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## NYSEG Ithaca Utility Thermal Energy Network Pilot Project

**100% DESIGN NARRATIVE REPORT**

**OCTOBER 2025**

CONFIDENTIAL

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## DEFINITIONS & ACRONYMS

### Commonly Used Acronyms & Abbreviations

ASHP	Air Source Heat Pump
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ATS	Automatic Transfer Switch
BMS	Building Management System
BTU	British Thermal Unit
CD	Construction Documents Phase (60% to 100% design)
COP	Coefficient of Performance
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
DD	Design Development (30% to 60%)
DER	Distributed Energy Resource
EER	Energy Efficiency Ratio
GPM	Gallons Per Minute
HVAC	Heating, Ventilation, and Air Conditioning
kW	kilo-Watt (1,000 W)
kVA	Kilo-Volt-Ampere
MT	Metric Tons
MVA	Mega-Volt-Amp
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
O&M	Operation & Maintenance
PVC	Polyvinyl Chloride
RTU	Rooftop Unit
SD	Schematic Design Phase (0% - 30%)
SF	Square Foot
VRF	Variable Refrigerant Flow
WC	Water Closet

# SCOPE OF WORK & PROJECT REQUIREMENTS

## Scope of Project

Following the Order on Developing Thermal Energy Networks Pursuant to the Utility Thermal Energy Network and Jobs Act issued by the New York Public Service Commission (“PSC”) on September 15, 2022, NYSEG has engaged LaBella Associates to complete engineering design services as part of Stage 2. NYSEG will be required to proceed into construction and UTEN operation under Stages 3 and 4 once approval of Stage 2 has been granted by the PSC. The scope of the project includes the design of all mechanical conversions within each building along with the design of the utility distribution system (UDS) as required by the utility thermal energy network (“UTEN”). This document outlines the design that has been completed based on site visits of all pilot buildings, review of existing mechanical and electrical systems, development of thermal loads, and discussions with pilot participants. The table to the right outlines all the buildings included as part of the design. Note that (36) buildings have expressed letters of interest, while (1) building opted out of the pilot and (3) buildings never responded to any solicitations. Of the buildings that provided a LOI, (9) are commercial buildings, (14) are multifamily housing authority buildings, and (13) are private single and multifamily buildings. Site visits have been completed for all (36) buildings. It is not anticipated that any additional building owners will provide LOIs in advance of Stage 3. However, the main utility distribution system was sized based on the capacity of all buildings along the UTEN main, regardless of LOI status. This ensures the utility main is sized adequately to serve all potential customers.

*Table 1: Buildings in Scope*

Building #	SF	Residential/Commercial	Enrollment Status	Site Visit Date
310 HANCOCK ST.	1,208	Residential		10/9/2024
304-06 HANCOCK ST.	1,920	Residential		11/14/2024
423 FRANKLIN ST.	1,302	Commercial (Dispensary)		10/9/2024
435 FRANKLIN ST.	4,400	Commercial (Market)		10/9/2024
412 1ST ST.	5,096	Church		10/9/2024
316 HANCOCK ST.	1,232	Residential		11/14/2024
402 3RD ST.	12,821	Office		11/14/2024
504-14 1ST ST.	10,298	Warehouse (Water Authority)		Renovation
510 1ST ST	8,392	Office (Water Authority)		Renovation
504/506 ALICE MILLER WAY	2,268	Residential (Housing Authority)		11/14/2024
508/510 ALICE MILLER WAY	2,268	Residential (Housing Authority)		11/14/2024
512/514/516 ALICE MILLER WAY	2,268	Residential (Housing Authority)		11/14/2024
518/520 ALICE MILLER WAY	2,268	Residential (Housing Authority)		11/14/2024
301 FRANKLIN/522 ALICE MILLER	2,268	Residential (Housing Authority)		11/14/2024
303/305 FRANKLIN ST	2,268	Residential (Housing Authority)		11/14/2024
307/309 FRANKLIN ST	2,268	Residential (Housing Authority)		11/14/2024
521/523 1ST ST	2,268	Residential (Housing Authority)		11/14/2024
517/519 1ST ST	2,268	Residential (Housing Authority)		11/14/2024
513/515 1ST ST	2,268	Residential (Housing Authority)		12/16/2024
509/511 1ST ST	2,268	Residential (Housing Authority)		12/16/2024
505/507 1ST ST	2,268	Residential (Housing Authority)		12/16/2024
308/310 ADAMS ST	2,268	Residential (Housing Authority)		11/14/2024
304/306 ADAMS ST	2,268	Residential (Housing Authority)		11/14/2024
417 2ND ST.	1,138	Residential		12/4/2024
411 2ND ST.	1,791	Residential		12/16/2024
320 HANCOCK ST.	1,968	Residential		12/16/2024
302 HANCOCK ST.	2,110	Residential		12/4/2024
416 1ST ST.	1,552	Residential		12/4/2024
402 ADAMS ST.	1,152	Residential		12/4/2024
405 3RD ST.	2,494	Office		12/16/2024
506 1ST ST.	8,866	Office		12/16/2024
421 2ND ST.	1,380	Residential		3/31/2025
415 2ND ST.	1,068	Residential		7/17/2025
407 2ND ST.	1,774	Residential		7/9/2025
312 HANCOCK ST.	1,784	Residential		7/8/2025
301 3RD ST.	18,982	Commercial (Mixed Use)		7/9/2025

## Work Completed

Upon submission of the 100% Design Narrative Report, the following tasks have been completed:

- ❖ Documentation of existing mechanical and electrical conditions for all buildings that signed a LOI
- ❖ Development of Hourly Analysis Program (HAP) load models for all residential and commercial buildings that provided a LOI
- ❖ Development of ACCA Manual J load models for all residential buildings that provided a LOI
- ❖ Demolition drawings outlining existing equipment to be removed
- ❖ New work drawings outlining proposed equipment within customer buildings
- ❖ New work drawings outlining UDS-side equipment (energy transfer stations, pump station, etc.)
- ❖ Controls schematics and sequences for building-side HVAC
- ❖ Controls schematics and sequences for UDS equipment
- ❖ Details and specifications for all relevant disciplines (Mechanical, Electrical, Civil, Architectural, Structural, Environmental)
- ❖ Regulated building materials scope of work identified, notably asbestos and lead paint
- ❖ A revised network load analysis based on the results of the load models
- ❖ Identification of metering devices, equipment, and software required for tracking performance metrics required by Staff
- ❖ Updated cost estimates based on vendor selections
- ❖ Incorporation of NYSEG comments for 100% construction documents

## Next Steps

Prior to submission of the Stage 2 Filing, the following tasks are anticipated:

- ❖ Development of operation and maintenance procedures for the proposed design

## Procurement Approach

To ensure construction is completed with the most experienced and appropriate parties involved, the project will be bid as three (3) separate contracts: a contract for the residential HVAC conversions, a contract for the commercial HVAC conversions, and a contract for the utility infrastructure outside of the buildings. A prime contractor will be selected through a competitive bidding process for each contract. They will subcontract the work as required. Contracts with the prime contractors will require that they comply with all requirements pertaining to prevailing wage and apprenticeship requirements once made clear by the NYS Department of Labor (DOL) as it pertains to the UTEN pilot projects. The designs as outlined in this report have preference towards HVAC systems that are most replicable and familiar to potential contractors. Although the utility thermal energy network is novel as a concept, the proposed HVAC conversions and installation of a water main (UDS) are relatively straightforward and commonly found across NYSEG's service territory.

## Performance Metrics

Following the guidance provided by the New York Public Service Commission ("PSC") on June 13, 2025, LaBella kept the required performance metrics at the forefront of the design, strategically selecting equipment and metering devices to track all required data while minimizing overall cost. Compared to the comprehensive list of data points that are required to be tracked, the data that is most relevant to those operating the system is a much smaller subset. For this reason, the design team and NYSEG identified which of the listed performance metrics would be used by future operators of the system. This data, deemed "mission critical", would be tracked via Flowboss RTU's integrated into NYSEG's existing SCADA system. The entirety of these data points are tied to the UDS pump house and well energy transfer stations. Subsequently, (1) Flowboss RTU was selected for each of these enclosures. The units will track all data relevant to the enclosure, including inlet and outlet temperatures, flow, electric consumption, etc. They also will have their own SIM card routers, as non-customer WiFi is unavailable on site.

Non-"mission critical" data such as the inlet and outlet temperature of customer ETS's or the performance of individual heat pumps was tracked via a variety of methods. Where feasible, data tracked by the heat pumps was leveraged. For WaterFurnace heat pumps, the Symphony system can track valuable data such as heat pump electric consumption and COP. For heat pumps that do not have a packaged data tracking system built-in, third-party data tracking systems such as GeoFease's Vigilant & Ensure were incorporated. Note that while these devices can utilize customer WiFi for data tracking purposes, NYSEG indicated that the preference would be to have SIM card routers to reduce dependency on customer WiFi. Stage 3 will need to include providing access to WiFi networks as part of the customer agreement.

By strategically selecting smart circulation pumps, additional data points can be tracked without extensive independent sensors and metering devices. For all customer buildings, pumps capable of tracking flow, temperature, and electricity were selected. These pumps then transmit the data via BACNET to a central hub. For data that is unable to be tracked via the heat pumps or circulation pumps, such as the inlet & outlet temperature on each heat exchanger, independent sensors were required. Because this introduces additional cost and complexity into the design, use of this strategy was limited.

A list of all required performance metrics with associated tracking equipment is included in Appendix F. To reduce the overall cost of the data tracking system, a sampling rate can be applied for the residential buildings. This strategy limits the number of metering devices required and can potentially yield similar learnings. For purposes of the cost estimate and in accordance with PSC requirements, it is assumed that performance metrics are tracked for all buildings.

# RESIDENTIAL BUILDING CONVERSIONS

The following section provides a narrative of the basis-of design for the building HVAC conversions, including the following:

- ❖ Existing Equipment & Scope of Demolition
- ❖ Proposed new work and equipment selections
- ❖ Calculated Building Loads
- ❖ 8760 Load data
- ❖ HVAC Conversion Approach and Scope of Alterations
- ❖ Electric Capacity and Extent of Upgrades

The table below outlines all residential buildings along with their estimated building loads. For the buildings not enrolled, the heating and cooling loads were estimated on a per square foot basis using the loads of comparable completed buildings.

*Table 2: Residential Building Summary*

Building #	Conditioned SF	Residential/Commercial	Enrollment Status	Peak Heating (MBH)	Peak Cooling (MBH)
310 HANCOCK ST.	1,238	Residential		28	13
304-06 HANCOCK ST.	1,893	Residential		38	18
316 HANCOCK ST.	1,407	Residential		29	13
504/506 ALICE MILLER WAY	2,076	Residential (Housing Authority)		32	17
508/510 ALICE MILLER WAY	2,233	Residential (Housing Authority)		33	15
512/514/516 ALICE MILLER WAY	2,626	Residential (Housing Authority)		42	19
518/520 ALICE MILLER WAY	2,190	Residential (Housing Authority)		33	15
301 FRANKLIN ST/ 522 ALICE MILLER WAY	2,227	Residential (Housing Authority)		32	14
303/305 FRANKLIN ST	2,107	Residential (Housing Authority)		32	15
307/309 FRANKLIN ST	2,150	Residential (Housing Authority)		34	17
521/523 1ST ST	2,140	Residential (Housing Authority)		35	16
517/519 1ST ST	2,248	Residential (Housing Authority)		35	16
513/515 1ST ST	2,135	Residential (Housing Authority)		34	16
509/511 1ST ST	2,137	Residential (Housing Authority)		34	16
505/507 1ST ST	2,248	Residential (Housing Authority)		35	16
308/310 ADAMS ST	2,142	Residential (Housing Authority)		33	17
304/306 ADAMS ST	2,190	Residential (Housing Authority)		33	14
417 2ND ST.	1,229	Residential		28	13
411 2ND ST.	2,653	Residential		52	27
320 HANCOCK ST.	2,357	Residential		51	26
302 HANCOCK ST.	2,117	Residential		43	21
416 1ST ST.	1,569	Residential		32	14
402 ADAMS ST.	1,147	Residential		26	14
421 2ND ST.	1,380	Residential		37	14
415 2ND ST.	1,068	Residential		26	11
407 2ND ST.	1,774	Residential		49	19
312 HANCOCK ST.	1,784	Residential		39	14

Estimated

1,097

506

A summary outlining all residential loads is included in Appendix D. Upon completion of 60% design, the design team held individual review meetings with the building owners to present design concepts and solicit feedback. The building owners were largely receptive to the proposed designs with minimal pushback.

## Electrification of Domestic Hot Water

For the residential buildings converting natural gas water heating to efficient electric water heating will prove expensive, at times complex and generally have negative utility bill impacts. The six different options below show the pros and cons for each conversion type and if they result in a negative bill impact (i.e., higher operating costs) or positive bill impact (i.e., operating savings). The COP is the coefficient of performance which is the heating efficiency metric that's the ratio of output energy divided by input energy. The energy input is electricity in these examples.

### 1. Straight Electric Tank, *COP = 1.0*

**Pros:** Least expensive to install; Great for small volume households

**Cons:** Expensive to operate per BTU; Slow recovery

→Bill impact relative to natural gas DHW: **Very Negative**

### 2. On-Demand Electric, *COP = 1.0*

**Pros:** Takes up almost no space; Endless hot water if sized properly

**Cons:** Needs a very large circuit (amps) to run; Sensitive to hard water

→Bill impact relative to natural gas DHW: **Very Negative**

### 3. HPWH Heat Pump Water Heater (aka Hybrid), *COP ~ 2.0*

**Pros:** Savings typically over oil or propane DHW; Much better efficiency than straight electric

**Cons:** Expensive to install; Requires condensate line

- Noisy if near occupied spaces

- Cools space the space it's in

- Requires access to room air (~700 cu ft) (can be ducted in some cases)

→Bill impact relative to natural gas: **Slightly Negative**

### 4. GSHP Desuperheater on System, *COP ~2.5*

**Pros:** Main HP contributes summer & winter; Best with variable speed HPs

**Cons:** Expensive to install; Works much better with two tanks

→Bill impact relative to natural gas DHW: **Slightly Negative**

### 5. GSHP Dedicated Water-to-Water/Indirect Tank, *COP ~3.5*

**Pros:** 100% GSHP hot water; Good COP but not as #6 below

**Cons:** Expensive to install. Efficiency suffers much above 120F

→Bill impact relative to natural gas DHW: **Neutral**

### 6. GSHP Packaged Unit - Priority DHW/Indirect Tank, *COP ~4.0*

**Pros:** 100% GSHP hot water – Best COP

**Cons:** Expensive overall heat pump system. Limited models and only centrally ducted systems

→Bill impact relative to natural gas DHW: **Slightly Positive**

Where possible LaBella & Aztech are recommending HPWHs since they are a single tank system with reasonable efficiencies. They are also familiar to a large number of local installers. Since the overall UTEN system is "heating dominant", having the HPWH will also keep the overall load profile from being further imbalanced. There are a few homes where a dedicated water-to-water heat pump with an indirect tank a good alternative may be. These are homes where we recommend hydronic distribution for heating and cooling.

**Pages 18 - 91 redacted due to contains Customer data**

## Residential Flow Diagrams

The following section outlines flow diagrams for each of the residential approaches that were designed.

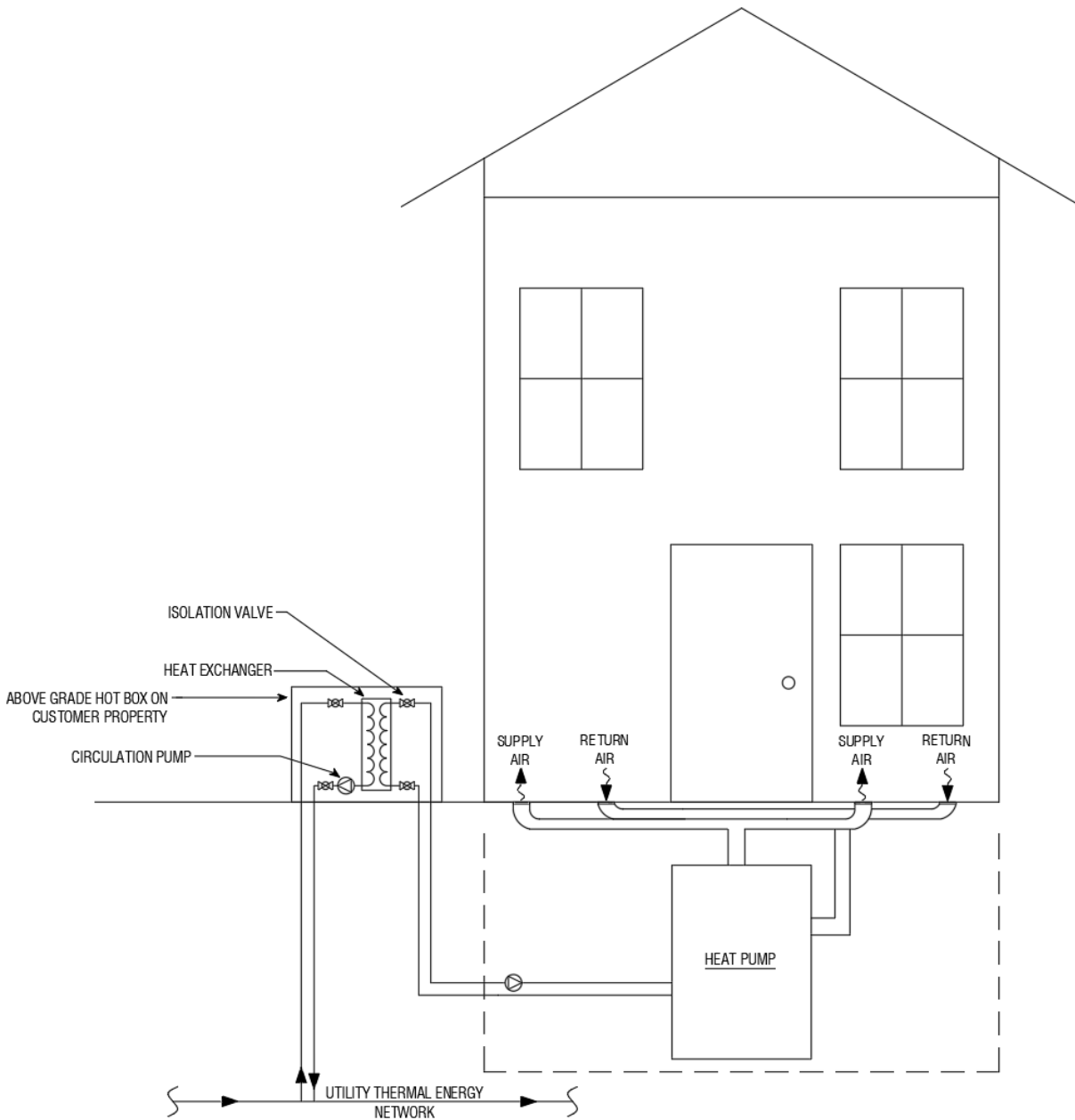


Figure 146: Water to Air Heat Pump Diagram

The flow diagram above pertains to all residential buildings that have an existing furnace. The existing furnace would be swapped out with a water-to-air heat pump, keeping all ductwork in place. The basis-of-design manufacturer for these buildings is WaterFurnace.

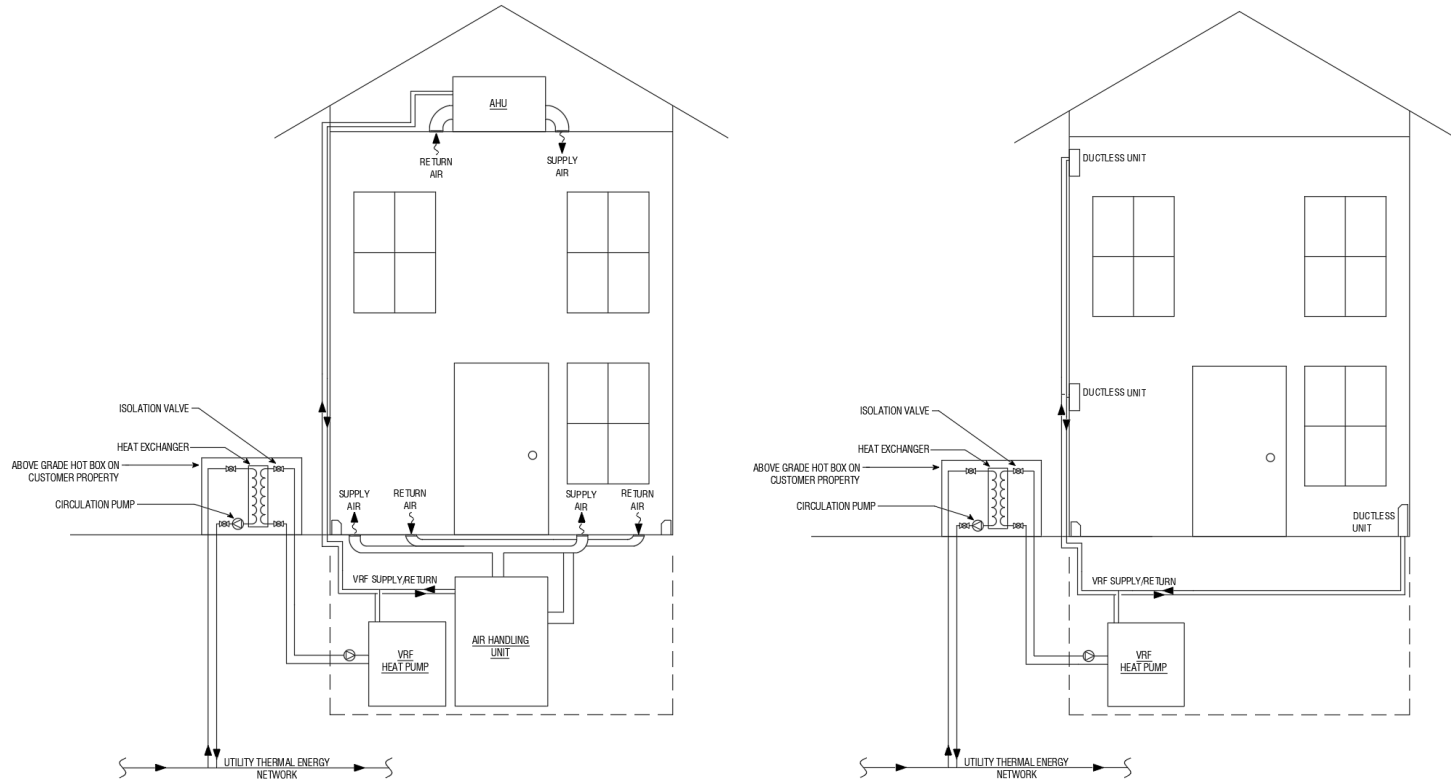


Figure 147: VRF Heat Pump Flow Diagrams

The flow diagram above pertains to all residential buildings that have an existing hydronic system. For this design, all hydronic baseboard and piping will be abandoned. The existing boiler will be swapped out with a heat pump VRF that serves ductless units and air handling units. The left diagram illustrates a typical housing authority building with a VRF located in the mechanical room and two air handling units. The VRF piping will run up the side of the house into the attic for the second floor air handling unit and next to the heat pump for the first floor air handling unit. For buildings where the first floor air handling unit is in a different room, refrigerant piping will be run under the house through the crawlspace to the first floor air handling unit. The right diagram illustrates a VRF serving an air handling unit on the second floor and a highwall on the first floor. The inclusion of an air handling unit with ductwork is dependent on available space; for residential buildings that do not have sufficient space, ductless units will be used. Refrigerant charge calculations were estimated for all residential buildings with a VRF system recommended to ensure ASHRAE 15 requirements were met. The basis-of-design manufacturer for these buildings is Samsung.

## **Residential Controls**

Each residential site shall have its own central controller which shall be responsible for all communications and control of any associated equipment including but not limited to: data collection, unit startup, and sensor terminations. Each location's controller shall operate standalone as there is no central building management system to be installed due to various factors such as the decentralized nature of the network and cost. The main unit at each location shall come provided with a manufacturer installed controller which will facilitate the unit's factory provided sequence of operations. The energy transfer station (ETS) associated with the building shall be enabled to run when there is a call for heating / cooling.

The following data shall be collected per New York State requirements: electric consumption, heat exchanger inlet & outlet temperatures, flow. This data shall be sent from the central controller to a web based storage system that may be accessed as needed.

## COMMERCIAL BUILDING CONVERSIONS

The following section provides a narrative of the basis-of design for the commercial building HVAC conversions, including the following:

- Existing Equipment & scope of demolition
- Proposed new work and equipment selections
- Calculated Building Loads
- 8760 Load data
- HVAC Conversion Approach and Scope of Alterations
- Electric Capacity and Extent of Upgrades
- Hazardous Materials Management Approach
- Energy Transfer Station

The table below outlines all commercial buildings along with their estimated building loads. All commercial buildings provided a letter of interest.

*Table 3: Commercial Building Summary*

Building #	Conditioned SF	Residential/Commercial	Enrollment Status	Peak Heating (MBH)	Peak Cooling (MBH)
423 FRANKLIN ST.	1,302	Commercial (Dispensary)		73	85
435 FRANKLIN ST.	4,400	Commercial (Market)		195	268
412 1ST ST.	5,096	Church		169	156
402 3RD ST.	12,821	Office		294	354
504-14 1ST ST.	10,298	Warehouse (Water Authority)		11	8
510 1ST ST	8,392	Office (Water Authority)		366	284
405 3RD ST.	2,494	Office		120	96
506 1ST ST.	8,866	Office		318	165
301 3RD ST.	18,982	Commercial (Mixed Use)		391	486

Estimated

1,935

1,902

Note that the water authority office is undergoing a renovation that is currently in the design phase through TetraTech. The floorplan, building load, and HVAC conversion from their 60% design drawings were used to size the UDS equipment for the building.

**Pages 96 - 123 redacted due to contains Customer data**

## **Commercial Controls**

Each site shall have its own central controller which shall be responsible for all communications and control of any associated equipment including but not limited to: data collection, unit startup, and sensor terminations. Each location's controller shall operate standalone as there is no central building management system to be installed due to various factors such as the decentralized nature of the network and cost. The main unit at each location shall come provided with a manufacturer installed controller which will facilitate the unit's factory provided sequence of operations. The energy transfer station (ETS) associated with the building shall be enabled to run when there is a call for heating / cooling.

The following data shall be collected per New York State requirements: electric consumption, heat exchanger inlet & outlet temperatures, and flow. This Data shall be sent from the central controller to a web based storage system that may be accessed as needed.

## **Management of Hazardous Materials**

In accordance with current regulations, LaBella's environmental team has conducted a targeted regulated building materials (RBM) inspection in order to address building conditions prior to renovation. The inspection was tailored for those materials impacted by the proposed scope of work and included identification and quantification of asbestos containing materials (ACM), lead based paint (LBP), and Polychlorinated Biphenyl's (PCBs). Samples of suspect materials were collected and submitted to our in-house or partnering laboratory for analysis. A final report was prepared for the project and is included in Appendix I. The report lists confirmed RBMs by area, describes locations, condition, and provides approximate quantities.

In addition to the final inspection reports, hazardous material drawings and project specifications have been produced to show locations and types of confirmed RBMs to be abated. LaBella has identified any potential hazards and their associated regulatory constraints involved with the management and /or abatement of hazardous materials. Specifications have been carefully crafted and coordinated with other trades in order to keep abatement costs to a minimum while complying with all state and federal regulations and agency requirements.

## UTILITY DISTRIBUTION SYSTEM

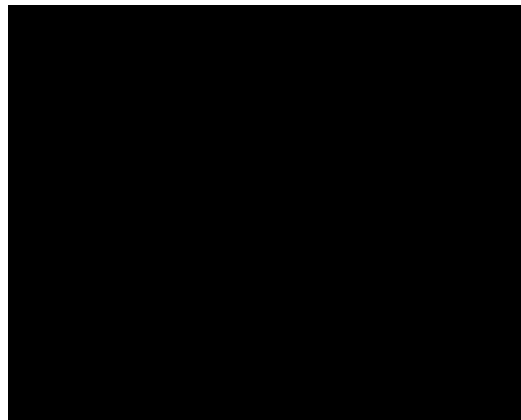
The following section provides a narrative on the following relating to the utility distribution system:

- Service Connection Routing
- Network Load Analysis
- UDS Routing, Materials, & Extent of Alterations
- Well Locations & Performance Specifications, Pump/HX Specifications
- Pump Station Design
- Permitting & Approvals

### Service Connections

The energy transfer station was located on the exterior of each building to accommodate future access without tenant interruption. An uninsulated box will be fixed to the side or rear of the building and will contain a brazed plate heat exchanger and constant speed circulation pump. On either side of the heat exchanger will be the source and building loops. The source loop is comprised of the piping from the ambient temperature loop to the hot side of the heat exchanger, known as the service connection. The constant speed pump will provide flow for the 20% propylene glycol mix to pass through the heat exchanger and return to the ambient loop, transferring thermal energy to or from the building loop. The building loop is comprised of piping from the heat pump unit to the cold side of the heat exchanger. This loop will be filled with a 20% propylene glycol mix and flow will be provided by a constant speed pump located within the building, just after the pipes penetrate the building. Additional equipment is also required for the building loop, such as an expansion tank and an air separator. The expansion tank will accommodate thermal expansion and contraction as the fluid becomes heated or cooled and the air separator will ensure even thermal transfer and will prevent scale build up on the heat exchanger both within the energy transfer station as well as within the heat pump unit. The size of the transfer station will be heavily dependent on the load of the building, as a higher load will result in a larger heat exchanger. Pump sizes will remain relatively consistent as required flow rates and effective pressure drop will be comparable.

From the perspective of the utility, the service connections will be identical across all buildings; a supply and return pipe will be routed to an energy transfer station located on the exterior of the building. Depending on the number of heat pumps that the building uses, the supply and return pipes on the customer side of the heat exchanger may branch off into several separate loops via a manifold. For the residential buildings, the proposed path of construction starts at the street and branches off perpendicular to the main loop. From there, the piping runs to the side of the house and connects to the energy transfer station. Shown to the right is the location of the service connection for [REDACTED]



The energy transfer station will be accessible outside of the building and piping will penetrate into the building to connect to the water-to-air heat pump. The piping from the heat exchanger to the respective unit(s) in the apartment will be the only penetration(s) into the building. For designs involving a VRF system that serves an AHU in the basement and in the attic, it is likely that the refrigerant piping will be routed on the exterior of the home and a separate penetration will be made into the attic.

Each of the housing authority buildings has one service connection placed on the opposite side of the porch to reduce public visibility. From there, piping will be routed into the crawlspace underneath the building and up through the floor into the mechanical room(s), where the heat pump VRF unit will be located. Refrigerant from these units will be routed to the air handling unit on the first floor. An additional refrigerant line will run on the outside of the building into the air handling unit located in the attic. For housing authority buildings that do not have sufficient space for a multi-position air handling unit, ductless units tied to the VRF heat pump are proposed.

The service connections for commercial buildings follow the same strategy: one supply and return pipe to an easily accessible energy transfer station. Shown to the right is the proposed service connection for [REDACTED]. For this building, a supply and return pipe would be routed behind the building to the energy transfer station located next to the electric meters. From there, piping would be routed along the exterior of the building and along the roof to each of the rooftop units. The location of service connections and energy transfer stations were strategically selected to ensure that they were easily accessible for the utility while also remaining discrete to minimize the potential for theft or vandalism.

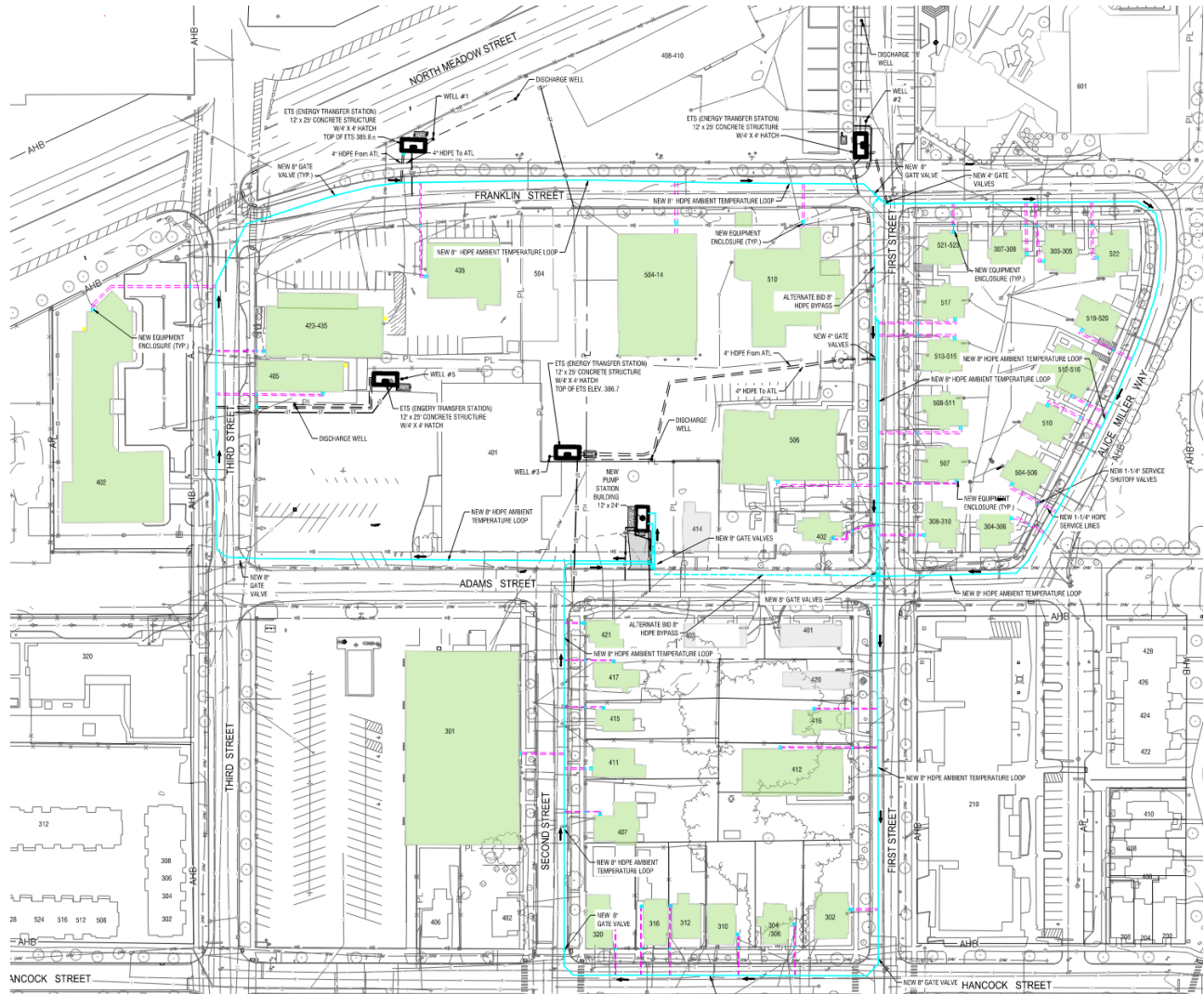
All services connections will be extended from the UDS main to the building by open cut trenching. While boring would reduce the restoration required, it adds risk to potentially interfering with other utilities. The service connections (with energy transfer stations) for each building will be housed in hot box enclosures. Shown to the right is a potential option for the hot box enclosure. The hot boxes will be insulated and will house the heat exchanger, a UDS service pump and shut off valves. The pumps housed in each hot box will be small and will connect to the homeowner's electric panel.



*Figure 197: Service Connection Hot Box*

**UDS Main Piping**

Shown below is the proposed pipe layout for the UDS main. This one-pipe loop will circulate water mixed with refrigerant that is used to transfer heat between the wellfields and the buildings.



*Figure 198: UDS Main Layout*

The project will develop an open loop system to circulate groundwater to act as a heat sink for the regional geothermal system. The proposed geothermal system is anticipated to service buildings generally bounded by North Meadow Street on the north, Cascadilla Creek to the east, Hancock Street to the south and 3rd Street to the west. The proposed loop will be high density polyethylene pipe (HDPE) sized based on anticipated loading. The proposed loop will be valved to isolate portions of the system for operation and maintenance. The pipe network is anticipated to be located within the roadway right-of-way. Location within the right-of-way is anticipated to be a combination of under the roadway, within the tree lawn (between the sidewalk and the roadway) and under the sidewalk. All disturbed areas will be restored to City of Ithaca standards. Final location of the pipe network within each right-of-way was based on a review of final pilot program participants, minimization of utility conflicts and tree disturbance and restoration requirements.

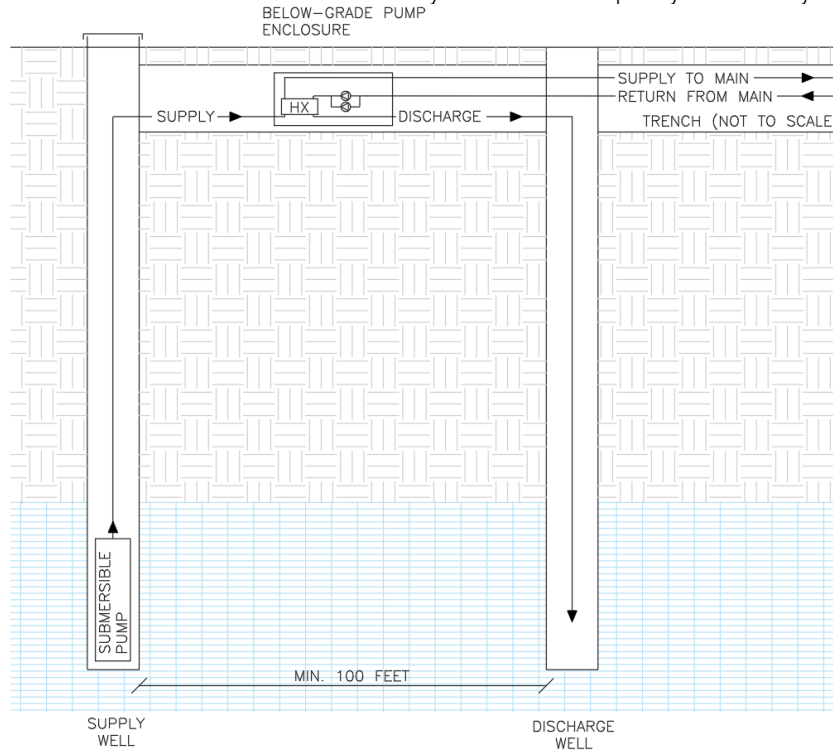
The proposed pipe network northern limit will be installed on Franklin Street from 3rd Street northeasterly to Alice Miller Way. It is anticipated that this segment will pick up the warehouse at 408-410 Franklin Street and other pilot program participants along the southside of Franklin Street within this segment. The loop systems easterly limit will be continued southerly down Alice Miller Way, along Adams Street to 1st Street and then southerly down 1st Street to Hancock Street. It is anticipated the system will service pilot program participants on the west side of Alice Miller Way and both sides of these portions of Adams Street and 1st Street. The southern limits of the proposed pipe network will be continued westerly Hancock Street from 1st Street to 3rd Street. This portion of the loop will pick up pilot program participants along the north side of Hancock Street within this segment. The western limit of the proposed pipe network will be constructed along 3rd Street from Hancock Street to Franklin Street which will close the perimeter pipe loop of the system. It is anticipated that this segment will pick up the medical office building at 402 3rd Street as well as pilot program participants along the eastside of 3rd Street. "Internal" sub-loops will be created with the installation of piping along 1st Street from Franklin Street to Adams Street and along Adams Street from 1st Street to 3rd Street and is anticipated to service pilot program participants along both sides of these roadway segments.

This project is anticipated to require City of Ithaca Common Council and/or Planning Board approval requiring a SEQR review. This will require completion of an Environmental Assessment form which will require various state agency documentation. Additionally, construction of the pipe network and services will require other additional City of Ithaca permits/approvals.

Several UDS bypasses were included as design alternates. These bypasses can be enabled via manual valves to isolate sections of the UDS main that may become damaged and require servicing. Additional detail for the bypass piping can be found in Appendix H.

**Wells**

Based on the projected building loads and well testing, (4) wellfields have been sized and located throughout the UDS. These wellfields will connect to the UDS main via an energy transfer station consisting of a heat exchanger and several pumps. These energy transfer stations will reside within enclosures that are adjacent to the wellfield and are below grade. Shown below is a flow diagram for the wells which illustrates how the systems are kept hydronically separate.



*Figure 199: Well Conceptual Diagram*

Shown below are the flow rates and sizes for each well. A TRYNYSYS model was completed which confirmed the required flow rates at each well based on the building loads. The results of pump tests for two (2) production wells that were drilled indicate that the formation is capable of producing the required 150 GPM.

*Table 4: Wellfield Details*

20% Glycol Side									
Well Location	Peak Load (MBH)	$\Delta T$	GPM	Size (inch)	Velocity (ft/s)	Length (ft)	Head Loss (ft./100 ft)	HX Head Loss (ft)	Total Head (ft)
1	1.056	14	150	4.00	3.83	60	1.20	12	12
2	1.056	14	150	4.00	3.83	50	1.20	12	12
3	1.056	14	150	4.00	3.83	720	1.20	12	20
4	1.056	14	150	4.00	3.83	380	1.20	12	16

Water Side									
Well Location	Peak Load (MBH)	$\Delta T$	GPM	Size (inch)	Velocity (ft/s)	Length (ft)	Head Loss (ft./100 ft)	HX Head Loss (ft)	Total Head (ft)
1	1.056	14	150	4.00	3.83	325	1.20	12	15
2	1.056	14	150	4.00	3.83	465	1.20	12	17
3	1.056	14	150	4.00	3.83	300	1.20	12	15
4	1.056	14	150	4.00	3.83	315	1.20	12	15

## Anticipated Geology

A local driller referred to the flat areas in downtown Ithaca as an old lake bottom, consisting of sand, gravel, and clay. Drillers will encounter a pressurized aquifer between 125 feet and 170 feet with the borehole yielding in excess of 100 GPM. Our team also spoke with Dominick DeLucia, a Senior Engineer with Taitem Engineering, PC (located in Ithaca) concerning the Purity Ice Cream ground source heat pump system. Mr. DeLucia underscored the difficulties encountered by the geothermal drillers, who installed thirty (30), 220-foot boreholes, with casing extending the full length, so no bedrock was encountered. The formation thermal conductivity test showed a 1.0 thermal conductivity, which is lower than found in most formations across NYS. The Purity Ice Cream system did ultimately prove successful in its operation and provides a basis for the means, methods, and projected cost of installing a closed loop system in this part of town, which is within 0.3 miles of the Ithaca DMV site.

### US Geological Survey maps for surficial and bedrock geology:

**Surficial geology** in the area of the site has been mapped by the New York State Museum – Geological Survey on the Surficial Geologic Map of New York – Finger Lakes Sheet as: Glacial Outwash consisting of Sand Deposits associated with large bodies of water, generally a near shore deposit or near a sand source, well sorted & stratified, generally quartz sand, 2 to 20 meters (6.5 to 66 feet) in thickness.

**The subsurface geology (bedrock)** in the area of the site has also been mapped by the United States Geological Survey – Mineral Resources Online Spatial Data – Geologic Maps as the Genesee Formation that consist of gray shale and mud stone that ranges in thickness from 200 to 1,000 feet. This rock formation is Upper Devonian in age. Secondary rock types within the Genesee Group consist of Siltstone and Limestone beds indicating that this area was a transitional zone when the sediments were deposited.

## Well Drilling Approach and Test Wells

A local well drilling company was consulted to develop a scope of work for the well drilling required. As previously discussed, (2) test wells and associated production wells were included in the design to confirm groundwater flow rates and develop the TRYNSYS model. The first phase of the test well is a 6" test bore. Preliminary estimates indicate that 100' is the depth of drilling, but this may be revised dependent on site conditions. The drill and drive method was used which allows for sampling of the water and determination of potential flow rates. Bore logging and water sampling validated preliminary geologic assumptions and set the stage for what was required in phase 2. Phase 2 included development of a test well and subsequent testing. This involved 10" mud drilling with 8" casing at the depth determined in phase 1 (~100'). It was estimated that up to 40 hours per well are required for development. Drilling incurred mud discharge which was left on site. While test wells can be developed at each potential well location, it was proposed that two test wells be conducted to reduce project cost.



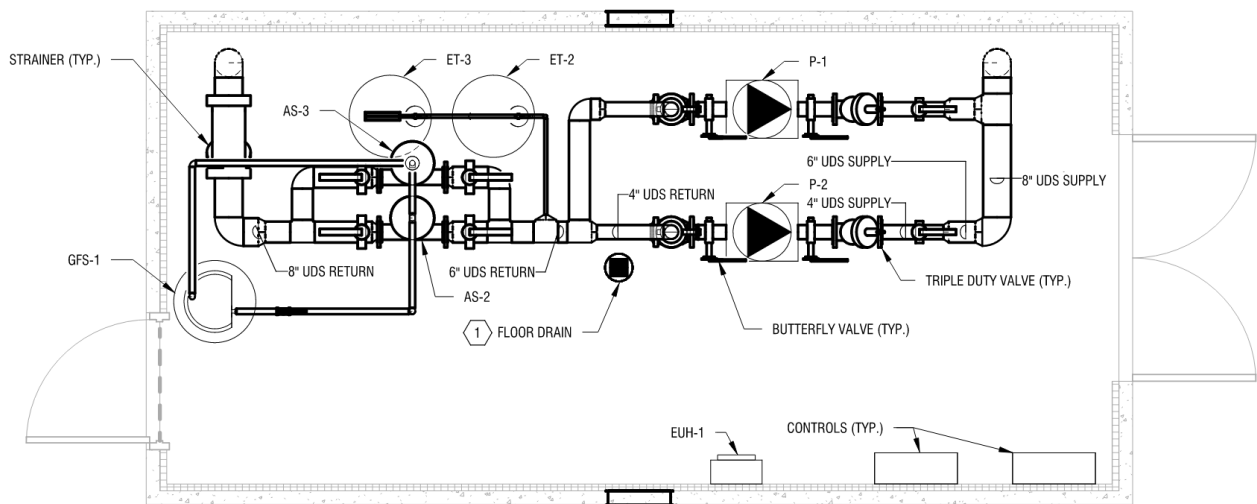
Figure 200: Drilling Production Well #1

## Pump Station

To provide sufficient flow through the UDS, a pump station has been included. The pump station houses (2) 3 HP pumps, valves, a glycol fill station, an expansion tank, an air and dirt separator, controls equipment, and electrical cabinets within an above-grade pump house enclosure. A backup generator is also included to provide backup power to the pumps. Shown to the right is a schematic for the above-grade pump station. The pump station will require a new electrical service to feed the pumps, controls, and any additional ancillary equipment. The station will require a new 200A/208V/3-phase electrical service including a service rated transfer switch with a 15kW generator adjacent to the building. Shown below is a site plan outlining all mechanical equipment within the pump station.



*Figure 201: Pump Station Model*



*Figure 202: Pump Station Plan*

## Pump Station Controls

The associated pumps as well as any additional end devices shall be terminated and controlled by a central controller that shall operate standalone. The pumps shall operate at constant speed on a call for heating & cooling by the downstream systems. The following data is to be collected and stored in a web based server for access per NYS requirements: electric consumption, inlet & outlet temperatures, energy flow. A Flow Boss FB3000 is to be used for the well energy transfer stations and shall serve as the main point of data collection for the following information: inlet & outlet temperatures, loop pressure, pump electric consumption, pump speed, pump status. The FB3000 shall also be interfaced with the central BAS controller. The Flow Boss is to be integrated with the gas control SCADA system. The GeoFease Ensure system shall be installed to monitor a flow meter & BTU meter. Similar to the Flow Boss mentioned above this system is also a web based data storage system and shall be interfaced with the associated central BAS controller as well.

## Well Energy Transfer Stations

To transfer heat from the aquifer to the UDS, an energy transfer station at each well location has been included. The energy transfer station will be housed in a below-grade precast concrete vault to reduce public visibility and potential for vandalism. The approximate dimensions for the underground vault are 21' long, 7.5' wide, and 6' deep. It is important to note that the ground water does not come into direct contact with the glycol loop of the UDS main. The heat exchanger isolates each fluid.

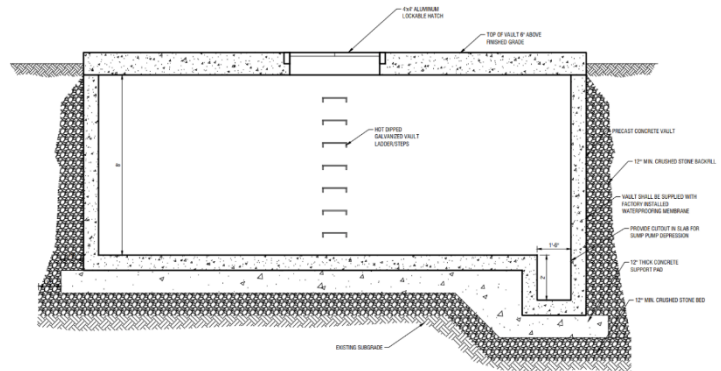


Figure 203: Well Energy Transfer Station (typ.)

Shown below is a schematic for a below-grade energy transfer station which connects to the well. The vault houses a heat exchanger, (2) 2 HP pumps, valves, and electrical cabinets. Electric service to (1) 15 HP submersible pump in the aquifer is tied to the well ETS. An above-ground backup generator is also included. The location of the generator will vary depending on the energy transfer station. For a below-grade energy transfer station, an important design consideration is proper drainage of the vault. Each well includes a sump to discharge any water that accumulates within the vault.

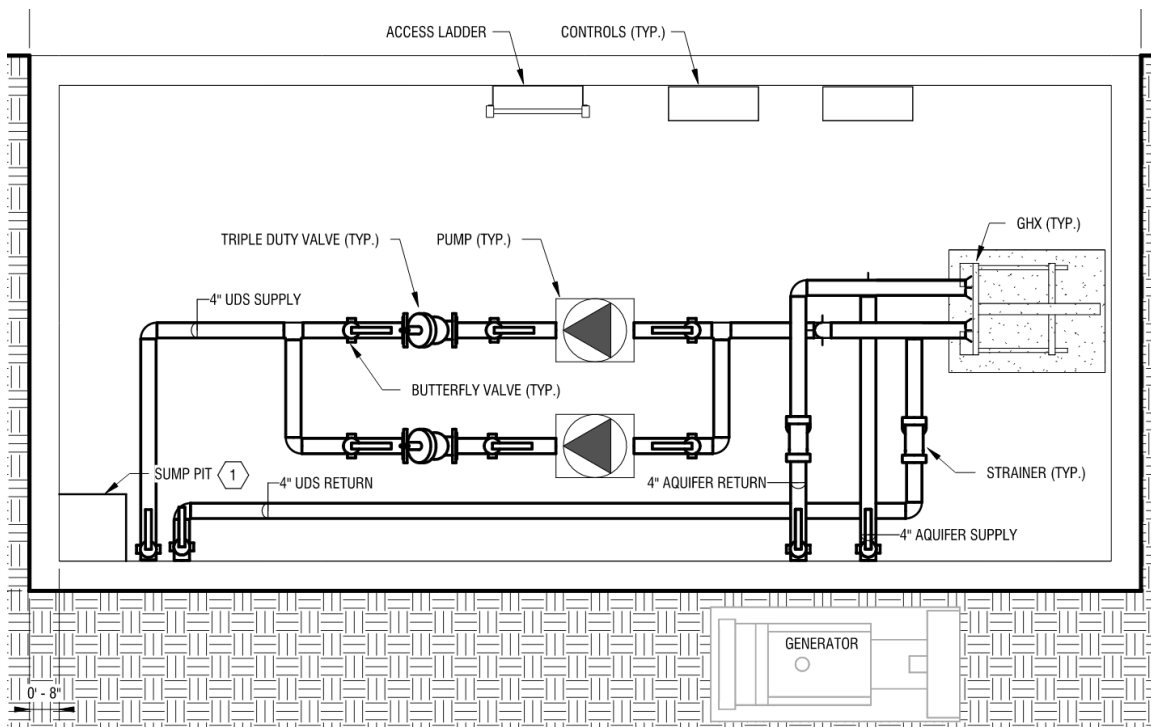


Figure 204: Well Energy Transfer Station Plan

Each energy transfer station will require a new electrical service to feed the pumps, controls, and any additional ancillary equipment. The station will require a new 200A/208V/3-phase electrical service including a service rated transfer switch mounted on pedestal with a 30kW generator adjacent to the vault.

## Well Energy Transfer Station Controls

The associated pumps as well as any additional end devices shall be terminated and controlled by a central controller that shall operate standalone. On a call for heating / cooling by the main unit on the building side, the pumps shall be enabled and the flows shall be adjusted.

Temperature sensors located on the inlet side of the open loop heat exchangers from the ambient loop will determine the pump speed of the submersible pump and district side circulation pump:

- When the entering fluid temperature is 52°F, the pump variable frequency drive activates the minimum flow rate of 20% and ramps linearly as the temperature decreases.
- When the fluid temperature decreases to 46°F, the pump variable frequency drives the flow rate to 100%.
- When the entering fluid temperature is at 58°F, the pump variable frequency drive activates the minimum flow rate of 20% and ramps linearly as the temperature increases.
- When the fluid temperature increases to 64°F, the GHX pump variable frequency drives the flow rate to 100%.

The following data is to be collected and stored in a web based server for access per NYS requirements: electric consumption, heat exchanger inlet & outlet temperatures, flow. A Flow Boss FB3000 is to be used for the well energy transfer stations and shall serve as the main point of data collection for the following information: inlet & outlet temperatures, loop pressure, pump electric consumption, pump speed, pump status. The FB3000 shall also be interfaced with the central BAS controller. The Flow Boss is to be integrated with the gas control SCADA system. The GeoFease Ensure system shall be installed to monitor a flow meter & BTU meter. Similar to the Flow Boss mentioned above this system is also a web based data storage system and shall be interfaced with the associated central BAS controller as well.

## Emergency Scenarios

The following list below covers emergency scenarios regarding leak detection:

- Install pressure sensors on the district/utility side main pipe to monitor for abnormal pressure drops indicative of a leak. Pressure sensors should be installed together with the temperature sensors used for the control of the energy transfer station pumps. Another pressure should be installed in the pump station building. Therefore, a total of 5 pressure sensors located through out the main district pipe.
- In the event of a detected leak, an alert is sent to utility personnel for immediate response.
- In the event of a detected leak, an alert is sent to utility personnel for immediate response.
- The utility team locates the leak and manually closes the isolation valves to isolate it. The following section Bypass Operation Scenarios outlines the various scenarios to isolate certain sections of the district system to maintain operation for as much buildings as possible.
- Once the leak is isolated and addressed, refill the fluid on the district utility side and resume normal operation.

**Network Load Analysis**

Shown below are the cumulative loads for the network. Note that an assumed peak heating and cooling load was estimated for the water authority building given its pending renovation.

*Table 5: Aggregate Building Loads*

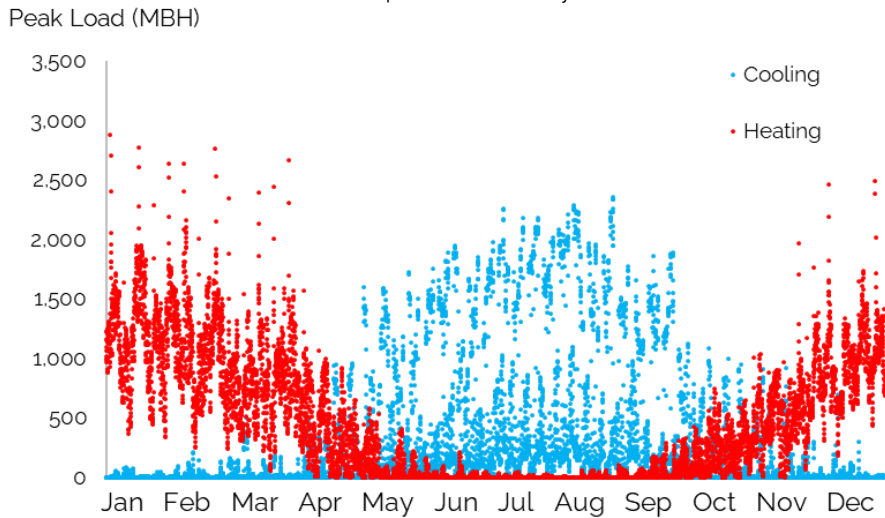
Building #	Conditioned SF	Residential/Commercial	Enrollment Status	Peak Heating (MBH)	Peak Cooling (MBH)
310 HANCOCK ST.	1,238	Residential		28	13
304-06 HANCOCK ST.	1,893	Residential		38	18
316 HANCOCK ST.	1,407	Residential		29	13
504/506 ALICE MILLER WAY	2,076	Residential (Housing Authority)		32	17
508/510 ALICE MILLER WAY	2,233	Residential (Housing Authority)		33	15
512/514/516 ALICE MILLER WAY	2,626	Residential (Housing Authority)		42	19
518/520 ALICE MILLER WAY	2,190	Residential (Housing Authority)		33	15
301 FRANKLIN ST/ 522 ALICE MILLER WAY	2,227	Residential (Housing Authority)		32	14
303/305 FRANKLIN ST	2,107	Residential (Housing Authority)		32	15
307/309 FRANKLIN ST	2,150	Residential (Housing Authority)		34	17
521/523 1ST ST	2,140	Residential (Housing Authority)		35	16
517/519 1ST ST	2,248	Residential (Housing Authority)		35	16
513/515 1ST ST	2,135	Residential (Housing Authority)		34	16
509/511 1ST ST	2,137	Residential (Housing Authority)		34	16
505/507 1ST ST	2,248	Residential (Housing Authority)		35	16
308/310 ADAMS ST	2,142	Residential (Housing Authority)		33	17
304/306 ADAMS ST	2,190	Residential (Housing Authority)		33	14
417 2ND ST.	1,229	Residential		28	13
411 2ND ST.	2,653	Residential		52	27
320 HANCOCK ST.	2,357	Residential		51	26
302 HANCOCK ST.	2,117	Residential		43	21
416 1ST ST.	1,569	Residential		32	14
402 ADAMS ST.	1,147	Residential		26	14
421 2ND ST.	1,380	Residential		37	14
415 2ND ST.	1,068	Residential		26	11
407 2ND ST.	1,774	Residential		49	19
312 HANCOCK ST.	1,784	Residential		39	14
420 1ST ST.	1,480	Residential		26	12
401 ADAMS ST.	2,520	Residential		45	21
403 ADAMS ST.	2,520	Residential		45	21
414 1/2 ADAMS ST.	1,480	Residential		26	12
423 FRANKLIN ST.	1,302	Commercial (Dispensary)		73	85
435 FRANKLIN ST.	4,400	Commercial (Market)		195	268
412 1ST ST.	5,096	Church		169	156
402 3RD ST.	12,821	Office		294	354
504-14 1ST ST.	10,298	Warehouse (Water Authority)		11	8
510 1ST ST	8,392	Office (Water Authority)		366	284
405 3RD ST.	2,494	Office		120	96
506 1ST ST.	8,866	Office		318	165
301 3RD ST.	18,982	Commerical (Mixed Use)		391	486

Estimated

3,033

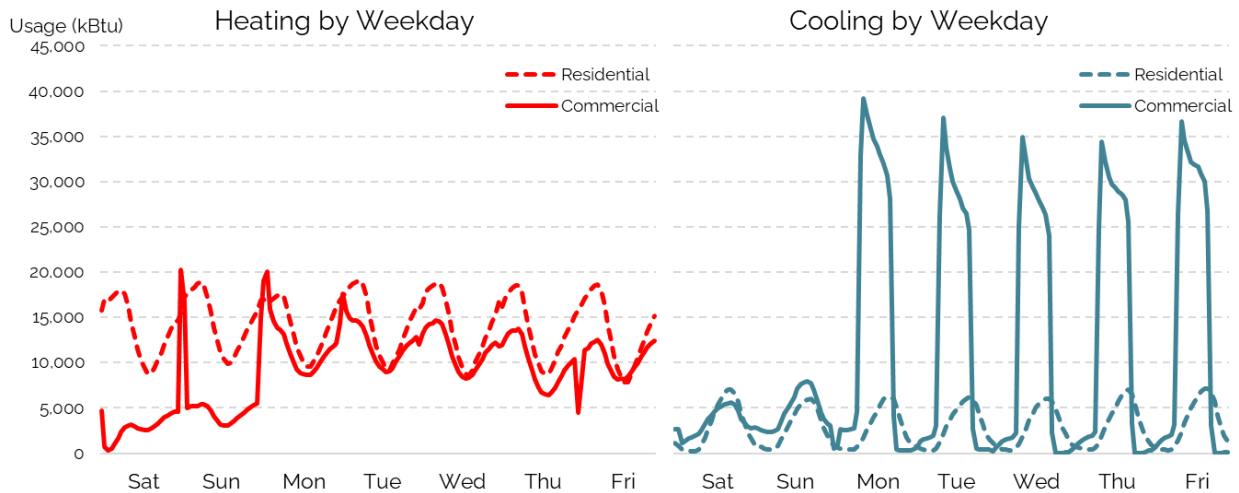
2,407

The district has a peak heating load of 2,877 MBH and a peak cooling load of 2,358 MBH. Note that these peaks are lower than the sum of the peaks in the table above due to load diversity. Shown below are the cumulative load profiles for a year.



*Figure 205: Aggregate Load Profile*

Shown below are annual heating and cooling consumption for residential and commercial buildings by weekday. Note that the commercial cooling energy consumption is significantly higher during the workweek while the residential energy consumption is relatively constant throughout the week. Cooling loads peak in the middle of the day while heating loads peak in the early morning.



*Figure 206: Consumption by Weekday*

Monthly load profiles for the loop are shown below. Monthly load profiles for each individual building are included in Appendix D.

*Table 6: Aggregate Monthly Building Loads*

Month	Peak Heating (MBH)	Peak Cooling (MBH)	Total Heating (kBtu)	Total Cooling (kBtu)
January	2,878	89	912,947	3,543
February	2,758	211	722,610	7,232
March	2,661	502	608,888	15,208
April	1,571	960	248,762	64,611
May	580	1,727	50,066	271,007
June	210	1,974	5,647	414,702
July	47	2,253	1,501	532,988
August	106	2,358	4,052	517,752
September	327	1,891	24,403	320,564
October	1,007	1,080	168,011	93,199
November	1,964	924	419,106	39,751
December	2,493	700	722,478	12,707
Max / Sum	2,878	2,358	3,888,472	2,293,264

**Permitting & Approvals**

There are a number of permitting and regulatory requirements that must be considered during the design. These considerations include, but are not limited to:

- ❖ Obtaining easements for locating infrastructure across public rights of way or across properties that are not included in the district.
- ❖ Gaining access to private property owners with protection and/or compensation.
- ❖ Coordination with existing utilities.
- ❖ Compliance with local standards and authorities having jurisdiction.

Any subsurface easements created for a district geothermal system must be conveyed via a written document which is signed and acknowledged by the creator. District geothermal systems which also cross public rights of way over land, such as roads and highways, must obtain easements from the state or municipal subdivision which controls these public rights of way. Through the project, (12) authorities having jurisdiction (AHJ's) were identified on Federal, State, and Local levels. A summary of all AHJ's including any permitting that may be required with associated timeframes for approval is shown below. AHJ's relevant to the systems as presented in this document are emboldened.

*Table 7: Authorities Having Jurisdiction*

Agency Level	AHJ	Description of Permit/Approval	Estimated Timeframe of Approval
Federal	United States Environmental Protection Agency (EPA)	Authorizes "by rule" the use of geothermal wells as class V injection wells under the UIC program. Specific inventory information on the wells and the site's hydrogeologic conditions must be submitted prior to construction. Vertical closed loop and open loop supply wells are exempt.	4 to 6 weeks
State	NYS Department of Transportation (NYS DOT)	Permitting approval required for subsurface work across state highways or railroads. Agreement between project developer and railroad on compensation, maintenance, and decommissioning.	Several weeks
State	<b>NYS Department of Environmental Conservation (NYS DEC)</b>	<b>CWA Section 401 Water Quality Permit (open loop or surface water thermal system). SPDES Permit (open loop or surface water thermal system). Division of Water Approval for wells less than 500 feet or over 500 feet.</b>	<b>Unknown</b>
State	NYS Office of Renewable Energy Siting (NYS ORES)	Additional siting requirements may apply for projects over 25 MW of thermal capacity.	Up to 12 months
State	NYS Department of Health (NYS DOH)	Design must not return water used in conjunction with heat exchangers back to the public water system.	N/A
State	<b>NYS Public Service Commission (NYS PSC)</b>	<b>Requires approval for pricing for geothermal service, if regulated. Requires submetering and notices</b>	<b>6 to 12 months</b>
State	NYS Department of Public Service (NYS DPS) and NYS Historic Preservation Office (NY SHPO)	Requires approval for design which interferes with historical or cultural resources.	Unknown
Local	<b>Town of Ithaca Code Enforcement and Zoning Department</b>	<b>Requires general construction permit</b>	<b>Unknown</b>
Local	<b>Town of Ithaca Public Works Department</b>	<b>Requires temporary closure of roads application and right of way permit application</b>	<b>Unknown</b>
Non-Government	Private Property Owners Served by System	Agreement between developer and property owner to install system on private property, with an agreement on pricing, maintenance, and decommissioning.	Several months
Non-Government	Private Property Owners Not Served by System	Private easement from property owner to install and maintain parts of district system on or across private property, with an agreement on compensation, maintenance, and decommissioning.	Several months
Non-Government	Utilities (electric, gas, water, sewer, cable, telephone)	<b>Confirm project infrastructure does not interfere with utility infrastructure Project developer to notify all utility operators of project and receive "all clear" from utilities Project design which interferes with utility infrastructure or requires infrastructure upgrade requires agreement on compensation, maintenance, decommissioning, and liability.</b>	Several months

## **APPENDIX A: MANUAL J CALCULATIONS (RESIDENTIAL)**

## **APPENDIX B: COMMERCIAL HVAC LOAD CALCULATION REPORTS**

## APPENDIX C: SITE SURVEY

## **APPENDIX D: LOADS SUMMARY**

*Table D.1: Monthly Heating Loads*

Heating Building #	SF	Total Load (kBtu)												Annual	Peak Load (MBH)												
		January	February	March	April	May	June	July	August	September	October	November	December		January	February	March	April	May	June	July	August	September	October	November	December	Annual
310 HANCOCK ST.	1,208	13,723	11,035	9,550	4,683	1,109	56	0	31	412	3,087	7,316	11,429	62,431	28	27	25	20	12	7	0	3	10	17	18	25	28
304-06 HANCOCK ST.	1,893	16,559	13,279	10,878	4,523	688	11	0	0	233	2,838	8,429	13,872	71,309	38	34	32	24	12	4	0	0	9	20	22	31	38
316 HANCOCK ST.	1,407	13,171	10,733	9,339	4,698	1,412	215	36	126	842	3,535	7,441	11,236	62,783	29	26	25	20	12	8	5	6	11	17	18	25	29
504/506 ALICE MILLER WAY	2,076	16,598	13,827	11,855	5,578	955	7	0	0	148	3,047	8,684	14,112	74,809	32	31	31	24	12	2	0	0	6	19	22	30	32
508/510 ALICE MILLER WAY	2,233	16,752	13,838	11,665	5,244	822	8	0	0	146	3,024	8,708	14,146	74,352	33	32	31	24	12	3	0	0	7	19	22	31	33
512/514/516 ALICE MILLER WAY	2,626	22,133	18,588	15,970	7,619	1,406	18	0	2	220	4,019	11,511	18,818	100,304	42	40	40	33	17	5	0	1	10	25	29	39	42
518/520 ALICE MILLER WAY	2,190	15,106	12,187	10,170	4,420	647	5	0	0	106	2,447	7,555	12,587	65,230	33	30	28	22	10	2	0	0	5	17	20	28	33
301 FRANKLIN ST/ 522 ALICE MILLER WAY	2,227	15,355	12,646	11,023	5,418	1,177	40	0	12	414	3,440	8,307	12,867	70,699	32	30	28	22	13	6	0	2	10	18	20	28	32
303/305 FRANKLIN ST	2,107	15,685	12,863	11,233	5,528	1,201	37	0	9	402	3,439	8,411	13,107	71,915	32	31	29	23	13	6	0	2	10	19	20	29	32
307/309 FRANKLIN ST	2,150	16,068	12,944	10,343	3,845	302	0	0	0	1	1,594	7,473	13,436	66,004	34	31	30	23	10	0	0	0	0	16	22	31	34
521/523 1ST ST	2,140	17,847	14,872	12,604	5,703	915	8	0	1	155	3,393	9,395	15,176	79,948	35	33	32	26	13	3	0	0	7	21	24	32	35
517/519 1ST ST	2,248	18,356	15,474	13,443	6,401	1,116	10	0	0	192	3,630	9,894	15,751	84,267	35	33	32	27	13	3	0	0	8	21	24	32	35
513/515 1ST ST	2,135	17,100	14,165	11,963	5,373	835	7	0	0	134	3,089	8,877	14,425	75,968	34	32	31	25	12	2	0	0	7	19	23	32	34
509/511 1ST ST	2,137	17,403	14,552	12,516	5,842	991	9	0	1	182	3,327	9,203	14,813	78,841	34	32	31	25	13	3	0	0	7	20	23	31	34
505/507 1ST ST	2,248	18,988	16,187	14,164	6,832	1,208	11	0	1	235	3,989	10,504	16,481	88,602	35	34	33	28	14	3	0	0	9	22	25	33	35
308/310 ADAMS ST	2,142	14,376	11,571	9,657	4,098	820	1	0	0	61	2,218	7,130	11,912	61,563	33	29	27	21	10	0	0	0	4	17	19	27	33
304/306 ADAMS ST	2,190	15,885	13,121	11,442	5,639	1,240	45	0	17	452	3,656	8,673	13,347	73,517	33	31	29	23	13	6	0	2	10	19	21	29	33
411 2ND ST.	1,138	13,241	10,781	9,263	4,464	984	44	0	49	427	3,250	7,349	11,212	61,066	28	25	23	18	10	6	0	4	9	16	17	24	28
411 2ND ST.	1,791	24,105	19,703	16,939	8,239	1,734	53	0	27	668	5,535	13,199	20,368	110,571	52	45	43	34	19	9	0	4	15	28	31	44	52
320 HANCOCK ST.	1,968	23,809	19,361	16,672	8,067	1,862	95	0	79	866	5,657	13,011	20,039	109,518	51	46	44	34	19	11	0	6	17	29	31	44	51
302 HANCOCK ST.	2,110	20,843	16,904	14,550	7,213	2,078	308	54	187	1,304	5,335	11,536	17,669	97,982	43	42	40	31	18	11	6	8	16	27	28	39	43
416 1ST ST.	1,552	16,777	13,670	11,808	5,782	1,196	31	0	6	367	3,707	9,064	13,972	76,380	32	32	30	24	14	6	0	2	10	20	22	30	32
402 ADAMS ST.	1,152	12,065	9,747	8,353	4,042	986	75	5	52	523	2,959	6,695	10,234	55,736	26	23	22	18	10	6	2	4	9	15	16	22	26
421 2ND ST.	1,380	18,701	15,165	13,147	6,355	1,070	3	0	0	187	3,882	10,035	15,486	84,032	37	34	32	25	13	2	0	0	8	20	23	32	37
415 2ND ST.	1,068	9,733	7,331	5,844	2,477	486	35	5	11	253	1,380	4,431	7,857	39,843	26	23	22	16	9	4	3	4	7	14	15	22	26
407 2ND ST.	1,774	20,478	16,116	13,150	5,172	546	0	0	0	35	1,947	8,913	16,076	82,433	49	43	41	30	14	0	0	0	5	24	28	40	49
312 HANCOCK ST.	1,784	14,952	10,786	7,521	2,077	9	0	0	0	0	402	5,181	11,479	52,407	39	34	30	21	3	0	0	0	0	14	21	31	39
420 1ST ST.	1,480	12,871	10,576	9,044	4,244	834	36	3	20	279	2,631	6,842	10,870	58,250	26	25	24	19	10	4	0	1	7	15	17	24	26
401 ADAMS ST.	2,520	21,916	18,008	15,399	7,227	1,420	61	5	34	475	4,480	11,649	18,509	99,183	45	42	40	32	17	6	1	2	12	26	29	40	45
403 ADAMS ST.	2,520	21,916	18,008	15,399	7,227	1,420	61	5	34	475	4,480	11,649	18,509	99,183	45	42	40	32	17	6	1	2	12	26	29	40	45
414 1/2 ADAMS ST.	1,480	12,871	10,576	9,044	4,244	834	36	3	20	279	2,631	6,842	10,870	58,250	26	25	24	19	10	4	0	1	7	15	17	24	26
423 FRANKLIN ST.	1,302	23,414	19,353	15,214	6,196	2,062	455	71	377	1,464	5,548	10,550	17,673	102,378	73	73	69	46	41	12	5	12	30	43	69	73	73
435 FRANKLIN ST.	4,400	53,297	43,802	32,474	10,940	2,235	368	62	325	1,978	8,988	20,068	38,658	213,196	195	194	183	139	84	18	4	11	58	111	177	192	195
412 1ST ST.	5,096	44,047	36,127	26,197	8,514	2,405	806	375	583	2,135	7,666	16,733	32,075	177,662	169	169	169	97	34	10	7	17	47	64	169	169	169
402 3RD ST.	12,821	40,544	26,319	26,948	7,976	1,189	241	37	210	829	6,230	14,116	29,070	153,708	294	294	292	141	70	6	3	10	45	97	159	294	294
504-14 1ST ST.	10,298	6,160	5,692	5,416	3,569	1,188	91	0	0	159	1,623	3,577	5,327	32,800	11	11	10	8	5	2	0	0	2	5	7	10	11
510 1ST ST	8,392	50,541	32,809	33,593	9,943	1,482	300	46	262	1,033	7,766	17,597	36,238	191,609	366	366	364	176	87	8	4	12	56	121	198	366	366
405 3RD ST.	2,494	32,769	26,931	19,966	6,726	1,374	226	38	200	1,216	5,526	12,338	23,768	131,079	120	119	112	85	52	11	2	7	35	69	109	118	120
506 1ST ST.	8,866	82,820	67,928	49,257	16,009	4,523	1,516	705	1,096	4,014	14,413	31,462	60,309	334,052	318	318	317	183	65	19	13	32	89	120	317	318	318
301 3RD ST.	18,982	53,971	35,035	35,872	10,617	1,583	320	49	280	1,103	8,293	18,791	38,697	204,612	391	391	389	188	93	8	4	13	60	129	212	391	391

Estimated

*Table D.2: Monthly Cooling Loads*

Cooling Building #	Total Load (kBtu)												Peak Load (MBH)														
	SF	January	February	March	April	May	June	July	August	September	October	November	December	Annual	January	February	March	April	May	June	July	August	September	October	November	December	Annual
310 HANCOCK ST.	1,208	0	0	0	9	791	2,074	3,951	3,034	1,431	18	0	0	11,308	0	0	0	2	11	12	13	12	12	4	0	0	13
304-06 HANCOCK ST.	1,893	0	0	0	128	1,778	3,652	5,610	4,451	2,370	116	1	0	18,107	0	0	0	8	16	17	17	18	17	8	1	0	18
316 HANCOCK ST.	1,407	0	0	0	46	979	2,115	3,639	2,770	1,382	65	3	0	10,998	0	0	0	0	5	12	13	13	13	6	1	0	13
504/506 ALICE MILLER WAY	2,076	0	0	0	0	918	2,856	5,538	4,286	1,839	3	0	0	15,441	0	0	0	0	15	17	17	16	16	2	0	0	17
508/510 ALICE MILLER WAY	2,233	0	0	0	14	1,008	2,712	4,998	3,864	1,717	10	0	0	14,322	0	0	0	3	14	15	15	15	14	4	0	0	15
512/514/516 ALICE MILLER WAY	2,626	0	0	0	21	1,181	3,197	6,113	4,784	2,190	19	0	0	17,504	0	0	0	4	17	18	19	18	18	6	0	0	19
518/520 ALICE MILLER WAY	2,190	0	0	0	26	1,117	2,818	4,926	3,893	1,904	30	0	0	14,714	0	0	0	5	14	15	15	15	15	7	0	0	15
301 FRANKLIN ST/ 522 ALICE MILLER WAY	2,227	0	0	0	2	821	2,413	4,629	3,511	1,527	4	0	0	12,906	0	0	0	1	12	14	14	14	14	2	0	0	14
303/305 FRANKLIN ST	2,107	0	0	0	1	812	2,441	4,735	3,599	1,570	6	0	0	13,164	0	0	0	1	13	15	15	15	15	3	0	0	15
307/309 FRANKLIN ST	2,150	0	0	0	94	1,849	3,927	6,026	5,025	2,819	73	0	0	19,813	0	0	0	9	16	17	16	17	16	8	0	0	17
521/523 1ST ST	2,140	0	0	0	12	1,070	2,944	5,447	4,247	1,874	7	0	0	15,600	0	0	0	3	15	16	16	15	15	4	0	0	16
517/519 1ST ST	2,248	0	0	0	1	865	2,777	5,566	4,290	1,703	1	0	0	15,203	0	0	0	1	15	16	16	16	16	0	0	0	16
513/515 1ST ST	2,135	0	0	0	12	1,110	3,055	5,565	4,352	1,926	7	0	0	16,026	0	0	0	3	15	16	16	16	16	4	0	0	16
509/511 1ST ST	2,137	0	0	0	6	932	2,726	5,198	4,027	1,692	5	0	0	14,586	0	0	0	3	14	15	16	15	15	3	0	0	16
505/507 1ST ST	2,248	0	0	0	0	823	2,703	5,452	4,123	1,557	0	0	0	14,659	0	0	0	0	15	16	16	16	16	0	0	0	16
308/310 ADAMS ST	2,142	0	0	0	17	1,407	3,623	6,240	4,910	2,327	17	0	0	18,541	0	0	0	4	16	17	17	17	17	6	0	0	17
304/306 ADAMS ST	2,190	0	0	0	2	795	2,332	4,475	3,381	1,437	3	0	0	12,425	0	0	0	1	12	14	14	14	14	2	0	0	14
417 2ND ST.	1,138	0	0	0	6	926	2,348	4,358	3,281	1,416	6	0	0	12,341	0	0	0	1	11	13	13	12	12	3	0	0	13
411 2ND ST.	1,791	0	0	0	1	1,702	4,948	9,457	7,051	2,949	6	0	0	26,114	0	0	0	1	25	27	27	27	26	4	0	0	27
320 HANCOCK ST.	1,968	0	0	0	23	1,714	4,399	8,058	6,065	2,670	23	0	0	22,952	0	0	0	5	24	26	26	26	26	8	0	0	26
302 HANCOCK ST.	2,110	0	0	9	148	1,734	3,562	5,799	4,472	2,397	157	15	0	18,292	0	0	3	9	20	20	21	21	20	11	4	0	21
416 1ST ST.	1,552	0	0	0	2	847	2,464	4,631	3,525	1,513	9	0	0	12,991	0	0	0	1	12	13	14	13	13	4	0	0	14
402 ADAMS ST.	1,152	0	0	0	2	847	2,464	4,631	3,525	1,513	9	0	0	12,991	0	0	0	1	12	13	14	13	13	4	0	0	14
421 2ND ST.	1,380	0	0	0	0	806	2,723	4,964	3,782	1,475	2	0	0	13,752	0	0	0	0	13	14	14	14	14	1	0	0	14
415 2ND ST.	1,068	7	1	78	433	1,466	2,342	3,255	2,754	1,859	455	128	0	12,779	2	0	5	6	9	11	11	11	11	7	6	0	11
407 2ND ST.	1,774	0	0	0	44	1,532	3,550	5,659	4,664	2,576	168	0	0	18,194	0	0	0	5	14	18	19	19	18	8	0	0	19
312 HANCOCK ST.	1,784	0	0	71	607	2,513	3,857	5,147	4,471	3,147	702	119	0	20,634	0	0	7	9	13	14	14	14	14	10	7	0	14
420 1ST ST.	1,480	0	0	0	19	855	2,251	4,106	3,168	1,436	19	1	0	11,855	0	0	0	2	11	12	12	12	12	3	0	0	12
401 ADAMS ST.	2,520	0	0	0	32	1,455	3,833	6,992	5,394	2,445	33	1	0	20,185	0	0	0	4	19	21	21	21	21	6	0	0	21
403 ADAMS ST.	2,520	0	0	0	32	1,455	3,833	6,992	5,394	2,445	33	1	0	20,185	0	0	0	4	19	21	21	21	21	6	0	0	21
414 1/2 ADAMS ST.	1,480	0	0	0	19	855	2,251	4,106	3,168	1,436	19	1	0	11,855	0	0	0	2	11	12	12	12	12	3	0	0	12
423 FRANKLIN ST.	1,302	976	978	1,507	3,416	8,235	12,356	14,486	15,587	9,226	3,718	1,951	1,257	73,693	5	8	19	43	71	85	85	85	85	42	34	25	85
435 FRANKLIN ST.	4,400	997	1,135	2,683	8,294	24,877	37,945	44,204	48,794	29,463	11,064	4,792	2,184	216,402	29	17	58	143	228	268	266	268	267	141	130	90	268
412 1ST ST.	5,096	15	153	792	3,890	14,540	21,914	25,597	28,485	17,300	6,084	1,998	493	121,262	5	10	39	77	136	156	156	156	156	89	87	62	156
402 3RD ST.	12,821	370	1,384	2,605	12,650	51,046	66,876	74,829	77,610	55,016	18,867	8,475	2,353	372,080	23	59	105	207	335	353	353	354	354	221	182	134	354
504-14 1ST ST.	10,298	0	0	0	0	204	1,915	1,577	479	0	0	0	0	4,175	0	0	0	0	5	8	8	8	7	0	0	0	8
510 1ST ST.	8,392	297	1,111	2,091	10,157	40,984	53,694	60,079	62,312	44,172	15,148	6,804	1,889	298,739	19	47	84	166	269	284	284	284	284	178	146	107	284
405 3RD ST.	2,494	355	404	955	2,952	8,855	13,496	15,734	17,368	10,487	3,938	1,706	777	77,028	10	6	20	51	81	95	95	96	95	50	46	32	96
506 1ST ST.	8,866	16	162	837	4,115	15,381	23,182	27,078	30,133	18,301	6,435	2,113	522	128,276	5	11	42	81	144	165	165	165	165	94	92	66	165
301 3RD ST.	18,982	509	1,902	3,578	17,379	70,127	91,875	102,801	106,622	75,582	25,920	11,643	3,232	511,170	32	81	144	284	461	486	486	486	486	304	251	184	486

## **APPENDIX E: ELECTRIC LOAD FORMS**

## **APPENDIX F: PERFORMANCE METRICS**

## **APPENDIX G: CONTROL AND MONITORING PLAN**

## APPENDIX H: UDS DRAWINGS

## APPENDIX I: RBM REPORTS