Rochester District Thermal:

NYSERDA Community Heat Pump Scoping Study

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NYSERDA Community Heat Pump Scoping Study

Final Report

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Abstract

The Rochester District Thermal: NYSERDA Community Heat Pump Scoping Study evaluates the feasibility of implementing a community heat pump system in downtown Rochester, NY (the "RDT community heat pump system"). The heat pump system would be a thermal distribution loop throughout the area connecting multiple buildings to provide heating and/or cooling. The loop would be conditioned by renewable resources and connect multiple buildings to share resources and reduce energy consumption. If successful, the goal is to create a model that is repeatable and scalable within other areas. This report summarizes the findings of the RDT project team for connecting multiple buildings throughout downtown Rochester to an efficient all-electric heating and cooling community heat pump solution. The central plant would use the renewable resources (geothermal and sewer heat recovery) to condition a two-pipe ambient loop system with distributed pumping throughout the city to member buildings. The ambient loop will provide conditioned water to member buildings where the energy can be used to provide space heating, space cooling, and domestic hot water (DHW) heating. Costs estimates were calculated for the central plant, distribution piping, and participant buildings.

The RDT project team is sharing all project findings with NYSERDA. The summary report details the cumulative efforts and findings of the scoping study, including summaries of the technologies explored, thermal network model, regulatory considerations, and the conclusions of financial and energy impact. Using sewer heat recovery and the ambient loop yields significant energy and greenhouse gas emissions savings compared to an electrification baseline. However, the results of the financial model yielded a net present value of -$16 million, indicating that the project as currently configured would require a significant investment from a third party. Alternatively, a smaller, more centrally focused thermal network may be a more viable option when considering a project in the future.

Keywords

building electrification, district thermal, sewer heat recovery, heat pump, Rochester, Rochester District Heating

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Acronyms and Abbreviations

Btu	British thermal unit
CBA	collective bargaining agreement
CBECS	commercial buildings energy consumption survey
Climate Act	Climate Leadership and Community Protection Act
CO_2	carbon dioxide
COI	certificate of incorporation

COMIDA	County of Monroe Industrial Development Agency
COP	coefficient of performance
CPI	Consumer Price Index
DEC	New York State Department of Environmental Conservation
DHW	domestic hot water
ft	foot/feet
°F	degrees Fahrenheit
gpm	gallons per minute
HVAC	heating, ventilation, and air conditioning
HW	hot water
IRA	Inflation Reduction Act of 2022
ITC	inflation tax credit
kV	kilovolt
kW	kilowatt
MBH	1,000 Btu/hr
Mlb	1,000 pounds of steam
MMBtu	one million British thermal units
MWh	megawatt hour
NEPA	National Environmental Policy Act
NPV	net present value
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
NYISO	New York Independent System Operator, Inc.
PILOT	payment in lieu of taxes
PSC	Public Service Commission
PV	photovoltaic
RDH	Rochester District Heating Cooperative, Inc.
RDT	Rochester District Thermal
RG&E	Rochester Gas and Electric Corporation
SEQRA	State Environmental Quality Review Act
SPEDES	State Pollutant Discharge Elimination System
W	watts
W/gpm	watts per gallons per minute
WET	wastewater energy transfer
WSHP	water-source heat pump

Executive Summary

In anticipation of meeting New York State (NYS) and federal decarbonization goals, the Rochester District Heating Cooperative, Inc. (RDH), partnered with EMCOR Services Betlem (EMCOR), Michael A. Howard Law Office, Noventa Energy Partners, and Koester Associates to investigate the feasibility of installing an ambient temperature loop within a portion of downtown Rochester, or the Rochester District Thermal (RDT) community heat pump system. The project's goal is to maintain the loop temperature using a combination of renewable resources and waste heat within the district, supplemented by electric heat pumps as necessary. The RDH provides steam to 48 member buildings in downtown Rochester through a central steam plant with approximately 9 miles of distribution piping. RDH has experience with district energy loops, providing expertise in managing regulatory restrictions and operating energy distributions systems in the area.

The following summarizes the RDT community heat pump system scoping study approach:

1. Define the scope area and participants
   - Contact participants and gather high-level building information
2. Identify thermal resources
   - Discuss feasibility of using geothermal as a primary or secondary thermal resource depending on needed capacity and drilling location
   - Determine the location of sewer heat extraction and use logged sewer data to quantify the energy available from sewer heat recovery
3. Create building thermal models using eQuest and use the hourly data to determine the 8,760-hour aggregate analysis for the RDT community heat pump system
4. Develop a conceptual design for community heat pump system
   - Design the layout and schematic design the central plant using sewer heat recovery and geothermal systems (the distribution network was defined in this step)
   - Develop schematic designs for the participant connection points and the systems to provide the necessary hot and chilled water to building using the ambient loop

5. Conduct a financial analysis to determine the 30-year impact of community heat pump system compared to the electric boiler baseline system
   - Develop the preferred business model
   - Develop cost estimates for the central plant, distribution system, and participant building retrofits
   - Develop financial analysis assumptions that include the project and operating costs for the new system
   - Create the financial analysis with the assumptions and findings to determine the net present value to the membership
6. Review any regulatory and permitting requirements for developing the community heat pump system
7. Summarize findings and recommendations

The team developed thermal models using eQuest for each participant building. High-level building information gathered from each participant and engineering assumptions were used to develop thermal models. Hourly thermal model results were used to determine each building's needs and create an aggregated spreadsheet model to determine the community heat pump system's aggregated hourly load. This information was used to determine the participant's energy usage with both an electric boiler solution and a community heat pump solution. The baseline option selected the electric boiler option to minimize retrofit needs for each participant's heating, ventilation, and air conditioning (HVAC) system. This approach allows RDH to continue providing steam to their current members using electric boilers.

Concurrent with developing thermal models, the availability and impact of the sewer heat recovery and geothermal resources were defined. Based on the location of the combined sewer system on Main Street and the central plant location in the West Broad Street tunnel, sewer heat recovery was explored as a thermal resource. Temperature and flow data was monitored for a 6-month period to determine the energy available within the sewer system. Using a sewer heat recovery system was determined to provide the modeled community heat pump system with the necessary heating and cooling through the ambient loop. With this schematic design, geothermal energy is not necessary for the proposed system but could serve as thermal storage and be a source of thermal resource expansion if the thermal need exceeds the available energy from the sewer heat recovery.

Cost estimates were divided into two parts: one for the system and another for retrofitting participant buildings. In addition to these project costs, operating and ongoing costs associated with a community heat pump system were calculated using RDH's and Noventa's experience in thermal energy generation. The life-cycle cost analysis used the cost estimates and developed annual cost assumptions to determine the financial impact the RDT community heat pump system will have with the member-owned business model. The total project's net present value is -$16,398,710, indicating a financial loss over the 30-year cost analysis. The team concluded that the current assumptions regarding the loan discount rate, capital expenses, and operating costs (e.g., lease agreement costs, maintenance costs, employee overhead, insurance, property tax) predominantly affect the project's net present value. Improving these aspects will have the most impact in making this project financially viable. Although the financial conclusion indicates a financial loss, the community heat pump solution is a long-term, highly efficient solution that aligns with New York State's decarbonization and electrification goals and could provide a variety of buildings with an efficient non–natural-gas heating solution for downtown Rochester. The RDH will continue to assess the project and explore potential partnerships with other investors and entities interested in bring a clean electric heating option to Rochester.

1 Characterization of Proposed Community

1.1 Defining Scope Area and Proposed Community Participants

During the beginning of the Community Heat Pump Scoping Study, the team identified the scope area based on its proximity to the West Broad Street tunnel, an unused underground space that would allow for easier distribution piping access and a possible underground central plant. Figure 1 shows the scope area encompassing 29 locations selected as participants for the Community Heat Pump Scoping Study. Of these, 21 are current RDH members, and they were contacted through RDH. The remaining eight buildings are either owned by RDH members (but the building is not a part of RDH) or were contacted through the team's existing network. The team attempted to engage other nearby building owners with easy access to the proposed distribution system, but no additional participants were added. Each participant signed a letter of participation, allowing their building to be included in the study. Participants were informed that that the letter of participation was solely for the scoping study with no obligation to connect to the potential thermal energy network.

Figure 1. Community Heat Pump Scope Area

The goal of gathering participants was to include a broad range of space uses and building sizes to demonstrate the impact on a thermal network with a diverse membership. The study included a variety of both privately owned and municipal buildings, including office, retail, residential, parking garages, event spaces, and libraries. Nineteen of the 29 buildings belong to the city of Rochester and Monroe County. To gather information about each building (e.g., address, primary space type, floor area), the team met with the participants whenever possible. When building information was unattainable, assumptions from city property information and the New York Technical Resource manual were used. The data, shown in Table 1, was then used to develop high-level building energy models.

Table 1. Community Heat Pump Scoping Study Participants

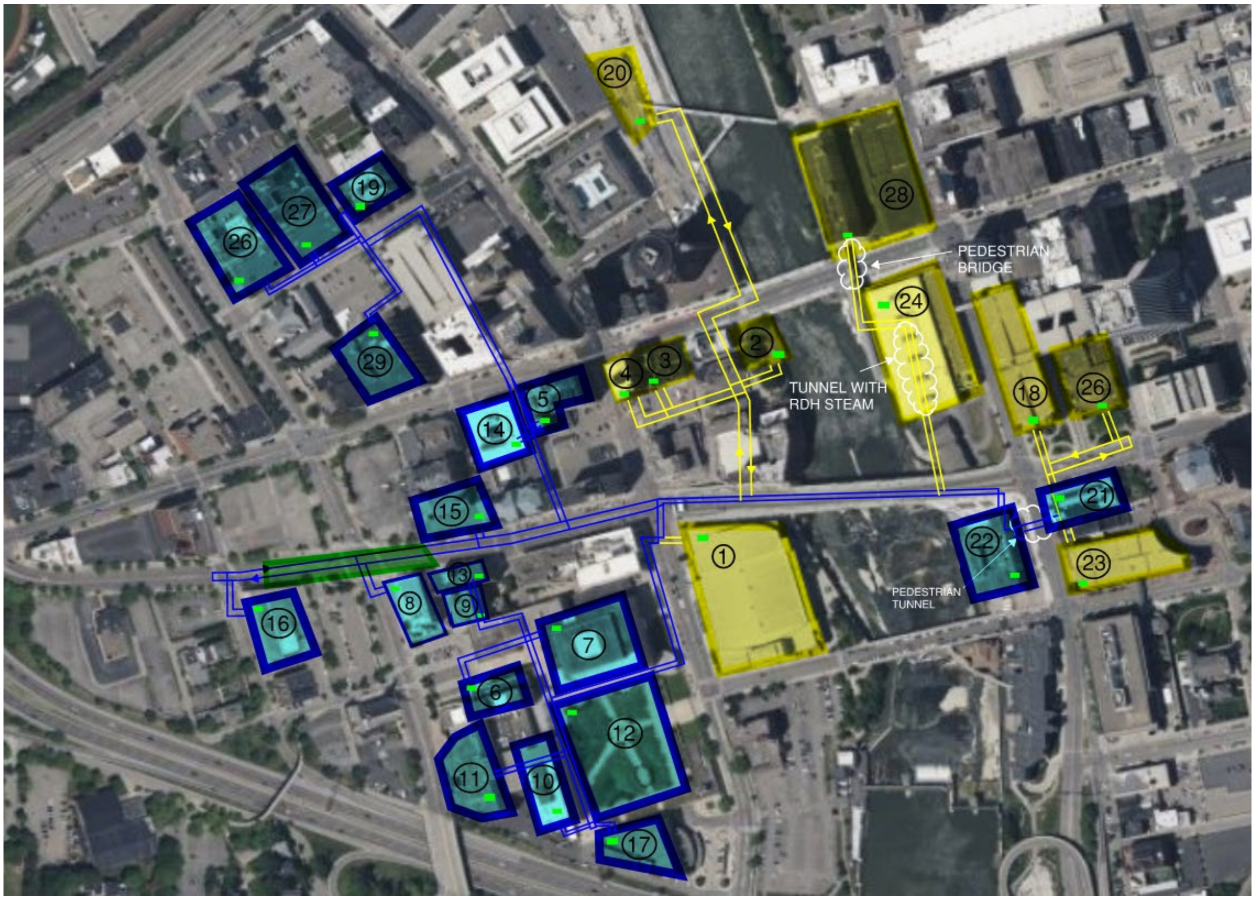
Building	Building Address	Primary Space Type	Floor Area	Phase
City of Rochester Blue Cross Arena	100 Exchange Blvd	Event Space	356,960	2
Forester Corp	31 E Main St	Office	31,125	2
Rochesterville 2 LLC (Talman Building)	23–27 E Main St	Office	26,897	2
Oakgrove	17 E Main St	Office	18,577	1
Oakgrove (Wilder Buiding)	1–9 E Main St	Office	61,910	2
Monroe County (Public Safety)	130 S Plymouth Ave	Office	219,898	1
Monroe County (Hall of Justice)	99 Exchange Blvd	Office	351,621	1
Monroe County (Crime Lab)	85 W Broad St	Lab	43,424	1
Monroe County (Watts Bldg)	47 S Fitzhugh St	Office	59,077	1
Monroe County (Old Jail)	130 S Plymouth Ave	Jail	188,114	1
Monroe County (New Jail)	130 S Plymouth Ave	Jail	228,179	1
Monroe County (Parking Garage)	55 S Fitzhugh St	Parking Garage	525,000	1
Terminal Building Roc LLC	37 S Fitzhugh St	Residential	70,208	1
Monroe County Office Building	39 West Main St	Office	174,898	1
The Church of St Luke & St Simon Cyrene Episcopal (Two Saints)	17 S Fitzhugh St	Worship	14,258	1

Table 1. (continued)

Building	Building Address	Primary Space Type	Floor Area	Phase
City of Rochester (RCSD)	131 W Broad St	Office	96,216	1
City of Rochester (Public Safety)	185 Exchange Blvd	Office	155,000	1
City of Rochester (South Ave Garage)	39 Stone St	Parking Garage	619,686	2
City of Rochester (City Hall)	30 Church St	Office	100,345	1
City of Rochester (Crossroads Garage)	69 Andrews St	Parking Garage	263,100	2
City of Rochester (Bausch and Lomb Library)	114 South Ave	Library	124,200	1
City of Rochester (Rundel Library)	115 South Ave	Library	91,680	1
City of Rochester (Court St Garage)	194 Court St	Parking Garage	278,890	N/A
City of Rochester (Rochester Convention Center)	123 E Main St	Event Space	188,000	2
Frontier Communications	63 Stone St	Office	62,000	2
Frontier Communications	120 Plymouth Ave N and 95 N Fitzhugh St	Office/Data Center	250,000	1
Rochester Riverside Hotel	120 East Main St	Residential/Hotel	321,192	2
Monroe County (Cityplace)	50 West Main St	Office	269,764	1

The business model proposed a phased approach as the schematic design and cost estimates for the thermal plant and distribution system were developed. Phase 1 involved implementing the plant and part of the distribution system, and phase 2 focused on expanding the distribution system. The phased approached was created to capture initial short-term opportunities and then integrating longer-term opportunities in the phase 2. Figure 2 illustrates Phase 1 in-blue, Phase 2 in yellow and the Central Plant is green. These phases inform our life-cycle cost analysis, with Phase 2 occurring over a 5-year period following Phase 1.

Figure 2. Phased Approach Distribution Layout



1.2 Participant Modeled Results

Using eQuest, EMCOR created thermal models for each participating building. An existing model was created using information and assumptions about the building's operations under current and normal conditions, which are assumed to be during a year without a pandemic when the facility's spaces are fully occupied with usual activities. The building model inputs were compiled based on provided information and assumptions based on the building's space types. The building model results were used to determine peak design conditions and building operating conditions (e.g., thermal load and energy consumption) through an 8,760-hour profile. Applicable utility data was normalized for weather and used for tuning the building models. As another means of tuning, CBECs energy usage index data was used to verify the thermal model energy consumption results were within the range of similar building types. When the individual thermal models were complete, the output data was used to create an aggregate thermal loop profile including all model results for each participant. Figures 3 and 4 illustrate the peak heating load of 51,595 thousand British thermal units (MBH) and a peak cooling of 3,586 tons.

Figure 3. Aggregated Heating Load

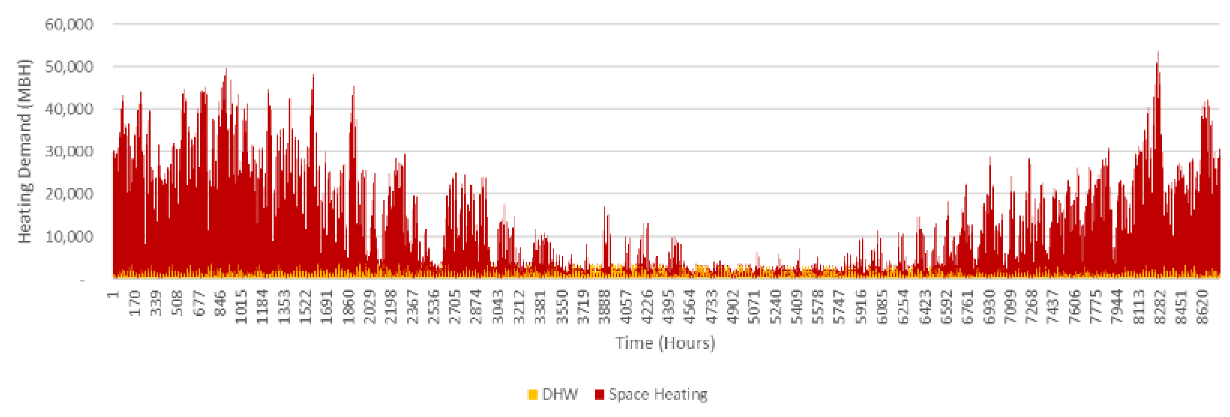
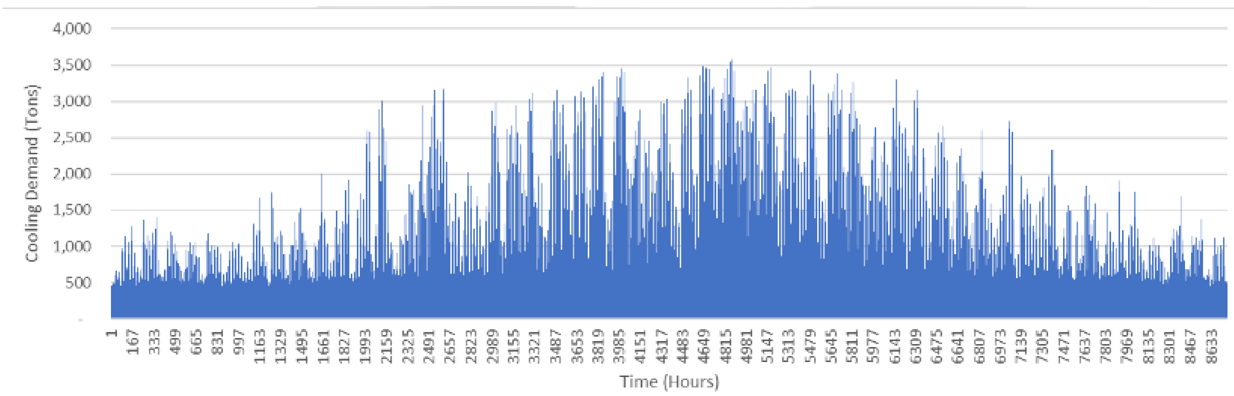


Figure 4. Aggregated Cooling Load



1.3 Participant Constraints and Hurdles

During the scoping study development, constraints and challenges have been identified and will need to be addressed if the project is to be implemented.

1.3.1 Location of Participants and Routing of Piping

Due to the geography and digging constraints, installing new piping underground is difficult and expensive. The current underground infrastructure has various utilities buried throughout the city under the streets. RDH's distribution team has experience with coordinating and routing their distribution steam piping to current members and shared that most streets will require routing to avoid other utilities. Microtunneling and directional drilling were assumed as the methods for installing headers along West Broad Street to reach different members. Pipe routing also leverages current tunnels, parking garages, and other easily accessible space as much possible. Having piping to reach each member will require analysis and may need to be implemented in phases or when additional members are ready to connect to the piping. The cost of the distribution piping relative to energy distributed will be an important consideration in implementing a community heat pump system.

1.3.2 Current Participant Heating, Ventilation, and Air Conditioning Systems

Each building operates its own HVAC system to distributes heating throughout the building. Some systems will require varying degrees of retrofitting to connect to a two-pipe thermal network system. As part of the retrofit designs, booster heat pumps were included that would provide hot water to the systems, ensuring minimal changes to air-handling equipment where retrofitting space is limited. The following systems were identified and used as overarching assumptions for the building models and retrofit costs:

- **Steam only**
  These systems use steam throughout their building from steam boilers or directly from the RDH. Steam is used in baseboard radiation or air handlers. Because the steam-only systems would need new piping for any water, the assumption was that these systems would be replaced with fan coil units that would use the distributed thermal system's water temperatures.
- **Steam and hot water/steam**
  These systems use steam to generate hot water and use steam in different applications. Most of the systems identified this way use low-pressure steam, from RDH or their own boilers, in air handlers and/or perimeter heating. Then the building uses steam generated hot water in reheat coils and/or perimeter heat. The required hot water temperature of these systems ranged from 160 degrees Fahrenheit (°F) to 180°F. The design basis for these participant systems relied on a booster heat pump using the thermal network's water to meet the higher water temperature requirements for the building's hot water systems.
- **Hot water**
  These systems use hot water generated from their own boilers or the RDH and distribute it throughout the building to their air handlers and other end uses. Due to the higher water temperatures needed, a booster heat pump using the thermal network's water to provide the building's hot water systems was the basis of design for these participant systems.
- **Water-source heat pumps (WSHPs)**
  The ambient loop of WSHPs is provided supplemental heat from a steam to hot water (HW) heat exchanger or an onsite boiler. These systems use the thermal network's energy directly, requiring only a booster heat pump for dedicated outdoor air systems.

2 Technologies Assessed

2.1 Types of Thermal Source and Sinks

The community heat pump system focused on two technologies for thermal energy: sewer heat recovery and geothermal. With the location of the thermal loop being within downtown Rochester and limited space for borefields, sewer heat recovery was determined to be the main thermal source and sink, with geothermal acting as a thermal battery. Noventa used its sewer heat recovery system expertise to layout and provide a schematic design for the sewer heat recovery system. In addition to the sewer heat and geothermal energy sources, the team briefly explored the use of river water during the initial stages of the scoping study, but determined it was not viable due to concerns about maintaining enough warm water during winter, associated maintenance requirements, and compliance with environmental regulations. Discussions regarding accessing river water involved meetings with the University of Rochester, Rochester Gas and Electric Corporation (RG&E), and Monroe County to determine the advantages and challenges. Using river water for the project would necessitate involvement with the city of Rochester, Monroe County agencies, New York State (NYS) agencies, federal agencies, not-for-profit organizations, and RG&E. The inconsistencies of water flow after the Court Street dam could also pose issues for a reliable thermal source/sink.

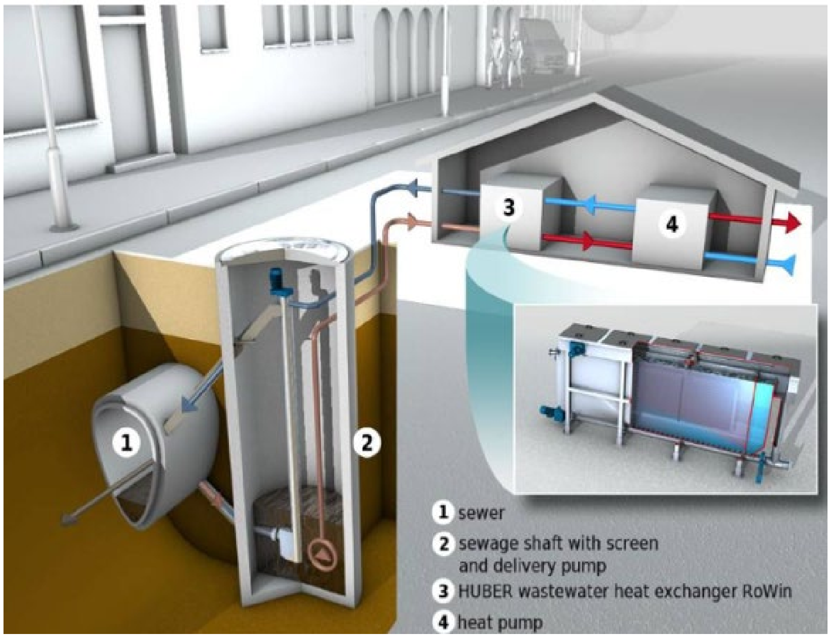
2.1.1 Sewer Heat Recovery

Sewer heat recovery is a technology that uses raw sewage from an available sewer stream as a thermal energy source or sink during the heating or cooling seasons, respectively. Noventa's wastewater energy transfer (WET) system was the design basis for analyzing the extraction of the sewer's thermal energy, which incorporates the following three integral parts to use the available sewer as a thermal resource:

- **Wetwell**
  The wetwell intakes raw sewage via a gravity feed connected to the Main Street sewer line. The sewage is pumped through screening and auger processes to remove coarse solids. These operations are done within an underground well that will be installed adjacent to the sewer line. For this analysis, the well is proximate to the sewer lateral, with utility hole access, located on the corner of Main Street and South Plymouth Avenue. This was considered as the ideal location due to its proximity to the central plant.
- **Heat exchanger**
  The processed sewage is pumped through heat exchangers located at the West Broad Street tunnel central plant. This part of the central plant will have a series of heat exchangers to exchange the necessary energy to a water loop that serves the plant's heat pumps.

- **Heat pumps**
  A series of WSHPs in the central plant will provide the necessary heating or cooling to the RDT ambient loop. The heat pumps use the water from the heat exchangers as the necessary thermal resource to receive or reject heat depending on heating or cooling operation, respectively. Noventa used Trane heat pumps as a basis of design.

Figure 5. Wastewater Energy Transfer System



Noventa and EMCOR worked together to determine the sewer heat recovery capabilities and feasibility using recorded sewer data during the study as well as annual data Monroe County's Pure Waters division provided. A sewer flow and temperature meter recorded sewer data from July 2022 to mid-October 2022, at the Front Street utility manhole location. The overall average wastewater flow for the logging period was 10,136 gallons per minute (gpm). The average wastewater temperature was 65°F. Table 2 summarizes the sewer wastewater data collection from this period. Noventa used this data and Pure Water's water treatment influent temperature data from 2021 as the basis for its annual sewer heat recovery feasibility analysis. Based on the 2021 Pure Water influent data, the average temperature for the wastewater is 60.8°F and 69.8°F during the winter and summer, respectively. Sewer data will continue to be collected into the winter to account for cold weather events. Because sewer lines are a combination of sewer and stormwater collection, the project team evaluated a freeze-and-thaw event to evaluate the minimum water temperature experienced in these lines. This data was shared with Noventa, and the energy-balance model will be checked if the temperatures are different than the previously provided data.

Table 2. Wastewater Data Logging Summary Table

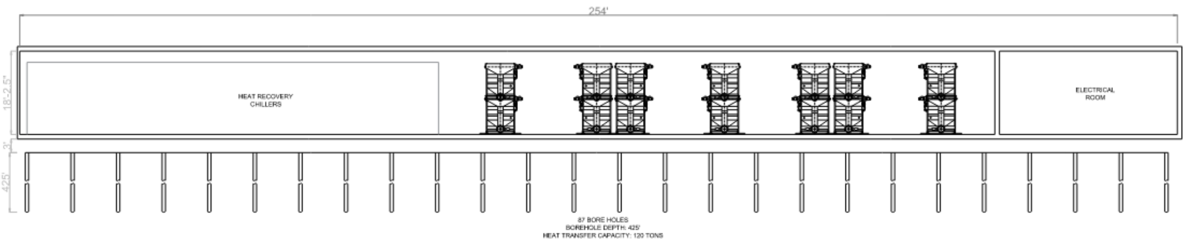
Month	Flow (gpm)			Temperature (°F)		
	Min.	Max.	Average	Min.	Max.	Average
July	726	39,743	9,469	62	71	64
August	607	55,376	10,995	64	76	66
September	2,464	34,374	10,660	61	70	65
October	4,132	38,256	9,237	60	65	63

Based on the gathered temperature and flow information, Noventa determined the thermal potential of a sewer heat recovery system, which will include a heat exchanger network and heat pumps to provide the ambient loop with the necessary thermal energy exchange. The proposed wastewater heat exchanger network will comprise 14 HUBER RoWin BG-14 heat exchangers. Due to the limited flow, Noventa is proposing to configure the RoWin heat exchangers in a cascaded arrangement to maximize the volume of energy that can be extracted from the wastewater flow in the Main Street trunk sewer. Ten RoWin BG-14 heat exchangers will be connected in parallel with an additional four RoWin heat exchangers connected in series on the shell side to reuse wastewater to extract or reject more thermal energy using the same volume of wastewater. This configuration can provide a total of 34,356 MBH of heating energy and 4,216 tons of cooling energy. Based on this configuration and the energy available in the sewer, six additional cascading heat exchangers can be installed to provide more energy to the ambient loop. Noventa has determined that these six heat exchangers will provide 11,600 MBH more heating and 1,431 tons more of cooling based on the available sewer data. For redundancy and resiliency during the heating season, the system will be connected to the RDH's steam system. RDH steam will be able to provide necessary heat if the plant heat pumps were to shut down for unexpectedly or if an interruption occurs in the necessary levels sewer heat available during the winter.

2.1.2 Geothermal

For geothermal design, EMCOR consulted with local contractors who have experience with drilling geothermal wells in downtown Rochester. Although drilling test wells were not incorporated into the cost of this scoping study, the team recommends drilling a test well at the project site and measuring the thermal conductivity during the design phase. The geothermal goal in New York State is a maximum depth of 499 feet (ft) to avoid the need of additional permitting for deeper boreholes. Recent legislative changes (Chapter 483 of the Laws of 2023) aim to moderate these permitting requirements for certain closed-loop boreholes. Local contractors have successfully drilled boreholes up to 499 ft deep within the city limits using proper drilling techniques. The area predominantly consists of bedrock with the possibility of natural gas pockets. Due to the amount of energy available in the sewer, the RDT team approached using geothermal within the constraints of the central plant construction. A borefield will be drilled under the central plant's footprint, offsetting the ambient loop load. Figure 6 illustrates that the footprint can ideally fit 87 boreholes that will be interconnected with the sewer heat recovery loop. This configuration can be expanded within the West Broad Street tunnel if additional geothermal wells are required. Noventa analyzed this approach with 87 bores at 425 ft each, estimating a total heating and cooling capacity of 120 tons from the geothermal loop will be used.

Figure 6. Central Plant and Borefield Cross Section



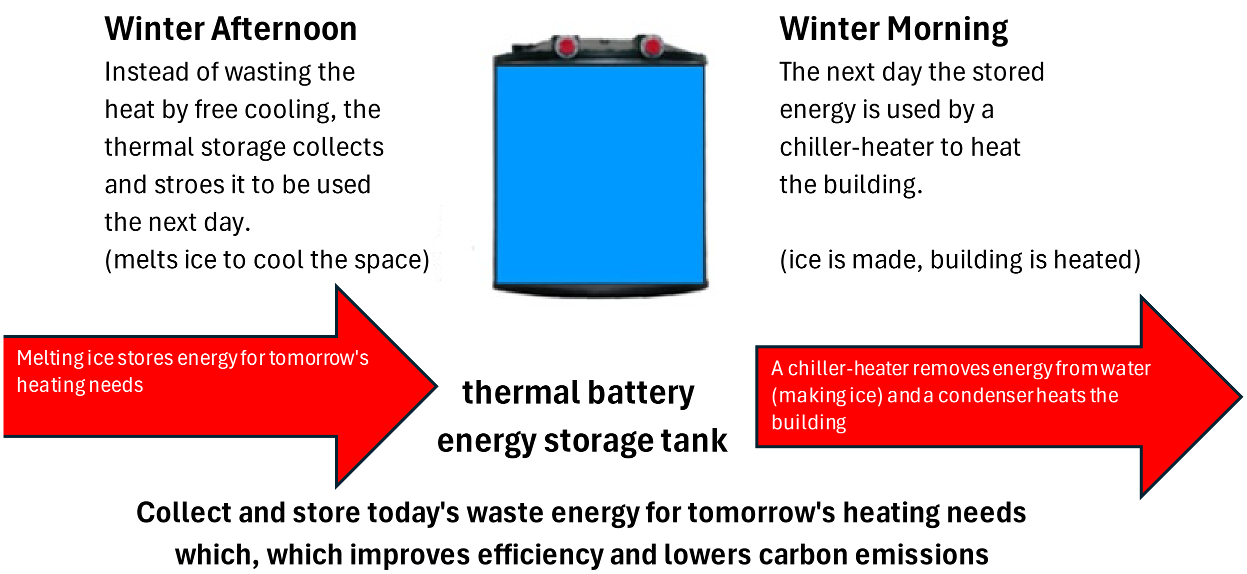
2.1.3 Large Water-Source Heat Pumps

The team proposed WSHPs as the source of mechanical heating and cooling in the system. Within the central plant, large WSHPs were sized to use the sewer heat recovery to provide the thermal water loop with the necessary heating and cooling. In addition to the central plant heat pumps, WSHPs are found throughout the participant buildings. The participant building heat pumps would be used as booster heat pumps to provide the building's system with hot water. The booster heat pumps are designed to use the thermal network's ambient water that is planned at 110°F to provide the building's hot water system with water ranging from 160°F to 180°F. These booster heat pumps will enable the building to provide simultaneous heating and cooling through the hot water and chilled water systems.

2.2 Adjunct Systems: Thermal Storage

The RDT analysis team evaluated a modular thermal storage system using Calmac, a Trane-owned company, as the basis of design. The Calmac system has water thermal storage and phase change (or ice storage) thermal storage options. The team evaluated the possibility of implementing these systems at the central plant and building levels and determined that a modular thermal storage system may be a more economical solution due to the size and its ability to fit within the West Broad Street tunnel. Phase change thermal storage units have a smaller footprint as ice stores more energy per volume than water. This is due to the phase change cycle being more energy dense through latent heat compared to sensible heat outside of the phase change instance. Figure 7 illustrates how thermal storage acts as a storage facility for today's wasted energy to be used tomorrow. This process, called thermal balancing, allows for less wasted energy during release or retrieval.

Figure 7. Thermal Storage Balancing Concept



Thermal storage allows for peak load shaving daily (rather than seasonally), especially during the peak heating and cooling seasons when available thermal resources, such as the sewer heat recovery and geothermal, are at capacity. During off-peak hours, excess energy from the sewer and geothermal sources for conditioning the ambient loop can be used to recharge the thermal storage for the next day. Due to the available energy from the sewer, the team determined that thermal storage was not currently required but would be considered once expansion of the thermal district occurs to the point sewer heat recovery will not meet the loop's needs.

2.3 On-Site Solar Photovoltaic System

As a part of task 3, solar photovoltaic (PV) possibilities were explored with input from GreenSpark Solar and Nexamp. Solar generation near the plant was explored at surrounding buildings and parking lots. The area highlighted in Figure 9 shows the area of solar opportunity explored. The small area available for a PV array led the RDT team to explore the possibility of using carport PV arrays that would be above adjacent parking lots.

Figure 8. Solar Photovoltaic Carport Example

Figure 9. Solar Photovoltaic Analysis Location

For the basis of the analysis, GreenSpark analyzed the cost of installing a carport solar PV array (Figure 8), covering the Melvin Alley/Scott Alley parking lot located between Main Street and West Broad Street. This parking lot is roughly 60,000 square feet and an array that would fit this footprint would be between 650 kilowatts (kW) and 700 kW. The carport system would cost between $2 million and $3.5 million compared to a ground or rooftop mounted system similarly sized for approximately $1.5 million.

Installing solar in a downtown setting would be difficult for space and economic reasons. Additionally, many of the open parking areas adjacent to the central plant are owned by developers who may have future construction plans that would inhibit the construction of solar PV systems. The cost per square foot is more than an offsite application. GreenSpark suggested that if RDT wanted to include solar generation within its scope, offsite generation could be more beneficial allowing the owner of the RDT system to receive solar credits for the offsite array. Offsite options will be explored when final design is developed.

3 Analytical Methods

3.1 Participant Building Heating and Cooling Models

For this scoping study, eQuest version 3.65 was used to model each building and EMCOR used the results to create individual and aggregated thermal loop profiles. These models are developed at a high level to meet the requirements of the scoping study while providing the necessary information on the effects of a community heat pump system. General building information was obtained and put into the model as compared to a full detailed building energy model, which helped to expedite the analysis. eQuest's Design Development Wizard was used to input general building information. If specific input data was not provided, the modeling software's default was used as the starting point as these inputs may have changed during the tuning process. If floor plans were not provided, information from Rochester's property data and scaled images from Google Earth were used to estimate building size and space allocation. (Appendix B details each building's assumptions.) The existing models were created to represent the current energy consumption during a normally occupied schedule, removing the lower occupancy element seen during the pandemic. In addition to energy consumption, the heating and cooling capacities were used to estimate the hourly profile of an aggregated loop.

Each model was tuned compared to applicable weather normalized utility data, which the participant provided. Weather normalization is a process that sets seasonally variable loads of the given period (12 months of utility bills) to those expected in a "normal" period using 30-year average heating and cooling degree day data. By weather normalizing the utility data, the baseline model can be tuned to a utility data set that represents a typical weather year, accounting for hotter or colder months throughout the observed year.

Once each existing model was tuned, a baseline energy model was created. A baseline energy model replaced the natural gas consuming equipment with electric equipment. The energy impact of installing electric boilers to replace natural gas boilers was compared to the existing building models. This baseline is an all-electric comparison to the potential RDT community heat pump system.

3.2 Community Heat Pump System Thermal Model

A mass-energy balance model was created from the eQuest hourly heating and cooling load data provided in task 2. Noventa and EMCOR used the hourly data to determine the power consumption that the new community heat pump configuration would require. The energy consumption of the central plant using the WET system to drive the ambient water temperature to the loop setpoint. Individual buildings use the ambient loop water to provide space conditioning and domestic hot water (DHW) heating. Booster heat pumps within each building will provide hot water during the heating season and ambient water will be used directly to cool the chilled water system. This community heat pump configuration was used to determine the thermal model results compared to the energy consumption of the current systems in place and the electric boiler baseline system that were both analyzed.

The following assumptions were made to model the WET system and the building booster heat pumps:

- Average wastewater flowrate: 9,400 gpm
- Average wastewater summer temperature: 69.8°F
- Average wastewater winter temperature: 60.8°F
- Ambient loop flowrate: 2.5 gpm per ton
- Ambient loop pumping power: 28.76 watts (W) per gpm
- Geo-exchange assumptions
    - Geo-exchange provides the first 2,088 MBH of thermal energy for heating to the WET heat recovery chillers in the energy transfer system
    - Average winter soil temperature at a depth of 425 ft: 53.6°F
    - Average summer soil temperature at a depth of 425 ft: 69.8°F
    - Borefield winter flowrate: 1.65 gpm per ton
    - Borefield summer flowrate: 0.75 gpm per ton
    - Borefield pumping power: 19.1 W per gpm
- The system operates in heating mode from October 2 to April 30
- The system operates in cooling mode from May 1 to October 1
- Heating mode (winter)
    - Ambient loop supply temperature: 110°F
    - DHW supply temperature: 145°F
    - The space heating hot water supply temperature was determined using an outdoor air reset curve where the building hot water supply will be 180°F at an outdoor air temperature of 25°F or less. At 70°F outdoor air temperature, the hot water supply will be 70°F. Outdoor air temperatures between these temperatures will change the hot water setpoints as a linear relationship. This is based on hot water boiler reset curves.
- Cooling mode (summer)
    - Booster heat pumps are bypassed, and chilled water is supplied directly to coils/air handling units
    - Chilled water supply temperature: 42°F
    - Chilled water return temperature: 56°F
    - Booster heat pumps extract thermal energy from chilled water return line to provide DHW
    - DHW supply temperature: 145°F

3.2.1 Energy Consumption Calculations Results and Impact

The mass-energy flow model used thermal needs from eQuest for the basis of analysis in the 8,760-hour calculations. An annual heating demand of 103,426 one million British thermal units (MMBtu) and cooling demand of 119,838 MMBtu results in the RDT system (including the booster pumps) consuming 16,540,853 kilowatt hours (kWh) to condition the participant buildings and heat their hot water. For comparison based on the results, current (hot water and chilled water) and baseline consumptions were calculated. Current systems, assuming 80% heating efficiency and a 4.2 coefficient of performance (COP) chiller efficiency, consume 1,292,826 therms and 8,362,162 kWh. The baseline case of electrifying the heating systems with electric boilers at a COP of 0.98 results in a total consumption of 39,293,245 kWh. The RDT system is calculated to save 22,752,392 kWh due to the efficiency impact of using heat pumps rather than electric boilers.

3.3 System Design Approach

The system design approach is to design a central plant that uses sewer heat recovery and geothermal to supply thermal energy to a network of water piping to member buildings. The central plant would be located in the West Broad Street tunnel and connect to the participant buildings through underground connections. The thermal energy would be used through a water-to-water heat exchanger, providing a thermal source for booster heat providing hot water to the building's systems or chilled water directly to the chilled water system. The demarcation point between the thermal network and the members is assumed to be the heat exchanger. This high-level approach for building retrofits was used to determine the cost of retrofitting the current HVAC system. Moving forward with design will require more detail on the building's systems and layouts. Determining the extent of the required retrofitting for the buildings will determine the level of complexity of the final.

3.4 Financial Analysis Approach

Noventa Energy's project economist assisted with a financial analysis to determine the financial impact of creating a member-owned thermal district that eliminates fossil fuel consumption and uses RDT's thermal loop. The financial analysis used a member-owned cooperative as the business model and the financial impact was analyzed through a 30-year life-cycle cost analysis. The proposed system is a central plant of heat pumps providing 110°F and 42°F during the heating and cooling seasons, respectively. The baseline system used for this analysis is an electric boiler option that would provide necessary steam or hot water to the RDH members and other participants. The overall financial impact was determined, and sensitivity analyses were conducted to determine the highest financial impact factors. Variables from the financial analysis were shifted and the project's net present value was compared to the initial value to determine the financial impact each variable has on the project.

3.4.1 Assumptions Used in Financial Model

Overall life-cycle cost analysis assumptions include:

- **Day 1:** The start of the financial analysis is January 1, 2026. Estimated costs are inflated to represent the costs in 2026 where the 30-year analysis starts.
- **Inflation rate:** Annual inflation for the life-cycle cost analysis is 2%. This is applied to the annual capital costs outside of any assumed financed costs.
- **Phase 1:** Phase 1 consists of the 18 participants that will be connected during the initial implementation of the thermal district system beginning January 1, 2026.
- **Phase 2:** Phase 2 consists of the other eight participants that will become members of the thermal district over the first five years of the district being installed. The thermal and financial impact of these members are built into the model for the first five years, incurring 20% of the costs and energy impact each year.
- **Carbon costs:** Carbon costs are the additional costs associated with a social cost of carbon that is assumed to be applied to natural gas users. Any natural gas usage is accompanied by an additional rate of $55 per ton of carbon dioxide (CO_2) in greenhouse gas emissions, with an assumed 0.054 tons of CO_2 per 1 MMBtu of natural gas.

The financial model incorporates RDH-provided data from the energy model and steam sales to determine the energy consumption for space and DHW heating for the participants that are RDH customers. The following assumptions are derived from or based on the modeled and provided energy consumption information from RDH:

- **Total RDH steam sales**
  312,000 MMBtu of steam sales based on the average sales from 2018 to 2022, which RDH provided. The energy content of steam is 1.2 MMBtu per 1 million pounds (Mlb) of steam.
- **RDH's fixed annual losses**
  53,000 Mlbs of steam lost per year based on the average difference in steam sales and produced.
- **RDH member building load**
  Based on the comparison of the steam sales and modeled hourly energy from EMCOR, the overall annual usage from RDH is an average of 41% higher than the modeled results. This 41% factor was used for the non-RDH members to ensure that the conservative building consumption information was scaled to be more representative of the available steam data from RDH.

- **Convention center steam usage**
  The convention center is assumed to transition simultaneously during the implementation of the district thermal system. Six buildings within the civic center use RDH steam from a single meter. Steam sales were allocated among the buildings based on the energy model results.
- **DHW usage**
  Based on the known or assumed building types and sizes, not all participants appear to have central DHW systems. Seven participants are expected to use the district thermal system to provide a non–fossil-fuel sourced DHW solution. The eQuest models provided the DHW consumption, but it will need verification when these systems are designed. These buildings include: Blue Cross Arena, both Monroe County jails, City of Rochester Public Safety Building, Joseph A. Floreano Rochester Riverside Convention Center, Rochester Riverside Hotel, and Monroe County CityPlace. The remaining participants are assumed to have satellite DHW solutions that would not be economically viable to replace with a DHW heat pump solution.
- **Cooling loads**
  The building energy models were used to determine the thermal energy sales associated with cooling.
- **RDH natural gas use**
  Natural gas usage for RDH is determined when members join RDT's thermal system based on a statistical analysis that maintains the level of losses associated with steam generation and delivery. The gas equation is: Gas = Steam Sales × 1.095 + Days × 409.9 (R-squared = 0.981). The assumption is that steam loss in the distribution piping remains consistent regardless of the number of members on the system. A decrease in RDH steam sales of 46% will result from its members switching from RDH to RDT. Gas consumption for the RDH plant will only decrease by 32% due to the assumption that distribution losses will not change. This is a result of RDH not eliminating any steam piping within its distribution system. Distribution losses could decrease if RDH were to cap or remove unneeded steam piping.
- **RDH's current electricity consumption**
  RDH's annual electricity consumption does not change substantially based on the amount of steam generated. Electricity consumption is assumed to remain unchanged as members transfer to RDT's thermal loop.

Commodity costs were estimated using RDH's utility bills and published resources to determine their annual impact throughout the financial analysis.

- **Natural gas**
  - Gas commodity costs are determined using forward prices at the Leidy hub. Although located in Pennsylvania, Leidy is considered the most relevant hub for pricing gas in Rochester, among hubs for which forward prices are readily available.
  - Currently, RDH has locked in gas prices, including basis and commodity, through August 2024. Once the current contract expires, RDH will need to purchase gas at the current market rates unless it secures additional gas further into the future. In the financial model, therefore, gas commodity prices for both RDH and RDT customers are based on the forward prices.

- RDH's gas delivery charges are based on RG&E's large transportation service rate. RDT's customers' (avoided) gas delivery charges are based on RG&E's general service rate. Delivery charges are assumed to increase in keeping with inflation.

- **Electricity**
  - Electricity commodity prices for RDH, RDT, and RDT's customers are based on TeraTrends Consulting's forecast of New York Independent System Operator, Inc. (NYISO), Zone B wholesale market prices.
  - Electricity delivery charges for RDH, RDT, and RDT's customers are based on RG&E's nonresidential rate. Delivery charges are assumed to increase with inflation.

- **Water**
  Water charges for RDH, RDT, and RDT's customers are determined using the Rochester's Directory of Water Service and Rates, which are assumed to increase with inflation. RDH is billed for two 6-ft connections, and RDT's customers is billed for one 6-ft connection. For RDT's customers, the per-meter charge is excluded because the charge will be incurred regardless of changes in their cooling tower water consumption.
- **Sewage**
  RDH's sewage charges are approximately 80% of its water charges. The bill is calculated based on the prior calendar year's water usage plus a capital charge based on assessed property value. For simplicity, sewage charges for RDH, RDT, and RDT's customers are assumed to be 80% of water charges.
- **Other costs included in RDH's energy expenditures**
  As a member-owned cooperative, RDH incurs other annual expenditures that are carried and applied.
  - Bank loan, principal and interest: This loan, with a current balance of $4.55 million, matures in January 2032. Annual interest charges of $606,310 are included through 2031. Although RDT will join RDH's membership, the loan is assumed not to be transferred to the RDT membership.
  - Rebates and revenue offset: This is not a true expense, but a budget allocation, and it is not included in the financial model.
  - Condensate return: RDH credits customers who return their condensate to RDH. These credits are treated as a cost in calculating the steam rate. The financial model focuses on calculating the average cost of steam (total costs divided by total steam sales), with no distinction between customers who do or do not return condensate. The condensate return credit, therefore, is not included in the calculations.

Fixed operating costs are determined for ongoing annual expenses associated with labor, services, property tax, and services such as accounting, marketing, and legal. The team assumed that some of RDH's staff will be allocated to assist with the operation of RDT.

- **RDH fixed operating costs**
  RDH's fixed costs include necessary operating costs allocated to the membership through the steam demand costs. RDH reviewed and provided these costs.

- RDH’s current fixed operating costs are $3,788,360. For simplicity, these costs are assumed to increase with inflation.
- When established, RDT is intended to share a portion of these costs through a management fee service agreement. Proposed reallocation percentages have been created for each category of expense, ranging from 10% for capital expenditures, maintenance, and supplies, to 80% for legal services, resulting in a total annual allocation of $1,438,269. The financial model assumes that this amount, adjusted for inflation in 2022 dollars, will be deducted from RDH’s fixed costs and added to RDT’s fixed costs when RDT is established.

- **RDT fixed operating costs**
  RDT operating costs are determined based on RDH’s current operating expenses as a member-owned cooperative. These estimates are preliminary and will be finalized when the RDT cooperative is established. RDH assisted with estimating these costs based on its operational experience.
  - Plant payroll and benefits: Three staff members are projected for year 1, with an additional two staff members expected by year 5, each with a total anticipated cost of $127,595 per individual (in 2022 dollars). The total includes wages, payroll taxes, paid time-off, company-funded retirement plan contributions, and medical/disability insurance premiums. Staffing requirements for the RDT central plant will comply with chapter 103 of Rochester’s general ordinances (stationary engineers and refrigeration operators licensing ordinance). Generally, central plants of this type do not require on-site staff. However, if the ordinance requires on-site staffing, it will require four full-time plant operators. Alternatively, if on-site staffing is not required, operational staff could be dispatched from RDH as needed. Regardless of these considerations, due to the increase in distribution piping and members, one additional mechanic is planned.
  - Outside services: For year 1, the budget for information technology services, plant controls support, engineering services, environmental compliance, if any, and payroll processing is $135,000 with annual escalation. This does not include routine maintenance costs.
  - Capital expenditures, maintenance, and supplies: In year 1, $300,000 is budgeted, with an additional $600,000 by year 5. The year 1 costs include inventories of spare parts and tools, which have been included in the capital cost (details follow). Maintenance of the Wetwell, HUBER equipment, pipes, and heat pumps will require annual or biennial maintenance by outside contractors. The estimate maintenance expense has been adjusted to $300,000 per year (in 2023 dollars), beginning in year 1.
  - Debt service, RDT: This is to cover the capital cost of the WET System, which is discussed later in the capital cost section.
  - Debt service, RDH payoff: This is for refinancing $3.5 million of the bank loan. For now, that debt is assumed to remain with RDH, although this may be reconsidered in the future.
  - Lease, central plant: The year 1 estimated cost is $115,000 is based on leasing space in the abandoned/unused tunnel beneath West Broad Street that could potentially accommodate 80 parking spaces with a current market rental rate of $120 per month.
  - Insurance: The year 1 budgeted amount is $120,000, which equals approximately 0.4% of the $28-million capital cost.

- Property tax: The year 1 estimated cost is $606,286; the year 5 figure includes escalation. These estimated are based on projected assessed values for RDT property, applying the same tax rate as RDH. Property taxes will need to be adjusted depending based on any Monroe County Industrial Development Agency payment in lieu of tax (PILOT) agreement.
- Accounting and marketing: The year 1 budgeted amount is $100,000, decreasing to $50,000 by year 5, which is reasonable for a new and complicated project.
- Legal: Legal costs for establishing the RDT are included in the initial project financing. Operational costs for general legal requirements such as member agreements and bylaw management are planned at $100,000 in year 5.
- The General and administrative costs: These include five other categories (payroll and benefits, outside services, office rent, professional fees, and office administrative costs) for which costs are shown for year 5 but not for year 1. Year 5 costs are approximately equal to 20% escalation of the RDH costs reallocated to RDT. (For example, 67% of payroll and benefits costs are reallocated to RDH, equal to $578,713 in year 1. The year 5 cost of $115,743 is 20% of this.). The assumption is that establishing the RDT will result in no incremental costs in these categories.

- **RDT members**
  RDT members are assumed to install the necessary equipment to use the provided thermal energy within their respective building.
  - RDT customers will need their own heat pumps to raise the temperature of the RDT-supplied hot water (110°F) up to the temperature needed in their building. However, all RDT customers except the two parking garages currently use and maintain chillers and cooling towers, which will no longer be needed after transitioning to RDT. Initially, the cost of maintaining the heat pumps is assumed to be approximately the same as the cost of maintaining the existing chillers and cooling towers, so that transitioning to RDT will not increase the customers' maintenance costs. Further analysis may reveal potential reductions in maintenance costs because the existing chillers require cooling towers and the heat pumps will not. Additionally, differences in capacities between heat pumps and existing chillers may result in cost savings.
  - Maintenance costs for heat pumps at the two parking garages have not been estimated. These facilities are owned by Monroe County and the city of Rochester, respectively. The cost of maintaining heat pumps specifically for the garages will most likely be offset by savings on chiller and cooling tower maintenance at other properties.

RDT district thermal system's capital costs are estimated based on installing the central plant, sewer heat recovery, and distribution piping.

- **RDT system capital cost**
  The RDT capital costs are estimated and used within the annual capacity charge to the RDT members.

- The cost of the WET system is estimated to be $29,220,154 for the central plant, with an additional $8,014,989 for the distribution system installation associated with the second phase, for a total of $37,235,143.
    - Includes allowances for permits, project management, and contingencies
    - Capital cost estimates are in 2023 dollars, so one year of escalation (2%) has been added
    - Capital expenditures are assumed to be incurred in 2024
- Noventa's fee for managing this project will be 6% of capital costs, or $2,234,109 including escalation.
- This capital cost will be financed through Noventa, with RDT incurring a financing charge. Details have not been determined. For now, the financial model makes the following assumptions:
    - 30-year term
    - 4.8% loan interest rate, covering Noventa's debt and equity
    - A flat capacity charge with no escalation
    - All these assumptions may be reconsidered in the future
- The 4.8% loan interest rate is determined based on a combination of the following financing assumptions:
    - 20% of the capital expenses will be financed at the 8.5% market rate
    - 70% of the capital expenses with be financed with an Energy Infrastructure Reinvestment Program loan at a 4.25% rate
    - The remaining 10% of the capital expenses will be financed through the NYS Green Bank at a 1.5% rate
- Potential incentives and tax credits were incorporated into the financial model. A 30% federal tax credit was applied based on proposed legislation supporting tax credits for energy-efficient capital projects, although not currently supported by law. Additionally, the project was assumed to qualify for NYSERDA's Community Heat Pump Category C funding of $4 million, thereby reducing the initial investment estimated at $15,840,775.
- An initial inventory of spare parts and tools, estimated to cost $300,000 with inflation accounted for, is expected to be incurred in year 1.
- The capital costs include a vehicle for the distribution repair crew.
- Legal costs for implementing the RDT district thermal system and establishing the new member-owned cooperative are budgeted at $1.5 million with inflation accounted for.

- **RDT customers capital costs**
    - To transition to RDT (whether from RDH or from their own boilers and chillers), customers will need to invest in heat pumps and other equipment replacements and upgrades to increase the 110°F water supplied by RDT to the temperature required by their building. Additionally, many customers will need to convert their equipment from steam to hot water.

- The combined estimated total for all 26 participants is $26.8 million, including engineering costs, contingency funds, overhead expenses, and the builder's profit.
- These costs were estimated based on 2023 costs. The financial model adjusts these costs annually with a 2% inflation rate until the year prior to each customer's connection to RDT. For the 18 phase 1 customers, this occurs in 2024. For the 8 phase 2 customers, 20% of the capital cost is assumed to be incurred in 2025, 20% in 2026, 20% in 2027, 20% in 2028, and 20% in 2029.
- Some of these costs are likely to be offset by capital costs that customers would otherwise incur. For example, some customers may have older boilers, chillers, and/or cooling towers that would need to be replace even if they did not switch to RDT. The financial model does not currently take such offsets into account.
- The installation cost factor determines the down payment for the capital costs of implementing the RDT system connection. This is carried to be 50%, meaning that half of the customer implementation cost will be paid for by a combination of grants, incentives, and tax credits.
    - A 30% federal tax credit was assumed based on the total installation cost
    - Assumed funding 20% of the cost factor will be funded by other grants and incentives, including local utility incentives or the Clean Heat Program

3.4.2 Sensitivity Analysis Approach

Given the extensive list of variables in this financial analysis, sensitivity analyses were created to determine their impact on the net present value for different assumptions. Each sensitivity analysis' impact was determined based on the net present value of the 30-year financial analysis when the variable(s) are changed. These variables include:

- **Cost of electricity**
  As New York State advances its plan to reduce reliance on natural gas, the potential impact on electricity cost remains uncertain. Currently, the cost of electricity is assumed to be $66.71 per MWh based on TeraTrend Consulting's electricity market rate forecast for New York Zone B wholesale prices in 2023.
- **Social cost of carbon (cap and invest)**
  The financial analysis integrates the social cost of carbon as a carbon tax associated with natural gas usage, specifically for members joining to the thermal loop in phase 2. The social cost of carbon is assumed to be applied as a Cap-and-Invest Program auction assessment from New York State. The financial analysis uses a social cost of carbon equal to $55 per ton of CO_2 based on the first carbon surcharge value included in the Climate Leadership and Community Protection Act (Climate Act). The change in the social cost of carbon shows the impact from no assessment associated with the social cost of carbon up to the value published in the Climate Act's "Establishing a Value of Carbon: Guidelines for Use by State Agencies." The cost of carbon is published to be $126 with a 2% discount rate (page 34 of the guidelines) in 2020 and is converted to 2023's value using the U.S. Consumer Price Index (CPI). The CPI increased 18.62% between 2020 and 2023, resulting in $149.46 per ton of CO_2 from the published $126. Additionally, the sensitivity analysis includes the scenario where no social cost of carbon was used.

- **Loan discount rate**
  Capital costs for installing the district thermal system are expected to be financed through a loan with an interest rate of 4.8%, determined from a combination of financing opportunities. The sensitivity analysis for the loan's discount rate shows the change in net present value with the loan discount rate at 1.5%, 3%, 4.8%, and 8%.
- **Capital expenses**
  Capital costs were included to determine the necessary loan amount to finance the district thermal project. Potential tax credits, incentives, and grants are anticipated to offset the overall capital cost of implementing the district thermal system, which would reduce the financing requirement. Upfront funding is assumed to be 30% of the total capital cost of the district thermal system, plus $4 million from the Category C NYSERDA Community Heat Pump System Program.
- **Total operating costs**
  Operating costs are the annual costs associated with operating the district thermal system excluding energy costs. These estimates based on the current overhead expenses associated with operating RDH. Due to their consistency, these costs have a significant impact on the net present value. A sensitivity analysis examined a range of costs to determine the impact on net present value for the system's operating costs.

4 System Design

4.1 Community Heat Pump Infrastructure

The community heat pump distribution system was designed to include a central plant located in the West Broad Street tunnel and a piping system connecting the members to the thermal network. The design basis for the distribution system is a two-pipe system that will deliver 44°F water during cooling season and 110°F during the heating season.

4.1.1 Central Plant

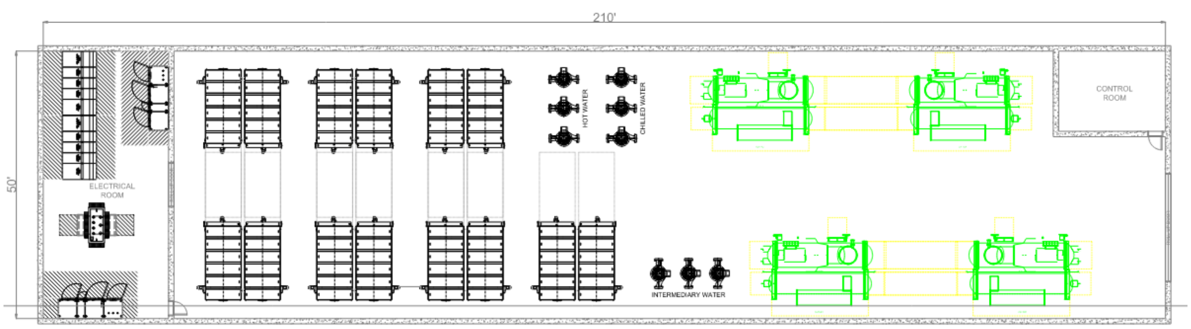
The RDT plant would be located in the West Broad Street tunnel, underneath the intersection of West Broad Street and South Plymouth Avenue (see the shaded area in Figure 10 for approximate location). This area in the tunnel will be used to contain the central plant equipment for RDT. Figure 10 also indicates the potential location of the sewer heat recovery well, identified with the green dot. This location was chosen for its proximity to member buildings and the sewer main, thereby allowing easier installation of the required piping systems to connect to member facilities. A potential significant cost for the system installation could be burying thermal distribution piping within the city. Using the West Broad Street tunnel to install the piping network without the need for major excavation, therefore, would reduce the implementation costs significantly. The central plant will connect to the Main Street sewer line, indicated at the top of the image in Figure 10.

Figure 10. Central Plant Location

The initial central plant layout allows for necessary vehicle traffic to travel through it with at least one pass-through lane. The plant's design uses Noventa's WET system along with additional geothermal resources. Based on the estimated available space and the necessary equipment, the project team created a preliminary central plant layout, designed to occupy an area of approximately 50 ft by 210 ft. Although Noventa has developed several potential plant layouts, the option displayed in Figure 11 is the preferred solution. The central plant includes the following major components:

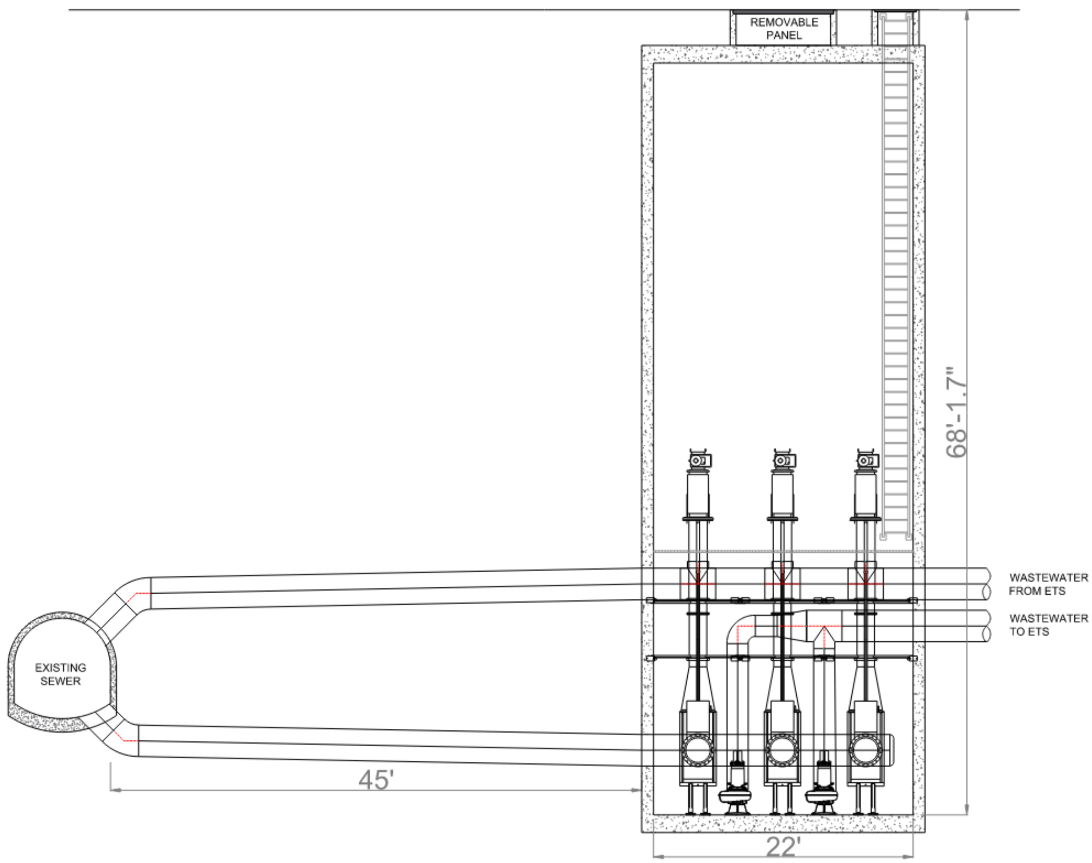
- Sewer heat recovery heat exchangers
- Heat recovery heat pumps
- Central distribution pumps
- Control room for the on-site operators
- Electrical room
    - Receive the incoming 11.5 kilovolt (kV) service
    - Switchgear for this service, accessible on surface level
    - Power distribution panels
    - Necessary transformers for central plant equipment
- Geothermal wellfield (buried under the proposed plant)

Figure 11. Central Plant Layout



The WET system includes a wetwell to retrieve sewer water from the Main Street sewer trunk. The well structure would be located below grade at the intersection of Main Street and South Plymouth Avenue, allowing access to the wastewater flowing through the existing Main Street trunk sewer. The well structure is a vertical shaft estimated at 68 ft deep, with at-grade access through a utility hole. Furthermore, the 22-ft-diameter well acts as a temporary storage for diverted wastewater from the Main Street sewer pipe, equipped with screening equipment and submersible pumps to supply sieved wastewater to heat exchangers located in the central plant structure. Figure 12 illustrates a sectional view of the well layout. Appendix A has Noventa's central plant and WET system drawings.

Figure 12. Noventa's Wetwell Layout



The RDT team discussed necessary upgrades to the electrical infrastructure of the central plant with RG&E's engineering team. The discussions revealed that bringing a 4.16 kV service from outside Rochester's Inner Loop would be cost prohibitive. As an alternative, an 11.5 kV service was considered, which would need an aboveground switchgear for RG&E's accessibility. Noventa confirmed an 11.5 kV service could be used for the plant equipment. The closest available location for an 11.5 kV is the former Gannett Building, at the corner of Exchange Boulevard and Main Street. The switchgear is located on the south side of the building, although it may be altered for a smaller service due to a change in building occupancy. The study assumed that the 11.5 kV service would be used.

4.1.2 Distribution System and Customer Connection

The ambient loop for the RDT will include:

- Distribution piping network
- Central plant pumps
- Participant connection circulation pumps

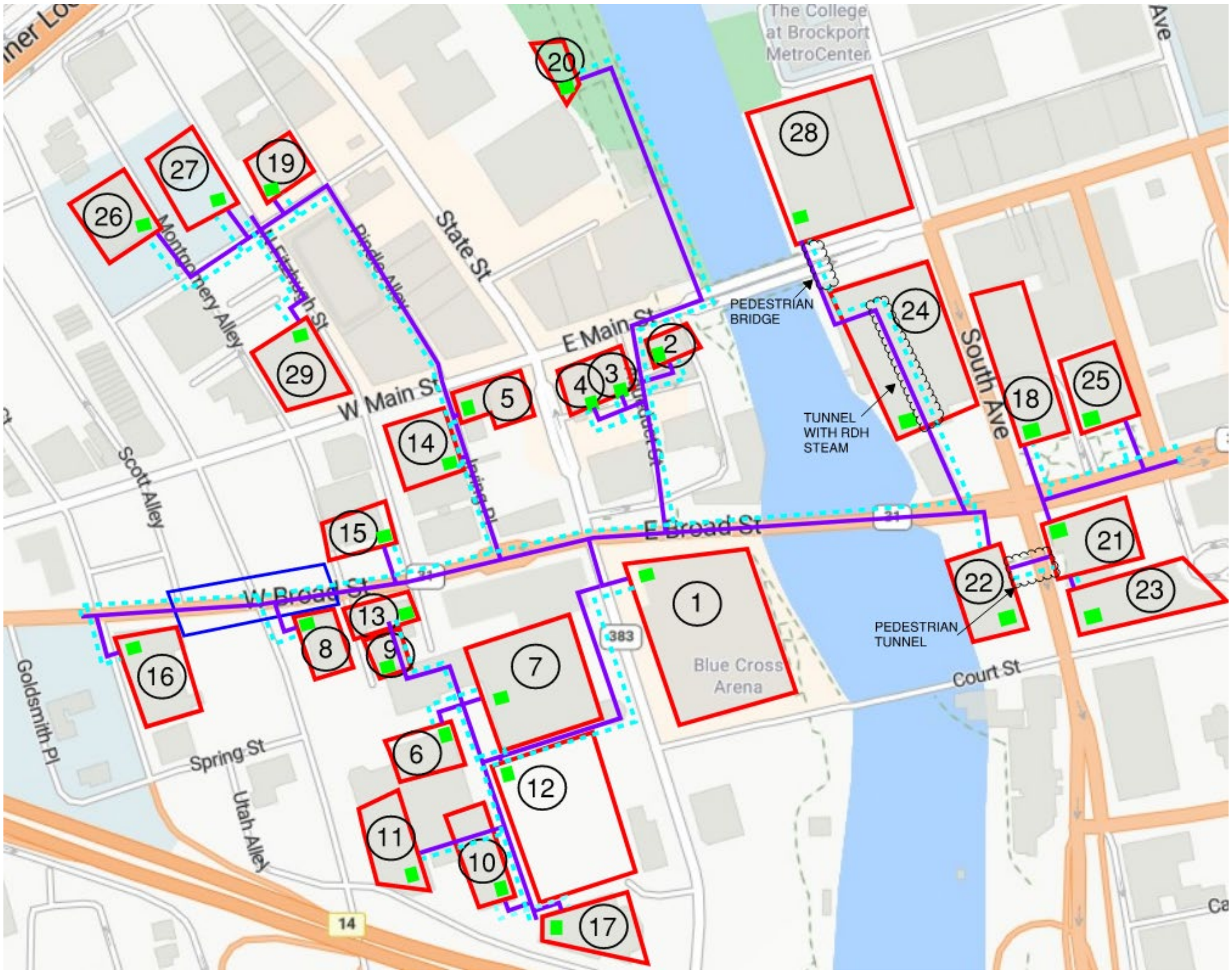
- Ambient loop to building loop heat exchangers (the heat exchanger will be the point of demarcation between the community heat pump and member facilities)

Based on the available resources, a theoretical piping layout (shown in Figure 13) was created and used as the design basis for the pumping analysis. Pumping flows were derived from the thermal energy on an hourly basis for the entire loop and for each participant.

4.1.2.1 Distribution Piping Layout

The distribution piping network will be a two-pipe system that will supply and return the ambient water to and from each customer. The preliminary piping layout ensures that all the participants access to the district thermal loop. Downtown Rochester's underground utility network is very dense, making excavation for new piping networks challenging. To understand the ideal distribution piping, RDH and EMCOR leveraged the RDH distribution team's expertise in steam piping, existing rights-of-way, and other utility routing under the street level. Figure 13 illustrates this piping layout incorporating existing underground walkways, piping tunnels, parking garages, and overpasses. These routes were identified to minimize the need for excavation at ground level.

Figure 13. Rochester District Thermal Distribution Layout



In areas where excavation is unavoidable, options such as microtunneling or directional drilling will be explored. Mircotunneling, a trenchless construction technique, creates small utility tunnels ranging from 2 ft to 10 ft, providing continuous support throughout the excavation process, making it effective for tunneling under roadways. Similar to horizontal directional drilling, microtunneling uses enhanced technologies for increased accuracy and longer drilling lengths. This tunneling approach allows the main distribution piping runs to reach the necessary extents of the loop.

Directional drilling is another construction technique that could help alleviate some of the piping issues that may arise in implementing a distribution network. This technique allows for the drilling of horizontal boreholes that would avoid possible interference with existing utilities. Directional drilling allows the horizontal angle to change, avoiding possible utility conflicts.

5 Business Model

5.1 Preferred Business Model and Approach

The preferred business model for this project is to use a member-owned cooperative. Since its inception in 1985, the RDH has been organized as a not-for-profit [Internal Revenue Code §501(c)(12)] member-owned, nonstock cooperative corporation under the New York State Cooperative Corporations Law. Even with some members transitioning to RDT, the RDH will continue to operate as a not-for-profit member-owned, nonstock cooperative. The central steam plant located on Lawn Street will continue to serve the members that do not transition to RDT.

The project team recommends structuring the RDT as a 501(c)(12) member-owned, nonstock cooperative corporation, either as a member of RDH or as a separate cooperative. Two options considered for the RDT and its business model are: (1) establishing it as a separate not-for-profit member-owned, nonstock cooperative corporation, or (2) integrating it as a member classification within RDH. RDH's cooperative business model has enabled it to successfully meet the needs of its unique membership by providing energy at mutually beneficial and agreed-on rates for nearly 40 years, and the project team believes that these successes would carry over to RDT as a cooperative.

The project team used a force field analysis to evaluate each business model option. This method analyzes both positive and negative forces, establishing a weighting to each force. The positive and negative force weightings are then totaled, and a positivity ratio is created by dividing the total positive forces by the total negative forces. The higher the ratio, the better the solution, comparatively. Perpetual items received a higher rating compared to one-time forces. Forces that are equally applicable to all business model options were excluded from the analysis. Therefore, the force field analysis does not encompass all policy and force matters.

Table 3. Rochester District Heating Cooperative, Inc., and Rochester District Thermal as Separate Cooperatives: Positive and Negative Forces

Positive Forces	Rating (1-5)	Negative Forces	Rating (1-5)
Separate board of directors	1	Intercompany transfers	5
Steam exemptions still work, amendment to law not required	5	Multiple books and tax returns	5
Financing options for RDT due to ESG	5	Borrowing power, scale, and ESG for RDH	5
Cost sharing of fixed costs—overhead allocation from RDH	3	Member approval of RDT	5
View of decarbonization of RDH (CLCPA)	3	Impacts to remaining RDH members	6
Synergies of labor force	2	County participation requires special legislation	5
Potential risks to RDH or RDT if one is insolvent	6	Collective bargaining agreement	5
Separation of financial performance	5	Require to file separate certificate of incorporation for RDT	1
Calculation of rates and demand between RDH and RDT	3	Requires new COMIDA PILOT	3
Create bylaws, rules, regulations, and MUAs	4	Separate meetings, minutes, and administration	4
Member voting	4	Bifurcated IT	4
RDT risk to RDH abandonment of steam mains	4	Bifurcated insurance	3
Separate risk and liability	6	Bifurcated control systems	4
Piercing the corporate veil doctrine	1	Separate policies and procedures	2
Sale of one business	5	Payroll and 401(k)	5
Ease of expanding RDT - new plants/loops elsewhere in city	4	Apply for IRS tax exemption for RDT	4
Inclusion of non-RDH partners	3	Going/growing concern for RDH	5
		Ramp up solvency of RDT, phased members	4
Total	**64**	**Total**	**75**

Positivity Ratio	**0.85**

* Ratings are based on a 1–5 scale (1 = insignificant, 2 = minor, 3 = middle ground, 4 = important, 5 = major items), with an additional point (+1) for perpetual items.

Table 4. Rochester District Heating Cooperative, Inc., and Rochester District Thermal as a Combined Cooperative: Positive and Negative Forces

Positive Forces	Rating (1-5)	Negative Forces	Rating (1-5)
Steam exemptions still work, amendment to law not required	5	Potential risks to RDH or RDT if one is insolvent	6
Cost sharing of fixed costs	5	Separation of financial performance	4
Accounting, bookkeeping, and tax returns	5	Calculation of rates and demand between RDH and RDT	3
Clearer view of decarbonization of RDH (CLCPA)	5	Amend certificate of incorporation to include thermal	3
Impacts to remaining RDH members	3	Amend bylaws, rules, and regulations	3
County participation already established (to be verified)	3	Creation of the classification of members	3
Borrowing power, scale, and ESG	3	Board of directors mix	5
Member approval of RDT	4	Member voting	5
Synergies of labor force	5	Implications to the COMIDA PILOT (currently based on steam)	3
Collective bargaining agreement	2	RDT risk to RDH abandonment of steam mains	4
Shared IT	4	Shared risk and liability	5
Shared insurance	3	Piercing the corporate veil doctrine	2
Shared control systems	4	Sale of one business	2
Shared policies and procedures	2	Carbon included in ongoing business	5
Payroll and 401(k)	4	Inclusion of non-RDH partners	1
Supports legacy steam members	6		
Total	**63**	**Total**	**54**

Positivity Ratio	**1.17**

* Ratings are based on a 1–5 scale (1 = insignificant, 2 = minor, 3 = middle ground, 4 = important, 5 = major items), with an additional point (+1) for perpetual items.

If operating as a separate not-for-profit, member-owned, nonstock cooperative corporation is determined to be more beneficial for the RDT, several steps will be required:

1. Obtain the required certificate of incorporation (COI).
2. Secure an employer identification number from the Internal Revenue Service after the COI is approved.
3. File for a determination letter from the Internal Revenue Service to seek federal tax exemption under Internal Revenue Code §501(c)(12), which grants tax exemptions to cooperatives meeting an 85% revenue test (i.e., 85% of a cooperative's income each year must be derived from its membership, and income must be collected solely to cover losses and expenses). Use Form 1024, Application for Recognition of Exemption Under Section 501(a) or Section 521 of the Internal Revenue Code, for electronic filing of the application.

The organizing document (COI) and bylaws must be prepared and submitted with the application. Generally, approval from the Internal Revenue Service regarding tax exempt status can take three to six months, unless expedited processing is requested. In addition to preparing the bylaws, the rules and regulations must be drafted, including the determination of voting rights, membership classifications within RDT, and rates and charges, which will take approximately six to nine months.

If RDT becomes a member of RDH, RDH's COI will need to be amended to include provisions for producing and distributing thermal energy in addition to steam. In addition, the bylaws, rules, and regulations must be revised to create two classes of members—one for steam members and one for thermal energy members—with a description of their respective voting rights, submembership classifications, and rates and charges. Conducting an analysis will determine whether the existing federal tax exemption will continue to apply or whether a supplemental filing is necessary due to the amended COI. This process, like the process to establish a separate cooperative model, including the determination of voting rights, membership classifications within RDT, rates, and charges, will take approximately six to nine months.

Table 5. Other Cooperative Considerations of Each Business Model

Combined Model	Policy Item	Separate Model
Requires approval by RDH members to include RDT as a member classification	Approvals	Requires some method to allow RDH members to transition from RDH to RDT including either the assignment or termination by mutual agreement of the RDH Member Use Agreement before its natural expiration
Requires amendments to current documents. The mix of the board of DIRECTORS and member voting rights will need to be adjusted to balance the relative interests of RDH and RDT members as members transition from steam to community thermal over time	Bylaws, Rules, Regulations, and Board of Directors	Requires new documents, separate boards of directors, and member voting rights
Requires analysis to determine whether county could participate in RDT based on the current State legislation passed in 1985	Municipal Participation	Requires new State legislation to allow the county to participate in RDT
Alternate thermal business ventures already incorporated into the CBA, but requires some revision (i.e., memoranda of understanding) to customize sections for RDT	CBA	Requires new negotiated CBA
Continue using existing franchise for steam operations; requires analysis to determine whether a new franchise or an amendment is needed to authorize thermal energy other than steam	Franchise	Requires a new franchise
Requires analysis to determine whether an amendment to the current PILOT agreement is acceptable or whether a new PILOT is needed	COMIDA	Requires new PILOT
Operating costs would be allocated through the normal RDH budget process and membership rates	Administrative Agreement between RDH and RDT	Requires an agreement allowing RDH to provide shared management, administrative, and labor support to RDT to be updated annually

With a member-owned cooperative, long-term agreements are established with the initial term matching the financing term of the project. This approach allows members the ability to participate in decisions and allocate funds, ensuring proper and efficient operation of the thermal network. Each member's contract with the cooperative will include the cost of consuming the energy and overhead for operating and maintaining the thermal network. Members will be responsible for all systems on their side of the demarcation point, which is defined as the water-to-water heat exchanger using the ambient loop.

For project development, ensuring members are committed to tie into the community heat pump loop once it is implemented is crucial. Binding agreements must be signed before implementation for the initial members, and their building systems will need to be updated to use the ambient loop.

5.2 Regulatory Review

RDH and its legal consultant conducted a regulatory review to explore possible permitting and regulatory requirements for implementing a district community heat pump system.

5.2.1 Project Policy Items: Environmental Review

Prior to implementing or constructing this project, certain precursor policy items must be completed.

- The project will undergo State Environmental Quality Review Act (SEQRS) and National Environmental Policy Act (NEPA) review and approval. This will require designating a lead agency and most likely the support of a qualified engineering firm familiar with SEQRA and NEPA (if applicable) requirements to support of the overall project permitting process. This process will need to address the requirements of the NYS Office of Parks, Recreation and Historic Preservation because the West Broad Street Bridge is currently under consideration for addition to the NYS Register of Historic Places and/or the National Register of Historic Places.
- Importantly, no government agency can undertake, fund, or approve the project unless and until the project has fully complied with SEQRA and NEPA. The SEQRA review will need to evaluate the effect of the proposed action on disadvantaged communities including whether it would create or exacerbate disproportionate or inequitable burdens. Compliance with environmental justice considerations, as required by the Climate Act and DEC regulatory requirements, is also required. Additionally, DEC may be obligated to prepare an existing burden report for all projects requiring a DEC permit, following adoption of DEC regulations. Based on the projected decrease in emissions associated with the transition from steam to community thermal, the project is expected to significantly reduce impacts on disadvantaged communities.
- Environmental due diligence, including a phase 1 environmental site assessment, is required for key components of the project, such as the central plant, sewer heat recovery wetwell, and the distribution piping system.

5.2.2 Real Property Matters

- A complete title search will be required for all properties impacted by the project including the central plant with access via the West Broad Street tunnel, the sewer heat recovery wetwell, and the distribution piping system (including private owners of property abutting the tunnel/streets/public rights-of-way).

5.2.3 Potential Legislative Matters

- In 1985, special state legislation was required to enable Monroe County to participate as a member in RDH as a cooperative corporation. An assessment is needed to determine whether this legislation authorizes the county's participation in amended RDH/RDT or whether additional state legislation may be necessary.

- Rochester granted RDH a nonexclusive franchise for distributing steam within the specified franchise area. An assessment is needed to determine whether the existing franchise can be amended to include the distribution of thermal energy or whether a separate franchise will be required.
- Approval from both the City Council and County Legislature will be required to authorize participation in RDT, including executing a long-term membership and use agreements providing for thermal services.
- Approval from both the City Council and County Legislature will be required to authorize any required amendments to the RDH Monroe County Industrial Development Agency PILOT agreement and/or to establish a new PILOT agreement for RDT.

5.2.4 Monroe County Pure Waters

The Monroe County Pure Waters sewer system is the project's primary energy source and sink. The plan is to connect to the sewer system near Main Street and Plymouth Avenue. This will require a connection near the bottom of the sewer lateral where effluent would be extracted from the sewer into a wetwell, and liquids and solids would be separated. The liquid portion would be piped to the central plant where heat exchangers would transfer energy in and out, depending on seasonal needs. A connection on the upper portion of the sewer lateral will be required to return the solids from the wetwell and liquids from the central plant back into the sewer system.

The pure water sewer connection will be sized and constructed to support the entire load profile of the proposed project, regardless of the phases of the implementation and building connections.

The connection to the sewer system will require agreements with Monroe County Pure Waters:

- Establish an agreement for access and use to connect to the sewer lateral
- Negotiate an agreement for the energy exchange with the sewer effluent, including any financial considerations:
    - Conduct an analysis of applicable procurement considerations regarding use of a Monroe County asset, whether through competitive bidding and/or a reverse procurement
    - Conduct an analysis, if necessary, to confirm that granting rights to use the municipal sewer system does not implicate the public trust doctrine that bars the use of certain municipal property (including, e.g., land under water and waterfront property) without the approval of the NYS Legislature.
- Address operational considerations, including:
    - Implementing odor controls
    - Ensuring maintenance access is established
    - Establishing influent minimum and maximum temperatures

- Defining influent maximum dwell times (duration before ~~it~~ sewer water returns to the sewer lateral)

- Ensure compliance with permitting requirements applicable to significant industrial users of the county's publicly operated treatment works

These provisions could be in one or more agreements, and additional items may need to be negotiated as well.

5.2.5 Wetwell

The wetwell contains pumps and filters that separate the sewer effluent solids and liquids and sends the liquids to the central plant. Solids are returned to the sewer lateral and are combined with the returning sewer liquids. The wetwell is a substantial structure currently planned at 22 ft in diameter and nearly 70 ft deep. The final location of the wetwell will determine the actual dimensions.

The exact placement of the wetwell has not been finalized. Currently, it is shown on private property earmarked for a mixed-use, multistory development. A recommendation has been made relocate the wetwell to a public space near the sewer lateral connection. If the location remains on private property, the project team will explore options such as a long-term lease or purchase of the area.

The piping connecting the wetwell to the central plant will most likely run through both public and private spaces.

The wetwell will be sized and constructed to support the entire load profile of the proposed project, regardless of the phases of the implementation and building connections.

The connection to the sewer system will require agreements with Monroe County Pure Waters, the city of Rochester, and private owners, including these actions:

- Secure an access and use agreement for construction of the wetwell
- Obtain DEC permit (Region 8 Division of Water) for sewer infrastructure improvements, as applicable
- Incorporate Monroe County Pure Waters requirements into the agreements
- If the wetwell and piping are located in public spaces, including public rights-of-way, negotiate agreements with either the city of Rochester or Monroe County; if it is within private property, it will require agreements with the property owner:
  - Negotiate license agreements for the construction, access, use, operation, and maintenance
  - Arrange easements as necessary

5.2.6 Central Plant

The central plant is planned for construction in the western West Broad Street tunnel underneath the intersection of West Broad Street and South Plymouth Avenue. It measures 254 ft from east to west, and 51 ft from north to south. This footprint leaves approximately 17 ft for vehicular traffic through the tunnel. The central plant will house pumps, heat exchangers, heat pumps, electrical gear, operator areas, controls, and other ancillary equipment. RDT may also be responsible for installing lighting and traffic control devices and signals in the tunnel for vehicular traffic.

Geothermal borewells are planned to be installed beneath the floor of the central plant. The current plan specifies 87 425-ft deep borewells. Using this subsurface space would require either a lease or license agreement (unless purchased) with the city of Rochester following an analysis of applicable procurement considerations regarding use of a city of Rochester asset whether pursuant to competitive bidding and/or a reverse procurement. In addition, an access agreement would need to be negotiated with the Rochester to provide access to the plant through the West Broad Street tunnel. Typically, these types of systems also require a remediation plan in case the geothermal assets need to be removed.

This location was selected because of its proximity to member buildings and space availability within the West Broad Street tunnel for equipment. The proposed area is owned by the city of Rochester, and multiple attempts have been made over the past decades to convert this space to a parking lot. However, efforts to develop the area into parking spaces have not materialized, and discussions with the City of Rochester were supportive (but not committal) regarding the potential use of the space for the central plant. The project team would seek a long-term lease or occupancy agreement with the city to use the tunnel for RDT's central plant. The lease cost is assumed to be similar to the average cost of parking within a garage. If the space is purchased, access agreements would be required to allow RDT's access into the space through the city-owned areas.

Construction of the central plant and boreholes will require agreements with the city of Rochester, as well as approvals from other authorities having jurisdiction approvals, including these actions:

- Negotiate lease agreement with the city (or purchase of the space)
- Secure access agreement through tunnel
- Obtain easements for appurtenant utilities
- Arrange geothermal lease (or purchase) and create remediation plan
- Obtain NYS Department of Transportation approval for construction within any NYS roadways/rights-of-way, including considerations for construction underneath a public road (West Broad Street tunnel)

- Comply with NYS Environmental Conservation Law Article 23 regarding well drilling
- Comply with 6 New York State Codes Rules and Regulation Part 704 regarding State Pollutant Discharge Elimination System (SPEDES) permit if applicable
- Comply with Safe Water Drinking Act, Environmental Protection Agency (SDWA-EPA) Class V injection well if applicable
- Comply with DEC Policy CP52 Best Technology Available if applicable

5.2.7 High Voltage Switchgear

Powering a plant of this magnitude is significant. The project team has been working closely with RG&E, the local utility, to determine electrical loads necessary to support the project, including the planned individual buildings. The scope is to build an 11.5 kV aboveground switchgear proximate to the central plant. RG&E informed the project team that significant work is required to bring power to that location, and it has provided documents specifying the design and technical requirements, as well as its project specification and request form. The project team must complete and submit an electric load form to RG&E for evaluation. The form will assume that the wetwell and central plant will remain in the proposed locations.

The team considered reusing an existing 11.5 kV switchgear on private property near the planned central plant location. However, RG&E does not believe is a viable solution. The private property owner has not been contacted regarding this.

RG&E is proposing using private property north of West Broad Street and east of Plymouth Avenue. Discussions with the property owner have not yet occurred.

Constructing the high-voltage switchgear will require agreements with the city of Rochester and RG&E, including these actions:

- Negotiate lease, license, or purchase agreement with the private property owner
- Complete and obtain approval for RG&E Project Specification and Request form
- Complete RG&E Load Evaluation form
- Obtain RG&E approval and authorization

5.2.8 Distribution Piping Systems

The project team has evaluated several alternatives for the distribution piping for the thermal energy loop.

Using the West Broad Street tunnel is an important consideration for our project because it allows for installing a substantial portion of the distribution piping without excavation. Rochester is currently in the design phase of a major project (ROC the Riverway—Aqueduct Reimagined), which will repurpose the West Broad Street Bridge from a vehicular bridge into a public park-style area. As part of the design, the city has allocated space within the renovated bridge for RDT's distribution piping. Approval from the NYS Department of Transportation may also be required for installing the pipe within the West Broad Street Bridge.

Outside of the tunnel, the team has identified areas where piping can be installed with minimal excavation. These areas include pedestrian tunnels, parking garages, utility chases, and others locations. The team specifically focused on spaces the RDH currently uses for its steam distribution and condensate return piping. Because most of the streets in Rochester are constrained by existing utilities, the project team will need to develop a piping route around these obstacles using methods such as directional drilling to avoid excavation and interference with other utilities.

Installing the distribution piping will require extensive title searches and reviews. While many of the locations are within city-owned spaces and rights-of-way spaces, numerous private properties are involved as well, including those adjacent to streets and public rights-of-way. Detailed maps will need to be prepared that include the metes and bounds descriptions required for easement agreements to be negotiated with affected owners. Alternatively, the project may need to request the City of Rochester to acquire necessary easements using its condemnation powers pursuant to the eminent domain procedure law.

In the past, Rochester exercised these powers to condemn an easement for the section of the RDH steam system initially acquired from RG&E in 1985. Subsequently, the City of Rochester transferred this easement to RDH. RDH then reimbursed the city over a decade, covering the costs of the proceedings and the condemnation award. If any component of the distribution loop or other project infrastructure is situated within a municipal park, state legislation will be necessary to authorize such a transfer, including granting an easement, following NYS Office of Parks, Recreation and Historic Preservation procedures.

Historically, Rochester used these powers to condemn an easement for the portion of the RDH steam system originally acquired from RG&E in 1985. Subsequently, the City of Rochester transferred this easement to RDH. RDH, in turn, reimbursed the city for the cost of the proceedings including the value of the condemnation award over a period of 10 years. If any part of the distribution loop or other project facilities are located within a municipal park, New York State must enact legislation to approve such an alienation (including granting an easement) in accordance with NYS Office of Parks, Recreation and Historic Preservation procedures.

Additionally, RDH will need to work with the city of Rochester to obtain a franchise for the ambient loop, either amending the existing steam franchise or granting a new franchise. The geographic boundaries of the franchise will need to be determined. Procedurally, an auction is required for awarding the franchise, which would be nonexclusive and require approval of the City Council.

An analysis will need to be conducted to determine whether the RDT will be subject to the NYS Transportation Corporations Law. By special NYS legislation, RDH was previously exempted from the obligation to serve provisions applicable to district steam corporations under Section 110 of the Transportation Corporations Law. It does not appear that the RDH meets the definition of a water works corporation (under Section 40) or of a pipeline corporation (under Section 80). However, this interpretation needs to be confirmed. Therefore, RDT would not be afforded the condemnation powers granted by statute to such entities.

Additionally, an analysis will be required to determine to the extent to which the RDT will be subject to regulations pursuant to the recently enacted Utility Thermal Energy Networks and Jobs Act. Ostensibly adopted to expand the reach of regulated gas and electric utilities to include thermal energy networks, the act amends the definition of gas and electric corporations to include “every corporation . . . owing, operating or managing any thermal energy network” and is arguably broad enough to include RDT and its thermal energy system.

The Public Service Commission (PSC) is statutorily directed to adopt rules and regulations within two years of the effective date of the act to exempt “small-scale thermal energy networks not owned by utilities” from PSC regulation. However, to clarify the act’s applicability prior to that deadline, the project may either seek an advisory opinion from the PSC or, if needed, seek State legislation. By contrast, the PSC has not typically regulated the provisions for hot water and chilled water, and the provision of steam by RDH, operating as a member-owned, not-for-profit cooperative, has been exempted from PSC regulation by special State legislation. If applicable to RDT, the act would also extend the reach of New York Labor Law, including apprenticeship and prevailing wage requirements, as well as the need for a "labor peace agreement," to include RDT.

The construction of the distribution piping will require agreements with the city of Rochester and private property owners, including these actions:

- Secure easements for all locations
- Negotiate license agreements for the construction of the system
- Conduct utility conflict study
- Obtain granting of a franchise
- Ensure compliance with Utility Thermal Energy Networks and Jobs Act (or seek exemption)

5.2.9 Tax Considerations

In addition to securing an exemption from federal and state income taxes, RDT will need to confirm if it receives the same tax exemptions as RDH under Section 77 of the New York State Cooperative Corporations Law, specifically regarding franchise, license, corporation, and gross receipt taxes.

Application of the existing PILOT agreement will need to be determined with respect to RDT. Currently, the RDH PILOT agreement allows RDH to reduce its real property tax in direct proportion to its exempt load, with the remaining tax being allocated to its taxable members. This helps to reduce overhead costs for tax-exempt members and ensures their participation in RDH does not impose a tax obligation that would otherwise not be imposed if such municipal members installed their own heating facilities.

RDT will also need to determine whether the responsibility for the real property tax assessment function, currently performed by the Rochester City Assessor, will continue to be performed by the local assessor or be transferred to the NYS Office of Real Property Tax Service, which has jurisdiction over "special franchise property" of utilities.

Benefits from a sales tax exemption for similar items related to steam production and distribution for sale. It is assumed that construction of the central plant building, wetwell, electrical switch gear, and ambient loop would qualify for sales tax exemption under NYS capital improvement exemptions, given their capital nature and permanent status of the projects.

The application of NYS sales tax to RDT operations will need to be determined. While current law addresses the production of refrigeration for sale, additional guidance is needed from the NYS

Department of Taxation and Finance regarding the applicability of sales and use taxes to thermal energy networks. The sales tax exemption would need to encompass machinery, equipment, parts, tools, and supplies used or consumed in, and ancillary repairs made during, the production and distribution of thermal energy for sale. Currently, RDH has a sales tax exemption for similar items associated with steam production and distribution of steam for sale. The assumption is that construction of the central plant building, wetwell, electrical switchgear, and ambient loop would be sales tax exempt through the NYS capital improvement exemptions due to the capital and permanent nature of the projects.

RDH currently charges its non–tax-exempt members sales tax based on monthly steam use and demand costs, less any applicable credits. RDT members are similarly expected to incur sales tax, with the RDT responsible for collecting and remitting the tax to the State authority.

The project will also need to determine eligibility for the Investment Tax Credit (ITC) as recently amended and expanded under the Inflation Reduction Act of 2022 with respect to the geothermal wells and other project components. The U.S. Department of the Treasury is currently drafting regulations, and preliminary indications are that the ITC will not extend to either the ambient loop or the sewer heat recovery components. Additionally, refundability of the ITC, assuming it applies in part to the project, is also being evaluated to lower overall project costs given the assumed tax-exempt status of RDT.

5.2.10 Climate Leadership and Community Protection Act Compliance

The Climate Act mandates a 40% reduction in New York State economy-wide greenhouse gas emissions by 2030 and 85% by 2050 from 1990 levels. Section 7.3 of the Climate Act directs that in issuing permits, State agencies (including DEC) must avoid disproportionately burdening disadvantaged communities and must prioritize reductions of greenhouse gas emissions and co-pollutants in these communities. In addition, recent legislation (Chapter 840 of the laws of 2022) prohibits the DEC from approving or renewing permits, including air permits, if they could directly or indirectly cause a disproportionate or inequitable pollution burden on a disadvantaged community. Based on the projected decrease in emissions associated with the transition from steam to community thermal, the project is expected to result in a significant reduction in impacts to disadvantaged communities and will serve as a cornerstone in RDH’s Climate Act compliance strategy.

5.2.11 Constitutional Amendment

New York State recently amended its Article I Bill of Rights to include a constitutional amendment guaranteeing that "each person shall have a right to clean air and water, and a healthful environment." This provides a broader context for the planned transition from steam to community thermal as RDH works to reduce environmental impacts while fulfilling its ongoing commitment to provide cost-effective and environmentally responsible thermal solutions for its members.

6 Community Heat Pump System Impact

Implementing a community heat pump system in downtown Rochester will provide a clean electric heating solution to the system's members. This scoping study reveals various building and heating/cooling system types within the thermal network area. The system schematically designed and analyzed within this study uses an untouched thermal source/sink with the sewer heat recovery, enabiling the delivery of clean heat to a developed urban area.

6.1 Baseline and Proposed Solutions Comparison

A baseline solution was developed to demonstrate the impact of implementing a less invasive electric solution. The baseline solution uses electric boilers to provide steam or hot water within the participant buildings. RDH's plant would be outfitted with electric boilers, providing RDH participants with steam and on-site electric boilers for non–RDH members. However, because this solution would require a new high-voltage feed to service the RDH plant, it is less feasible. The total estimated cost of the baseline project is $61,273,304, compared to the total estimated cost of $68,363,424 for the community heat pump system, including the building retrofits.

Table 6 compares the 30-year life-cycle cost of the proposed community heat pump system with those of the electric boiler baseline option. The assumptions for the analysis include project cost, operating costs, project loan discount rate, inflation utility costs, maintenance costs, incentives, and the application of the phased approach. The net present value of the net cash flow of the baseline and proposed projects is $-16,398,710.

Table 6. Life-Cycle Cost Analysis Snapshot Summary

Cash Flow Analysis Snapshot Summary				
Year		2026	2030	2055
Electric Boilers	Steam	$848,428	$5,623,784	$8,921,506
	Natural Gas Costs	$50,120	$0	$0
	Carbon Costs	$35,637	$0	$0
	Electricity Costs	$170,649	$1,674,902	$3,156,717
	Water Costs	$9,295	$33,509	$63,155
	Chemical Costs	$12,271	$44,237	$83,375
	Wastewater Costs	$8,656	$31,203	$58,809
	Capital Costs Spent	$0	$0	$0
	Capital Costs Expensed	$0	$106,377	$106,377
	Total	**$1,135,057**	**$7,514,013**	**$12,389,939**
District Thermal System	RDT Charges	$4,062,407	$6,004,087	$9,218,158
	Electricity Costs	$373,345	$1,345,868	$2,536,581
	Capital Costs Spent	$4,107,841	$734,459	$0
	Capital Costs Expensed	$256,039	$874,241	$1,017,143
	Total	**$4,691,791**	**$8,224,196**	**$12,771,882**
Total Diff in Cash Flow		*($3,556,735)*	*($710,183)*	*($381,943)*

6.1.1 Sensitivity Analyses

Sensitivity analyses were conducted to highlight the factors with the greatest impact on the financial analysis. Each sensitivity analysis shows the impact each variable has on the net present value of the district thermal system project. These analyses illustrate how each variable affects the project's net present value.

The variable with the least impact on the net present value of the financial analysis is the social cost of carbon because of the way the financial analysis is set up with an electric solution as the baseline case. The social cost of carbon is shown as a cap-and-invest auction assessment or cost for using natural gas for space heating needs, whether within the participant's facility or through RDH-generated steam. Considering the social cost of carbon is important not only to comply with Climate Act requirements, but also to analyze the financial impact of continued natural gas use.

In the sensitivity analysis presented in Table 7, the impact of electricity rates and the social cost of carbon show the impact of utility costs within the financial analysis. The cost of electricity has a greater impact to the net present value of the investment because both the base case and proposed case both have an electric option with natural gas eliminated after the first five years. A 25% decrease in the electric rate will increase the net present value by $1.46 million. Conversely, the impact of the social cost of carbon is minimal because natural gas is eliminated in both the proposed and baseline scenarios. If a carbon tax is implemented, however, then natural gas usage would have a greater impact with the current systems.

Table 7. Electricity Cost and Social Cost of Carbon Sensitivity Analysis

Electric Cost and Socail Cost of Carbon		Electricity Cost (per MWh)						
		$16.35	$32.70	$49.05	*$65.40*	$81.75	$98.10	$114.45
Social Cost of Carbon Rate ($/tonne of CO2)	$0.00	($13,468,562)	($14,929,577)	($16,390,591)	($17,851,781)	($19,312,621)	($20,773,635)	($22,234,650)
	$26.44	($12,742,090)	($14,203,105)	($15,664,119)	($17,125,309)	($18,586,148)	($20,047,163)	($21,508,178)
	$39.66	($12,378,854)	($13,839,869)	($15,300,883)	($16,762,073)	($18,222,912)	($19,683,927)	($21,144,942)
	$52.88	($12,015,491)	($13,476,506)	($14,937,521)	*($16,398,710)*	($17,859,550)	($19,320,564)	($20,781,579)
	$66.10	($11,652,382)	($13,113,397)	($14,574,411)	($16,035,601)	($17,496,440)	($18,957,455)	($20,418,469)
	$79.32	($11,289,146)	($12,750,161)	($14,211,175)	($15,672,365)	($17,133,204)	($18,594,219)	($20,055,233)
	$149.46	($9,361,962)	($10,822,977)	($12,283,991)	($13,745,181)	($15,206,020)	($16,667,035)	($18,128,049)

The loan discount rate was assumed to be 4.8% based on a combination of market rate, the NYS Green Bank rate, and the Energy Infrastructure Reinvestment Program. A sensitivity analysis included loan interest rates at 1.5%, 3%, 4.8%, and 8%. When comparing the loan interest rates, decreasing the interest rate from 4.8% to 3% would increase the net present value by $5.5 million. In addition to the loan interest rate, the sensitivity analysis included the amount of capital expenses, representing how much of the project would have to be financed. The project's net present value will yield a positive result when capital expenses are 25% of the total cost ($10,959,602) and the loan interest rate is 1.5%. This sensitivity analysis indicates that this system will need sufficient funding and financing to yield a positive net present value and underscores the importance of sufficient financial resources to ensure the project's viability and economic feasibility.

Table 8. Loan Combined Discount Rate and Capital Expenses Sensitivity Analysis

Discount Rate and Capital Expenses		Capital Expenses					
		$43,838,408	$32,878,806	*$26,686,886*	$21,919,204	$10,959,602	$0
Discount Rate	*1.50%*	($14,755,896)	($9,618,418)	($6,715,863)	($4,480,941)	$656,537	$5,794,014
	3.00%	($20,707,424)	($14,412,626)	($10,856,211)	($8,117,827)	($1,823,029)	$4,471,769
	4.80%	($28,674,470)	($20,830,417)	*($16,398,710)*	($12,986,365)	($5,142,313)	$2,701,739
	8.00%	($44,696,200)	($33,736,598)	($27,544,677)	($22,776,996)	($11,817,394)	($857,791)

The change in operating costs shows a substantial impact on the net present value of the district thermal system. A 25% reduction in annual operating costs are decreased 25% results in a net present value increase of $5.917 million, or a 36% impact. Throughout the analysis, operating costs were shown to have a significant financial impact on to the district thermal system. When engaging this business model, accurately defining and quantifying annual operating costs is essential to understanding the system's true costs. Reducing annual operating costs will directly decrease the thermal energy rate to the members.

Table 9. Loan Combined Discount Rate and Annual Operating Costs Sensitivity Analysis

Discount Rate and Operating Costs		Total Operating Costs				
		$985,038	$1,185,038	$1,585,038	$1,985,038	$2,185,038
Discount Rate	*1.50%*	$2,159,991	($798,627)	($6,715,863)	($12,633,099)	($15,591,717)
	3.00%	($1,980,357)	($4,938,975)	($10,856,211)	($16,773,447)	($19,732,065)
	4.80%	($7,522,856)	($10,481,474)	*($16,398,710)*	($22,315,946)	($25,274,564)
	8.00%	($18,668,823)	($21,627,441)	($27,544,677)	($33,461,913)	($36,420,531)

Based on the sensitivity analyses results, changing the shown variables by 1% of their assumed values results in the impact shown in Table 10. For example, a 1% decrease in capital expenses, from the assumed value of $266,868, would increase the net present value of the project by $191,005. Based on this high-level impact analysis, the least impactful variables are the social cost of carbon and electricity costs. Conversely, the discount rate, capital expenses, and operating costs all have significant impact on the net present value, with operating costs having the highest impact based on the comparative decrease compared to the other variables.

Table 10. Net Present Value Change per Percent Change of Assumption

NPV Change per Percent Change of Assumption		
Electricity Cost	$	58,441
Social Cost of Carbon	$	14,530
Discount Rate	$	151,944
Capital Expenses	$	191,005
Operating Costs	$	234,476

6.1.2 Energy Consumption

The estimated energy consumption of the community heat pump system totals 17,022,883 kWh, including the participant booster heat pumps and pumping consumption. The greenhouse gas emissions from this system total 1,804 metric tons of CO_2, calculated using the Upstate eGrid 2020 total equivalent CO_2 emissions 1.06×10^{-4} metric tons of CO_2 per kWh. This is an estimated 5,934 equivalent tons of CO_2 emissions improvement annually compared to the current natural gas systems. The total estimated emissions saved over the 30-year analysis period totals 178,018 metric tons of CO_2 based on current electric sources.

7 Conclusion

The community heat pump project alone may not be financially viable for the RDH to implement independently. However, forming a partnership with the local utility and/or other clean energy investors could change this assessment. A partnership with RG&E could potentially benefit both entities because under the Utility Thermal Energy Network and Jobs Act, the utility is required to develop one or more pilot projects. Both RDH and RG&E are looking for cost-effective strategies to meet New York State's emission reduction mandates, which would make a partnership mutually beneficial.

The proposed community heat pump system is a potential solution that would allow buildings—commercial, industrial, and residential—within the project area to transition from fossil fuels to electric heating. The existing buildings' systems could be retrofitted and new construction could connect to a more efficient clean heating solution rather than the individual electric heating options given the load diversity within the system. In addition to providing a clean heat solution to the buildings, the proposed community heat pump system scope area is located in a disadvantaged community. Implementing this project would benefit the community by decreasing the greenhouse gas emissions associated with natural gas consumption. A community heat pump system within this location would be accessible to various city and county buildings, allowing for their buildings' systems to align with the State's emissions reduction goals as well as applicable city and county climate action plans.

The location of the community heat pump system's central plant, sewer heat recovery system, and distribution system will require an in-depth regulatory review during the design phase. Establishing a diverse team including RDH, city and county officials, legal consultants, and potential partners is essential to ensure that regulatory hurdles are analyzed and resolved. During the scoping analysis, both the city and county have expressed interest in adopting green solutions to provide heating and cooling within their facilities, which not only represents an investment in the future of the area's decarbonization and electrification efforts, but also aligns with New York State's goals.

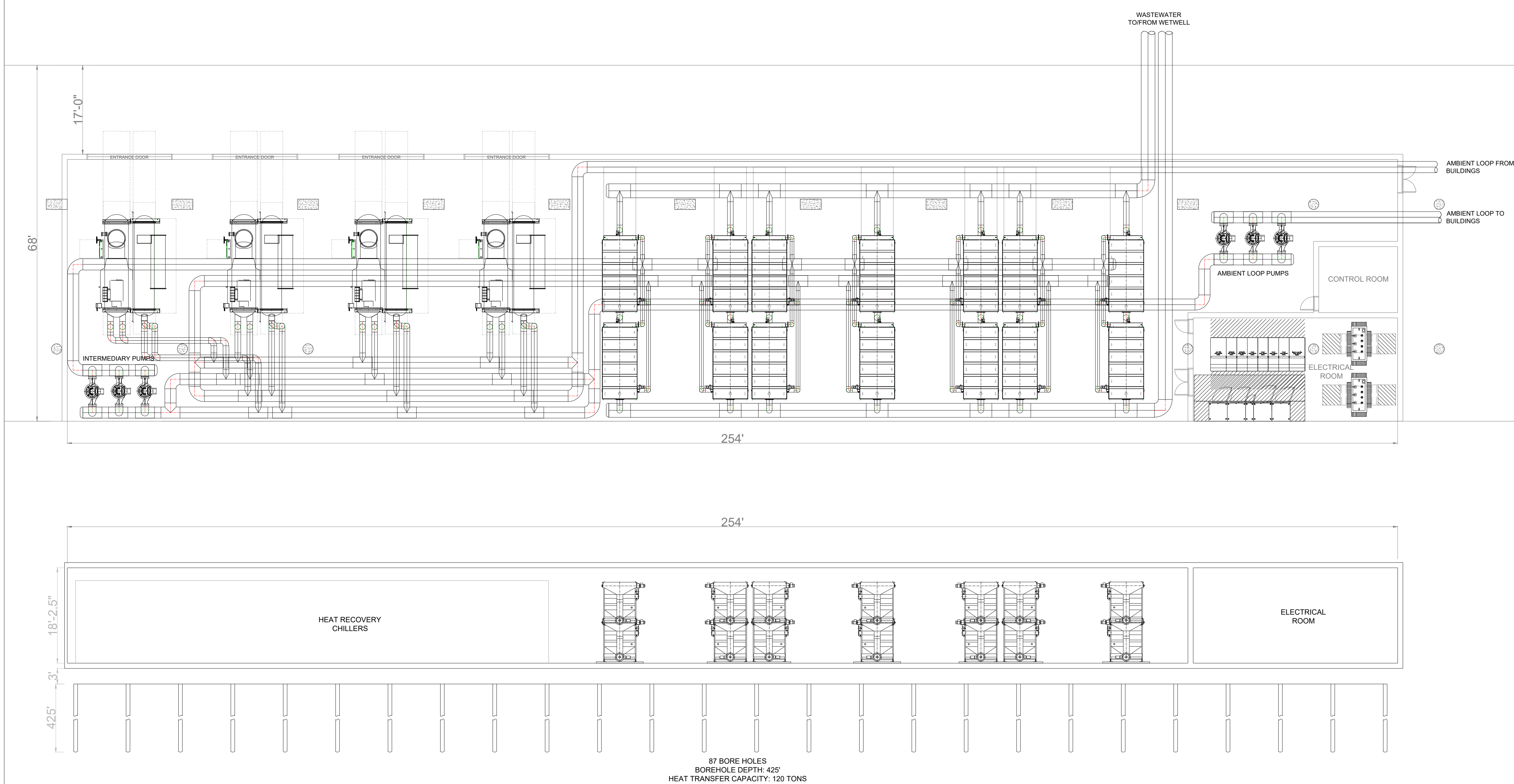
Securing low-interest financing coupled with substantial upfront funding from grants, incentives, and potential investors would significantly improve the financial viability of the proposed district thermal system. Lower interest rates for any project financing would improve its financial outlook for the district system and its potential members. Retrofitting member buildings will require major capital investments, requiring low-interest financing, grants, and incentives. The true cost to the potential members will have to be determined with more information on their buildings and the specifics of the available incentives, grants, and tax credits.

As the Climate Act requirements and the emerging New York State Cap-and-Invest program continue to evolve, the RDT team will continue to evaluate the feasibility of the system. In addition to the state-level funding and emission reduction benefits, potential federal funding opportunities, such as those offered through the Inflation Reduction Act of 2022, will be explored as they become available and better defined. Preliminary regulations indicate that sewer heat recovery technology and central plant equipment may not qualify for the Inflation Reduction Act's tax credit without a favorable advisory opinion or clarifying guidance from the U.S. Department of the Treasury, allowing for a tax credit of around 25% to 30%. This and other tax credits will need to be further defined and clarified as the project moves steps toward implementation.

The analysis team sees sewer heat recovery and geothermal energy as a promising opportunity to deliver clean heating and cooling to buildings in downtown Rochester. This approach could be scalable and applicable to other urban areas across the state and nationwide. New York State has established ambitious greenhouse gas emission reduction targets that will impact all sectors of its economy. Implementing sewer heat recovery in Rochester could serve as a viable solution for electrification efforts in the region.

The analysis team believes that using sewer heat recovery and geothermal energy is an opportunity to provide clean heating and cooling to buildings in the downtown Rochester. This approach potentially could be scalable and replicated in other urban areas throughout the state and nationwide. New York State has established greenhouse gas emission reduction plans that will impact all sectors of the economy. Using sewer heat recovery for Rochester could serve as a viable option for electrification.

Appendix A. Central Plant Drawings



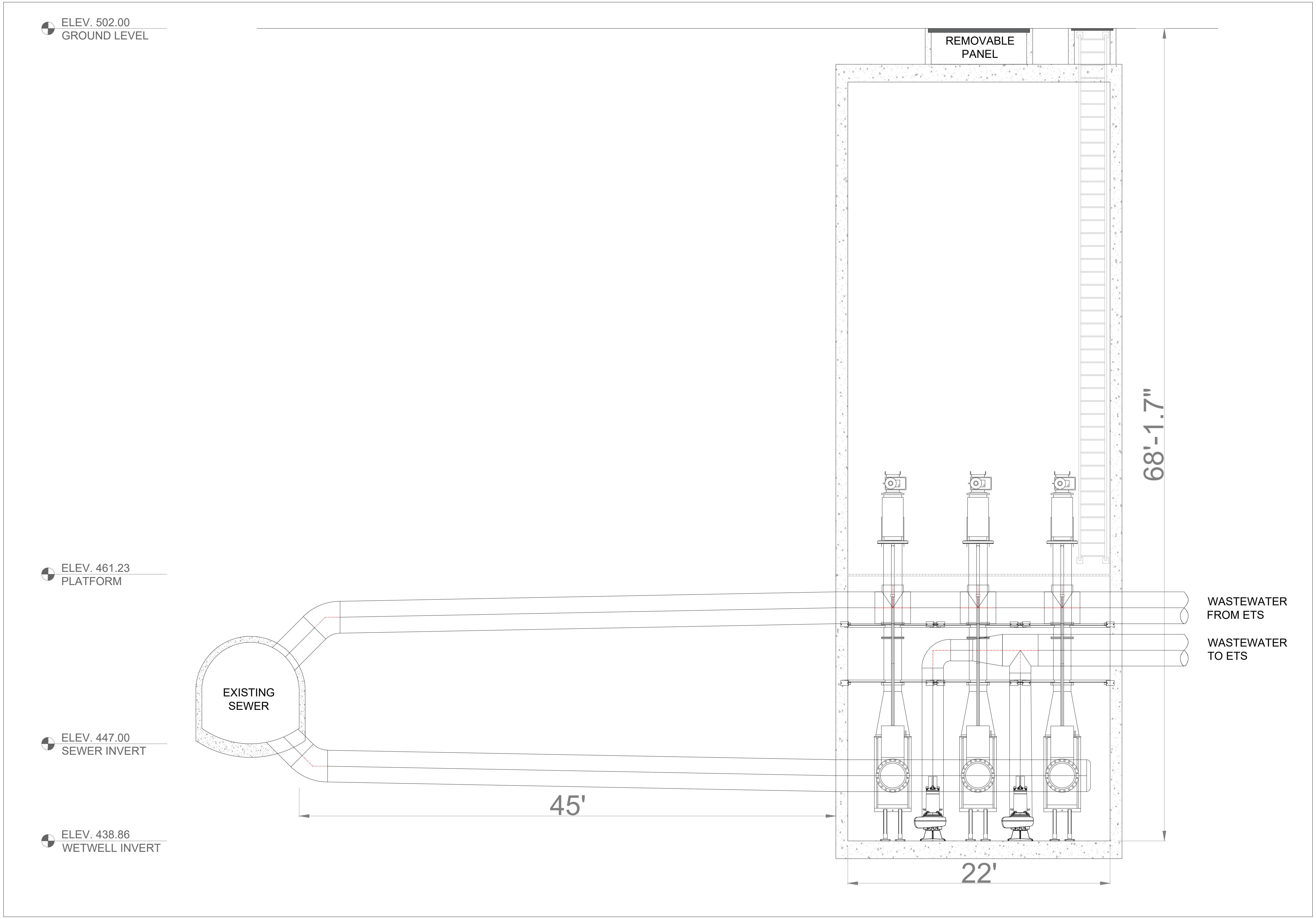
1
M-1
ENERGY TRANSFER STATION LAYOUT

1	PRELIMINARY DIAGRAM	01/10/2023
NO.	REVISION DISCRIPTION	MM/DD/YY

N

Noventa
REIMAGINING ENERGY

PROJECT ROCHESTER DISTRICT HEATING - WASTEWATER ENERGY TRANSFER SYSTEM	DRAWN BY: C.K. CHECKED BY: S.C. SCALE:
DRAWING TITLE ENERGY TRANSFER STATION	DRAWING NO.: M-1



1
M-3
WETWELL LAYOUT

NO.	REVISION DISCRIPTION	MM/DD/YY
1	PRELIMINARY DIAGRAM	01/10/23

Noventa
REIMAGINING ENERGY

PROJECT
ROCHESTER DISTRICT HEATING - WASTEWATER ENERGY TRANSFER SYSTEM

DRAWN BY:
C.K.

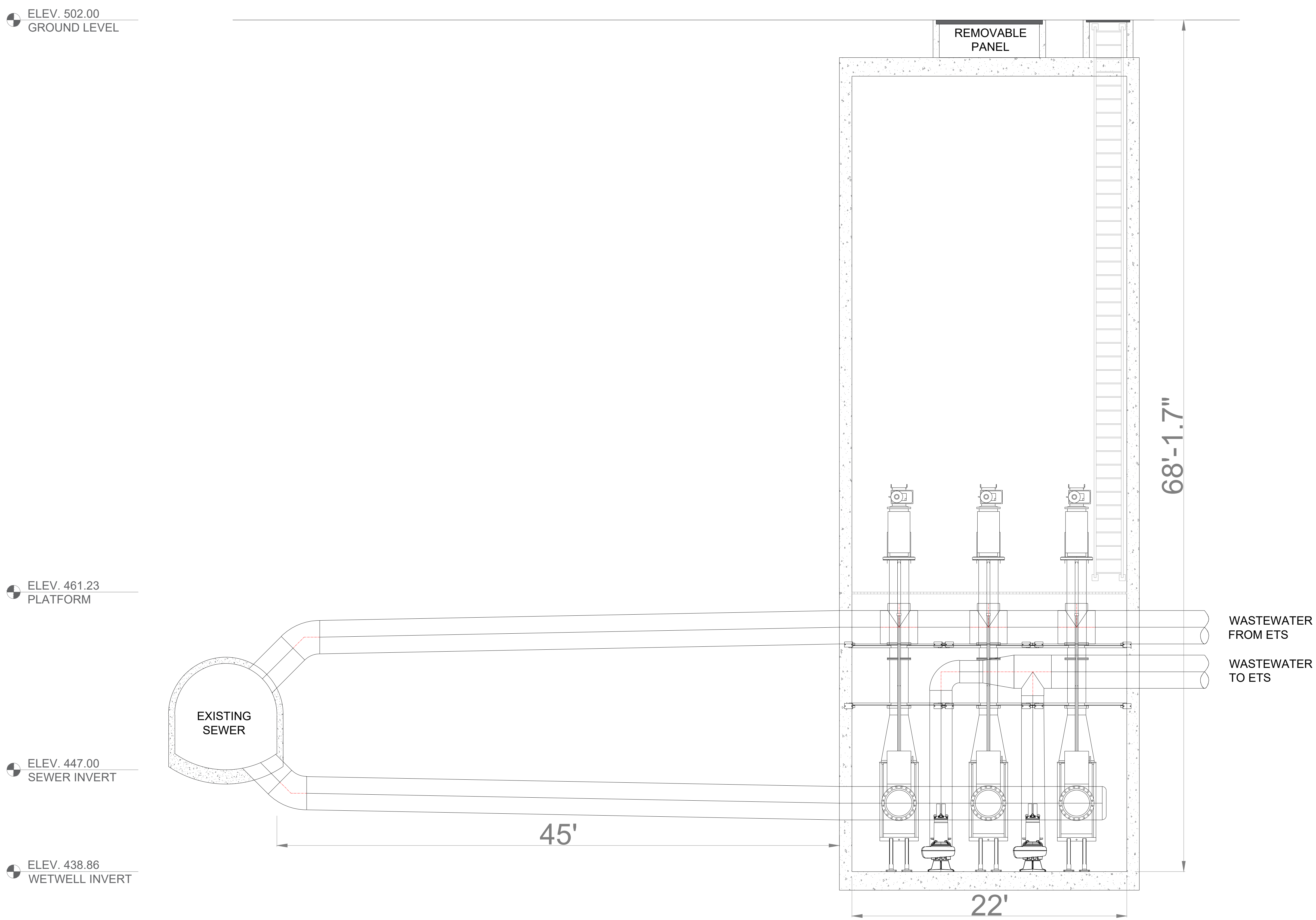
CHECKED BY:
S.C.

SCALE:

DRAWING TITLE
WETWELL LAYOUT

DRAWING NO.:
M-3

Appendix B. Participant Building Model Assumptions



1
M-3

WETWELL LAYOUT

NO.	REVISION DISCRIPTION	MM/DD/YY
1	PRELIMINARY DIAGRAM	01/10/23

Noventa
REIMAGINING ENERGY

PROJECT: ROCHESTER DISTRICT HEATING - WASTEWATER ENERGY TRANSFER SYSTEM

DRAWN BY: C.K.

CHECKED BY: S.C.

SCALE:

DRAWING TITLE: WETWELL LAYOUT

DRAWING NO.: M-3

City of Rochester, Blue Cross Arena

Characteristic	Description
Address	100 Exchange Boulevard
Vintage	Built 1955
Floor Area and Space Type Breakout	Conference / Convention Center: 255,540 sq. ft.
Number of Floors	3
Wall Construction and R-Value	Brick, Concrete, Glass
Roof Construction and R-Value	Reinforced Concrete
Glazing Type	Double Pane
Lighting Power Density	Lobby: 1.77 W/sq ft Office: 1.1 W/sq ft Retail Sales: 2.38 W/sq ft Corridor: .57 W/sq ft Restrooms: .77 W/sq ft Storage: 1.19 W/sq ft Mechanical/Electrical Room: .81 W/sq ft
Plug Load Density	Theater: .25 W/sq ft
Operating Hours	M-F 9am to 9pm, Sat. 9am to 10pm, Sun. 11am to 10pm
HVAC System Type	Standard VAV with HW reheat; Chiller
Existing RDH Customer? (Yes/No)	Yes: District steam loop
Thermostat Setpoints	Cooling 75 °F and Heating 68 °F
Misc. Notes	Modeled to utility bills from 2021

The Blue Cross Arena is an arena that holds events throughout the year including concerts, the American Hockey League games, and other events. Utility data and building information was gathered through conversations with the City's facilities staff, a past energy study, and available public property information. The building uses air handlers with hot water and chilled water coils to heat and cool their facility. The hot water (including domestic hot water) is heated by RDH district steam. Space cooling chilled water is provided by the Monroe County Civic Center chilled water plant. Utility bills were provided by the City of Rochester and RDH. The electric, district steam, and chilled water information was used to understand the existing building energy consumption compared to the modeled consumption results.

City of Rochester, RCSD

Characteristic	Description
Address	131 West Broad Street
Vintage	Built 1979
Floor Area and Space Type Breakout	Office: 96,216 sq ft
Number of Floors	3
Wall Construction and R-Value	Reinforced Concrete
Roof Construction and R-Value	Reinforced Concrete
Glazing Type	Double Pane
Lighting Power Density	Computer Server Room: 1.1 W/sq ft Office: 1.1 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Conference Room: .92 W/sq ft Mechanical/ Electrical Room: .81 W/sq ft
Plug Load Density	Office: .7 W/sq ft
Operating Hours	M-F 8am to 5pm, Sat. - Sun. Closed
HVAC System Type	Standard VAV with HW reheat
Existing RDH Customer? (Yes/No)	No
Thermostat Setpoints	Cooling: 72 °F and Heating 68 °F
Misc. Notes	No electric bills provided for model tuning

The RCSD administration building is located at 131 West Broad Street. No electric data was provided for the Rochester City School District office building, nor is it part of the RDH steam loop. The model was tuned to that of a typical office schedule. No site walkthrough or meeting with building manager was held However, the City's facilities team were able to share some general information of the building's systems, but no further detail was able to be shared due to the City not being responsible for maintenance of the building. Systems in place include a CHW/HW system, AHUs, and data center cooling. Building shell information such as shape and size were estimated from Google Earth, Bing Maps, and the Rochester City Property Information database.

City of Rochester, Public Safety

Characteristic	Description
Address	185 Exchange Boulevard
Vintage	Built 2002
Floor Area and Space Type Breakout	Office: 155,000
Number of Floors	8
Wall Construction and R-Value	Reinforced Concrete, R-6
Roof Construction and R-Value	Reinforced Concrete
Glazing Type	Double Pane
Lighting Power Density	Office: 1.24 W/sq ft Computer Server Room: 1.20 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Conference Room: .92 W/sq ft Mechanical/Electrical Room: .81 W/sq ft Storage: 1.19 W/sq ft
Plug Load Density	Office: .7 W/sq ft
Operating Hours	M-F and Sat. Sun 24/7
HVAC System Type	Water Loop, Water-Source Heat Pump
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling 72 °F and Heating 68 °F
Misc. Notes	

The City's Public Safety Building is an existing RDH steam member. Utility data was provided and used to assist tuning the existing building model. Representatives from the City's facilities department provided general HVAC system, occupancy, and operation information to use. Systems in place include steam to hot water heat exchanger supplying WSHPs, steam radiation and steam coils. DHW is also heated by RDH's district steam loop. Although some areas have a schedule, most of the building is occupied 24/7.

City of Rochester, City Hall

Characteristic	Description
Address	30 Church Street
Vintage	Built 1905
Floor Area and Space Type Breakout	Office: 67,666 sq ft
Number of Floors	5
Wall Construction and R-Value	Brick: R-5, Reinforced Concrete: R-6
Roof Construction and R-Value	Reinforced Concrete: R-10.5
Glazing Type	Double Pane
Lighting Power Density	Conference Room: .92 W/sq ft Office: 1.10 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Storage: 1.19 W/ sq ft Mechanical/Electrical Room: .81 W/sq ft
Plug Load Density	Office: .7 W/sq ft
Operating Hours	M - F: 5am to 9pm, Sat. and Sun.: Closed
HVAC System Type	Water Loop, Water-Source Heat Pump
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 72 °F and Heating 68 °F
Misc. Notes	Supply fans are under default setting, assumed. Fans are assumed to cycle throughout unoccupied times.

Rochester's City Hall was built in 1905 and had an extension built in 1970. Building information was gathered through conversations with the City's facilities representatives, Google Earth, Bing Maps, and the Rochester City Property Information database. Utility information was provided and used to assist tuning the building model. General HVAC information and space use was used to build the energy model. City Hall is an existing RDH member and uses district steam to heat their building through water-source heat pumps and air handlers.

City of Rochester, Bausch and Lomb Library

Characteristic	Description
Address	114 South Avenue
Vintage	Built 1996
Floor Area and Space Type Breakout	Museum: 124,200 sq ft
Number of Floors	4
Wall Construction and R-Value	Reinforced Concrete: R-13
Roof Construction and R-Value	Reinforced Concrete: R-18
Glazing Type	Double Pane
Lighting Power Density	Library: 1.00 W/sq Library (reading areas): .90 W/sq ft Lobby: 1.30 W/sq ft Office: 1.10 W/sq ft Computer Room: .60 W/sq ft Restrooms: .90 W/sq ft
Plug Load Density	Library: 1.00 W/sq ft
Operating Hours	M-Th. 9am to 9pm, F-Sat. 9am to 5pm, Sun. 1pm to 5pm
HVAC System Type	Water Loop, Water-Source Heat Pump
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 72 °F and Heating: 68 °F
Misc. Notes	

The Bausch and Lomb Library is a city owned public library that was built in 1996. Building information, including building drawings, was provided by the City of Rochester's facilities representatives. The building is primarily heated and cooled by water-sourced heat pumps. Utility bills were provided and used to assist model tuning. The library is also a RDH member and uses district steam to heat their domestic hot water.

City of Rochester, Rundel Library

Characteristic	Description
Address	115 South Avenue
Vintage	Built 1941
Floor Area and Space Type Breakout	Library: 133,000 sq ft
Number of Floors	4
Wall Construction and R-Value	Reinforced Concrete: R-6
Roof Construction and R-Value	Reinforced Concrete: R-12
Glazing Type	Double Pane
Lighting Power Density	Library: .80 W/sq ft Corridor: .50 W/sq ft Office: 1.10 W/sq ft Restrooms: .90 W/sq ft Conference Room: 1.30 W/sq ft Computer Room: 1.50 W/sq ft
Plug Load Density	Library: 1.00 W/sq ft
Operating Hours	MWF 9am to 5pm, TR 9am to 9pm, Sat. 9am o 5pm, Sun. 9am to 5pm
HVAC System Type	Multizone Air Handler with HW Heat
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 74 °F and Heating 70 °F
Misc. Notes	

Rundel Library is a city-owned public library built in 1941 that operates as an archive space for Monroe County and the City of Rochester. A lot of the floor area within this library is dedicated to office space and storage for the archives. There are public stacks and reading areas available. Building information from floor plans and conversations with the facilities staff was used to create an existing building model. Most of the heating and cooling is done through air handlers and baseboard steam heating. Chilled water is provided through a river-water cooled chiller that utilizes river water through the library's chiller condenser. Utility bills were provided and assisted in tuning the existing model. Rundel is a RDH district steam member and utilizes steam for space heating and domestic hot water.

City of Rochester, Rochester Convention Center

Characteristic	Description
Address	123 East Main Street
Vintage	Built 1987
Floor Area and Space Type Breakout	Convention Center: 188,000 sq ft
Number of Floors	1
Wall Construction and R-Value	Reinforced Concrete: R-19
Roof Construction and R-Value	Metal Frame: R-30
Glazing Type	Double Pane
Lighting Power Density	Convention/Meeting Center: 1.27 W/sq ft Conference Room: .92 W/sq ft Office: 1.10 W/sq ft Corridor: .57 W/sq ft Kitchen/Food Preparation: 1.19 W/sq ft Restrooms: .77 W/sq ft
Plug Load Density	Convention Center: .6 W/sq ft
Operating Hours	M-F 9am to 9pm, Sat. 9am to 11pm, Sun. 10am to 5pm
HVAC System Type	Multizone Air Handler with HW Heat
Existing RDH Customer? (Yes/No)	No
Thermostat Setpoints	Cooling: 72 °F and Heating 70 °F
Misc. Notes	

The Rochester Convention Center is a city-owned event space that hosts various events throughout the year within a mix of large and smaller event spaces. Available mechanical plans were used to understand the facility's mechanical systems. Air handlers with hot water and chilled water coils are used to provide conditioned air throughout the facility's spaces. Utility bills were provided for the Rochester Convention Center, but 2021 did not represent normal operation due to the COVID-19 pandemic, therefore the utility bills were not followed too closely for tuning the existing building model.

Monroe County, Public Safety

Characteristic	Description
Address	130 Plymouth Avenue South
Vintage	Built 1962
Floor Area and Space Type Breakout	Office: 294,000 sq ft
Number of Floors	8
Wall Construction and R-Value	Reinforced Concrete: R-6
Roof Construction and R-Value	Reinforced Concrete: R-10.5
Glazing Type	Double Pane
Lighting Power Density	Storage: 1.19 W/sq ft Office: 1.10 W/sq ft Corridor: .57 W/sq ft Lobby: 1/52 W/sq ft
Plug Load Density	Office: .7 W/sq ft
Operating Hours	M-F, Sat./Sun. 24/7
HVAC System Type	Multizone Air Handler with HW Heat; Chiller
Existing RDH Customer? (Yes/No)	Yes
Floor Area and Space Type Breakout	Cooling: 72 °F and Heating: 68 °F
Misc. Notes	Civic center steam and electric meter

Monroe County's Public Safety Building was built in 1962 and is the oldest building in the county jail's facility. General building information was gathered through conversations with facility staff and provided floor plans. There are air handler units throughout the building with steam and chilled water coils. Steam is provided by RDH through the shared Civic Center steam meter and chilled water is provided by the Civic Center's chilled water plant. The Public Safety Building's utilities are a part of the Civic Center's shared meters. The provided information was used to create an existing building model.

Monroe County, Hall of Justice

Characteristic	Description
Address	99 Exchange Boulevard
Vintage	Built 1993
Floor Area and Space Type Breakout	Office: 351,621 sq ft
Number of Floors	7
Wall Construction and R-Value	Reinforced Concrete: R-6
Roof Construction and R-Value	Reinforced Concrete: R-10.5
Glazing Type	Double Pane
Lighting Power Density	Office: 1.24 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Courtrooms: 1.98 W/sq ft
Plug Load Density	Office: .7 W/sq ft
Operating Hours	M-F 8am to 5pm, Sat and Sun. Closed
HVAC System Type	Standard VAV with HW Reheat: Chiller
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 72 °F and Heating 68 °F
Misc. Notes	Civic Center steam and electric meter

The Hall of Justice is a part of the Monroe County Civic Center and is comprised mostly of offices and court rooms. General building information was gathered through conversations with facility staff and provided floor plans. There are air handler units throughout the building with steam and chilled water coils. Reheats are supplied by hot water. Steam is provided by RDH through the shared Civic Center steam meter and chilled water is provided by the Civic Center's chilled water plant. The Hall of Justice's utilities are a part of the Civic Center's shared meters. This building has an estimated 125 kW solar array located on the roof. Provided information was used to create an existing building model. The building model was modeled based on normal operation, forgoing the limited operation that was experienced during the COVID-19 pandemic.

Monroe County, Old Jail

Characteristic	Description
Address	130 South Plymouth Avenue
Vintage	Built 1970
Floor Area and Space Type Breakout	High-Rise Hotel: 188,114
Number of Floors	10
Wall Construction and R-Value	Reinforced Concrete
Roof Construction and R-Value	Reinforced Concrete
Glazing Type	Double Pane
Lighting Power Density	Hotel/Motel: 1.46 W/sq ft Convention and Meeting Center: 1.27 W/sq ft Corridor: .57 W/sq ft Mechanical/Electrical Room: .81 W/ sq ft Office: 1.10 W/sq ft
Plug Load Density	Hotel: .25 W/sq ft
Operating Hours	M-F, Sat./Sun. 24/7
HVAC System Type	AHUs with Steam Preheat and HW VAVs
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 76 °F and Heating 70 °F
Misc. Notes	A part of the Civic Center meters

Monroe County's jail is comprised of two buildings, one being tagged as the "Old Jail" and the other being the "New Jail." The Old Jail is a facility that has a mixture of correction facility and office space uses. General facility information was gathered through floor plans and conversations with facilities staff. Heating and cooling are provided through air handlers' steam coils and chilled water coils, respectively. The top 6 floors are not cooled within this building. The Old Jail's utilities are a part of the Civic Center's shared meters. Provided information was used to create an existing building model.

Monroe County, New Jail

Characteristic	Description
Address	130 South Plymouth Avenue
Vintage	Built 1992
Floor Area and Space Type Breakout	Hotel/Motel: 228,179 sq ft
Number of Floors	10
Wall Construction and R-Value	Reinforced Concrete: R-6
Roof Construction and R-Value	Reinforced Concrete: R-9
Glazing Type	Double Pane
Lighting Power Density	Hotel/Motel: 1.46 W/sq ft Convention/Meeting Center: 1.27 W/sq ft Corridor: .57 W/sq ft Office: 1.10 W/sq ft Kitchen and Food Prep.: 1.19 W/sq ft
Plug Load Density	Hotel: .25 W/sq ft
Operating Hours	M-F, Sat., Sun. 24/7
HVAC System Type	Standard VAV with Reheat
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 76 °F and Heating 70 °F
Misc. Notes	Civic Center steam and electric meter

Monroe County's New Jail is a correctional facility that is a part of the Monroe County Civic Center. The building is heated by steam coils and cooled by chilled water coils in an air handler and HW VAV system. Steam is provided by the RDH steam meter and chilled water is provided by the Civic Center chilled water plant. Building information for modeling was gathered through floor plans and conversations with Monroe County's facilities group. As an additional building load, this facility has a large kitchen that provides cooking and food for jails. The kitchen utilizes steam kettles (with steam provided by RDH) and some natural gas equipment. The New Jail's utilities are a part of the Civic Center's shared meters.

Monroe County, Crime Lab

Characteristic	Description
Address	85 West Broad Street
Vintage	Built 2011
Floor Area and Space Type Breakout	43,078 sq ft
Number of Floors	Office: 43,424 sq ft
Wall Construction and R-Value	Reinforced Concrete
Roof Construction and R-Value	Reinforced Concrete
Glazing Type	Double Pane
Lighting Power Density	Lab: 3.19 W/sq ft Office: 1.10 W/sq ft Corridor: .57 W/sq ft Lobby: 1.00 W/sq ft Restrooms: .77 W/sq ft Storage: 1.19 W/sq ft
Plug Load Density	Lab: 1.00 W/sq ft
Operating Hours	M-F: 7am to 5pm, Sat. 9am to 4pm, Sun. Closed
HVAC System Type	Standard VAV with HW reheat; Chiller
Existing RDH Customer? (Yes/No)	No
Thermostat Setpoints	Cooling: 72 °F and Heating: 68 °F
Misc. Notes	

Monroe County's Crime Lab was built in 2011 and is a stand-alone county building. Laboratory and office space make up most of the floor area for this facility. Floor plans and building information provided by the county's facilities group was used to make the existing building model. Space heating and cooling are provided by air handlers, with hot/chilled water coils, and baseboard hot water radiation. The Crime Lab is not part of the RDH system and hydronic hot water is provided through natural gas fired boilers. The lab spaces have exhaust fans that operate throughout the day. It was reported that this facility was open with normal occupancy throughout the pandemic, therefore the provided utility information was used to assist in tuning the building model.

Monroe County, Watts Building

Characteristic	Description
Address	47 South Fitzhugh Street
Vintage	Built 1970
Floor Area and Space Type Breakout	Office: 56,477 sq ft
Number of Floors	10
Wall Construction and R-Value	Reinforced Concrete: R-9
Roof Construction and R-Value	Reinforced Concrete: R-6
Glazing Type	Double Pane
Lighting Power Density	Office: 1.10 W/sq ft Kitchen and Food Prep.: .80 W/sq ft Lobby: 1.00 W/sq ft Restrooms: .77 W/sq ft Conference Room: .92 W/sq ft Copy Room: .90 W/sq ft
Plug Load Density	Office: .7W/sq ft
Operating Hours	M-F: 7am to 6pm, Sat./Sun.: Closed
HVAC System Type	Water-Source Heat Pump
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 70 °F and Heating: 68 70 °F
Misc. Notes	

The Watts building is a Monroe County office building that is a part of the Civic Center. Floor plans and building information was provided by the county's facility staff. Watts is heated and cooled by water-sourced heat pumps that utilize RDH's district steam to heat the heat pump's ambient loop. Steam is provided through the Civic Center's RDH steam meter and the facility has its own electric meter. The utility information was used to tune the existing building model, accounting for the occupancy change during the pandemic.

Monroe County, Office Building

Characteristic	Description
Address	39 West Main Street
Vintage	Built 1896
Floor Area and Space Type Breakout	Office: 116,484
Number of Floors	7
Wall Construction and R-Value	Reinforced Concrete: R-9
Roof Construction and R-Value	Reinforced Concrete: R-6
Glazing Type	Double Pane
Lighting Power Density	Office (open): 1.24 W/sq ft Office (executive/private): 1.49 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Conference Room: .92 W/sq ft
Plug Load Density	Office: .7 W/sq ft
Operating Hours	M-F: 7am to 7pm, Sat.: 9am to 4pm, Sun.: Closed
HVAC System Type	Water-Source Heat Pump
Existing RDH Customer? (Yes/No)	No
Thermostat Setpoints	Cooling: 72 °F and Heating 70 °F
Misc. Notes	

The Monroe County office building located at 39 West Main Street has various county government and service offices. Floor plans and building information was provided by Monroe County and their facilities staff. Spaces are heated by a combination of water source heat pumps and air handlers. The hot water is heated by district steam provided by RDH. This building has its own chilled water generation. RDH steam and electric utility bills were used to assist with tuning the existing building models.

Monroe County, City Place

Characteristic	Description
Address	50 West Main Street
Vintage	Built 1890
Floor Area and Space Type Breakout	Office: 269,764 sq feet
Number of Floors	7
Wall Construction and R-Value	Reinforced Concrete
Roof Construction and R-Value	Reinforced Concrete
Glazing Type	Double Pane
Lighting Power Density	Office: 1.24 W/sq ft Corridor: 0.57 W/sq ft Lobby: 1.52 W/sq ft Conference Room: 0.92 W/sq ft
Plug Load Density	Office: 0.7 W/sq ft
Operating Hours	M-F: 8 AM to 5 PM, Sat.: 9 AM to 4 PM, Sun: Closed
HVAC System Type	VAV system with HW reheat
Existing RDH Customer? (Yes/No)	No
Thermostat Setpoints	Cooling: 72 °F and Heating 70 °F
Misc. Notes	

City Place is an office building Monroe County built in 1890 and purchased by the county in 2018. Building information was gathered through conversations with the county's facility staff. The mechanical systems include a mix of water-source heat pumps, air handlers, and VRF heat pumps. There are natural gas fired boilers and a chiller that serve the hot water and chilled water systems. Electric and natural gas utility bills were provided by the county. Due to the COVID-19 pandemic, occupancy was inconsistent during the analysis period, therefore the building model was not tuned to closely follow the utility bills.

Frontier Communications, 120 North Plymouth Street and 95 North Fitzhugh

Characteristic	Description
Address	120 North Plymouth Avenue and 95 North Fitzhugh Street
Vintage	
Floor Area and Space Type Breakout	125,000 (N Plymouth) and 120,000 (N Fitzhugh)
Number of Floors	3 (N Fitzhugh) and 4 (N Plymouth)
Wall Construction and R-Value	Reinforced Concrete: R-10.5
Roof Construction and R-Value	Reinforced Concrete: R-6
Glazing Type	Double Pane
Lighting Power Density	Office: 1.10 W/sq ft IT/Telecom Equipment Room: 1.20 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Conference Room: .92 W/sq ft Mechanical/Electrical Room: .81 W/sq ft
Plug Load Density	Office: .75 W/ sq ft
Operating Hours	M-F, Sat./Sun.: 24/7
HVAC System Type	Standard VAV with HW reheat; Chiller
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Heating 76 °F and Heating: 68 °F
Misc. Notes	Properties combined within eQuest because of shared utilities

Frontier Communications own both 120 North Plymouth Street and 95 North Fitzhugh Street. Although these buildings are separate, they share district steam and chilled water together, therefore they were analyzed together for building energy modeling purposes. Each building has similar operations with a combination of office space and data centers throughout. Building information was gathered during an onsite staff with Frontier's onsite facilities staff. There is a combination of water-sourced and air-sourced equipment (including Liebert units) that operate to condition the data centers in both buildings. Air handlers with hot water and steam coils operate to heat/cool the office and common spaces. The space heating hot water is heated by district steam provided by RDH. Combined utility bills were used to assist in the tuning the energy model. There is an opportunity to utilize the data center heat rejection during the winter to provide heat to RDT Community Heat Pump System.

Frontier Communications, 63 Stone Street

Characteristic	Description
Address	63 Stone Street
Vintage	
Floor Area and Space Type Breakout	Office: 62,000 sq ft
Number of Floors	4
Wall Constuction and R-Value	Reinforced Concrete: R-9
Roof Construction and R-Value	Reinforced Concrete: R-6
Glazing Type	Double Pane
Lighting Power Density	Office: 1.10 W/sq ft IT/Telecom Equipment Room: 1.20 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Conference Room: 1.00 W/sq ft
Plug Load Density	Office: 1.25 W/sq ft
Operating Hours	M-F, Sat./Sun.: 8am to 5pm
HVAC System Type	Multizone Air Handler with HW Reheat, Chilled Water Coils
Existing RDH Customer? (Yes/No)	No
Thermostat Setpoints	Cooling 72 °F and Heating 70 °F
Misc Notes	

Frontier Communications also owns 63 Stone Street, and it is included in the proposed loop on the East side of the Genesee River. General building information was gathered during an onsite visit with Frontier's facilities staff. This facility mostly consists of office space with a data center that is half of the first floor. Space heating and cooling are provided by air handlers with hot and chilled water coils. The hot water is heated by steam boilers. Utility information was provided for this building, but the office space was near empty during the pandemic, therefore they were not used to tune the building energy model.

Oakgrove Companies, Wilder Building

Characteristic	Description
Address	1-9 East Main Street
Vintage	Built 1870
Floor Area and Space Type Breakout	Office: 61,910 W/sq ft
Number of Floors	11
Wall Construction and R-Value	Brick: R-7
Roof Construction and R-Value	Reinforced Concrete: R-12
Glazing Type	Double Pane
Lighting Power Density	Office: 1.10 W/sq ft Kitchen/Food Prep.: 1.20 W/sq ft Corridor: .50 W/sq ft Storage: .80 W/sq ft Mechanical/Electrical Room: 1.50 W/sq ft
Plug Load Density	Office: .22 W/sq ft
Operating Hours	M-F: 7am to 6pm, Sat./Sun.: 9am to 3pm
HVAC System Type	Packaged Single Zone DX and Steam Baseboard
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 75 °F and Heating: 70°F
Misc. Notes	

Information regarding the Wilder Building was obtained through meetings with the building owner, Oakgrove. The building is an office building with multiple tenants throughout. Space heating and cooling is done by air handlers with steam and DX coils. In addition, there are steam baseboard heat on the exterior zones with steam provide by RDH. Steam and electric data were provided by Oakgrove, but the building was a minimal occupancy during the pandemic. Due to the low occupancy, the utility bills were not utilized for building energy model tuning.

Oakgrove Companies, 17 East Main Street

Characteristic	Description
Address	17 East Main Street
Vintage	Built 1930
Floor Area and Space Type Breakout	Office: 18,577
Number of Floors	6
Wall Construction and R-Value	Reinforced Concrete: R-12
Roof Construction and R-Value	Reinforced Concrete: R-7
Glazing Type	Double Pane
Lighting Power Density	Office: 1.10 W/sq ft Kitchen/Food Prep.: 4.30 W/sq ft Dining Area: 1.70 W/sq ft Storage: .80 W/sq ft Corridor: .50 W/sq ft Restrooms: 1.00 W/sq ft
Plug Load Density	Office: .22 W/sq ft
Operating Hours	M-F: 7am to 6pm, Sat./Sun.: Closed
HVAC System Type	Packaged Single Zone DX and Steam Baseboard
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 77 °F and Heating: 72 °F
Misc. Notes	

Oakgrove Companies owns 17 East Main Street. 17 East Main Street is a multiple story building with restaurant space on the first and ground floor. The rest of the space is office space. The building is conditioned by small air handlers with DX cooling and RDH steam heating. Steam baseboard heat is used as supplemental heat on the exterior walls of the building. Utility bills were provided but not used in tuning due to the building having little occupancy during the analysis period.

Liberty Plaza

Characteristic	Description
Address	31 East Main Street
Vintage	Built 1900
Floor Area and Space Type Breakout	Office: 17,801 sq ft
Number of Floors	4
Wall Construction and R-Value	Reinforced Concrete
Roof Construction and R-Value	Reinforced Concrete
Glazing Type	Double Pane
Lighting Power Density	Office: 1.10 W/sq ft Corridor: .57 W/sq ft Lobby: 1.05 W/sq ft Restrooms: .77 W/sq ft Conference Rooms: .92 W/sq ft Mechanical/Electrical Room: .81 W/sq ft
Plug Load Density	Office: .7W/sq ft
Operating Hours	M-F: 9am to 5pm, Sat./Sun.: Closed
HVAC System Type	Standard VAV with HW Reheat, Chilled Water Coils
Existing RDH Customer? (Yes/No)	No
Thermostat Setpoints	Heating: 72 °F and Cooling: 70 °F
Misc. Notes	Utility data not accurate or building was unoccupied

Forester Corporation owns 31 East Main Street, the Liberty Plaza. It is a multiple floor office building with first floor retail spaces. No building information or floor plans were shared, therefore public property information and Google Earth was used to determine the floor area and building uses. 31 East Main Street had little occupancy and it was reflected in the utility bills, therefore the utility bills were not used in tuning the building model.

Talman Building

Characteristic	Description
Address	23-27 East Main Street
Vintage	Built 1900
Floor Area and Space Type Breakout	Office: 26,897 sq ft
Number of Floors	5
Wall Constuction and R-Value	Reinforced Concrete
Roof Construction and R-Value	Reinforced Concrete
Glazing Type	Double Pane
Lighting Power Density	Office: 1.10 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Conference Room: .92 W/sq ft Mechanical/Electrical Room: .81 W/sq ft
Plug Load Density	Office: 1.00 W/sq ft
Operating Hours	M-F: 7am to 6pm, Sat./Sun.: Closed
HVAC System Type	Multizone AHU with HW Reheat
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Cooling: 72 °F and Heating: 68 °F
Misc Notes	

The Talman Building located at 23-27 East Main Street is a multiple story office building. No building information or floor plans were shared, therefore public property information and Google Earth was used to determine the floor area and building uses. RDH provided steam consumption data for the Talman building. No other utility information was provided; therefore, the building energy model was tuned to include just the steam consumption data.

Terminal Building

Characteristic	Description
Address	37 South Fitzhugh Street
Vintage	Built 1920
Floor Area and Space Type Breakout	Multifamily Mid-Rise: 70,208 sq ft
Number of Floors	8
Wall Construction and R-Value	Reinforced Concrete: R-10.5
Roof Construction and R-Value	Reinforced Concrete: R-6
Glazing Type	Double Pane
Lighting Power Density	Residential: .5 W/sq ft Corridor: .57 W/sq ft Storage: 1.19 W/sq ft Office: 1.10 W/sq ft
Plug Load Density	Residential: .30 W/sq ft
Operating Hours	M-F: 5pm to 7am, Sat./Sun. 4pm to 9am
HVAC System Type	4-Pipe Fan Coils with HW Reheat
Existing RDH Customer? (Yes/No)	No
Thermostat Setpoints	Heating: 72 °F and Cooling: 68 °F
Misc. Notes	

The Terminal building located at 37 South Fitzhugh Street is a multiple story office building built in 1920 and underwent a complete renovation and repurposing in approximately 2018. No building information or floor plans were shared, therefore public property information and Google Earth was used to determine the floor area and building uses. No utility bill information was provided; therefore, the building energy model was not tuned based off utility information.

Two Saints

Characteristic	Description
Address	17 South Fitzhugh Street
Vintage	Built 1900
Floor Area and Space Type Breakout	Religious: 5,280 sq ft
Number of Floors	1 and 4 (back office space)
Wall Construction and R-Value	Reinforced Concrete: R-10.5
Roof Construction and R-Value	Reinforced Concrete: R-6
Glazing Type	Double Pane
Lighting Power Density	Office: 1.10 W/sq ft Corridor: .57 W/sq ft Lobby: 1.52 W/sq ft Restrooms: .77 W/sq ft Conference Room: .92 W/sq ft Mechanical/Electrical Room: .81 W/sq ft
Plug Load Density	Office: .20 W/sq ft
Operating Hours	M-F: 8am to 5pm, Sat./Sun.: Closed
HVAC System Type	Steam Baseboards with no Zone Ventilation
Existing RDH Customer? (Yes/No)	Yes
Thermostat Setpoints	Heating: 70 °F and Cooling: 68 °F
Misc. Notes	No cooling data

St Luke and St Simon Cyrene Episcopal Church (Two Saints) is a church located at 17 S Fitzhugh Street. No building information or floor plans were shared, therefore public property information and Google Earth was used to determine the floor area and building uses. RDH provided steam consumption data for the Two Saints building. The electric data showed little to no use and this was due to the COVID19 pandemic. The steam usage was used to help tune the building energy model, but the electric data was not used.

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