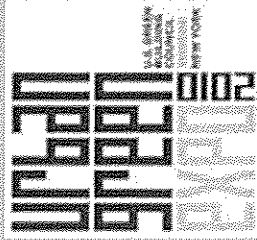


What is “Geothermal”?

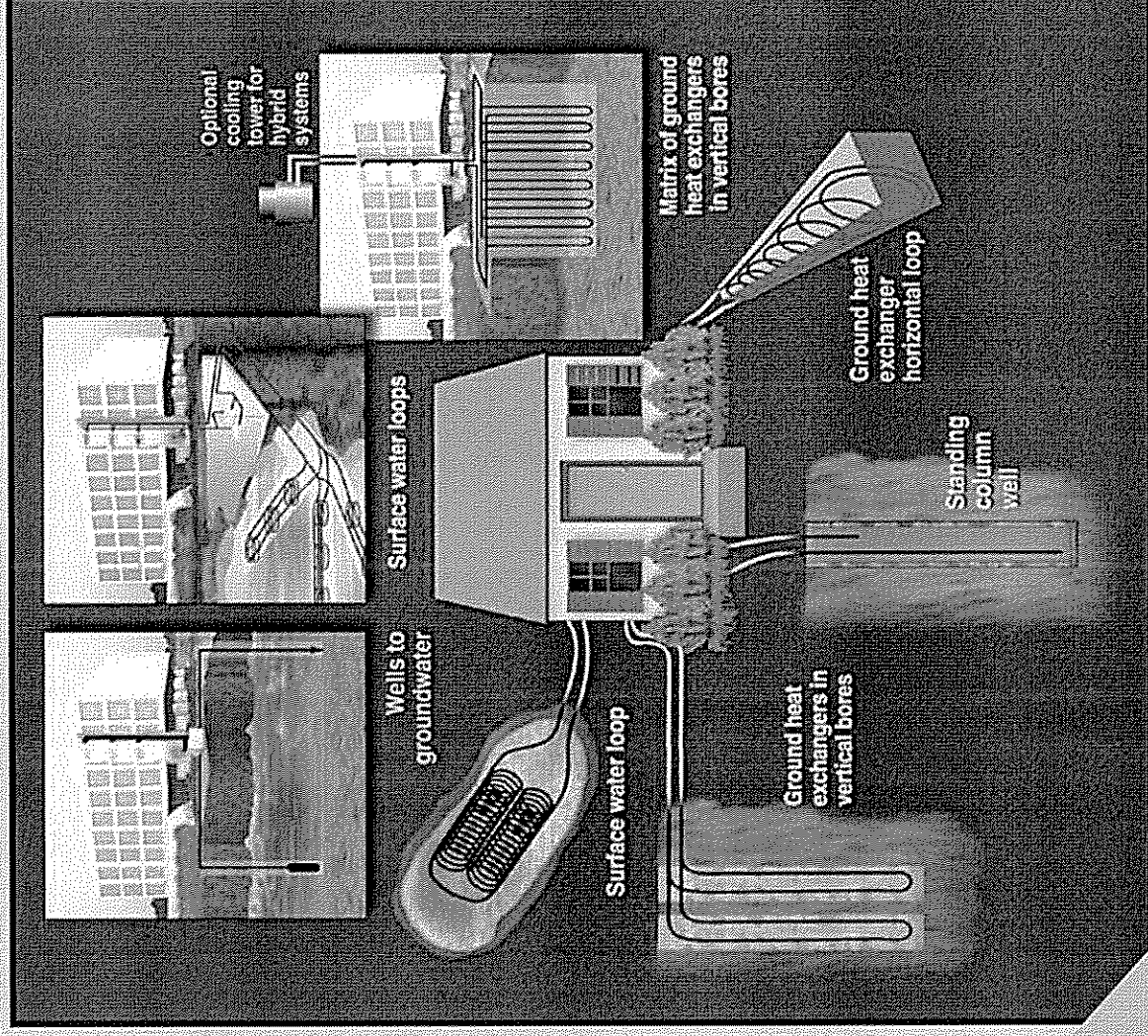
- Technically, means “earth heat” 2
- Several varieties of “geothermal” being tapped
- NYC geothermal primarily used for space conditioning...heating and cooling
- In NYC metro area, average earth temps. are moderate and stable, about 50-60 degrees F
- For heating, nearly limitless amount of heat energy contained in earth materials beneath us—soil, rock, groundwater
- For cooling, these same earth materials serve as a “sink” to reject and store excess heat

John
Rhyner



GEOHERMAL
APPLICATIONS

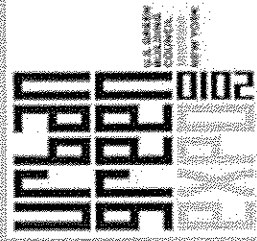
The type of *Ground Couplings* depends on site conditions



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APPLICATIONS

Source: US Dept. of Energy

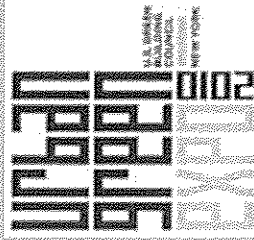
John
Rhyner



Due Diligence and Feasibility Analysis

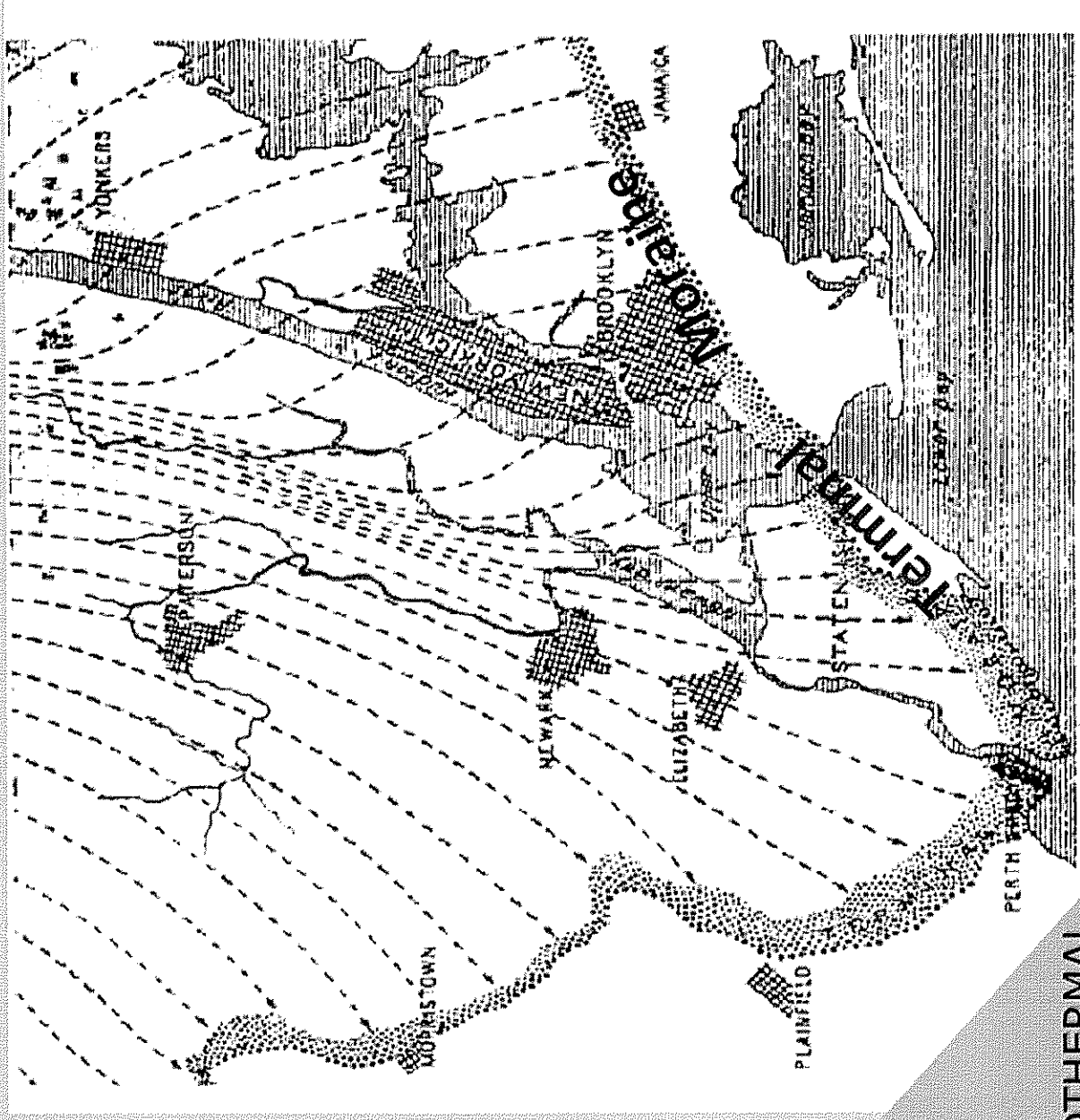
- Subsurface Geologic Conditions--The earth is NOT a black box!
- What's the estimated depth to bedrock and groundwater?
- Any city water tunnels nearby (500 feet)?
- What are the heating/cooling loads?
- Is there enough land area to drill to meet building peak demand?
- Any environmentally bad neighbors?
- Which ground couples are suited for site?

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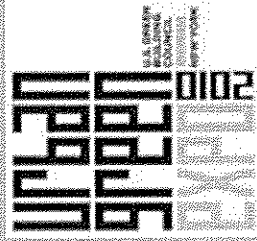


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NYC Geology – Glacial Age Ice Sheet

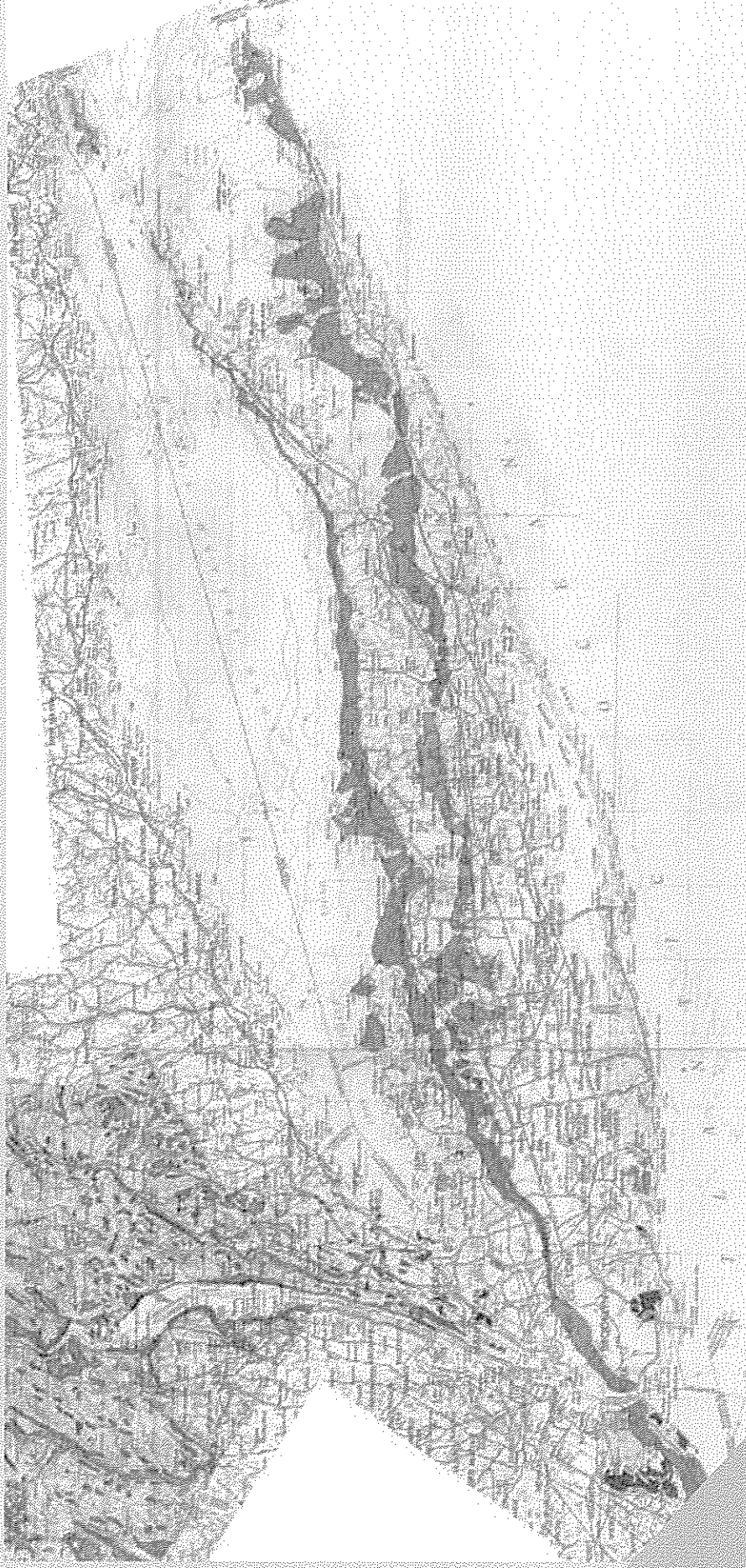


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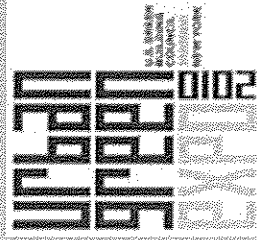


GEOHERMAL
APPLICATIONS

Surficial Glacial Deposits – NYC and Long Island

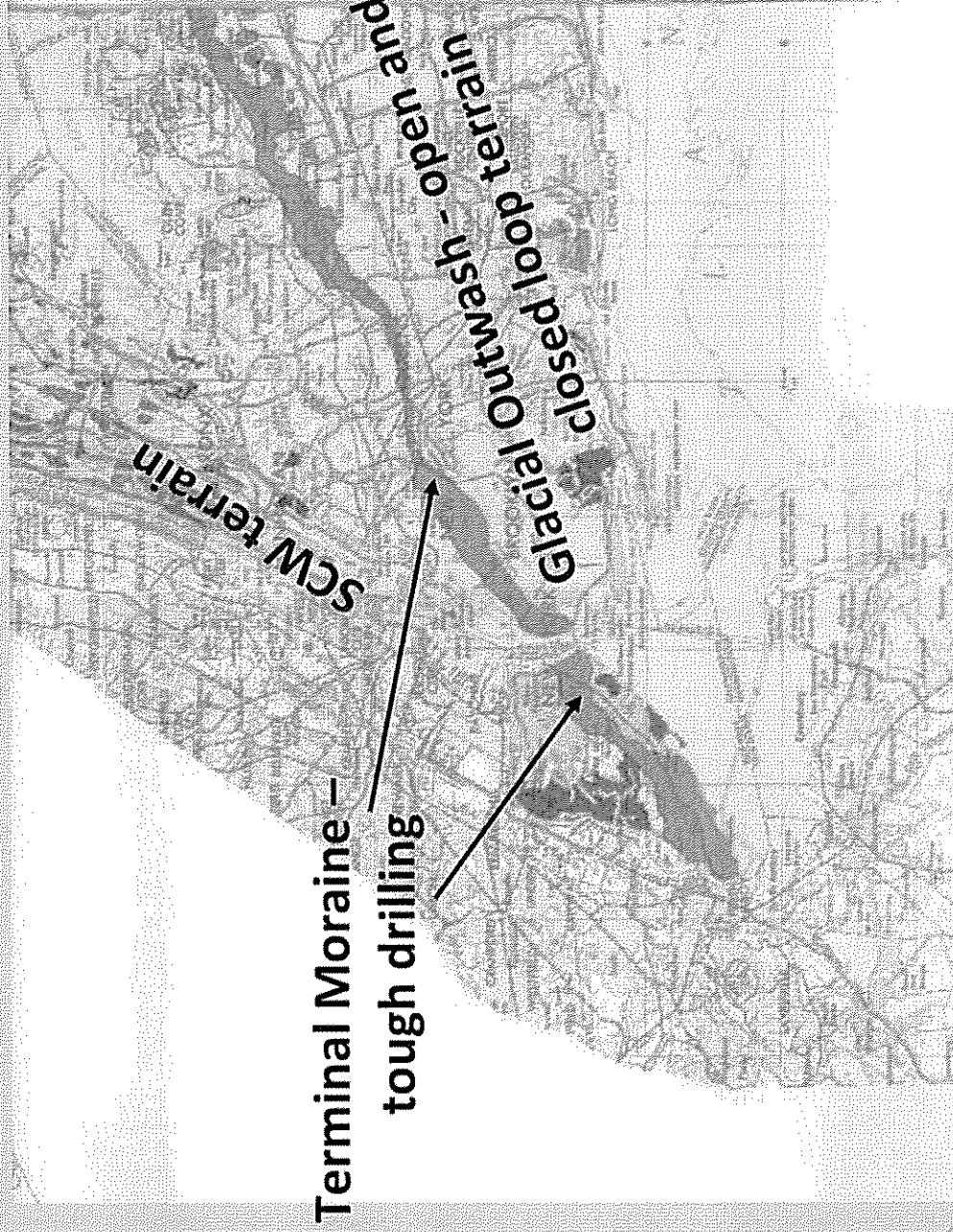


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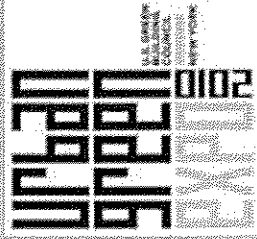


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APPLICATIONS

Surficial Glacial Deposits – New York City

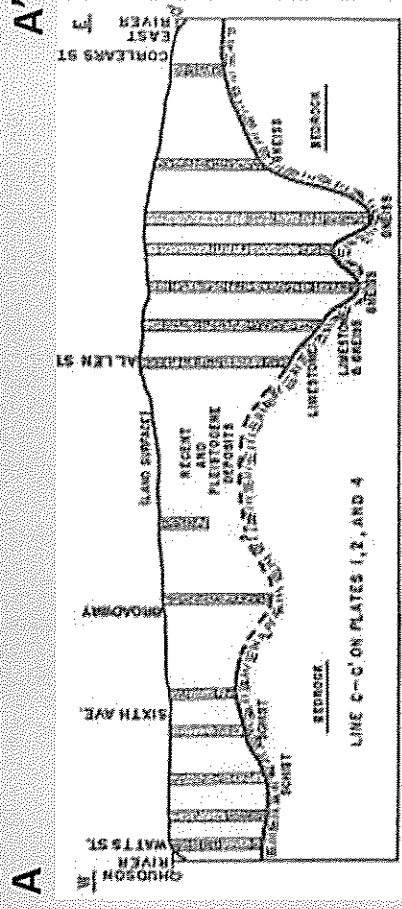


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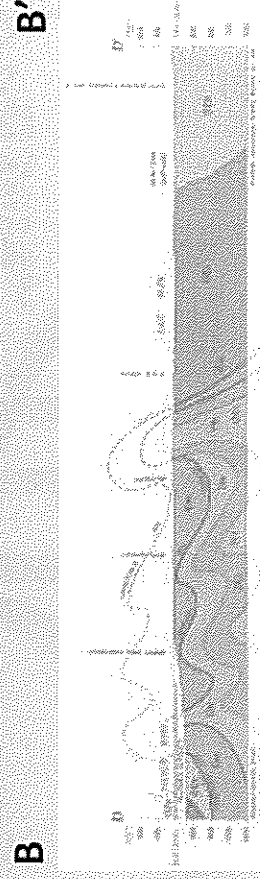


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APPLICATIONS

South Manhattan Geology

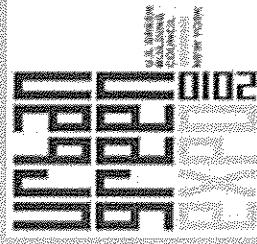


Canal St. Glacial
Outwash Deposits



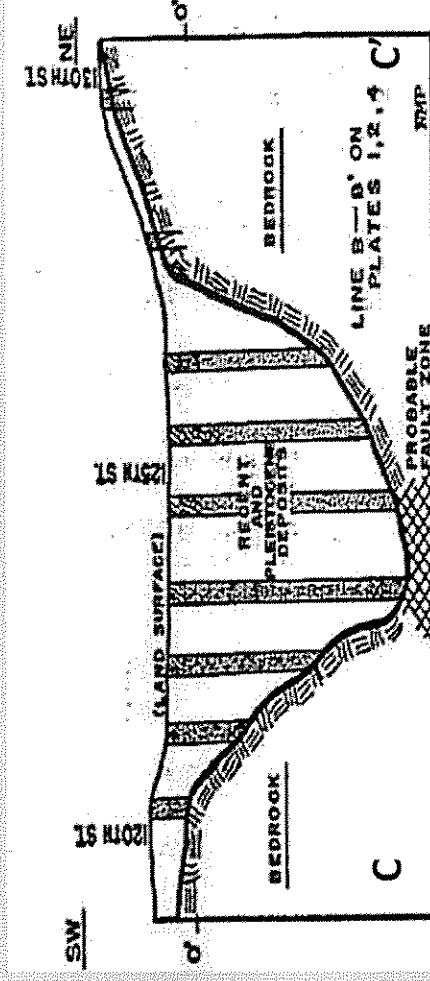
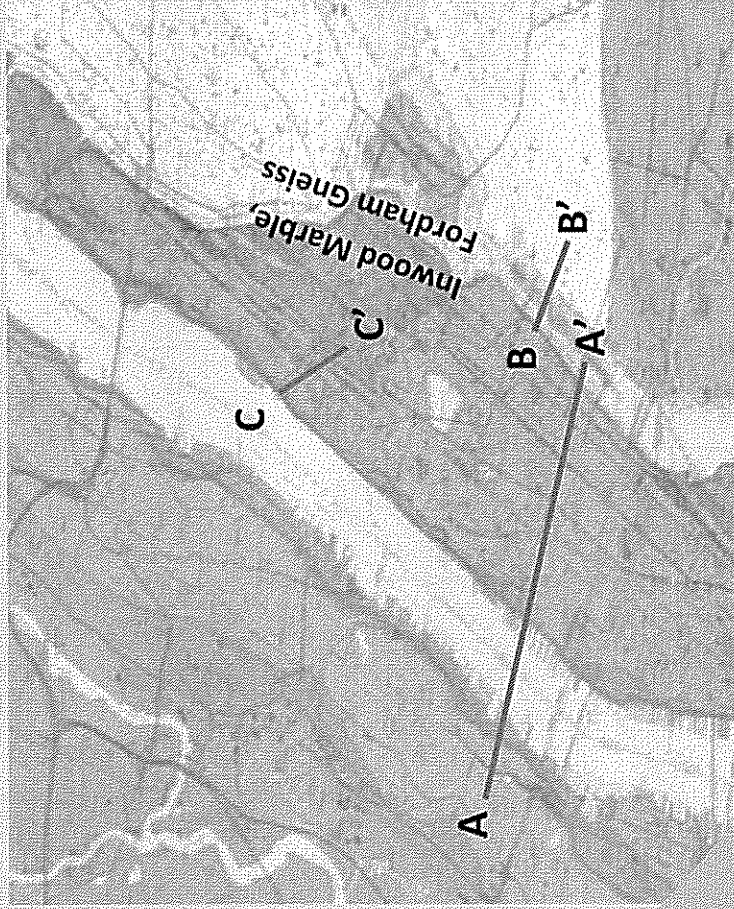
Bedrock Section

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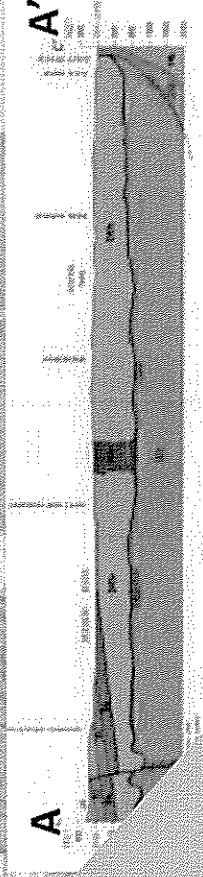


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APPLICATIONS

Central Manhattan Geology

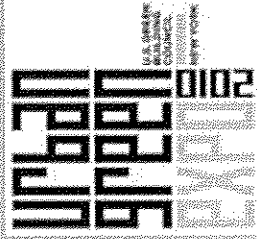


125th St Glacial Outwash Deposits

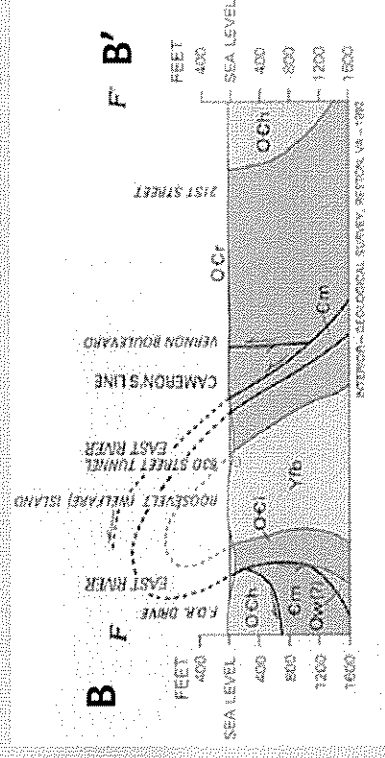


Midtown

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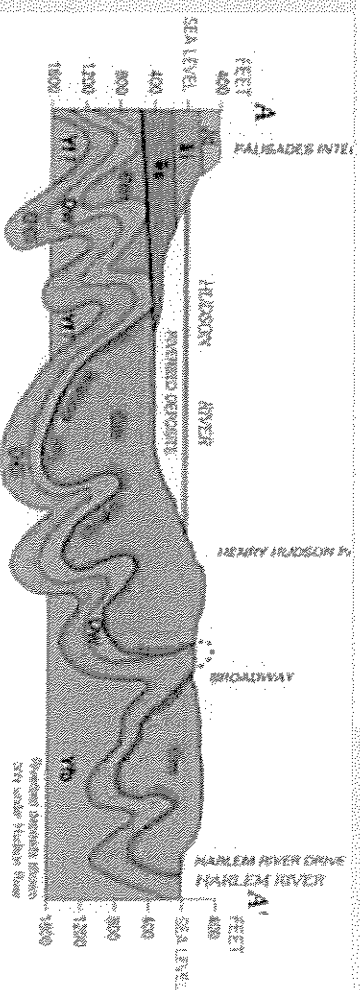
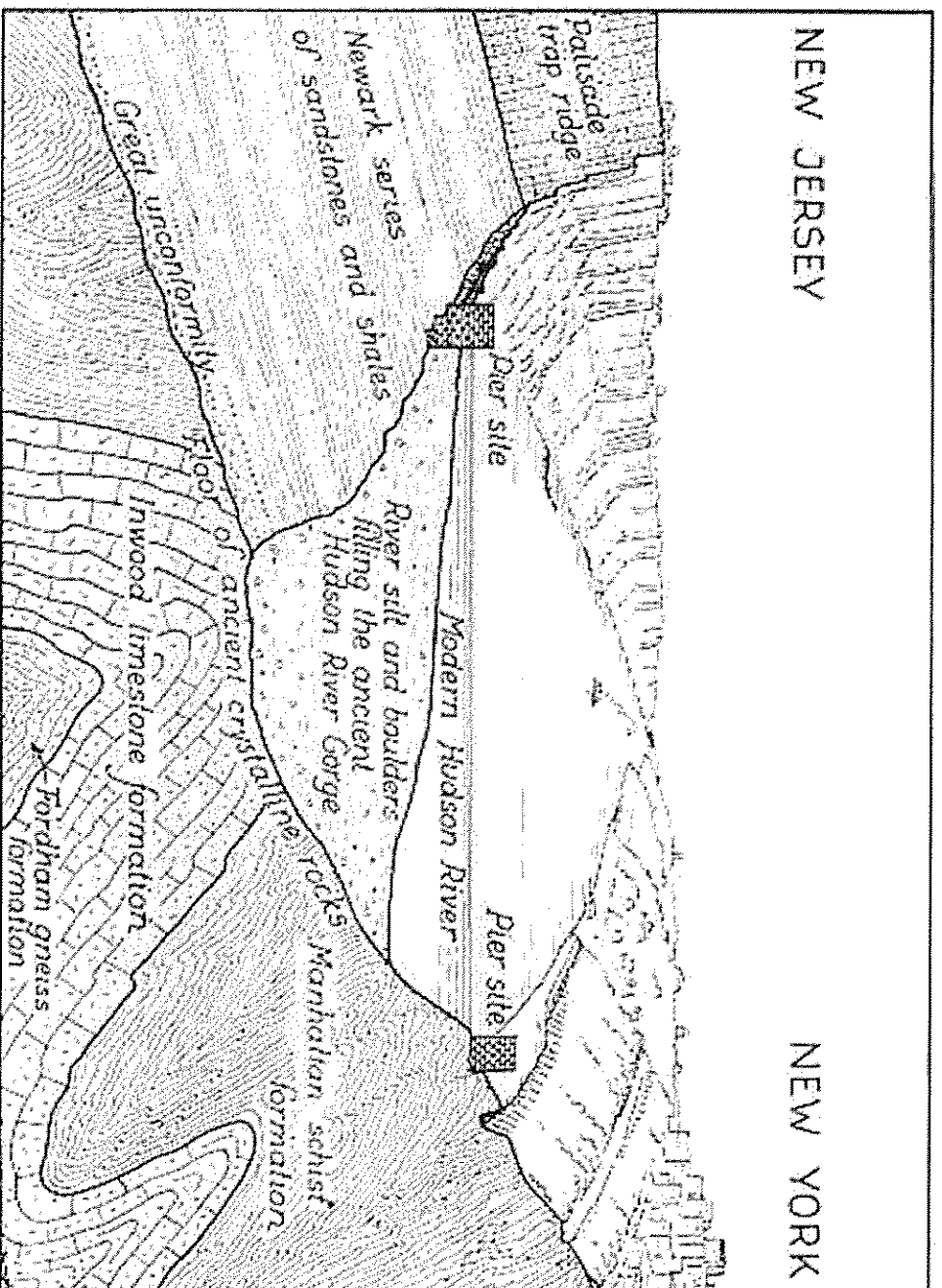


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APPLICATIONS

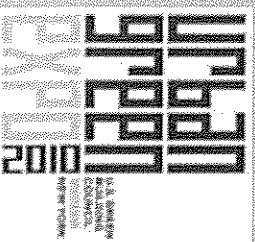


Roosevelt Island

George Washington Bridge Crossing

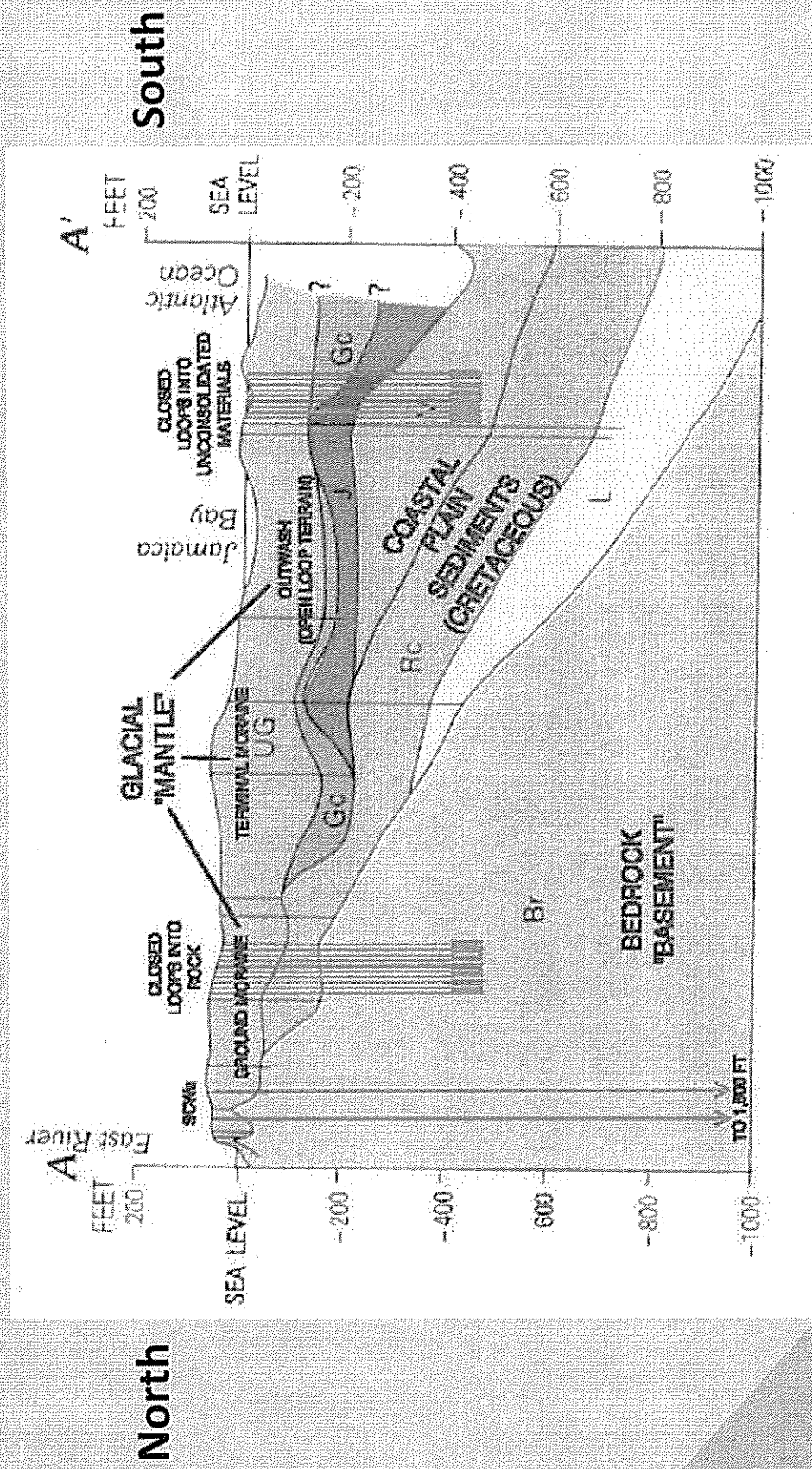


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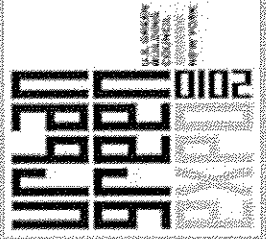


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Brooklyn and Queens Geology

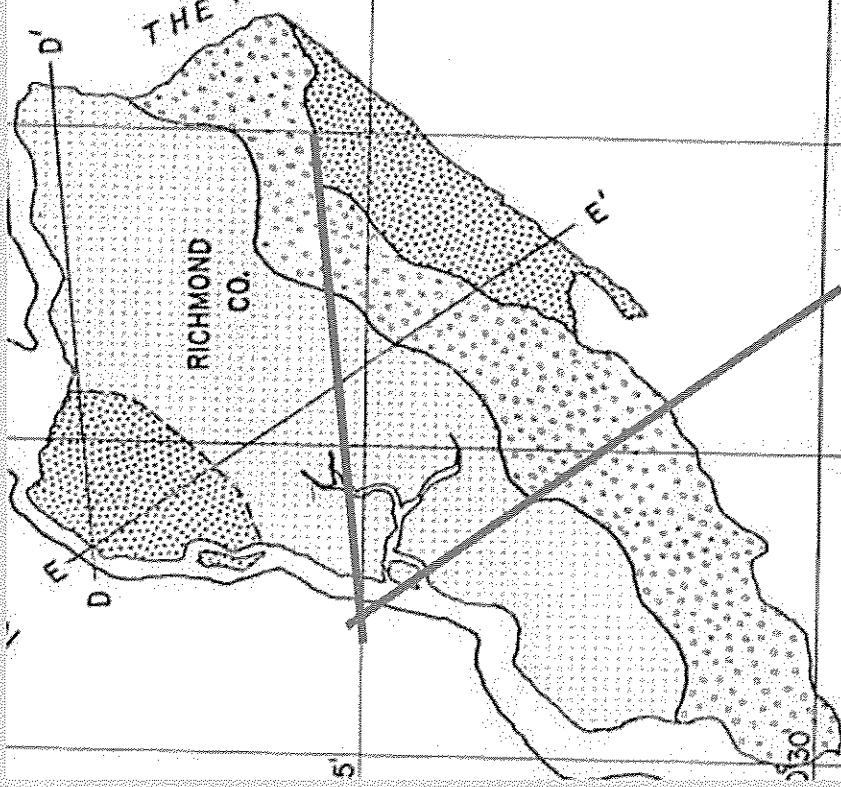


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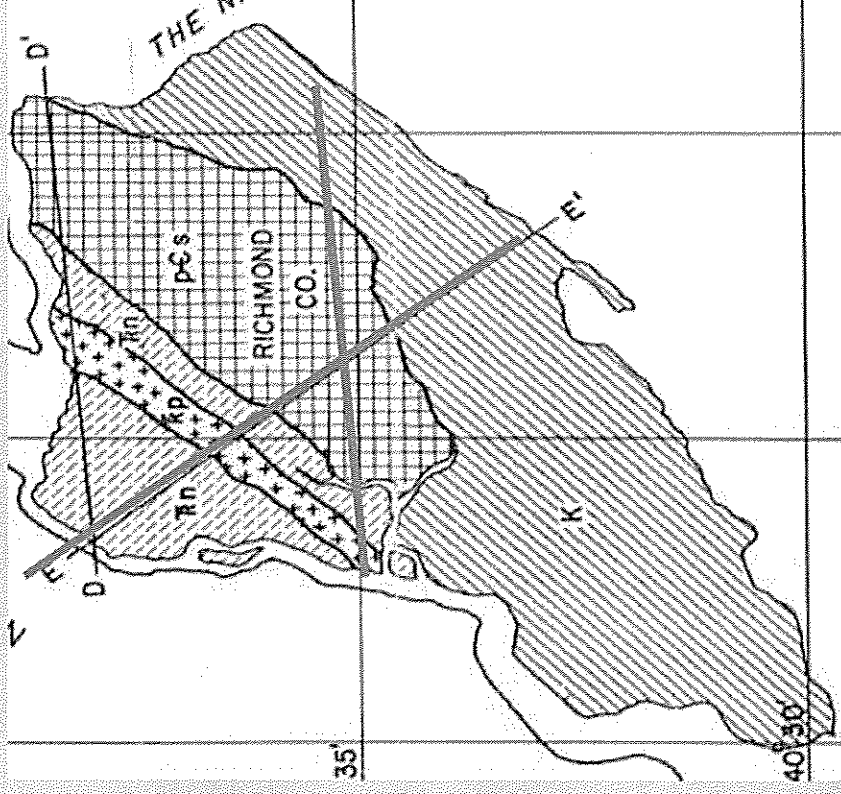


GEOHERMAL
APPLICATIONS

Staten Island Geology

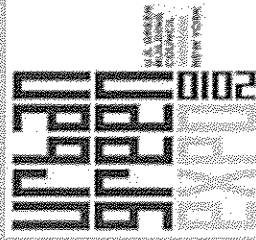


Surficial Glacial Geology



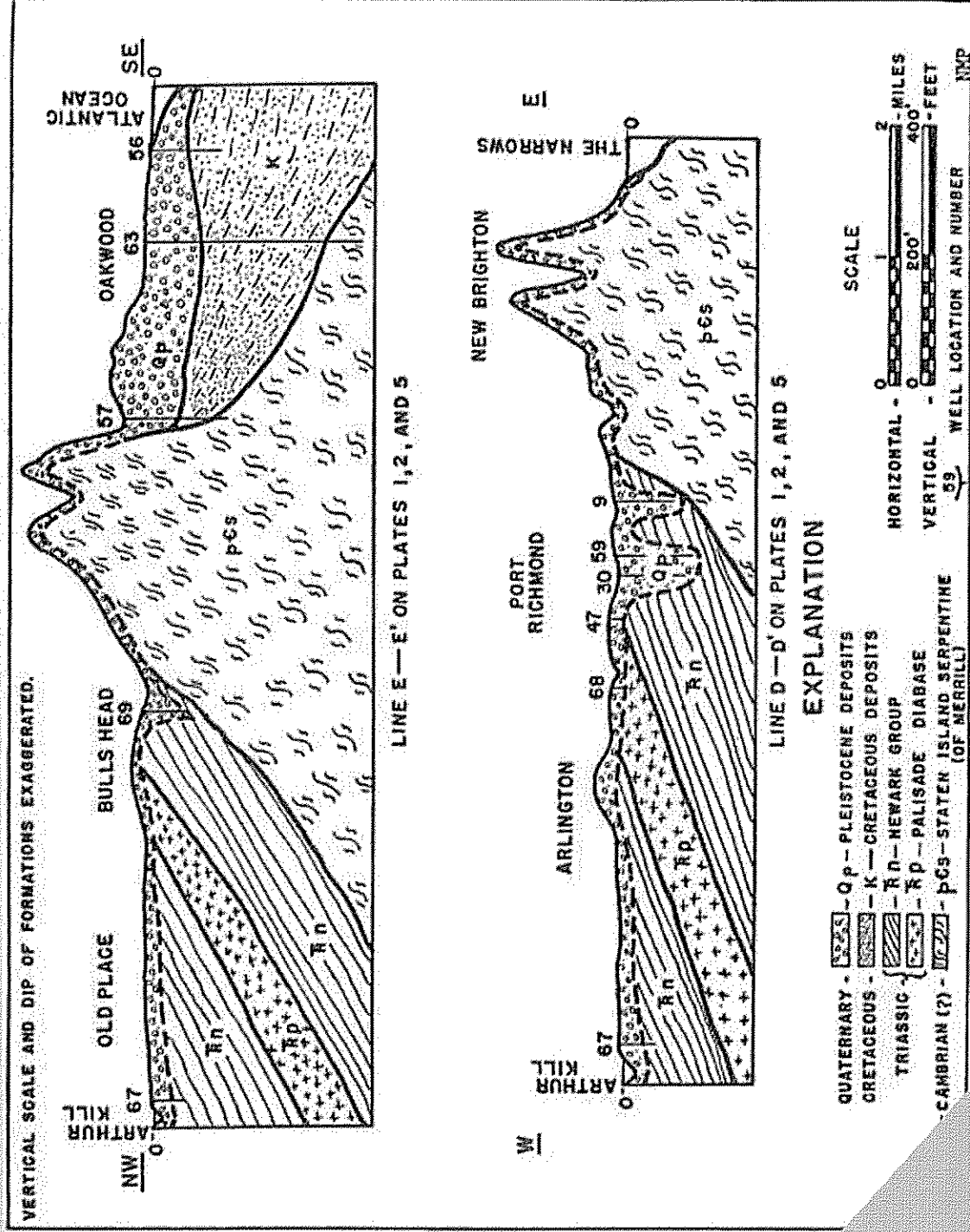
Bedrock Geology

John
Rhyner

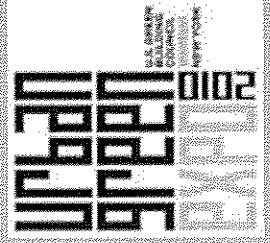


GEO THERMAL
APPLICATIONS

Staten Island Geology

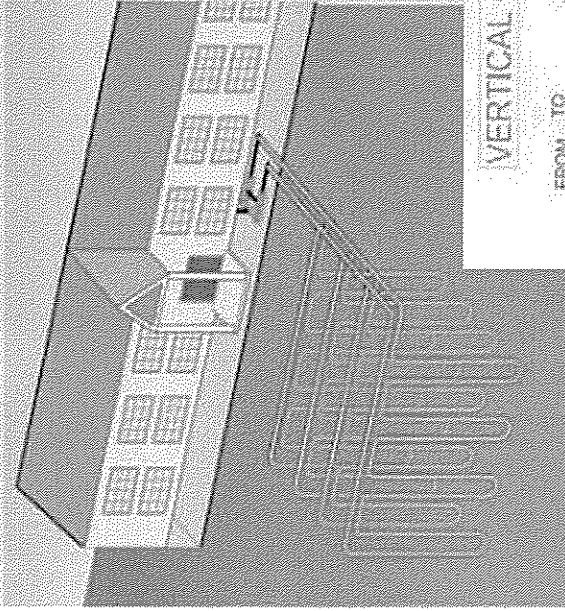


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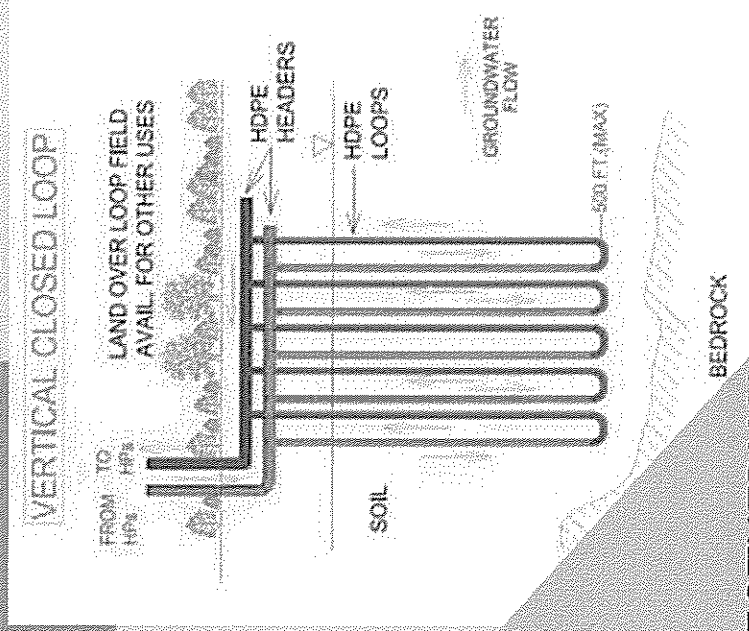


GEOHERMAL
APPLICATIONS

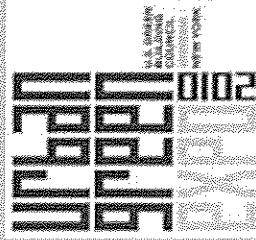
Vertical Closed Loop



- Drilled boreholes with plastic piping inserted
- Typical depths: 150-500 feet
- Use water or water and non-toxic antifreeze as heat carrier
- Heat exchange by conduction into/ from ground
- Piping system sealed off from environment
- Not affected by groundwater quality
- Low maintenance but large land area required compared to other options
- More drilling required thus higher install costs.

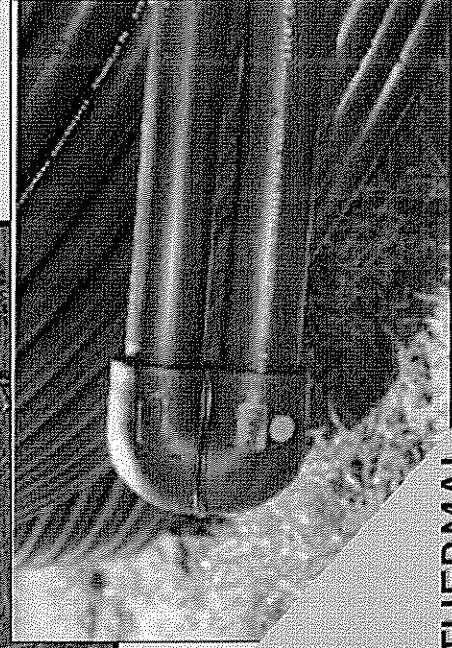
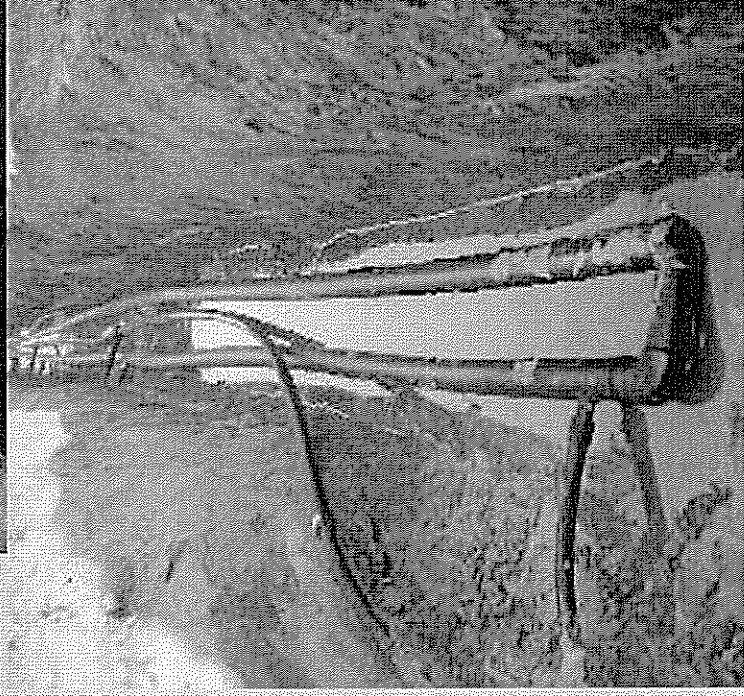
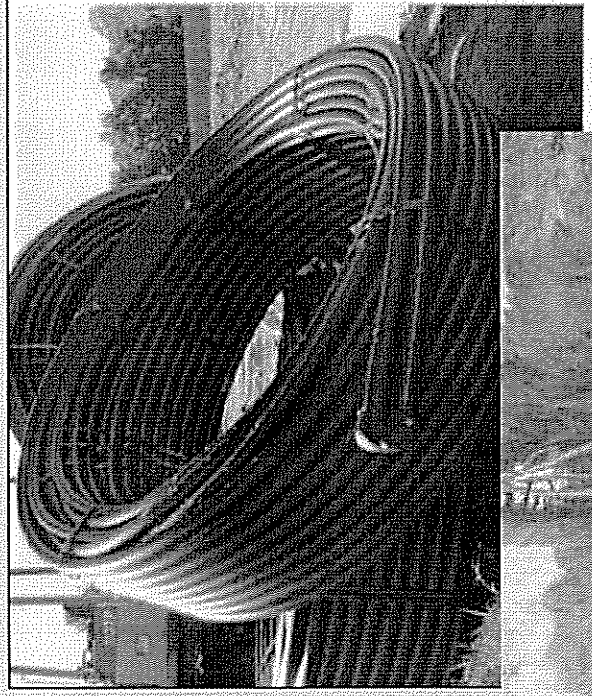


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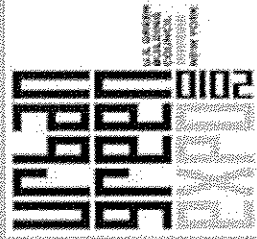


GEOHERMAL
APPLICATIONS

Vertical Loop Field Installation



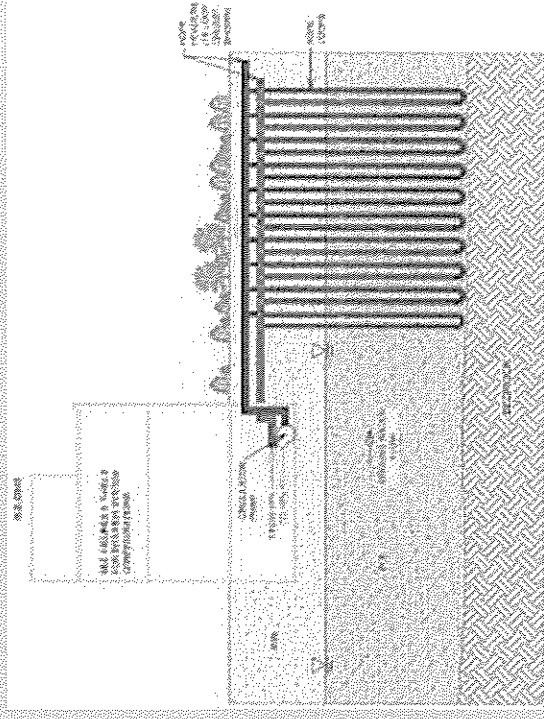
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Vertical Closed Loop

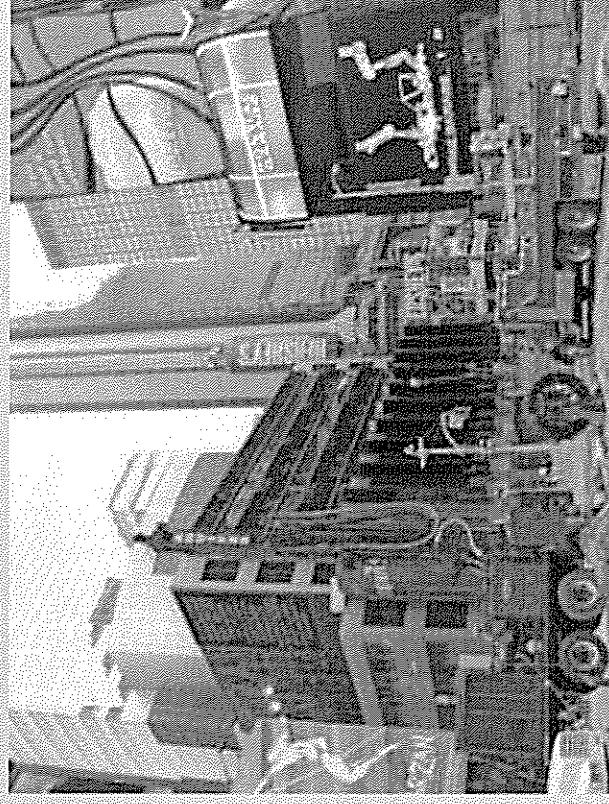
TKTS Booth, Times Square



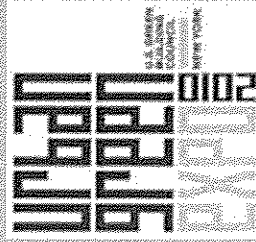
Drilling in progress



View of the heat pumps



John Rhynes

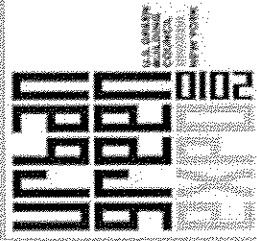


Closed Loop Feasibility in New York City

- Feasible in all boroughs
- Premium if rock deep, loops must go into rock
- Lloyd Protected Aquifer



John
Rhyner

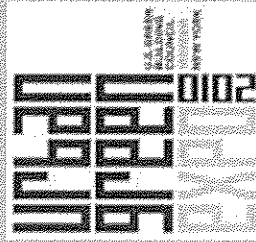


GEOHERMAL
APPLICATIONS

Open Loop

- Need a highly productive aquifer—sand and gravel, not bedrock
- Separate wells enough to prevent “thermal breakthrough”
- Poor groundwater quality can be a project killer – high iron, organic carbon, VOCs, chlorides
- Need a test well with groundwater sampling and pumping test
- Wells must be accessible for O&M
- Greater O&M than closed systems
- Thermal capacity depends on flow rate

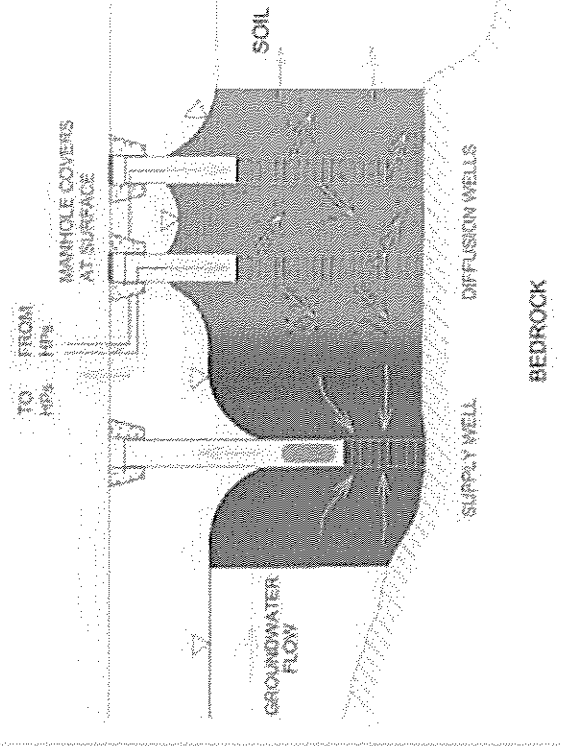
John
Rhyner



GEOHERMAL
APPLICATIONS



OPEN LOOP



Open Loop

Esquire Building, Williamsburg, Brooklyn
– 70 condominium units

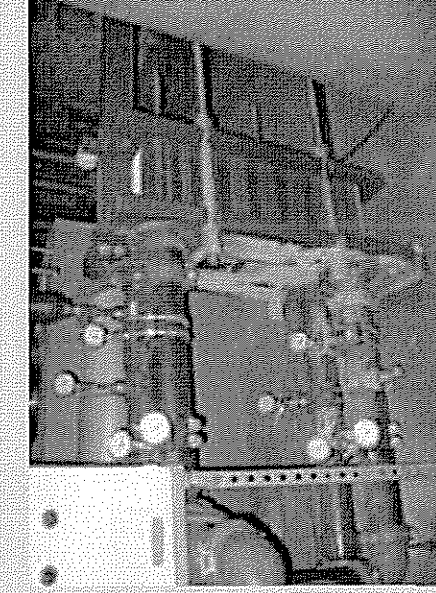
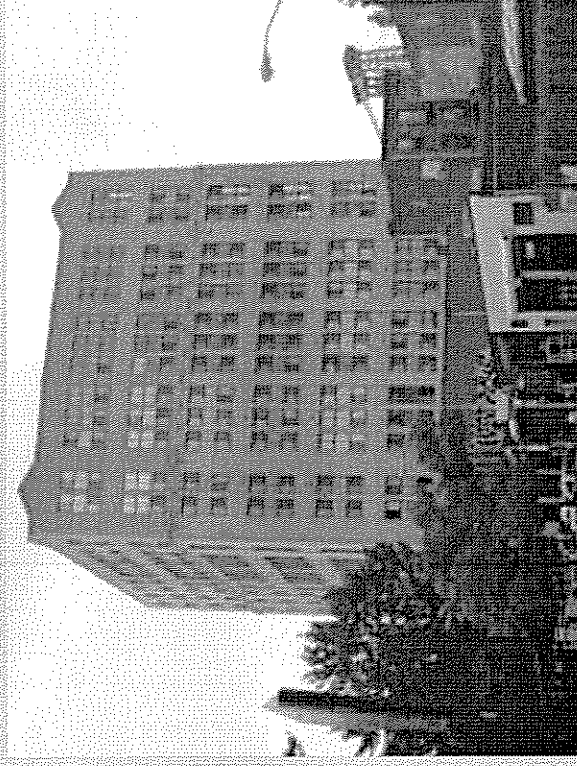
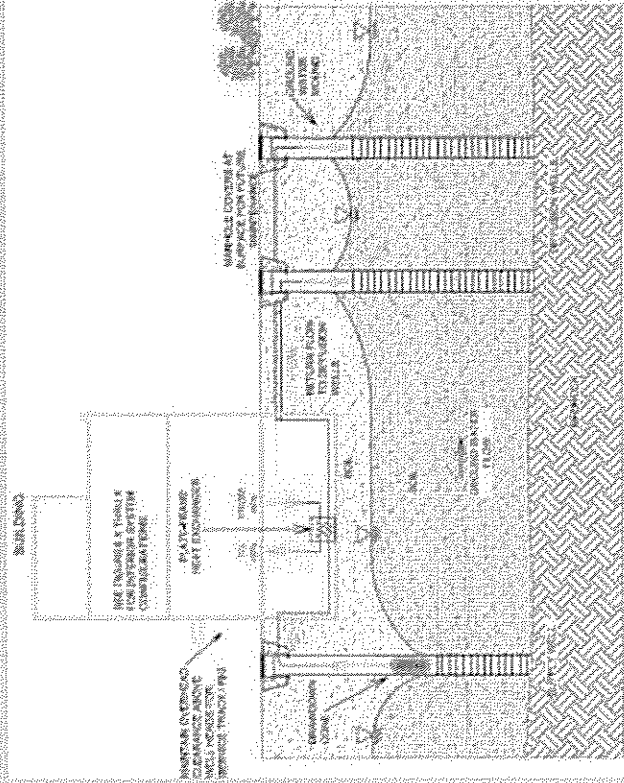
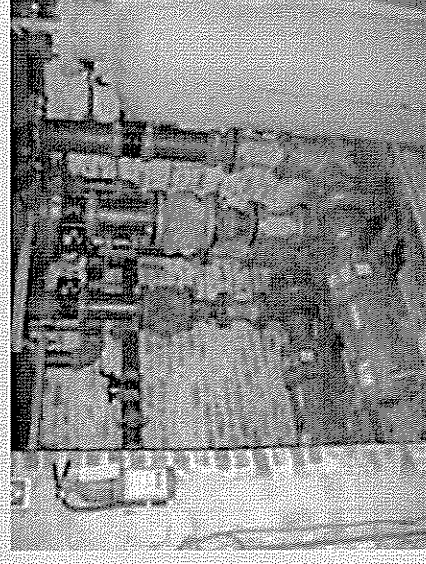
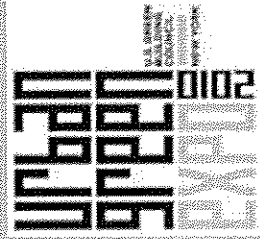


Plate-frame heat exchanger



Building loop circulator pumps

John
Rhyner



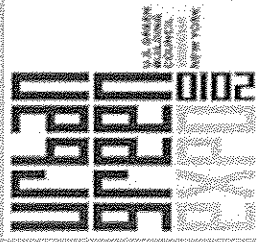
GEO THERMAL
APPLICATIONS

Open Loop Feasibility in New York City

- Feasible throughout Brooklyn and Queens, parts of Manhattan and SI



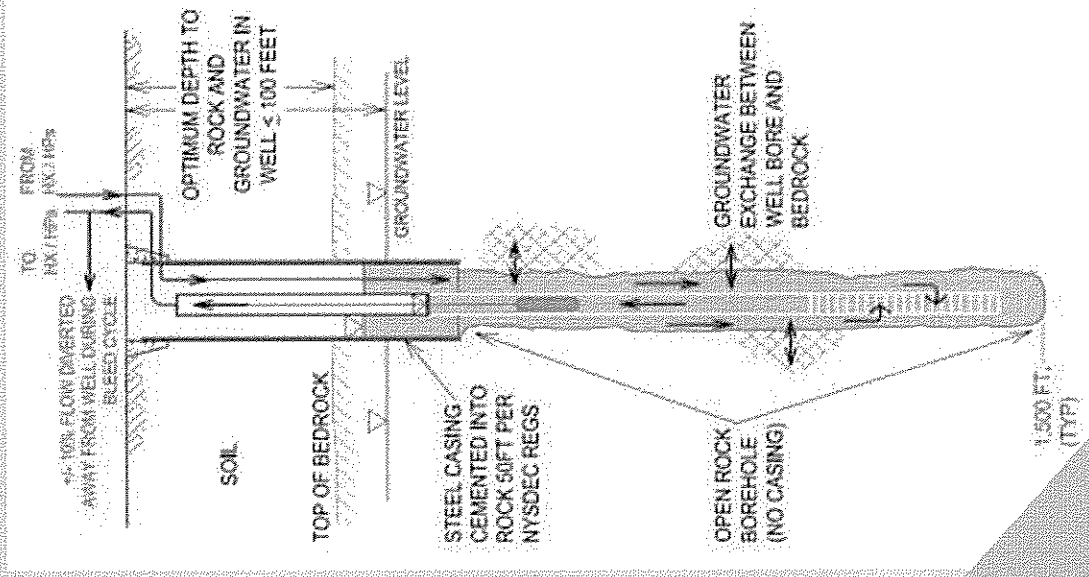
John
Rhynier



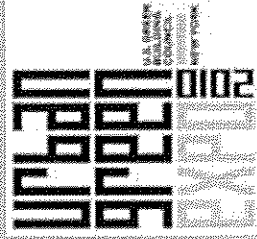
GEOHERMAL
APPLICATIONS

Standing Column Wells (SCWs)

- Groundwater “re-circulating” well
- 8-inch diameter “free standing” rock borehole
- Drilled to typ. depths of 1500-1800 feet
- Bedrock and groundwater should be < 100 ft deep
- Potential biggest thermal “bang for the buck,” up to 40+ tons (at optimum bleed)
- Space wells 50+ feet apart
- Don’t count on getting the desired bleed, low end capacity of approx. 15-20 tons per well with no bleed

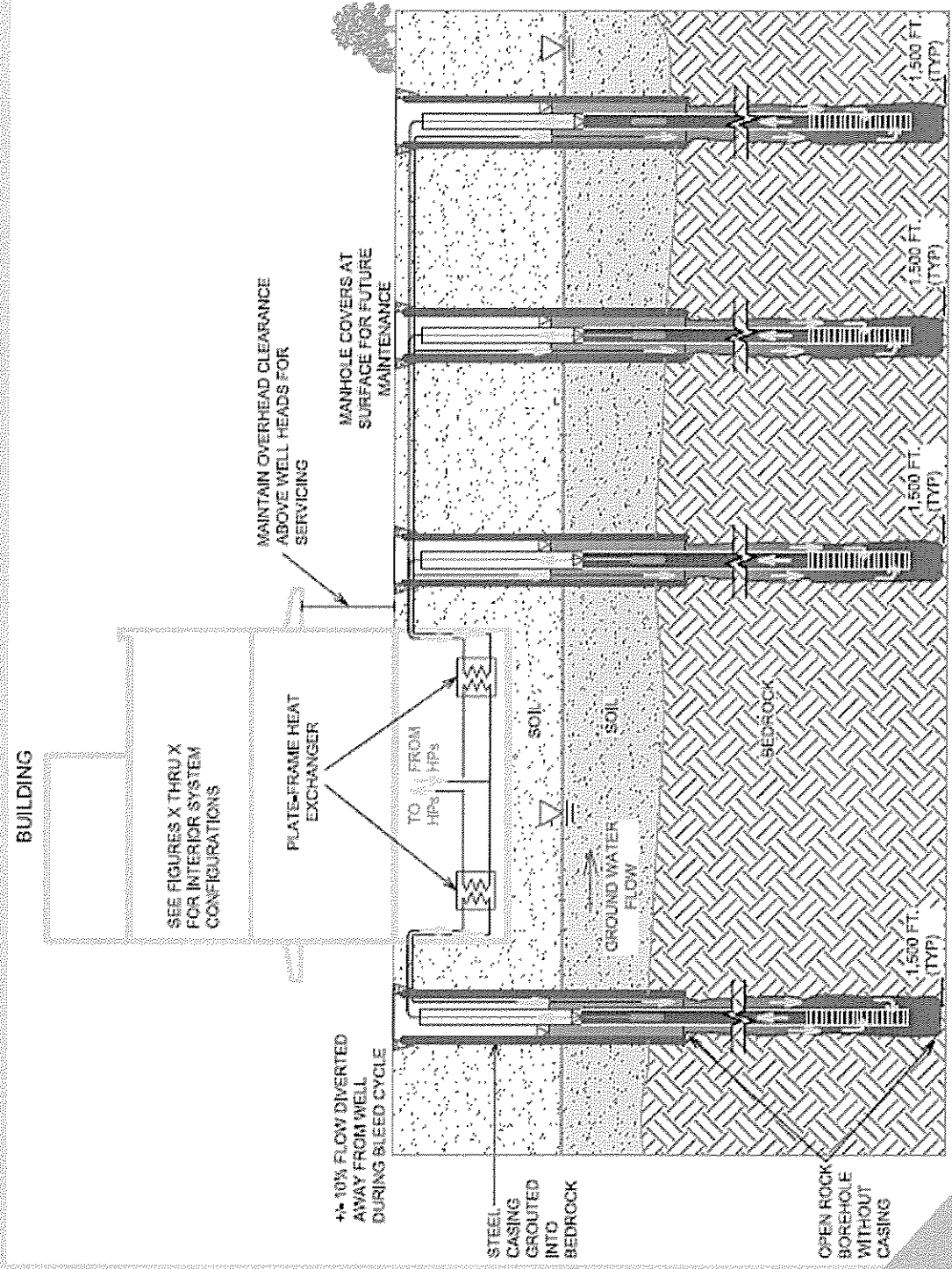


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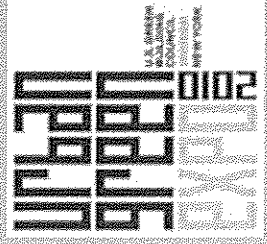


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Standing Column Wells



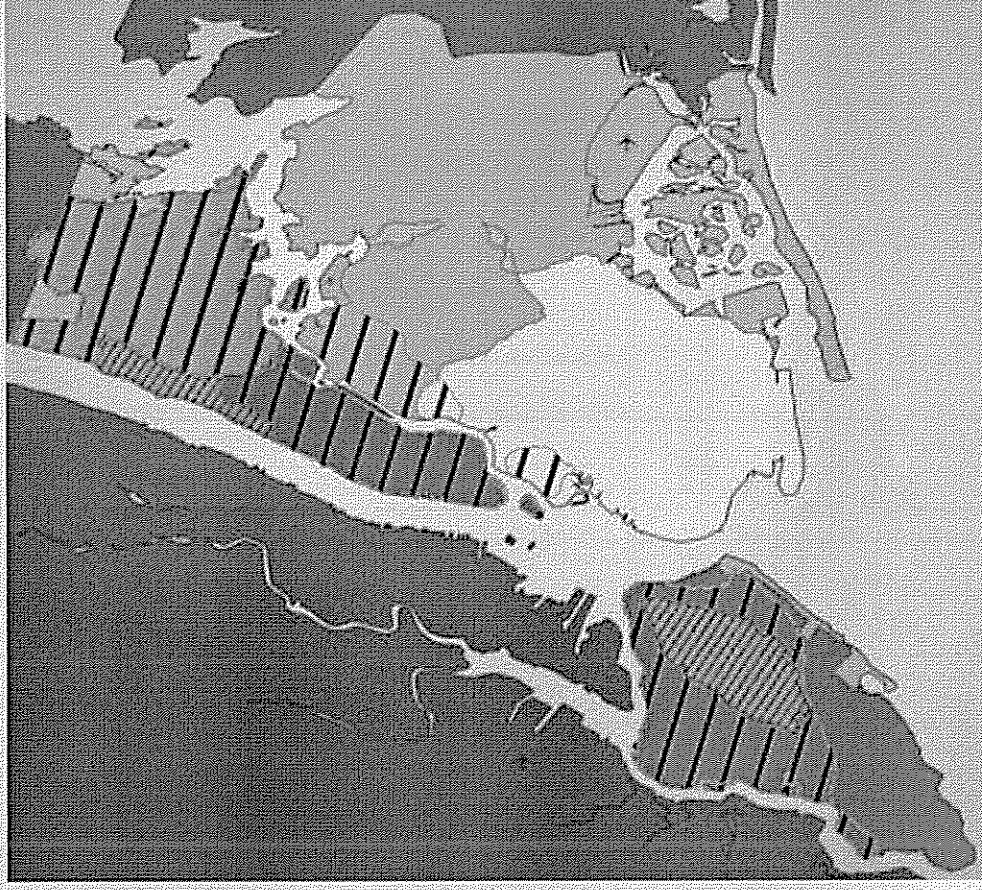
John
Rhynier



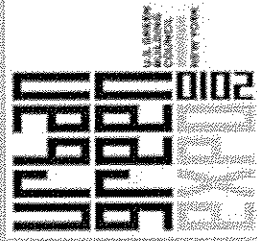
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Standing Column Well Feasibility in New York City

- Feasible mostly in Manhattan, Bronx, and SI
- Depth to ground water possibly too deep



John
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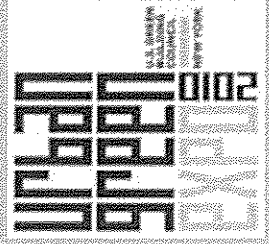


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APPLICATIONS

Ranking Ground Couplings

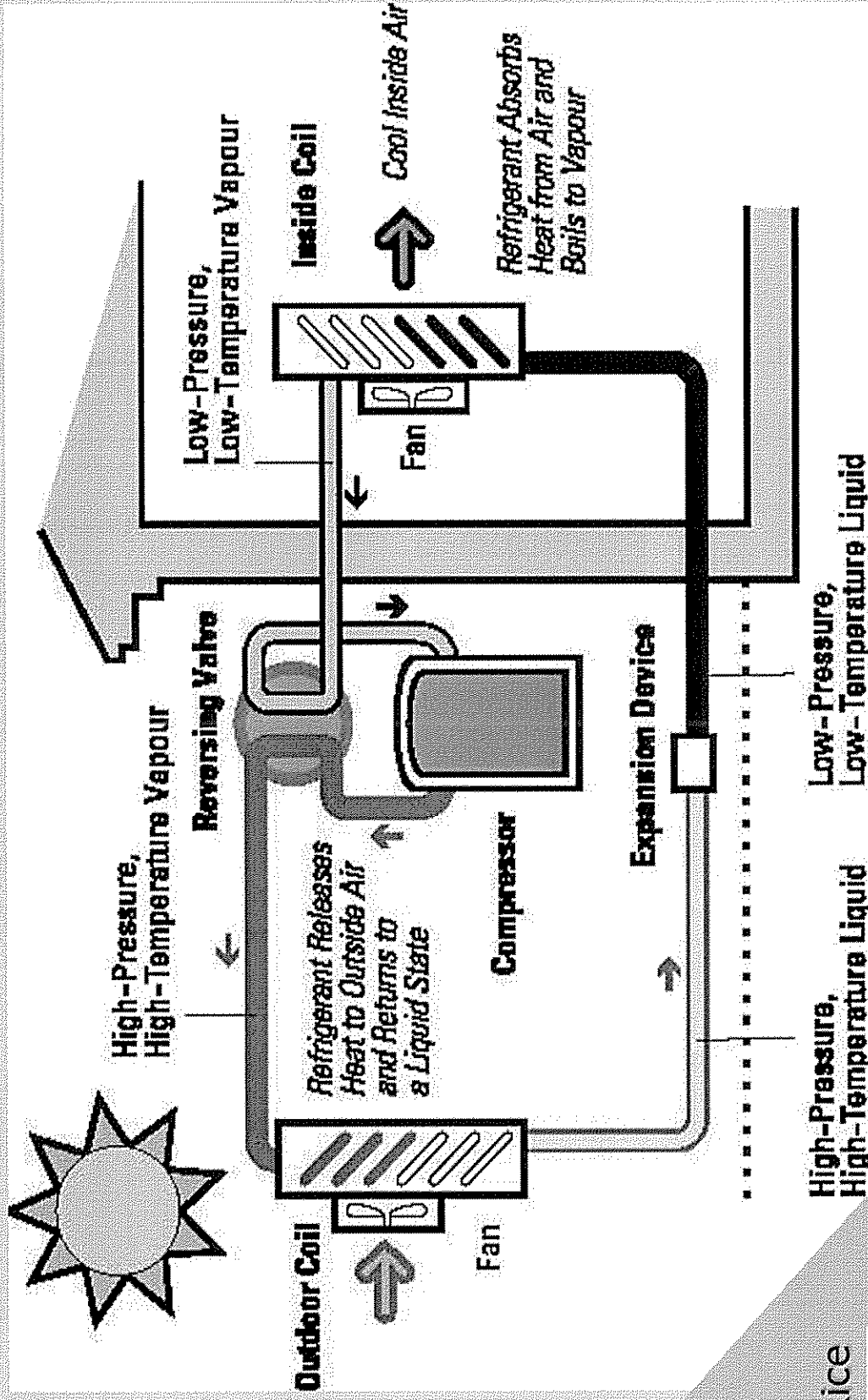
Considerations	Geothermal System Type		
	Vertical Closed Loop	Open Loop	Standing Column Well
Efficiency	LOWEST	HIGHEST	INTERMEDIATE
Reliability	HIGHEST	INTERMEDIATE	LOWEST
Drilling Cost	INTERMEDIATE	LOWEST	HIGHEST
Amount of Trenching	HIGHEST	LOWEST	INTERMEDIATE
Land Area Affected	HIGHEST	LOWEST	INTERMEDIATE
Amount of Field Testing	LOWEST	HIGHEST	INTERMEDIATE
Soft Costs	LOWEST	HIGHEST	INTERMEDIATE
Maintenance	LOWEST	HIGHEST	INTERMEDIATE
Effected by Ground Water Quality	NO	YES	YES

John
Rhynier

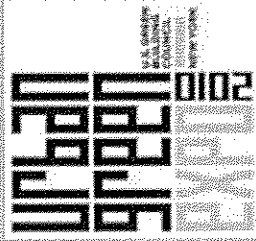


GEOHERMAL
APPLICATIONS

Heat Pump Refrigeration Cycle Cooling Cycle

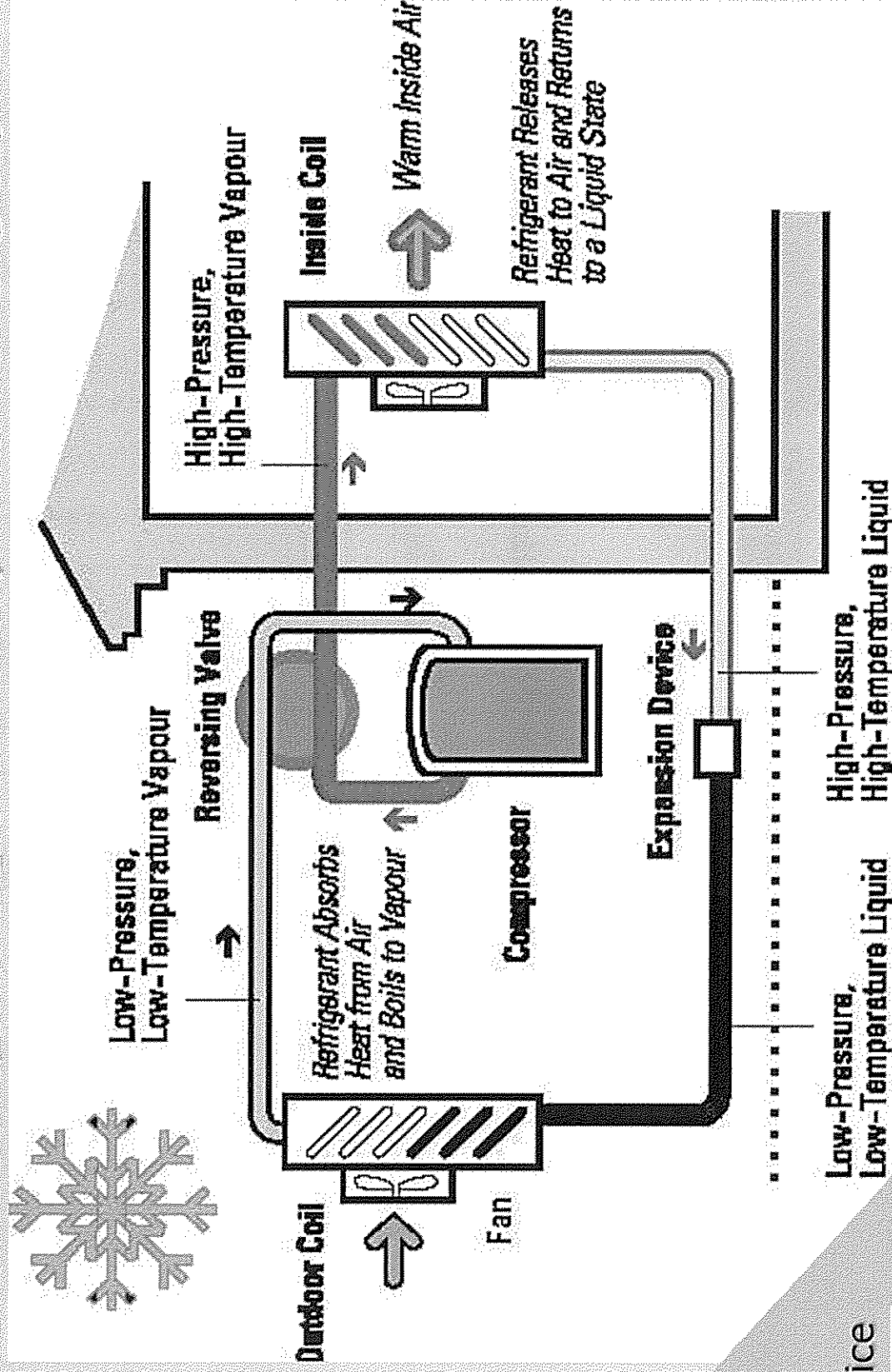


John Rice

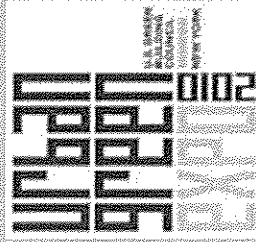


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APPLICATIONS

Heat Pump Refrigeration Cycle Heating Cycle

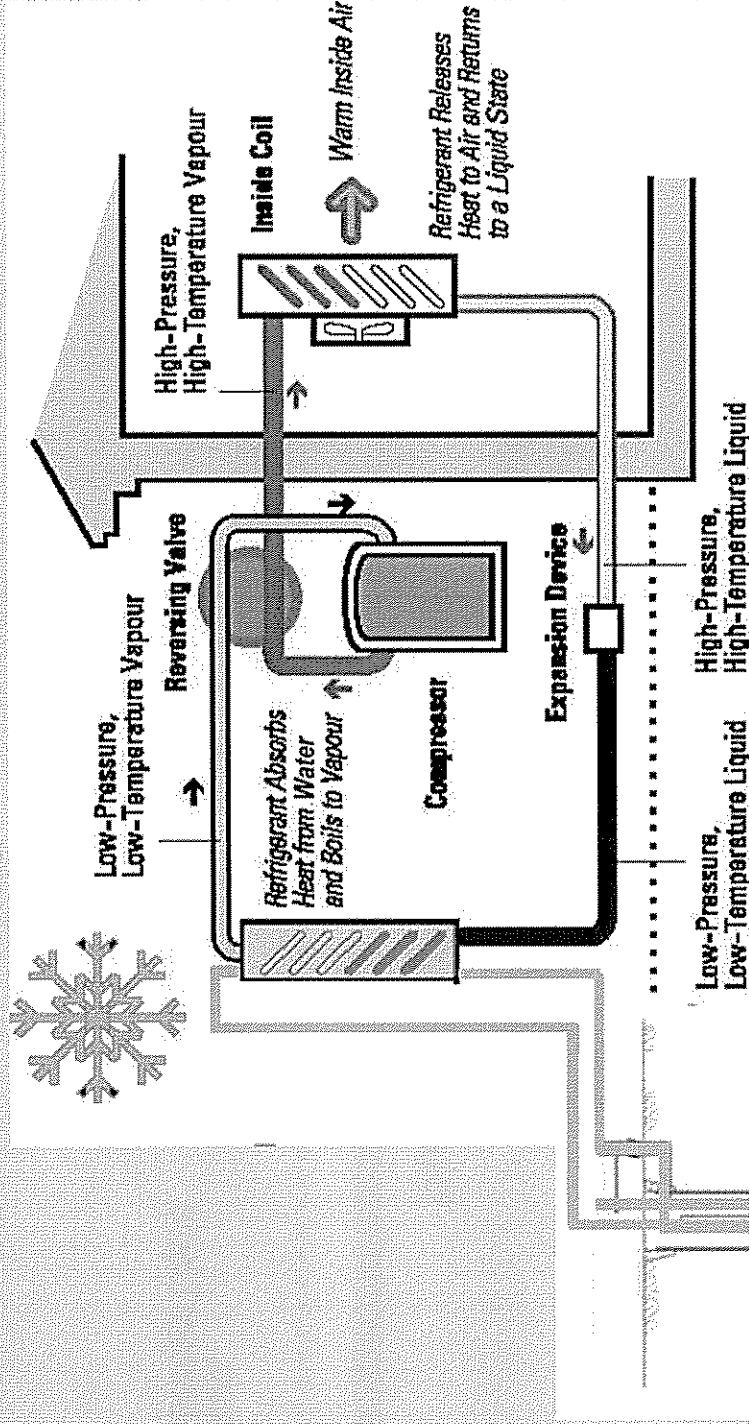


John Rice

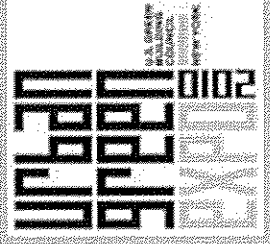


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APPLICATIONS

Geothermal Heat Pump – Water-to-Air

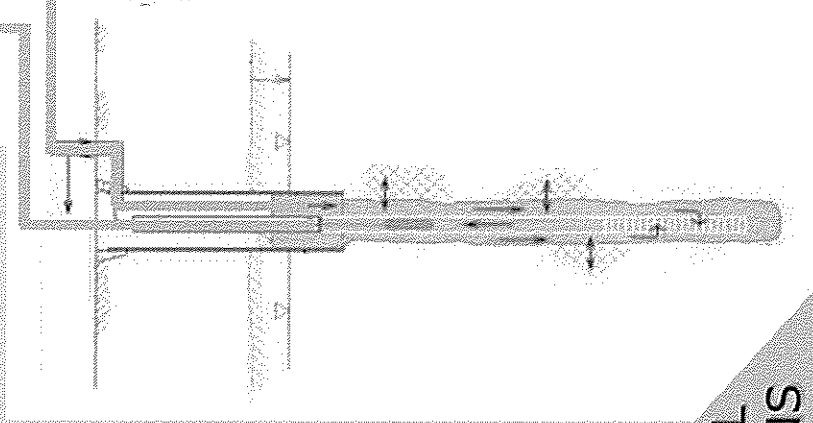
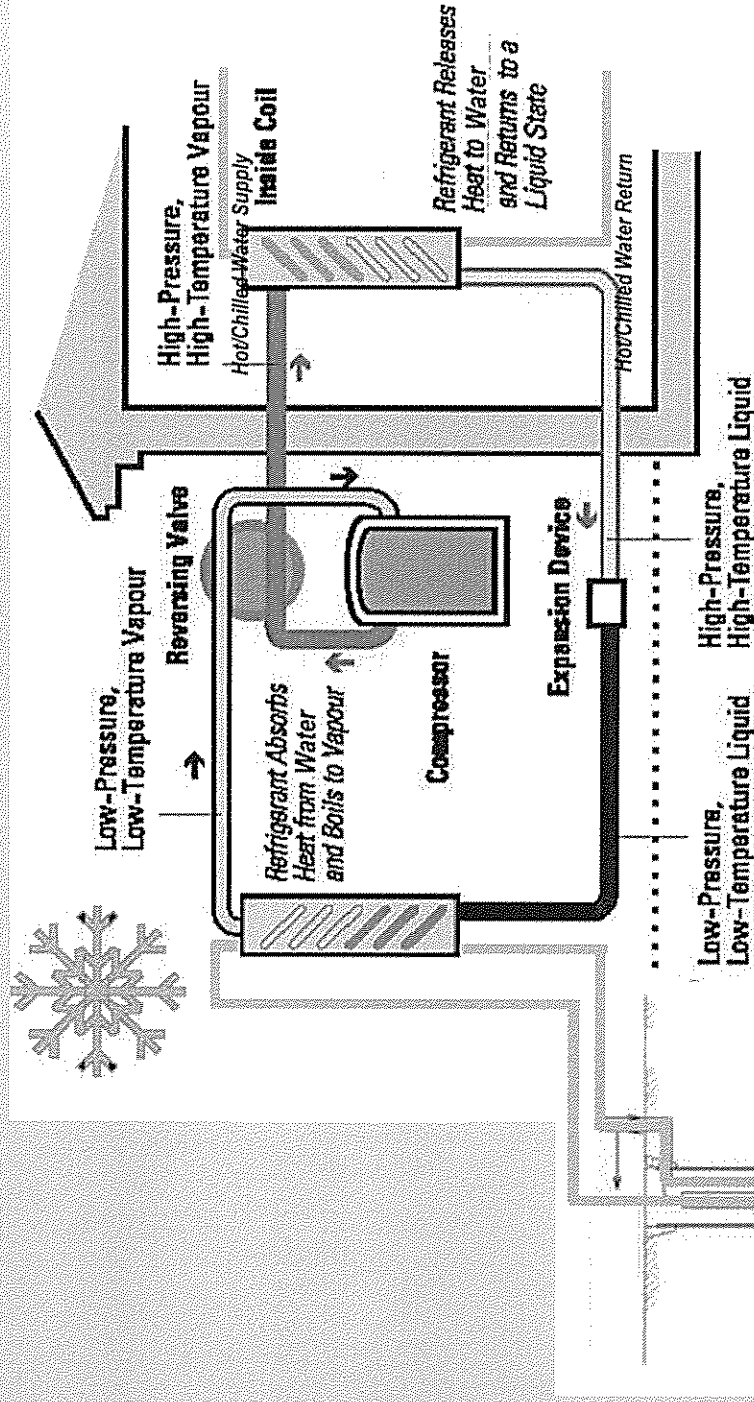


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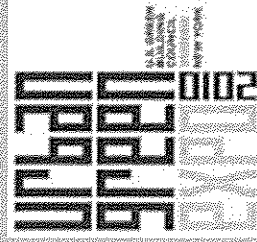


GEO THERMAL
APPLI CATIONS

Geothermal Heat Pump – Water-to-Water

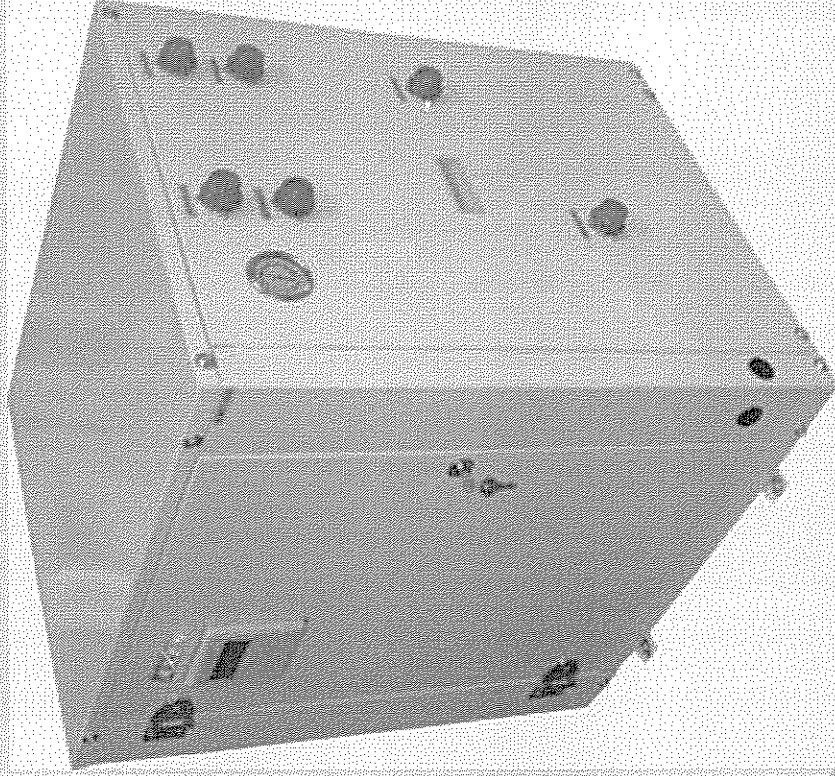


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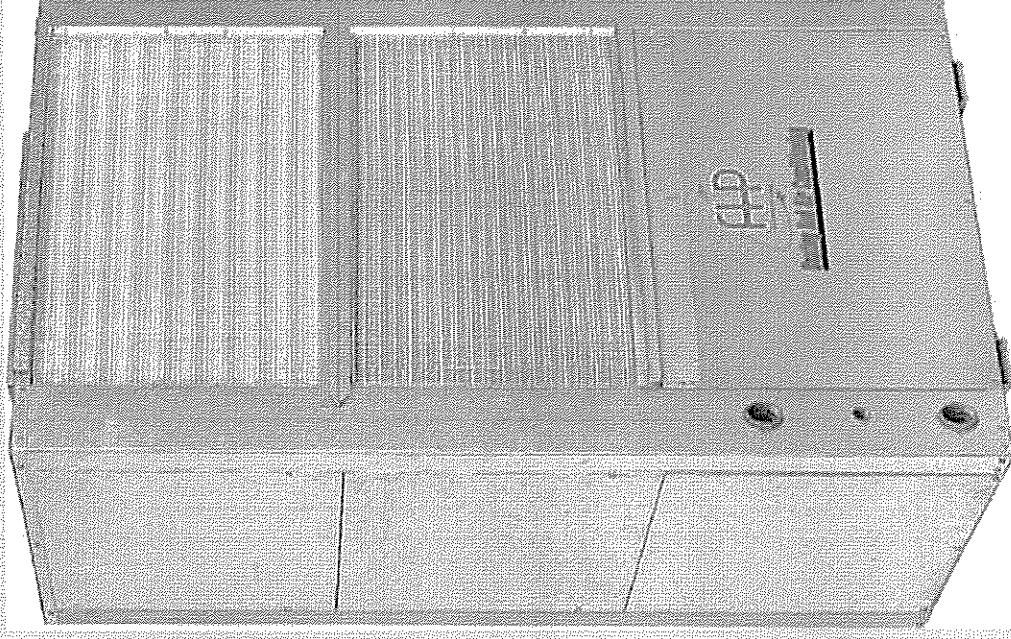


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APPLICATIONS

Water vs. Air Evaporators

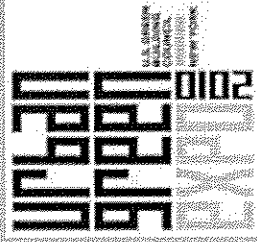


Water-to-Water Heat Pump



Water-to-Air Heat Pump

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APPLICATIONS

Measures of Efficiency

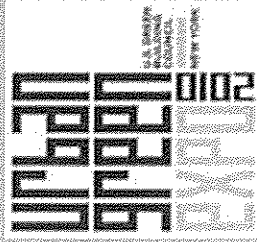
- Coefficient of Performance (COP): *is defined as the heat output divided by the supplied work.*

Units = [Btu/Btu] (Dimensionless)

- Energy Efficiency Ratio (EER): *is defined as the cooling (or heat) output divided by electrical input.*

Units = [Btu/watt-hours]

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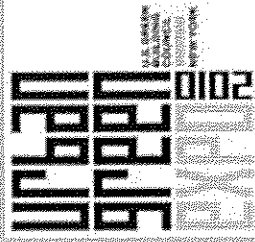
GEOTHERMAL
APPLICATIONS

Water Source Heat Pumps

Capacities/Efficiency Table

TYPE	HEATING MODE		COOLING MODE	
	CAPACITY (MBH)	COP	CAPACITY (Tons)	EER
Traditional Boiler & Chillers	All	80% (0.8 COP)	> 250	21.5
Large Wtr-to-Wtr Heat Pumps	2,800	3.7 COP	250	22.3
Small Wtr-to-Wtr Heat Pumps	375	3.1 COP	30	16.5
Water-to-Air Heat Pumps	850	4.5 COP	60	23

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APPLICATIONS

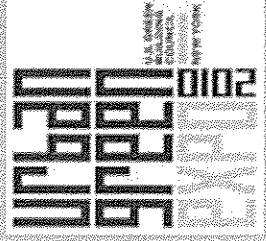
Heating Systems: Fuel Costs/Efficiencies

	Utility Rate	Efficiency	Heating Value	Fuel Cost \$/MBtu
BNY Cogen Partners - Site Steam	\$17.92/mLB	84%	970,000 BTU/mLB	\$21.26
Hi-Efficiency Gas-fired Condensing Boiler	\$1.50/Therm	94%	100,000 Therm/Gal	\$15.96
Geothermal Heat Pump	\$0.185/KWH	310% (3.1 COP)	3414 BTU/KWH	\$9.45

Cooling Systems: Costs/Efficiencies

	Utility Rate	Efficiency	Heating Value	Fuel Cost \$/MBtu
Air-Cooled DX Split System	\$0.185/KWH	11 EER	1,000 WH/KWH	\$16.82
Air-Cooled Chiller	\$0.185/KWH	8.6 EER	1,000 WH/KWH	\$21.51
Geothermal Heat Pump	\$0.185/KWH	17.9 COP	1,000 WH/KWH	\$10.34

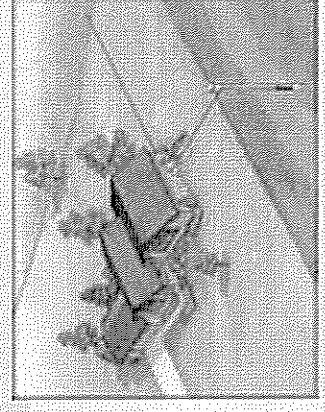
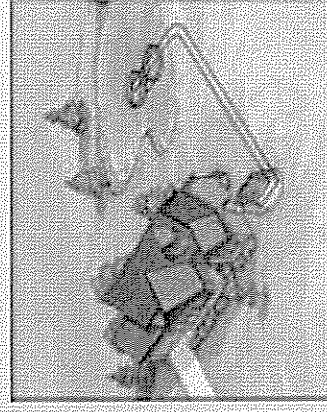
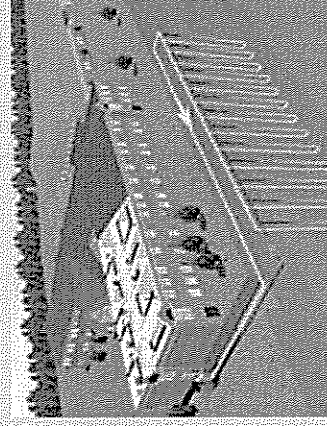
John Rice



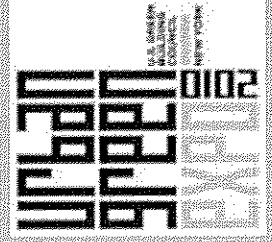
GEOHERMAL
APPLICATIONS

GEOHERMAL WELLS CAPACITIES/COSTS

	Depth (Ft.)	Tons/Well	\$/Well	\$/Ton
Closed Loop	400	2	\$9,000	\$4,500
Standing Column Well	1,500	35	\$90,000	\$2,570
Open Loop	100	100	\$20,000	\$200
River Water	15	100	\$100,000	\$4,000



John Rice

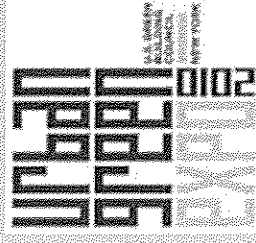


GEOHERMAL
APPLICATIONS

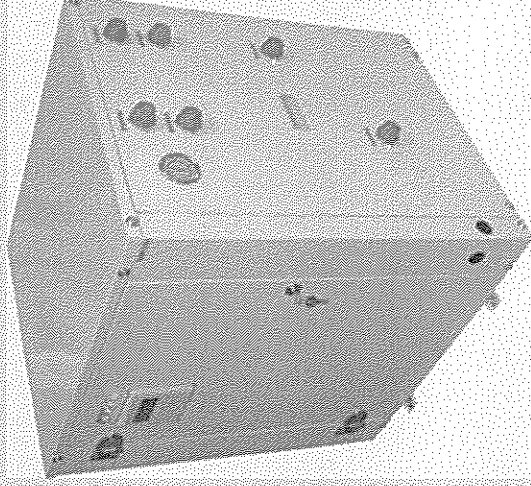
Retrofitting Geothermal Systems in Buildings

- Fan coil units replace radiators.
- Hot water systems replace steam systems.
- Water-to-air heat pumps replace air handling units
- Water-to-water heat pumps replace boilers and chillers.
- Retrofits of existing systems work **best when** the existing infrastructure can be maintained.

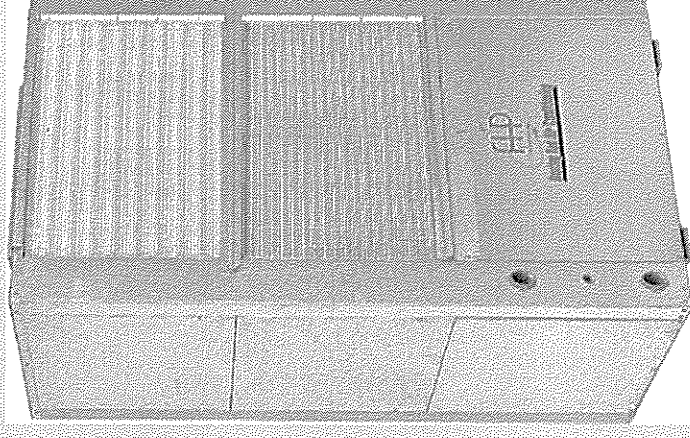
John Rice



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Water-to-Water Heat Pump

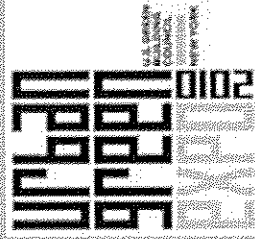


Water-to-Air Heat Pump

Take-Aways

- DDC was an early proponent of the use of geothermal systems for both historic and new buildings.
- Revisions are imminent on the DDC's *Geothermal Heat Pump Manual*, which is regarded nationally as the leading source of information.
- Case Studies include Queens Botanical Garden, Brooklyn Children's Museum, Weeksville Heritage Center, and Snug Harbor.

Alex
Posner

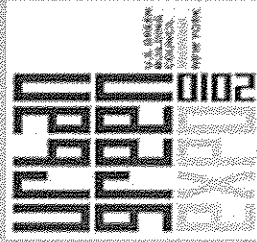


GEOTHERMAL
APPLICATIONS

What Does NYC DDC Do?

- City's primary Capital Construction Project Manager
- Construction Portfolio Value - \$6 billion per year
- Client Agencies – firehouses, libraries, police precincts, courthouses, cultural institutions, correctional facilities, etc.
- Publish Various Sustainability Manuals

Alex
Posner

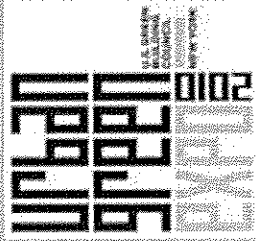


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Why Use Geothermal Systems

- Energy Savings \$\$\$\$
- Historical Landmark Buildings – eliminates need for unsightly cooling tower on roof
- Lower Maintenance Costs
- Quieter Operation
- Client wants to make their building environmentally ‘friendly’ - LEED point toward certification

Alex
Posner

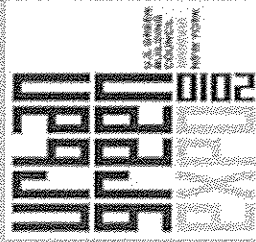


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Current NYC DDC Geothermal Projects

- Queens Botanical Garden (LEED Platinum)
- Brooklyn Children's Museum (LEED Gold)
- Bronx Zoo - Lion House\Madagascar Exhibit (LEED Silver)
- Weeksville Heritage Center (under construction, LEED Gold)
- Staten Island Museum Renovation of Building A, Snug Harbor, Staten Island (under construction, LEED Silver)

Alex
Posner

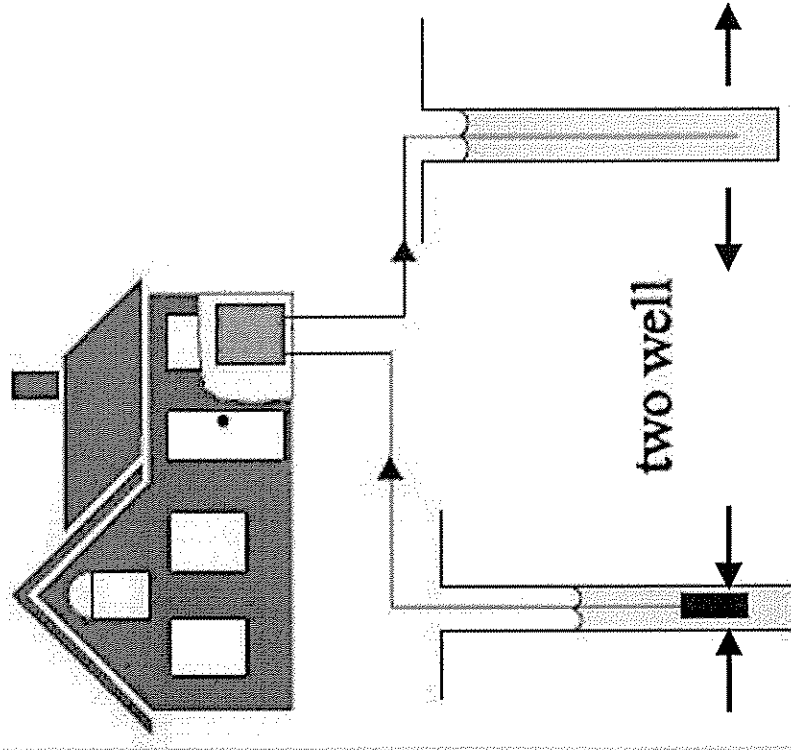


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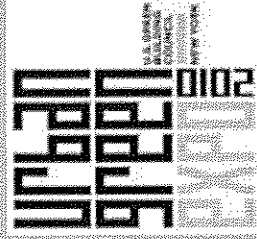
Open Loop Systems

- Most efficient, and lowest 'first cost' of the three.
- Requires one or more supply wells and one or more diffusion wells.
- Permitting by NYS DEC required.
- Well operation is subject to water quality (bacteria, water hardness, etc.)

Queens Botanical Garden,
Brooklyn Children's
Museum



Alex
Posner



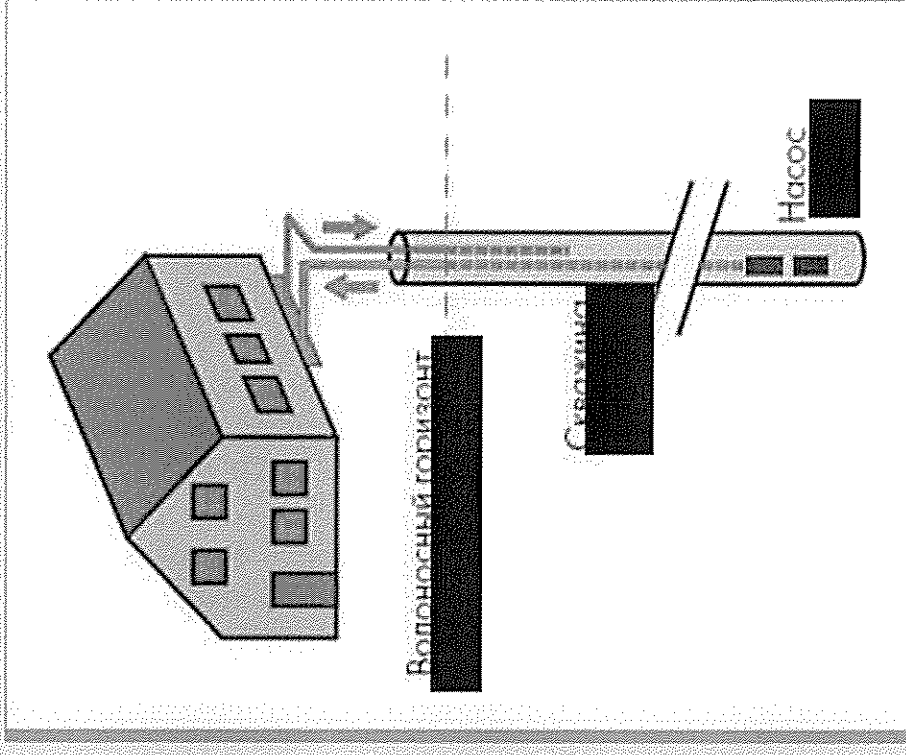
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<http://watervalegeothermal.com/geotech.htm>

Standing Column Wells

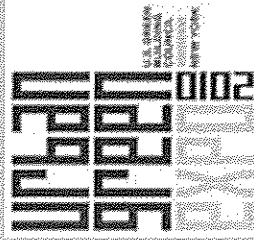
- System combines the supply and diffusion wells into one unit.
- Dependant on thermal exchange with the bedrock rather than availability of ground water.
- Generally up to 1,500 ft. deep.
- Permitting by NYS DEC required if greater than 500 ft.

Lion House, Bronx Zoo



http://esco-ecosys.narod.ru/2008_4/art189.htm

Alex
Posner

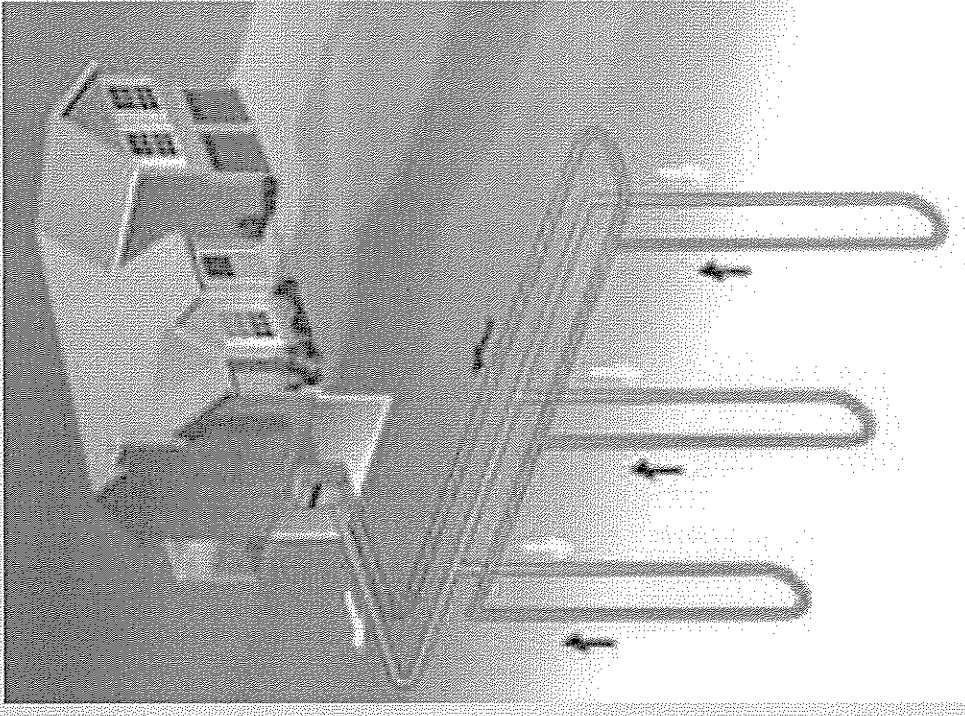


GEOHERMAL
APPLICATIONS

Closed Loop System

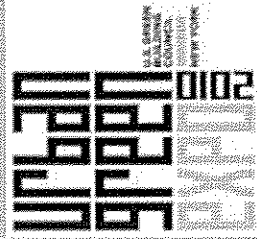
- Least efficient of the three, and greatest 'first cost'.
- Requires greater horizontal space on site.
- Lowest maintenance of the three.
- Use of ground water is not required; system relies on an antifreeze or water solution.
- Each inter-connected well transfers energy from bedrock to the circulating solution.

Weeksville Heritage Center,
Snug Harbor



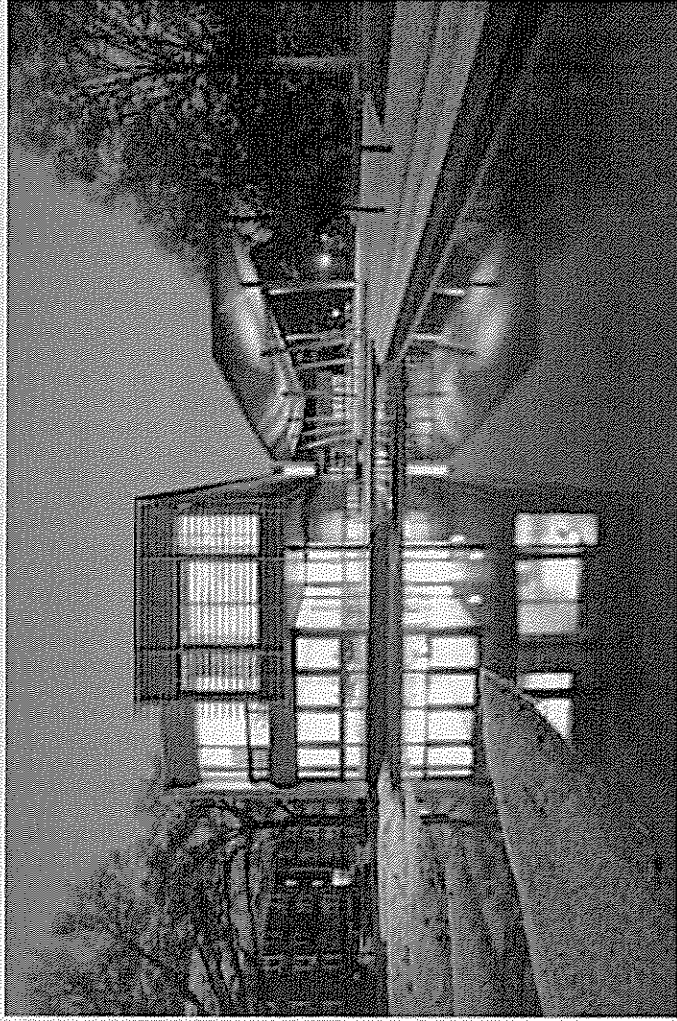
<http://greenlifesmartlife.wordpress.com/>

Alex
Posner

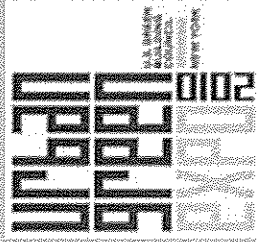


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QBG Visitor and Administration Center



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Posner

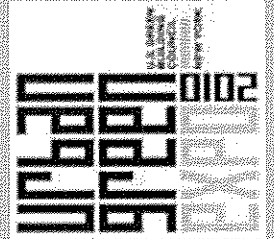


GEOHERMAL
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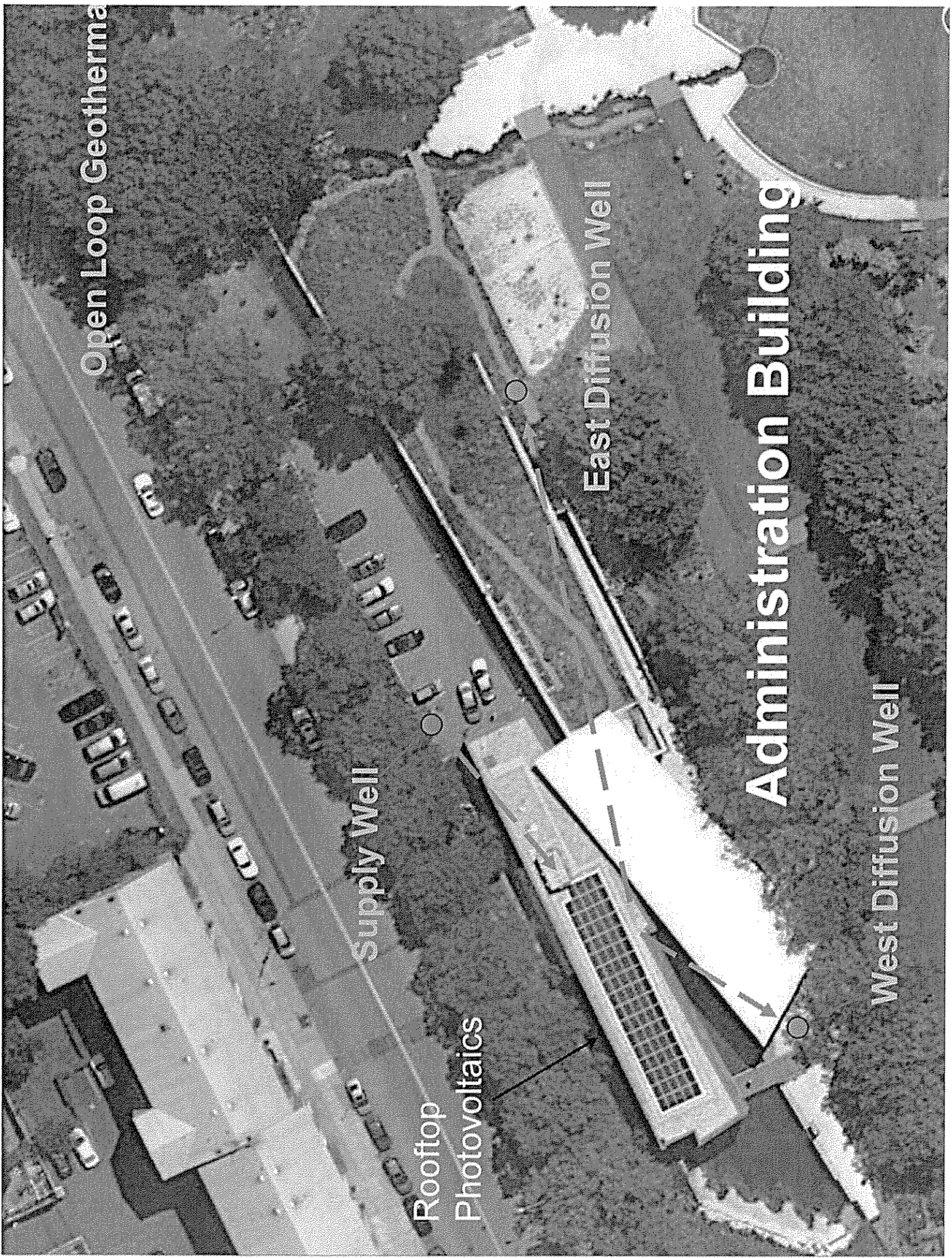


Queens Botanical Garden

Alex
Posner



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Open Loop Geothermal

Supply Well

Rooftop
Photovoltaics

East Diffusion Well

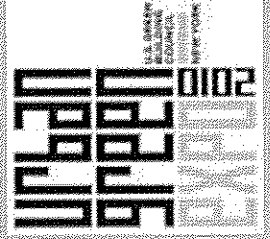
Administration Building

West Diffusion Well

Geothermal Heat Pumps at QBG



Alex
Posner

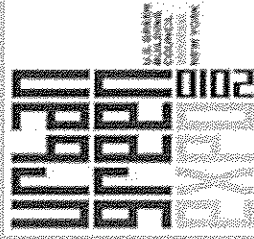


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QBG Heating and Cooling Loads

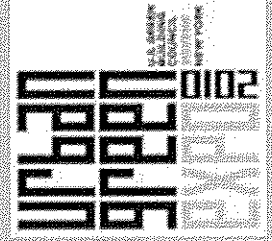
- 16,000 sq. ft. building, 2 levels
- 8 Heat Pumps - Only 5 or 6 are actually used
- Heating Loads = 600,000 BTUs needed for building, 100,000 BTUs per heat pump
- Cooling Load- 40 to 45 tons (8 tons\heat pump)
- 1 Supply Well 305 ft. deep
- 2 Diffusion Wells 305 ft. deep

Alex
Posner

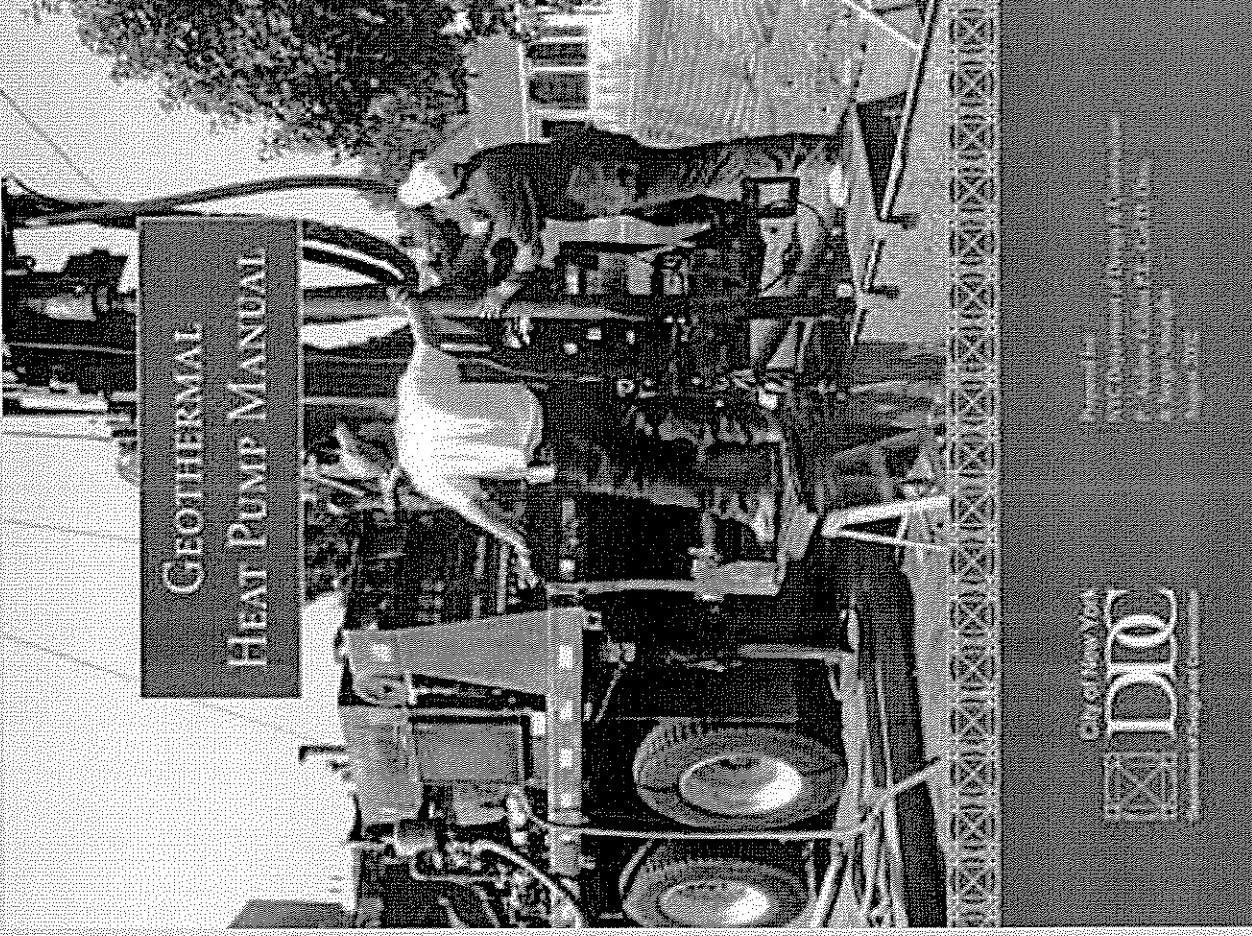


GEOHERMAL
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Alex
Posner



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August 2002

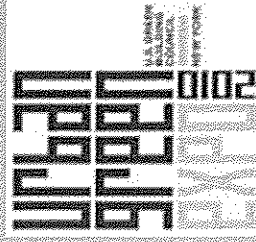
www.nyc.gov/html/ddc/downloads/pdf/geotherm.pdf

NYC DDC's New Geothermal Heat Pump Manual

New, updated edition will include:

- Lessons learned
- NYC DDC and private sector case studies
- Proper screening for site selection
- Improved hydrogeologic characterization of the 5 boroughs.
- Updated permitting requirements

Alex
Posner

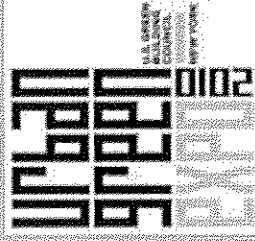


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Permitting for Drilling Geothermal Wells in NYC

Agency ⁽¹⁾	Description	Duration (from filing to approval)
NYCDOT	1) Revocable consent required to drill and install wells and piping beneath city sidewalks.	Minimum 3 months
	2) Sidewalk or street closure permits required for temporary closure during construction.	Varies - TBD by expediter or CM
NYSDEC/ DMR	A "mining" permit is required for drilling below a depth of 500 ft.	Minimum 6 weeks; Review/approval period on the order of 5 to 7 months.
NYCDEP	A sewer discharge permit is required to dispose of groundwater generated during drilling/ well installation to a city sewer. ⁽²⁾	3-4 weeks
	Notification if drilling in proximity to one of the city water tunnels is required.	Minimum 3-4 weeks
NYCTA/MTA, LIRR, Metro North	Notification and approval are required if drilling within 50 feet of any subway or railroad tunnels .	2-3 months
USEPA/ UIC	USEPA authorizes "by rule" the use of geothermal wells as Class V injection wells under the UIC Program.	4 weeks

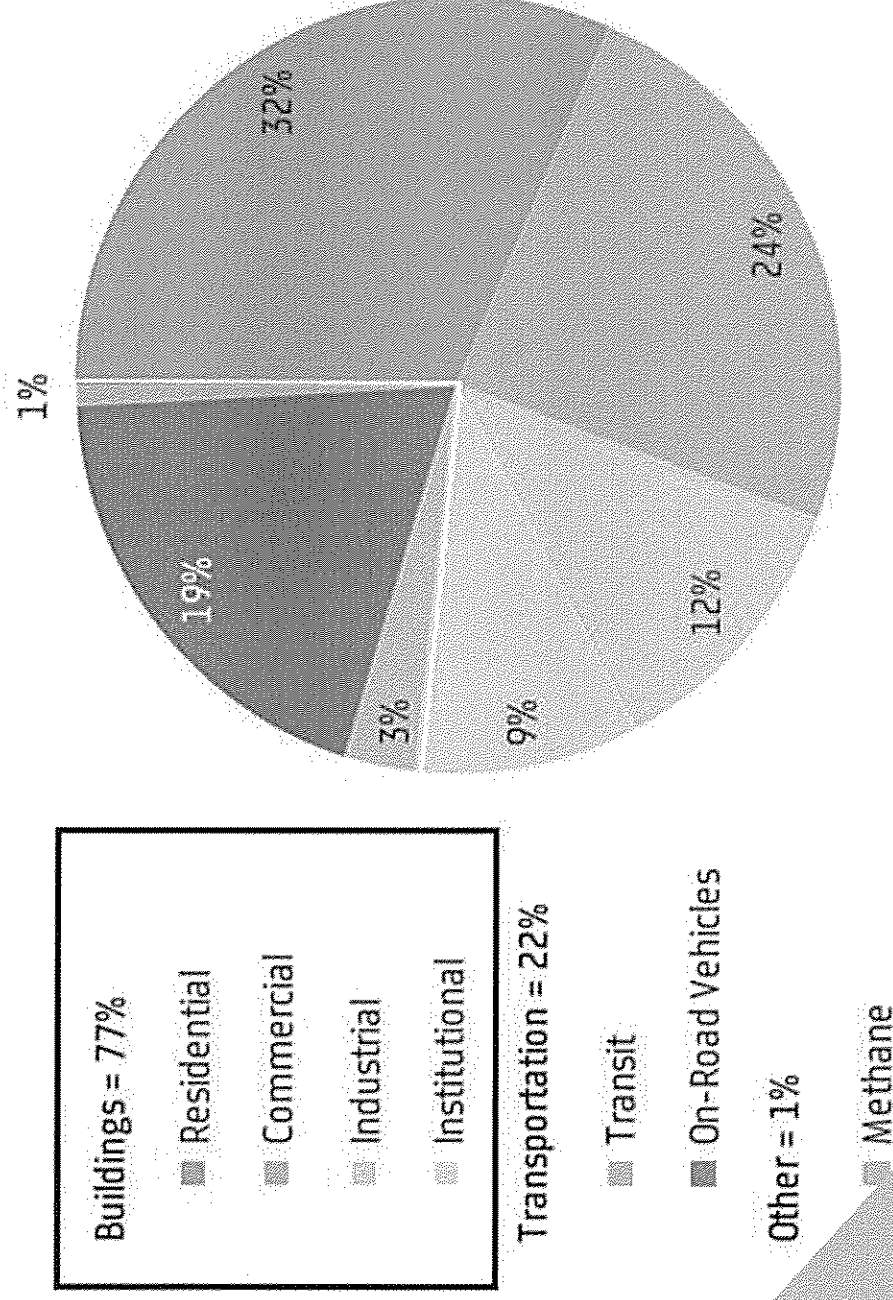
Alex
Posner



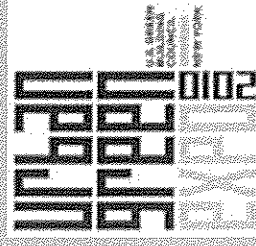
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Buildings make up nearly 80% of NYC's GHG emissions...

2007 Citywide CO₂e Emissions by Sector



Tate Rider



GEOHERMAL APPLICATIONS



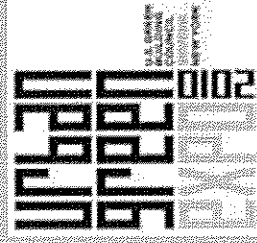
Source: Mayor's Office of Long-Term Planning and Sustainability

...And nearly half of all energy consumed in NYC buildings is for heat and hot water

Energy Usage by Building Type in NYC (in BTUs)

BUILDING TYPE	HEAT	HOT WATER	LIGHTING	APPLIANCES	COOLING	OTHER	TOTAL
1 – 4 family residential	7.6%	2.6%	1.7%	2.2%	0.6%	0.0%	14.7%
Multi-family residential	7.4%	7.4%	3.0%	3.9%	1.2%	0.0%	22.0%
Commercial	8.5%	2.8%	10.2%	4.5%	4.5%	0.9%	31.4%
Industrial	2.6%	2.1%	4.0%	3.3%	1.1%	0.2%	13.0%
Institutional / government	6.3%	4.0%	3.6%	1.7%	1.4%	0.9%	17.9%
ALL TYPES	32.4%	18.9%	22.5%	15.6%	8.8%	2.0%	100%

Tate Rider



GEOHERMAL APPLICATIONS

Source: PlanNYC

3 Key findings on market potential in NYC

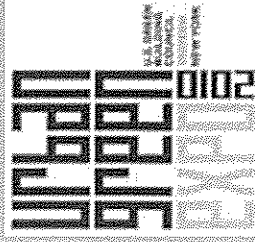
1. Geothermal Heat Pumps have significant market potential in NYC

- Most of the potential is outside Manhattan

2. Geothermal can reduce costs relative to traditional systems under certain conditions

- New building OR heating and cooling systems must be replaced
- No retrofitting required for distribution system
- Access to inexpensive capital / long-term investment perspective

Tate Rider



GEOHERMAL
APPLICATIONS

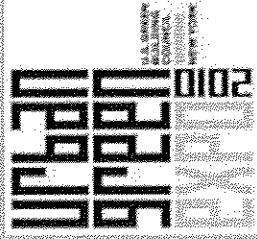
Source: Study for NYCEDC by Columbia University
Business School and Engineering Students, December
2009

Conclusion

What's next for geothermal in NYC?

- Every project is different
- Further industry developments—technical and business models—are needed
- Explore non-building based applications
- The sluggish real estate market will affect new construction applications...but what about retrofits?

Tate Rider



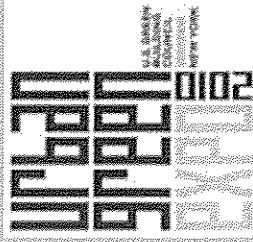
GEOHERMAL
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Source: Study for NYCEDC by Columbia University
Business School and Engineering Students, December
2009

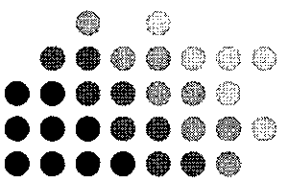
Benefits of Geothermal Systems

- Environment Friendly/No fossil fuel burning, no on-site emissions
- Low Maintenance – No boiler/chiller
- No outdoor equipment/noise
- Energy efficiency
- Open loop systems are more cost effective because of their ability for “free cooling.”

Margaret
Castillo



GEOHERMAL
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What can the legislative branch do to support the use of geothermal ground coupled technology in buildings?

- Create a viable and accessible geothermal industry through legislation by:
 - Creating a web-based clearing house of information on geothermal systems targeting 1, 2 and 3 family building owners (see IGSHPA as a model);
 - Make well drillers and HVAC installers accessible to owners of 1, 2 and 3 family buildings to allow competitive bidding;
 - Establish trade schools for well drillers (loopers) and additional training for HVAC and plumbers for the installation of the interior systems;
 - Create a simple registration procedure for trades people in NYC;
 - Bring Con Ed into the fold by requiring the Public Service Commission to classify geothermal as an “all-electric” HVAC system. This will equalize summer and winter electric peak demands;
 - Establish a finance entity dedicated to making a large investment of this type to be in the range of affordable \$150-\$200 month payments, with a loan terms of 7.5 years (50% of compressor life);
 - Seek synergies with existing subsidy programs such as rebates from utility companies and NYSERDA for photovoltaic installations;
 - Establish a program that encourages the installation of a PV system together with each geothermal heat pump system.
- The geothermal industry has not yet attained critical mass in NYC!



Written Testimony on Draft Amendment (New Local Law) to the NYC Charter to Facilitate Development of Geothermal Energy in New York City

June 11, 2012
Public Hearings on Int. No. 694

Good morning, Chairman Gennaro, Council members and invited guests. Thank you very much for the opportunity to address you today regarding facilitating the development of geothermal heat pump systems ("GHP systems") in New York City.

My name is John Rhyner. I am a licensed Professional Geologist and Senior Manager with the engineering consulting firm of P.W. Grosser Consulting, Inc. (PWGC), with main office in Bohemia, Long Island, New York, and satellite offices in Manhattan, Connecticut, and Syracuse.

I have read the proposed legislation and was extremely encouraged. My firm has been in the forefront of the geothermal industry in the NYC metropolitan area for over 20 years. Personally, I have worked exclusively in the geothermal industry for nearly 12 years, all the while advocating for greater recognition and adoption of the technology. As a practicing geologist, my particular expertise is in the area of evaluating the feasibility and designing the portion of a GHP system that is connected to the ground through drilled boreholes or wells.

I have had the fortunate opportunity to collaborate and interface with numerous city agencies in advancing this technology in the city. I have been working with the NYC Department of Design and Construction for over 10 years, with my present firm and previous employer. The DDC has been a pioneer in the development of geothermal energy in the city throughout this time. Besides assisting the DDC with implementing the technology on several projects, I am the lead author of an update of DDC's *Geothermal Heat Pump Manual*, originally published in 2002. This document has been a widely referenced "go to" document for the industry, not only locally but nationally as well. We hope to see the updated version published by year's end.

As the Council has stated and no doubt will be echoed by others giving their testimony today, compared to conventional HVAC systems GHP systems offer tremendous benefits for residents of the city. These benefits include reduced annual energy usage, peak demand reduction offering reduced utility costs, and elimination of on-site fossil fuel combustion, air pollution and greenhouse gas generation which benefits us all. The large summer peak load reduction offered by geothermal heat pumps benefits local utilities through reduction of capacity expansion, increased grid reliability, and reduced operating costs. The annual level electrical load also offers better utilization of the power plants and grid throughout the year.

Specific to New York City's urban character, the following additional benefits should be considered:

- Components of a GHP system are entirely underground (loop field/wells) and within the building.
- There are no noisy roof-top chillers or cooling towers to detract from the city skyline or impact occupants in adjoining buildings.
- For the above reasons, GHP systems are ideal for landmark structures with pitched roofs or other limitations and restrictions on exterior improvements as dictated by the New York City Landmarks Preservation Commission. Moreover, these structures can be retrofitted for central air-conditioning rather than window units which detract from their aesthetic character.
- GHP technology can offer air conditioning to Landmark buildings (many of which are city owned) that have gone without for their lifetime, offering fuller use of these structures.
- GHP technology can facilitate wider adoption of other sustainable technologies including green roofs and solar PV installation since there is no associated rooftop equipment.

New York City is in the forefront of construction of LEED certified buildings. It is clear from the literature sources I have reviewed that a large percentage of buildings achieving LEED certification incorporate GHP systems in their design, owing to the LEED energy credits that can be achieved due to the energy efficiencies of the technology. The same is true for Net Zero Energy Buildings in the literature. Wider adoption of GHP technology in the city can help to secure the city's high ranking in LEED and Net Zero building development.

The GHP industry is "home grown" and creates local jobs:

- The major global geothermal heat pump manufacturers started and operate in this country.
- Every geothermal system requires involvement of numerous design disciplines and construction trades.
- Involved in system design are mechanical/HVAC engineers, geothermal engineers, geologists, hydrogeologists and geotechnical engineers.
- On the construction end are mechanical, electrical, civil and plumbing contractors and well drillers.
- Much of the materials used in construction derive nationally, for example the geothermal heat pumps and casing, drilling mud, and grout used for well construction.

I would like to make four points regarding the concept of geothermal subzones based on geologic and hydrogeologic conditions in the proposed legislation:

1. While subsurface geologic and hydrogeologic conditions are indeed a critical controlling factor on the **type(s)** of geothermal system suited, they are only one of many site-specific, project-specific, and owner-specific considerations.
2. Geothermal heat pump systems are viable in virtually all geologic conditions present throughout the city, wherever there is sufficient open outdoor area to install enough geothermal wells to meet the building's heating and cooling demand.
3. Design of each geothermal system requires a site-specific study of the subsurface geologic and hydrogeologic conditions. We start by referencing the extensive publicly-available resources developed by the U.S. Geological Survey and follow-up with site-specific test drilling.
4. For DDC's *Geothermal Heat Pump Manual*, we have built on the USGS data by mapping areas of the city where the three main geothermal system types--open loop, standing column wells, closed loop—are viable based on the mapped geologic conditions (see illustrations on following page).

I would also like to inform the Council of cutting-edge research completed by the NYC Economic Development Corporation (EDC) and Columbia University that directly addresses today's topic. I was fortunate to have participated in this effort. Columbia graduate students developed an energy model of electrical consumption and heating and cooling demand for the existing structures on each block in the city. My part was to select the most suitable type of GHP system based on geologic conditions and to estimate the available areas to drill and the associated thermal capacity of the ground beneath. Geothermal viability was determined by relating the available ground thermal capacity to the buildings' demand on that particular block. The significant conclusions reached by Columbia follow. The geothermal feasibility map developed by Columbia is also presented in a following page.

1. The residential market for geothermal is enormous, ranging from over 75% of total square footage in the Bronx to nearly 95% in Staten Island (excluding Manhattan).
2. The commercial market ranges from over 20% in the Bronx to almost 50% in Staten Island (excluding Manhattan).
3. The outer boroughs have the larger geothermal potential due to greater open outdoor space for drilling and lower densities.
4. Over 900,000 buildings could be feasibly served.

For these reasons, the study of geothermal subzones would seem unnecessary and there may be better uses of the resources at hand.

Closed Loop Feasibility in New York City

- Feasible in all boroughs
- Cost premium occurs if rock is deep and loops must go into rock
- Depth in Brooklyn and Queens is limited where protected Lloyd Aquifer exists



John
Rhyner



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Standing Column Well Feasibility in New York City

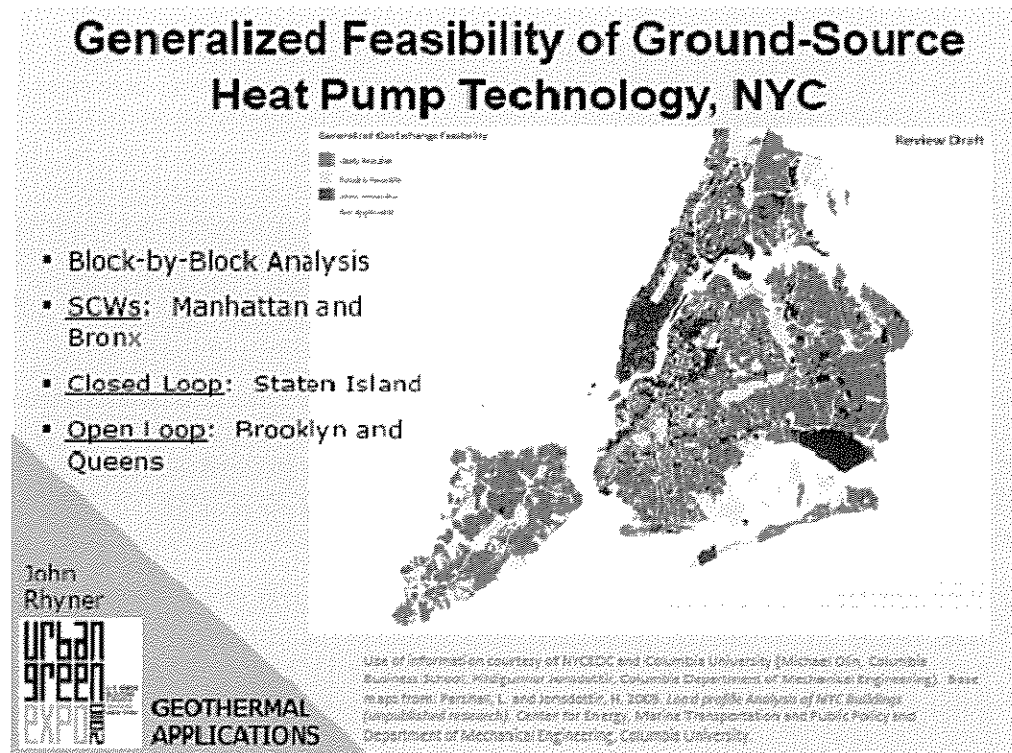
- Feasible mostly in Manhattan, Bronx, and SI
- Depth to groundwater may be too deep in central Staten Island and Upper West Side



John
Rhyner



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Note: dark green = "Likely Feasible" and yellow is "Probably Feasible"

Columbia recommended that the city should consider the following:

1. Subsidize training of suppliers for GHP systems—engineers, architects and contractors (that is not already provided by NYSEDA)
2. Approve GHP training for NYC Workforce Investment Board grants.
3. Provided the building meets initial feasibility screening, sponsor/subsidize more detailed site analysis and a cost/benefit assessment.
4. Conduct feasibility studies for EDC buildings.
5. Ease permitting requirements by city agencies.
6. Analyze third-party models for applicability in NYC.

These would be my recommendations as well. You may be aware that the EDC Energy office sponsoring the Columbia research was disbanded and I am not aware of the status of these recommendations.

In summary, the market potential and feasibility of GHP systems in New York City is tremendous. I have experienced willingness with all of the city agencies I have dealt with

over the past ten years to consider the merits and special considerations for this technology, including DDC, DOT, DEP, EDC, DCAS, and Parks. Besides the private sector opportunities, New York City as the largest landlord in the city has a unique opportunity at hand. The city's building stock is huge, through EDC's properties and buildings managed by the Department of Citywide Administration. DCAS is currently implementing energy performance contracts on some of their buildings. I understand they were to require contractors to consider GHP technology. I am also pleased that NYC School Construction Authority and the city Board of Education have decided to use the technology for the first time in their first Net Zero building application at P.S. 62R in Staten Island.

I will leave the Council with a concern and a suggestion. First, the proposed legislation mentions a NYCHA project in the works on East 28th Street that is scheduled to be converted "...to geothermal heat and hot water." This raises a red flag to me because the types of GHP systems feasible in Manhattan must be used for both heating **and** cooling to balance the thermal load on the earth.

Secondly, the city should be vigilant over distinguishing the type of geothermal technology that is feasible in this area--that is "ground-source geothermal heat pumps." There is much confusion between ground-source geothermal energy and "hot rock" geothermal, which is used in the western United States, Iceland and Hawaii, for example, but not in the eastern United States. Ground-source geothermal is a solar derived resource and is used exclusively for space conditioning and domestic hot water production. Whereas, hot rock geothermal energy derives from deep within the earth and can be used directly for heating or to drive turbines to generate electricity.

I appreciate the opportunity to submit this testimony. I will be glad to answer any questions you may have about this issue.

Sincerely,

John W. Rhyner, P.G., LEED AP
Senior Project Manager, P.W. Grosser Consulting

GEO NII

Geothermal National & International Initiative Inc.

Washington, DC

PO Box 145, Springfield, PA 19064

A Triple E Solution Provider

"The Road to 30%" - Our Industry Goal

Energy Independence, Environmental Security and Economic Prosperity!

Good morning, Chairman Gennaro, Council members and invited guests. Thank you very much for the opportunity to address you today regarding facilitating the development of geothermal heat pump technology in New York City.

My name is Jack DiEnna and I am the Executive Director of the Geothermal National & International Initiative (**GEO-NII**) and the Marketing Chairman of the International Ground Source Heat Pump Assoc. (**IGSHPA**) and a former Director of the Geothermal Heat Pump Consortium (**GHPC**). I currently consult to the New York State Energy Research and Development Authority (**NYSERDA**) and have worked with them since 2000 in the development of GHP technology in NY State.

I have read the proposed legislation and I applaud your efforts but I would suggest that this could be stronger. There are over **100** projects in the five boroughs currently in operation so to study geothermal subzones seems redundant. To design a geothermal system there must be studies done by the engineer or installer evaluating the thermal properties of the ground that the ground loop heat exchanger will be installed in, so a better use of resources would be to establish standards for the installation of these systems in the five boroughs. Our industry does have accreditations, certifications and standards already in place that we can share with you.

Geothermal Heat Pumps (GHPs) use the earth's thermal properties, in conjunction with electricity, to provide heating and cooling to facilities such as schools, hospitals, office buildings and houses. It does this by using the "**Energy Under Our Feet**", the energy we already own, to deliver space conditioning and water heating to these facilities. This technology offers the **Triple E** solutions of **E**nergy independence and security, **E**nvironmental stability and **E**conomic prosperity.

A recent study conducted by the Rockefeller Foundation and DB Climate Change Advisors makes the point that buildings consume approximately **40% of the world's primary energy** and are responsible for **40% of the global carbon emissions**. They also state that "upgrading or replacing energy consuming equipment in buildings offers an important capital investment opportunity, with the potential for significant economic, climate and employment benefits." They go on to say that an investment of this type of initiative could yield more than **\$1 Trillion** of energy savings over 10 years, equivalent to savings of approximately **30%** of the annual electricity spend in the US." According to a report from the US Department of Energy, **40%** of the energy used in buildings is for space conditioning and water heating.

The State of Maryland recently passed Senate Bill **652** which effectively makes GHPs an accepted technology available for Renewable Energy Credits (**RECs**) under the State's Renewable Portfolio Standard (**RPS**). This action recognizes GHPs as a renewable energy source, (that does not need the sun to shine or the wind to blow and works 24 / 7) giving utilities credit for the thermal load avoided.

I have recently done a survey of projects installed in NJ and after reviewing the work of just two design professionals that they have collectively designed and installed **52,000 tons** of capacity which accounts for over square feet.

The New York City residential market comprises over **66%** of the total floor area and the institutional market accounts for another **9.8%** in the five boroughs. This points to a major opportunity for GHPs to make a dramatic impact in these markets.

I have discussed two of the solutions, **Energy independence & security** and **Environmental stability** but the most important one, I believe is **Economic prosperity**. The workforce for this technology is comprised of **90% "Green"** collar workers and **10% "White"** collar workers. In a recent industry survey we found that a commercial project touches **22** job classifications. This does not include the pipe or compressor manufacturer.

Currently I am working with NYSERDA to bring professional development training to NY State and create a stronger sustainable infrastructure. I am also in discussions with some of the PSC Commissioners who support the expansion of GHP technology in NY State.

I have included with this testimony a report that the GHPC did for NYSERDA in 2003 in which we identified **106** GHP systems installations across the state, which accounted for a total of **17,387 tons** of heating and cooling and served over **6.6** million sq. ft. of facility space. These systems reduced demand by **15.3 MWe** and accounted for **128.3 MWt**. The report also shows fossil fuel savings, carbon reduction and barrels of crude saved.

In conclusion, I appreciate the opportunity to address the council and discuss the various benefits that this technology would afford your constituency. I would leave you with one last thought and that is: Geothermal Technology is beyond "**GREEN**" it is "**GOLD**" sitting right below the ground outside your building. Thank you.

John (Jack) P DiEnna Jr. Executive Director
Geothermal National & International Initiative
jdienna@geo-nii.org
610-659-4998



TESTIMONY OF TERENCE O'BRIEN BEFORE THE
ENVIRONMENTAL PROTECTION COMMITTEE OF THE
NEW YORK CITY COUNCIL ON JUNE 11, 2012 ON INT.
No. 694

Good Afternoon: My name is Terence O'Brien; Deputy Director of the Plumbing Foundation of the City of New York, Inc. which is a clearinghouse and educational forum for the entire plumbing industry. The Plumbing Foundation is a nonprofit association of licensed contracting firms, engineering associations, manufacturers, and suppliers whose mission is to ensure the public health through the enactment and enforcement of safe plumbing codes. I am here today to testify in support of Intro. No. 694 which will establish a study on the benefits of using geothermal technologies. Hopefully this study will foster the use of geothermal energy for heating, cooling, and hot water in many buildings in NYC thereby making the City more "Green."

Since its establishment in 1986 the Plumbing Foundation has worked diligently to ensure that the

plumbing industry has as little a "carbon footprint" on New York City as possible. The plumbing industry has historically utilized environmentally friendly materials and technologies. Geothermal and solar technologies for heating, cooling, and hot water are the next waves of innovation that will help the plumbing industry lessen the City's "carbon footprint". Licensed Master Plumbers have the training and skills to ensure that these new technologies are installed properly while at the same time guaranteeing safety and making the City more "green." Any technology that can lead to less energy usage, and water consumption, for heating/cooling/ or to generate hot water is fully supported by the Foundation.

Mountain Air Conditioning & Heating Corp.

AUTHORIZED



DEALERS

COMMERCIAL AIR CONDITIONING - HEATING - VENTILATION - ELECTRICAL WORK

735 SOUTH BROADWAY
HICKSVILLE, N.Y. 11801

516-935-0149

Fax 516-932-9677

Good afternoon I am James McKeon owner of Mountain air conditioning & heating corp. I started the company in 1980 after graduating from Farmingdale's HVAC collage program in 1977 and working in the field for four years some of my experience is as follows

- ♦ Rooftop package unit replacement and new installation 1-1/2 to 100 ton
- ♦ Chilled water systems service and replacement
- ♦ Small ammonia systems (certified by Robur Corporation Servel Gas A/C)
- ♦ Geothermal Heating and Air Conditioning (certified by International Ground Source Heat Pump Association)
- ♦ Water tower service and replacement to 500 tons
- ♦ Gas fired heating (certified by nat-grid)
- ♦ Critical timing jobs (replaced the A/C systems that cool the GSO and ESO main Control rooms at KEYSpan)

ELECTRICAL

- ♦ Building management control systems
- ♦ General electrical wiring (T.O.B. Master Electrical License No. 00886)
- ♦ Generator installations Gas and Oil fired (Installed a 400 KW generator for Cedarbrook CC)
- ♦ UPS installations (Installed 300 KVA UPS system at ADP corp.)
- ♦ Primary and secondary feeder installation

REFRIGERATION

- ♦ General refrigeration service and installation (EPA approved universal)
- ♦ Ice machine service and installation
- ♦ Walk in boxes installed and serviced
- ♦ Ice skating rinks installed and serviced (Installed the first Ice Rink in Saudi Arabia)
- ♦ In 1994 I was asked to design build the replacement of the HVAC systems in the nat-grid office building in Brentwood this was my first exposure to Geo-thermal systems. I studied the systems and design criteria and was able to install the 180 tons for the building. This job was published in the trade publication THE NEWS 5/15/95 Later years I installed Geo-thermal equipment in the Hewlett office building of nat-grid and the Riverhead office building of nat-grid. I designed and oversaw the installation of 30 tons of geothermal equipment for a residence on 86th street in Manhattan using a standing Coulomb well that saves the home owner thousands of dollars on the project by eliminating the need for a rooftop water tower and boiler in the basement as well as allowing the roof to be used as a garden and freeing up the space that would be required to run the chimney up the six floors to the roof. I have been the project manager for other geothermal jobs on the island using the builders contractors when requested.





Testimony presented to the New York City Council Committee on Environmental Protection

Oversight: The Potential of Geothermal Energy Use in New York City and

Int. 694, A Local Law to amend the New York city charter,
in relation to facilitating the development of geothermal energy.

June 11, 2012

On behalf of the New York Chapter of the American Institute of Architects and its nearly 5,000 architect and affiliate members based in Manhattan it is our distinct pleasure to offer testimony on this important issue. We support the goals of Intro 694 which if enacted would require a study to identify the most suitable subzones in the city for the use of geothermal energy for building heating, cooling and electricity generation and the identification and tracking of public and private projects which are utilizing or expect to utilize geothermal energy. For almost nine years we have operated the Center for Architecture at 536 LaGuardia Place in Greenwich Village with geothermal ground source wells providing all of the energy for cooling of our 15,000 square foot space.

When AIA New York created the Center for Architecture in 2003, green issues were at the forefront of our design. As a client the American Institute of Architects decided that a geothermal system was worth the initial investment - mostly the cost of well-drilling in Manhattan schist. The system was designed by Michelle Norris, P.E. of Norfast Engineering working with Andrew Berman Architect. Each of our two wells took a week to dig, as a drill descended 1,260 feet through the sidewalk, gravel, soil and bedrock - deeper than the Empire State Building is tall. The drilling, a relatively noisy activity, took place only in the afternoons to mitigate intrusive acoustical annoyance in a community of late nights and later mornings. Set-up and moving of the drilling rig in the street and hay bales for water containment took an additional week. One lane of traffic remained open, and the sidewalk, protected by safety barricades, also stayed open for passage throughout the drilling period.

The Center's geothermal system has two wells that provide an energy-saving boost for the heat-exchange method in both cooling and heating modes. Heat pumps use the 53 degree Fahrenheit or 12 degree Celsius geothermal environment as a reservoir from which heat is extracted in winter and into which heat is transferred in the summer - far more efficient than a conventional air-exchange system in which heat pumps extract heat from freezing air in the winter and transfer heat into warm air in summer. Water in the wells circulates back to ground level. During system operation, water moves cyclically through a 2520-foot path, transferring heat from the heat pumps to the bedrock surrounding the well along the way. Here it regulates the temperature of the air in the meeting rooms, galleries and offices of the Center for Architecture.

This is one of the first geothermal installations in New York City. Since the start-up of the system, the Center has proudly displayed our mechanical systems to all who want to see. We have saved money and done a small part to save the environment, keeping our space comfortable year round.

To put the cost into perspective, the Center for Architecture at 15,000 GSF construction and fit out cost \$3 million. The Geothermal System cost \$100,000 which was largely offset by a grant from the New York State Energy Research Development Association (NYSERDA).

There are several reasons why this system became the choice for the Center for Architecture:

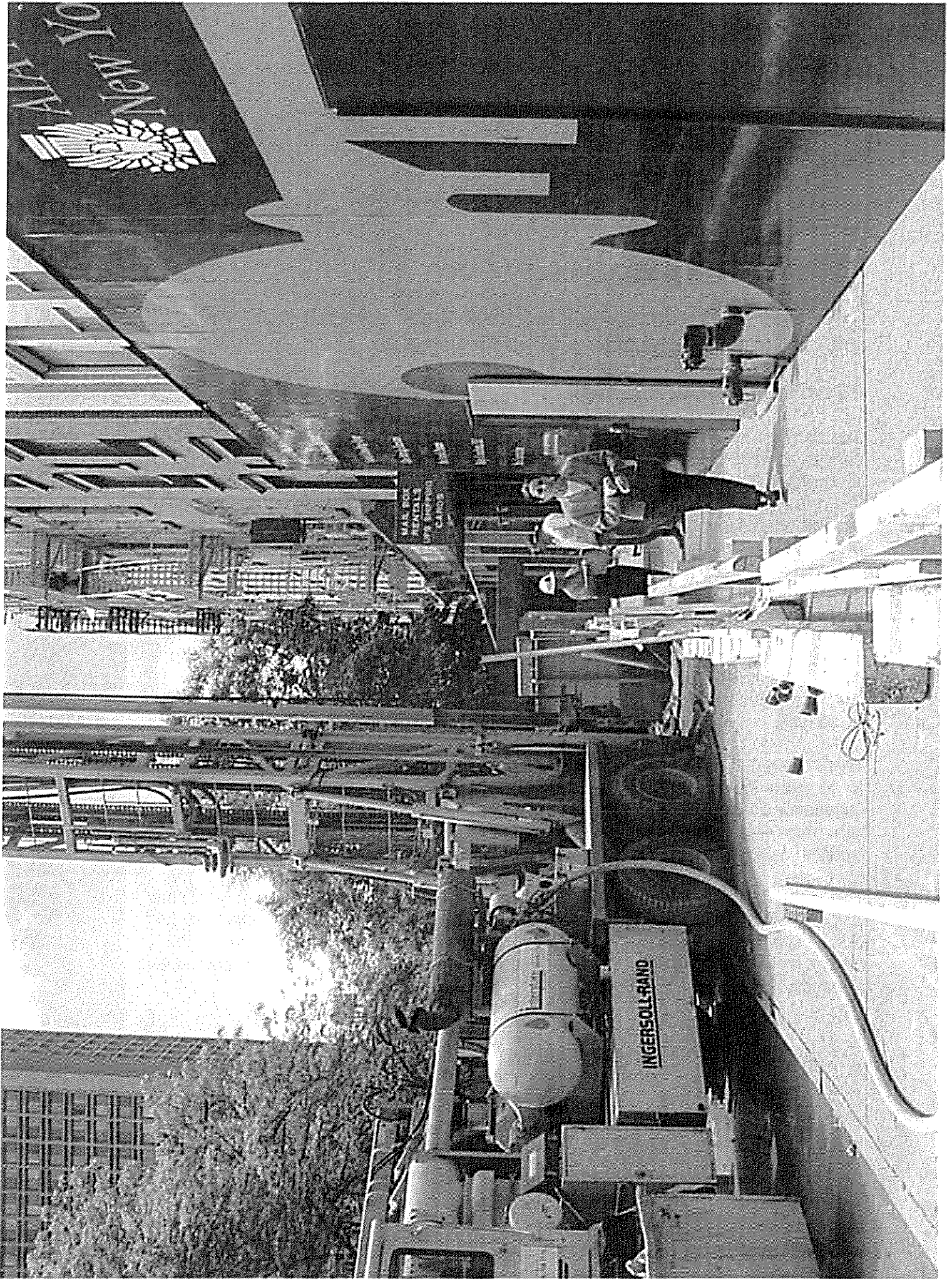
- It consumes over 30% less energy than a conventional air-cooled condenser-type air conditioning system;
- It did not require any exterior equipment such as large heat transfer grilles on the façade of the building;
- It did not require adding a cooling tower to the roof of a fully-occupied building with seven floors of live-work lofts above the ground floor;
- It was installed as new technology in the retrofit of the existing building;
- Because the system is entirely internal, it has no noise impact on the street or on adjacent buildings; and
- It was estimated that, given the projected costs of heating and cooling the Center for Architecture by conventional means, the geothermal system would pay for itself in less than three years.

In conclusion we offer our continued support and professional expertise with efforts to allow for the expanded use of geothermal energy in New York City, and commend the New York City Council for putting forth this legislation and for holding this oversight hearing. We invite members of the Committee on Environmental Protection to the Center for Architecture in the coming months to experience the geothermal energy system first-hand.

Respectfully submitted,



Rick Bell, FAIA
Executive Director





Center for Architecture

EXPLANATION OF THE GEOTHERMAL SYSTEM

The Center for Architecture employs geothermal heat exchange for heating and cooling. This is an energy efficient technology.

How does Geothermal work?

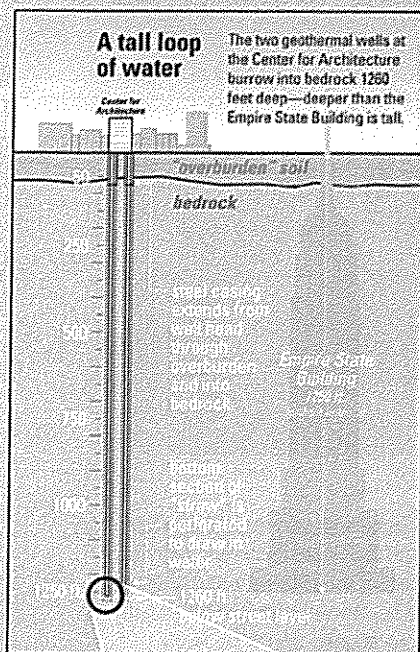
Geothermal heat exchange is based on the fact that the ground temperature in New York stays at 52 to 55 degrees Fahrenheit year round. Two 1260 foot deep wells have been drilled at the Center into the Earth. These wells naturally fill with ground water. The groundwater is pumped out of the bottom of the well and circulated through a heat plate which is located in a mechanical room. The heat plate connects to heat pumps, which contain compressors. The heat pump is able to reject heat in the summer and accept heat in the winter. Air is blown over water that is cooled or heated via the heat pumps and distributed through the Center in ductwork.

The water that has been extracted from the bottom of the well is returned to the top of the well. The 6inch diameter well is called the standing column, and is a closed loop. At no time is the water from the earth mixed with any other water or materials; it is simply pumped out of the well, passed through the piping of the heat plate and returned to the well.

There are a number of reason why this system was selected for the Center for Architecture including: the system consumes significantly less energy than a conventional condenser type air conditioning system, the system does not require large heat transfer grilles in the façade of the building, and this system was able to be installed as a new technology in a retrofit of an existing building.

This is the first geothermal heat exchange system used for a public space in New York City. NYSERDA has given the Center for Architecture a grant helping to offset the cost of the initial system installation. The geothermal heat exchange system is part of the Center for Architecture's employment of sustainable design principles, technologies and materials.

Geothermal at the Center for Architecture



With the support of the City of New York and the New York State Energy Research and Development Authority, the Center for Architecture is the region's first building open to the public that uses geothermal design and technology.

The Center's geothermal system has two wells containing 55°F water that provides an energy-saving "boost" for the heat-exchange method in both cooling and heating modes. Heat pumps use the 55°F geothermal environment as a reservoir from which heat is extracted in winter and into which heat is transferred in the summer—far more efficient than a conventional air-exchange system in which heat pumps extract heat from freezing air

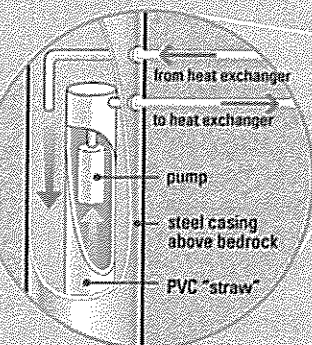
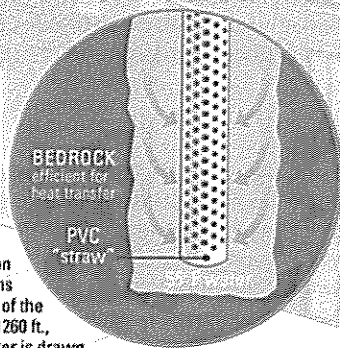


The geothermal wells were drilled directly through the sidewalk in front of the Center. (photo by Peter Aaron/Esto)

in winter and transfer heat into warm air in summer.

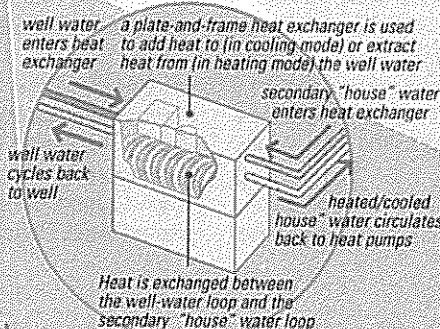
During system operation, water moves cyclically through the closed ground loop on a 2520-foot path, transferring heat from the heat pumps to the bedrock surrounding the well along the way.

1 The circulation process begins at the bottom of the well, at a depth of 1260 ft., where the 55°F water is drawn through intake perforations into a PVC "straw."

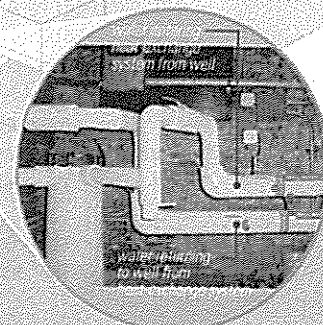


2 A small pump within each "straw" moves the water to the heat-exchanger units in the mezzanine-level mechanical room.

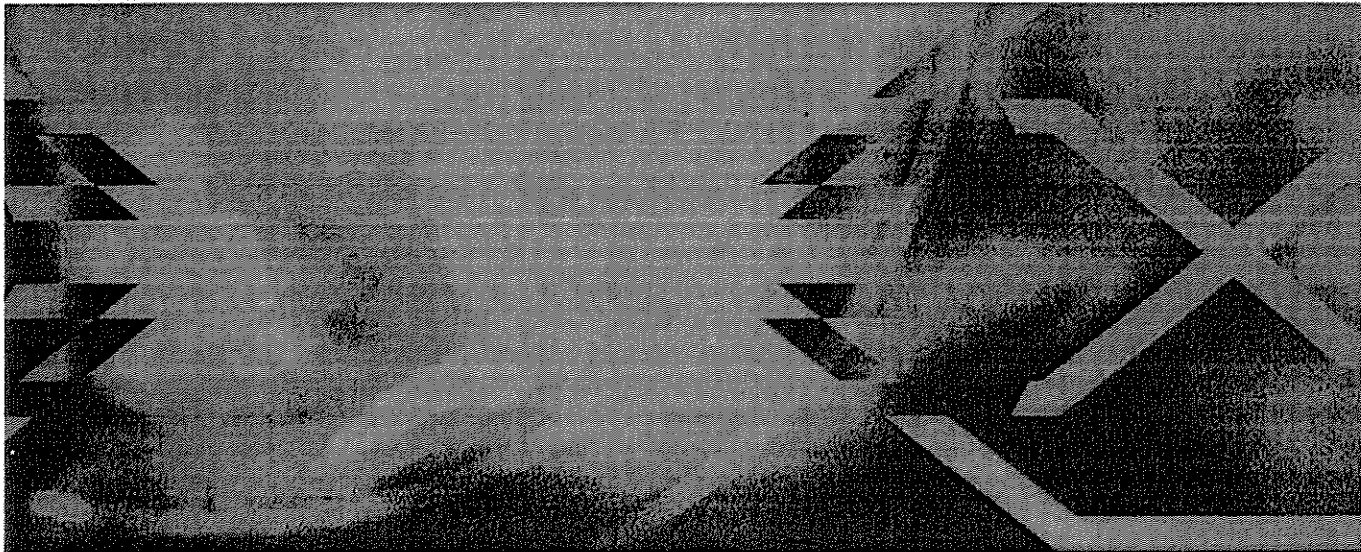
3 The heat exchanger either extracts heat from or transfers heat to the well water, depending upon the mode (cooling vs. heating). This heat is exchanged with the secondary "house" water loop that runs from the heat exchanger to the interior heat pumps and back.



4 The heated/cooled "house" water circulates to nine heat pumps located in mechanical rooms throughout the three floors occupied by the Center. The heat pumps use a refrigeration cycle to heat or cool the air in the space. The house water then returns to the heat exchanger to begin the cycle again. The house loop facilitates heat transfer between spaces, since each heat pump can heat or cool at any time. During spring and fall, this provides additional efficiency.



5 Once the well water has coursed through the heat exchanger, it flows back to the well and along its way to the bottom, losing or regaining heat energy to reach the 55°F starting temperature again.



GEOHERMAL AT THE CENTER FOR ARCHITECTURE

Rick Bell, FAIA,
AIA, New York Chapter
Joyce Lee, AIA
NYC Office of Management and Budget

If architecture is to be grounded in the earth, the Center for Architecture has achieved just that by going 1,260 feet into the bedrock of Manhattan. Spurred by a grant from the New York State Energy Research and Development Authority (NYSERDA), Architect Andrew Berman, AIA and Engineer Michelle Noris, PE have designed an energy efficient heat pump system that has few, if any, counterparts in the region in a publicly accessible building.

The Center for Architecture, the new home of the American Institute of Architects (AIA) New York Chapter and the New York Foundation for Architecture, is located in the heart of Greenwich Village in New York City. The 536 LaGuardia Place location had been chosen because of the demographics of movement by architecture and design firms towards Lower Manhattan, as well as the AIA's desire to have a storefront presence. The Center's mission of civic engagement is exemplified by Chapter events involving the public sector, collaboration with a wide variety of other professional organizations and not-for-profit groups and a range of exhibitions pertaining to the public realm.

Daylight penetrates deep into the ground floor "public resource center" lobby, the "common room" library and

two subterranean levels containing galleries and a lecture hall. Transparency and accessibility are recurrent themes. The design is the antithesis of an 18th century gentleman's clubhouse or its later day equivalent. The glazed storefront facade strives to engage everyone, from students and community residents living nearby to the overseas culture seeker who studies the New York City subway map to find the Center just south of Washington Square Park.

Why Geothermal?

From the context of design, why celebrate a geothermal system when most of it is hidden underground? The answer is deceptively simple: its design appeal stems from the system serving a much needed cooling and heating function without the usual clutter of mechanical equipment and the predictable noise of the fans at the rooftop. This design freedom can be particularly valuable in urban buildings with restricted rooftop access and in the renovation of historically significant structures where the roofscape cannot be altered.

Using the latent heat storage capacity in the earth is an effective way to reduce the urban heat island effect. The geothermal systems eliminate the need for rooftop cooling towers which releases heat into the atmosphere. It is also good news to local botanists when the constant evaporative effect from the cooling towers is absent, thus allowing better survival opportunities for plant species nearby the building.

An article by Peter Hall in the May 2004 issue of Metropolis magazine described the geothermal system at the new Center for Architecture. Hall's description, "a network of white plastic pipes gurgles and guzzles around a heat pump like the arteries of a newly transplanted heart," hints at the organic importance of the

geothermal system to the new space. When the AIA decided to move from its uptown aerie at the New York Design Center at 200 Lexington Avenue, green issues were at the forefront of site analysis, program development and architect selection.

The location purchased by the AIA, across from Neil Estern's statue of Fiorello LaGuardia, presented significant challenges. A storefront with a 5,000 square foot floor plate came with basement and cellar levels of equivalent area. These dark and damp spaces were barely usable for storage. An east-facing storefront allowed light to penetrate into the former poster shop interrupted by columns and randomly placed interior partitions. But the possibilities seemed unlimited. An open two-stage design competition was organized with a program brief that stressed creative environmental solutions. The eight green criteria in the program included the requirement to "embrace design features that combine environmental and educational value." The competition winning firm, Andrew Berman Architect, went beyond the program requirements to open up the three levels of space to natural light, enhancing visibility and transparency of AIA operations and Center activities.

The design entails removing almost 2,000 square feet of concrete slab to create double and triple-height lecture and gallery spaces, resulting in 12,000 net square feet with a permissible occupancy approaching 500 people. The AIA as client, along with their architects and engineers, considered early-on the use of geothermal heat exchange for both heating and cooling. There are several reasons why this became the choice for the Center for Architecture:

- It consumes over 30% less energy than a conventional condenser-type air conditioning system
- It does not require large heat transfer grilles on the façade of the building
- It preserves all the valuable window openings and daylighting opportunities on the ground floor
- It could be installed as new technology in the retrofit of an existing building
- It did not require adding a cooling tower to the roof of an occupied building with seven floors of live-work lofts above the ground floor

The 65-ton system designed by Michelle Noris, PE of Norfast Consulting Group, with advice from William Bobenhausen, FAIA (then of Steven Winters Associates, now president of Sustainable Design Collaborative, LLC) is the first geothermal heat exchange installation used for a public space in New York City. The closed-loop system has standing column wells, which extract cool water from the bottom of the well and replace the heated water at the top. The heat exchanger has two fluid loops: the ground water loop and the secondary loop. The heat exchanger functions to isolate the ground

water from the heat pumps and piping, preventing potential sediment problems in the heat pump coils. The Center has several other features to enhance energy efficiency. The heat pumps are zoned by use, so only occupied spaces are heated and cooled accordingly. The fresh air supply fan and the secondary water pumps are both on variable frequency drives. Such modular efficiency is particularly well suited to a building with daily schedules and occupancy as varied as the Center.

The grant from NYSEDA significantly offset the \$100,000 cost of the drilling of the two wells, each 1,260 feet deep. With proper permitting from the City's Department of Transportation and Department of Environmental Protection, the well drilling took place over a three-week period in the summer of 2003, shortly before the Center for Architecture opened to the public on October 7th.

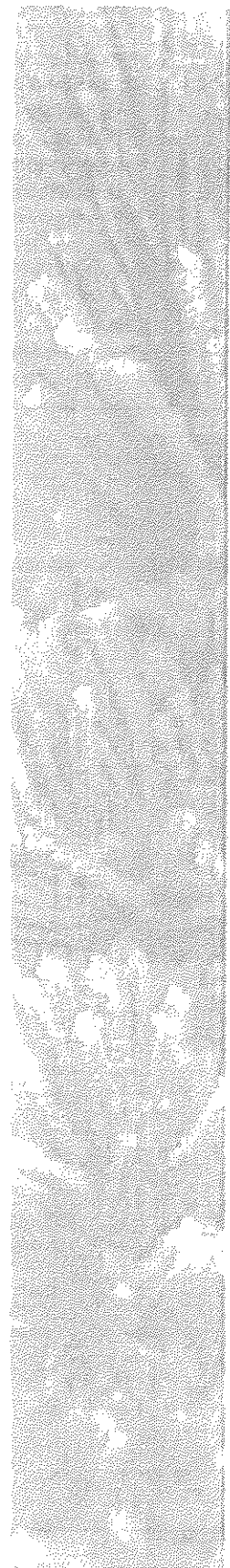
Each well took a week to drill, with the relatively noisy activity taking place only in the afternoons to mitigate intrusive acoustical annoyance in a Village community of late nights and later mornings. Set-up and moving of the drilling rig in the street and hay bales for water containment took an additional week. One lane of traffic remained open, and the sidewalk in front of the Center, protected by safety barricades, also stayed open for passage throughout the drilling period.

Other Examples

Buildings can become pedagogic tools for their inhabitants and visitors. For example, in Boston, where the mayor has recently convened a green building task force, Richardson's Trinity Church is being renovated by Goody Clancy Architects, who have incorporated wells dug deep under Copley Square. Mechanical equipment could clearly not have been added to the top of this landmark structure visible on all sides from the public square.

In the New York region, geothermal systems are found in a variety of buildings, including the Bard College Performance Arts Center by Frank Gehry and the 1400 Fifth Avenue affordable housing project developed in Harlem by Full Spectrum. The Front Street residential project by Cook + Fox Architects brings geothermal to market rate housing in Lower Manhattan's South Street Seaport historic district. The new Queens Botanical Gardens administration building by BKSK Architects will break ground this year with the latest geothermal installation.

Other projects on the drawing board include Kensington Library and Weeksville historic house from the high performance buildings portfolio at the New York City Department of Design and Construction. More recently, the system is also being considered at Fort Tryon Park by the New York City Parks Department because of the potential microclimate improvement for flora and fauna nearby.

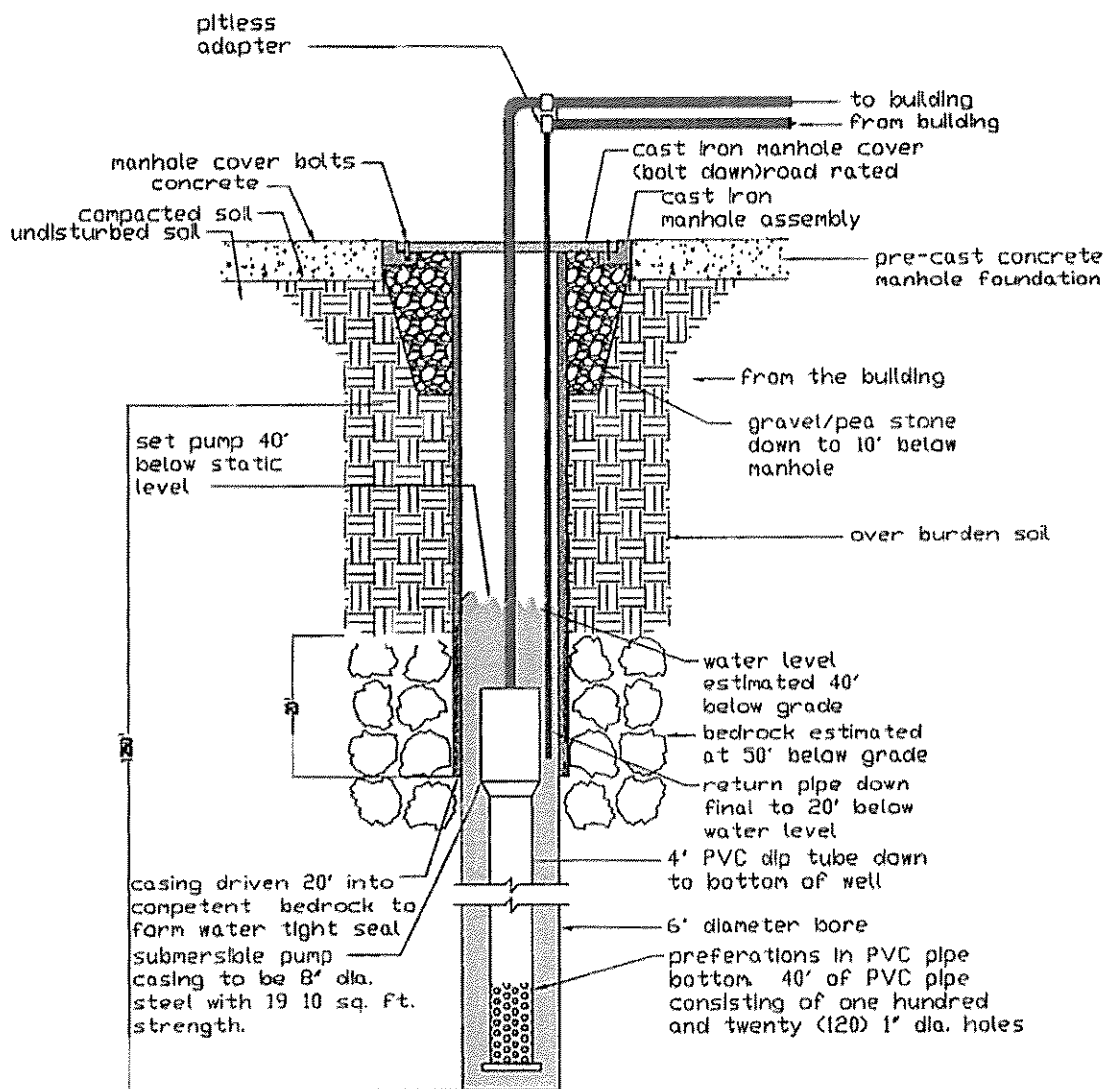


Technology of the Future?

The fact that geothermal systems are starting to be used more widely in New York City and the region is remarkable. Even more remarkable is that this relatively simple technology is seen as futuristic. The City, along with NYSERDA, was far-sighted enough to have given capital support to the creation of the Center. The advice and consultations from the New York City Economic Development Corporation, the Department of Buildings and the Department of Cultural Affairs were invaluable. Visitors to the Center for Architecture who witness the quiet pipes at work and feel the cool air wafting freely inside on a hot summer day can only say that they have seen the future, and the future is here.

Rick Bell is executive director of the New York Chapter of the American Institute of Architects. At the AIA, Rick has worked to raise the profile of the architectural community on public policy issues, including accessibility, preservation, quality based selection, and sustainable design. He previously was chief architect and Assistant Commissioner of the NYC Department of Design & Construction, where he had responsibility for design excellence and helped create the City's High Performance Building Guidelines.

Joyce S. Lee serves as Chief Architect at the New York City Office of Management and Budget and is a former board member of the AIA New York Chapter. In 2002, she was chair of the National AIA Committee on the Environment, and most recently received the AIA NYS President's Award for Professional Contribution.



WELL DETAIL

Courtesy of Michelle Norris, PE and Rafael Jaquez

6-11-12

New York City Council

Committee on Environmental Protection - Public Hearing

Int. No. 694 – In Relation to facilitating the development of geothermal energy, The Potential of Geothermal energy Use in New York City

Good morning Chairman Gennaro and distinguished members of the City Council. It is truly an honor and pleasure to be here this afternoon to offer support for your efforts to explore measures that will facilitate and increase the use of geothermal energy sources in New York City.

I am Paul Bony, and I have over 25 years of experience focused on energy efficiency, renewable energy and electric utility peak demand management. I am the Market Development Director for ClimateMaster, an Oklahoma based manufacturer of geothermal heat pumps with over 1,000 dealers and distributors across the U.S.

Based on my experience, this pending legislation will provide many benefits to the citizens of New York City.

This legislation will save energy. Buildings use nearly 40% of all U.S. primary energy with heating, cooling, and water heating accounting for nearly one half of this use. Geothermal heat pumps can reduce this energy consumption by up to 50%.

This legislation will **save consumers money**. Families and businesses can benefit greatly from energy efficiency upgrades including geothermal heat pumps that provide energy bill reductions. With the high cost of heating fuels and electricity in New York City, ground source heat pumps, combined with building efficiency upgrades, should easily allow families and businesses to reduce their annual energy use by 50% or more.

This legislation will create jobs. The installation of efficient ground source heat pumps will generate employment for local labor. The installation of the geothermal equipment and ground loops has to be done locally. It is impossible to import a ground loop from off shore. Based on my experience as a geothermal contractor, a business installing 50 to 70 residential geothermal heat pump systems annually will employ 7 full time people in good paying jobs. This does not include employment by other sub-contractors needed to provide related services including energy audits, drilling ground loops, electrical work, carpentry, and weatherization upgrades. With over 3 million housing units, the replacement of fossil fuel heating systems with ground source technology will be able to generate construction employment in New York City for many years.

This legislation will reduce the city's carbon foot print and summer peak electric demand. Geothermal heat pumps provide significant peak load reduction and improved electric system load factor. This allows the electric utility to provide energy efficiency to their rate payers and reduce the need for expensive new generation, without putting pressure on electric rates. These energy savings also provide approximately 10 metric tons of annual carbon savings per home per year.

In conclusion, ClimateMaster is very supportive of this legislation. I am convinced that it will provide great benefits to the millions of citizens of New York City and serve as a leadership example to city governments across the U.S.

Thank you for giving me the opportunity to share my comments with you this afternoon. I will close my testimony with a short presentation on ground source heat pumps and look forward to answering any questions you may have.

New York City Council

Committee on Environmental Protection

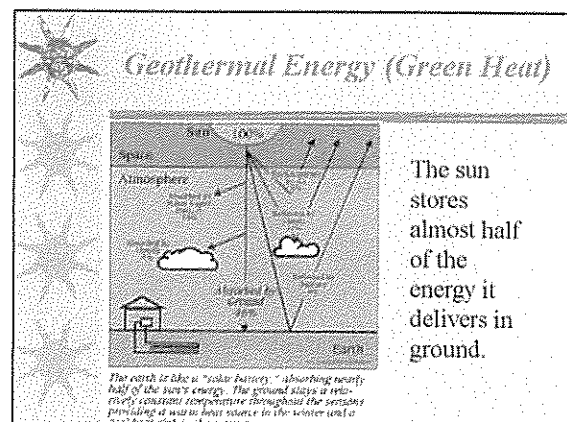
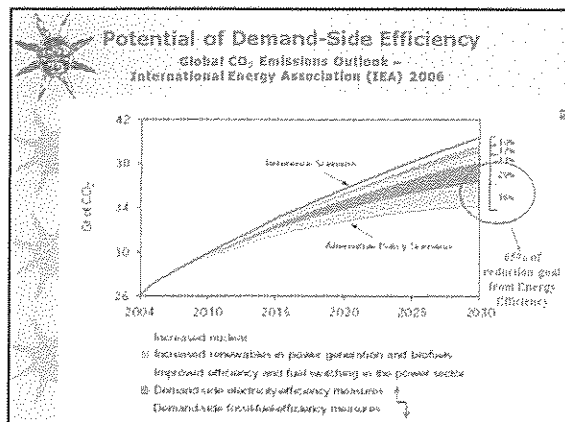
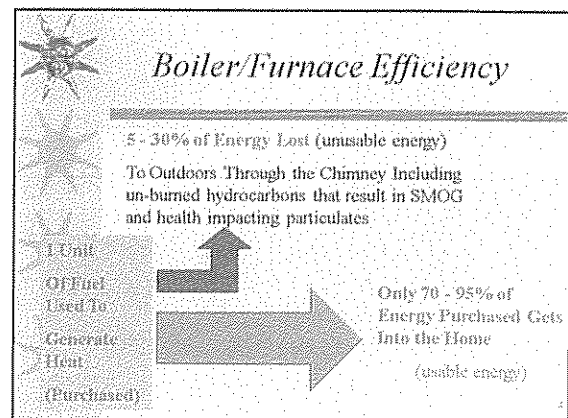
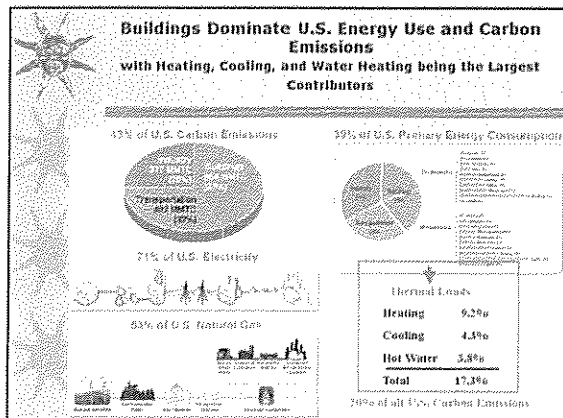
Introduction to Geothermal Heat Pump Systems

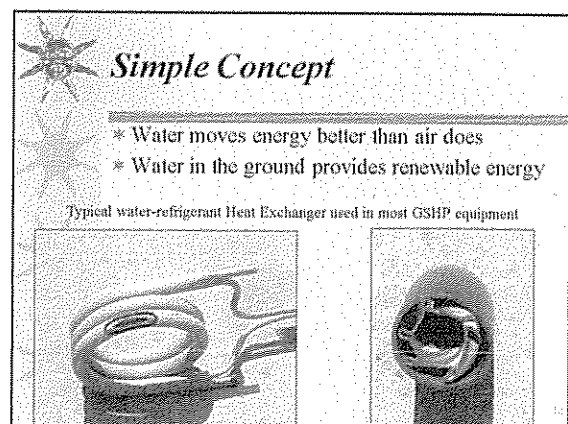
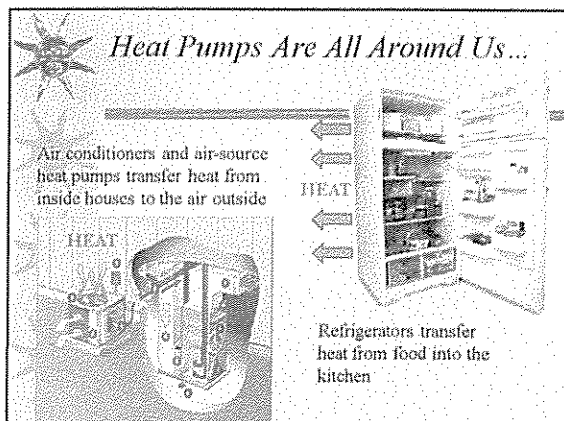
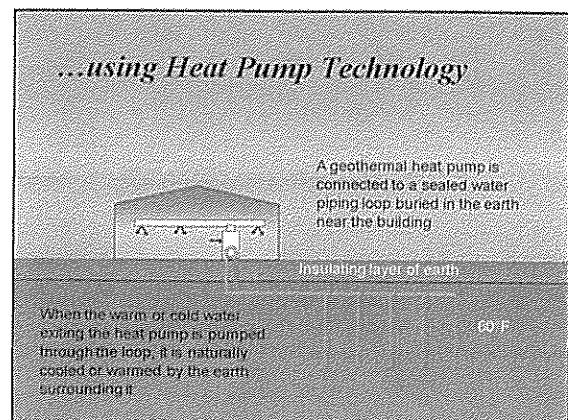
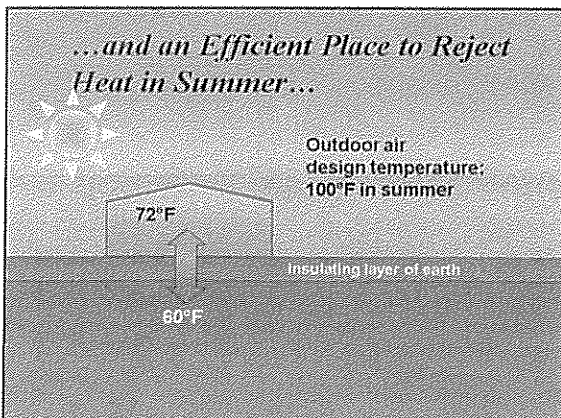
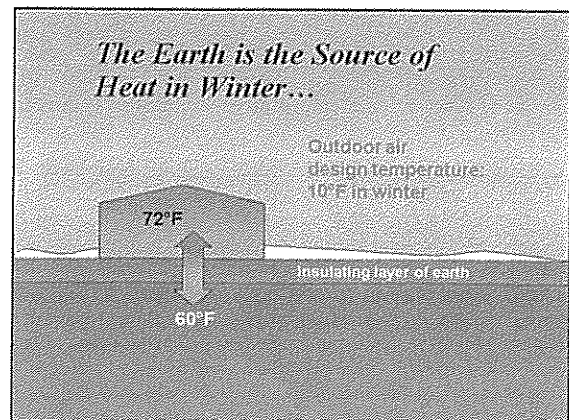
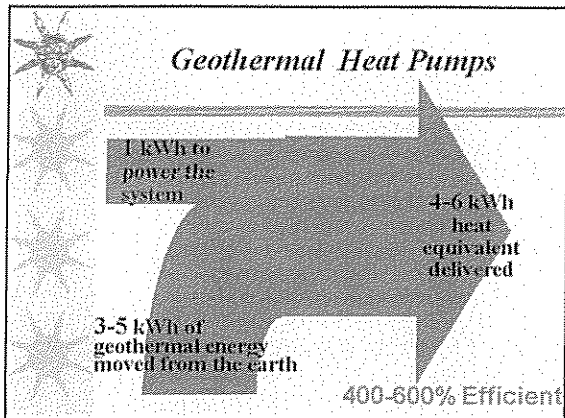
By
Paul Bony
Director of Market Development
ClimateMaster

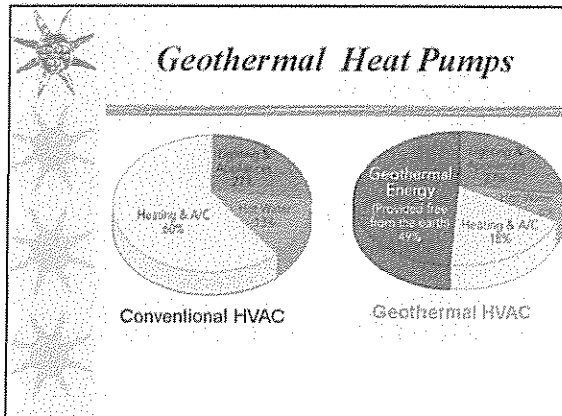
June 11, 2012

Introduction to Geothermal

- * So, what is a ground source (GeoExchange, GX, geo thermal,, ground coupled) heat pump system?
- * Why should policy makers care about them?



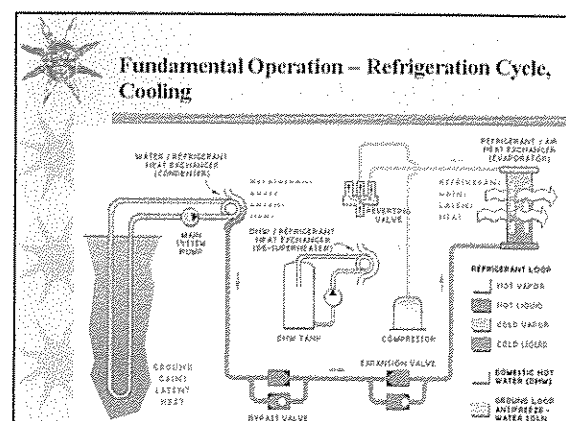
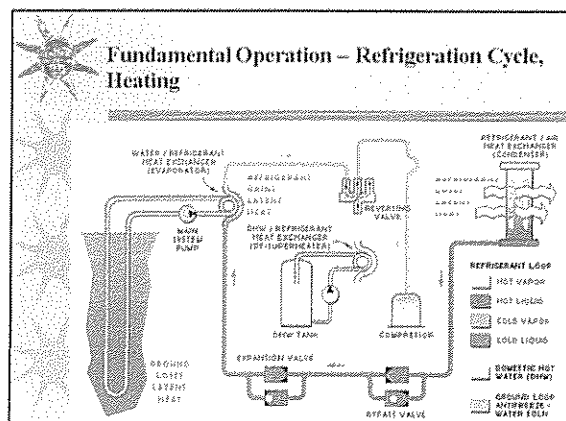




- ### Geothermal Heat Pumps
- * The difference in the before and after system efficiency = carbon emissions savings.
 - * 300,000 GSHP retrofits, replacing oil and natural gas boilers/furnaces and standard air conditioning, could eliminate the carbon emissions of a 500 mW coal plant (which serves 500,000 homes!)

- ### Geothermal Heat Pumps
- * Geothermal heat pumps produce the lowest carbon dioxide emissions, including all source effects, of all available space-conditioning technologies (EPA, 1993).
 - * A GeoExchange systems saves more CO₂ than an equivalent investment in solar PV.
 - Based on Colorado electric energy carbon load and weather data.

- ### Federal Study – Department of Energy
- * Oak Ridge National Lab
 - 2010 Report
 - Found geothermal heat pumps would:
 - Reduce the purchased energy consumed for Heating, cooling and hot water (H/C/DW) by 45%
 - Reduce peak energy demand for H/C/DW by 56%
 - Reduce consumer's bills for H/C/DW by 48%
 - Reduce CO₂ emissions for H/C/DW by 45%



GX Components

- * Unit
 - Self contained for forced air (ducted) applications
 - Or geothermal "boiler" with heating distribution (fan coils)
- * Loop Flow Controller/Pump Kit
- * Thermostat
- * Loop

Basic GeoExchange Unit

The diagram shows a cross-section of the unit with the following components labeled:

- Insulated Coaxial Heat Exchanger
- High Efficiency Compressor
- Bi-directional TXV (provides heating & cooling)
- Internally mounted hot water generator
- PSC or ICM Blower
- Advanced Air coil
- Swivel Water loop Connections
- Internally trapped condensate
- Wiring/control board

Ground Source Heat Pumps have sizes and configurations for every application

The diagram illustrates different configurations and components:

- Upflow & Downflow Fan coil
- Water-to-Water (boiler replacement)
- Outdoor Split
- Indoor Split
- Horizontal Field pipe
- Cascade
- Common outdoor Top

Basics

Geothermal Heat Pumps are a Scalable Technology

1,300 Sq. Ft. Low Energy Habitat for Humanity Homes - Oklahoma City

Alta Condos, Washington DC

Geothermal Heat Pumps

The grid shows the following buildings and locations:

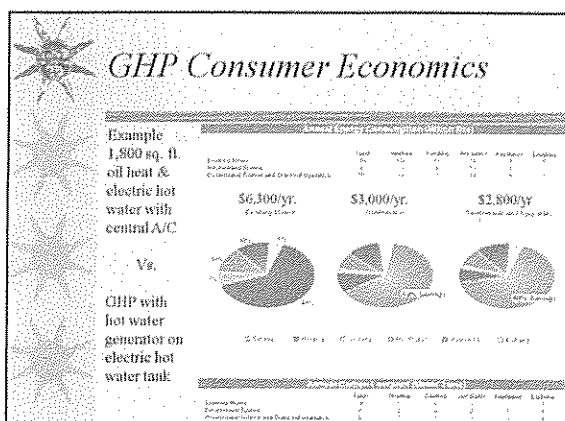
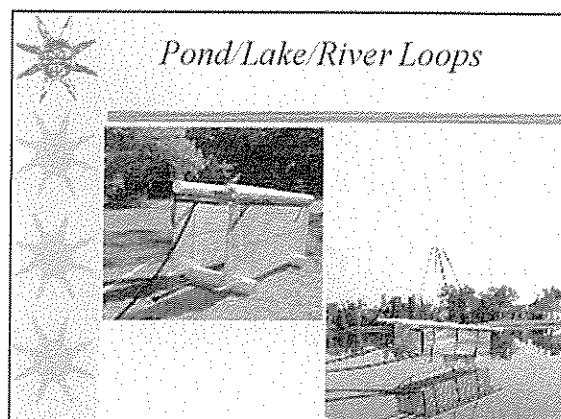
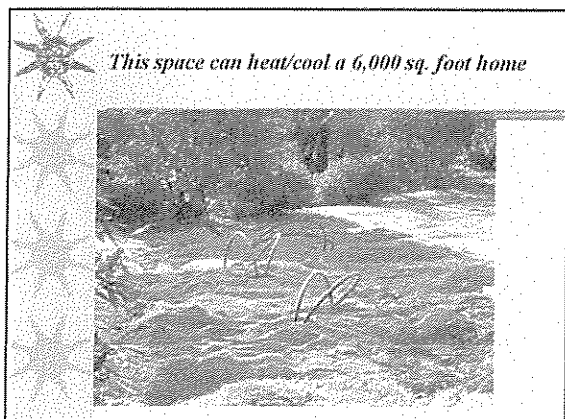
- John F. Kennedy DA Bldg.
- ADDAF Headquarters - Atlanta, GA
- Carl Hines House - Louisville, KY
- Bank Trust Bldg. - Peoria, IL
- Alta Condos, Washington DC
- Harvard Library - Cambridge, MA
- Paul's Laundry Bldg. - Reno, NV
- Studen Village - St. Catharines
- Yale Art School - New Haven, CT
- Osaka Office - Osaka, Japan
- California University of PA
- Harvard Science - Boston, MA

Commercial Buildings

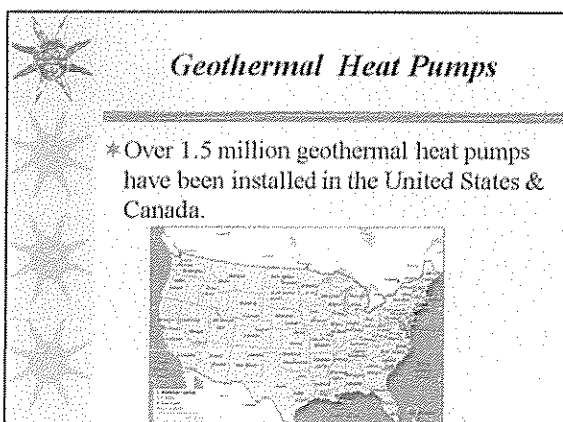
Basics

The diagram illustrates the installation process:

- Drilling*
 - * or surface water
- Pipe Loop Insertion
- Fusing Piping
- Loops Ready for Unit
- Installed Heat Pump



- Geothermal Heat Pumps*
- * Are a market proven technology.
 - * Cut total heating & cooling bills.
 - * Tap renewable solar energy from the earth.
 - * Have low power requirements that can be provided by zero carbon renewable sources!
 - * Provide business and residences immediate positive cash flow with conventional financing!



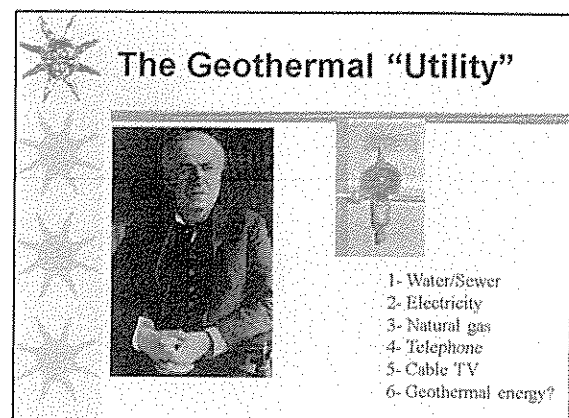
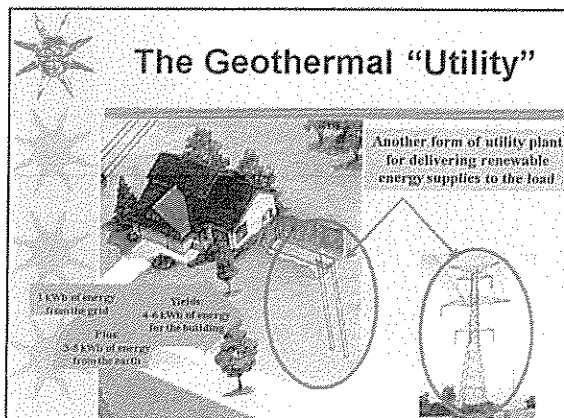
- Geothermal Market Goal - DOE*
- * DOE Industry Roadmap Growth Goal - 1 Million GHPs Annually by 2017
 - Results in 3.3 million installations by 2017
 - 26 MMT annual CO2 reduction
 - 520 MMT lifecycle CO2 reduction over 20 yr GHP life
 - Creates/saves up to 100,000 jobs

Geothermal Heat Pumps = Jobs

Activity	#man days / home
Home Audit & system design	1
Home Repair/Weatherization	2
Utility and loop locates	0.25
Loop Construction	2.5
Loop tie-in/landscape	0.5
Geo system installation	4
Back Office - supervision	0.75
Other trades	0.25
Manufacturing-transport-dist	0.5
Total	11.75
Assumptions	1880 man-days per year
	94 hours/home
	70.0 homes/job
	5.00 jobs/100 homes

Geothermal Heat Pumps

- * Fed tax credits cover 1/3 of the cost of a residential Geo installation.
- * Federal tax code covers 10% of commercial Geo installations, plus provides accelerated depreciation (5 years) and efficient building tax credits.
 - covering, in many cases, over 1/2 the total installation cost.



The Ground Loop "Utility"

The Utility Loop Concept

- * Utility (electric, water/sewer, gas) owns and recovers the cost of the loop, interest expense, program costs, and added income through a monthly fee.
 - Utility installs or contracts out loop construction.
 - Controls system design and installation quality
 - Carbon credits stay with the utility (future value)
- * Consumers Get:
 - Lower total energy bills.
 - Utility grade service and reliability

Utility Geothermal Support

- * The Wyandotte, Michigan City Council recently approved the creation of a geothermal utility. The general manager of Wyandotte Municipal Services said there are many reasons to be excited about the introduction of geothermal energy, including its heating and cooling efficiency, its affordability, because geothermal helps Wyandotte Municipal Services improve the operation of the electric system and reduce power supply costs, and benefits to the environment. (August 2010)

Geothermal Heat Pump Initiative Opportunities

- * Immediate Green-Tech Jobs Creation – “Shovel-Ready” Projects
- * Creation of New, local “Green-Tech” Industry
- * National Leadership Position in GHP Installations
- * Create New City Income Source
- * Significantly Reduce Carbon Footprint
- * Reduce Peak Loads on Electricity Generators
- * Conserve Natural Gas and Fuel Oil
- * Reduce Businesses’ and Homeowner’s Utility Costs – Stimulate The Economy
- * Improved Air Quality (reduce combustion emissions)

Geothermal Heat Pump Takeaways

GHPs provide the most efficient (and cost effective) method of heating and cooling a building

GHPs are both a renewable and energy efficient technology

GHPs reduce utility peaks and improve load factor

There is no question – THEY DO WORK!

Additional Resources

- * <http://residential.climate-master.com>
- * <http://www.geo-exchange.ca>
- * <http://www.whoknowsthisstuff.com/Video-Geothermal.html>
- * <http://www.geoexchange.org>
- * <http://www.igshpa.okstate.edu>
- * http://residential.climate-master.com/dealers_area/tools

Thank You For Your Attention! Questions?



If you ever need a hand you can reach me at:

Paul Bony
paulsbony@yahoo.com
 970-249-8476



Remember that this is just a demonstration of the potential savings and is not an implied promise of actual savings. To get a more accurate assessment, get in touch with a ClimateMaster dealer today. Each home is different and your experienced and knowledgeable ClimateMaster dealer can help you pick the right system and give you a better understanding of just how much you can expect to lower your heating and cooling costs.

Your home profile

City / Providence	New York
HomeType	Existing
Conditioned Space(sq FT)	1800
Insulation and Air Leakage	Average
HVAC Equipment Age	>15 years old
HVAC Equipment Efficiency	Standard
Heating Type	Fuel Oil
Water Heating Type	Electric

Energy Efficiency Improvements

Geothermal Heating and Cooling System	with Hot Water Generator
Insulation and Air Leakage Level Upgrade	Good
Appliance Type Upgrade	None
Lighting Type Upgrade	None

Utility Rates for New York

	Winter	Summer	Unit of Measure
Electricity	0.15	0.19	kWh
Natural Gas	1.48	1.79	Therm
Propane	3.26	3.19	Gallon
Fuel Oil	4.05	3.88	Gallon

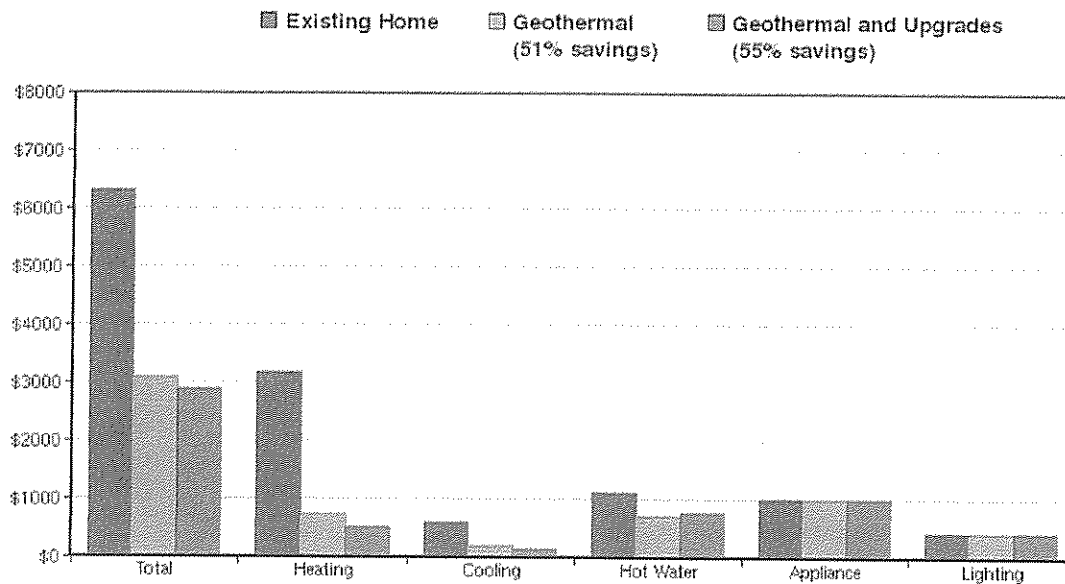
Source U.S. Energy Information Administration
Reported Statistics and Analysis

Design Data

	Winter	Summer	Unit of Measure
Outdoor Design Temp	15	92	Deg F
Heating Degree Days	4,880		Deg F
Earth Temp	54		Deg F
Current Building Load	39,800	28,000	Btu/hr
Upgrade Building Load	27,400	26,400	Btu/hr
Hot Water	64		Gal/day
Heating Type	80% - Natural Draft		
Cooling Type	8 SEER		

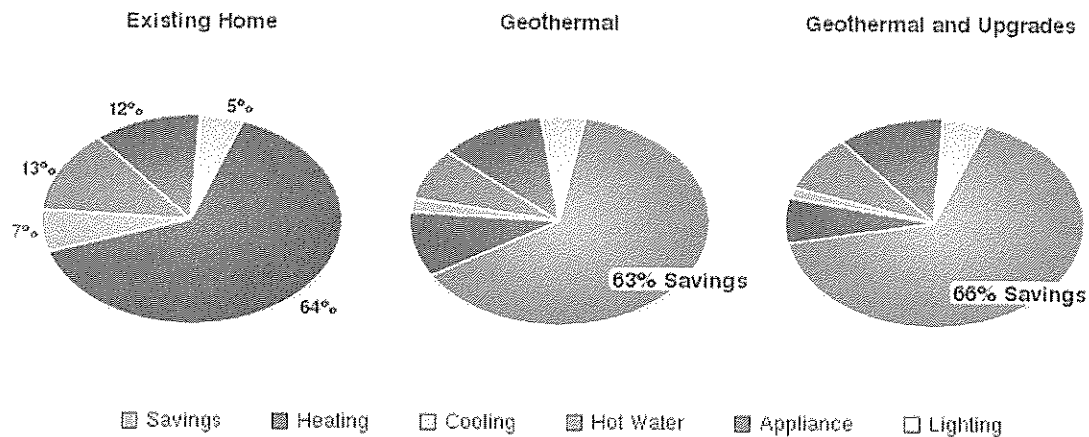
Annual Energy Costs

	Total	Heating	Cooling	Hot Water	Appliance	Lighting
Existing Home	\$6,320	\$3,164	\$600	\$1,122	\$1,011	\$422
Geothermal System	\$3,082	\$746	\$202	\$701	\$1,011	\$422
Geothermal System and Selected Upgrades	\$2,874	\$516	\$157	\$766	\$1,011	\$422



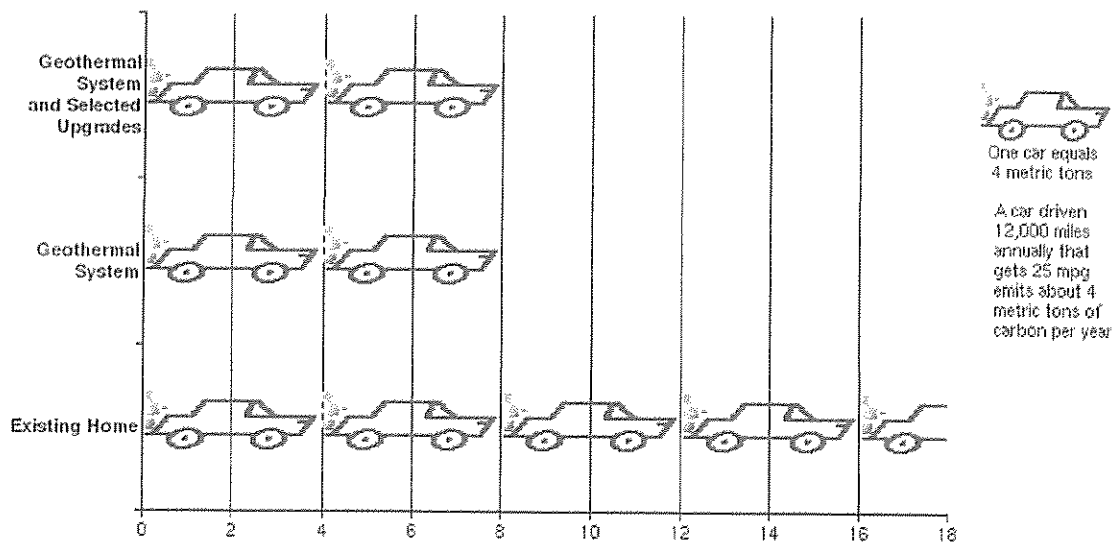
Annual Energy Consumption (Million Btu)

	Total	Heating	Cooling	Hot Water	Appliance	Lighting
Existing Home	164	106	11	21	19	8
Geothermal System	60	17	4	13	19	8
Geothermal System and Selected Upgrades	55	11	3	14	19	8



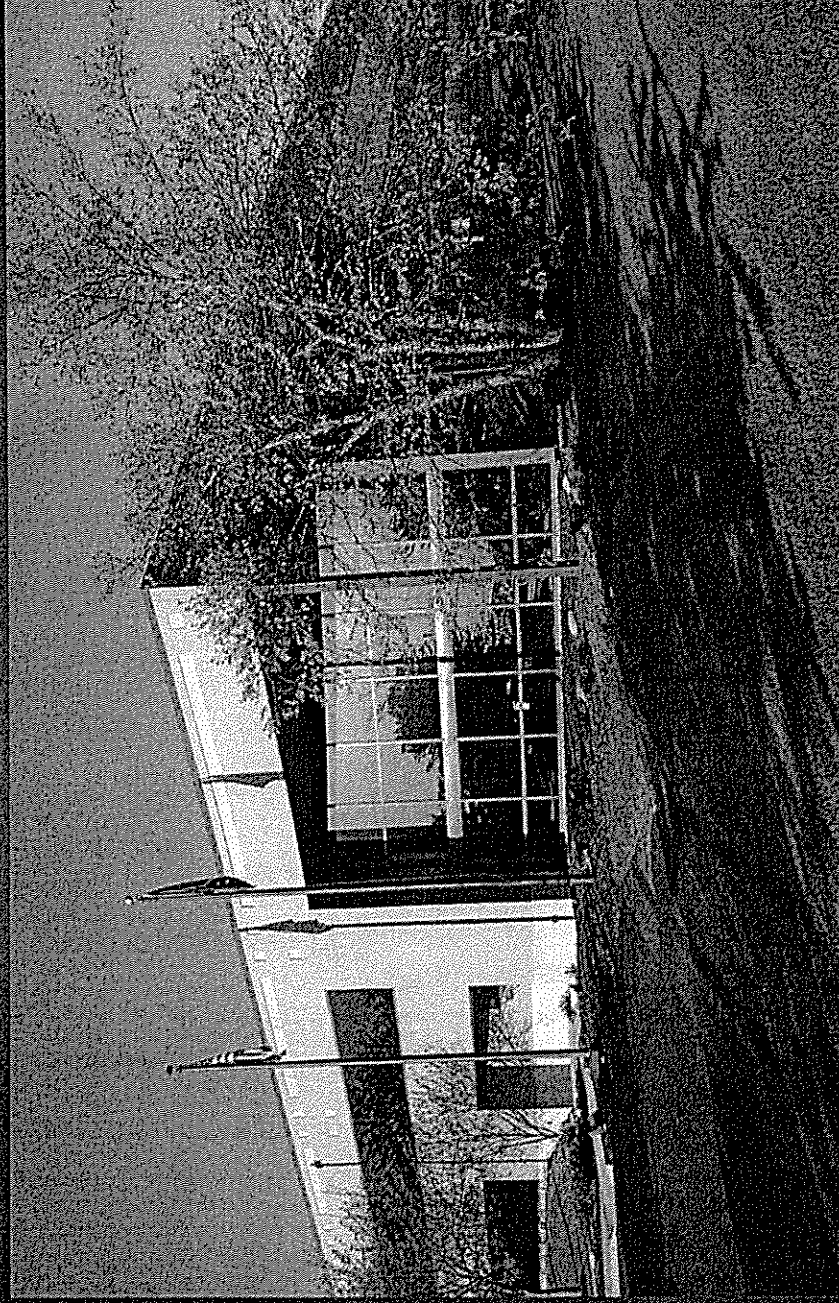
Annual Carbon Footprint (Metric Tons)

	Total	Heating	Cooling	Hot Water	Appliance	Lighting
Existing Home	18	9	1	3	3	1
Geothermal System	8	2	0	2	3	1
Geothermal System and Selected Upgrades	8	2	0	2	3	1



Source: NREL

Welcome to WaterFurnace



System Selection

- The owner wants to know options
 - Budget
 - Why use a system?
 - Installed cost
 - Operating cost
 - Space – interface cost
 - Reliability and risk – redundancy for example
 - Function is required



WHY WSHP

- Low installed cost is why WSHP developed

- Condenser loop
- 2-pipe, no insulation
- Owner buys central plant

Simple system to communicate, install, and maintain

- Boiler, DHW Boiler; heat exchangers, even the ground
- Cooling tower, dry cooler, many hybrid options
- Pumps
- Pipe, 2-pipe alternate materials; even one-pipe distribution
- Tenant buys units or Zones of control



Common sense evolution

- 1950's – water-cooled better than air-cooled
- 1960's – Closed loops in buildings
 - Installed cost
- 1970's – Energy transfer
- 1980's – exploded in offices and schools
- 1990's – EER and extended range expansion
- 2000's – Refrigerant, EER, and ECM



Owner flexibility

- We provide the owner
 - Total Tons and a number of zones of control
 - The central plant and pipe do not change
 - The owner cost can be fixed
 - Changes in building use can be addressed as tenant finish
- There are multiple choices with WSHP
 - Unit type, efficiency range, and enhancements



Back to basics

- The following is a readily available system analysis tool online. Free
- It is produced by a pump company – Taco
- It includes default systems
- The following starts with the basic defaults
 - VAV to WSHP closed loop
 - Unitary to WSHP
 - WSHP to WSHP with enhancements



Project information page

click on "Energy Cost" compares systems

Jaco System Analysis Tool default.van.vst

File Edit Help

Project | System 1 | System 2 | System 3 | System 4 | Energy Costs | Life Cycle

Project

Project: alternate systems - default - var

Location: Ft. Wayne

Engineer: JUS

Date: today

Nearest Climatological Data Location

State: IN City: FORT_WAYNE

Building Dimensions

Length: 100 Ft Floor Height: 10 Ft Perimeter Width: 12 Ft

Width: 60 Ft Number of Floors: 5

Energy Costs

Electricity Demand: 10.00 \$/Kw

Electricity Consumption: 10 \$/Kwh

Fossil Fuel Oil: 30 \$/Gal

Fossil Fuel Natural Gas: 1.50 \$/Therm

Fossil Fuel Propane: 100 \$/Gal

Select Predefined Systems

System 1

System 2

System 3

System 4

Heat Loss

Enter Breakdown

Total Heat Loss: 720000 BTU

Ventilation Loss: 231900 BTU

Envelope Heat Loss: 308200 BTU

Heat Gain

Enter Breakdown

Total Heat Gain: 500000 BTU

Ventilation Sensible Gain: 53000 BTU

Ventilation Latent Gain: 97000 BTU

People Heat Gain: 50000 BTU

Life Cycle Cost

Cost of Money: 0.0 % Inflation on Maintenance Cost: 0.0 %

Inflation on Energy Cost: 0.0 % Project Life Cycle: 0 Years

Light Heat Gain 204000 BTU

Equipment Heat Gain 142000 BTU

Envelope Heat Gain 323301 BTU

Don't FORGET!

Size and perimeter

Heat loss Heat Gain



For this example

Project Detail Taco Energy Analysis Apr 19, 2012

Project

Project: alternate systems - default - vav
Location: Ft. Wayne
Engineer: US
Date: today

Nearest Climatological Location

State: IN
City: FORT_WAYNE

Building Dimensions:

Length: 100 Ft
Width: 60 Ft
Perimeter Width: 12 Ft
Height: 10 Ft
Number of Floors: 5

Heat Loss:

Total: 720000 BTU
Ventilation: 331800 BTU
Envelope: 388200 BTU

Heat Gain:

Total: 900000 BTU
Ventilation Sensible: 63000 BTU
Ventilation Latent: 97066 BTU
People: 60000 BTU
Light: 204000 BTU
Equipment: 102000 BTU
Envelope: 373934 BTU

Energy Costs

Electricity Demand: 10.00 /Kw
Electricity Consumption: .10 /KwHr
Fossil Fuel Oil: .00 /Gal.
Fossil Fuel Natural Gas: 1.50 /Therm
Fossil Fuel Propane: .00 /Gal.

Life Cycle Cost:

Cost of Money: 0.0 %
Inflation on Maintenance Cost: 0.0 %
Inflation on Energy Cost: 0.0 %
Project Life Cycle: 0 Years



There are Multiple choices

click system 1 then highlight and repeat for 2,3,4

TACO SYSTEM ANALYSIS

System 1

Energy Costs

System	Electricity Demand	Electricity Consumption	Fossil Fuel Oil	Fossil Fuel Natural Gas	Fossil Fuel Propane
System 1	10.00	\$/hr	10	\$/GJ	100
System 2					
System 3					
System 4					

Heat Gain

System	Light Heat Gain	Equipment Heat Gain	Envelope Heat Gain
System 1	204000	BTU	100000
System 2			
System 3			
System 4			

Life Cycle Cost

System	Cost of Money	Inflation on Energy Cost	Inflation on Maintenance Cost	Project Life Cycle
System 1	0.00	%	0.00	%
System 2				
System 3				
System 4				

Building Dimensions

Length: 100 Ft Floor Height: 10 Ft Perimeter Width: 12 Ft

Width: 60 Ft Number of Floors: 5

Nearest Climatological Data Location

Size: IN City: FORT WORTH

Date: today

select

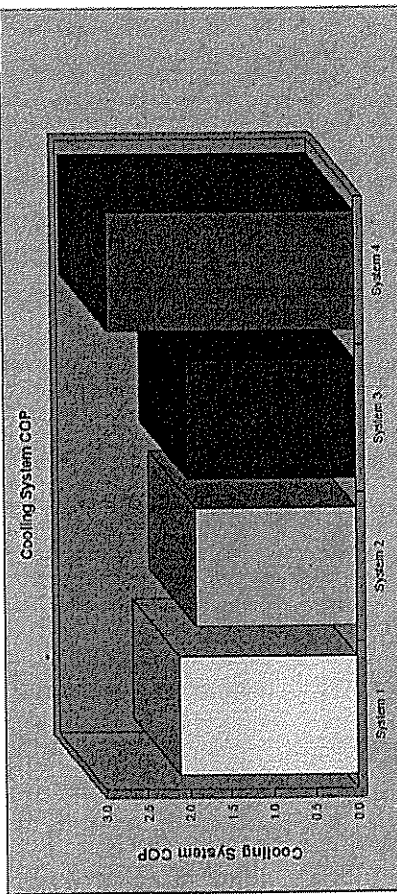
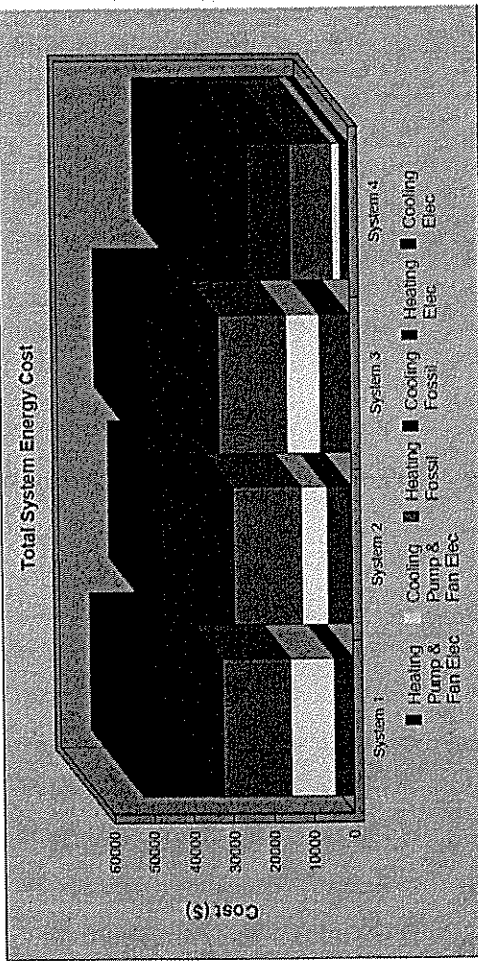


The results – same input VAV

System Comparison Taco Energy Analysis Apr 19, 2012

Heating Pump & Fan HP:	System 1	System 2	System 3	System 4	HP
Cooling Pump & Fan HP:	7.74	15.19	12.71	2.49	HP
Cooling System COP:	36.12	57.71	48.39	12.57	
Electrical Consumption:	2.12	1.91	2.02	2.95	KWHr
Electrical Consumption Cost:	210309	161221	195288	166700	\$
Electrical Demand Cost:	21031	16122	19529	16670	\$
Total Electrical Cost:	14487	14362	14311	13425	\$
Fossil Fuel Consumption:	35518	30484	33840	30095	\$
Fossil Fuel Cost:	11353	11353	11353	6969	\$
Total Cost:	17029	17029	17029	10453	\$
Savings for System 4:	52547	47513	50869	40547	
	12000	6966	10322		

WSHP saves
At least 40%



System 1: Variable Volume - Variable Temperature
System 2: Variable Air Volume Induction Box - 4 Pipe
System 3: Variable Air Volume Fan Terminal Box - 4 Pipe
System 4: Heat Pump Water Source - 2 Pipe



WaterFurnace®

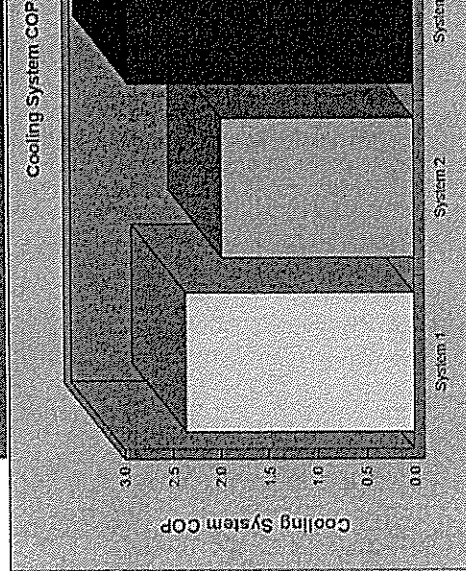
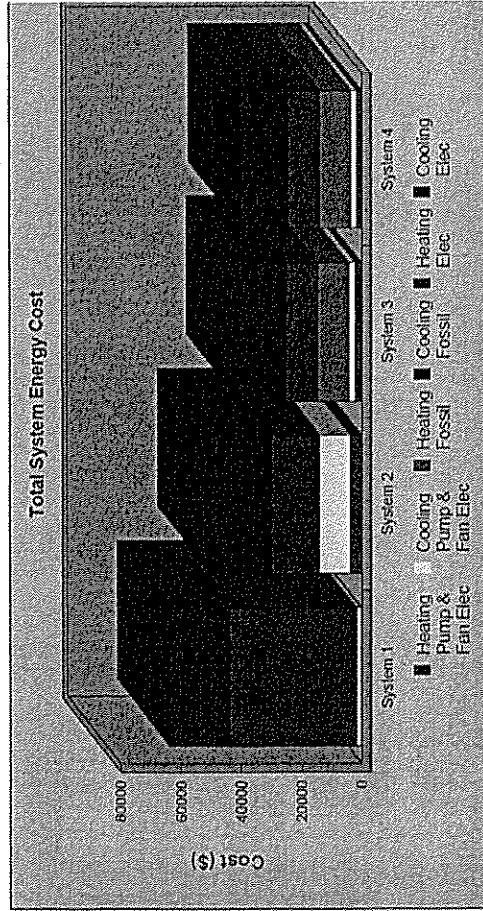
Commercial Division

Same input - unitary

System Comparison Taco Energy Analysis Apr 19, 2012

	System 1	System 2	System 3	System 4
Heating Pump & Fan HP:	2.49	8.24	2.49	2.76
Cooling Pump & Fan HP:	9.32	37.98	12.57	11.52
Cooling System COP:	2.36	1.98	2.95	2.98
Electrical Consumption:	367910	294183	166700	161084
Electrical Consumption Cost:	36791	29418	16670	16108
Electrical Demand Cost:	26883	20604	13425	13285
Total Electrical Cost:	63674	50022	30095	29393
Fossil Fuel Consumption:	0	0	6969	6969
Fossil Fuel Cost:	0	0	10453	10453
Total Cost:	63674	50022	40547	39846
Savings for System 4:	23828	10176	701	

WSHP saves
60 - 150%!



- System 1: Packaged Terminal Air Conditioning
- System 2: Heat Pump Air Source - Commercial Air Distribution System
- System 3: Heat Pump Water Source - 2 Pipe
- System 4: Heat Pump Water Source - 1 Pipe LoadMatch

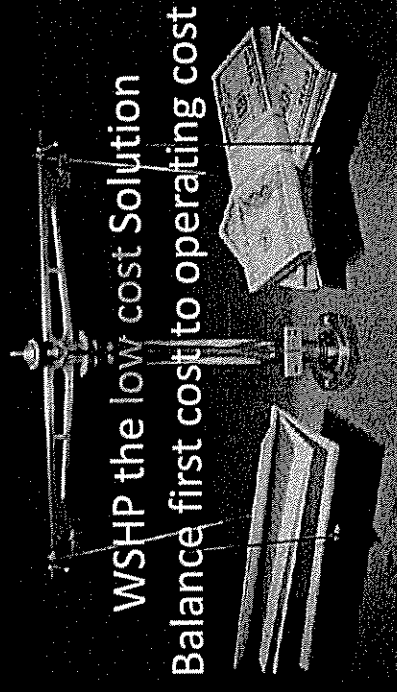


WSHP Enhanced

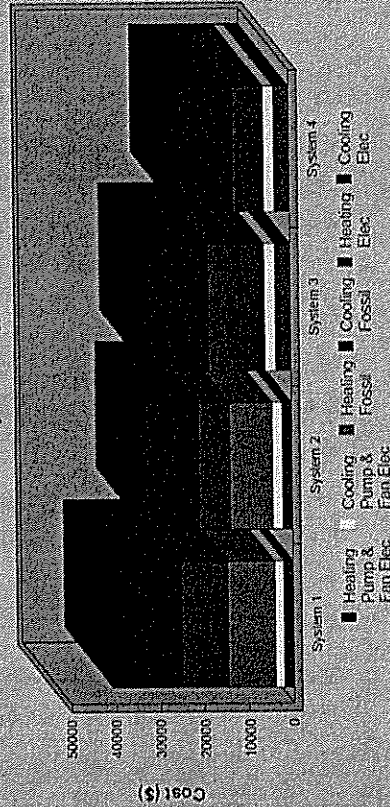
System Comparison Taco Energy Analysis Apr 20, 2012

Heating Pump & Fan HP:
Cooling Pump & Fan HP:
Cooling System COP:
Electrical Consumption:
Electrical Demand Cost:
Total Electrical Cost:
Fossil Fuel Consumption:
Fossil Fuel Cost:
Total Cost:
Savings for System 4:

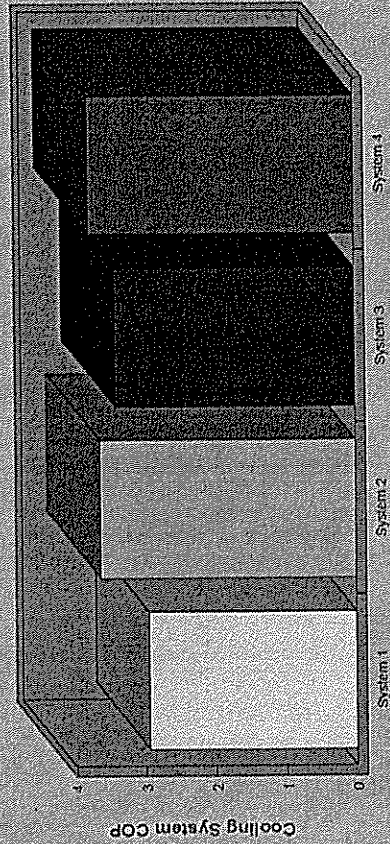
	System 1	System 2	System 3	System 4
HP	2.49	2.49	2.49	2.49
HP	12.57	12.86	14.93	14.82
KW/Hr	2.95	3.64	3.42	3.79
\$	166700	130397	186924	142798
\$	16670	13040	18692	14280
\$	13425	10385	13308	10426
\$	30095	23424	32000	24706
\$	6969	6386	0	0
\$	10453	9579	0	0
\$	40547	33003	32000	24706
\$	15841	8297	7294	



Total System Energy Cost



Cooling System COP



System 1: Heat Pump Water Source - 2 Pipe
System 2: Heat Pump Water Source - 2 Pipe boiler and EER
System 3: Heat Pump Water Source - 2 Pipe GEO low eff - default
System 4: Heat Pump Water Source - 2 Pipe Geo higher eff



WaterFurnace

Commercial Solutions Group

The results:

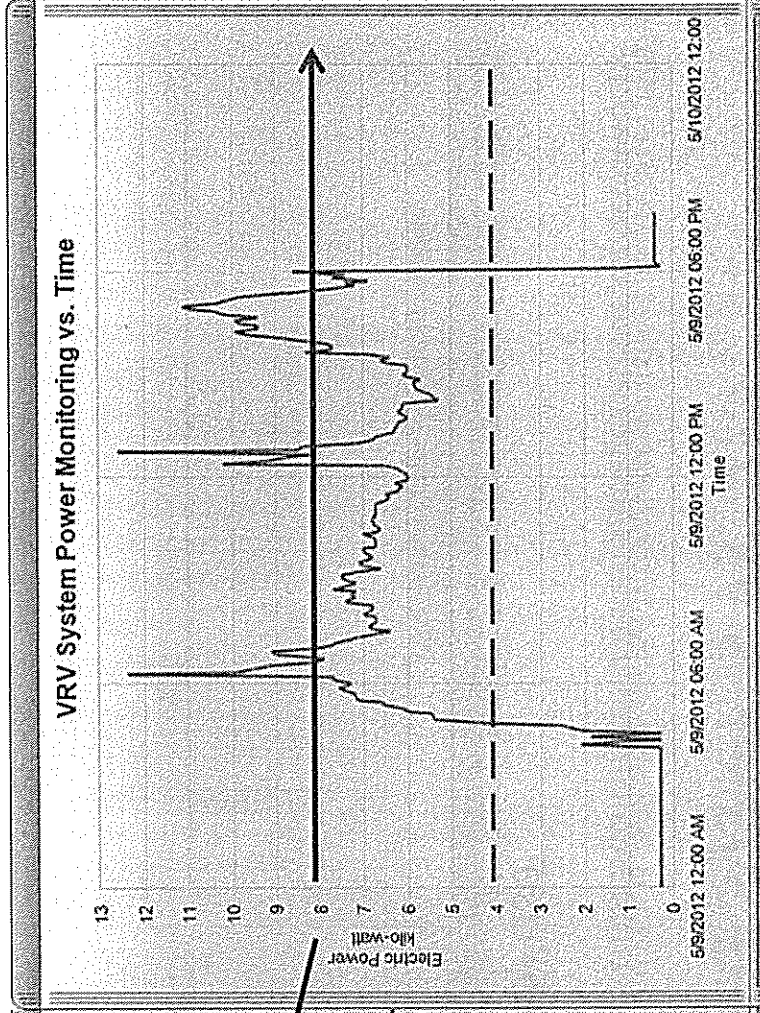
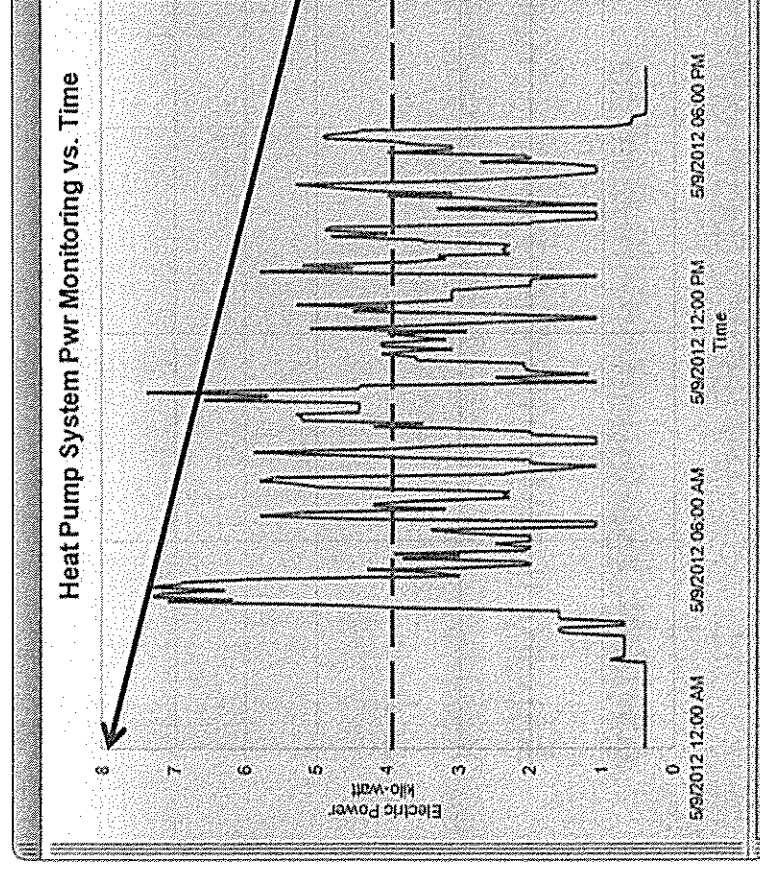
WLHP Enhanced Systems vs. VRF

ASHRAE Headquarters in Atlanta

Live Data Available online

May 9, 2012 Energy Use

<http://images.ashrae.biz/renovation/>



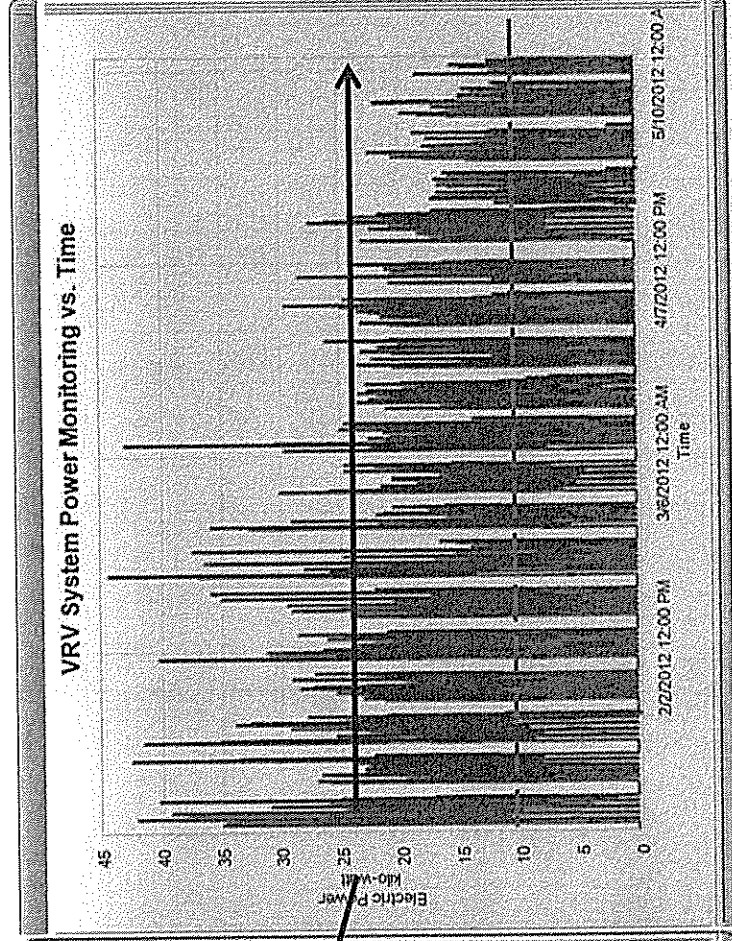
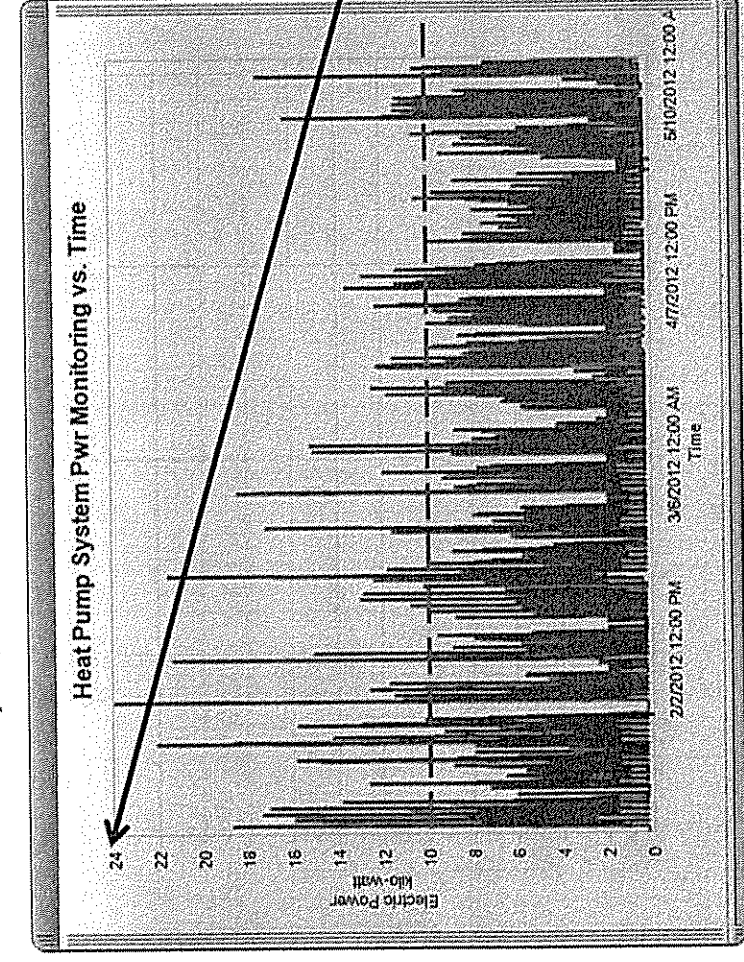
GLHP System Dramatically reduces Daily Peak Load

The results:

WLHP Enhanced Systems vs. VRF

ASHRAE Headquarters in Atlanta Live Data Available online <http://images.ashrae.biz/renovation/>

January 1, 2012 to May 9, 2012 Energy Use



**GLHP System Dramatically reduces Daily Peak Load
AND reduces total annual energy consumption**

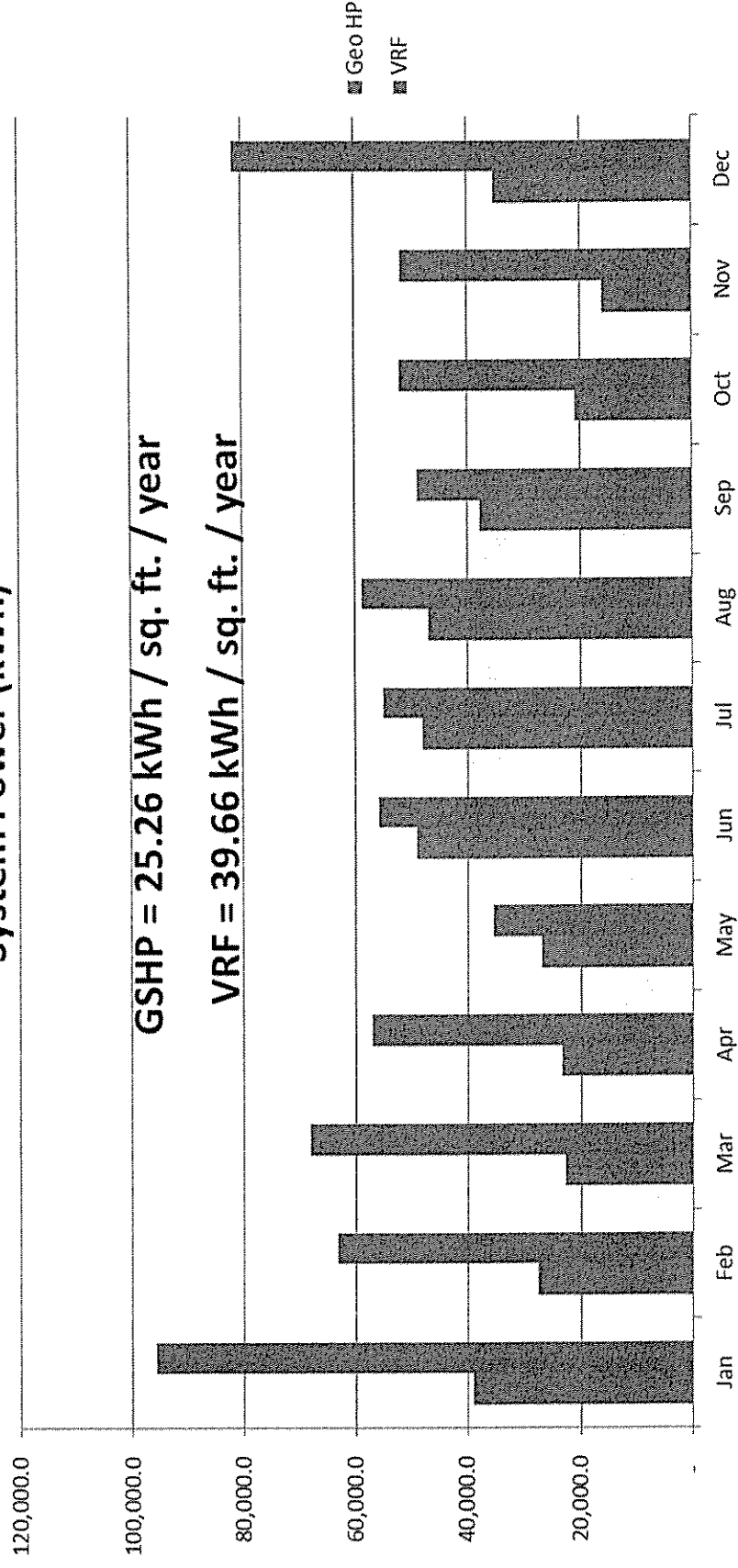
The results:

WLHP Enhanced Systems vs. VRF

ASHRAE Headquarters in Atlanta 2010 HVAC Energy

GLHP vs. VRF

System Power (kWh)



Software – where do you get data

Ground and Loop Information

Building and Heat Pump Information

Borehole Design Project - FCB

Results | Fluid | Soil | U-Tube | Pattern | Extra kW | Information

Calculate | Monthly Data

	COOLING	HEATING
Total Length (ft):	35510.1	46040.6
Borehole Number:	150	150
Borehole Length (ft):	236.7	306.9
Ground Temperature Change (°F):	+0.0	+0.0
Unit Inlet (°F):	90.0	40.0
Unit Outlet (°F):	99.7	33.9
Total Unit Capacity (kBtu/hr):	3369.0	2780.7
Peak Load (kBtu/hr):	2950.4	2780.7
Peak Demand (kW):	182.3	196.0
Heat Pump EER/COP:	16.2	4.2
System EER/COP:	16.2	4.2
System Flow Rate (gpm):	737.6	695.2

Optional Cooling Tower/Boiler

	Cooling Tower	Boiler	Load Balance
Condenser Capacity (kBtu/hr):	0.0	0.0	0 %
Cooling Tower Flow Rate (gpm):	0.0	9.6	0 %
Cooling Range (°F):	0	0	0 %
Annual Operating Hours (hr/yr):	0.0	0.0	0 %
Boiler Capacity (kBtu/hr):	0.0	0.0	0 %

Average Block Loads - FCB

Reference Label: FCB.zon

Design Day Loads

7.0 Days/Week	Time of Day	Heat Gains (kBtu/hr)	Heat Losses (kBtu/hr)
Transfer	8 a.m. - Noon	70.1	2780.7
Calculate Hours	Noon - 4 p.m.	2950.4	62.3
Monthly Loads	4 p.m. - 8 p.m.	70.1	62.3
	8 p.m. - 8 a.m.	70.1	62.3
Annual Equivalent Full Load Hours:		504	822

Heat Pump Specifications at Design Temperature and Flow Rate

Custom Pump Pump Name NS 036

	Cooling	Heating
Capacity (kBtu/hr)	3369.0	2780.7
Power (kW)	208.14	195.97
EER/COP	16.2	4.2
Flow Rate (gpm)	737.6	695.2
Partial Load Factor	0.88	1.00

Flow Rate: 3.0 gpm/ton Unit Inlet (°F): 90.0 40.0

Geo as far back as the 50's, growth in the 70's, closed loop in the 80's

Geothermal Water-Source Heat Pumps

Formation Thermal Conductivity Test Report

Date March 7-9, 2005
Location Mesquite, NV

Borehole Data

Undisturbed Soil Temperature Approx. 73-76°F
Borehole Diameter 5 inches

Drill Log

S gravel, trace sandy clay	0'-50'
S-M gravel, trace clay, some cobbles	50'-60'
S-L gravel, trace sandy clay	60'-80'
M-L gravel, trace sandy clay, cobbles	80'-120'
S-L gravel, trace sandy clay	120'-130'
60% coarse sand, 35% L chips, 5% sand	130'-140'
50% coarse sand, 40% fine sand, 10% S-M gravel	140'-150'
70% S-M gravel, 20% sandy clay, 10% sand	150'-160'
60% sandy clay, 40% S-M gravel	160'-200'
70% loose sand, 30% S gravel and coarse sand, trace clay	200'-210'
60% sandy clay, 40% S-M gravel	210'-240'
50% loose sand, 40% coarse sand, 10% S-M gravel	240'-250'
70% S-M gravel, 30% sandy clay	250'-280'
80% S-M gravel, 20% sandy clay	280'-300'
60% sand, 40% S-M gravel	300'-310'
S gravel, coarse sand	310'-320'
70% S-M gravel, 30% sandy clay, trace clay	320'-340'
80% S-M gravel, 20% sandy clay	340'-360'
70% sand, 30% S-M gravel	360'-370'
80% S-M gravel, 20% sandy clay	370'-380'
50% coarse sand and S gravel, 50% sandy clay	380'-415'

U-bend Size 1 1/4 inch HDPE
U-Bend Length 404 ft
Grout Type GeoPro TGL88
Grout Solids 63%
Grouted Portion 0 - 250 ft

Test Data

Test Duration 42.0 hrs.
Average Voltage 239.8 V
Average Power 6,081 W
Total Heat Input Rate 20,753 Btu/hr
Calculated Circulator Flow Rate 7.7 gpm

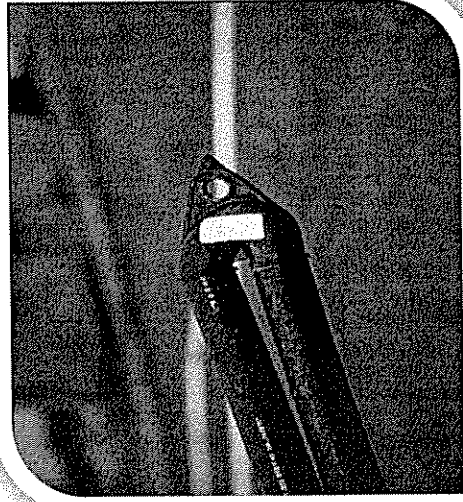
**Drillers Need to Know
to bid competitively**

Geothermal Water-Source Heat Pumps

Who pays for test? The owner – how? There are options

**HDPE Pipe with U-
Bend Assembly (below)**

**Vertical Well with Pipe
Installed (right - not grouted)**



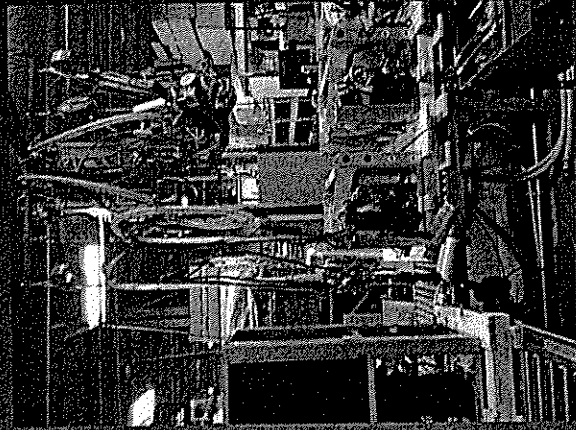
What if TC test shows loop field needs to change?

Why WSHP is favorable

- Water-cooled compressor
- No Part load efficiency loss – actually improves
 - On/off or Part load units
 - Cooling tower is central economizer
 - GeoExchange is renewable
 - Manage the loop for efficiency - Hybrids
- Heat Transfer by design
- The lowest operating cost for the Budget

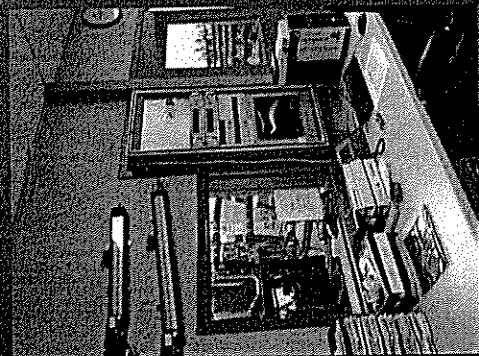


Thank you



Water-Furnace.

WATER-FURNACE CORPORATION



**THE COUNCIL
THE CITY OF NEW YORK**

Appearance Card

I intend to appear and speak on Int. No. geothermal Res. No. _____

☒ in favor ☐ in opposition

Date: 6/11/12

Name: Rich Bell (PLEASE PRINT)

Address: 536 La Guardia Pl., NYC

I represent: American Institute of Architects

Address: 536 La Guardia Pl., NYC

**THE COUNCIL
THE CITY OF NEW YORK**

Appearance Card

I intend to appear and speak on Int. No. 694 Res. No. _____

☒ in favor ☐ in opposition

Date: 6/11

Name: TEAGUE O'BRIEN (PLEASE PRINT)

Address: _____

I represent: Plumbing Foundation

Address: 44 West 58th St NY NY 10001

**THE COUNCIL
THE CITY OF NEW YORK**

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☒ in favor ☐ in opposition

Date: 6/11/12

Name: PAUL ANTHONY COLLINS (PLEASE PRINT)

Address: 15 W 26th St

I represent: P.A. COLLINS PE

Address: 15 W 26th St NY 10

Please complete this card and return to the Sergeant-at-Arms.

**THE COUNCIL
THE CITY OF NEW YORK**

Appearance Card

I intend to appear and speak on Int. No. _____ Res. No. _____

☐ in favor ☐ in opposition

Date: _____

(PLEASE PRINT)

Name: RICK BOSTIAN

Address: OKLAHOMA CITY, OK

I represent: WATER FURNACE

Address: FORT WAYNE, IN

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THE CITY OF NEW YORK**

Appearance Card

I intend to appear and speak on Int. No. 694 Res. No. _____

☒ in favor ☐ in opposition

Date: 6-11-2012

(PLEASE PRINT)

Name: JOHN A. DIENHART

Address: 517 PHILMAN COURT SUITE A GARYFIELD NJ

I represent: Geothermal National & International INITIATIVE

Address: same as above

Please complete this card and return to the Sergeant-at-Arms

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THE CITY OF NEW YORK**

Appearance Card

I intend to appear and speak on Int. No. 694 Res. No. _____

☒ in favor ☐ in opposition

Date: 6-11-12

(PLEASE PRINT)

Name: John Rhiner

Address: 630 Johnson Avenue

I represent: P.W. Grosser Consulting

Address: 630 Johnson Ave., Bohemia, N.Y.

◆ Please complete this card and return to the Sergeant-at-Arms ◆

**THE COUNCIL
THE CITY OF NEW YORK**

Appearance Card

I intend to appear and speak on Int. No. 694 Res. No. _____

☒ in favor ☐ in opposition

Date: 6-11-12

(PLEASE PRINT)

Name: Paul Bony

Address: 12689 61st Rd Montrose Co.

I represent: Clinate Mgrs

Address: 7300 SW 44th ST Odessa City FL

◆ Please complete this card and return to the Sergeant-at-Arms ◆