costs (assuming an ownership configuration that makes credits available for both the geothermal system and the heat pumps).[12] With these federal, state, and local incentives, the net capital cost would be $4.7 million.

Two factors – exacerbated by exceptionally high material and labor costs – pushed projected capital costs higher than anticipated:

- The thermal load of the target facility's 132 residential apartments is quite uniform (i.e., not diverse), hence the central geothermal system required to serve the simultaneous load of all apartments would be substantial. Moreover, no waste heat would be available to offset this load.
- Wallingford Housing Authority, which owns the site, indicated at the time of the team's application for Phase 1 funding that it expected to replace the existing gas boilers; however, during the Phase 1 work the organization learned that state funds would not be allocated for boiler replacements, which, accordingly, could not proceed. As a consequence, the avoided cost of ultimately replacing the gas boilers could not be factored into the near-term capital cost of the geothermal scenario. Moreover, because WHA does not own the existing window air conditioning units (the tenants do), the avoided cost of replacing these units could not be counted as a factor in the geothermal cost analysis.

Tenant Costs – The team's modeling indicates that, with implementation of the community geothermal system, tenants' overall utility costs would decrease. This is the case even though the modeling reflects provision of a service that for Ulbrich Heights would represent an important new benefit: universal access to cooling.

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[10] Details on projected capital, operating/maintenance, lifecycle costs, and emissions are available in the team's report "Technical, Economic, and Environmental Assessment for Ulbrich Heights Community Geothermal Heat Pump Project." The report is available on the project web page.

[11] *Estimate capital costs*: $8.1 million for equipment and labor; $552,000 for various fees. *Estimated operating costs*: $39,000 for electricity and maintenance of geothermal system (excluding insurance); $129,000 for tenants' electricity cost for WSHPs; and $5,500 for filter media for WSHPs (two changes per year; excludes cost of labor for filter changes and other WSHP maintenance).

[12] Through IRA's "direct pay" provision, tax credits would be available to WHA or another non-profit entity that has no tax liability.

Tenants currently rely on an assortment of inefficient window air conditioning in scattered rooms; the new system would provide efficient, comprehensive cooling throughout the warm months.

Modeling suggesting that tenants would save 12-31% on energy bills, depending on allocation of shared operation and maintenance costs.

UConn estimated a current average annual tenant baseline energy cost (electricity and gas) of $1,744. With the geothermal system and heat pumps, tenant annual energy cost would decrease $548 (31 percent). If tenants also were assigned the cost of operating and maintaining the central geothermal infrastructure, their average savings would be reduced to $253 annually (14 percent). If tenants also paid the cost of filters for semi-annual heat pump maintenance (but not labor costs for this maintenance), they would save $212 annually (12 percent).[13]

Lifecycle Costs – Accounting for net capital cost as well as the full cost of operations and maintenance, the community geothermal design is projected to cost $8.6 million over 30 years.[14] Fully electrifying by adding HPWHs to the design would bring the 30-year cost down to $6.6 million; and incorporating both HPWHs and solar PV would bring it down to $6.7 million. Both HPWHs and PV would involve higher capital costs, however. Alternatively, deploying a conventional, distributed geothermal system at Ulbrich Heights – with one or more wells for each building rather than a central borefield and pumphouse – is projected to cost $7.8 million over 30 years, while deploying ASHPs instead of geothermal is projected to cost far more: $21.5 million. Either distributed geothermal or ASHPs would involve a net capital cost slightly lower than that of community geothermal.

Emissions – The community geothermal design would reduce carbon emissions 41 percent, NOx emissions 29 percent, and particulate (PM2.5) emissions 34 percent. Reductions in all three of these categories would be significantly greater with the addition of HPWHs and/or solar PV. Emission reductions with distributed geothermal would be comparable to those obtained with the community geothermal design, while reductions with ASHPs would be less substantial.

Workforce

To assess the workforce needs of Connecticut's geothermal heating and cooling industry, NEEP and DEEP contacted ground source heat pump installers, drillers, trade associations, nonprofits, unions, relevant state agencies, utilities, training centers, technical high schools, and other industry professionals. Through surveys and interviews, NEEP identified workforce needs in three main areas: licensing (specifically for heating, piping, and cooling work), drilling capacity, and attracting and training new entrants. NEEP first developed a Workforce Needs Assessment and then organized four workshops with diverse stakeholders to discuss the findings and

[13] Although assessing tenants for "common charges" would not be possible if WHA owned the system, this might be possible under other ownership scenarios.

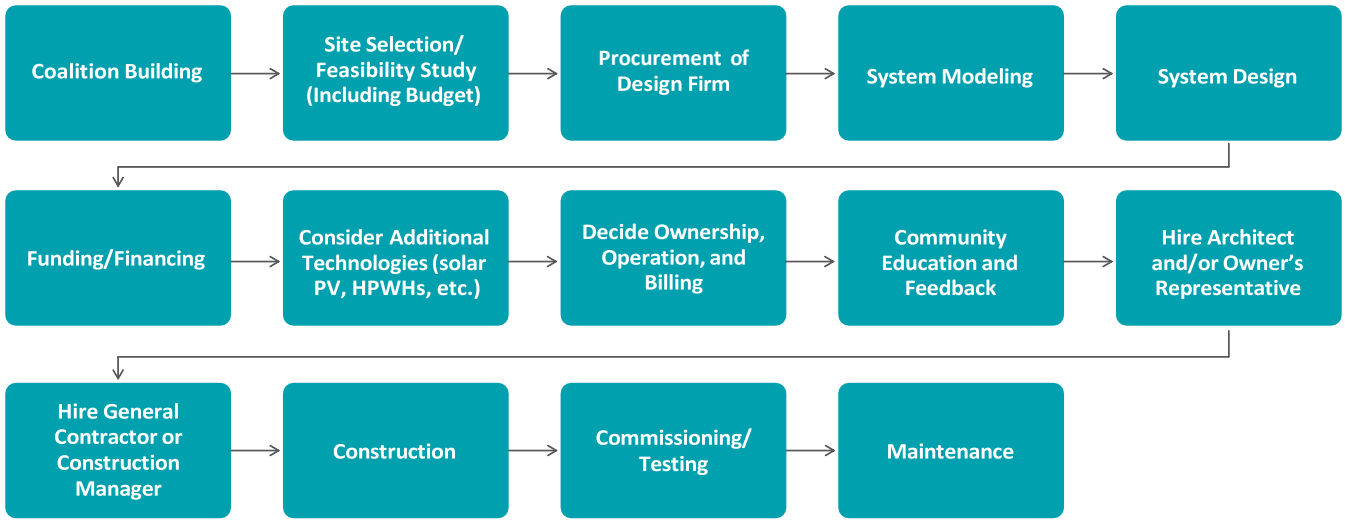
[14] This estimate assumes WHA would hire a third-party firm or firms for maintenance of both the geothermal system and the WSHPs.

explore potential solutions. These discussions were instrumental in shaping NEEP's recommendations to the state in the CT Geothermal Workforce Development Plan.

Process for Creating a Community Geothermal System

Figure 7 shows a series of steps necessary to plan and execute a community geothermal system. The order and exact steps may vary based on the local context, driving factors for developing a community geothermal system, and involved stakeholders. For example, coalition building may happen continuously as the project team engages more building owners and stakeholders who are interested in joining the project. Also, community education and feedback should ideally happen throughout the project, especially if the goal is to engage multiple building owners or homeowners to join the network.

Figure 7. ***Flow chart of the process for creating a community geothermal system.***



Conclusion

While community geothermal systems are complex and require extensive coordination, they provide an important opportunity both to upgrade heating and cooling systems for cost savings, efficiency, and comfort and to reduce greenhouse gas emissions and other forms of pollution. This case study offers insight into the design process and may assist others in designing and assessing the feasibility of community geothermal projects. The economics of the Ulbrich Heights design show that implementation could reduce utility costs for residents, even when factoring in operational and maintenance costs. Given growing awareness of geothermal as an important decarbonization solution and the availability of federal incentives under the Inflation Reduction Act, the project team is hopeful that the state, region, and nation will see many new community geothermal projects in the years ahead. Unfortunately, the combination of high capital costs and lack of a clear solution to the ownership

challenge have forced the project team to conclude that the Phase 1 design is not viable for the Ulbrich Heights affordable-housing community at this time. However, the project team intends to continue investigating ways to support deployment of community geothermal in Connecticut and particularly in affordable multifamily housing.

For further information: https://portal.ct.gov/deep/energy/ulbrich-heights-community-geothermal-project
To contact the DEEP team: deep.geothermal@ct.gov

Appendix H – Data uploaded to DOE Geothermal Data Repository

- Community Geothermal: Thermal Conductivity Test and Data Analysis Report – Wallingford, CT
    - GDR submission number: 1590
    - Upload date: March 3, 2024
    - Link: https://gdr.openei.org/submissions/1590
- Community Geothermal: Connecticut Workforce Needs Assessment Report and Data
    - GDR submission number: 1597
    - Upload date: April 30, 2024
    - Link: https://gdr.openei.org/submissions/1597
- Community Geothermal: Mechanical, Electrical, and Plumbing Design Report and Drawings – Wallingford, CT
    - GDR submission number: 1623
    - Upload date: July 31, 2024
    - Link: https://gdr.openei.org/submissions/1623

Appendix I – Community Engagement Plan

Community Engagement Plan:
Ulbrich Heights Geothermal Pilot Project

SEPTEMBER 2024

Table of Contents

This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Geothermal Technologies Office (GTO) and the Community Geothermal Heating and Cooling Design and Deployment, Award Number DE-EE0010667 administered by the Connecticut Department of Energy and Environmental Protection (DEEP).

Executive Summary

This community engagement plan was produced for the Connecticut Department of Energy and Environmental Protection (CT DEEP)'s District Geothermal Heating + Cooling Deployment in an Environmental Justice Community initiative, funded by the US Department of Energy (DOE). Phase 1 of the project is focused on creating a program for the design and implementation of a networked geothermal heating and cooling system at Ulbrich Heights, a multifamily affordable housing campus in Wallingford, Connecticut. If implemented, this geothermal system will affordably serve the heating and cooling needs of at least 50 percent of units on the property, with the goal of serving all units, while improving indoor and outdoor air quality and enhancing tenant safety and comfort. As this is a competitive grant, program implementation and the implementation of this plan is contingent on the project's selection by DOE for Phase 2 funding.

This plan was developed by analyzing Phase 1 community engagement activities conducted by the project team and through research on best practices for equitable and inclusive program implementation. One main takeaway from resident engagement during Phase 1 is that most residents are excited about the potential for having central air conditioning and are generally receptive to the project. The project team collated the lessons learned from these activities and incorporated best practices to develop tailored strategies that support a community-centered approach to program implementation.

Given the potential for this project to significantly impact residents and housing authority staff at Ulbrich Heights, engaging with the community is crucial. This plan will bolster stakeholder support for the project by increasing awareness of geothermal technology and its benefits among residents and staff. Additionally, this plan will establish channels of communication between residents, housing authority staff, and the project team. To achieve these goals, the plan calls for increasing geothermal awareness through activities such as distributing instructional materials and offering educational opportunities to Ulbrich Heights residents and staff; collaborating with a nearby high school to develop a clean technology and geothermal curriculum; and creating a second case study about the implementation of the project. The plan proposes resident engagement activities including forming effective communication channels, holding stakeholder listening sessions, identifying opportunities for resident input on program implementation, and planning social events to provide a forum for community involvement in the project.

During Phase 1, the project team's engagement with the community was in the "inform" and "consult" stages of the Spectrum of Community Engagement. If the team wins a Phase 2 award, the project team will be committed to equitable program implementation and will seek to continuously raise awareness about geothermal technologies and engage Wallingford Housing Authority residents. During Phase 2, the project team will seek to foster community ownership of the project, and at a minimum, strive to meet stage three, "involve".

1. Introduction

1.1. DOE Community Geothermal Project

The U.S. Department of Energy (DOE) is providing financial support to 11 community coalitions seeking to develop reliable and scalable networked geothermal models as part of its Community Geothermal Heating and Cooling Design and Deployment Initiative. Connecticut DEEP leads one of these community coalitions in partnership with Northeast Energy Efficiency Partnerships (NEEP), the University of Connecticut (UConn), the Wallingford Housing Authority (WHA), the Wallingford Electric Division (WED), and engineering firm LN Consulting. The objective of the District Geothermal Heating + Cooling Deployment in an Environmental Justice Community project is to design and implement a networked geothermal heating and cooling system at Ulbrich Heights, a multifamily affordable housing development located in a community with a history of environmental justice concerns in Wallingford, Connecticut. The initiative is intended to develop replicable models for the equitable implementation of geothermal heating and cooling systems in multifamily affordable housing communities in Connecticut and beyond. Grant funding for projects within this DOE initiative is competitive, and the implementation of this geothermal heating and cooling program is dependent upon the project's selection by DOE for Phase 2 funding.

If implemented, the geothermal heating and cooling system being designed for Ulbrich Heights will provide clean, high-efficiency climate control for at least 50 percent, and ideally 100 percent, of the property's apartments while eliminating the current system of natural gas boilers and window-mounted air conditioning units. Installation of this geothermal system is projected to eliminate 155 tons of annual CO_2 emissions, improve indoor and outdoor air quality at the property, and enhance resident comfort and safety. After performing extensive site energy assessments and system design modeling, a test bore hole was completed at the project site in February 2024.

In addition to these activities, the project team has completed a workforce needs assessment for the state of Connecticut to identify relevant industry trends and gaps in workforce capacity. This assessment was then used to prepare a workforce development plan that proposes systemic solutions to encourage geothermal workforce expansion. A separate workforce plan specifically tailored to the Ulbrich Heights project and the local geothermal workforce is currently under development.

This community engagement plan details the team's strategies for geothermal education and resident outreach, best practices for such engagement, and recommended approaches to ongoing engagement with stakeholders at Ulbrich Heights and the wider Wallingford community. These strategies are the result of direct feedback from stakeholders, active community engagement, and research into the community's physical infrastructure and formal and informal social networks. If the project is selected for Phase 2 funding, the project team will validate the information and strategies presented in this plan to ensure alignment with program implementation activities and create an ongoing platform for stakeholder input.

1.2. Ulbrich Heights and Stakeholder Network

Ulbrich Heights is a 132-unit affordable housing campus constructed in the 1950s in Wallingford, Connecticut. The property is one of six currently managed by the Wallingford Housing Authority. All apartments at the property are heated by natural gas-fired boilers and none have central air conditioning systems. Residents are responsible for installing their own window air conditioners and electric cooking ranges. The property's utilities are metered individually, and residents are responsible for electricity and gas expenses. Due to the age of the apartment units, the presence of fossil fuel-based equipment, and the relative inefficiency of window-mounted air conditioning systems, energy upgrades are an acute need at the property. Ulbrich Heights is located in a community with a history of environmental concerns and was formerly designated a Connecticut environmental justice community. The property currently qualifies for Connecticut's Moderate Rental Family Affordable Housing Program for residents in the 80 percent Area Median Income (AMI) band.[1]

1.2.1. Ulbrich Heights Residents

As of July 2024, there were 296 residents at Ulbrich Heights. Seventy-nine percent of residents are White, 20 percent are Black, and less than one percent are Asian or of unknown race. Roughly 68 percent are non-Hispanic, and 32 percent are Hispanic. Approximately 53 percent of the community's households have one or more children. As of July 2024, Ulbrich Heights was home to 21 disabled residents, 19 elderly residents, and 100 female-headed households. Through funding from the State-Sponsored Housing Portfolio Capital Plan, the campus is currently undergoing a renovation to increase the number of apartments that meet the Americans with Disabilities Act (ADA) and Fair Housing Act standards for disabled residents. This renovation will also include adding new siding, insulation, doors, and windows to units. After these renovations are complete (anticipated end date of January 2025), 14 one-bedroom units will be fully accessible with mobility ramps for each front entrance, widened doorways, roll-in showers, and wheelchair-accessible kitchen countertops.

Most residents at Ulbrich Heights are English speakers. However, in a door-to-door survey of 16 Ulbrich Heights residents, three people reported at least one family member with limited English proficiency. Non-English languages reported by survey respondents were Turkish and Spanish. Wallingford Housing Authority does not currently translate written communications for residents at Ulbrich Heights into other languages. The U.S. Department of Housing and Urban Development (HUD) requires translations if at least five percent of a housing program's eligible participants or more than 1,000 community members have Limited English Proficiency.

1.2.2. Stakeholders

During Phase 1, the project team identified and spoke with a variety of stakeholders who provided valuable insight into topics such as energy efficiency, housing, and workforce in Wallingford and Connecticut more broadly. From the beginning of the project, CT DEEP and NEEP worked with a Project Advisory Committee

[1] "Income Limits and Gross Rents Look-up", Connecticut Housing Finance Authority, https://www.chfa.org/rental-housing-for-owners-and-management-agents-tools-calculators-look-ups/.

comprised of experts in geothermal, affordable housing, community engagement, and environmental justice from across the state to inform the project at a high level. The project team also made connections with Wallingford Housing Authority facilities staff, Ulbrich Heights residents, and local workforce groups. The team determined that it will be critical to disseminate information regarding geothermal technologies to increase awareness and proficiency among this stakeholder network, in addition to officials in the Town of Wallingford, regional Councils of Government (COGs), Connecticut legislators, and the local workforce. The project team hopes to continue to expand this stakeholder network in Phase 2, as detailed in Sections 2 and 3.

NEEP identified additional stakeholder groups for future outreach, including community groups like the Wallingford Family YMCA, the Spanish Community of Wallingford, and local schools. One opportunity for outreach that could be particularly impactful would be engaging with students at Lyman Hall, a high school adjacent to Ulbrich Heights. Other activities will target members of the communities that adjoin Ulbrich Heights, neighboring business owners, representatives from the Town of Wallingford, and other affordable housing stakeholders including the Connecticut Housing Finance Authority and the Connecticut Department of Housing. The team can also work to establish relationships with local architects, engineers, energy consultants, and general contractors who design buildings.

1.3. Plan Goals

This plan aims to provide lessons learned, best practices, and strategies that will enable the project team to engage with the community at Ulbrich Heights. The primary goals of the plan are:

- To build support for the project from residents, WHA facility managers and maintenance staff, as well as WHA board members and staff;
- To establish channels of communication and feedback mechanisms for Ulbrich Heights residents; and
- To expand awareness of geothermal technologies and workforce opportunities, with a focus on projects at affordable housing properties in Connecticut.

To achieve these goals, the plan envisions two sets of activities: education on geothermal technologies (covered in Section 2 of this report) and resident engagement (covered in Section 3). Both of these key elements of the plan should adhere to best practice principles of community engagement, as discussed next and throughout each of the following sections.

1.4. Best Practices

Community engagement strategies outlined in this plan are rooted in current research and best practices gleaned from previous community engagement activities. In particular, the project team consulted *The Spectrum of Community Engagement to Ownership* to determine goals and gauge progress on engagement (Figure 1).

Phase 1 engagement activities centered around the “inform” stage of the spectrum. The project team provided geothermal informational resources to increase resident understanding of the project. Phase 1 also included some “consult” steps, including door-to-door surveying and hosting interactive webinars.

In Phase 2, the NEEP team will seek to advance additional engagement activities to foster community ownership per the Spectrum of Community Engagement. At a minimum, the team will strive to meet stage three, which is to "involve" the community in the process. The strategies outlined in this plan will concentrate on offering additional opportunities for community consultation, involvement, and collaboration while also adhering to the project timeline and constraints.[2]

Figure 1. ***The Spectrum of Community Engagement to Ownership from Facilitating Power***

2. Geothermal Technologies Education

The general public is not yet widely familiar with geothermal heating and cooling as an emerging technology, nor is much of the heating, ventilation, and air conditioning (HVAC) workforce. The project team's research into the geothermal workforce revealed that even among those involved in or interested in the HVAC industry, there are gaps in knowledge about geothermal technology that could constrain workforce expansion. This trend was also evident when the project team conducted resident surveys at Ulbrich Heights: 96 percent of respondents reported they had no knowledge of the technology, and the remaining four percent reported limited knowledge. This lack of knowledge is an entry point for meaningful community engagement and presents an opportunity for outreach to stakeholders through geothermal knowledge-building and educational activities.

The project team aims to engage several key stakeholder groups to increase knowledge of geothermal technology in general and of the Ulbrich Heights project specifically. Educating stakeholders allows them to develop a basic understanding of geothermal heating and cooling and become familiar with the terminology used to discuss the technology. These knowledge- and capacity-building activities help foster community buy-in

[2] The Spectrum of Community Engagement to Ownership, Facilitating Power, https://movementstrategy.org/wp-content/uploads/2021/08/The-Spectrum-of-Community-Engagement-to-Ownership.pdf.

and engagement. These activities will be particularly important for Ulbrich Heights residents, given that they will be most directly affected by the installation. Section 2.1 will address resident education in detail.

2.1. Educational Activities Employed in Phase 1

In July 2024, the project team produced "Geothermal Heating and Cooling for CT Affordable Multifamily Housing," a webinar that provided insights into geothermal as a pathway to enhancing energy efficiency and reducing pollution at affordable multifamily properties. The webinar featured a panel discussion with speakers from the University of Connecticut, the project's engineering firm, LN Consulting, CT DEEP, and the Meriden Housing Authority to share lessons learned from designing and implementing geothermal heating and cooling systems and best practices for equitable project implementation. Project partners LN Consulting and University of Connecticut presented findings from the property's energy analysis and discussed the project design model used to design the proposed system for Ulbrich Heights. Representatives from another Connecticut housing authority, the Meriden Housing Authority, shared takeaways from past geothermal projects. One hundred and thirty-two individuals registered for the webinar, and approximately 75 registrants attended. Attendees watched and engaged throughout the panel and during the subsequent question-and-answer period. This format prompted a substantive discussion on geothermal system design. The webinar also allowed the project team to educate attendees and connect with individuals from a variety of stakeholder groups, including those working in Connecticut's multifamily affordable housing sector.

The team has also conducted direct educational outreach to residents of Ulbrich Heights at two in-person events and shared printed materials that can be distributed at community outreach events at the property to explain how geothermal systems work. To increase accessibility and promote comprehension, these materials feature graphics and frequently asked questions (FAQs). This information was paired with details about the project, allowing residents to identify geothermal technology proposed for Ulbrich Heights. Additionally, team members directed residents and other stakeholders to educational content on the project's website and CT DEEP's Geothermal Energy webpage.

2.2. Lessons Learned in Phase 1

The webinar held in July was one of the most highly impactful activities. It allowed the team to raise awareness of the project and make strategically important connections with new stakeholders. In Connecticut and across the Northeast, geothermal heating and cooling systems are gaining attention as an effective strategy for municipal stakeholders and regional affordable housing stakeholders to increase energy efficiency and reduce pollution at multifamily properties.

Moving forward, the project team will seek additional ways to include Wallingford and Ulbrich Heights community voices in discussions and presentations. While this webinar was targeted to a wider audience, the team recognizes that community input would enhance all project activities. Community voices are critical for equitable program implementation, as they provide insights into how the community will ultimately interact with the networked system and are useful for the program implementers, industry representatives, and affordable

housing professionals who will design the systems. The project team is focused on future opportunities to empower resident involvement in the project and allow those designing and implementing energy efficiency and electrification programs the opportunity to broaden their understanding of how program implementation is perceived by residents.

The project team will continue to provide educational resources at project events. While there are no processes in place to measure the rate at which residents and interested stakeholders are reading or accessing materials, consistent dissemination of educational materials is an essential strategy for building awareness of the project. Door-to-door surveying of residents revealed that very few tenants are familiar with geothermal technology. More effort will be needed to improve understanding as the project progresses into Phase 2.

2.3. Educational Activities for Phase 2

If this project is selected for Phase 2, the team will work to implement multiple strategies to increase knowledge of geothermal technologies and workforce opportunities within the community. These strategies include continuing to develop educational materials such as project flyers, informational handouts, and instructional resources on energy efficiency and geothermal, and providing these at events. The team will conduct further outreach to residents and housing authority staff. Direct outreach will be particularly critical as the project team begins to install heating and cooling equipment in apartments and as residents begin interacting with the technology. The team will look for opportunities to host an in-person event where residents can learn and ask questions about the operation of the in-unit equipment. Educational events should be held at least twice to accommodate residents' varying schedules, and the team will seek out community workforce partners to assist with hands-on learning. Resources and flyers on geothermal will continue to be available at tenant engagement activities and community events. Webinar sessions such as the Neighborhood-Scale Decarbonization: Geothermal and Beyond, hosted by CT DEEP, could be held to provide additional opportunities for resident and community education on geothermal technologies more broadly.

There is a possibility that the geothermal system could be built to allow expansion to surrounding buildings and properties. If the final designs of the system include expansion options, the team will expand its educational outreach to stakeholders in the surrounding community. Anticipated activities include sharing educational resources with neighboring townhouses and the daycare and schools adjacent to Ulbrich Heights. Other anticipated educational outreach activities include hosting informational sessions for the public and connecting with STEM teachers at nearby schools to develop learning materials and conduct demonstration events for the students.

Additionally, the team is working on a case study that will detail how the project partners built strategic coalitions to drive the project, how they approached the design process, and how they assessed the geothermal workforce. This case study will be published as a resource for other municipalities that are considering a geothermal system, so that these stakeholders can benefit from lessons learned at Ulbrich Heights and adopt relevant best practices. The team will host a webinar detailing the case study in greater depth and invite other interested municipalities to attend to further disseminate lessons learned. The project team will be available for questions and time will be dedicated at the end to allow collaborative discussion between municipalities.

In Phase 2, the team will develop a second case study to gather lessons learned from the implementation of the geothermal system. This case study will inform development of replicable and scalable model designs – a critical goal of this project – and provide a clear path forward for housing providers interested in implementing similar programs.

2.4. Phase Two Educational Resources

The project team will ensure that the following materials on geothermal technologies are developed and available for distribution to relevant stakeholders as part of its outreach and education strategy:

- Informational geothermal technology handouts like "one-pagers" and FAQs that explain the benefits of community geothermal;
- Instructional flyers that show how to operate in-unit equipment controls and whom to contact for questions and assistance; and
- Handouts that discuss strategies for saving money through proper operation and maintenance of in-unit equipment.

These educational materials must use easy-to-understand language and illustrations. Materials should be translated for the benefit of non-English speaking residents. The project team will continuously update the project website as new resources are released. Any recordings from webinars that the team hosts will also be uploaded to the site.

Additionally, the team will work with WHA to post all instructional or educational materials in highly visible locations around the Ulbrich Heights campus. These could include posting permanent infographic signs on the Ulbrich Heights property, either during or after installation, that explain the system and provide contact information for the project team for residents who would like to learn more.

3. Resident Engagement

To ensure that project implementation would be as equitable as possible, the team must ensure that residents are not only educated and informed, but also comfortable and able to share their input and feedback with the project team. To enable this, the team must facilitate events, provide opportunities for residents to build relationships with the project team and share their ideas and concerns, and actively solicit input. This section discusses approaches the team took in Phase 1 and recommendations for engaging with residents during Phase 2.

3.1. Community Engagement Activities Employed in Phase 1

When funding for the project was initially announced in fall 2023, the project team created a public-facing project webpage with information such as the anticipated project timeline, opportunities to get involved, relevant published resources, and an overview of geothermal heating and cooling technologies.

During Phase 1, NEEP, CT DEEP, and WHA worked together to create and disseminate easily accessible educational materials, conduct door-to-door surveys of residents, and host in-person events at Ulbrich Heights. Prior to drilling the test borehole in February 2024, NEEP created flyers to inform residents about the project and the upcoming activity. WHA provided these materials to residents in an electronic format sent out via email and via flyers placed in resident's mailboxes. The project team also created a system to route messages from the project email address to multiple key staff members across the project partner organizations. The flyers included the project email address and a phone number so that those with questions could follow up.

While the test borehole was being drilled in February, the presence of the large drilling rig made the project highly visible. Partners from NEEP, CT DEEP, UConn, WHA, and the Wallingford Electric Division (WED) took advantage of this visibility by gathering in person, providing donuts and coffee, and interacting directly with residents. The event was scheduled after gathering input from Wallingford Housing Authority staff and was scheduled to maximize exposure during a time of high foot traffic. During the summer, the team held a second in-person event at Ulbrich Heights. This event was a cookout and was primarily focused on creating an inviting atmosphere and building relationships between the project team and community members. The secondary focus of this event was educating residents about the project.

In July, NEEP staff conducted a door-to-door survey to directly engage with residents and collect more personalized feedback and input. NEEP staff knocked on 56 doors and surveyed 16 residents over the course of about two-and-a-half hours. The survey covered multiple topic areas, gauging residents' satisfaction with their current heating and cooling systems, the affordability of their energy costs, their familiarity with geothermal heating and cooling systems, and how they get information about events and activities at Ulbrich Heights. The next section discusses findings from these surveys.

3.2. Lessons Learned in Phase 1

Through interviews with housing authority staff and discussions with community members during the resident survey, the project team found no existing formal community network and limited informal networks at Ulbrich Heights. One resident reported that there had formerly been a tenant council at the property, but it had been inactive for some time. The team did not encounter any sustainability-focused groups in the wider Wallingford area that would be natural proponents of the project. During door-to-door surveys, tenants reported low awareness of the project despite project flyers having been distributed to each unit and drilling having taken place on the property. Approximately half of the residents surveyed reported a general lack of communication with housing authority staff in terms of being notified of recent weatherization activities and projects such as siding replacement on the exterior of the apartments. Most survey respondents reported that maintenance staff are generally responsive to repair work orders and very responsive to emergency work orders. Through conducting surveys and engaging in informal discussions with residents, it became apparent that effective communication with residents will take persistence and a willingness on the part of the project team and housing authority staff to meet residents where they are through direct engagement activities, such as door-to-door campaigns and distributing information through multiple channels (flyers, phone calls, emails, etc.).

Roughly 30 residents attended the cookout event at Ulbrich Heights in August (see Figures 2 and 3). Representatives from CT DEEP, NEEP, WHA, and WED spoke with residents about what geothermal heating and cooling is, how it works, and what it would entail if WHA were able to move forward implementing the design.

Figure 2. ***Flyer Advertising the Community Cookout***

Many residents expressed excitement about the concept of having central cooling, and people were generally receptive to geothermal. When asked about their utility costs, residents said they were not a huge concern given the low electricity costs of WED. To keep utility bills low, most tenants said that they run their window AC units only when necessary and keep the thermostat set relatively low in the winter. Some expressed concern about construction already happening at the site for other projects, and how disruptive it had been, but most people agreed that disruption was to be expected when properties need updating. Construction of the geothermal system installation was not a major concern, though residents confirmed the need for clear communication around project schedules and updates and suggested that efficient communication could help alleviate potential confusion and disruptions. To set clear expectations, the project team reiterated to tenants that the implementation of the geothermal project was dependent on competitive funding and therefore construction was not guaranteed.

Figure 3. ***Set Up of the Community Cookout and CT DEEP Staff Interacting with Ulbrich Heights Residents***

As the project moves forward, the lack of existing formal or informal community networks at Wallingford Heights may impede relationship-building with tenants. Ulbrich Heights does not have any common buildings or indoor space, which presents a barrier to hosting events (particularly during colder weather) and distributing information. The lack of easily identifiable community networks at Ulbrich Heights highlights a need to identify community leaders and trusted community voices, which is a necessary first step of successful community engagement. Frequent and consistent communication and seeking creative and inclusive strategies for engaging with the community will be critical as the project begins to directly impact residents during Phase 2 implementation activities.

One approach to identifying community leaders and trusted community voices could be conducting further outreach to relevant community-based organizations (CBOs). CBOs are generally more embedded in communities and can facilitate deeper learning opportunities, make connections between the project team and community members, and help the project team and housing authority staff build trust with residents. Trust is central to reaching the "collaborate" and "defer to" stages of the Spectrum of Community Engagement. To attempt to connect with local CBOs during Phase 1, the project team conducted an outreach campaign targeting faith-based organizations in the area, the high school next door to Ulbrich Heights, and various other community groups, but these efforts had limited success. Identifying relevant and embedded CBOs and building relationships with such organizations would be conducive to more effective community engagement. The project team could consider offering compensation to CBOs for participating in stakeholder outreach, which has proven to be an effective approach to ensuring equity in engagement activities and would demonstrate the project team's commitment to effective and inclusive community engagement.[3]

3.3. Resident Engagement for Phase 2

During Phase 2, the project team plans to build trust by focusing on clear and consistent communication with residents about project timelines, expectations, and opportunities for input. Ensuring that community members are aware of and prepared for upcoming events is key to demonstrating respect and inclusiveness to community members. Strategies could include offering communication via multiple channels and ensuring communication methods align with residents' preferences. During the Phase 1 door-to-door survey, residents indicated that phone calls, texts, emails, or physical mail are preferred means of communication. Other communication strategies could include sending multiple notices about upcoming construction and publicizing the CT DEEP Ulbrich Heights project webpage with information relevant to residents' concerns, such as the project's progress and upcoming work that will have a direct impact on them. An additional way to facilitate resident awareness could be communicating regularly with maintenance staff about timeline and expectations and making sure they are comfortable communicating that to tenants. The team could also gauge tenant interest in establishing a committee or advisory group directly focusing on resident engagement in this project. The team might act

[3] Fostering Partnership for Community Engagement, The Urban Institute. https://www.urban.org/sites/default/files/publication/104935/fostering-partnerships-for-community-engagement_0.pdf

as facilitators for regular meetings if such a committee were to find traction. To give residents opportunities to be heard and provide their input, the project team plans to host in-person and virtual community listening sessions during Phase 2. These would provide a venue for residents to share concerns, ask questions, and provide feedback on the most effective engagement approaches. Having a third-party organization, such as NEEP, facilitate these listening sessions could make people more comfortable sharing feedback. An online feedback form that automatically directs communication to the project email address could also be provided for people who cannot attend meetings or prefer to give feedback in writing.

The project team would seek to earn resident buy-in on decisions related to project timelines, potential disruptions, in-unit work, location of boreholes in relation to individual housing units, and preferred communication channels for project notices. During construction, tenants may face disruption with in-apartment heat pump installation (potentially over the course of up to two weeks) as well as drilling and excavation noise (timing dependent on construction schedule). Depending on the distribution of work among subcontractors and the coordination between them, heat pump installation could be much faster than two weeks. LN Consulting has created a feasibility design during Phase 1. During Phase 2, the final construction-ready design can include more opportunities for resident feedback.

As the project transitions to construction, the project team will consider hosting various events to gather stakeholders and residents. This could include a "groundbreaking/shovel event" to kick off construction as well as a ribbon cutting event when the geothermal system is complete. At events held before and during the early stages of construction, materials such as pamphlets will be provided to educate residents on what to expect during construction.

During Phase 2, the team will also plan to create and deliver educational resources relating to workforce opportunities in the geothermal industry. Such resources will include both digital materials available on the website and printed flyers. The team may also hold an informational session on the landscape of the geothermal workforce and invite all Ulbrich Heights residents.

3.4. Phase Two Engagement Resources and Activities

To ensure that residents are prepared for changes brought by the project, the team will need to develop outreach materials covering topics such as bill impacts/new charges, what to expect during the construction period, and the projected timeline. These materials should include:

- Information on how to be involved in the decision-making process;
- A FAQ handout, also to be posted on the project website;
- An explanation of any shared charges relating to operation and maintenance of the central geothermal system;
- Information on how heating and cooling costs will be reflected on electricity bills from WED and how heating costs will no longer affect gas bills from Yankee Gas;
- Overall impacts on heating and cooling costs;

- What to expect during construction (disruptions, need to vacate unit and accommodations made for that time, times with high noise levels, etc.);
- Expected timeline of project (distinct phases of construction, when residents can expect workers for in-unit installation, etc.); and
- Contact information for project partners, with an invitation to get in touch.

As part of outreach related to the geothermal workforce, the team will develop materials including:

- Information on types of geothermal occupations;
- A list of training and educational institutions that offer geothermal courses;
- Information on certifications required for various occupations in the geothermal industry; and
- Contact information for project partners willing to talk about their roles in geothermal projects.

4. Targets

To ensure that project implementation during Phase 2 is equitable and provides thorough opportunity for community input and partnership, NEEP proposes the following metrics of success:

- Three community partnerships established in Wallingford;
- Six community engagement events held at Ulbrich Heights;
- A total of 50 residents attending community engagement events held virtually or in-person at Ulbrich Heights;
- Tracking social demographics of participants attending community engagement events held, not limited to race and gender; and
- A 50 percent increase in understanding and awareness over time of the project and geothermal technology.

A community partnership could be defined as a sustained relationship with a community-based organization or community leader, where both parties feel valued and believe that the engagement is mutually beneficial, maintained for the duration of the project. Community engagement events could be in-person, virtual, or hybrid and should include opportunities for asynchronous participation to make them more accessible. Potential community engagement events include discussions with residents on design options, groundbreaking, ribbon cutting, and commissioning events, community listening sessions, public educational webinars, information sessions on workforce opportunities, and events with neighboring schools.

Initial surveys found that less than 10 percent of residents were aware of the project after initial Phase 1 outreach efforts. To track trends in awareness and understanding of the project and the technology, follow-up surveys should be conducted after some community engagement events.

5. Timeline

To fulfill the goals of the project and meet the metrics for community engagement, the proposed engagement activities are organized into major milestones. Educating and communicating with community members, stakeholders, and residents will proceed as outlined in Table 1.

Table 1. ***Community Engagement Milestones***

Milestone	Approximate Timeframe (from Phase 2 start date)	Description
Educational Resources	**2 to 3 months and ongoing**	Educational resources on the installation, operation, and maintenance of the heat pumps, as well as information on entering the geothermal workforce will be provided to tenants, through multiple communication channels.
Resident Engagement Resources	**3 months and ongoing**	An FAQ handout will be created and distributed. It will include how to get involved in the project and information about potential bill impacts, common charges, and expectations for construction. This information will also be on the CT DEEP webpage for the project.
Resident Engagement and Education Event (first event)	**6 months**	The first in-person event will be preceded by a broad outreach campaign to provide opportunities for the entire community to share their input on the process so far, express any concerns, and learn about the operation and maintenance of the equipment.
Resident Engagement and Education Event (second event)	**8 to 10 months**	The second in-person event will be designed to reach younger community members in grades K-12, to strengthen career awareness for the geothermal industry, and to provide another opportunity for residents to speak with the project team and share their input or concerns
Resident Equipment Demos (third and fourth events)	**14 months**	Two outreach events at Ulbrich Heights will allow the residents to interact with the equipment and learn how to operate the heat pumps and controls. Residents will be able to ask questions and learn more about the project timeline. Two separate times will be offered to accommodate varying schedules.
Outreach to Wider Community and State Audience (fifth and sixth events)	**24 months**	When the geothermal system has been in place for some time, the facility will hold public events demonstrating the technology and use these events as opportunities to conduct outreach to towns across the state, reaching out through networks such as the CT Energy Network mailing list. This may include two community engagement events, either in-person or virtual. The team plans to reach out statewide to disseminate the results of the case study and to publicize key events.
Second Case Study and Accompanying Webinar	**28 months**	Pending installation of the geothermal system, the team will develop a second case study and distribute broadly among relevant stakeholders, including via a webinar.

6. Conclusion

Using the lessons learned from geothermal education and tenant outreach during Phase 1, the project team will plan strategic engagement activities for the duration of Phase 2 that focus on increased involvement of and collaboration with stakeholders. To effectively decarbonize at a community scale, it is crucial that people feel heard, valued, and involved in the process, and that all kinds of expertise and knowledge are valued. Following the Spectrum of Community Engagement, the team will begin by equipping residents and other local stakeholders with the information they need to be informed, and then solicit their input for shaping the education and engagement process to ensure it works for everyone involved. Activities to increase awareness and understanding of geothermal technologies will include developing instructional materials for using in-apartment controls and a corresponding hands-on training event, outreach to the local high school, and writing a second case study on implementation of the geothermal system. Activities to advance beyond the "inform" stage will include improving communication channels, holding listening sessions, and developing mechanisms for resident input on the geothermal system construction.

If Phase 2 funding is awarded to the Ulbrich Heights project, the project team will be committed to equitable program implementation and will seek to continuously raise awareness about geothermal technologies and engage WHA residents. The team will solicit resident feedback and adjust strategies as necessary to meet the needs of the community, assure the community understands and supports geothermal development, and enhance the community's ability to effectively engage in an energy economy that is rapidly decarbonizing.

Appendix J – Data Sharing Plan

This DATA SHARING AND NON-DISCLOSURE AGREEMENT (the "Agreement") is made by and among the undersigned entities, _____, ___, _____, and _____ (“Parties”), for purposes of setting forth the agreement of the Parties relative to data sharing and nondisclosure of confidential information.

WHEREAS, The U.S. Department of Energy (“DOE”) has awarded the State of Connecticut Department of Energy and Environmental Protection ("DEEP") Phase II Project entitled _____, (the “Project”) dated ____, 2024, Award Number ____ (the “Award”); and

WHEREAS, each Party hereto has agreed to participate in the Project and will play a unique and important role; and

WHEREAS, in carrying out the goals and objectives of the Project, DEEP as Grantee will be entering [has entered] into separate contracts with each Party hereto, and each Party shall be paid certain agreed upon amounts out of the Award funding; and

WHEREAS, in performing its obligations under its respective contracts with DEEP, each Party shall come into possession of certain data and confidential information belonging to tenants in a multi-family housing complex; and

WHEREAS, the Parties acknowledge that it is imperative that they share said data and confidential information in order to successfully accomplish the goals and objectives of the Project; and

WHEREAS, the Parties wish to memorialize their rights and obligations relating to sharing of data and confidential information.

NOW, THEREFORE, for good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, the Parties hereby agree as follows:

1. The Parties shall coordinate effective means of communication among them, as directed by DEEP.
2. In addition to communicating with each other, the Parties shall collaborate with each other to carry out the Project in the most efficient manner, as directed by DEEP.
3. The extent of collaboration and coordination shall be determined by DEEP and may include collaborating on best practices for clear communication, coordination of services and referrals between Parties, avoidance of burdensome processes, data sharing and confidentiality, and other items that arise at the discretion of DEEP.
4. The data to be shared includes:
    a. Full address/unit number
    b. Site Info:
        i. Meter type;

ii. Number of occupants;

iii. Space heating fuel type; and

iv. Size (square footage; number of units and stories in building).

c. …

5. The names of tenants and occupants of units shall not be shared.

6. All data and information shared shall be in a secured format approved by DEEP, consisting of data access files retrieved from an approved software program and sent via a secure SharePoint file, or another means of security or encryption to ensure protection. All files shall be protected by security measures at least comparable to multifactor authentication and improve or update security measures as they become available.

7. For purposes of this Agreement, "Confidential Information" includes any name, number or other information that may be used, alone or in conjunction with any other information, to identify a specific individual including, but not limited to, such individual's name, date of birth, mother's maiden name, motor vehicle operator's license number, Social Security number, employee identification number, employer or taxpayer identification number, alien registration number, government passport number, health insurance identification number, demand deposit account number, savings account number, credit card number, debit card number or unique biometric data such as fingerprint, voice print, retina or iris image, or other unique physical representation. Without limiting the foregoing, Confidential Information shall also include any information that the discloser classifies as "confidential" or "restricted." Confidential Information shall not include information that may be lawfully obtained from publicly available sources or from federal, state, or local government records which are lawfully made available to the general public.

8. "Confidential Information Breach" shall mean, generally, an instance where an unauthorized person or entity accesses Confidential Information in any manner, including but not limited to the following occurrences: (1) any Confidential Information that is not encrypted or protected is misplaced, lost, stolen or in any way compromised; (2) one or more third parties have had access to or taken control or possession of any Confidential Information that is not encrypted or protected without prior written authorization from the State; (3) the unauthorized acquisition of encrypted or protected Confidential Information together with the confidential process or key that is capable of compromising the integrity of the Confidential Information; or (4) if there is a substantial risk of identity theft or fraud to the Parties, a tenant, DEEP or the State.

9. Protection of Confidential Information.

a. Each Party, at its own expense, shall protect from breach all Confidential Information which it comes to possess or control in connection with the Project, wherever and however stored or maintained, in accordance with current industry standards.

b. The obligations hereunder shall extend to each Party's members, directors, officers, shareholders, partners, managers, representatives, agents, servants, consultants, and employees, and each Party shall be responsible hereunder for any breach of the terms of this

Agreement to the extent caused by its employees or any third party to whom it has disclosed the Confidential Information. Access to the Confidential Information shall be limited to employees of each Party who have a need to know said Confidential Information for the purpose contemplated by this Agreement, and who agree to observe and comply with the obligations of Parties under this Agreement with regard to such Confidential Information. Each such employee shall sign a copy of this Agreement; such copy shall be retained on file by the Party and provided to DEEP upon request.

c. Each Party shall develop, implement, and maintain a comprehensive data- security program for the protection of Confidential Information. The safeguards contained in such program shall be consistent with and comply with the safeguards for protection of Confidential Information, and information of a similar character, as set forth in all applicable federal and state law concerning the confidentiality of Confidential Information. Such data-security program shall include, but not be limited to, the following:

i. A security policy for employees related to the storage, access, and transportation of data containing Confidential Information;

ii. Maintaining a list of employees with access to records containing Confidential Information, including access to any locked storage where such records are kept, which list shall be retained on file by the Party and provided to DEEP upon request;

iii. A process for reviewing policies and security measures at least annually;

iv. Creating secure access controls to Confidential Information, including but not limited to multifactor authentication; and

v. Encrypting of Confidential Information that is stored on laptops, portable devices or being transmitted electronically.

vi. The Party shall notify DEEP as soon as practical, but no later than twenty-four (24) hours, after they become aware of or suspect that any Confidential Information which the Party has come to possess or control has been subject to a breach. If a Confidential Information Breach has occurred, the Party shall, within three (3) business days after the notification, present a credit monitoring and protection plan to DEEP for review and approval. Such credit monitoring or protection plan shall be made available by the Party at its own cost and expense to all individuals affected by the Confidential Information Breach. Such credit monitoring or protection plan shall include, but is not limited to, reimbursement for the cost of placing and lifting one (1) security freeze per credit file pursuant to Connecticut General Statutes §36a-701a. Such credit monitoring or protection plans shall be approved by DEEP in accordance with this Section and shall cover a length of time commensurate with the circumstances of the Confidential Information Breach. The Party's costs and expenses for the credit monitoring and protection plan shall not be recoverable from DEEP, any State of Connecticut entity or any affected individuals.

10. Each Party shall use all information disclosed by each other Party solely in connection with the Project as set forth herein, and shall not use, directly or indirectly, any Confidential Information

for any other purpose without DEEP's prior written consent. The Parties shall not knowingly use Confidential Information directly or indirectly for any illegal or nonlegitimate purpose.

11. In the event that a Party is required to disclose Confidential Information of another Party by subpoena, law or other directive of a court, administrative agency, or arbitration panel, the receiving Party hereby agrees to provide DEEP and the disclosing Party with prompt notice of such request or requirement in order to enable DEEP or the disclosing Party to:

    i. seek an appropriate protective order or other remedy,

    ii. consult with the receiving Party with respect to taking steps to resist or narrow the scope of such request or legal process, or

    iii. waive compliance, in whole or in part, with the terms of this Agreement.

    In the event that such protective order or other remedy is not obtained, or the disclosing Party waives compliance with the provisions hereof, the receiving Party hereby agrees to furnish only that portion of the Confidential Information which it's counsel advises is legally required and to exercise best efforts to obtain assurance that confidential treatment will be accorded such Confidential Information.

12. Return of Confidential Information. After a Party's participation in the Project terminates, or if at any time, in its sole discretion, DEEP requests the return of the Confidential Information, each Party shall promptly deliver to DEEP all Confidential Information including all copies, reproductions, summaries, compilations, analyses, or extracts thereof.

13. No Warranty. The Confidential Information is provided "as is" with all faults. In no event shall DEEP be liable for the accuracy or completeness of the Confidential Information.

14. DEEP shall not have liability to the Parties, or any other person or entity, for the Parties' use of any Confidential Information disclosed pursuant to this Agreement.

15. Equitable Relief; Audit. The provisions of this Agreement are necessary for the protection of the Confidential Information, including, but not limited to the personal identifiable information of tenants, and are considered by the Parties to be reasonable for such purpose. The Parties agree that any breach of this Agreement may cause DEEP and the State of Connecticut substantial and irreparable damages and, therefore, in the event of any such breach or threatened breach, in addition to other remedies which may be available, the DEEP and the State of Connecticut shall have the right to specific performance and other injunctive and equitable relief, it being acknowledged that legal remedies are inadequate. DEEP or another appropriate agency of the State of Connecticut may audit the Parties' compliance with this Agreement.

16. No Waiver. The Parties understand and agree that no failure or delay by DEEP in exercising any right, power, or privilege hereunder shall operate as a waiver thereof, nor shall any single or partial exercise thereof preclude any other or further exercise thereof or the exercise of any right, power, or privilege hereunder.

17. Governing Law. This Agreement shall be governed by and construed in accordance with the laws of the State of Connecticut without regard to its conflicts of laws principles.

18. Assignment Prohibited. Any assignment of the Parties' rights, obligations, or duties under this Agreement without DEEP's prior written consent shall be void.

19. Entire Agreement. This Agreement contains the entire agreement between the Parties concerning the protection of Confidential Information and no modification of this Agreement or waiver of the terms and conditions hereof shall be binding upon the parties, unless approved in writing by each of them.

20. Severability. If any provision or provisions of this Agreement shall be held to be invalid, illegal, or unenforceable, the validity, legality, and enforceability of the remaining provisions shall not in any way be affected or impaired thereby.

In Witness Whereof, the Parties have set their hands and seals as of this _____ day of _____, 202_.

_____ _____

_____ _____

_____ _____