2023 GeoStar Top Job
Geothermal Project Presentations

Presented Live at the NY-GEO 2023 Conference Albany, New York on April 26, 2023

Moderator:

Joanne Coons / *NY-GEO Member*

Finalists:

Christie Reaves / *Markland*

Johannes Rosemann / *Buffalo Geothermal*

Steve Taylor / *Historic Finch*

Jim Thomas / *Moonshot Farm*

Claire Lukasiewicz / *Zen Building*

A BIG THANK YOU to This Year's Sponsors!

We Couldn't Do It Without You! ● www.ny-geo.org

Moonshot Farm

Cut Flower Greenhouses

Thomas Geothermal Engineering

Jim Thomas

The Basics

Twin Long Tunnels

The Basics

- “Long tunnel” is 96’ long by 34’ wide – about 3264 SF
- Quonset hut style with steel tubular ribs
- Double layer 6 mil poly sheeting with air gap @ R 1.8
- Air gap maintained by small muffin fan
- 2’ deep vertical fiberglass band to inhibit heat transfer
- 8’ wide sliding doors on each end w-brush sealing
- Dual shuttered air vents with exhaust fans
- Manual rollup side curtains for fresh air
- Plants grown directly in floor soil – USDA requirement

Can this be done?

- First question is, would you want to do geo on a 3000+ SF home with almost no insulation and a soil floor?
- Propane unit heater rated input 200K Btuh @ 80% efficiency
- Consumed 2162 gallons during 2021-22 heating season Nov 1 – Mar 15 at a cost of $6775
- Wasted 35 million BTUs or 65% required to heat a NJ home
- Used Purdue University Controlled Environment Agriculture load model @ 15 deg design day = 10.86 tons
- Good match for two 6 ton residential single phase geo units
- Yes this can be done!

Financing

- 2022 USDA Rural Energy for America Program (REAP) offered 25% grant – almost all expected to be for solar
- Federal commercial 10% tax credit plus depreciation
- No New Jersey incentives
- Customer still wanted to move forward even after Build Back Better failed
- Fortuitously the Inflation Reduction Act boosted the Federal commercial tax credit to a 30% bonus rate gives 6 year ROI
- Rampant inflation in 2022 caused a 10% increased project cost but USDA grant based on original application proposal

The Design

- Winter flowers like 40 to 70 degree growing temperature
- Temperatures above 90 or below 32 can kill the crop
- Initial requirement was 50 degrees overnight @ 15 degrees OAT
- Decided to retain propane unit heater as backup
- Retained exhaust fans to help control temperature and humidity
- Conceived as a heating only system – very unbalanced load
- Added a custom “waterside economizer” to harvest compressor-less heat to charge the loop during summer
- Exploiting thermal energy storage!

The System

- Selected components for high reliability and performance
- USDA required 3 years of performance monitoring
- Easily fulfilled by WaterFurnace Aurora/Symphony system
- Chose a pair of high efficiency 6 ton WF Series 5 with variable speed ECM blowers + refrigeration & performance monitoring
- Modulating water valves at units to minimize pumping
- Easy logic to implement compressor-less cooling with WF "load shed" feature – low cost multisource – 1% of project
- Lightweight DuctSox fabric ductwork – removeable to clean

The System

The Loop

- 1.5 Acre pasture adjacent to tunnel – ideal for horizontal
- Selected high performance Twister pipe by Agreenability
- 2100’ pipe in 7 trenches 6’ deep
- Low outside Headloss @ 10 Feet of Head (FOH)
- Retained Twister center corrugated pipe above ground to dampen field with water
- High efficiency pumping with GeoFlo NP-Multi with Grundfos Magna3 variable ECM pump set at constant pressure
- Oversized HDPE to bring total head loss to about 40 FOH

The Loop

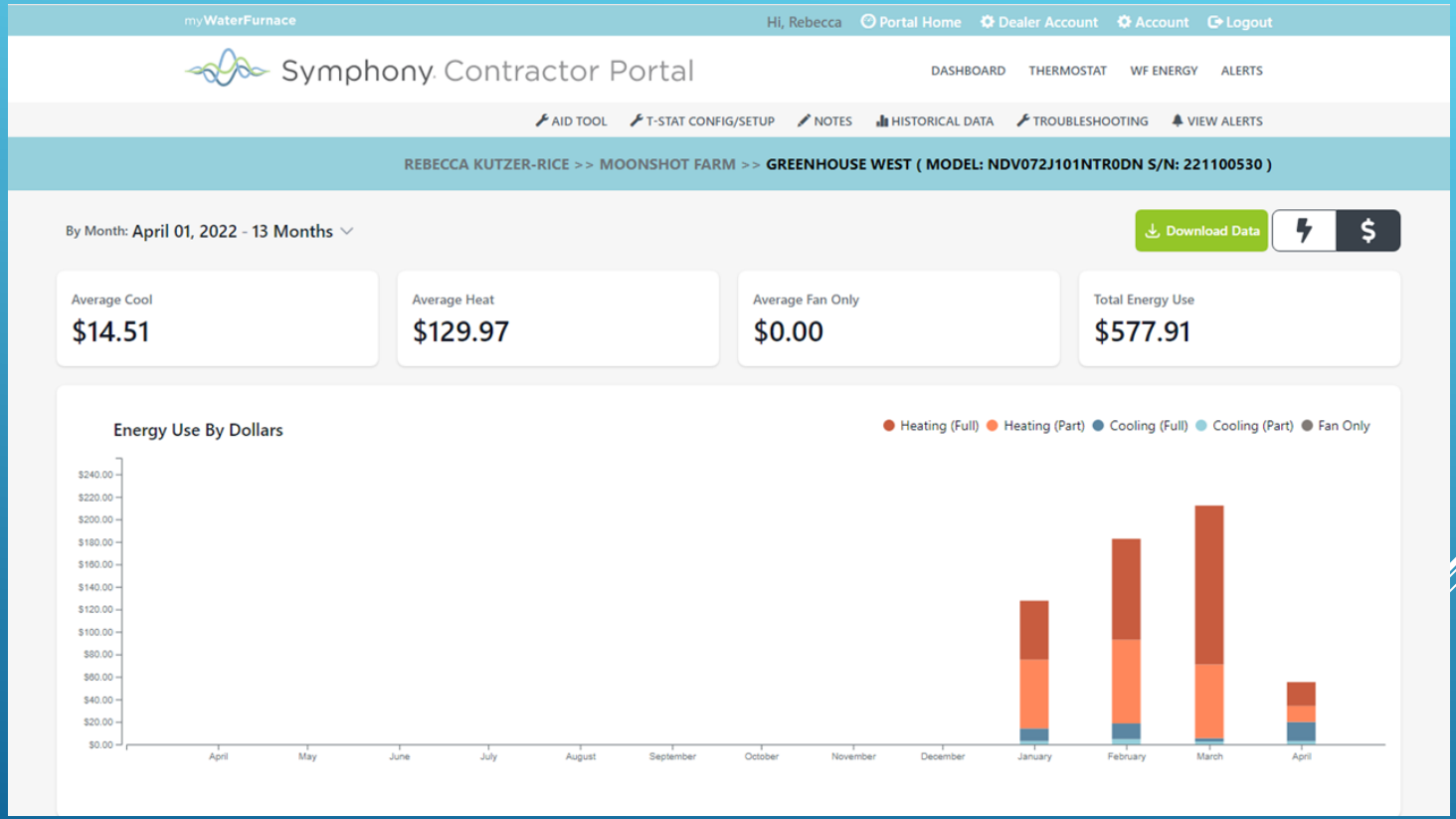
Early Discoveries

- Solar gain far above what we expected
- Tunnel would heat up to 90 degrees by 10 am when it was below freezing outside
- Owners would open sliding doors to cool off – but lost all reserve heat that had to be made up again
- But Heat load overnight was less from day soil charge-up
- High humidity a big problem - sometimes 85+%
- Mold growth and fungus a concern

How'd it go?

- Customer wanted overnight temp higher @ 55 degrees
- Wanted active cooling mid-winter to control overheat
- Active cooling also aided humidity control
- Saw active cooling as efficient ground charging – would generally run the loop up +15 degrees during the day
- Heat loss through the soil was not a significant factor
- Cost savings over propane within the ballpark estimate
- Electric consumption Jan 12 – Apr 15 was $1238
- Ground charging over the summer should increase efficiency further next and subsequent winters

How’d it go?


myWaterFurnace
Hi, Rebecca
Portal Home
Dealer Account
Account
Logout
Symphony Contractor Portal
DASHBOARD
THERMOSTAT
WF ENERGY
ALERTS
AID TOOL
T-STAT CONFIG/SETUP
NOTES
HISTORICAL DATA
TROUBLESHOOTING
VIEW ALERTS
REBECCA KUTZER-RICE >> MOONSHOT FARM >> GREENHOUSE WEST (MODEL: NDV072J101NTR0DN S/N: 221100530)
By Month: April 01, 2022 - 13 Months
Download Data
Average Cool
$14.51
Average Heat
$129.97
Average Fan Only
$0.00
Total Energy Use
$577.91
Energy Use By Dollars
Heating (Full)
Heating (Part)
Cooling (Full)
Cooling (Part)
Fan Only
$240.00
$220.00
$200.00
$180.00
$160.00
$140.00
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$0.00
April
May
June
July
August
September
October
November
December
January
February
March
April

The Future

- USDA REAP Grants up to 40% for 2023 Approved Projects
- Continue to enjoy Inflation Reduction Act tax benefits
- Helped Rutgers University apply this year to build two new greenhouses for educational purposes
- Moonshot looking to convert 2 more greenhouses and build another – customers like green growing concept
- Hydroponic farming and winter locally grown
- Biggest new opportunity could be cannabis growing in NJ
- Interest by Senator Cory Bookers office at Federal level

Questions?

thomasgeothermal@gmail.com

(609) 923-5424

Thank you!

ZEN (Zero Energy Nanotechnology) Building: Harvesting Alternative Energy

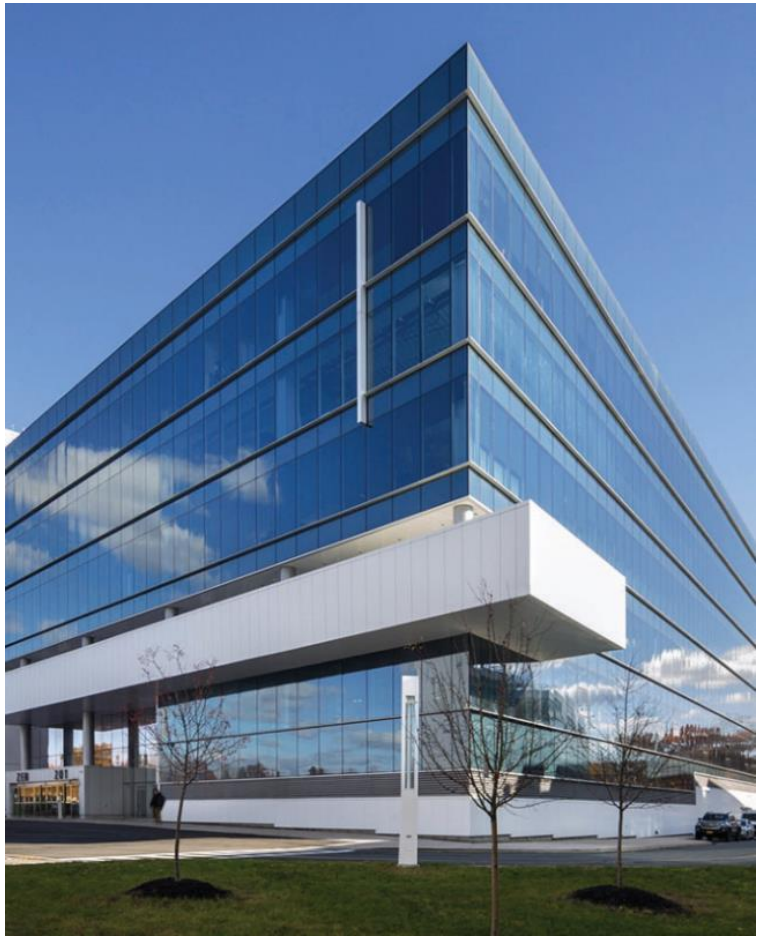
C. Lukasiewicz

April 26, 2023

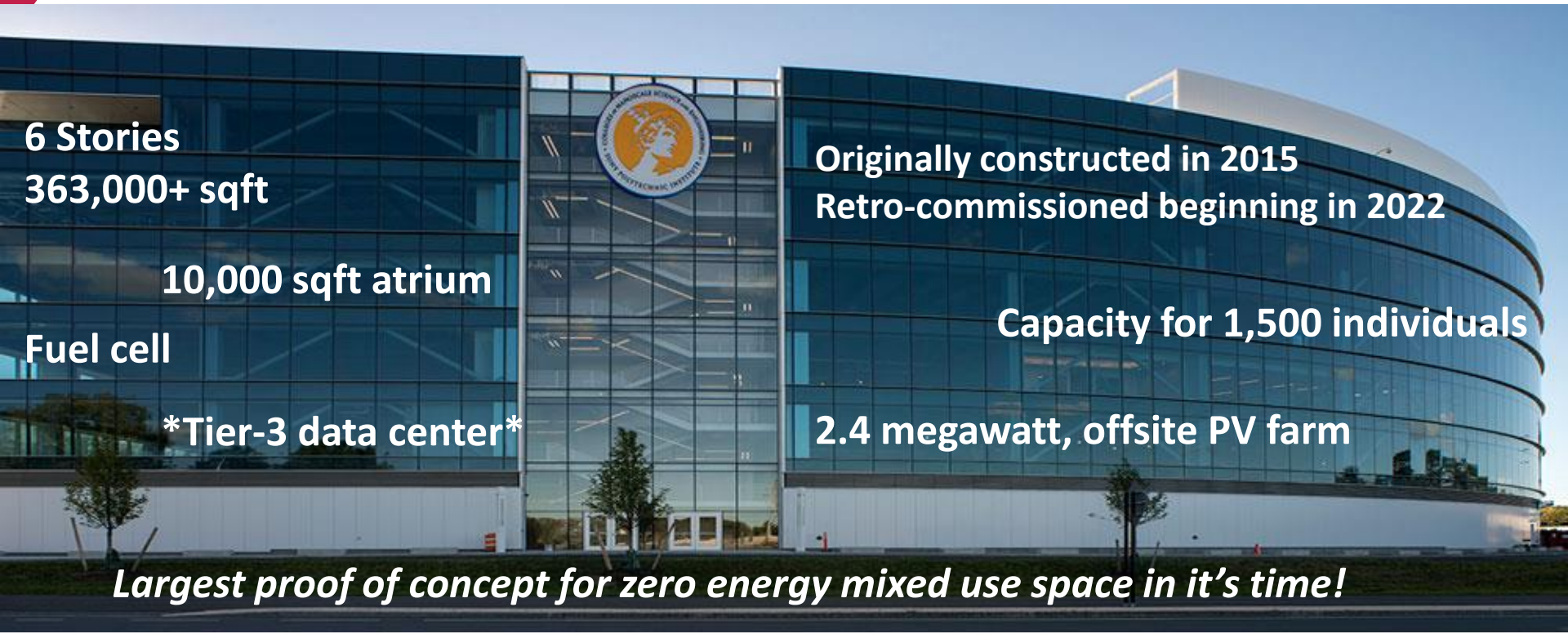
NYCREATES

Outline

- ZEN at a Glance
- Energy Efficiency Measures
  - Architectural
  - Mechanical Equipment
  - Energy Harvesting
- Retro-Commissioning Efforts
- Funding



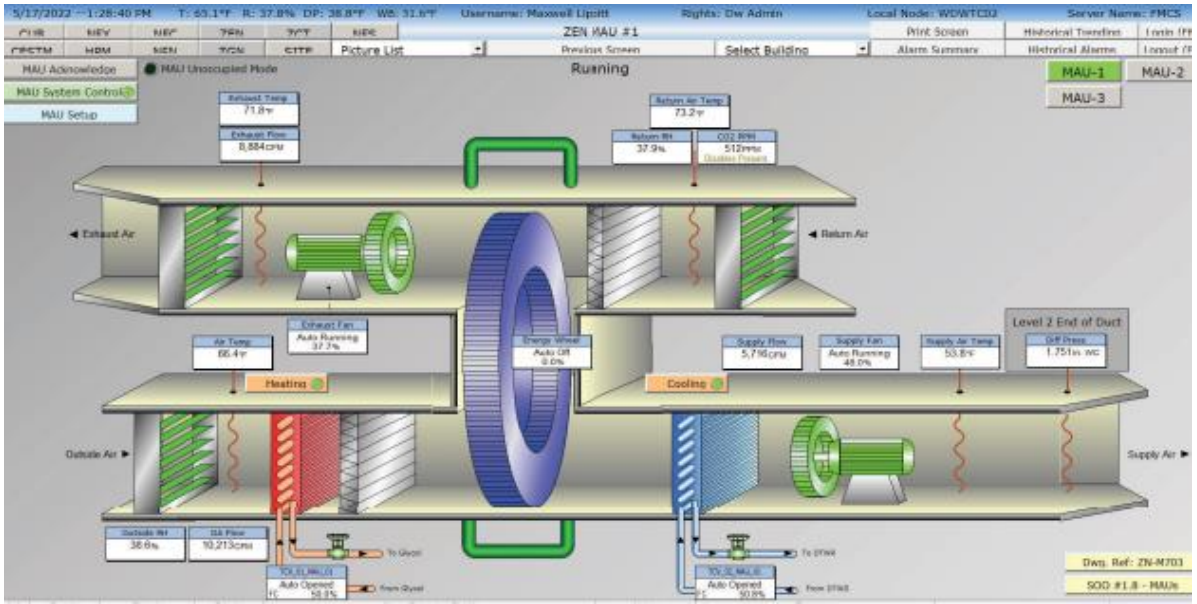
ZEN at a Glance



NYCREATES

Energy Efficiency Measures

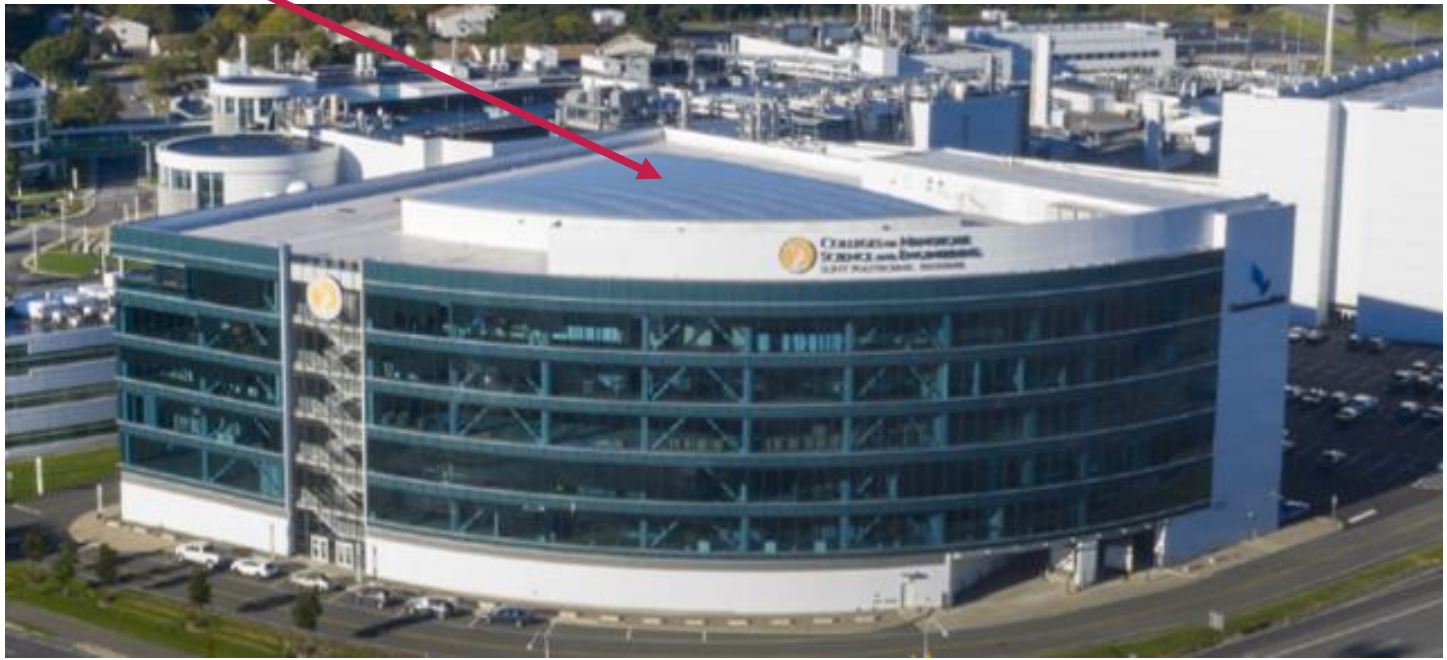
- **Architectural**
  - Lighting
- **Mechanical Equipment**
  - HVAC
  - Controls
- **Energy Harvesting Strategies**
  - Data Center Heat Recovery
  - Chiller-Heaters
  - Heat Pumps



Energy Efficiency Measures –Architectural

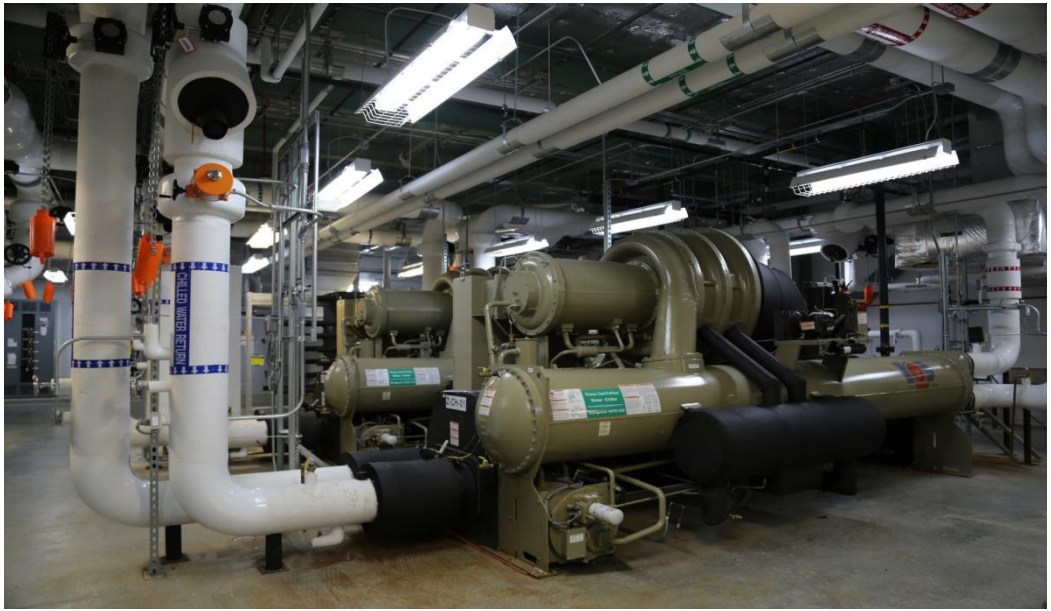
- “Donut Design”
  - Reduce lighting electricity needs by more than 70%
  - Often only a small LED lamp is needed
  - ETFE “Pillow Roof”

View of
“Pillow Roof”
from outside

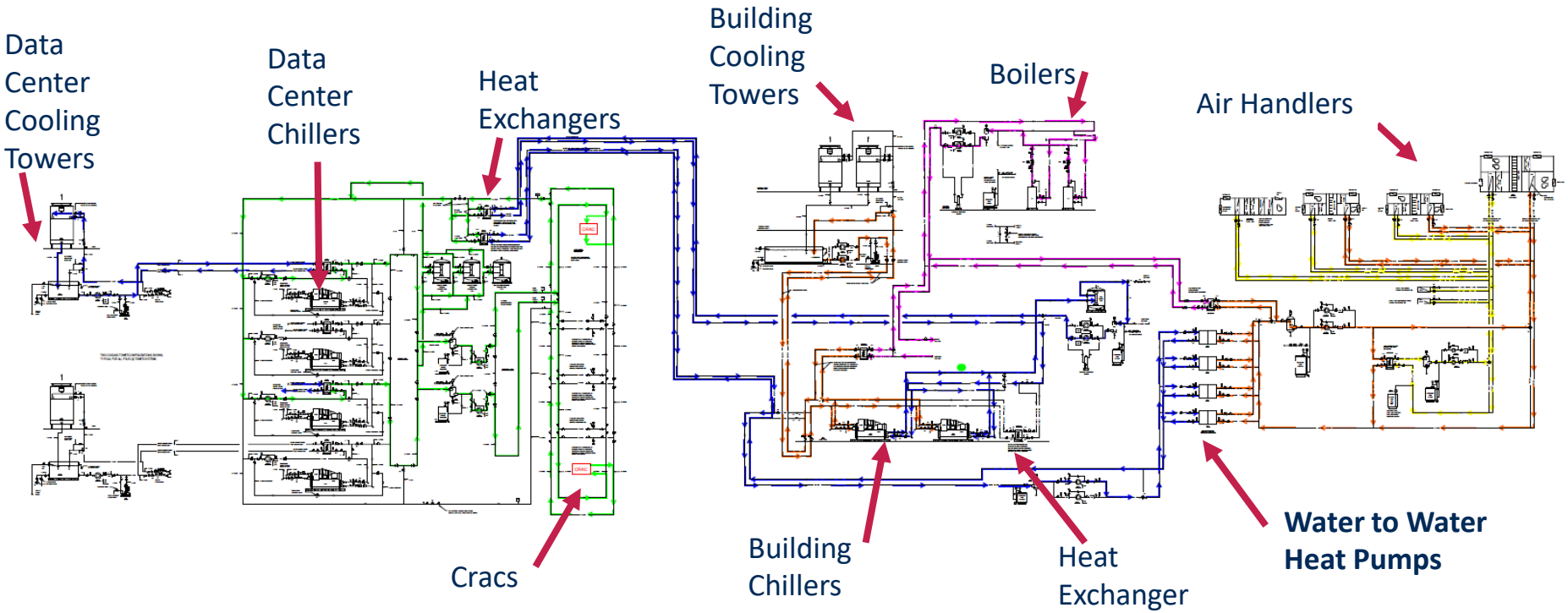


Energy Efficiency Measures –Mechanical Equipment

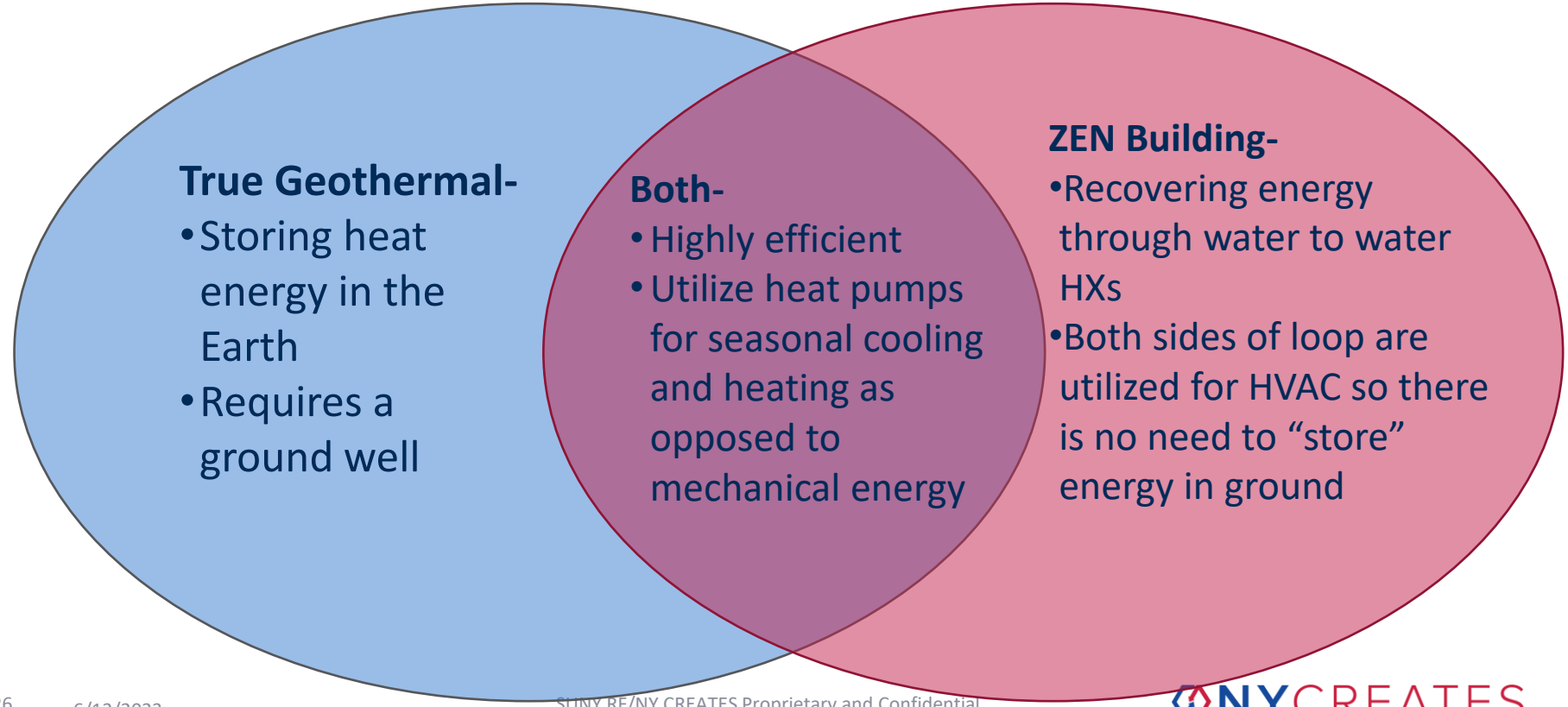
- Chillers with free cooling
- Energy recovery DOAS Units
- CO2 monitoring
- BMS paging and access
- VFDs on all motors (pumps, fans, etc.) for efficiency



Energy Efficiency Measures –Mechanical Equipment

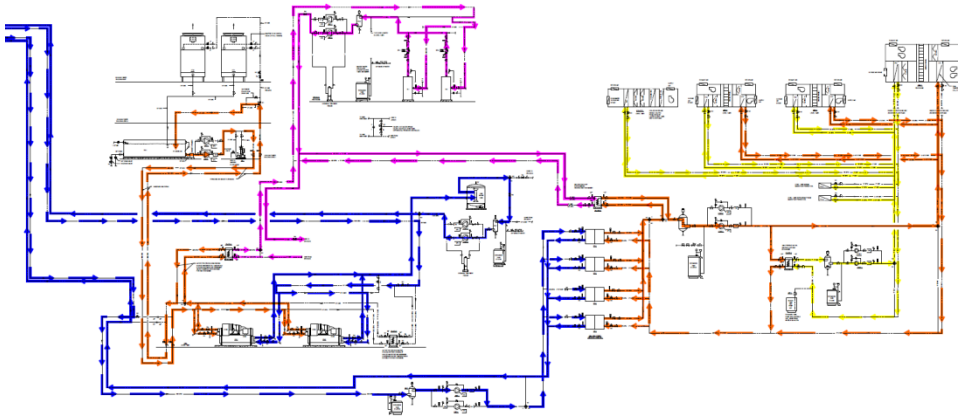


Is this geothermal?

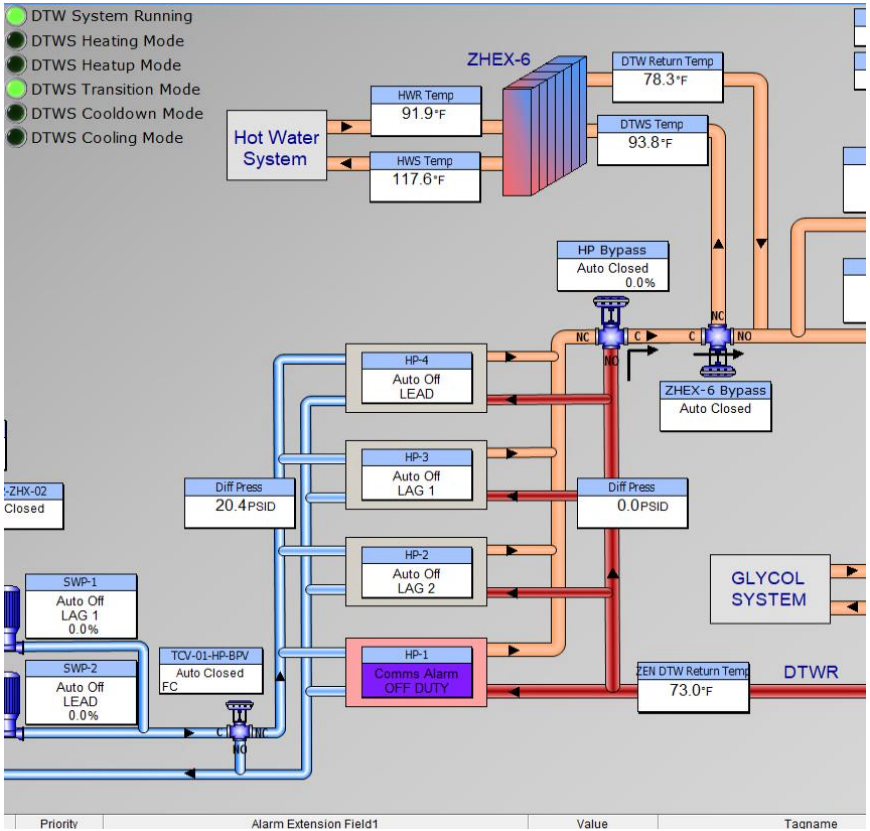


Energy Efficiency Measures –Energy Harvesting

- Data Center Heat Recovery
  - Winter mode: Free cooling at cooling towers often eliminates need to run mechanical cooling; heat pumps reject heat to the condenser water loop
  - Summer mode: Utilize control strategies to optimize chiller staging



Energy Efficiency Measures –Energy Harvesting



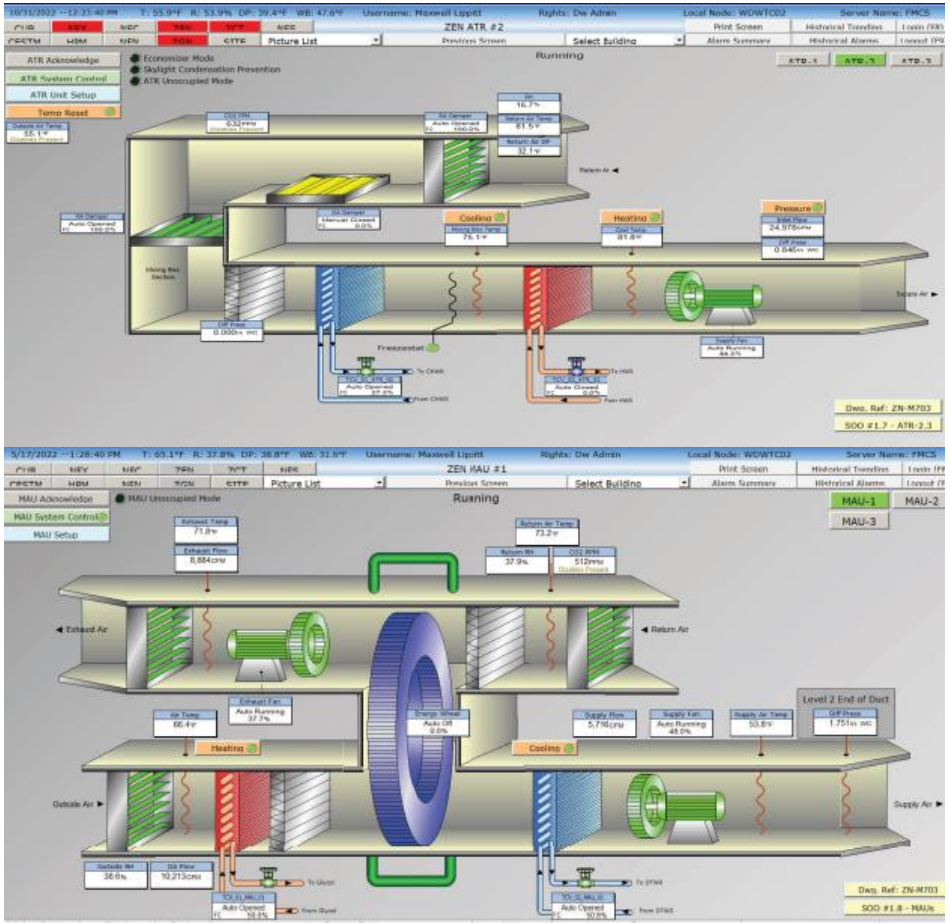
- Heat Pumps (DTWS)
  - Winter mode: Create warm water for AHU coils to act as “pre-heat,” heat rejection to the data center’s chilled water loop (free cooling)
  - Summer mode: Reject heat to the building condenser water loop, supply chilled water to AHU coils

Energy Efficiency Measures –Energy Harvesting

- Chiller-Heaters
  - Winter mode only: when ambient conditions allow, chillers may operate in “reverse”
  - Condenser and evaporator swap rolls
  - Allows ZEN to be heated with a chiller
  - “cold side of this loop” supports ZEN data center cooling
  - Conserves natural gas as there is no need to run a boiler

Retro-Commissioning

- Timing drove the need-
  - Design for this project: Summer 2013
  - Data Center majority loaded: Winter 2021
- Focus on BMS and control programming
- Implementation of Facility Connex
  - 1,000+ Fault Detection & Diagnostics
  - Hundreds of analytics
  - Web based access to site information 24/7, 365



Funding

- Original Project totaled ~$200 Million
  - Over 4+ years from design to completion
- Retro-commissioning largely grant funded
- Participating Parties
  - National Grid
  - NYSERDA
  - Japan's New Energy and Industrial Technology Development Organization
  - State and Federal Grants
- Aligned on goal to install, commission and demonstrate state of the art technologies including solar photovoltaics, lighting, fuel cells and smart building energy management systems to achieve a *net zero capable facility*
- High visibility project focused on setting worldwide example, keeping NY Forefront of scientific research, create jobs, stimulate economy

While the ZEN Building may be the first of it's kind, let's not make it the last!

BOUCHER ENERGY SYSTEMS, INC.

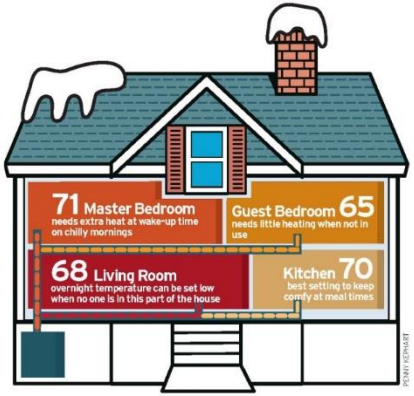
Steven Taylor

Installation Manager

Historic Fitch Tavern

Historic Fitch Tavern

- Eliminate fossil fuel
- Reduce carbon footprint
- Restore historic exterior
- Increase occupant comfort
- More control over individual living areas
- Remote access
- Equipment monitoring
- Improve efficiency of home



Project Goals

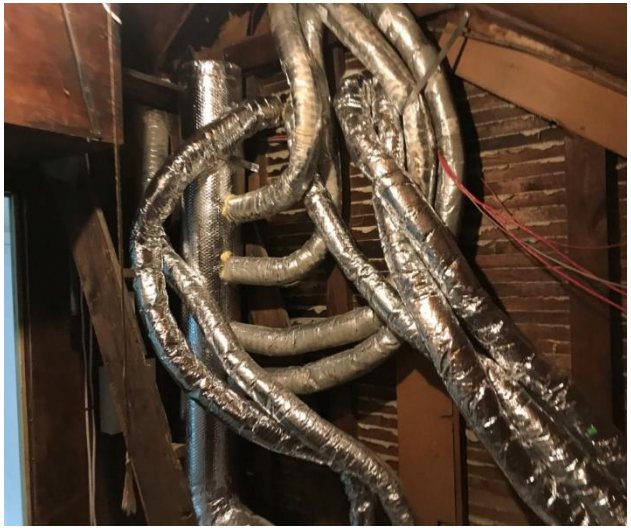
Oil fired hot water boiler

- 90% main living area
- Domestic hot water
- Kitchen wing radiant heating

Natural gas furnace

- In-law suite
- Grossly oversized for the space

Existing Conditions: Heating

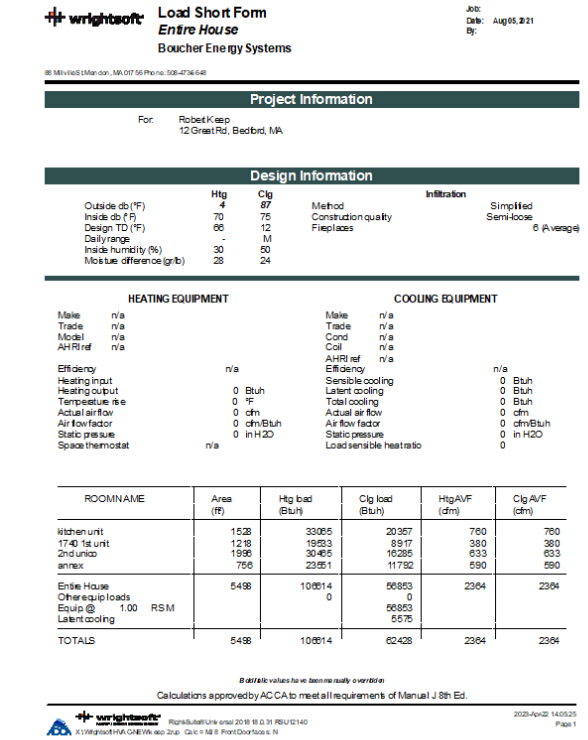


Existing Conditions: Cooling

Historic Fitch Tavern

- Manual J load calculation
- Define heating/cooling zones
- Choose Technology
  - GSHP
    - Higher installed cost
    - Lower operational cost
    - Utility incentives and Tax credits
  - ASHP
    - Lower installed cost
    - Higher operational cost

Steps to Success



wrightsoft

Load Short Form
Entire House
Boucher Energy Systems

Job:
Date: Aug 05, 2021
By:

88 Millville St Manchester, MA 01756 Phone: 508-4736648

Project Information

For: Robert Keep
12 Great Rd, Bedford, MA

Design Information

	Htg	Clg		
Outside db (°F)	4	87	Infiltration	
Inside db (°F)	70	75	Method	Simplified
Design TD (°F)	66	12	Construction quality	Semi-loose
Daily range	-	M	Fireplaces	0 (Average)
Inside humidity (%)	30	50		
Moisture difference (gr/lb)	28	24		

HEATING EQUIPMENT

Make	n/a		
Trade	n/a		
Model	n/a		
AHRI ref	n/a		
Efficiency	n/a		
Heating input			
Heating output	0	Btuh	
Temperature rise	0	°F	
Actual air flow	0	cfm	
Air flow factor	0	cfm/Btuh	
Static pressure	0	in H2O	
Space thermostat	n/a		

COOLING EQUIPMENT

Make	n/a		
Trade	n/a		
Cond	n/a		
Coil	n/a		
AHRI ref	n/a		
Efficiency	n/a		
Sensible cooling	0	Btuh	
Latent cooling	0	Btuh	
Total cooling	0	Btuh	
Actual air flow	0	cfm	
Air flow factor	0	cfm/Btuh	
Static pressure	0	in H2O	
Load sensible heat ratio	0		

ROOM NAME	Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Htg A/V (cfm)	Clg A/V (cfm)
kitchen unit	1528	33065	20367	760	760
1740 1st unit	1218	19533	8917	380	380
2nd unkco	1996	30465	16285	633	633
annex	756	23551	11792	590	590
Entire House	5498	106614	56853	2364	2364
Other equip loads			0		
Equip @ 1.00 RSM			56853		
Latent cooling			5575		
TOTALS	5498	106614	62428	2364	2364

Bold/italic values have been manually overridden

Calculations approved by ACCA to meet all requirements of Manual J 8th Ed.

wrightsoft RightSuite® Universal 2018 18.0.31 REU12140
X:\Wrightsoft HVAC\NEW\Accep 2.rup Calc = NEW Front Door faces: N

2023-Apr-22 14:05:25
Page 1

- Manual J load calculation
- Define heating/cooling zones
- Choose Technology
  - GSHP

    Higher installed cost

    Lower operational cost

    Utility incentives and Tax credits

  - ASHP

    Lower installed cost

    Higher operational cost

Steps to Success

Historic Fitch Tavern

- Water Furnace 5 Series Water to Water
  - Kitchen wing radiant heating
  - Unico Air Handlers Hot/Chilled Water Coils
    - Childrens bedrooms
    - Kitchen wing
    - Main first floor

Equipment Selection

The Unico System®
Small-Duct Central Heating & Air Conditioning

WaterFurnace
Smarter from the Ground Up™

Historic Fitch Tavern

- Water Furnace 5 Series Split
  - 2 Stage equipment to better match loads
  - Second floor Primary Suite
  - Third floor Office/Guest bedroom

Equipment Selection

The Unico System®
Small-Duct Central Heating & Air Conditioning

WaterFurnace
Smarter from the Ground Up™

Historic Fitch Tavern

- Water Furnace 5 Series Package
- 2 Stage equipment to better match loads
- Family room
- New connector

Equipment Selection

The Unico System®
Small-Duct Central Heating & Air Conditioning

WaterFurnace
Smarter from the Ground Up™

Historic Fitch Tavern

- Space constraints
  - Third floor completely is finished
  - Preserve historic look of home
  - Some systems already in place

Equipment Selection

The Unico System®
Small-Duct Central Heating & Air Conditioning

WaterFurnace
Smarter from the Ground Up™

Historic Fitch Tavern

- Water Furnace
  - Refrigerant/Performance monitoring options
  - Aurora Web Link
  - Symphony Web enabled controls
  - Fault notification
  - Variable speed flow centers minimize pumping power
- Unico System
  - Green Series air handlers with ECM blower motors
  - Even temperatures floor to ceiling
  - National Trust for Historic Preservation

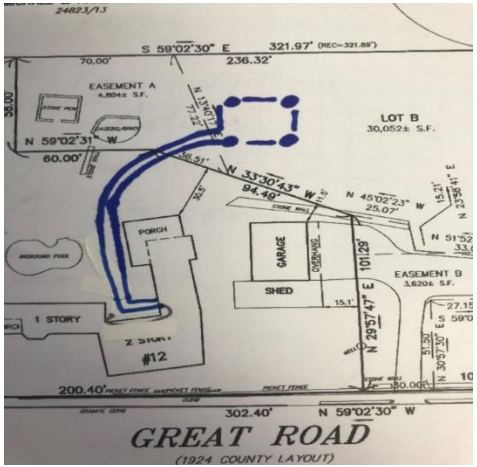
Key Features

The Unico System®
Small-Duct Central Heating & Air Conditioning

WaterFurnace
Smarter from the Ground Up™

Historic Fitch Tavern

- Ground Loop Design
  - 4 450’ Boreholes 1¼” pipe
  - 3” Main header pipe to basement
  - 175’ per ton of capacity



- Controls
  - HBX ECO-600 Geothermal reset control
  - Honeywell THM8320 thermostats
  - Honeywell Redlink wireless outdoor sensor
  - Honeywell Redlink internet gateway

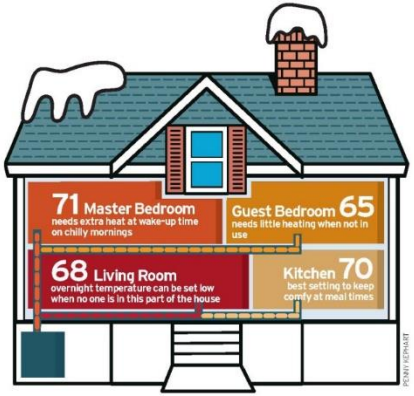
Key Features

The Unico System®
Small-Duct Central Heating & Air Conditioning

WaterFurnace
Smarter from the Ground Up™

Historic Fitch Tavern

- Eliminate fossil fuel
- Reduce carbon footprint
- Restore historic exterior
- Increase occupant comfort
- More control over individual living areas
- Remote access
- Equipment monitoring
- Improve efficiency of home



Success!

BUFFALO GEOTHERMAL HEATING™

www.BuffaloGeoThermal.com

The Pierce Arrow Lofts Geothermal Conversion


PIERCE-ARROW
MOTOR CAR COMPANY
1695
CENTER FOR DEVELOPMENT
OF HUMAN SERVICES

The Building

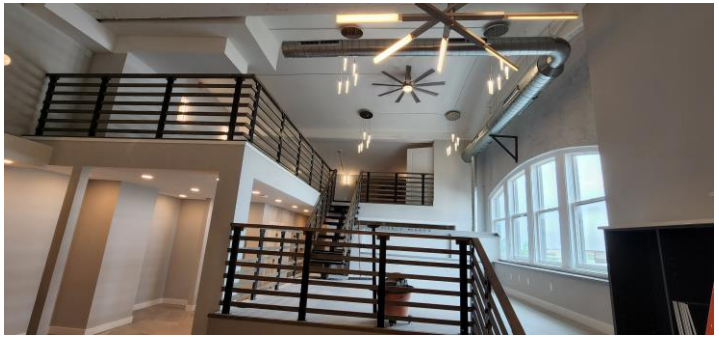
BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

- 158,000 sqft
- Build in 1908
- It is one of the 2 only historic buildings in the United States with a concrete Barrel Roof.
- It served as the administration building for the Pierce arrow production facility from 1908-1938.
- In 1974 added to the National Register of Historic Places.

The Conversion

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

- 127 Apartments
- 7,500 Sqft Restaurant
- Completely heated and cooled by Geothermal
- 100% of the Domestic Hot Water Supplied by Geothermal



Geothermal System

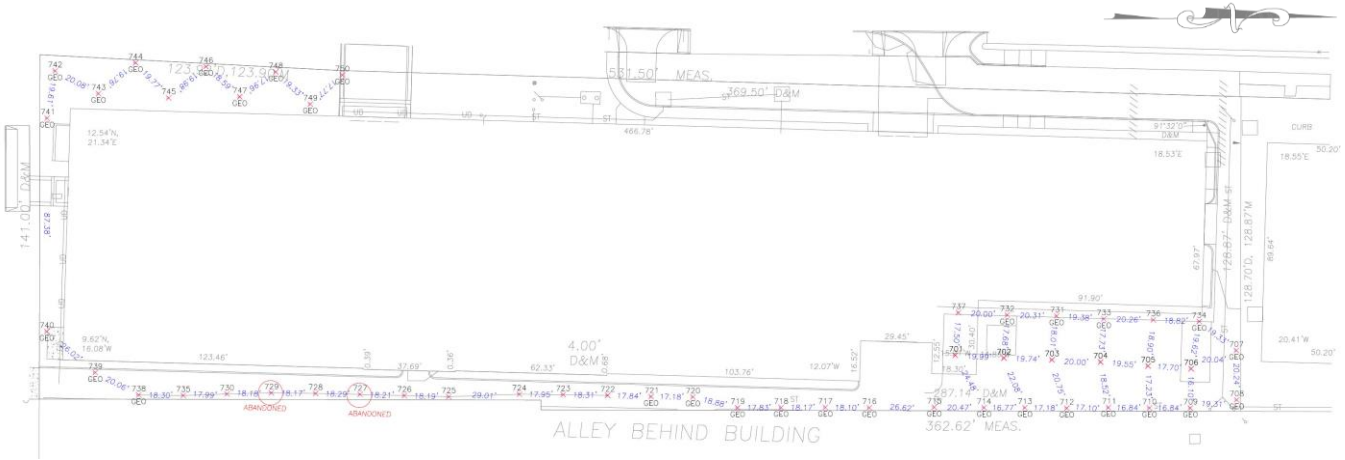
BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

Challenges

- Dense Urban Environment
- Efficient System Design
- Load Balancing

Dense Urban Environment
and the Loopfield

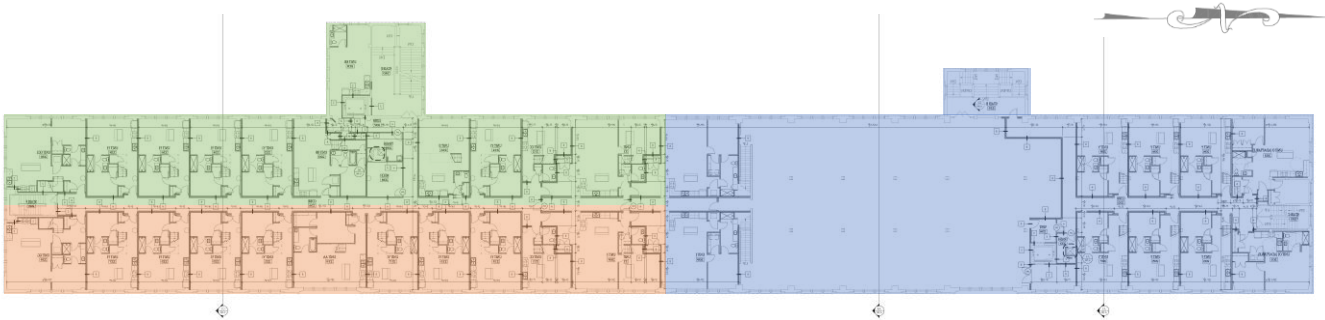
BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com



- 50 Boreholes
- 350ft Deep spaced 20ft apart
- Closed Loop 1 ½ HDPE U-Bend
- Graphite enhanced grout

Efficient System Design

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com



- 3 independent operating Flow-Centers
- pumping power is less than 3% of the system power consumption
- Reduced Pressure Loss by shortening average run out and connection Lengths

Efficient System Design
the Flowcenters

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

- ECM Driven Variable Speed Pump
- Automatic adjustment of Flowrate based on System back pressure

Efficient System Design
the Flowcenters

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

- Primary/Secondary Loop Setup
- ECM Driven Variable Speed Pump
- Automatic adjustment of Flowrate based on System back pressure

Load Balancing
with DHW Generation

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

- Balancing the Loads avoids temperature drift of the loopfield
- It enables to reduce the loopfield size

Load Balancing
with DHW Generation

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

- 2 Stage Design
- Average COP of 3.4 vs 2.9
- Increased Redundancy

Geothermal System

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

Recap

- 333 Tons of Heating and Cooling Load
- Closed Loop system with 50 – 350ft deep Boreholes
- 3 Flowcenter
- 147 Forced Air Heatpumps
- 6 - 5Ton Vapor Injection High Temperature Water-Water Units
- 8 - 162 Gallon High Efficiency Storage Tanks

Recognition and Impact

BUFFALO GEOTHERMAL HEATING™
www.BuffaloGeoThermal.com

- Supported with $400,000 Rebate from [redacted]

NYS Assemblyman
William Conrad

"Many thanks to the New York Geothermal Energy Organization for facilitating this morning's legislators tour of The Pierce Arrow Lofts, a beautiful showcase for renewable energy, with a geothermal system that illustrates our potential for energy independence…"

Thank You

Top Jobs: 240 Markland

April 26, 2023

GEOSOURCE
Innovating Infrastructure

GEOSOURCE

- Industry **leading**, **vertically integrated**, **geo-exchange solutions provider** with **20 years organizational expertise**.
- **Delivered over 400 projects**, accounting for **over 50% of the systems delivered in Ontario**.
- Experience with **large-scale residential**, **commercial** and **institutional** new builds and **retrofits.**

Project Collaborators

Carttera

Smith + Andersen

VR MECHANICAL

RATHCO ENG

ARK MANAGEMENT

ARMSTRONG

The Project - 240 Markland

Owner:	Carttera Management Inc
Location:	240 Markland Dr, Toronto
Project Delivery:	Design-Build-Operate

Retrofit Program:

10 storey & 135K-sq.ft/12.5K-sq.m

1,305 kBH/382 kW_{th} & 105 RT/363 kW_{th}

Planned Program:

9 storey and 205K-sq.ft/18.7K-sq.m

3,525 kBH/1,033 kW_{th} & 245 RT/846 kW_{th}

Themes:

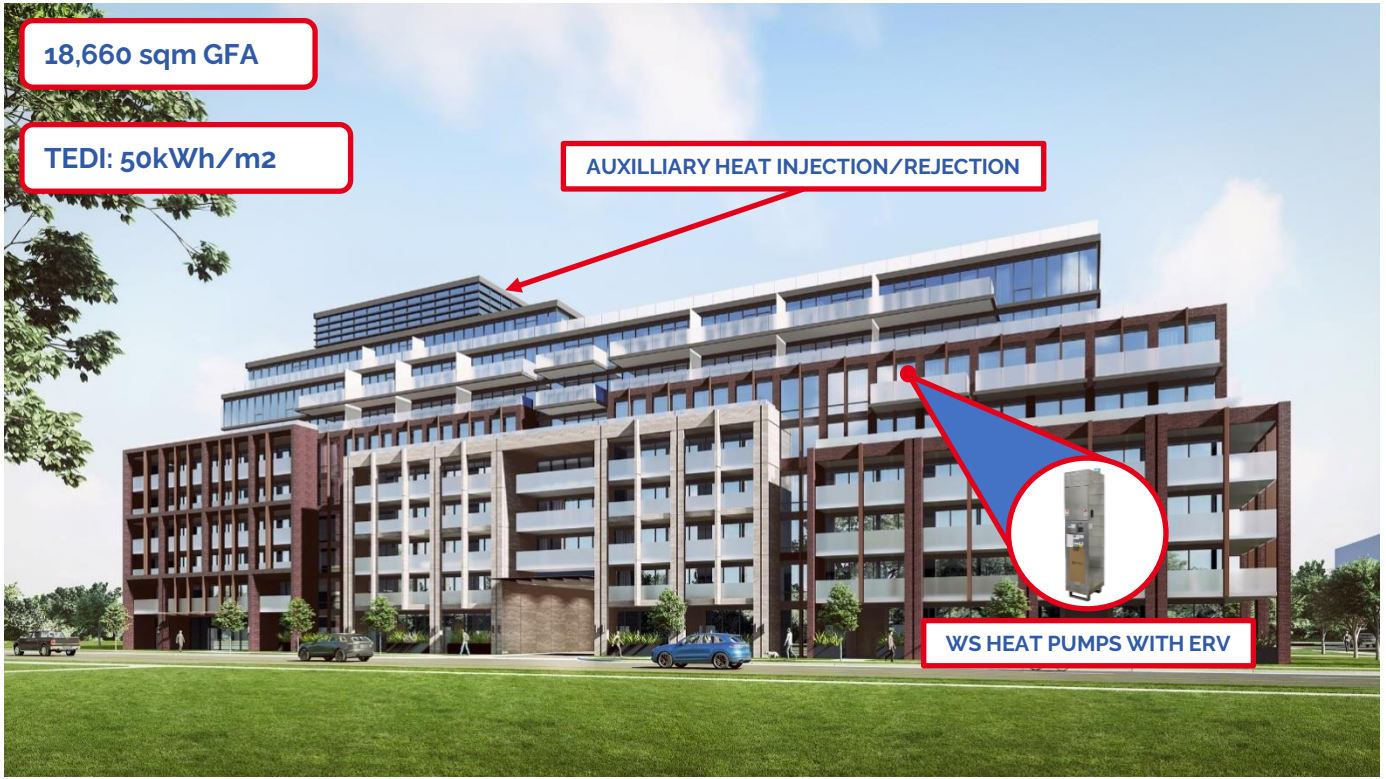
Fully electrify heating w/ retrofit

Community energy asset.

Turnkey – DBO

Retrofit Program

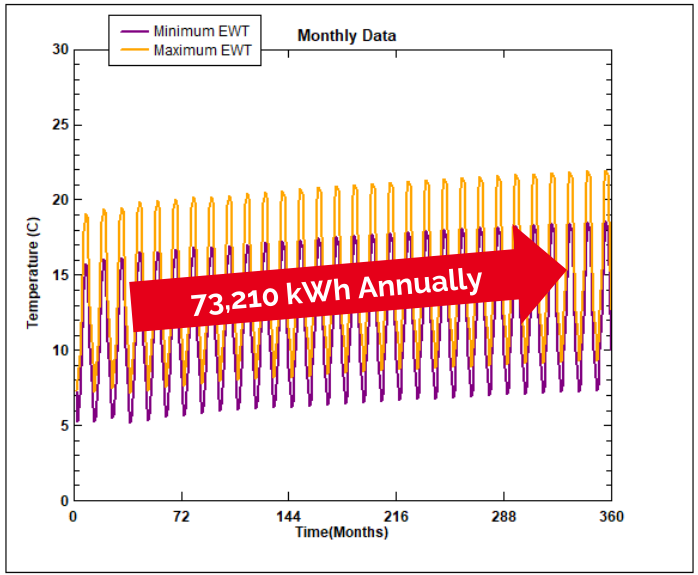
Planned Building Program



Ground Heat Exchanger Selection

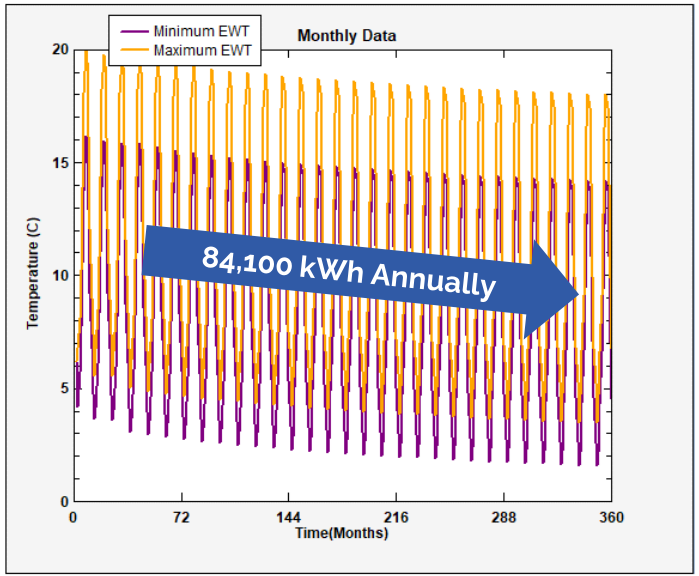
Retrofit Building

	Cooling	Heating
Geothermal Capacity [kW_{th}]	363	382
Geothermal Energy Production [MWh_{th}]	1,086	1,719
Ground-side Energy [kW_{th}]	343,268	427,368



New Building

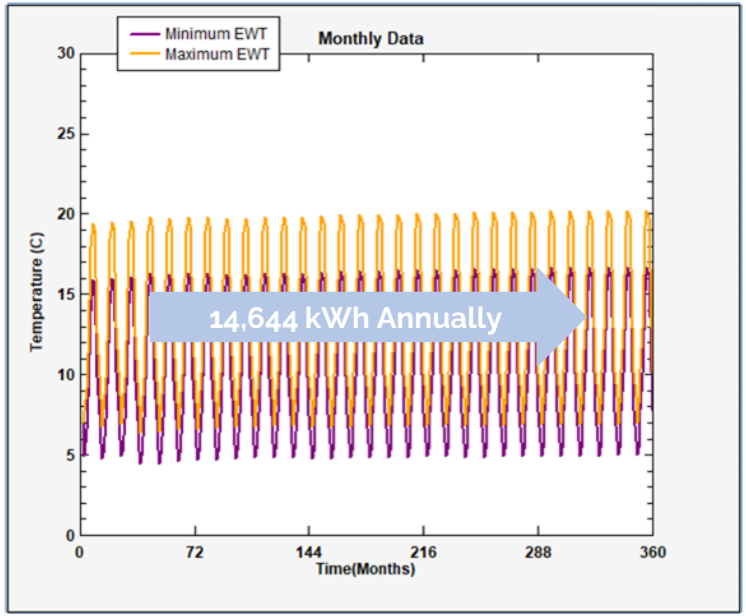
Basis of Design Loads on the GHX	Cooling	Heating
Geothermal Capacity [kW_{th}]	846	1,033
Geothermal Energy Production [MWh_{th}]	792	1,144
Ground-side Energy [kW_{th}]	924,185	850,974



Ground Heat Exchanger Selection

Combined System

Basis of Design Loads on the GHX	Cooling	Heating
Geothermal Capacity [kW_{th}]	1,209	1,415
Geothermal Energy Production [MWh_{th}]	1,086	1,719
Ground-side Energy [kW_{th}]	1,267,453	1,278,342



Annual Ground Imbalance:

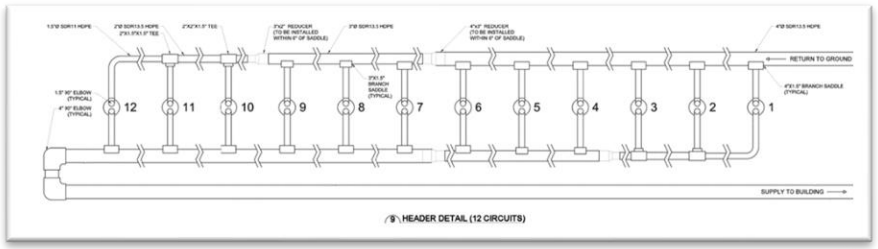
Heating dominate - 14,644 kWh overcool of ground and a imbalance of -0.9%.

Active Ground Balance:

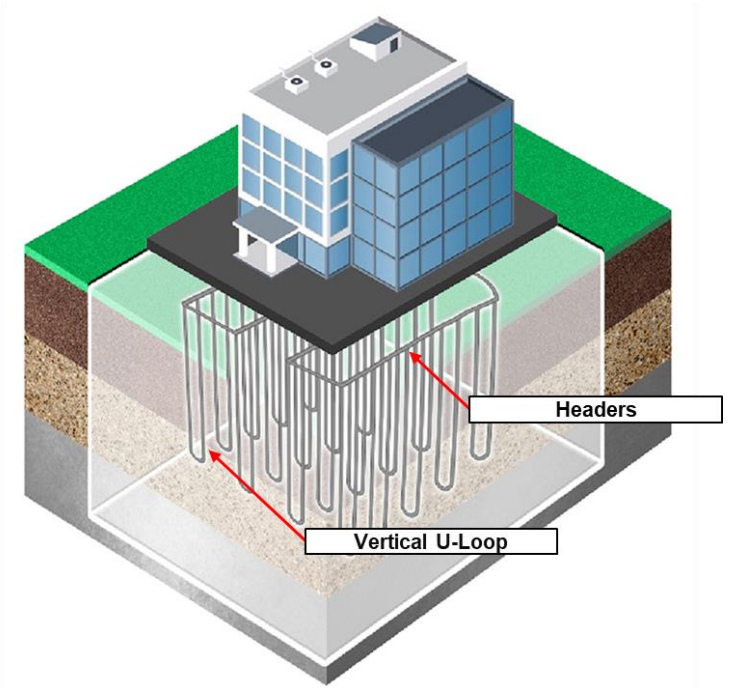
Dual purpose auxiliary systems installed for flexibility in the planned program.

Ground Heat Exchanger Solution

- Vertical Borefield design
  - 4.25" boreholes up to 850'
- Combined system size: 113 bh @ 850'
- 17.5' spacing preferred, 15' can be squeezed
- 113 boreholes at 17.5' spacing:
  - 3,215 sqm (13,280 sqft)

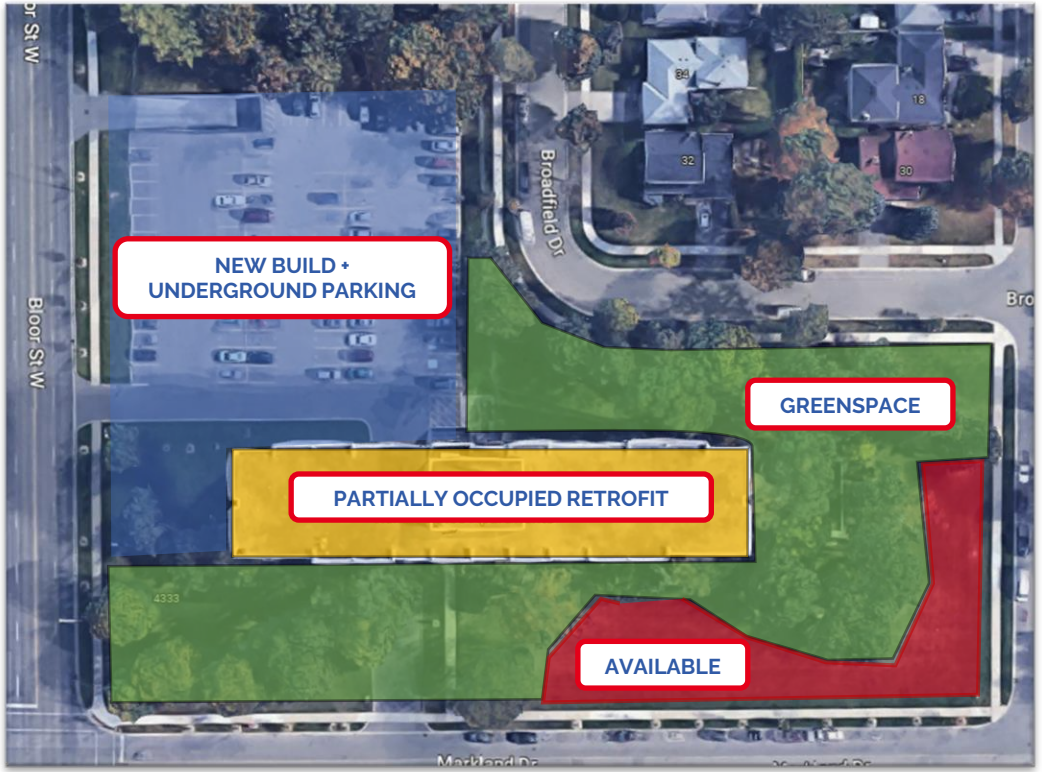


Geothermal Heat Exchanger (GHX):

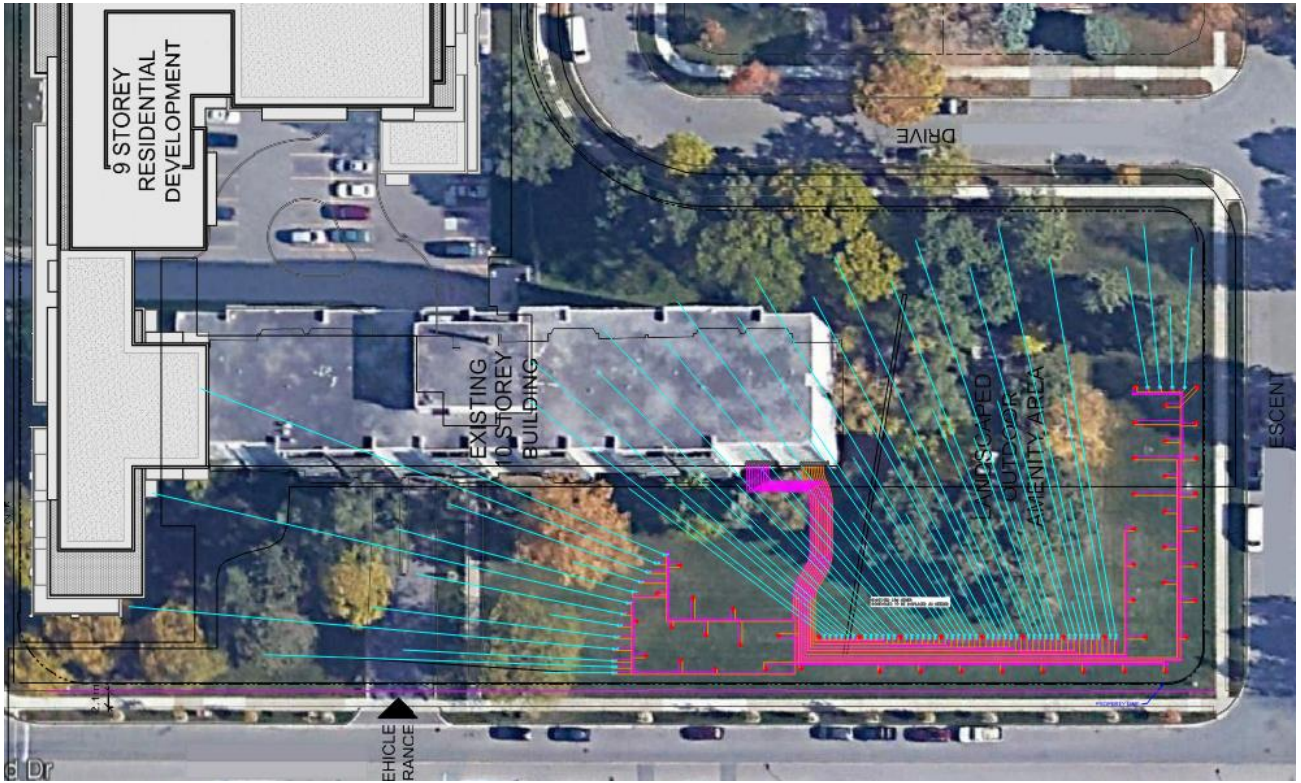


Project Goals & Constraints

- GHX size: 113 Boreholes
  - 2,400sqm- 3,200sqm
- Site Area: 12,700sqm
- CONSTRAINTS
  - Partially Occupied Retrofit serviced by May 2022
  - Uninterrupted Service
  - Mature trees
- Working area 1,250 sqm
  - Potential for vertical boreholes at 15' spacing: 59



Our Solution



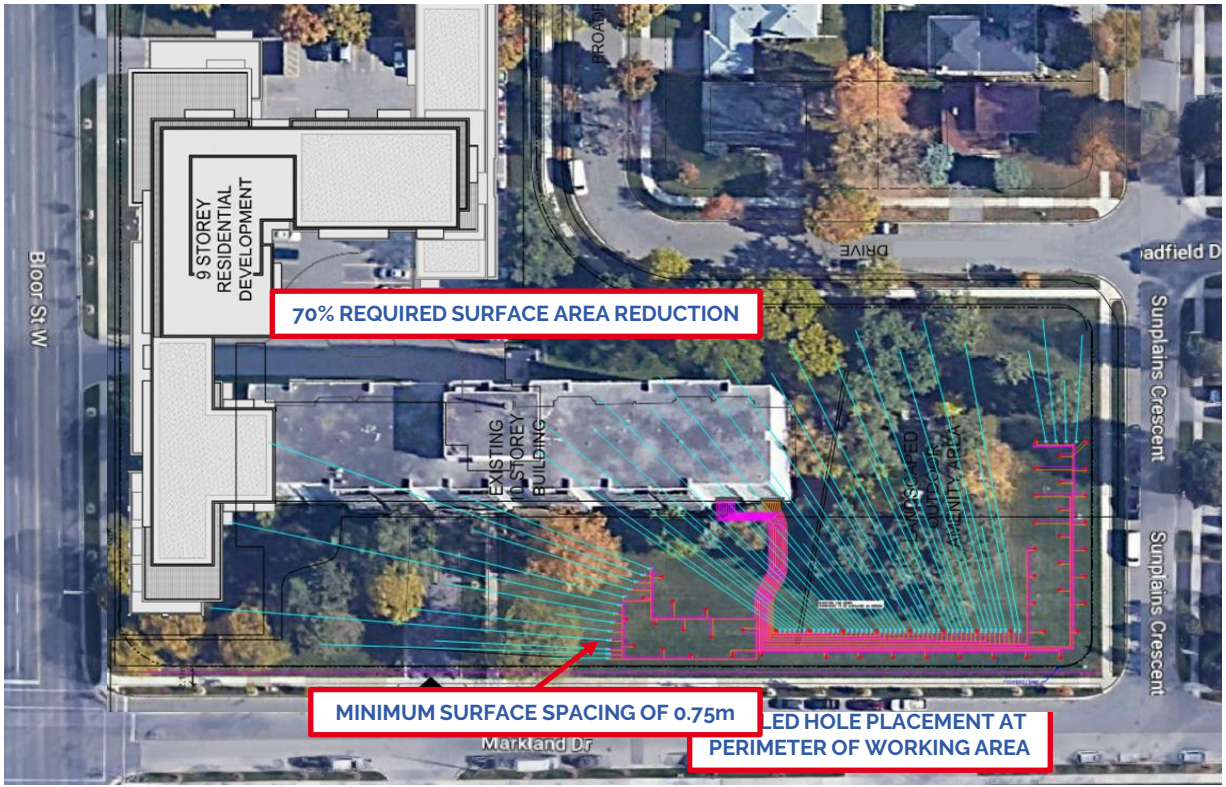
GEOSOURCE

Angled Drilling Technology

25° Maximum Tilt Angle

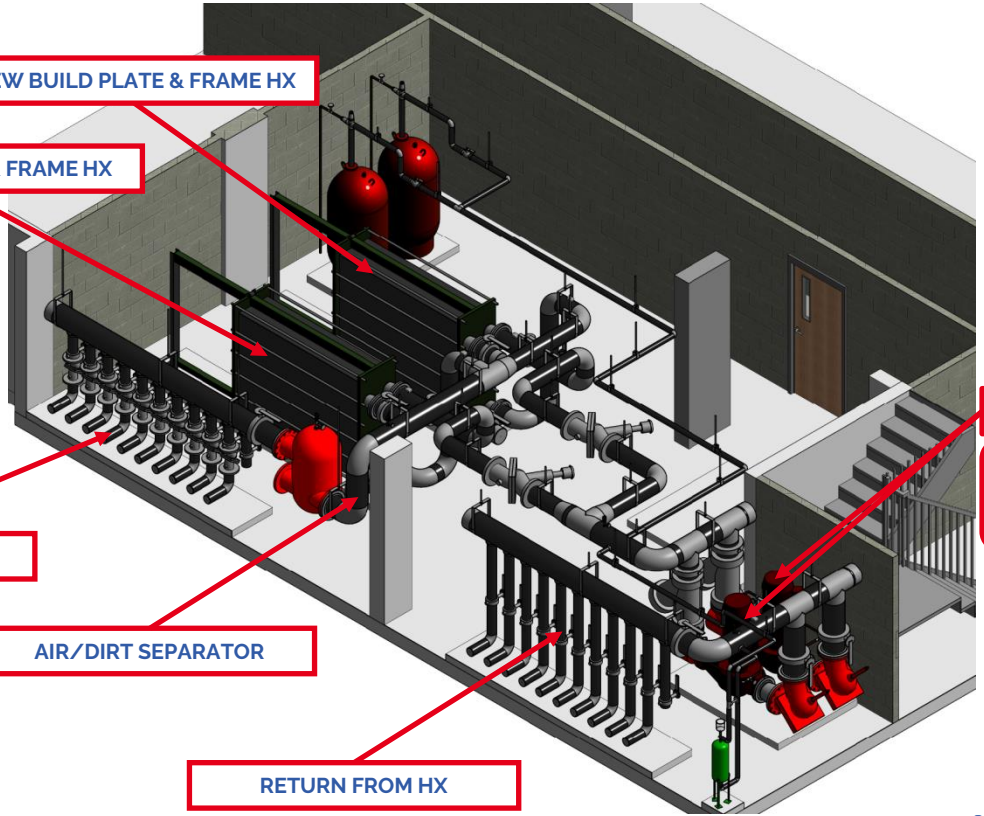
CUSTOM GPS ALIGNMENT SYSTEM

Angled Drilling Implementation



GEOSOURCE

Geothermal Mechanical Station



NEW BUILD PLATE & FRAME HX

RETROFIT PLATE & FRAME HX

SUPPLY TO HX

AIR/DIRT SEPARATOR

RETURN FROM HX

PARALLEL CIRCULATION PUMPS

- Sensorless pump technology
- Demand-based pumping

Control & Data Acquisition

Control Strategy:

Feed Forward Demand-Based Pumping

Merged GHX and Pump Performance Maps

Data Acquisition & Analytics:

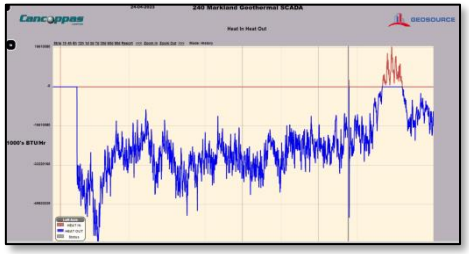
System Performance Logged on 5-min Intervals for 30+ years

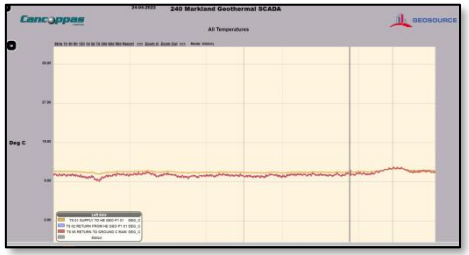
Data Analytics and Trends Available on Site and Remotely

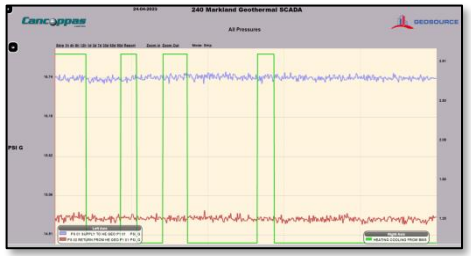
Future Functionality:

Dynamic Thermal Balance Management, via Thermal Imbalance Setpoint

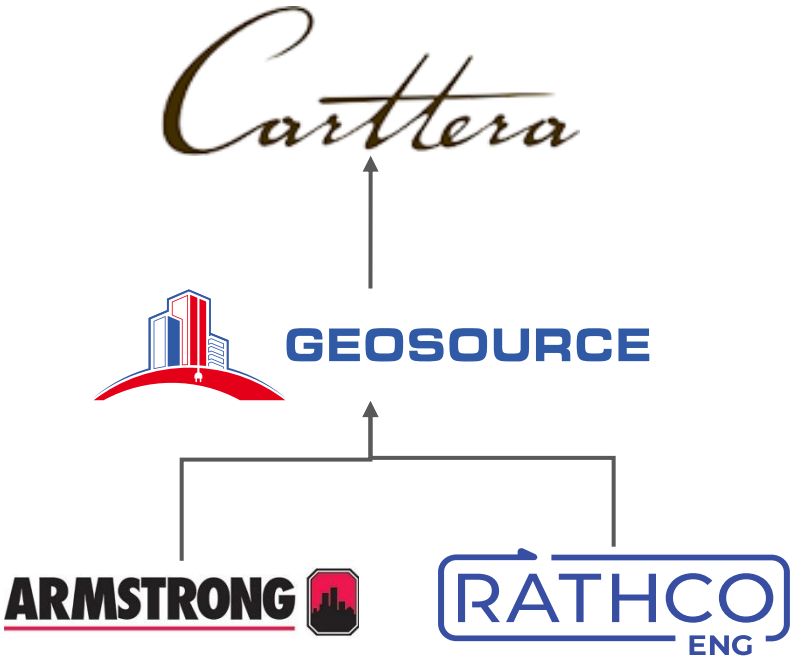
Future Machine Learning to Optimize System Performance Map







Project Delivery Model



Asset Ownership:

Carttera Owned Geothermal System, Capex Funded and Full Operational Savings Retained

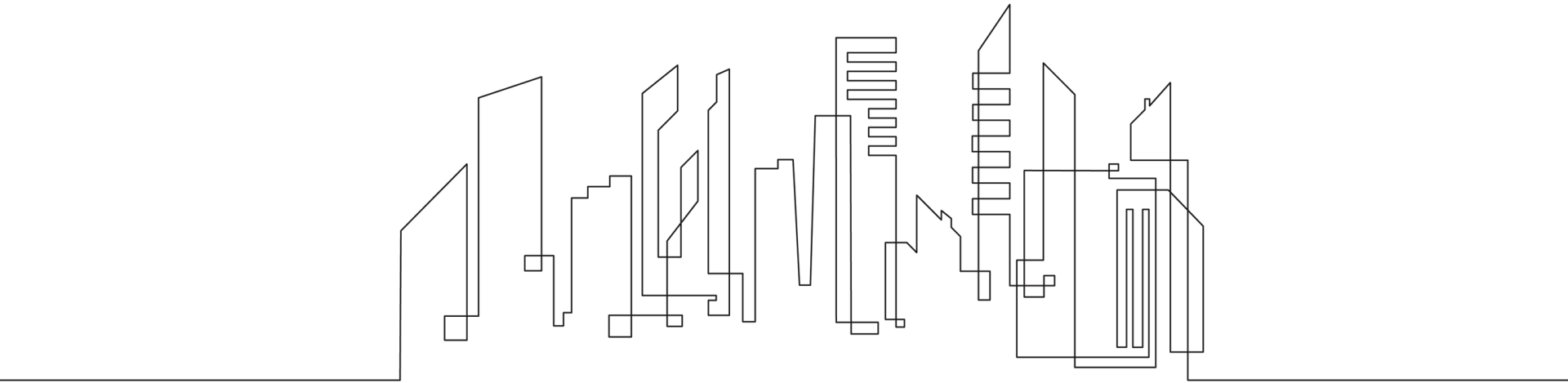
Asset Delivery:

Geosource Design-Built System, with Partners Rathco ENG and Armstrong Fluid Technology

Operational Support:

Geosource Retained to Operate the Asset, on Carttera' s behalf.

Including Building Operator Training, Monitor System Status, and Provide Semi Annual Performance Reports with Recommendations



Q&A

GEOSOURCE
Innovating Infrastructure